South Platte River Model

Hydrosphere Resource Consultants, Inc. 2001. Hydrosphere South Platte EIS Model, Inc. dated June 8, 2001.

See Wolvington et al. 2001.

South Platte River Model Output and Results

Spreadsheets, reports, and memos that describe various assumptions, projections, and modeling results used to evaluate Platte River Recovery Program alternatives from the perspective of effects on the South Platte River Basin in Colorado.

Wolvington, Roger, Rozaclis, L., and Anderson, Donald. 2001. User's guide for the South Platte River EIS Model (SPREISM), Version 1.0, dated May 21, 2001.

South Platte River Modeling Assumptions and Results

The spreadsheets, reports, and memos listed below describe various assumptions, projections, and modeling results used to evaluate Platte River Recovery Program alternatives from the perspective of effects on the South Platte River Basin in Colorado.

Model Assumptions and Results

Reservoir water leasing scenario:

This spreadsheet illustrates the assumed quantities of Program-leased water provided by each of six reservoirs in the lower South Platte River Basin in Colorado under the Water Emphasis and Full Water Leasing alternatives, modeled over the years 1947-1994. (Quantities were assumed to be the same under both alternatives on the presumption that the additional increment of leased water under the Full Water Leasing alternative would be obtained through the leasing of direct-flow rights). <ColoResWaterLeasing.xls>

Estimated increase in monthly flows:

These spreadsheets show modeled increases in monthly flows (May and June) from 1947 - 1994 at four different locations on the Lower South Platte River in Colorado (Weldona, Cooper, Balzac and Julesburg) as a result of Program water leasing under the Water Emphasis and Full Water Leasing alternatives. <ColoLeasingSPlatteFlows.xls>

Estimated changes in Colorado reservoir volumes and surface areas under the modeled alternatives:

This spreadsheet was used to estimate monthly differences (May – August) in reservoir volumes and surface areas over the modeled period (1947 – 1994) as a consequence of Program water leasing from six reservoirs in the lower South Platte River basin in Colorado. A narrative tab in the spreadsheet ("Notes") describes the procedures applied. <ColoLeasingVolumesAreas.xls>

Supporting Material from Hydrosphere Resource Consultants

Memo, August 21, 2003. "(Draft) Assumptions for First Increment depletions by Colorado"

Provides a summary of assumptions used to "scale down" Hydrosphere's analysis of an estimated 50+ years of water development in the South Platte River Basin of Colorado to correspond to projected First-Increment development (i.e. through approximately year 2020). <memo_2020_increment.pdf>

Memo, July 21, 2003. Draft Hydrosphere Report: “Potential Effects of Colorado’s Future Water Development on Central Platte River Peak Flows.”

A description of Hydrosphere’s assumptions and analysis of projected future water development in Colorado’s South Platte River Basin and its potential effect on peak flows in the South Platte and Platte Rivers in Nebraska. This analysis was used as a starting point to evaluate the likely effect of First-Increment water resources development in Colorado on flow distributions in the central Platte River. For additional description of how this analysis was used, see the South Platte Model Water Resources Appendix. <SPlattePeaksStudyHydrosphere7-21-03.pdf>

Peak Reduction Full Timeseries 2020_121KAF – New PACSM.xls

This spreadsheet accompanies the 7/21/03 draft Hydrosphere Report and 8/21/03 draft memo and contains adjusted historic daily flows in the South Platte River system (1947-1994) to analyze the effects on flows downstream of projected future water development in the South Platte River basin (specifically, expanded reservoir storage for native water, and increased re-use of legally re-usable return flows). This iteration of the spreadsheet included adjustments scaled to fit projected First-Increment (Year 2020) water development in the basin, and to avoid double-counting water development that was already implicitly included in Hydrosphere’s base PACSM modeling. <Peak Reduction Full Timeseries 2020_121KAF – New PACSM.xls>

User's Guide for the South Platte River EIS Model (SPREISM)

Version 1.0

May 29, 2001

Model created by:
Hydrosphere Resource Consultants, Boulder, Colorado

User's Guide prepared by:
Roger Wolvington, Hydrosphere Resource Consultants
Lee Rozaclis, Hydrosphere Resource Consultants
Don Anderson, U.S. Fish and Wildlife Service

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1. INTRODUCTION

1.1 Description and Purpose of the Model

The South Platte River EIS Model (SPREISM) was developed by Hydrosphere Resource Consultants of Boulder, Colorado, for the Platte River EIS Office of the Bureau of Reclamation (Reclamation) for use in the Platte River Programmatic EIS.

The purpose of SPREISM was to provide Reclamation with a tool to use in conjunction with the Central Platte River OPSTUDY and North Platte River Water Utilization models to evaluate the effectiveness of EIS alternatives in meeting flow targets in the Big Bend reach of the Central Platte River in Nebraska. Specifically, SPREISM was designed to estimate South Platte River flows at Julesburg, under current conditions and with various EIS alternatives superimposed upon current conditions, for the Platte River EIS. Output from SPREISM (flows at Julesburg) is used as input to the Central Platte River OPSTUDY model at this location for EIS alternatives analysis. Output from SPREISM is also used to assist in identifying environmental and socioeconomic impacts of EIS alternatives, such as recreational impacts, within the South Platte basin.

The model simulates the operation of the main stem of the South Platte River from Chatfield Reservoir to the Nebraska State line, estimating river flows, diversions, return flows, reservoir releases, and losses associated with evaporation and seepage. The model depicts current water development conditions superimposed upon the 1947-1994 period of hydrologic and climatic record. Historical inflows, diversions, gains and losses over that period were adjusted in the model to reflect current levels of municipal water use, transbasin imports and associated return flows, alluvial well use and recharge projects throughout the modeled period of record. The model was then used to evaluate the operation of South Platte components of EIS alternatives against this "current conditions" baseline.

Several caveats and limitations regarding SPREISM should be noted by the user. These are described in Section 1.2.

SPREISM is one component of the Platte River Endangered Species Partnership. For more information about the Platte River Endangered Species Partnership, please visit the Web site at http://www.platteriver.org.

1.2 Caveats and Limitations

SPREISM is a general model designed to produce results that are suitable for EIS analysis. It is not a detailed water rights model and it does not represent the operations of individual diversion structures, water rights, or augmentation plans. Its representation of existing conditions was derived using a variety of information sources and approximation techniques. SPREISM does not represent actual historical conditions nor does it reflect future water development conditions. It is therefore not suitable for analysis of historical or future operations of the South Platte River. The reader is referred to the SPREISM Technical Appendix and to other technical appendices of the Platte River EIS for important additional caveats and details regarding the South Platte River EIS Model.

1.3 The CRAM Modeling Tool

SPREISM was developed using Hydrosphere's Central Resource Allocation Modeling tool (CRAM). CRAM is a flexible modeling tool that represents a water resource system as a network of interconnected arcs. Arcs can represent inflows, stream segments, diversion and conveyance facilities, water rights, demands, return flows, losses, gains, and reservoirs. Arcs can be given upper and lower bounds and relative ranks. Upper and lower bounds can represent specified amounts of inflows, demands or water rights, physical capacities and operational targets. Tanks represent relative water right or operational priorities. Groups of arcs can be arranged to represent water supply systems and river basins.

The resulting network is solved using a network optimization algorithm known as the out-of-kilter algorithm (OKA). The algorithm allows the model to mathematically simulate the allocation of water under the prior appropriation doctrine. CRAM employs iterative solutions of the network to simulate certain aspects of water management such as water exchanges, reservoir releases to specific needs, return flows, etc. CRAM operates in a Microsoft Windows/Excel environment[1].

1.4 Modeling Approach

Development of SPREISM relied upon three existing point flow studies of the South Platte River. Point flow studies are mass-balance analyses performed on specific river segments defined by stream gages at their upper and lower ends. In each segment, mass-balance calculations are done incorporating all known inflows, outflows and intervening stream flows, including dry points. The residual unknowns represent net gains or losses to the stream segment in a given time step. Gains primarily consist of unmeasured return flows, ungaged tributaries, runoff from local precipitation, and recharge from alluvial aquifers. Losses primarily consist of unrecorded diversions, evaporation, and seepage into aquifers including depletions from alluvial wells.

These three point flow studies were used to intially configure SPREISM to represent the historical operation of the South Platte River main stem over the modeled period. This historical representation was then modified to account for major trends that occurred over the modeled period: growth in transbasin imports; growth in municipal water use along the Front Range, and associated changes in water rights and water use patterns; increased use of alluvial wells; and

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[1] "Windows", "Excel", "Microsoft Word" and "WordPad" are trademarks of the Microsoft Corporation.

development of recharge projects. The historical version of SPREISM was modified to reflect current conditions with respect to these trends and their effects on South Platte flows. This 'current conditions' version of SPREISM was then used as a baseline upon which various EIS alternatives were superimposed.

For more details, the reader is referred to the Technical Appendix for the South Platte River EIS Model.

1.5 Modeling Scenarios

The following list identifies the 13 different scenarios that may be modeled using SPREISM. For a detailed description of these scenarios, consult the SPREISM Technical Appendix.

- Adjusted Baseline.
- Water Banking 20 KAF from Colorado only.
- Water Banking 40 KAF 1/3 from Colorado.
- Water Banking 50 KAF 1/3 from Colorado.
- Water Banking 80 KAF 1/3 from Colorado.
- Julesburg Reservoir Enlargement.
- Wildcat Reservoir.
- Beebe Draw Exchange.
- Water Banking 20 KAF from Colorado only plus Beebe Draw Exchange.
- Water Banking 80 KAF 1/3 from Colorado plus Beebe Draw Exchange.
- Wildcat Reservoir plus Beebe Draw Exchange.
- Strict adherence to operating rules by Chatfield, Cherry Creek and Bear creek Reservoirs.
- Chatfield Reservoir to simulate availability of an extra 20KAF for ESA use.

2. INSTALLATION

2.1 System Requirements

The South Platte EIS Model has been tested and verified to run on the following computer operating systems:

- Microsoft Windows 95
- Microsoft Windows 98
- Microsoft Windows Me (Millenium Edition)
- Microsoft Windows NT 4.0

The model works best on Pentium II or Pentium III class computers with a screen resolution of at least 1024x768 and 256 colors. The model works best on systems with at least 64 MB of RAM. The model requires at least 30 MB of free space for the installation plus additional space if you wish to save the output from your own model runs.

The model also requires one of the following programs to have been installed prior to the installation of the model.

- Microsoft Excel 97 (stand alone or from Office 97)
- Microsoft Excel 2000 (stand alone or from Office 2000)

2.2 Quick Start

To install the South Platte EIS Model:

1. Insert the installation CD-ROM in your drive.

2. If AutoPlay is enabled on your computer a window will appear on your desktop as shown below.

or

2. If AutoPlay has been disabled on your computer open My Computer and click on the CD-ROM drive. Double click on Autorun.exe to launch the program shown above.

3. If the South Platte EIS Model has not been installed on your computer yet the Uninstall button will be disabled as shown above. Clicking on the Help button will bring up this help file.

4. Click on the Install button to launch the setup program. You could also start the setup program by clicking on SETUP.EXE on the CD-ROM drive from Windows Explorer.

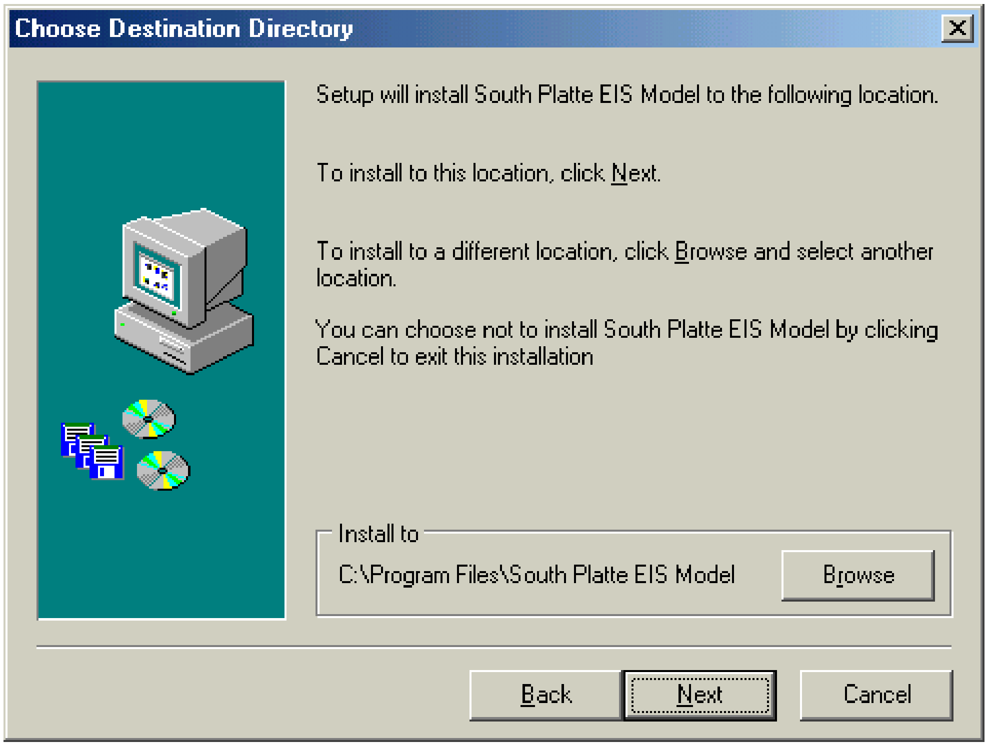
5. The setup program will ask you to close any running programs and click on the Next button.

6. The next screen in the setup program is the License Agreement. You should review the license agreement and click on the Yes button to accept the license agreement and continue the installation. If you click the No button the installation will be cancelled and no changes will have been made to your system. When you are finished with the setup a copy of the license agreement will have been installed in the target directory. The license will be written to a file called license.rtf which can be viewed with Microsoft Word or WordPad.

7. The next screen in the setup program is the Program Information dialog box. This dialog box will show last minute updates, changes and other information that may have been added to the program after the documentation was written. A copy of this information will be copied to the target directory in a file called readme.rtf which can be viewed with Microsoft Word or WordPad.

8. Next enter your name and license number from the sticker on the back of your CD-ROM jewel case (or disc sleeve). You must type in the user name and license number exactly as they are specified on the label or the product will fail to install. You must also type in a company name in the provided space, although this may be any name you wish. If the information on the label is not correct please contact Hydrosphere at (303) 443-7839 for assistance (ask for Roger Wolvington or Lee Rozaklis).

9. The model will next ask you for a directory to install the main modeling tool and scenarios, as shown below. The default is C:\Program Files\South Platte EIS Model. If you wish to change this, click on the Browse button.



10. The setup program will now ask for a Program Folder name to install the model icons in. The default folder is a Hydrosphere folder. You can type in a new name for the folder or choosing an existing folder from the list.

11. The next screen shows a review of all setting you have selected for the install. When you click on the Next button on this dialog box the setup program will begin copying files to your hard drive.

3. RUNNING THE MODEL

NOTE: Most of the following information is also provided by the on-screen SPREISM Help Pages, often with additional details. (To access these pages, consult the "Help Topics" window that pops up automatically when a model workbook is opened).

3.1 Loading the Model

The South Platte EIS Model consists of two parts. The first part is Hydrosphere's ExcelCRAM modeling tool and the second part is the South Platte EIS Model network diagram, scenarios and data.

Before the model can be run the user needs to start Hydrosphere's ExcelCRAM modeling tool and load the South Platte EIS Model scenarios. The modeling tool is loaded by starting Microsoft Excel and loading the file XLCRAM97.XLA, which can be found in the installation directory (The default directory from the setup program is C:\Program Files\South Platte EIS Model). Alternatively, when you click on the South Platte EIS Model icon, Excel 97 will automatically load the XLCRAM97.XLA worksheet. This Add-In workbook will add an ExcelCRAM menu item to your version of Excel 97 right before the Help menu item.

When this file is loaded into Excel you may get a pop-up dialog box warning you that the workbook you are opening contains macros and that some macros may contain viruses that could be harmful to your computer. This workbook should be considered to be from a trusted source and you should click on the Enable Macros button to allow the XLCRAM97.XLA setup macros to install the menu interface to the modeling tools. Hydrosphere recommends not unchecking the "Always ask before opening workbooks with macros" as this is a good way of catching unauthorized macros from running. If your version of Excel does not have "Macro virus protection" turned on in the Tools-Options dialog box you will not see this message when you load ExcelCRAM.

In a generic ExcelCRAM model the users would build a network using the menus above. For the South Platte EIS Model the user need only load the pre-built network model, data and scenarios found in the SPEIS.XCW file. This will load the model data for all available scenarios. To load the scenarios click on ExcelCRAM->Workbook->Open Existing Workbook and select the SPEIS.XCW file. If you don't see this file listed in the dialog box displayed you may need to change the current directory to C:\Program Files\South Platte EIS Model or wherever you installed the model.

Note: When the SPEIS.XCW file loads it may report that links need updating and offer two choices, Yes or No. Click on No in this dialog box.

The model data consist of a collection of workbooks with input data. The names of the worksheets in the workbook is very important. Do not rename or delete any of the worksheets in the South Platte EIS Model. Doing so may cause the model to cease to function. Section 3.3 describes the worksheets in the South Platte EIS model and the data they contain.

3.2 Running in Binary vs. Worksheet Output Mode

The South Platte EIS model may be run in one of two modes, producing output in either "Binary" or "Worksheet" format. The Worksheet Output option is generally preferable, as it allows model output to be immediately viewed within the active Excel workbook. In contrast, the Binary Output option requires rather labor-intensive post-processing of the output file, including manual cutting and pasting, before model results can be evaluated. Nevertheless, Binary Output may be necessary for the reasons described below.

If you want to generate output for more than 252 network element-parameters, then you will need to use the Binary Output format. (A "network element-parameter" is one parameter of any element in the network. For example, if you wanted to review the Flow on Link 65 and the Capacity on Reservoir 3 and the Evaporation on Reservoir 3, these would comprise three network element-parameters). This is because Microsoft Excel is limited to 256 columns in a spreadsheet. For model runs with less than 252 network element-parameter selections for the output you may use the Worksheet Output and have the results written to the worksheet you specify in the current model workbook.

Using binary output formats it is possible to compare model run results side-by-side in an Excel workbook using the CRAMC32A.XLA tool. See Section 3.6 for details.

3.3 Model Input and Output Worksheets

The Excel workbook for the South Platte Model consists of a large number of interrelated worksheets. Some of these worksheets provide input data to the model and normally should not be altered by the user. Others display output from model runs and are intended for the operator to use in reviewing model results. A general description of the various model worksheets follows.

The **Network Schematic** worksheet shows the physical connections in the network. It displays a graphical representation of the nodes and arcs which represent the river basin superimposed over a map (bitmapped image). You can access settings for the network elements by clicking on the objects. You can click on either a arc, a node, or a label for one of the objects (*e.g.*, Link 4), but not by clicking on the labels with names like "Lodgepole Creek". This worksheet serves as one input to the model run. The features themselves normally should not be edited by the end-user except to access and change feature settings to alter what is written to output files.

The **Output Sheet** contains the results of the last model run. The year and months appear in the far left columns and the values selected in the Worksheet Output Template (see below) appear as separate columns in this worksheet. This worksheet will automatically be created if it doesn't exist when the model is run and the Output to Worksheet checkbox is checked. This sheet gives a good quick way of reviewing model output for a given scenario.

The **Worksheet Output Template** holds a list of all the network objects that have been selected for recording to the Output Sheet worksheet in the current workbook during the model run. The worksheet can have its contents erased if you save the model run from the ExcelCRAM menu. To restore the complete list of elements to the Worksheet Output Template copy all of the cells from the **saved template** worksheet.

The **Binary Output Template** is analogous to the Worksheet Output Template. It holds a list of all the network objects that have been selected for recording to the binary output file during the model run. The worksheet can have its contents erased if you save the model run from the ExcelCRAM menu. To restore the complete list of elements to the binary output template, copy all of the cells saved from the **saved template** worksheet.

The **Difference Charts and Tables** (for example, the “Annual Julesburg Difference Chart” and the “Changes at Julesburg Tables”) contain results from the last model run. Specifically, they show the differences in SPREISM-modeled flows between the last modeled scenario and the “baseline condition” scenario, for five different South Platte locations (Kersey, Weldona, Cooper, Balzac, and Julesburg). Note that the bar charts showing differences in flows are only valid when the model is run for the *entire 1947-1994 period*.

A large number of **inflow, link, and demand worksheets** (e.g., “Link 96 River to Chatfield”) serve as static input data for the various scenarios run by the SPREISM model. As such, these sheets normally *should not be altered by the user*. For additional description of these worksheets, see Section 3.4, Reviewing Model Input.

The **Scenario Controls** worksheet is used to store the current settings for a model run. The end-user should not change any of the values on this worksheet directly. There are no options that should be set by the user on this worksheet. All values here are set via a dialog box when Start Simulation is selected from the ExcelCRAM menu.

3.4 Reviewing Model Input

SPREISM inputs consist of two types of data. The first type of data can be considered "static" data because they do not vary dependent on the month or year of the run. This type of data includes the to and from nodes, reservoir capacity, priority, etc. All of the data stored in the model workbook are Input data with the exception of model output worksheets, which can be named by the user. The default name for a model output run is Output Sheet. See the Section 3.6, Reviewing the Model Results, for more information about model output worksheets.

The second type of data are the "time series" data. These data can change from month to month or year to year. In some cases the data are a set of 12 monthly numbers that repeat for all years in the model run (evaporation rates for a reservoir, for example).

The model input data are stored in two types of places in the model. Time series data are stored on individual worksheets for each network element that has time series data. The month to month flow values for Inflow 1, for instance, are stored on a worksheet called "Inflow 1 BurlingtonToHendGains". The critical portion of this worksheet's name is the "Inflow 1" portion. The text after that is ignored when the model is run. The worksheets are named with the element type and number to identify the time series data. The static data can be reviewed by clicking on the graphical representation of the element on the Network Schematic worksheet. The evaporation rates are stored in the Network Schematic worksheet dialog boxes for each reservoir.

Values set in the dialog boxes for capacity and starting contents and other constraints can be overridden by values found in element worksheets elsewhere in the workbook, so before being sure of a value you should check for a worksheet with the name and number of the element you are reviewing. If there is another worksheet in the workbook that contains data for the element you are looking at, the text message "There is time series data on a worksheet for this element." will appear in the dialog box above the comments window.

3.5 Running the Model

Step 1. Decide on an output format (binary or worksheet), as described in Section 3.2.

If you wish to prepare a Worksheet Output Template:

- Click on the Network Schematic worksheet.
- Click on the network elements which you would like to have included in the output.
- Check off the parameters on the bottom of the dialog box that are of interest.

If you wish to prepare a Binary Output Template:

- Click on the worksheet named saved Binary template.
- Highlight the list of network elements in the first three columns and press Control-C.
- Click on the worksheet named Binary Output Template.
- Move to the cell A2 on this worksheet and paste the data from the clipboard with Control-V.

Step 2. Start the model.

- Click on the ExcelCRAM menu and choose Start Simulation from the drop-down menu.
- Specify the first and last years for the desired simulation (defaults are 1947 and 1994).
- Specify the Simulation Interruption Options for the desired simulation, if any

(default is none).

- In the Output Options group box check Binary or Worksheet and provide the names for the file and/or worksheet (in a binary output run, the normal extension for the output file is .bin).
- Click the Begin Simulation dialog box to get a list of scenarios available.

Step 3. Select a model scenario.

- Choose one of the model scenarios from the drop-down list show in the dialog box.
- Click the Continue button to start the model solving for the selected years and generating output.

Note: this model takes about 4 minutes to run 1947 to 1994 on a AMD Athlon 600 MHz computer (Pentium III 600 equivalent). The status bar in the lower left corner of the spreadsheet window displays the year and month currently being processed.

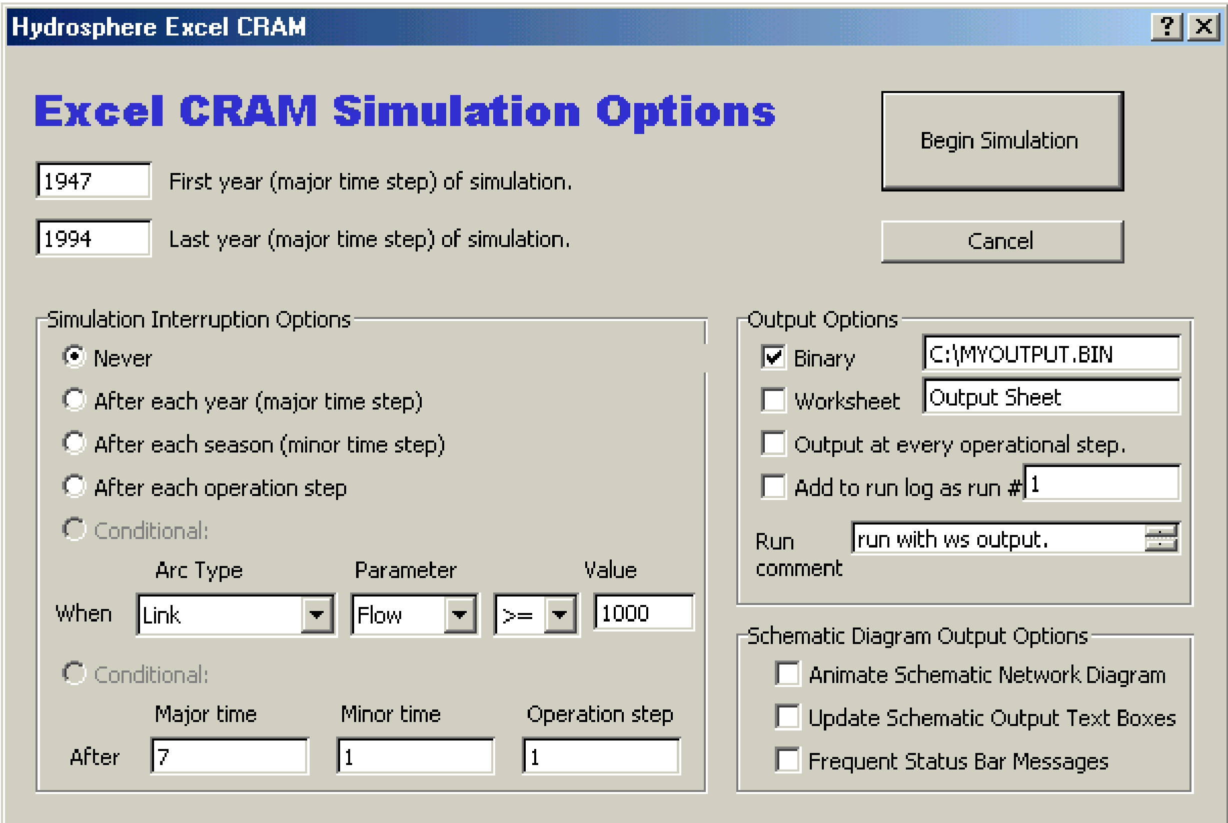
3.6 Reviewing the Model Results

To review worksheet output:

If you choose to use the Worksheet Output during the model run the results of the model run will appear in a worksheet in the current workbook (default: "Output Sheet"). They are ordered according to element type and then element number. This output format is limited to 256 network element-parameter combinations. If you use the Worksheet Output format you can compare the results of your model run to the Adjusted Baseline scenario using the pre-built graphs to the right of the Network Schematic worksheet.

To review binary output:

If you choose to use the Binary Output option during the model run the results of the model were saved to disk in the file specified in the model run dialog box. The picture below shows the output will be saved to a file called MYOUTPUT.BIN which will be processed into a MYOUTPUT.SRT for later review or comparison to other model runs.



Viewing Model output from outside of the Model requires the use of Excel 97 and a custom Excel 97 add-in, CRAMC32.XLA. With these tools, the analysis you may perform on the Model output is limited only by the items included in the Binary Output Template worksheet.

To review the output, load the file CRAMC32.XLA from the directory in which you installed the South Platte Model. When CRAMC32.XLA is loaded, it adds a menu pick to Excel's Insert menu called Paste Cram Function that will allow you to import data from the sorted binary files created by the Model (the .SRT files).

To use CRAMC32.XLA, you must first open a spreadsheet in Excel 97. You may then immediately begin "pasting" data into a new spreadsheet using the menu item Paste Cram Function. The Past Cram Function menu item appears under the Insert menu. You may also paste data into existing spreadsheets, but be careful not to overwrite anything accidentally. Data may be pasted in column or table format. Before using Paste Cram Function, be sure you have selected the cell in which the top row of the data should begin, and that you have enough empty cells below and to the right of the cursor to accommodate all the data that will be pasted into the spreadsheet.

Once you have set up your spreadsheet and placed your cursor in the appropriate cell, select the Insert menu, and choose the menu item Paste Cram Function, and a dialog box will appear. Use the File Select button to point CRAMC32.XLA at the proper output .SRT file, select the item in the file you wish to import, make sure all other settings are as desired (see “Detailed Discussion of the Paste Cram Function Dialog Box” in the on-line Help Pages), and click Paste Data. Monthly modeled data for the item you selected will be pasted into the spreadsheet. Any labels, such as years and months, must be added by the user (for additional guidance, see “Spreadsheet Format Suggestions” in the on-line Help Pages).

Using the Paste Cram Function dialog box to import data from the model output (.SRT File) into an Excel spreadsheet requires the following steps:

Step 1. Select a sorted Cram binary output file (.SRT file)

There are two ways to select the .SRT file:

- Type the name of a sorted bin file (including directory path) into the Binfile Name edit box and press the Read Binfile Header button.

  or

- Click on the File Select button. This will bring up a standard Windows file open dialog box where you can scan drives and directories to find the desired sorted binary file.

Step 2. Select the data to be imported

After the file has been selected, the contents of the .SRT file will be displayed in the large select box below the Binfile Name edit box. Scroll the list box until you find the item you wish to import. Each item contains an arc number (e.g. LINK 1, DEMN 2), a parameter for that arc (FLOW, HIGH, SHORT), and a 32-character description of the arc. Items in the list will contain only those arcs and parameters specified in the binary output template worksheet used at run time. Click once on the desired item to select it.

For the large models, the list will be very long, and finding a particular item can be very time consuming. Once the data has been pasted into the spreadsheet, however, the arc number and parameter can be changed. If you already know the arc you wish to import, to save time you can select the first item in the dialog box list, and then change it to the desired item after it has been pasted into the spreadsheet.

Step 3. Change the default format of the imported data

By default, all monthly values of the imported data will be pasted in a column in units of acre-feet. You can modify these default settings in the dialog box by selecting the appropriate option buttons.

- Paste Options
- Format Options

- Units
- Border
- Decimal Places

(For a description of each of the above options, please consult the on-line Help pages).

Step 4. Specify placement of the binary file name in the spreadsheet

Putting your cursor in the File Name Location edit box allows you to then click on a cell in your spreadsheet into which the binary file name will be pasted. All of the data you import must refer to a cell with the binary file name and path in it. By specifying a cell for the name, you can have all imported data refer to the same cell. This allows you to change the file name in one place, and have all the imported data in the spreadsheet update to that new file automatically.

If you are extracting data from several binary files in the same spreadsheet, you can specify different file name locations for different data. Having all data that refers to the same binary file also refer to the same cell for the file name greatly enhances the ability to compare data from different runs and to update spreadsheets to new runs.

Step 5. Paste Data

When all selections and settings are as desired, click the Paste Data button to import the data into the spreadsheet.

The pasted data contains the following information (Row 1 is the row in which your cursor was placed before invoking Paste Cram Function, and can be any row in the spreadsheet):

Row 1:	output .SRT file and path (or cell specified in dialog box)
Row 2:	Item Name
Row 3:	Item Parameter
Row 4:	Units
Rows 5 & 6:	Empty
Row 7:	32-character Arc Description
Rows 8 - end:	Seasonal modeled data

NOTE: For a description of other CRAM32.XLA fields and buttons, and for spreadsheet format suggestions, please consult the CRAM32.XLA discussion in the “Appendix” section of the on-line Help Pages.

APPENDIX A

SPREISM File Types

The following file types with the following extensions are used or produced by the ExcelCRAM model:

.BIN A binary output file generated by the model, this file is not sorted and is used as an intermediate file during model generation. This is the extension that should be used in the Model Run dialog box to specify an output file.

.SRT A sorted binary output file generated by the model. This file has been reordered to make access to the model results faster. This is the file extension that should be
used in the Paste Cram Function dialog box used by CRAMC32.XLA

.XLA A Microsoft Excel Add-In. This type of file contains forms and data that provide user interfaces and subroutines to perform customized functions within Excel. ExcelCRAM uses two .XLA files. XLCRAM97.XLA which is the generalized modeling tool and CRAMC32.XLA which provides an inferface to binary output files.

.XCW A Hydrosphere extension. An .XCW file is a ExcelCRAM model with network diagram, data sets and customized code for the model. The South Platte EIS model has only one .XCW file provided with the distribution. This file should be loaded by the user from the ExcelCRAM menu each time the model is launched.

APPENDIX B

ExcelCRAM

ExcelCRAM is a simulation framework adapted for the use in water resources applications. At its core is a network flow programming algorithm. Network flow programming algorithms are related to linear programming approaches.

There are a large number of types of network flow programming algorithms. ExcelCRAM uses a "pure network" algorithm. Like linear programming, pure network flow algorithms solve for a set of dependent variables that provide for the maximum or minimum value of a system-wide objective function subject to a set of constraints. In network flow programming, the problem is stated as a directed graph constructed of a set of arcs, connected by nodes. The dependent variable is the "flow" through the arcs, which are "capacitated" with constraints representing the upper and lower bounds of flow. Arcs are "directed", that is they have a "from" node and a "to" node, though this does not necessarily limit flows to one direction, as negative lower bounds on flow are allowed. Additional constraints are continuity at the nodes. The objective function is the system-wide "cost" of all flows in the system. Costs are assigned to each arc and are applied to each unit of flow in the arc. Networks amenable to solution by pure network formulations must be "circulating". This means that there can be no dead-end arcs in the system and that no flows enter or leave the network. This fundamental aspect of pure networks means that the solution algorithm guarantees mass balance.

Application of pure network algorithms to water resources problems requires that the real-world water resources system, its operating rules and its constraints be expressed in a form amenable to solution by the network. ExcelCRAM provides code that allows the user to use fairly high-level constructs (e.g. inflows, demands, reservoirs) to formulate a water resources problem and additional code that translates that high-level formulation into a form that can be solved by the network algorithm.

In formulating a network, arcs are used to represent river reaches, canals and other components. Arc capacities are used to represent real-world facility or reach capacities or diversion, demand or storage targets. Arc costs are mapped to water rights or system operation priorities. Note that while network flow algorithms are optimization algorithms, ExcelCRAM does not use the algorithm to prescribe an optimal set of operations. Rather, ExcelCRAM uses the optimization capabilities of the network flow algorithms to simulate water rights or operations that are based on priorities.

In ExcelCRAM a discrete network (which may include iterative solutions) is used to simulate conditions in a single time step. The system state variables (i.e., reservoir storage, return flows from previous time steps) are used at the beginning of each time step to initialize the network.

A fundamental assumption of the network approach is that flows within a single network and, thus, a single time step in our application, are in equilibrium. In practical terms this means that routing is not considered and all flows within a single time step are available at all points in the network. This means that if the length of the time step used to solve a system is less than the longest travel time between any two points in the system some errors will be introduced in the solution. In real-world systems, the presence of reservoirs often serves to minimize the significance of these errors. Hydrosphere has applied network flow solutions to systems with simulation time steps as short as one day.

ExcelCRAM embeds a network-flow-algorithm-based simulation system in Microsoft® Excel. The network solver and simulation codes are provided in a Dynamic Link Library (DLL). Code that manages model simulation steps and most of the input and output is written in VBA, the scripting language native to Excel. This provides for a simulation environment where the model inputs and outputs can be managed in a familiar spreadsheet program. Code to simulate special operations can be written in VBA.

Some specific components of a simulation are described in general terms in the on-line Help pages under the section “ExcelCRAM Network Components”.