WATER QUALITY GUIDELINE SERIES

Copper Water Quality Guideline for the Protection of Freshwater Aquatic Life
BC BLM User's Manual

Ministry of Environment and Climate Change Strategy

Water Protection & Sustainability Branch

BRITISH COLUMBIA

No.WQG-03-2

The Water Quality Guideline Series is a collection of British Columbia (B.C.) Ministry of Environment and Climate Change Strategy water quality guidelines. Water quality guidelines are developed to protect a variety of water values and usages: aquatic life, drinking water sources, recreation, livestock, irrigation, and wildlife. The Water Quality Guideline Series focuses on publishing water quality guideline technical reports and guideline summaries using the best available science to aid in the management of B.C.'s water resources. For additional information on B.C.'s approved water quality parameter specific guidelines, visit: Approved Water Quality Guidelines.

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Location: Quesnel Lake, B.C.

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1. INTRODUCTION

The British Columbia (B.C.) Ministry of Environment and Climate Change Strategy (ENV) Biotic Ligand Model (BC BLM) software (Version 1.11) automates the calculation of short-term acute and long-term chronic water quality guidelines (WQG) for copper (Cu) for the protection of aquatic life. A full technical description of the toxicity data set and derivation procedure can be found in the Copper Water Quality Guideline for the Protection of Freshwater Aquatic Life-Technical Report[1] document. The software uses two separate toxicity databases for chronic and acute Cu exposures for a diverse mixture of aquatic organisms, including plants, invertebrates, fish, and amphibians. The BC BLM software is used to normalize the toxicity database to site-specific water chemistry, which allows for consideration of the effects of certain water quality parameters on bioavailability. The BC BLM software requires the input of site-specific water quality information to calculate guideline values. The user can choose to run either the full BLM model that requires 11 input parameters or the simplified model that requires 4 input parameters and estimates the others.

The BC BLM[2] software is based on the BLM software created by Windward Environmental (version 3.40.2.45). Note that BLM data files created using the older version of the BLM Windows® Interface can be used directly with BC BLM.

This document describes the requirements for running the BC BLM software, details the data requirements, and provides a step-by-step guide to using the various features using an example BLM data file.

2. SETUP AND INSTALLATION

2.1. SYSTEM REQUIREMENTS

The BC BLM software is designed for use with Microsoft Windows®. The minimum requirements and the recommended system configurations are described below.

- Minimum system requirements
  - ✓ PC-compatible, Intel Pentium 233 MHz
  - ✓ Microsoft Windows® 95/98/2000/ME/XP/Vista/Win7
  - ✓ 32 MB RAM
  - ✓ 30 MB free disk space
- Recommended system configuration
  - ✓ Intel Pentium 3,500 MHz
  - ✓ 64 MB RAM
  - ✓ 100 MB free disk space

Even though the BC BLM software can be run on a system with the specified minimum requirements, the recommended system configuration or faster is recommended to minimize computation time.

2.2. INSTALLING THE BC BLM SOFTWARE

Install the BC BLM software from the setup file "bc_blm_setup.exe" and follow the prompts. The setup program will guide the user through a straightforward installation process, querying the user for information on where to install the necessary files (Figure 2.1). During the installation, a shortcut to the BC BLM application will be added to the 'Programs' sub-menu within the 'Start' menu on the Microsoft

[1] Available at: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/copper/bc_copper_wqg_aquatic_life_technical_report.pdf

[2] Available at: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/copper/bc_blm_setup.exe

Windows® desktop. In addition, the BC BLM application will also be registered in the system registry so that the BLM data files created by the user can be accessed directly by just double-clicking on the file name.

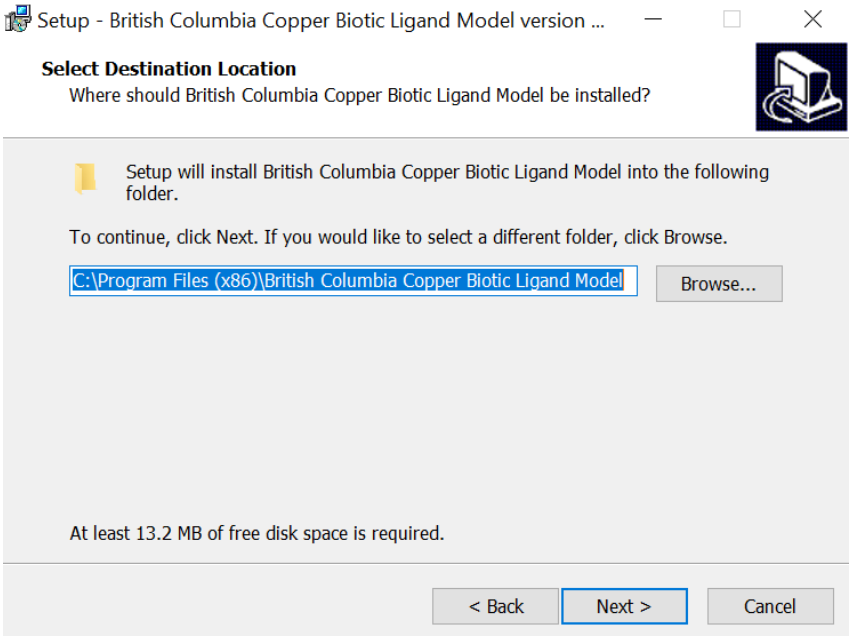


Figure 2.1. Installation directory screen for the BC BLM software setup program.

3. STARTING THE APPLICATION

To start the BC BLM, select 'Start -----> Programs -----> British Columbia Copper Biotic Ligand Model -----> British Columbia Copper Biotic Ligand Model' on the Microsoft Windows® desktop. The user will be presented with the screen shown in Figure 3.1., which contains the user input areas and the various functions of the BC BLM.

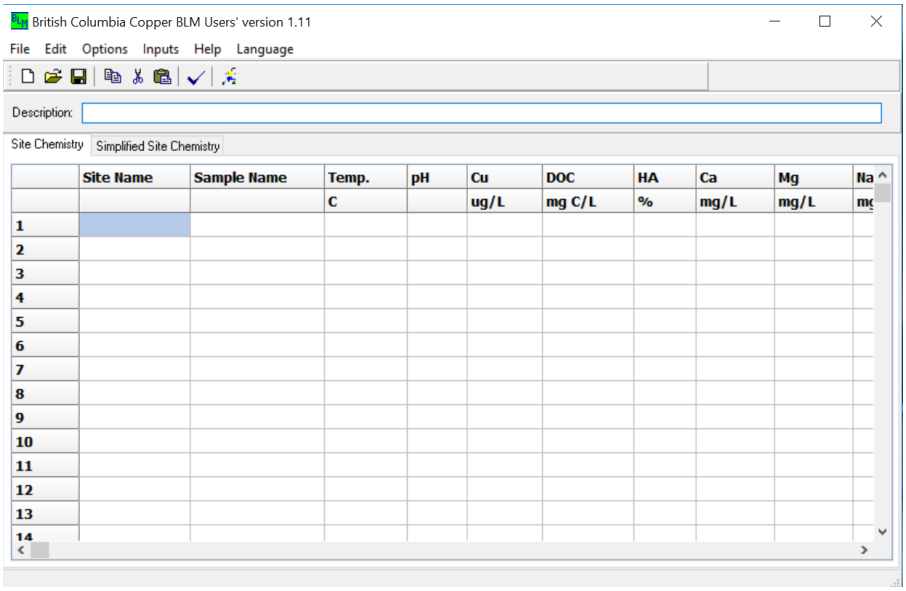


Figure 3.1. Opening screen for the BC BLM application.

Existing BLM data files created using other versions of the BLM Windows® Interface can be opened directly by double-clicking on the file name through a file system manager, such as Microsoft Windows® Explorer.

4. RUNNING THE APPLICATION

The following subsections describe the various functions and features available in the BC BLM Windows® Interface and its various predictive capabilities.

4.1. Quick Start Guide

Steps 1-7 provide an overview of the user's manual for quick application of the BC BLM. More details are provided in the following subsections.

Step 1: Enter water chemistry data or upload a saved '.blm' or '.blme' file (see sections 4.6 and 4.3.1);

Step 2: Save file on the desired destination on your computer (see Section 4.3.1);

Step 3: Select chronic/acute database (see Section 4.3.4);

Step 4: Select quick normalization if >3 sites are being run to improve run times (see Section 4.3.3.);

Step 5: Select run (see Section 4.4.4);

Step 6: Open the output directory suggested by the software (see Section 4.4.4);

Step 7: Obtain the acute/chronic WQG from the '.txt' file produced by the software (see Section 6).

4.2. Description of Interface

Figure 4.1 shows the BC BLM application. The interface provides an easy-to-use editor to construct input files for the BC BLM containing site-specific water chemistry data, checks and validates user input data to ensure the values entered for any given parameter are within the range for which the BC BLM has been calibrated, and runs the BC BLM to calculate WQGs. The interface window is divided into four areas based on their functionality. Each of these is described in the following subsections.

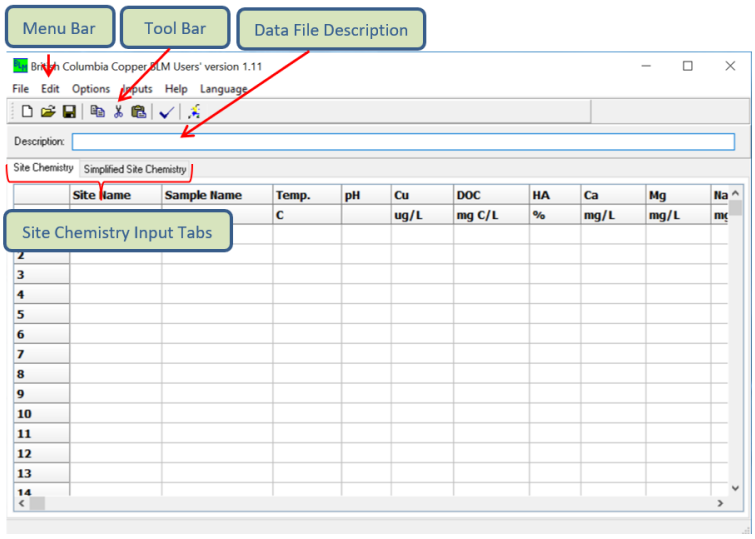


Figure 4.1. Opening screen for the BC BLM application.

4.3. Menu Bar

The Menu Bar located at the top of the interface window provides the user with a range of functions and features described in the following sections.

4.3.1. File

The *File* menu (Figure 4.2) includes basic file management utilities to: create a new BLM data file (*New*); open an existing BLM data file (*Open…*); save a BLM data file (*Save*); and save a BLM data file under a different name or in a new location (*Save as…*). Shortcut keys (shown to the right of each item) are also available for the different functions in this menu item. Note that the BC BLM data files created by the interface application are given a '.blm' or 'blme' extension for full or simplified chemistry, respectively. Clicking the 'Open' icon while in the full or simplified site chemistry tabs will filter for files with the extension of '.blm' or '.blme', respectively.

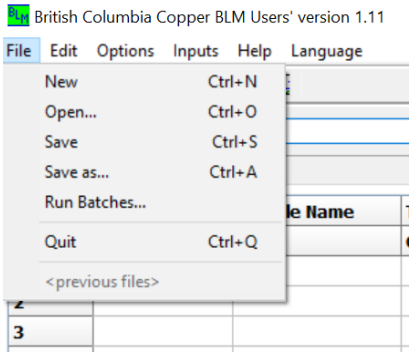


Figure 4.2. Snapshot of "File" menu item.

BLM data files can also be opened directly by double-clicking on the BLM data file in a file system manager, such as Microsoft Windows® Explorer. This avoids having to first start the application and then navigate through the file menu to locate the BLM data file of interest.

The *Run Batches…*function can be used to run several input files simultaneously.

The *Quit* function can be used to quit BC BLM application.

4.3.2. Edit

The *Edit* menu provides basic editing functions such as *Copy*, *Cut*, and *Paste* (Figure 4.3). These functions can be performed on a single cell or multiple cells by highlighting the cell with the cursor (left click and drag) or by using the Shift + Arrow functions on the keyboard. The editing functions can also be applied using the shortcut keys shown to the right of each function. Note that it is also possible to copy and paste data from external programs, such as spreadsheet applications, into the BC BLM.

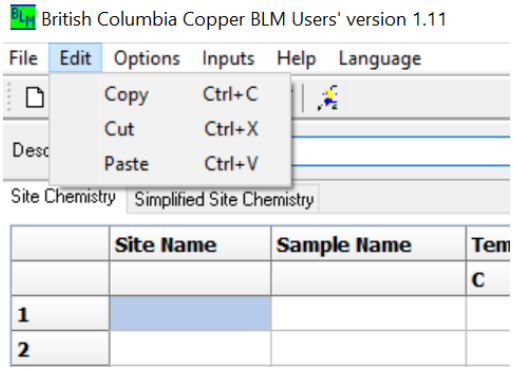


Figure 4.3. Snapshot of *Edit* menu item.

4.3.3. Options

Figure 4.4 shows the functions available under the *Options* menu.

Quick Normalization

The chronic and acute databases used to calculate WQGs in the BC BLM consist of 319 and 730 data points, respectively. The WQG calculation process may take a long time, particularly if several water chemistry scenarios are running at the same time. Thus, a *Quick Normalization* feature is provided under the *Options* menu which normalizes data for only the most sensitive species, rather than the whole database. The application of this feature reduces the run time significantly. However, less information will be provided by using this feature. The normal run can be used when more information is needed for individual sites.

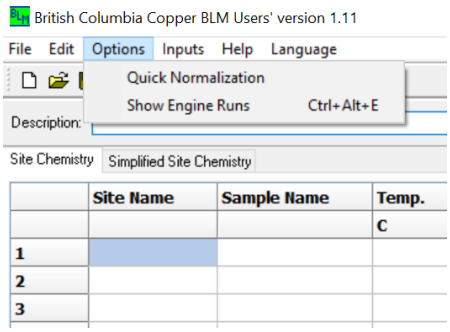


Figure 4.4. Snapshot of *Options* menu item.

Show Engine Runs

The run may take up to an hour when running several sites simultaneously, depending upon the computing power available. In these cases, it is recommended to select the *Show Engine Runs* option to show the software's progress allowing the user to ensure the software is working properly.

4.3.4. Inputs

Figure 4.5 shows the options available under the *Inputs* menu. The units for all parameters can be changed by selecting the *Set Units* function. For each component, the available units are displayed in the *Select Units* menu to the right. The Dissolved Inorganic Carbon (DIC) concentration is needed to run BC BLM. DIC can be calculated from alkalinity and since alkalinity is a more routinely measured, BC BLM requests for alkalinity data by default. However, the *Set Inorganic Carbon* function allows the user to input DIC instead of alkalinity in case of availability. If neither of measured DIC or Alkalinity data is available, DIC can be estimated from atmospheric CO_2.

Database Option allows the user to specify the calculation of either acute or chronic WQGs.

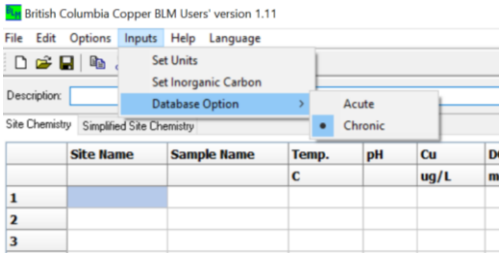


Figure 4.5. Snapshot of *Inputs* menu item.

4.3.5. *Help*

The User's Guide for the BC BLM can be accessed under the *Help* menu item (Figure 4.6). The *About BLM* option provides contact information for technical support. The *Create Debug Log* can be used to directly contact the developers of BC BLM (Windward Environmental) if the user faces a problem while working BC BLM.

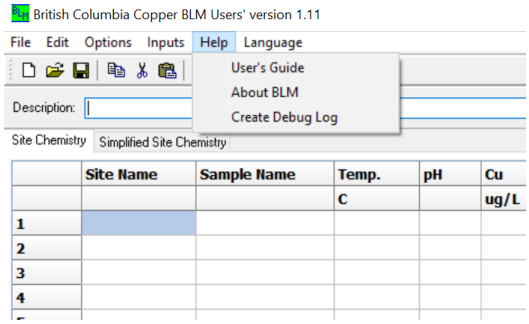


Figure 4.6. Snapshot of *Help* menu item.

4.3.6. *Language*

The user can select either English or French from the *Language* menu item.

4.4. Tool Bar

The *Tool Bar* provides shortcuts to some BC BLM functions (Figure 4.7).

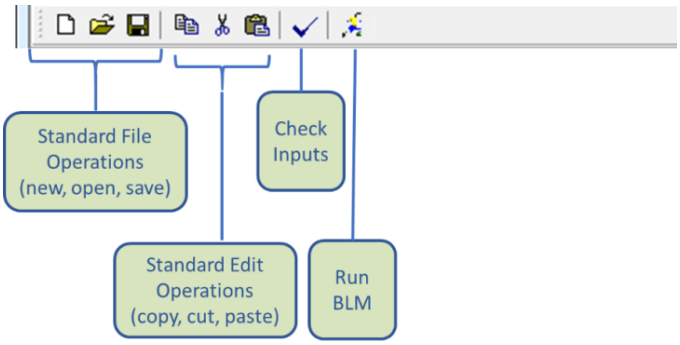


Figure 4.7. *Tool Bar* menu icons.

4.4.1. *Standard File Operations*

New File: this shortcut allows the user to create a new file for water chemistry input (Section 4.3.1).

Open File: this shortcut provides quick access to the BC BLM data files (Section 4.3.1). If the BC BLM data file being edited has changed since the last time it was saved and the user tries to open another file, the user will be asked if the current data file should be saved prior to opening another.

Save File: this shortcut allows quick saving of the BC BLM data file (Section 4.3.1). The data file will be saved with the same, existing name. If the user wishes to save the file under a different file name, the menu bar item *File* → *Save As* should be chosen.

4.4.2. Standard Edit Operations

Shortcuts for basic editing functions such as *Copy*, *Cut*, and *Paste* are provided and can be used to edit the water chemistry data at any point (Section 4.3.2).

4.4.3. Check Inputs

The range of parameter values used to develop and calibrate the BC BLM are listed in Table 4.1. These ranges were taken from chronic and acute toxicity studies that considered the effects of water chemistry (e.g., pH, DOC, or hardness cations) on Cu bioavailability. The BC BLM is only valid within these data ranges. After creating a BC BLM data file, the user may wish to check the water chemistry inputs to verify whether the parameter values are within the overall range for which the BC BLM has been calibrated, and to see whether data for all the parameters necessary for a BC BLM prediction have been specified. Clicking on this icon generates an input check report that contains information on which parameters are out of range (i.e., too high or too low when compared with the range for which the BC BLM has been calibrated) and which parameters are missing for any given input row. Figure 4.8 shows an example of an input check report.

If water quality input values are greater or less than these ranges, the BC BLM software automatically applies the upper or lower bounds while calculating WQGs.

Table 4.1. Ranges of values for BLM input parameters.

Parameter	Lower Bound	Upper Bound
Temperature (^{o}C)	5.5	27
pH	4.7	9.0
DOC (mg/L)	0.05	20
Humic acid content (%)	0.01	99
Calcium (mg/L)	2.2	72.94
Magnesium (mg/L)	0.48	18.4
Sodium (mg/L)	0.86	70.97
Potassium (mg/L)	0.59	156
Sulfate (mg/L)	0.5	1320
Chloride (mg/L)	0.2	119.8
Alkalinity (mg/L)	3	160
Hardness (mg/L)	7.8	236.8

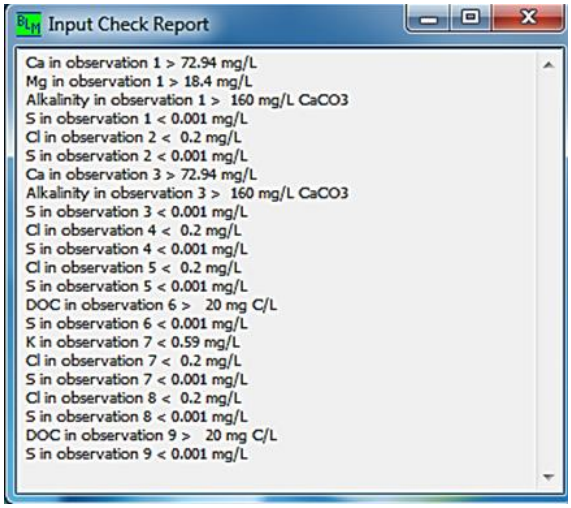


Figure 4.8. Example of an "Input Check Report" generated by the *Check Inputs* function.

4.4.4. Run BLM

The *Run BLM* icon is used to launch the BC BLM program to calculate WQGs for the user-specified water chemistry in the data file currently open. If the data file has unsaved changes, the user is given the option of saving the changes prior to running the BC BLM. The program will use either the chronic or acute database, depending on which database was selected from the *Inputs Menu* (see Section 4.3.4), and calculates the WQG for each row in the database. The runtime for BC BLM calculations can vary from a few seconds to a few hours depending on the number of input rows in the data file and the database selected (chronic or acute). Selecting the *Quick Normalization* option will reduce the run time considerably (see Section 4.3.3). Upon completion, the user is informed of the names and the locations of the output files, and given the option to open the directory, as shown in Figure 4.9.

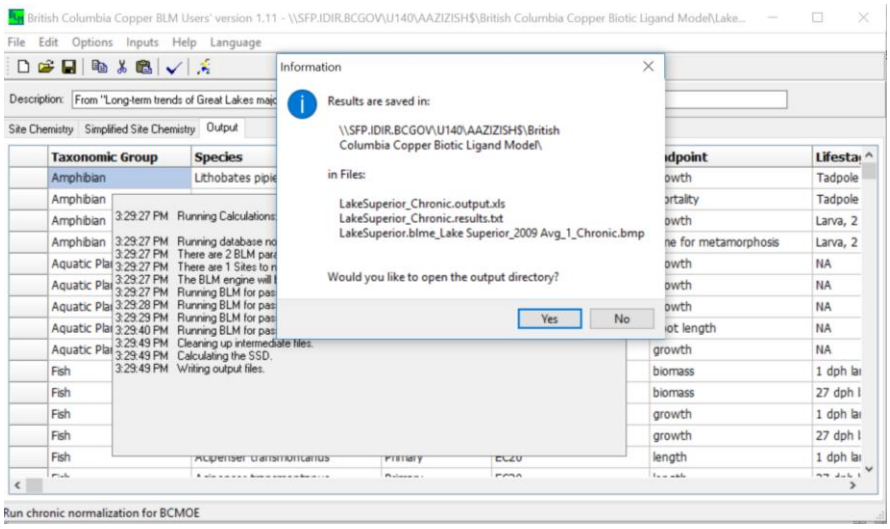


Figure 4.9. Example of the notification window shown at completion of BC BLM run.

4.5. Data File Description

The *Data File Description* field (Figure 4.10) allows the user to insert comments describing the BC BLM data file which will be saved with the water chemistry data entered by the user. Although this function is

not critical to the function of the BC BLM, it is useful for record-keeping and quality assurance/quality control purposes.

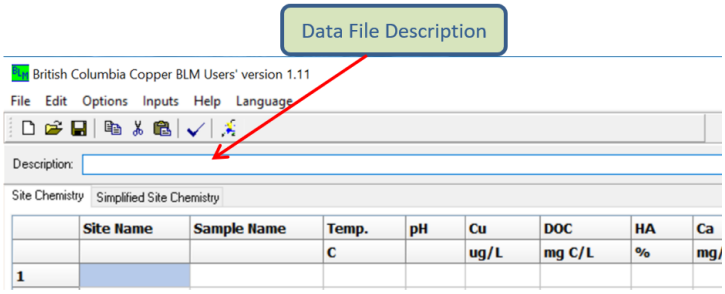


Figure 4.10. Snapshot of BC BLM application

Item Description

Located at the very bottom of the interface window, this area displays a brief description of the feature over which the cursor is currently positioned.

4.6. Site Chemistry Input Tabs

There are two options for entering the water chemistry data depending on the parameters available: *Site Chemistry* (i.e., full site chemistry) and *Simplified Site Chemistry*.

4.6.1. Site Chemistry

This region of the interface window contains a spreadsheet-based editor, which organizes the various BC BLM input data in a columnar format such that the chemistry for each discrete water sample can be specified in a separate row. Two additional columns are provided for labeling the sites and samples in a given BC BLM data file. Figure 4.11 shows the columns available for user input.

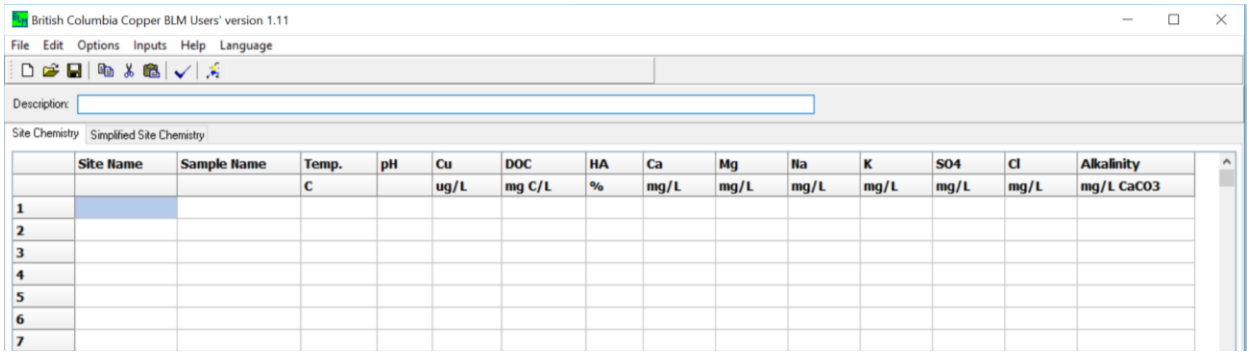


Figure 4.11. Columns for data input in the BC BLM.

The BC BLM predicts Cu toxicity in aquatic systems and calculates WQGs for a site based on the ambient water chemistry. The user is required to provide data describing the physical and chemical properties of the site water. The data requirements of the BLM are conventional physical and chemical parameters that are listed in Table 4.2. Some of these parameters have an important effect on BC BLM predictions, while others have only minor effects.

Table 4.2. Water chemistry factors necessary to run the BC BLM, their unit and relative importance in calculation of WQGs.

Factor	Unit	Importance
Temperature	°C	Low
pH	NA	High
Dissolved organic carbon (DOC)	mg/L	High
Humic acid fraction of DOC	%	Low
Calcium	mg/L	High
Magnesium	mg/L	High
Sodium	mg/L	High
Potassium	mg/L	Low
Sulfate	mg/L	Low
Chloride	mg/L	Low
Alkalinity	mg/L	High

Copper concentrations are not required for the model to calculate WQGs, however, this field is retained to allow compatibility with other BLM versions. Copper concentrations entered will not affect the WQG calculations but are included in the output text file for comparison with the WQG. The input file for the BC BLM is compatible with other BLM software versions, such as the US EPA BLM.

4.6.2. Simplified Site Chemistry

The *Simplified Site Chemistry* tab provides an option when all the water chemistry factors are not available. It differs from the *Site Chemistry* tab in that it only requires data for temperature, pH, DOC and hardness (mg/L as $CaCO_3$) to run the BC BLM. Selecting the *Simplified Site Chemistry* tab provides a simpler site chemistry data input spreadsheet (Figure 4.12).

Additionally, there is a side bar where the ion ratios can be set. The ion ratios will vary depending on watershed geology. The default values provided are the median ion ratios for B.C. and can be used if the ratios are unknown. These values can be changed to match the conditions of the site or test and can be reset to the default values at any time by clicking the *Restore Default Values* button at the bottom of the box. The *Select Ion Ratios…* button allows the user to select default ion ratios for other regions of North America. Note that this is not recommended for calculating WQGs in B.C.; this option is included only to make the BC BLM compatible with other versions of BLM Windows® Interface.

After the simplified site chemistry data has been entered, the BC BLM estimates the missing water chemistry information while calculating WQGs.

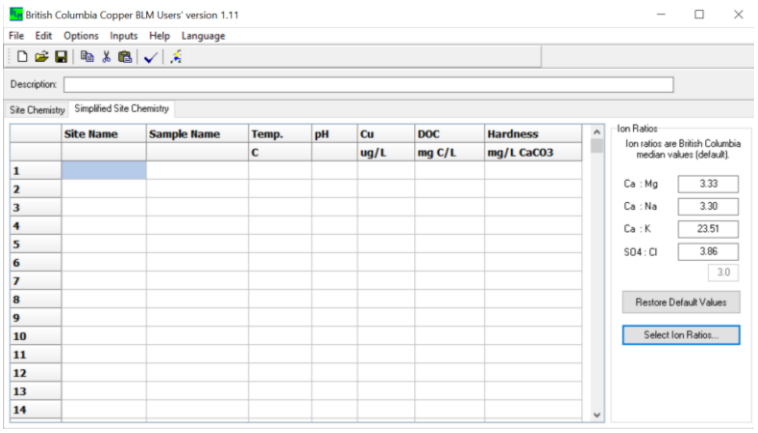


Figure 4.12. Snapshot of *Simplified Site Chemistry* inputs and ion ratios.

When enough water chemistry data for the simplified option are available (e.g., major ions), but insufficient for the full BC BLM, the following steps should be taken:

- Enter the parameters in the S*implified Site Chemistry* tab;
- Switch to the full *Site Chemistry* tab and replace the estimates for parameters with the available measured values;
- If alkalinity data are available, the *Set Inorganic Carbon* option should be selected from the *Inputs* menu and then *Closed System, Input Alkalinity* should be selected (Figure 4.13). An additional column for alkalinity will appear and the data are entered there.

Note that if you switch back to the *Simplified Site Chemistry* tab without saving the data, the water chemistry data will be deleted.

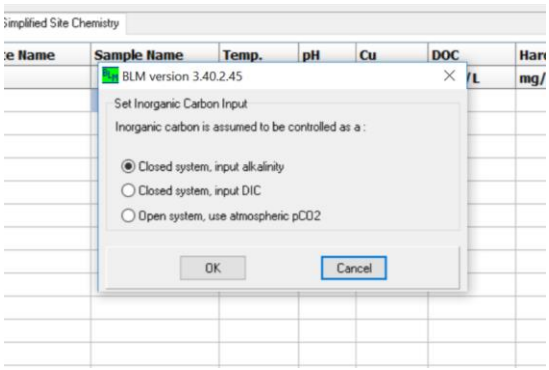


Figure 4.13. Snapshot of *Set Inorganic Carbon* menu item.

5. EXAMPLE APPLICATION

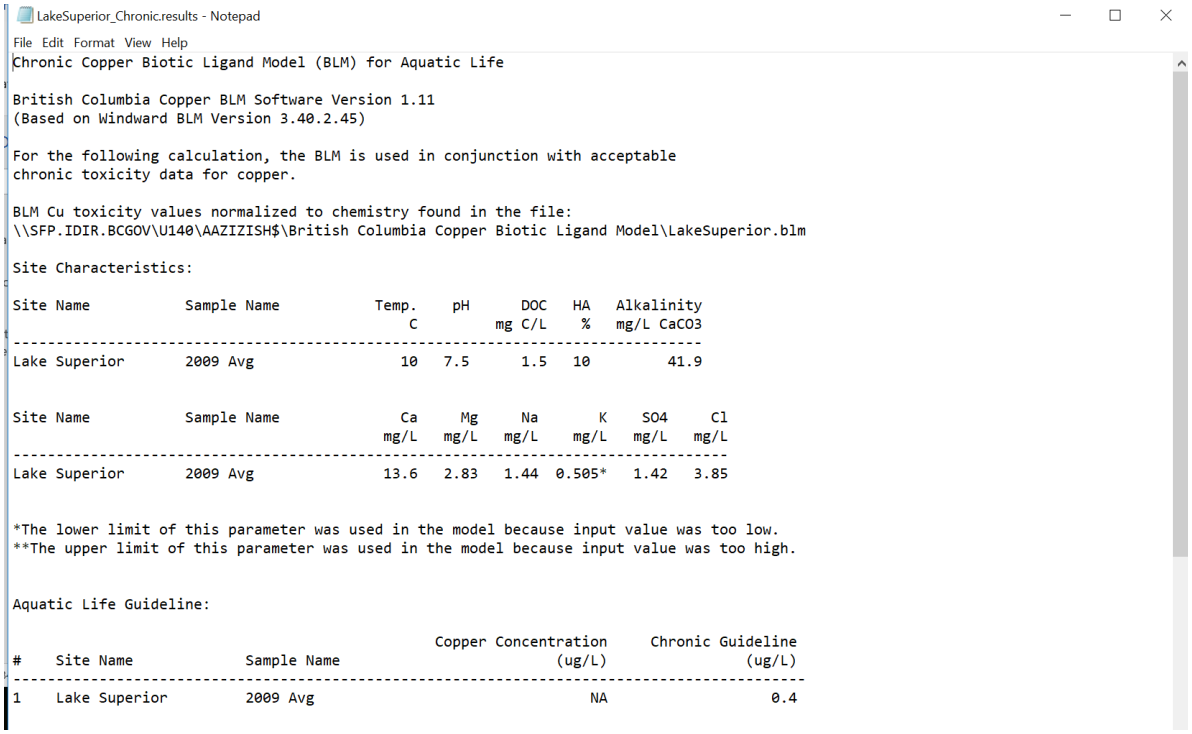
The BC BLM features an example application for demonstration purposes. This file, named 'Lake Superior.blm,' is installed along with the BC BLM and is in the "My Documents → British Columbia Copper Biotic Ligand Model" folder. The file can be opened directly, by double-clicking on the file name through a file-system manager such as Microsoft Windows® Explorer or by first starting the BC BLM and selecting the file through the 'File → Open' action. This data file 'Lake Superior.blm' can be used to calculate a Cu WQG example produced by the BC BLM.

6. DESCRIPTION OF OUTPUT FILES

The contents of the output files will appear in an *Output* tab in the BC BLM User Interface once the model has finished running. The main output is written to a text file and saved to the same location as the input file, with the same name as the input file but with '.results' appended (Figure 4.14). For example, using the input file 'LakeSuperior.blm' would create an output file titled 'LakeSuperior_Chronic.results.txt' or 'LakeSuperior_Acute.results.txt' depending on the selection of *Acute* or *Chronic* databases (see Section 4.3.4). The output file includes the site chemistry used, and the WQG value calculated for each site.

In addition, a bitmap image is produced for each site that illustrates the effect concentrations for the different species in the toxicity database, normalized to the specified site chemistry (Figure 4.15). Lines on the graphic indicate the "Minimum Low Effect Threshold Value" (i.e., most sensitive endpoint) and the "Guideline Value" calculated from it. The bitmap file will not be produced in the "Quick Normalization" mode.

A Microsoft Excel® file will also be produced that shows the values associated with the points in this graphic, and the species, life stage, endpoint, and endpoint quantifiers associated with each point (Figure 4.16).



LakeSuperior_Chronic.results - Notepad

File Edit Format View Help

```
Chronic Copper Biotic Ligand Model (BLM) for Aquatic Life

British Columbia Copper BLM Software Version 1.11
(Based on Windward BLM Version 3.40.2.45)

For the following calculation, the BLM is used in conjunction with acceptable
chronic toxicity data for copper.

BLM Cu toxicity values normalized to chemistry found in the file:
\\SFP.IDIR.BCGOV\U140\AAZIZISH$\British Columbia Copper Biotic Ligand Model\LakeSuperior.blm

Site Characteristics:

Site Name           Sample Name           Temp.    pH      DOC   HA   Alkalinity
                                             C           mg C/L    %   mg/L CaCO3
-------------------------------------------------------------------------------
Lake Superior       2009 Avg                10   7.5      1.5   10         41.9


Site Name           Sample Name             Ca     Mg     Na       K    SO4     Cl
                                           mg/L   mg/L   mg/L    mg/L   mg/L   mg/L
-------------------------------------------------------------------------------
Lake Superior       2009 Avg              13.6   2.83   1.44  0.505*   1.42   3.85


*The lower limit of this parameter was used in the model because input value was too low.
**The upper limit of this parameter was used in the model because input value was too high.


Aquatic Life Guideline:

                                                 Copper Concentration     Chronic Guideline
#    Site Name             Sample Name                       (ug/L)               (ug/L)
-------------------------------------------------------------------------------------------
1    Lake Superior         2009 Avg                             NA                  0.4
```

Figure 6.1. Example of a text file produced by BC BLM.

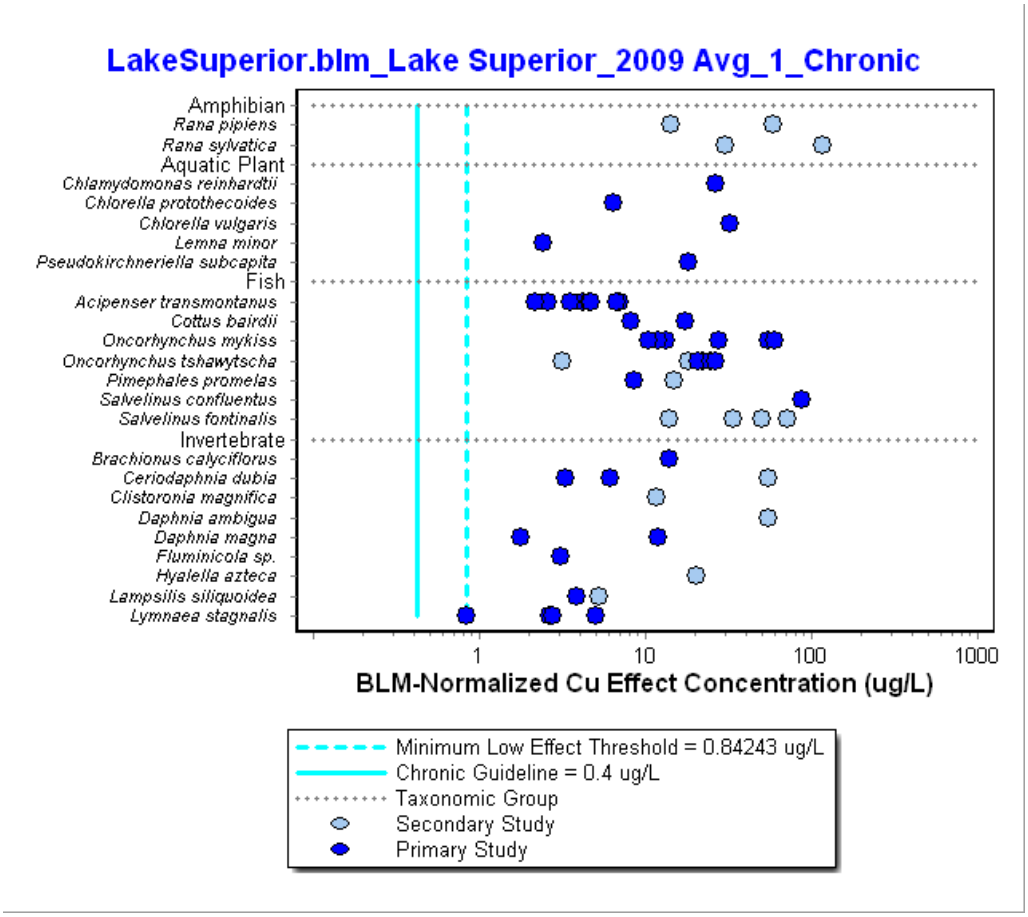
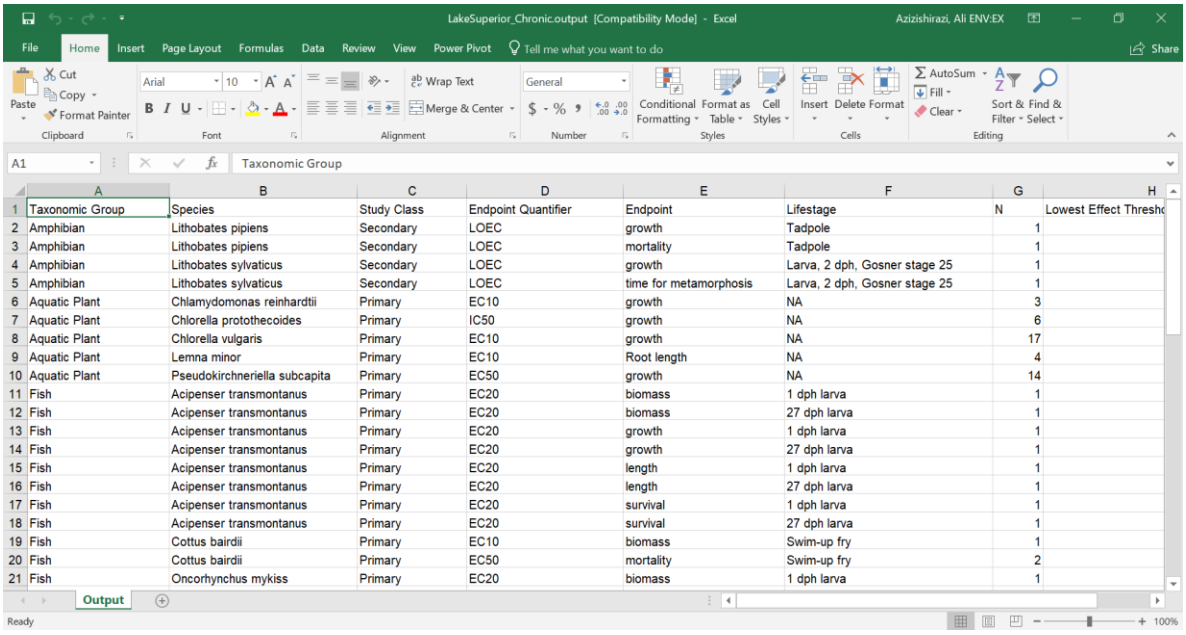


Figure 6.2. Example of the BC BLM graphic output for toxicity thresholds for different species.



	A	B	C	D	E	F	G	H
1	Taxonomic Group	Species	Study Class	Endpoint Quantifier	Endpoint	Lifestage	N	Lowest Effect Thresh
2	Amphibian	Lithobates pipiens	Secondary	LOEC	growth	Tadpole	1	
3	Amphibian	Lithobates pipiens	Secondary	LOEC	mortality	Tadpole	1	
4	Amphibian	Lithobates sylvaticus	Secondary	LOEC	growth	Larva, 2 dph, Gosner stage 25	1	
5	Amphibian	Lithobates sylvaticus	Secondary	LOEC	time for metamorphosis	Larva, 2 dph, Gosner stage 25	1	
6	Aquatic Plant	Chlamydomonas reinhardtii	Primary	EC10	growth	NA	3	
7	Aquatic Plant	Chlorella prototthecoides	Primary	IC50	growth	NA	6	
8	Aquatic Plant	Chlorella vulgaris	Primary	EC10	growth	NA	17	
9	Aquatic Plant	Lemna minor	Primary	EC10	Root length	NA	4	
10	Aquatic Plant	Pseudokirchneriella subcapita	Primary	EC50	growth	NA	14	
11	Fish	Acipenser transmontanus	Primary	EC20	biomass	1 dph larva	1	
12	Fish	Acipenser transmontanus	Primary	EC20	biomass	27 dph larva	1	
13	Fish	Acipenser transmontanus	Primary	EC20	growth	1 dph larva	1	
14	Fish	Acipenser transmontanus	Primary	EC20	growth	27 dph larva	1	
15	Fish	Acipenser transmontanus	Primary	EC20	length	1 dph larva	1	
16	Fish	Acipenser transmontanus	Primary	EC20	length	27 dph larva	1	
17	Fish	Acipenser transmontanus	Primary	EC20	survival	1 dph larva	1	
18	Fish	Acipenser transmontanus	Primary	EC20	survival	27 dph larva	1	
19	Fish	Cottus bairdii	Primary	EC10	biomass	Swim-up fry	1	
20	Fish	Cottus bairdii	Primary	EC50	mortality	Swim-up fry	2	
21	Fish	Oncorhynchus mykiss	Primary	EC20	biomass	1 dph larva	1	

Figure 6.3. Example of the Microsoft Excel® file produced by BC BLM.

7. UNINSTALLING THE BC BLM

To uninstall the BC BLM, select the Uninstall Utility using 'Microsoft Windows® Start Menu → Programs → British Columbia Copper Biotic Ligand Model → Uninstall.' All files installed by the BC BLM during setup will be uninstalled. None of the files created by the user and saved in the BC BLM installation directory will be deleted during this process. These need to be manually deleted by the user, if so desired.