Appendices

Appendix A

Calibration of HEC-ResSim3.0 Model

The research to simulation model for water management uses HEC-ResSim3.0 which is developed by The U.S. Army Corp of Engineers' Hydrologic Engineering Center's Reservoir System Simulation, April 2007, to create simulation model for reservoir management and its objectives are irrigation, navigation, hydropower plant and drinking water supply.

This research is a calibration model. This test uses elevation of reservoir and energy to compare with actual data by considering R^2 (Root Square), EI (Efficiency Index), RMSE (Root Mean Square Error) which are detailed as following items:
If R^2 =1, the simulation test is highly reliable, EI = 100%, the simulation test is highly reliable and RMSE = 0, the simulation test is highly reliable.

To research HEC-ResSim3.0 simulation model with actual data before using elevation of reservoir and energy. From simulation model with actual data by using water inflow, water out flow, elevation of daily, monthly, yearly, from 2003 to 2012 which are the perfect data, test consist of 2 steps as: water data test and energy data test

A.1 Water data calibration model

Use the average evaporation loss of Nam Ngum2 hydropower plant which is from design evaporation data of project construction and this data are used for NamNgum-1 hydropower plant by calculating percent, decreasing 100% to 9%, 8%, 7% ,the detail is shown as:

Table A.1 Average evaporation of NamNgum2 hydropower plant (100%).

Jan	Feb	Mar	April	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
127	128	161	164	145	127	123	117	116	136	135	129	1,608

A.1.1 First calibration model

Due to evaporation data of Nam Ngum-1 hydropower plant are not available, therefore, Use the average evaporation of Nam Ngum2 hydropower plant which is from design evaporation data of project construction and these data are used for

NamNgum-1 hydropower plant by calculating percent, decreasing 100% to 9%, and the detail is shown as below:

Table A.2 Evaporation of NamNgum2 hydropower plant (9%).

Jan	Feb	Mar	April	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
11	12	14	15	13	11	11	11	10	12	12	12	145

After having opened a HEC-ResSim3.0 or NamNgum-1 Watershed model, from the **Reservoir Network module** of the alternative model Editor, right click cursor at model and select the **Edit reservoir Properties.** An NamNgum-1Watershed browser window will open, as shown in Figure A.1.

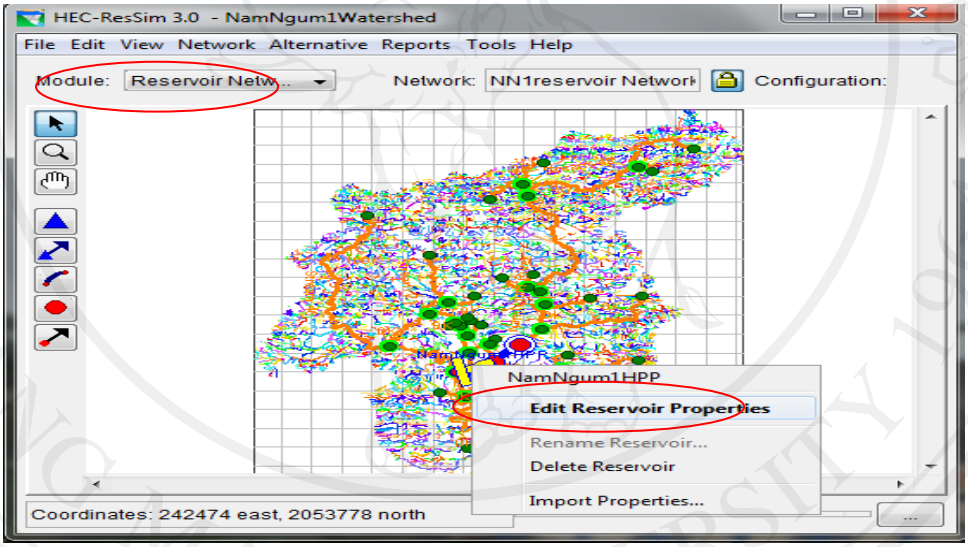


Figure A.1 Showing the input evaporation 9% into model

To edit Evaporation data, select **Evaporation** in the reservoir tree. Figure A.2 shows the Reservoir Editor's Evaporation data editor and its corresponding mini-plot. The mini-plot will reflect the values entered and can be viewed in full size when double-clicked on it. Choose either Monthly Average Evaporation or Evaporation data 9% of Nam Ngum2 in Table A.2.

Note: If select the **Monthly Average Evaporation:** Enter Evaporation values by month. To enter data into the table, either copy or paste it from a spreadsheet application or type in the values manually. Click Apply and Ok, as shown in Figure A.2.

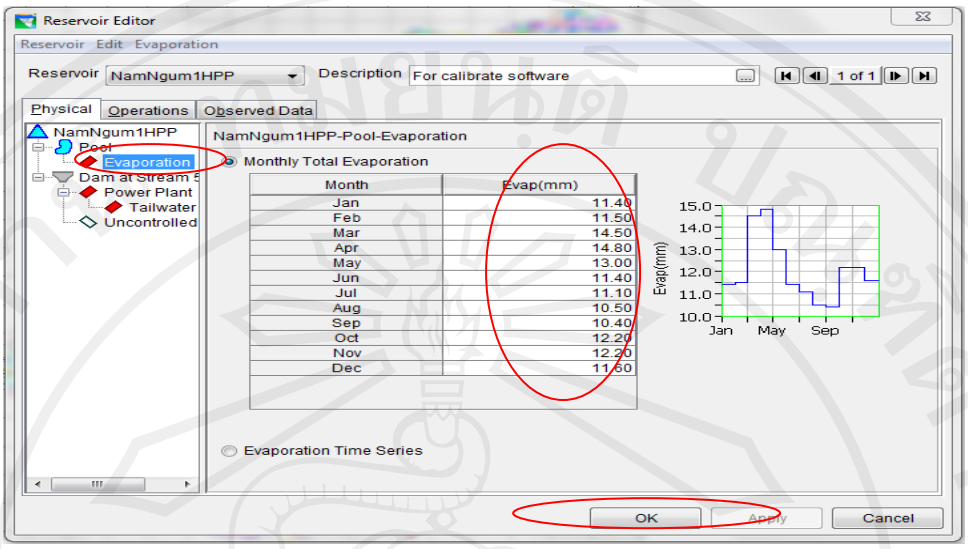


Figure A.2 Showing the input evaporation 9% into model

After inputting all data and parameters as desired, a Simulation can be computed. In the Simulation Control Panel of the main window of the Simulation Module, the simulation tree displays the current Simulation as a folder, beneath which is a list of the Alternatives associated with the Simulation. Also shown in the Simulation Control Panel is the time information associated with the Simulation.

To compute a Simulation, either click the **Compute** button in the Simulation Control Panel, as shown in Figure A.3.

After computing a Simulation, review results in many different forms. **Compute Messages** provide information about each step of the computation process. **Plots** and **Tables** in the Simulation Module offer detailed views of data and model results. **Reports** provide details about individual components of the Reservoir Network.

Plots and tables in the Simulation Module offer detailed views of data and model results. To access a **Plot** from the display area, right-click on a model element in the map display. The shortcut menu will provide a list of one or more plot options, as select the **plot** illustrated in Figure A.3. To get the result comparison with actual data record and Consider the R^2, EI, RMSE value the detail are shown as below:

R^2 =1, the simulation test is highly reliable

EI = 100%, the simulation test is highly reliable

RMSE = 0, the simulation test is highly reliable

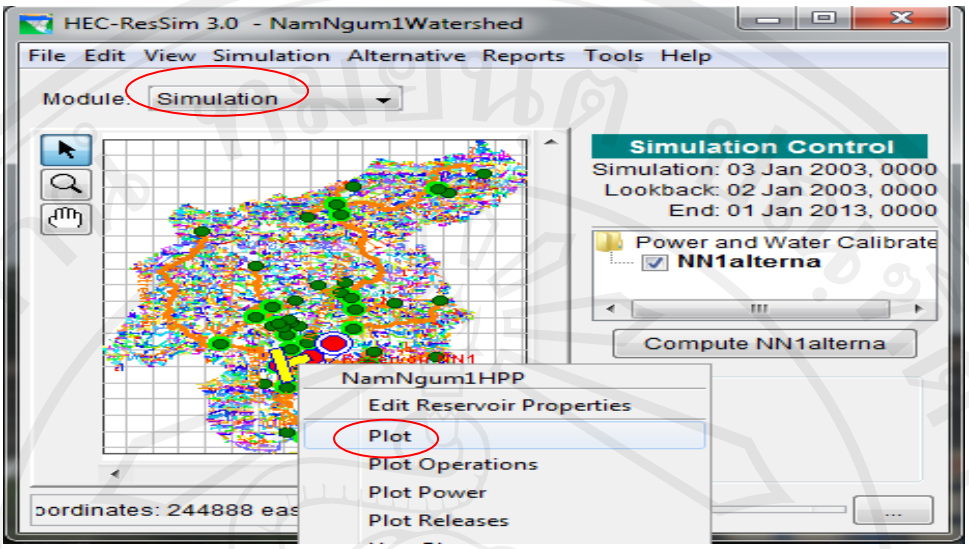


Figure A.3 Views the result of model

To get the result comparison with actual data record and see R^2, EI, RMSE value. From the **File** menu of the simulation module, select **Tabulate**. The **Plot** dialog box will open as illustrated in Figure A.4.

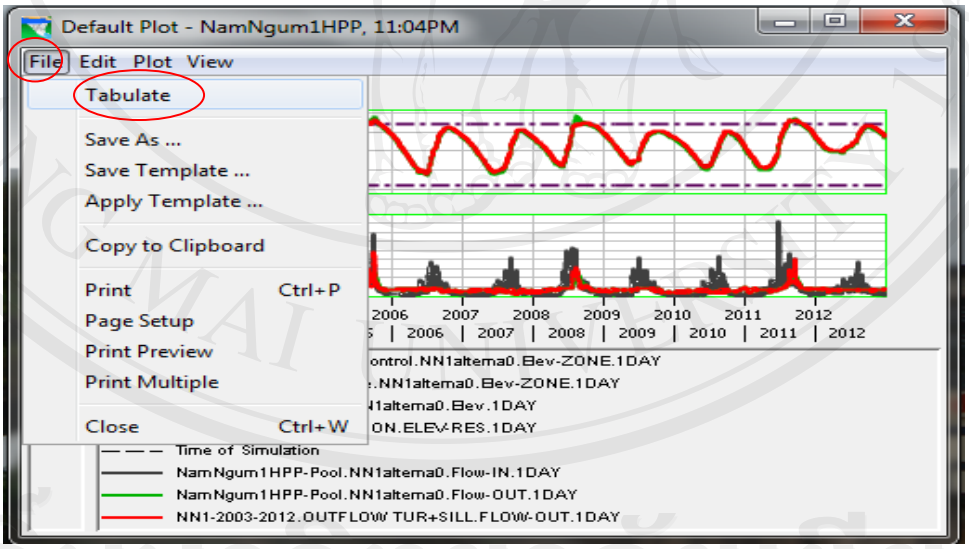
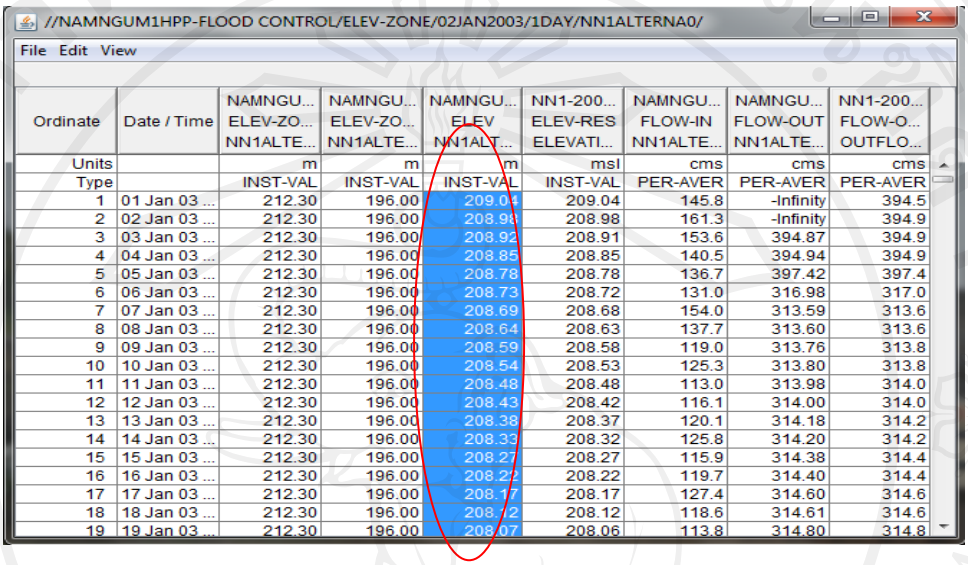


Figure A.4 Views the graph result of model

HEC-ResSim3.0 plots offer a variety of information that will assist with reviewing the results of a Simulation. Included in the information available from the default plots are reservoir elevation, storage, and release values as well as regulated and unregulated (without reservoirs and other projects) flow values. View plotted data

in tabular form by selecting **Tabulate** from the **File** menu of the plot. Select **Tabulate** the **Result table** dialog box will open as illustrated in Table A.3.

Table A.3 Views the graph result of model



//NAMNGUM1HPP-FLOOD CONTROL/ELEV-ZONE/02JAN2003/1DAY/NN1ALTERNA0/

File Edit View

Ordinate	Date / Time	NAMNGU... ELEV-ZO... NN1ALTE...	NAMNGU... ELEV-ZO... NN1ALTE...	NAMNGU... ELEV NN1ALT...	NN1-200... ELEV-RES ELEVATI...	NAMNGU... FLOW-IN NN1ALTE...	NAMNGU... FLOW-OUT NN1ALTE...	NN1-200... FLOW-O... OUTFLO...
Units		m	m	m	msl	cms	cms	cms
Type		INST-VAL	INST-VAL	INST-VAL	INST-VAL	PER-AVER	PER-AVER	PER-AVER
1	01 Jan 03 ...	212.30	196.00	209.04	209.04	145.8	-Infinity	394.5
2	02 Jan 03 ...	212.30	196.00	208.98	208.98	161.3	-Infinity	394.9
3	03 Jan 03 ...	212.30	196.00	208.92	208.91	153.6	394.87	394.9
4	04 Jan 03 ...	212.30	196.00	208.85	208.85	140.5	394.94	394.9
5	05 Jan 03 ...	212.30	196.00	208.78	208.78	136.7	397.42	397.4
6	06 Jan 03 ...	212.30	196.00	208.73	208.72	131.0	316.98	317.0
7	07 Jan 03 ...	212.30	196.00	208.69	208.68	154.0	313.59	313.6
8	08 Jan 03 ...	212.30	196.00	208.64	208.63	137.7	313.60	313.6
9	09 Jan 03 ...	212.30	196.00	208.59	208.58	119.0	313.76	313.8
10	10 Jan 03 ...	212.30	196.00	208.54	208.53	125.3	313.80	313.8
11	11 Jan 03 ...	212.30	196.00	208.48	208.48	113.0	313.98	314.0
12	12 Jan 03 ...	212.30	196.00	208.43	208.42	116.1	314.00	314.0
13	13 Jan 03 ...	212.30	196.00	208.38	208.37	120.1	314.18	314.2
14	14 Jan 03 ...	212.30	196.00	208.33	208.32	125.8	314.20	314.2
15	15 Jan 03 ...	212.30	196.00	208.27	208.27	115.9	314.38	314.4
16	16 Jan 03 ...	212.30	196.00	208.22	208.22	119.7	314.40	314.4
17	17 Jan 03 ...	212.30	196.00	208.17	208.17	127.4	314.60	314.6
18	18 Jan 03 ...	212.30	196.00	208.12	208.12	118.6	314.61	314.6
19	19 Jan 03 ...	212.30	196.00	208.07	208.06	113.8	314.80	314.8

To copy row select or result of simulation model to the Microsoft excel for comparison with actual data record and consider the R^2, EI, RMSE value, the details are shown as below, dialog box will open as illustrated in Table A.4.

R^2 =1, the simulation test is highly reliable

EI = 100%, the simulation test is highly reliable

RMSE = 0, the simulation test is highly reliable

Table A.4 Comparison result of model and actual data record

Calibration	
R^2	0.996
EI	98.99%
RMSE	0.73
WB	-0.15%

Vertification	
R^2	0.787
EI	#REF!
RMSE	35.29
WB	-14.43%

Evaporation 9%

Date	Simulated	Observed
01/01/2003	209.04	209.04
02/01/2003	208.98	208.98
03/01/2003	208.92	208.91
04/01/2003	208.85	208.85
05/01/2003	208.78	208.78
06/01/2003	208.72	208.72
07/01/2003	208.68	208.68
08/01/2003	208.63	208.63
09/01/2003	208.58	208.58
10/01/2003	208.53	208.53
11/01/2003	208.48	208.48
12/01/2003	208.42	208.42
13/01/2003	208.37	208.37
14/01/2003	208.32	208.32
15/01/2003	208.27	208.27
16/01/2003	208.22	208.22
17/01/2003	208.16	208.17
18/01/2003	208.11	208.12
19/01/2003	208.06	208.06
20/01/2003	208.01	208.01
21/01/2003	207.96	207.96
22/01/2003	207.90	207.91
23/01/2003	207.85	207.85

The plot window displays the location name in the title bar. Axis labels and a color-coded legend identify the data contained in the plot. The blue line is water elevation data result from simulation and red line is water elevation actual data record from 2003-2012.This test uses water elevation simulation to compare with actual data by considering R^2 (Root Square), EI (Efficiency Index), RMSE (Root Mean Square Error) which are details as following items:

If evaporation 9%, get the R^2 = 0.996, EI= 98.99% and RMSE = 0.73

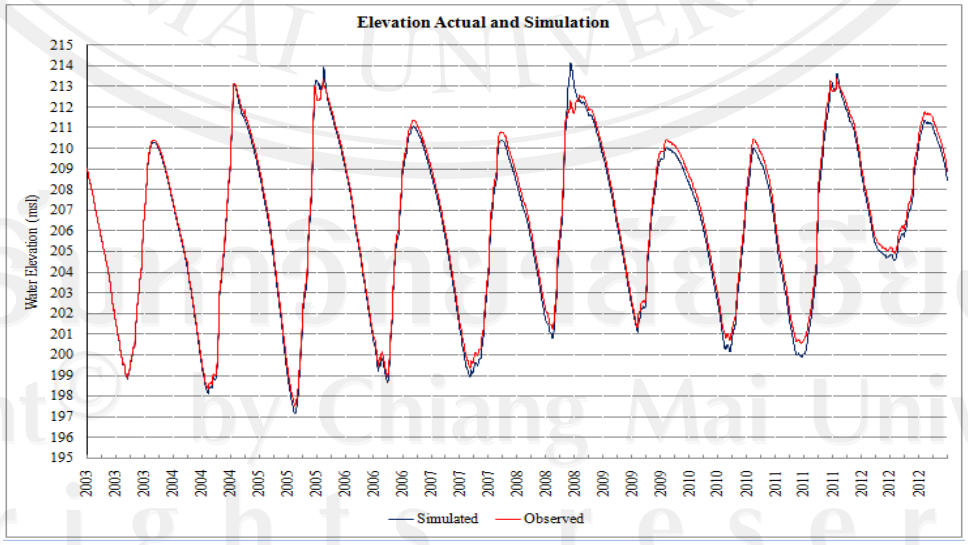


Figure A.5 Comparison water elevation simulation and actual data

Due to comparison of simulation result and actual elevation not highly reliable, Then calibration in the next step.

A.1.2 Second calibration model

Due to evaporation data of NamNgum-1 hydropower plant are not available, therefore, use the average evaporation of Nam Ngum2 hydropower plant which is from design evaporation data of project construction and these data are used for NamNgum-1 hydropower plant by calculating percent, decreasing 100% to 8%, the detail is shown as below:

Table A.5 Evaporation of Nam Ngum2 hydropower plant (8%)

Jan	Feb	Mar	April	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
10	10	13	13	12	10	10	9	9	11	11	10	129

Once having opened a HEC-ResSim3.0 or NamNgum-1 Watershed model. From the **Reservoir Network module** of the alternative model Editor. Right click cursor at model and select the **Edit reservoir Properties.** An NamNgum-1Watershed browser window will open, as shown in Figure A.6.

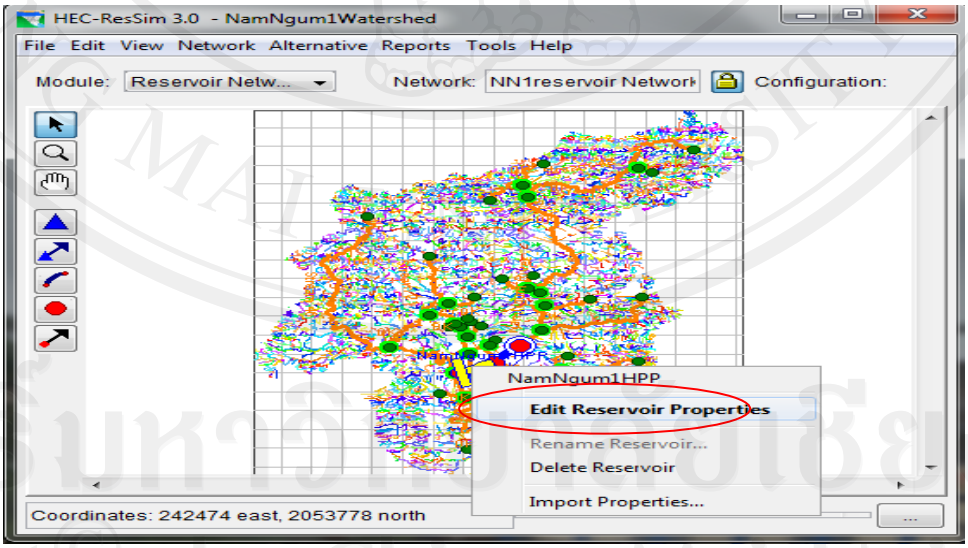


Figure A.6 Showing the input evaporation 8% into model

To edit Evaporation data, select **Evaporation** in the reservoir tree. Figure A.7 shows the Reservoir Editor's Evaporation data editor and its corresponding mini-plot.

The mini-plot will reflect the values entered and can be viewed in full size when double-clicking on it. Choose either Monthly Average Evaporation or Evaporation data 8% of Nam Ngum2 in Table A.5.

Note: If select the **Monthly Average Evaporation:** Enter Evaporation values by month. To enter data into the table, either copy or paste it from a spreadsheet application or type in the values manually. Click Apply and Ok, as shown in Figure A.7.

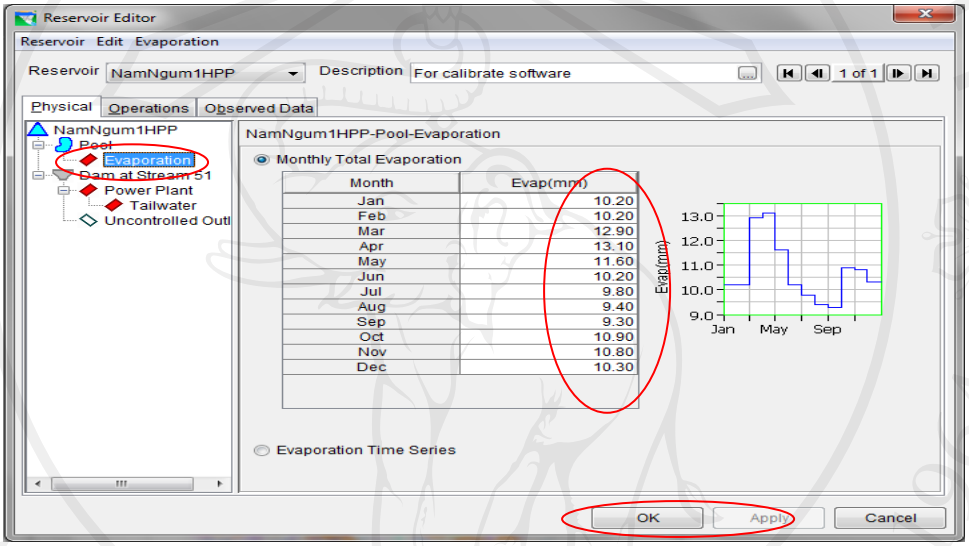


Figure A.7 Showing the input evaporation 8% into model

After inputting all data and parameters as desired, a Simulation can be computed. In the Simulation Control Panel of the main window of the Simulation Module, the simulation tree displays the current Simulation as a folder, beneath which is a list of the Alternatives associated with the Simulation. Also shown in the Simulation Control Panel is the time information associated with the Simulation.

To compute a Simulation, either click the **Compute** button in the Simulation Control Panel, as shown in Figure A.8.

After computing a Simulation, review results in many different forms. **Compute Messages** provide information about each step of the computation process. **Plots** and **Tables** in the Simulation Module offer detailed views of data and model results. **Reports** provide details about individual components of the Reservoir Network.

Plots and tables in the Simulation Module offer detailed views of data and model results. To access a **Plot** from the display area, right-click on a model element in the map display. The shortcut menu will provide a list of one or more plot options, as select the **plot** illustrated in Figure A.8. To get the result comparison with actual data record and Consider the R^2, EI, RMSE value, the detail are shown as below:

R^2 =1, the simulation test is highly reliable

EI = 100%, the simulation test is highly reliable

RMSE = 0, the simulation test is highly reliable

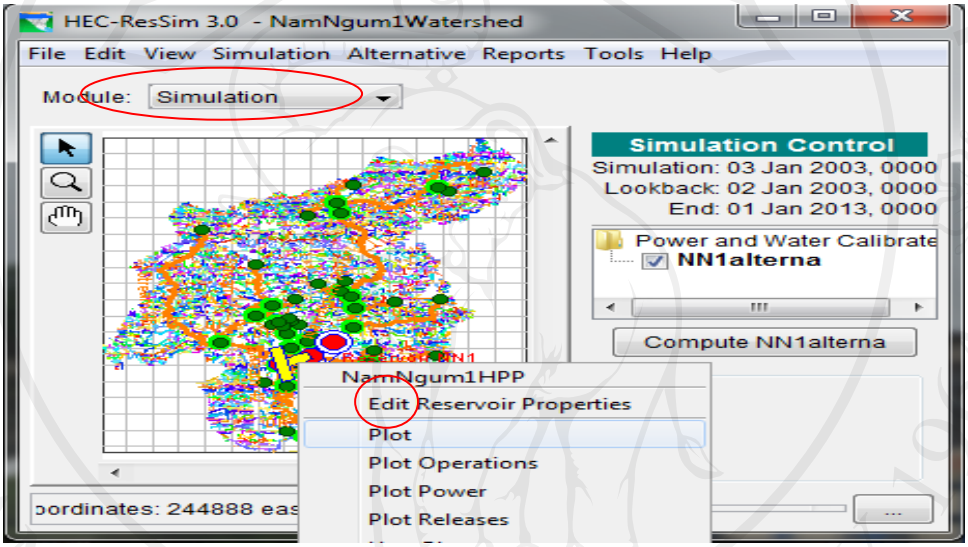


Figure A.8 Views the result of model

To get the result comparison with actual data record and see R^2, EI, RMSE value. From the **File** menu of the simulation module, select **Tabulate**. The **Plot** dialog box will open as illustrated in Figure A.9.

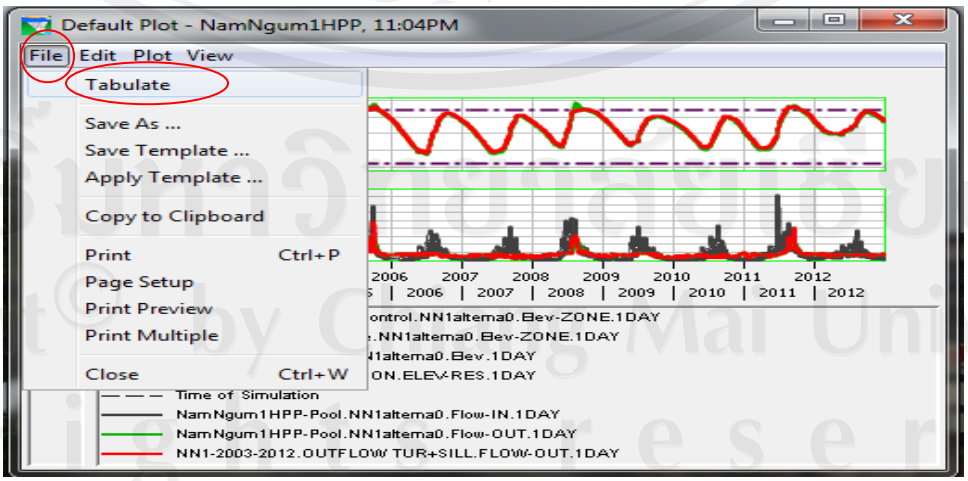
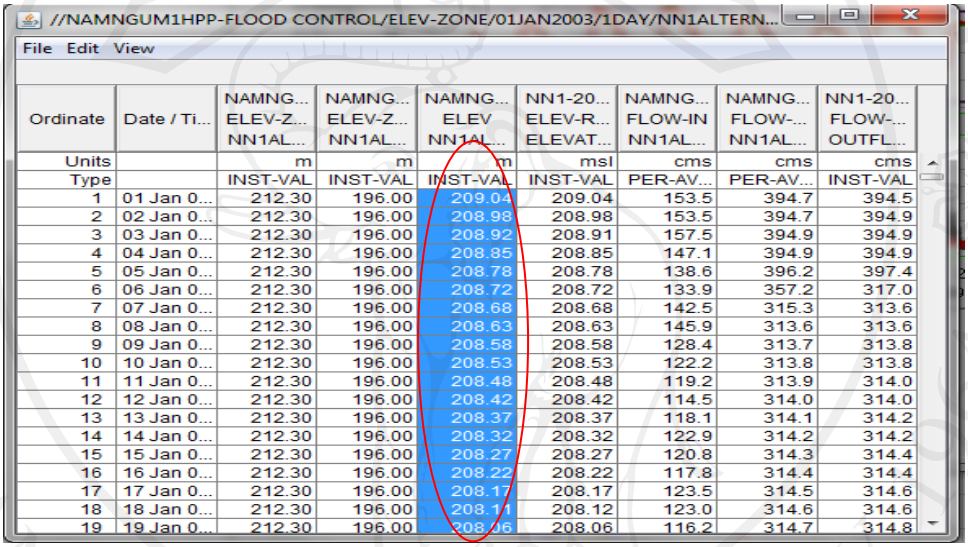


Figure A.9 Views the graph result of model

HEC-ResSim3.0 plots offer a variety of information that will assist with reviewing the results of a Simulation. Included in the information available from the default plots are reservoir elevation, storage, and release values as well as regulated and unregulated (without reservoirs and other projects) flow values. View plotted data in tabular form by selecting **Tabulate** from the **File** menu of the plot. Select **Tabulate** the **Result table** dialog box will open as illustrated in Table A.6.

Table A.6 Views the graph result of model



//NAMNGUM1HPP-FLOOD CONTROL/ELEV-ZONE/01JAN2003/1DAY/NN1ALTERN...

File Edit View

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Units		m	m	m	msl	cms	cms	cms
Type		INST-VAL	INST-VAL	INST-VAL	INST-VAL	PER-AV...	PER-AV...	INST-VAL
1	01 Jan 0...	212.30	196.00	209.04	209.04	153.5	394.7	394.5
2	02 Jan 0...	212.30	196.00	208.98	208.98	153.5	394.7	394.9
3	03 Jan 0...	212.30	196.00	208.92	208.91	157.5	394.9	394.9
4	04 Jan 0...	212.30	196.00	208.85	208.85	147.1	394.9	394.9
5	05 Jan 0...	212.30	196.00	208.78	208.78	138.6	396.2	397.4
6	06 Jan 0...	212.30	196.00	208.72	208.72	133.9	357.2	317.0
7	07 Jan 0...	212.30	196.00	208.68	208.68	142.5	315.3	313.6
8	08 Jan 0...	212.30	196.00	208.63	208.63	145.9	313.6	313.6
9	09 Jan 0...	212.30	196.00	208.58	208.58	128.4	313.7	313.8
10	10 Jan 0...	212.30	196.00	208.53	208.53	122.2	313.8	313.8
11	11 Jan 0...	212.30	196.00	208.48	208.48	119.2	313.9	314.0
12	12 Jan 0...	212.30	196.00	208.42	208.42	114.5	314.0	314.0
13	13 Jan 0...	212.30	196.00	208.37	208.37	118.1	314.1	314.2
14	14 Jan 0...	212.30	196.00	208.32	208.32	122.9	314.2	314.2
15	15 Jan 0...	212.30	196.00	208.27	208.27	120.8	314.3	314.4
16	16 Jan 0...	212.30	196.00	208.22	208.22	117.8	314.4	314.4
17	17 Jan 0...	212.30	196.00	208.17	208.17	123.5	314.5	314.6
18	18 Jan 0...	212.30	196.00	208.11	208.12	123.0	314.6	314.6
19	19 Jan 0...	212.30	196.00	208.06	208.06	116.2	314.7	314.8

To copy row, select or result of simulation model to the Microsoft excel for comparison with actual data record and consider the $R^{2,}$ EI, RMSE value. The details are shown as below; dialog box will open as illustrated in Table A.7.

R^2 =1, the simulation test is highly reliable

EI = 100%, the simulation test is highly reliable

RMSE = 0, the simulation test is highly reliable

Table A.7 Comparison result of model and actual data record

Calibration	
R^2	0.996
EI	99.08%
RMSE	0.70
WB	-0.14%

Vertification	
R^2	0.787
EI	#REF!
RMSE	35.29
WB	-14.43%

Evaporation 8%

Date	Simulated	Observed
01/01/2003	209.04	209.04
02/01/2003	208.98	208.98
03/01/2003	208.92	208.91
04/01/2003	208.85	208.85
05/01/2003	208.78	208.78
06/01/2003	208.72	208.72
07/01/2003	208.68	208.68
08/01/2003	208.63	208.63
09/01/2003	208.58	208.58
10/01/2003	208.53	208.53
11/01/2003	208.48	208.48
12/01/2003	208.42	208.42
13/01/2003	208.37	208.37
14/01/2003	208.32	208.32
15/01/2003	208.27	208.27
16/01/2003	208.22	208.22
17/01/2003	208.17	208.17
18/01/2003	208.11	208.12
19/01/2003	208.06	208.06
20/01/2003	208.01	208.01
21/01/2003	207.96	207.96
22/01/2003	207.90	207.91
23/01/2003	207.85	207.85

The plot window displays the location name in the title bar. Axis labels and a color-coded legend identify the data contained in the plot. The blue line is water elevation data result from simulation and red line is water elevation actual data record from 2003-2012.This test uses water elevation simulation to compare with actual data by considering R^2 (Root Square), EI (Efficiency Index), RMSE (Root Mean Square Error) which are detailed as following items:

If evaporation 8%, get the R2 = 0.996, EI= 99.08% and RMSE = 0.70

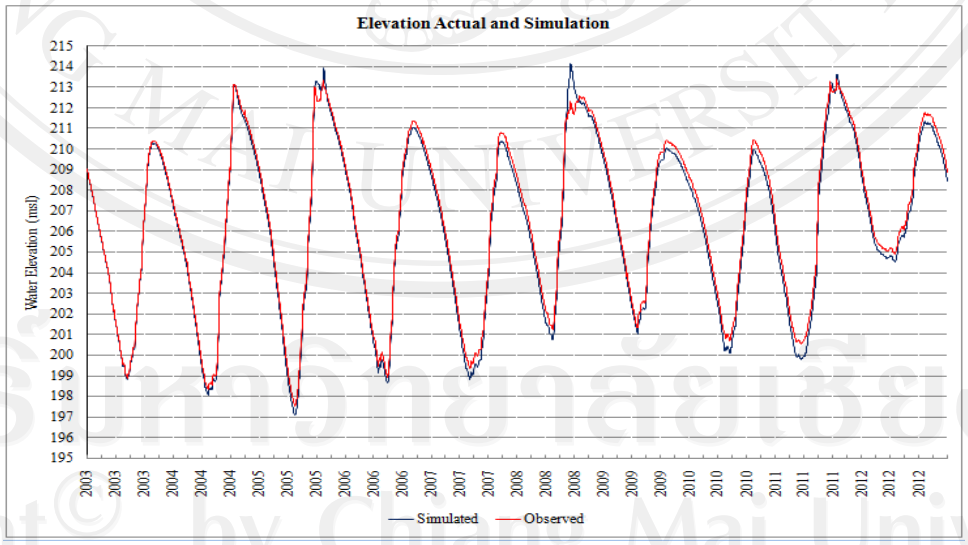


Figure A.10 Comparison water elevation simulation and actual data

Due to comparison of simulation result and actual elevation not highly reliable, then calibration in the next step.

A.1.3 Third calibration model

Due to evaporation data of NamNgum-1 hydropower plant are not available, therefore, use the average evaporation of Nam Ngum2 hydropower plant which is from design evaporation data of project construction and these data are used for NamNgum-1 hydropower plant by calculating percent, decreasing 100% to 7%, the detail is shown as below:

Table A.8 Evaporation of NamNgum2 hydropower plant (7%)

Jan	Feb	Mar	April	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
9	9	11	11	10	9	9	8	8	10	9	9	113

Once having opened a HEC-ResSim3.0 or NamNgum-1 Watershed Model. From the **Reservoir Network module** of the alternative model Editor. Right click cursor at model and select the **Edit reservoir Properties.** An NamNgum1Watershed browser window will open, as shown in Figure A.11.

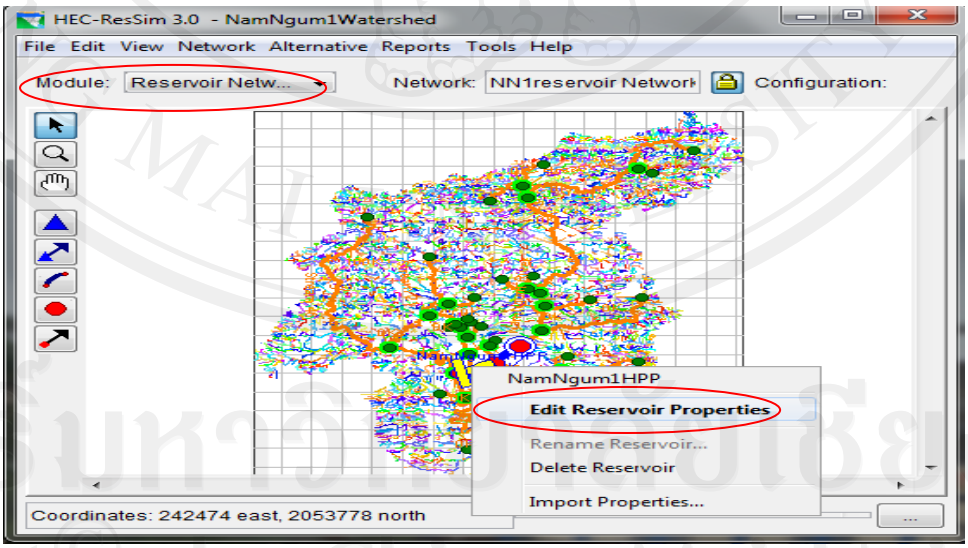


Figure A.11 Showing the input evaporation 7% into model

To edit Evaporation data, select **Evaporation** in the reservoir tree. Figure A.12 shows the Reservoir Editor's Evaporation data editor and its corresponding mini-plot. The mini-plot will reflect the values entered and can be viewed in full size when double-clicking on it. Choose either Monthly Average Evaporation or Evaporation data 7% of Nam Ngum2 in Table A.9.

Note: If select the **Monthly Average Evaporation:** Enter Evaporation values by month. To enter data into the table, either copy or paste it from a spreadsheet application or type in the values manually. Click Apply and Ok, as shown in Figure A.12.

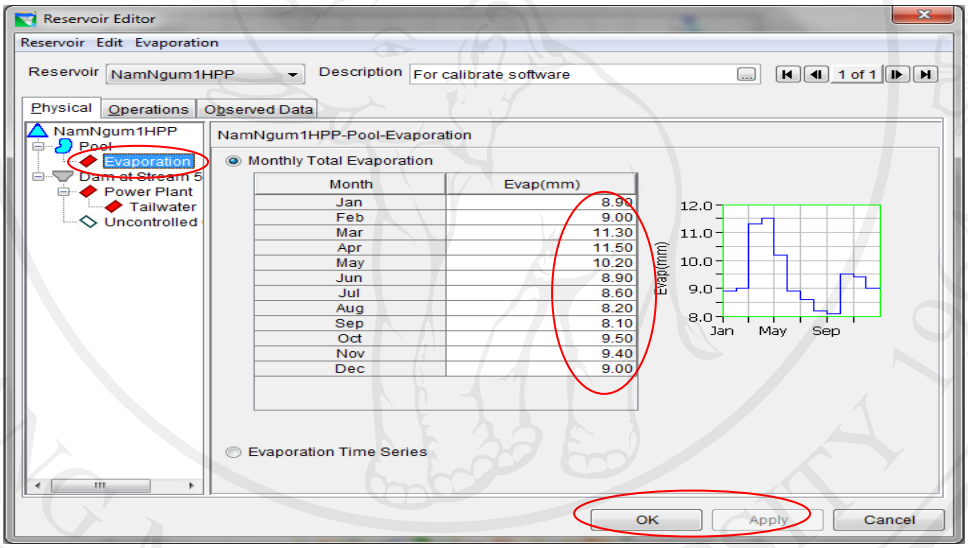


Figure A.12 Showing the input evaporation 7% into model

After inputting all data and parameters as desired, a compute a Simulation can be completed. In the Simulation Control Panel of the main window of the Simulation Module, the simulation tree displays the current Simulation as a folder, beneath which is a list of the Alternatives associated with the Simulation. Also shown in the Simulation Control Panel is the time information associated with the Simulation.

To compute a Simulation, either click the **Compute** button in the Simulation Control Panel, as shown in Figure A.13.

After computing a Simulation, review results in many different forms. **Computer Messages** provide information about each step of the computation

process. **Plots** and **Tables** in the Simulation Module offer detailed views of data and model results. **Reports** provide details about individual components of the Reservoir Network.

Plots and tables in the Simulation Module offer detailed views of data and model results. To access a **Plot** from the display area, right-click on a model element in the map display. The shortcut menu will provide a list of one or more plot options, as select the **plot** illustrated in Figure A.13. To get the result comparison with actual data record and consider the R^2, EI, RMSE value the detail are shown as below:

R^2 =1, the simulation test is highly reliable

EI = 100%, the simulation test is highly reliable

RMSE = 0, the simulation test is highly reliable

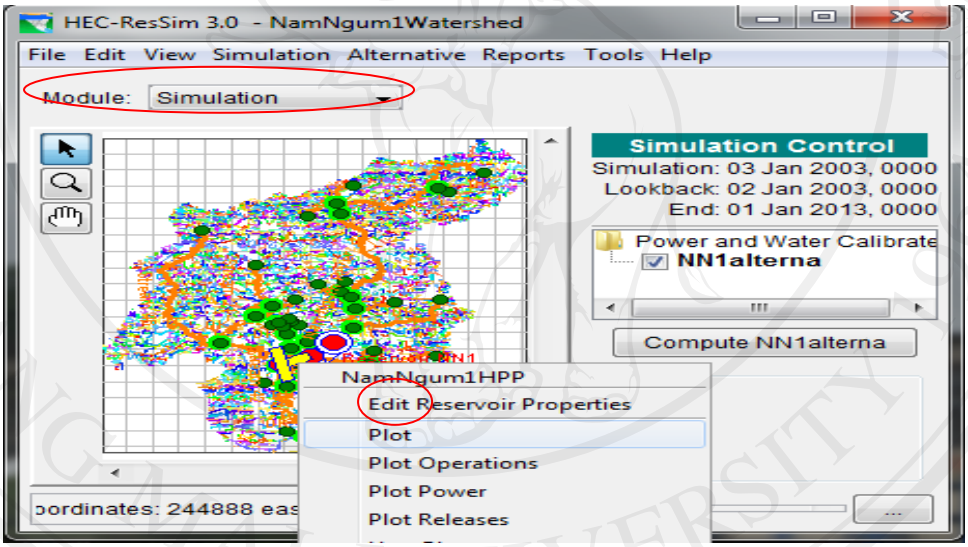


Figure A.13 Views the result of model

To get the result comparison with actual data record and see R^2, EI, RMSE value. From the **File** menu of the simulation module, select **Tabulate**. The **Plot** dialog box will open as illustrated in Figure A.14.

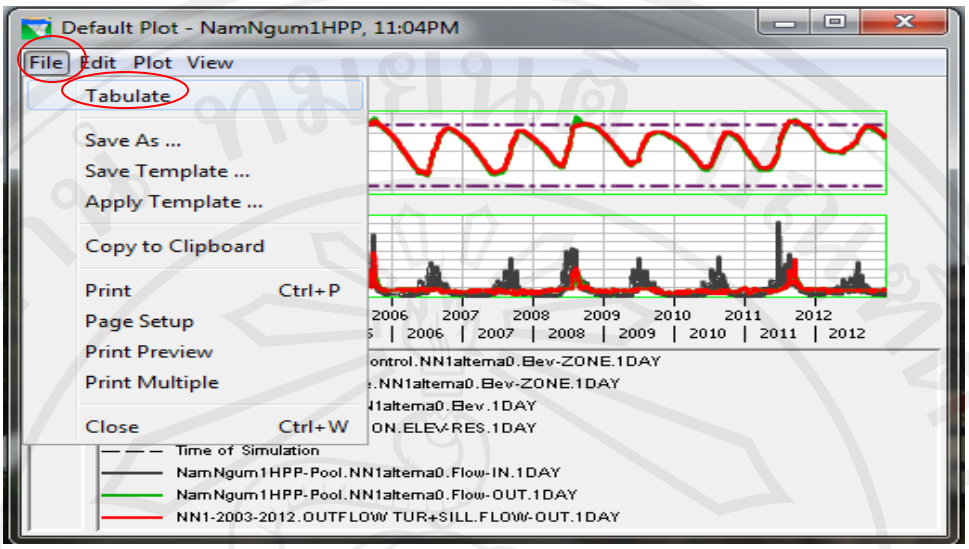
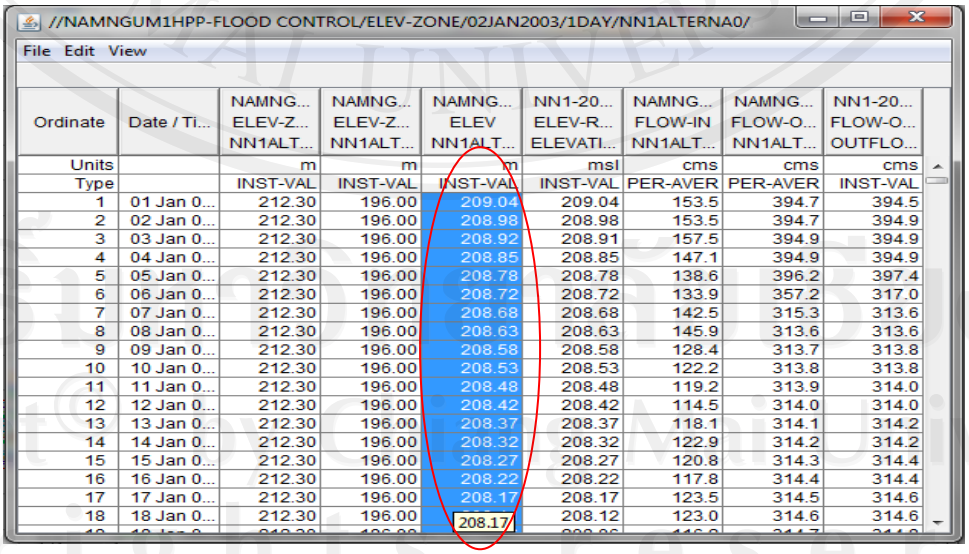


Figure A.14 Views the graph result of model

HEC-ResSim3.0 plots offer a variety of information that will assist with reviewing the results of a Simulation. Included in the information available from the default plots are reservoir elevation, storage, and release values as well as regulated and unregulated (without reservoirs and other projects) flow values. View plotted data in tabular form by selecting **Tabulate** from the **File** menu of the plot. Select **Tabulate** the **Result table** dialog box will open as illustrated in Table A.9.

Table A.9 Views the graph result of model



Ordinate	Date / Ti...	NAMNG... ELEV-Z... NN1ALT...	NAMNG... ELEV-Z... NN1ALT...	NAMNG... ELEV NN1ALT...	NN1-20... ELEV-R... ELEVATI...	NAMNG... FLOW-IN NN1ALT...	NAMNG... FLOW-O... NN1ALT...	NN1-20... FLOW-O... OUTFLO...
Units		m	m	m	msl	cms	cms	cms
Type		INST-VAL	INST-VAL	INST-VAL	INST-VAL	PER-AVER	PER-AVER	INST-VAL
1	01 Jan 0...	212.30	196.00	209.04	209.04	153.5	394.7	394.5
2	02 Jan 0...	212.30	196.00	208.98	208.98	153.5	394.7	394.9
3	03 Jan 0...	212.30	196.00	208.92	208.91	157.5	394.9	394.9
4	04 Jan 0...	212.30	196.00	208.85	208.85	147.1	394.9	394.9
5	05 Jan 0...	212.30	196.00	208.78	208.78	138.6	396.2	397.4
6	06 Jan 0...	212.30	196.00	208.72	208.72	133.9	357.2	317.0
7	07 Jan 0...	212.30	196.00	208.68	208.68	142.5	315.3	313.6
8	08 Jan 0...	212.30	196.00	208.63	208.63	145.9	313.6	313.6
9	09 Jan 0...	212.30	196.00	208.58	208.58	128.4	313.7	313.8
10	10 Jan 0...	212.30	196.00	208.53	208.53	122.2	313.8	313.8
11	11 Jan 0...	212.30	196.00	208.48	208.48	119.2	313.9	314.0
12	12 Jan 0...	212.30	196.00	208.42	208.42	114.5	314.0	314.0
13	13 Jan 0...	212.30	196.00	208.37	208.37	118.1	314.1	314.2
14	14 Jan 0...	212.30	196.00	208.32	208.32	122.9	314.2	314.2
15	15 Jan 0...	212.30	196.00	208.27	208.27	120.8	314.3	314.4
16	16 Jan 0...	212.30	196.00	208.22	208.22	117.8	314.4	314.4
17	17 Jan 0...	212.30	196.00	208.17	208.17	123.5	314.5	314.6
18	18 Jan 0...	212.30	196.00	208.17	208.12	123.0	314.6	314.6

To copy row select or result of simulation model to the Microsoft excel for comparison with actual data record and consider the R^2, EI, RMSE value, the detail are shown as below, dialog box will open as illustrated in Table A.10.

R^2 =1, the simulation test is highly reliable

EI = 100%, the simulation test is highly reliable

RMSE = 0, the simulation test is highly reliable

Table A.10 Comparison result of model and actual data record

Calibration	
R^2	0.997
EI	99.17%
RMSE	0.66
WB	-0.13%

Vertification	
R^2	0.787
EI	#REF!
RMSE	35.29
WB	-14.43%

	Evaporation 7%	
Date	Simulated	Observed
01/01/2003	209.04	209.04
02/01/2003	208.98	208.98
03/01/2003	208.92	208.91
04/01/2003	208.85	208.85
05/01/2003	208.78	208.78
06/01/2003	208.72	208.72
07/01/2003	208.68	208.68
08/01/2003	208.63	208.63
09/01/2003	208.58	208.58
10/01/2003	208.53	208.53
11/01/2003	208.48	208.48
12/01/2003	208.42	208.42
13/01/2003	208.37	208.37
14/01/2003	208.32	208.32
15/01/2003	208.27	208.27
16/01/2003	208.22	208.22
17/01/2003	208.17	208.17
18/01/2003	208.11	208.12
19/01/2003	208.06	208.06
20/01/2003	208.01	208.01
21/01/2003	207.96	207.96
22/01/2003	207.90	207.91
23/01/2003	207.85	207.85

The plot window displays the location name in the title bar. Axis labels and a color-coded legend identify the data contained in the plot. The blue line is water elevation data result from simulation and red line is water elevation actual data record from 2003-2012.This test uses water elevation simulation to compare with actual data by considering R^2 (Root Square), EI (Efficiency Index), RMSE (Root Mean Square Error) which are detailed as following items:

If evaporation 7%, get the R^2 = 0.997, EI= 99.17% and RMSE = 0.66

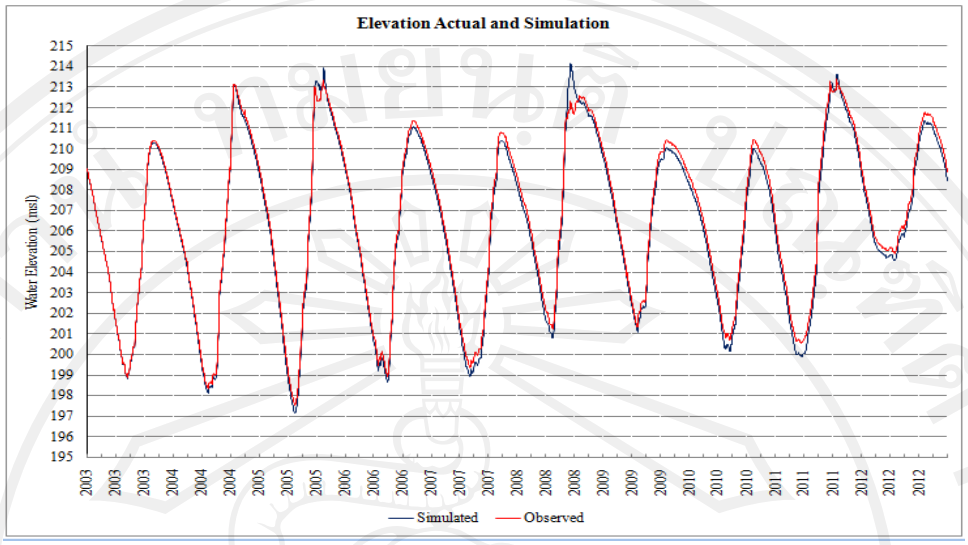


Figure A.15 Comparison water elevation simulation and actual data

From simulation result shows evaporation of 7% and station use, the simulation can provide the elevation closely with actual data. Therefore, in the next step, the simulation model will be used for water management of NanNgum-1 hydropower plant.

A.2 Power data calibration model

This research is calibration model. This test uses energy result from model to compare with actual data record by considering R^2 (Root Square), EI (Efficiency Index). Use the data Station Use and Hydraulic loss. These data are used for NamNgum-1 'reservoir loss by predicting step by step. Starting from 1.0, 1.5, 2.0 and constant efficiency 97%, the detail is shown in three steps:

A.2.1 First calibration model for power

Due to data **Station Use** and **Hydraulic loss** of NamNgum-1 hydropower plant no have not been recorded, use the method that makes a guess for the value, which is from guess data Station Use and Hydraulic loss. This data are used for NamNgum-1 reservoir to try, increasing 1.0, 1.5, and 2.0. Constance efficiency 97% the detail is shown as below:

Table A.11 Station Use, Hydraulic loss (1.0)

Station Use(cms)	Hydraulic loss(m)	Efficiency (%)
1.0	1.0	97

After having created a reservoir network or having opened an existing reservoir network. Select Network the list of model displays the name of the window or dialog box currently. The name of opened reservoir network displays next to. Select and click **Open** and dialog box will open as illustrated in Figure A.16.

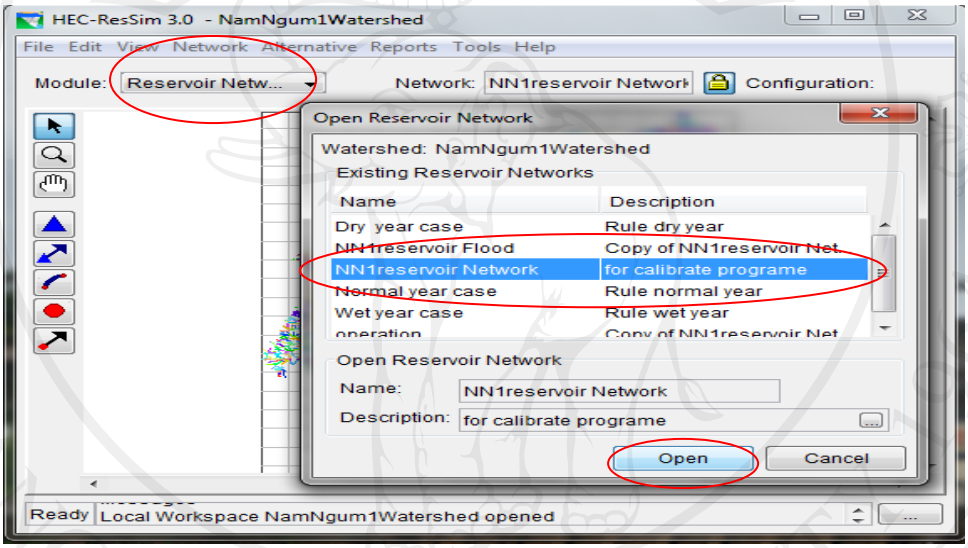


Figure A.16 Show open the model

Select the **Model.** Right-click on the picture and select **Edit Reservoir Properties** to open editing power plant physical data, as shown in Figure A.17.

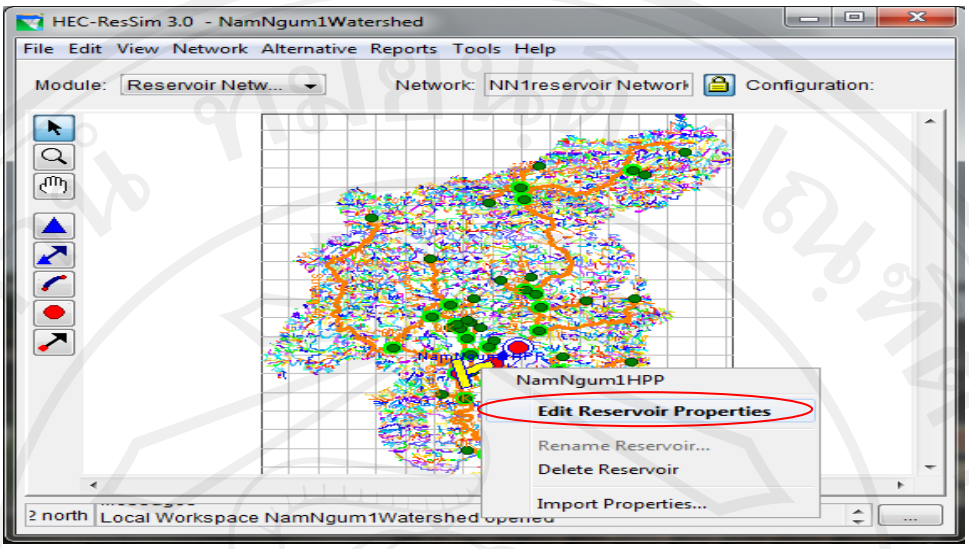


Figure A.17 Show open the model

On the **Power plant** tree, enter Station Use and Hydraulic loss data. Then click **Apply** and click **Ok** , as shown in Figure A.18.

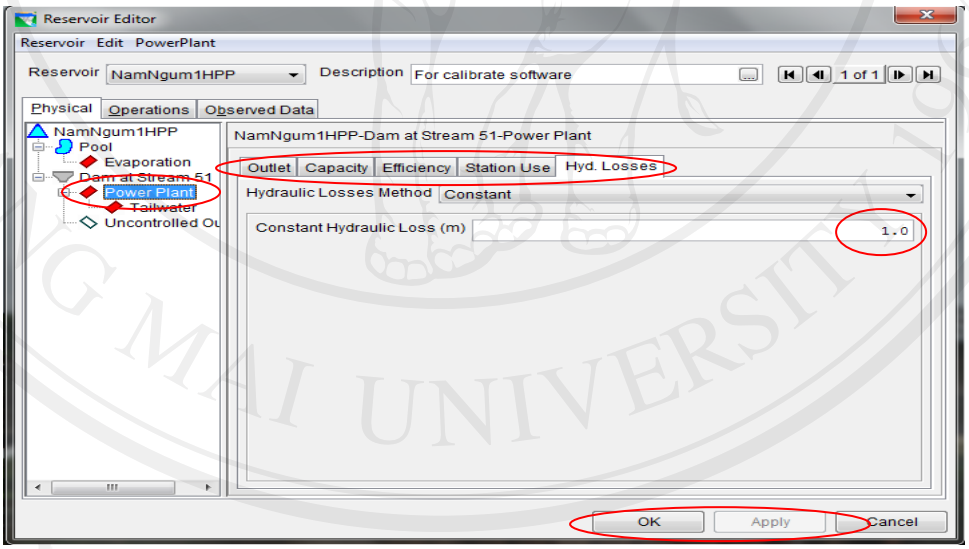


Figure A.18 Step input parameter into model

After inputting all data and parameters as desired, a Simulation can be computed. In the Simulation Control Panel of the main window of the Simulation Module, the simulation tree displays the current Simulation as a folder, beneath which is a list of the Alternatives associated with the Simulation. Also shown in the Simulation Control Panel is the time information associated with the Simulation.

Select the **New simulation** and select case simulation to open inputting time interval data and click **Compute NN1Alterna**, as shown in Figure A.19.

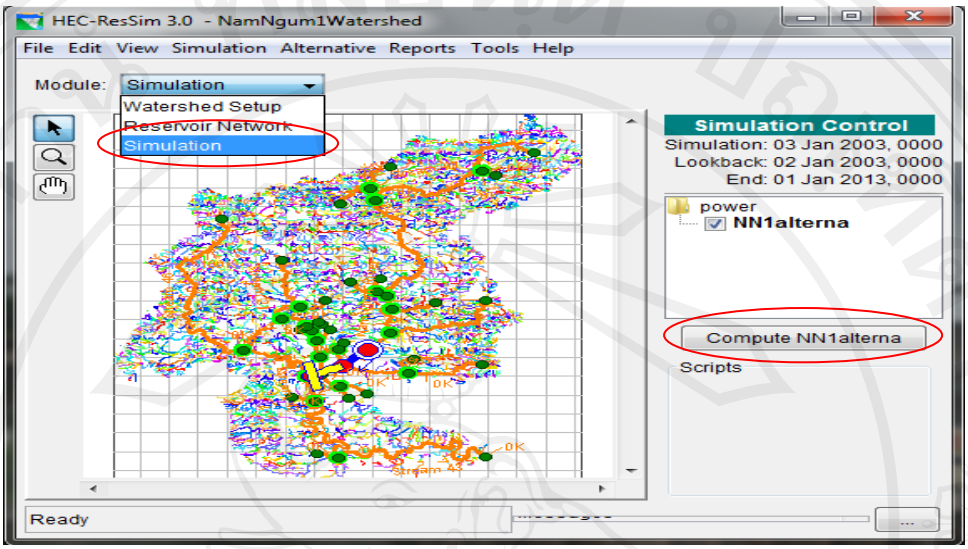


Figure A.19 Step of run simulation model

When computing a Simulation, a **Compute** window opens. The **Compute** window provides **Message Output** that contains information regarding the status of each step of the computation process. The **Progress Bar** indicates the percentage of completion for each step. When the computation is finished, the **Progress Bar** is completely filled in and reads “100%” along with the message “Compute Complete” in the **Message Bar** of the **Compute** window.

If there are errors or any problems during the execution process, review the Message Output Text area of the compute window. Also the **Compute Log** can provide information regarding the type of problem that exists. Click **Close** to close the Compute window, as shown in Figure A.20.

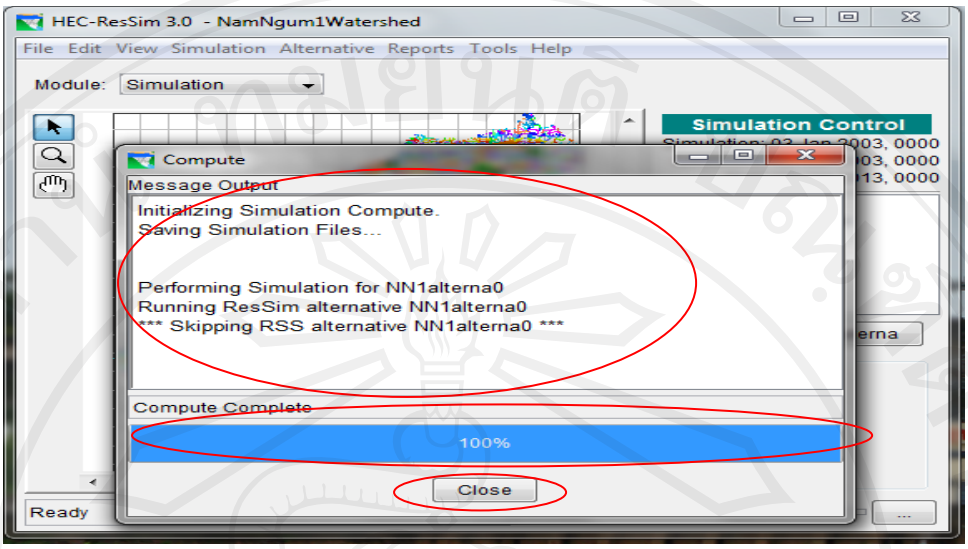


Figure A.20 Run simulation model

Plots and tables in the Simulation Module offer detailed views of data and model results. Access plots using shortcut menus in the Simulation Module's display area. To access a **Plot** from the display area, right-click on a model element in the map display. The shortcut menu will provide a list of one or more plot options, as illustrated in Figure A.21.

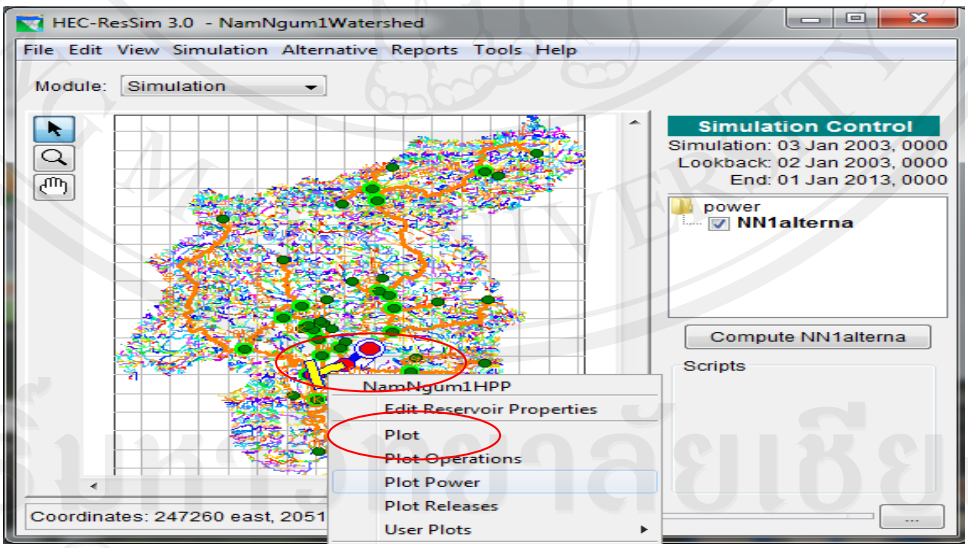


Figure A.21 To access result of simulation model

Once having opened a plot, also tabulate values by selecting **Select Variables** from the plot and from **File** menu select **Tabulate.**

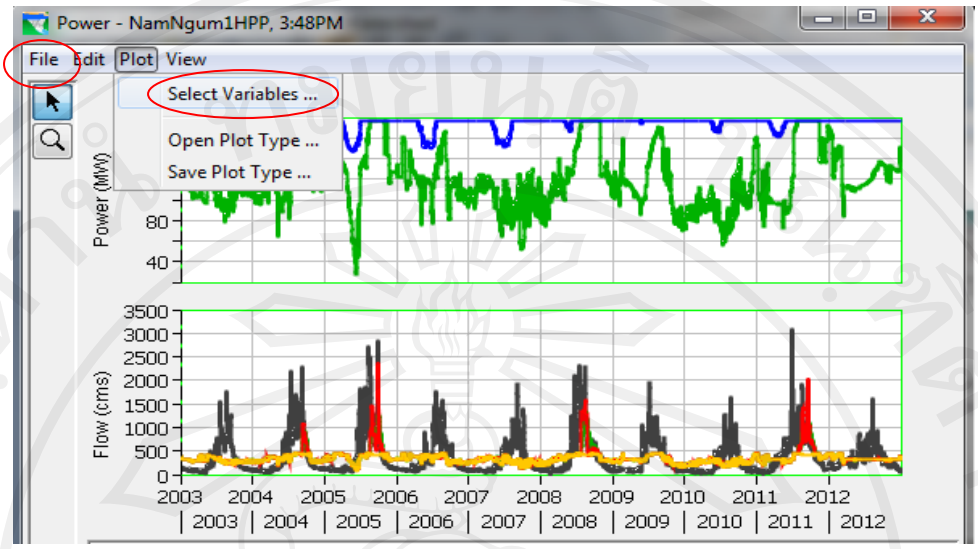


Figure A.22 To access result of simulation model

Select **Variables** from the **Plot** Menu. The **Select Plot Variables** dialog box will appear (Figure A.23). Select the Power Generated Power Capability and Power Required. Click the **Remove** button for changing of units from MW to MWh. Then select the **Apply** button and click **Ok** as illustrated in Figure A.23.

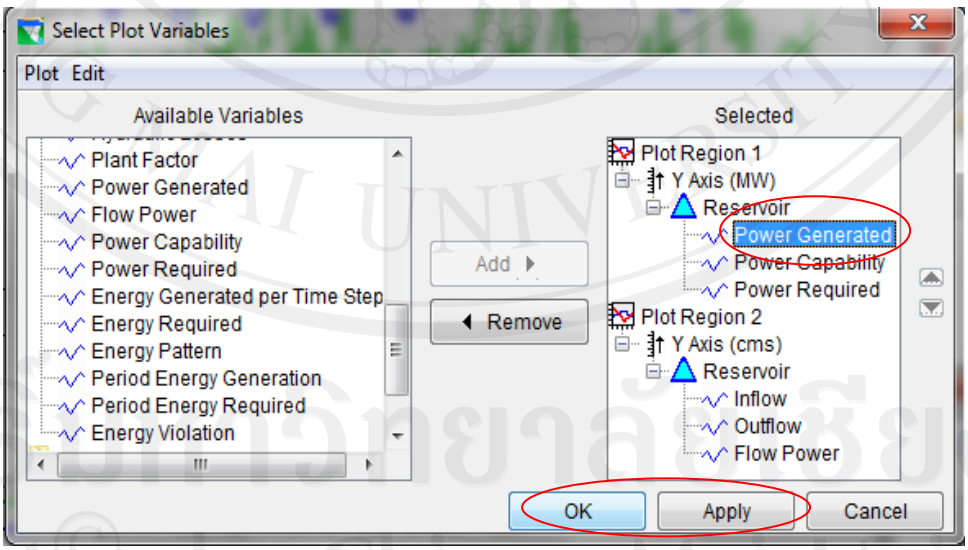


Figure A.23 To access result of simulation model

Select **Variables** from the **Plot** Menu. The **Select Plot Variables** dialog box will appear (Figure A.24). Select the **Energy Generate per Time Step**. Click the **Add** button for keep MWh. Then select the Apply button and click Ok as illustrated in Figure A.24.

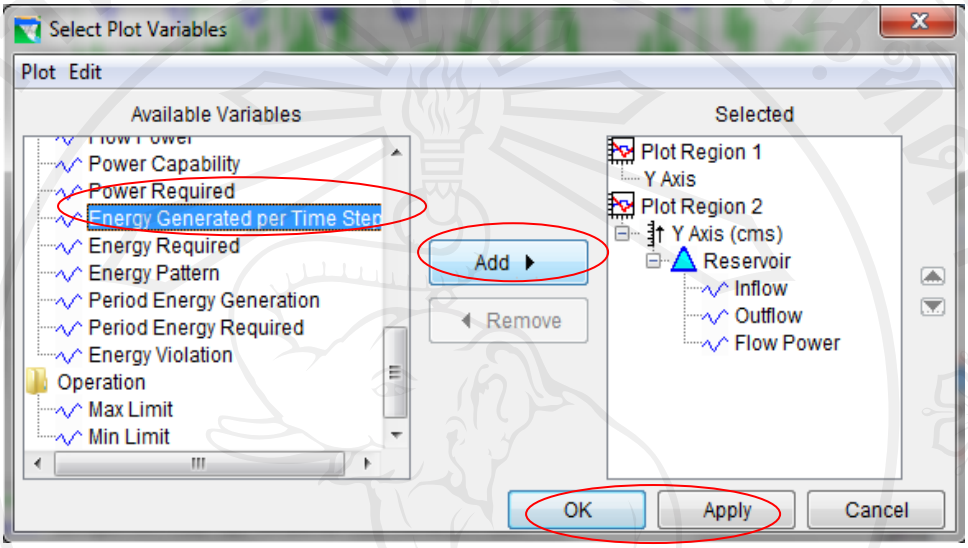


Figure A.24 To access result of simulation model

Once having opened a plot, also tabulate values by selecting **Select Variables** from the plot and from **File** menu select **Tabulate.**

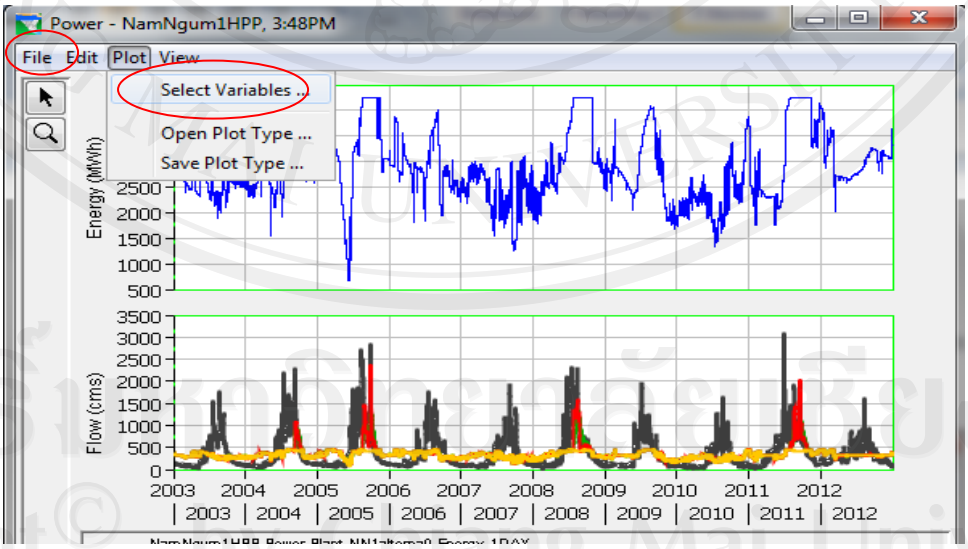
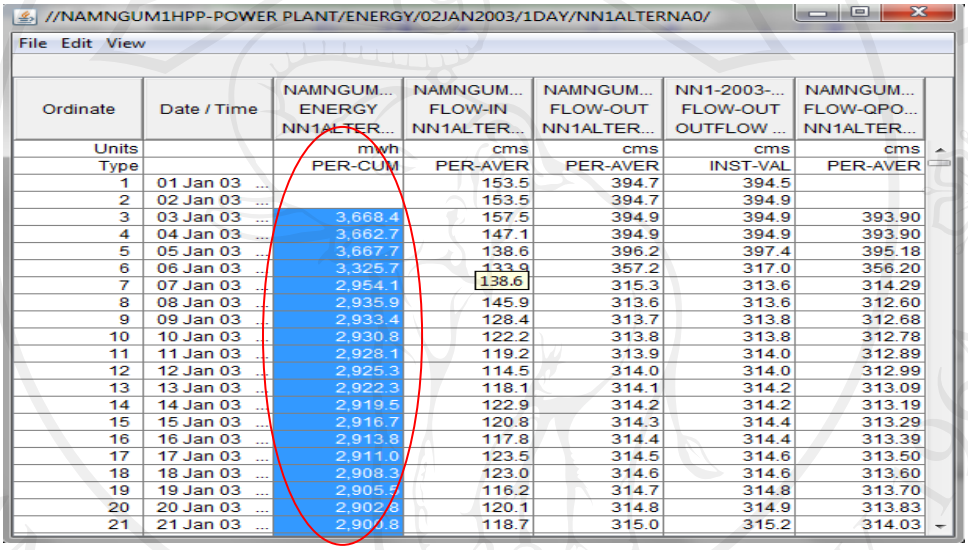


Figure A.25 To access result of simulation model

HEC-ResSim3.0 plots offer a variety of information that will assist with reviewing the results of a Simulation. Included in the information available from the default plots are energy, flow-in, flow-out and total release values as well as regulated and unregulated (without reservoirs and other projects) energy values. View plotted data in tabular form by selecting **Tabulate** from the **File** menu of the plot. Select **Tabulate** the **Result table** dialog box will open as illustrated in Table A.12

Table A.12 Views the graph result of model



//NAMNGUM1HPP-POWER PLANT/ENERGY/02JAN2003/1DAY/NN1ALTERNA0/

File Edit View

Ordinate	Date / Time	NAMNGUM... ENERGY NN1ALTER...	NAMNGUM... FLOW-IN NN1ALTER...	NAMNGUM... FLOW-OUT NN1ALTER...	NN1-2003-... FLOW-OUT OUTFLOW ...	NAMNGUM... FLOW-QPO... NN1ALTER...
Units		mwh	cms	cms	cms	cms
Type		PER-CUM	PER-AVER	PER-AVER	INST-VAL	PER-AVER
1	01 Jan 03 ...		153.5	394.7	394.5	
2	02 Jan 03 ...		153.5	394.7	394.9	
3	03 Jan 03 ...	3,668.4	157.5	394.9	394.9	393.90
4	04 Jan 03 ...	3,662.7	147.1	394.9	394.9	393.90
5	05 Jan 03 ...	3,667.7	138.6	396.2	397.4	395.18
6	06 Jan 03 ...	3,325.7	133.9	357.2	317.0	356.20
7	07 Jan 03 ...	2,954.1	138.6	315.3	313.6	314.29
8	08 Jan 03 ...	2,935.9	145.9	313.6	313.6	312.60
9	09 Jan 03 ...	2,933.4	128.4	313.7	313.8	312.68
10	10 Jan 03 ...	2,930.8	122.2	313.8	313.8	312.78
11	11 Jan 03 ...	2,928.1	119.2	313.9	314.0	312.89
12	12 Jan 03 ...	2,925.3	114.5	314.0	314.0	312.99
13	13 Jan 03 ...	2,922.3	118.1	314.1	314.2	313.09
14	14 Jan 03 ...	2,919.5	122.9	314.2	314.2	313.19
15	15 Jan 03 ...	2,916.7	120.8	314.3	314.4	313.29
16	16 Jan 03 ...	2,913.8	117.8	314.4	314.4	313.39
17	17 Jan 03 ...	2,911.0	123.5	314.5	314.6	313.50
18	18 Jan 03 ...	2,908.3	123.0	314.6	314.6	313.60
19	19 Jan 03 ...	2,905.5	116.2	314.7	314.8	313.70
20	20 Jan 03 ...	2,902.8	120.1	314.8	314.9	313.83
21	21 Jan 03 ...	2,900.8	118.7	315.0	315.2	314.03

To copy row select or result of simulation model to the Microsoft excel for comparison with actual data record and consider the R^2 and EI value the detail are shown as below, dialog box will open as illustrated in Table A.13.

R^2 =1, the simulation test is highly reliable

EI = 100%, the simulation test is highly reliable

Table A.13 Comparison result of model and actual data record

Station Use ,Hydraulic loss (1)

Calibration	
R^2	0.905
EI	88.71%
RMSE	418.77
WB	326772.02%

Vertification	
R^2	0.787
EI	#REF!
RMSE	35.29
WB	-14.43%

Date	Simulated	Observed
01/01/2003		
02/01/2003		
03/01/2003	3668.40	3523.50
04/01/2003	3662.70	3522.70
05/01/2003	3667.70	3514.40
06/01/2003	3325.70	3499.70
07/01/2003	2954.10	3493.60
08/01/2003	2935.90	2804.50
09/01/2003	2933.40	2790.30
10/01/2003	2930.80	2788.70
11/01/2003	2928.10	2782.90
12/01/2003	2925.30	2783.00
13/01/2003	2922.30	2776.00
14/01/2003	2919.50	2779.20
15/01/2003	2916.70	2774.30
16/01/2003	2913.80	2769.10
17/01/2003	2911.00	2767.10
18/01/2003	2908.30	2762.30

The plot window displays the location name in the title bar. Axis labels and a color-coded legend identify the data contained in the plot. The blue line is energy data result from simulation and red line is energy actual data record from 2003-2012.This test uses water elevation simulation to compare with actual data by considering R^2 (Root Square), EI (Efficiency Index), RMSE (Root Mean Square Error) which are detailed as following items:

If Station Use and Hydraulic loss 1.0, get the R^2 = 0.905 and EI= 88.71%

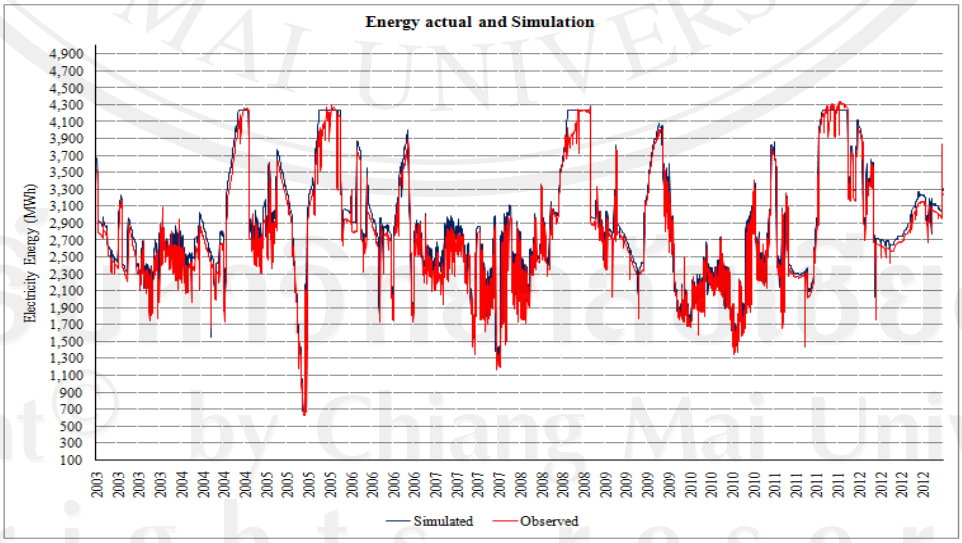


Figure A.26. Comparison water elevation simulation and actual data

Due to comparison of simulation result and actual energy not highly reliable, then calibration in the next step.

A.2.2 Second calibration model for power

Due to data **Station Use** and **Hydraulic loss** of NamNgum-1 hydropower plant no have recorded. Use the method makes a guess for the value, which is from guess data Station Use and Hydraulic loss this data is used for NamNgum-1' reservoir to try , increasing 1.0,1.5,and 2.0. Constant efficiency 97% , the detail is shown as below:

Table A.14 Station Use, Hydraulic loss (1.5)

Station Use (cms)	Hydraulic loss (m)	Efficiency(%)
1.5	1.5	97

After having created a reservoir network or have opened an existing reservoir network. Select Network the list of model displays the name of the window or dialog box currently. The name of opened reservoir network displays next to. Select and click **Open** and dialog box will open as illustrated in Figure A.27.

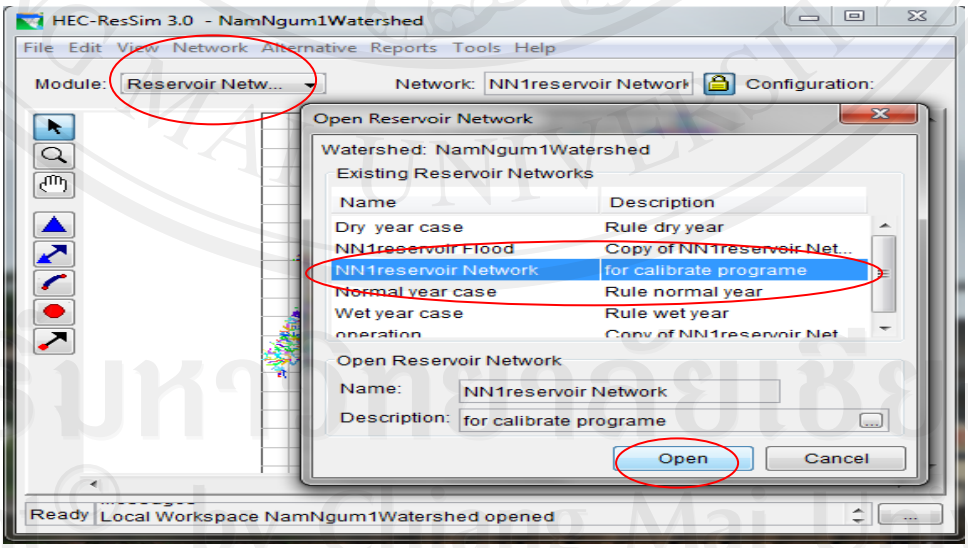


Figure A.27 Show open the model

Select the **Model.** Right-click on the picture and select **Edit Reservoir Properties** to open editing power plant physical data, as shown in Figure A.28.

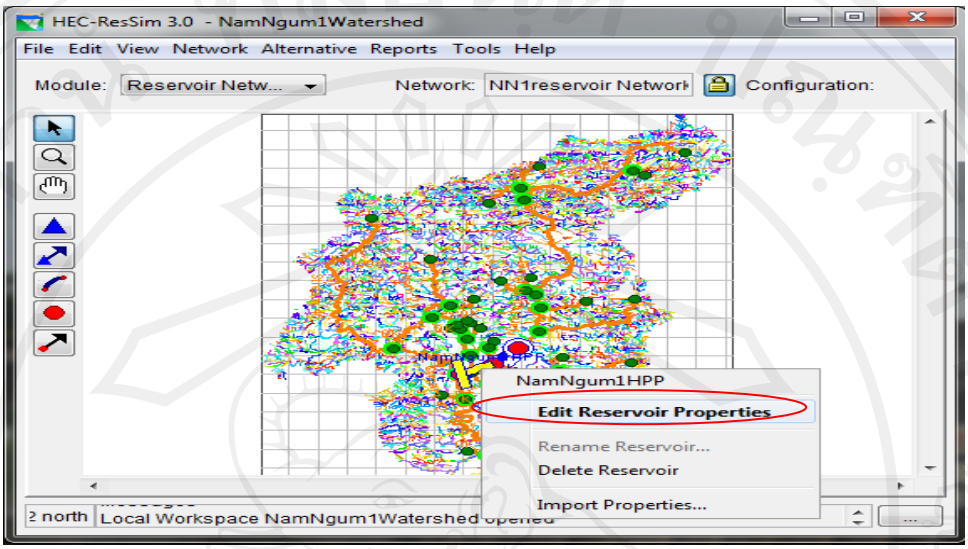


Figure A.28 Show opens the model

On the **Power plant** tree, enter Station Use and Hydraulic loss data. Then click **Apply** and click **Ok**, as shown in Figure A.29.

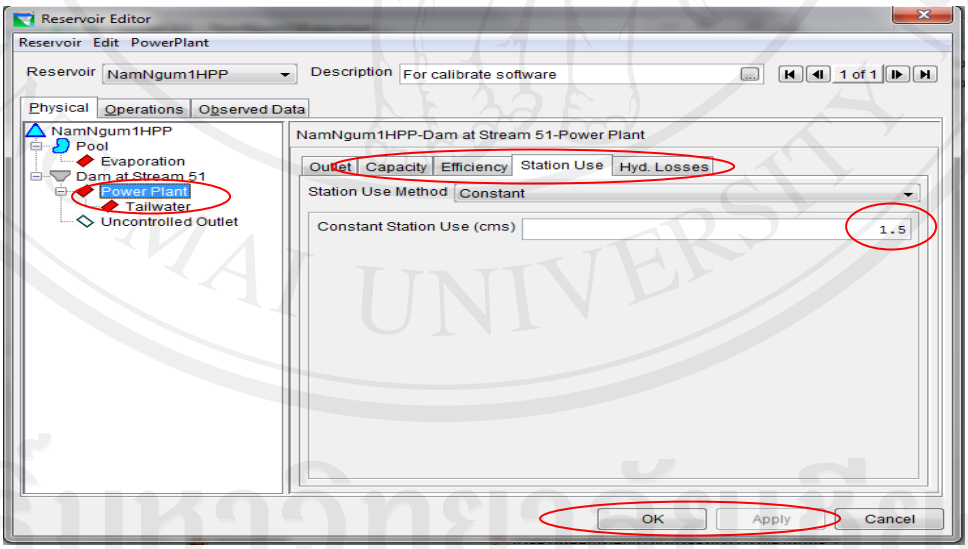


Figure A.29 Step input parameter into model

After inputting all data and parameters as desired, a Simulation can be computed. In the Simulation Control Panel of the main window of the Simulation Module, the simulation tree displays the current Simulation as a folder, beneath which

is a list of the Alternatives associated with the Simulation. Also shown in the Simulation Control Panel is the time information associated with the Simulation.

Select the **New simulation** and select case simulation to be opens inputting time interval data and click **Compute NN1Alterna** , as shown in Figure A.30.

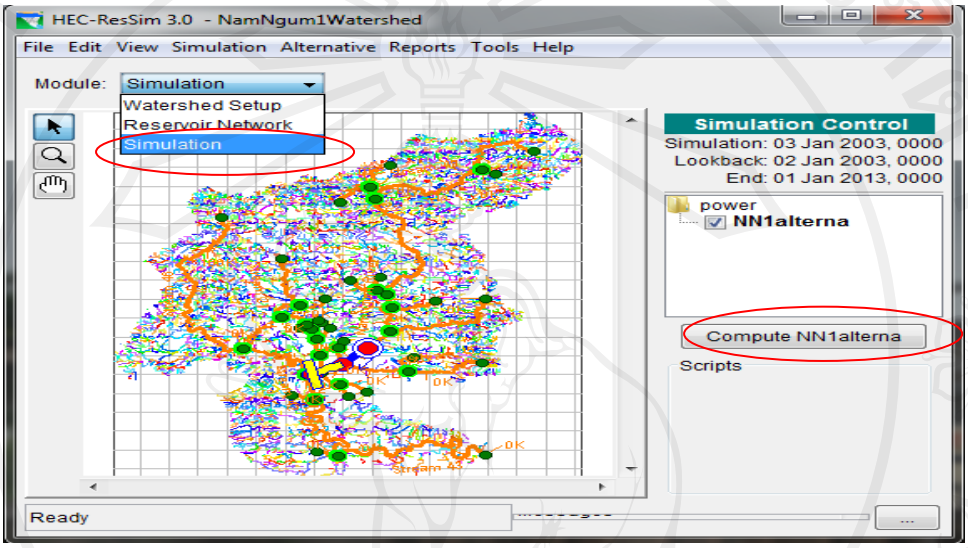


Figure A.30 Step of run simulation model

When computing a Simulation, a **Compute** window opens. The **Compute** window provides **Message Output** that contains information regarding the status of each step of the computation process. The **Progress Bar** indicates the percentage of completion for each step. When the computation is finished, the **Progress Bar** is completely filled in and reads “100%” along with the message “Compute Complete” in the **Message Bar** of the **Compute** window.

If there are errors or any problems during the execution process, review the Message Output Text area of the compute window. Also the **Compute Log** can provide information regarding the type of problem that exists. Click **Close** to close the Compute window, as shown in Figure A.31.

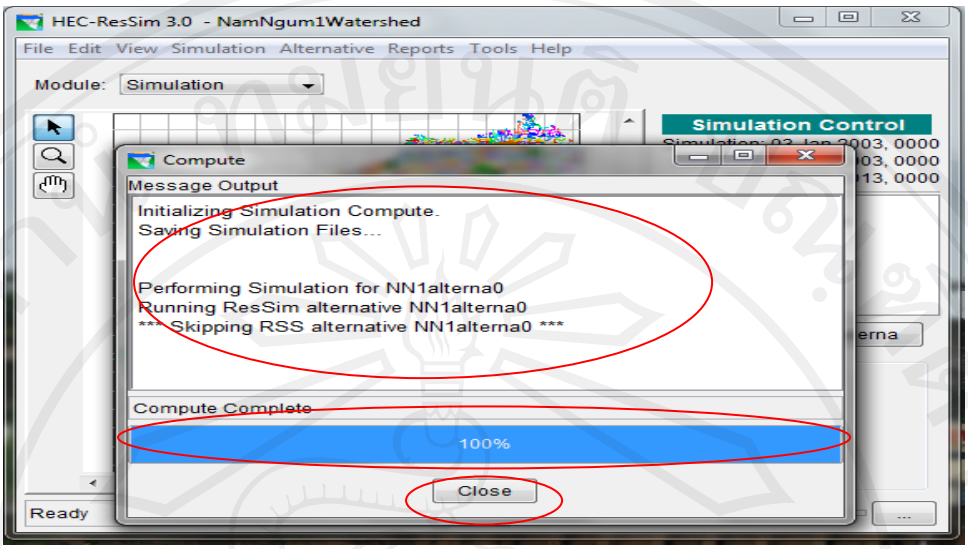


Figure A.31 Run simulation model

Plots and tables in the Simulation Module offer detailed views of data and model results. Access plots using shortcut menus in the Simulation Module's display area. To access a **Plot** from the display area, right-click on a model element in the map display. The shortcut menu will provide a list of one or more plot options, as illustrated in Figure A.32.

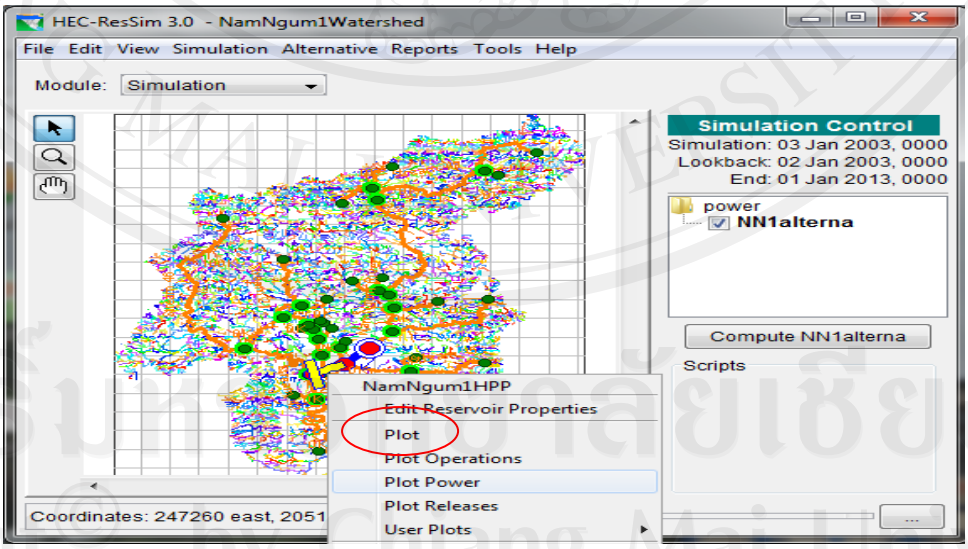


Figure A.32 To access result of simulation model

Once having opened a plot, also tabulate values by selecting **Select Variables** from the plot and from **File** menu select **Tabulate.**

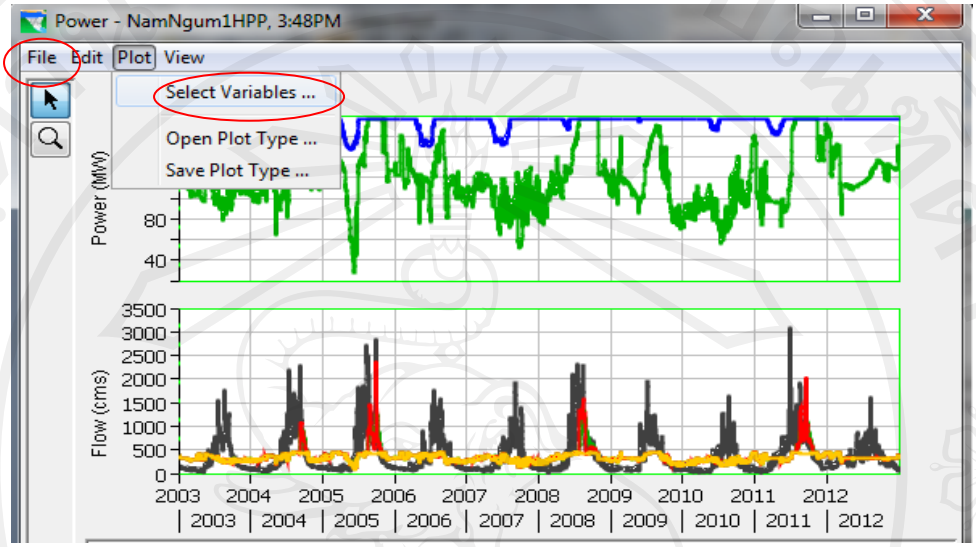


Figure A.33 To access result of simulation model

Select **Variables** from the **Plot** Menu. The **Select Plot Variables** dialog box will appear (Figure A.34). Select the Power Generated, Power Capability and Power Required. Click the **Remove** button for changing of units from MW to MWh. Then select the **Apply** button and click **Ok** as illustrated in Figure A.34.

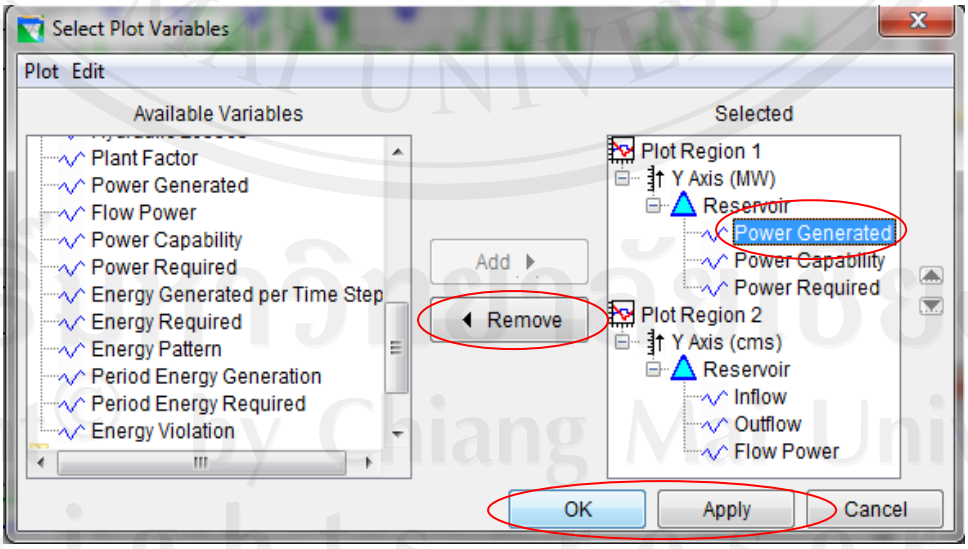


Figure A.34 To access result of simulation model

Select **Variables** from the **Plot** Menu. The **Select Plot Variables** dialog box will appear (Figure A.35). Select the **Energy Generate per Time Step**. Click the **Add** button for keep MWh. Then select the Apply button and click Ok as illustrated in Figure A.35.

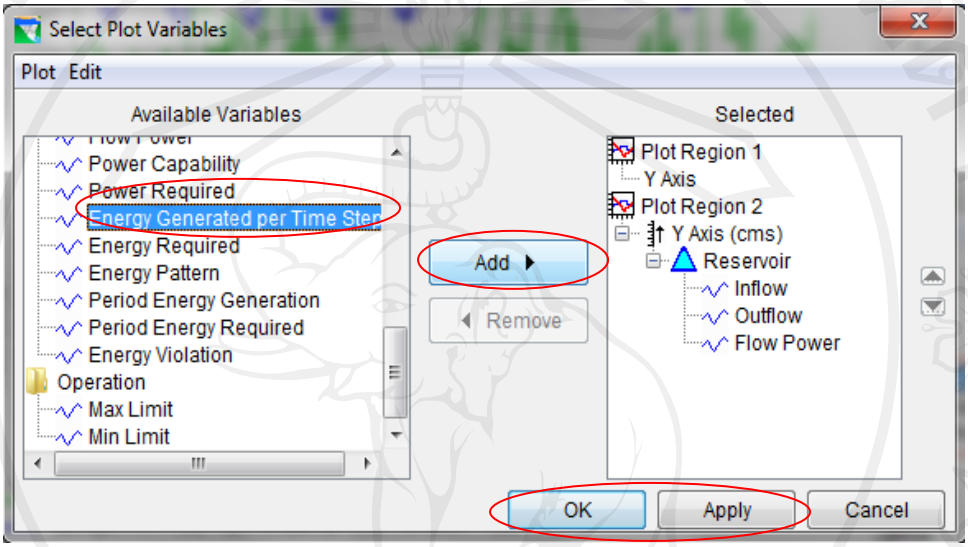


Figure A.35 To access result of simulation model

Once having opened a plot, also tabulate values by selecting **Select Variables** from the plot and from **File** menu select **Tabulate.**

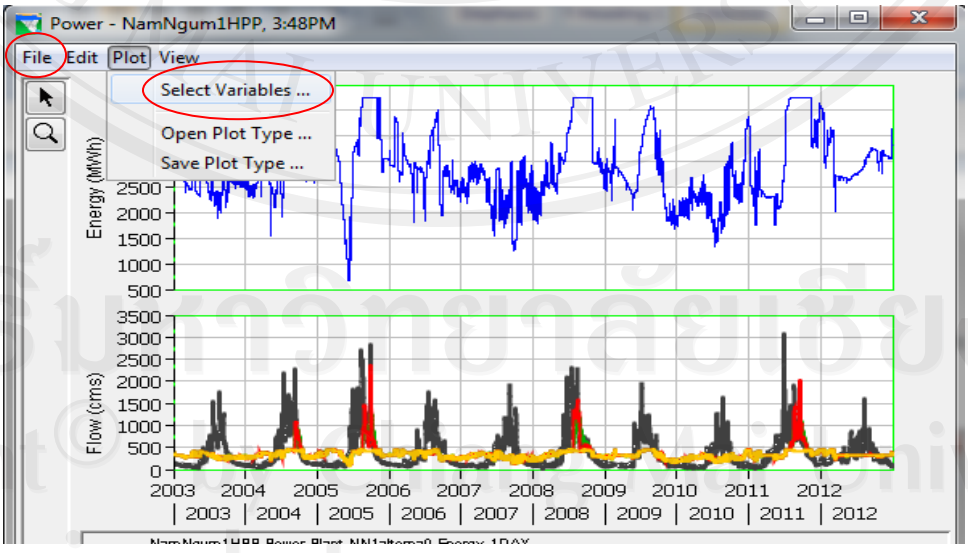


Figure A.36 To access result of simulation model

HEC-ResSim3.0 plots offer a variety of information that will assist with reviewing the results of a Simulation. Included in the information available from the default plots are energy, flow-in, flow-out and total release values as well as regulated and unregulated (without reservoirs and other projects) energy values. View plotted data in tabular form by selecting **Tabulate** from the **File** menu of the plot. Select **Tabulate** the **Result table** dialog box will open as illustrated in Table A.15

Table A.15 Views the graph result of model

Ordinate	Date / Time	NAMNGUM1HP... ENERGY NN1ALTERNA0	NAMNGUM1HP... FLOW-IN NN1ALTERNA0	NAMNGUM1HP... FLOW-OUT NN1ALTERNA0	NN1-2003-2012 FLOW-OUT OUTFLOW TUR...	NAMNGUM1 FLOW-QPOV NN1ALTERI
Units		mwh	cms	cms	cms	
Type		PER-CUM	PER-AVER	PER-AVER	INST-VAL	PER-A
1	01 Jan 03 24:00		153.5	394.7	394.5	
2	02 Jan 03 24:00		153.5	394.7	394.9	
3	03 Jan 03 24:00	3,618.9	157.5	394.9	394.9	39
4	04 Jan 03 24:00	3,613.4	147.1	394.9	394.9	39
5	05 Jan 03 24:00	3,618.0	138.6	396.2	397.4	39
6	06 Jan 03 24:00	3,280.4	133.9	357.2	317.0	35
7	07 Jan 03 24:00	2,913.6	142.5	315.3	313.6	3
8	08 Jan 03 24:00	2,895.6	145.9	313.6	313.6	3
9	09 Jan 03 24:00	2,893.1	128.4	313.7	313.8	3
10	10 Jan 03 24:00	2,890.5	122.2	313.8	313.8	3
11	11 Jan 03 24:00	2,887.8	119.2	313.9	314.0	3
12	12 Jan 03 24:00	2,884.9	114.5	314.0	314.0	3
13	13 Jan 03 24:00	2,882.0	118.1	314.1	314.2	3
14	14 Jan 03 24:00	2,879.1	122.9	314.2	314.2	3
15	15 Jan 03 24:00	2,876.3	120.8	314.3	314.4	3
16	16 Jan 03 24:00	2,873.5	117.8	314.4	314.4	3
17	17 Jan 03 24:00	2,870.7	123.5	314.5	314.6	3
18	18 Jan 03 24:00	2,868.0	123.0	314.6	314.6	3
19	19 Jan 03 24:00	2,865.2	116.2	314.7	314.8	3
20	20 Jan 03 24:00	2,862.4	120.1	314.8	314.9	3
21	21 Jan 03 24:00	2,860.4	118.7	315.0	315.2	3
22	22 Jan 03 24:00	2,858.3	110.4	315.2	315.2	3
23	23 Jan 03 24:00	2,849.6	112.1	315.0 314.7	314.1	3
24	24 Jan 03 24:00	2,838.2	119.7	313.8	313.5	3
25	25 Jan 03 24:00	2,831.5	115.7	313.5	313.6	3
26	26 Jan 03 24:00	2,829.8	106.4	313.7	313.7	3
27	27 Jan 03 24:00	2,826.7	97.0	313.8	313.8	3

To copy row select or result of simulation model to the Microsoft excel for comparison with actual data record and consider the R^2 and EI value, the detail are shown as below, dialog box will open illustrated in Table A.16.

R^2 =1, the simulation test is highly reliable

EI = 100%, the simulation test is highly reliable

Table A.16 Comparison result of model and actual data record

Station Use ,Hydraulic loss (1.5)

Calibration	
R^2	0.906
EI	89.84%
RMSE	394.87
WB	322573.46%

Verification	
R^2	0.787
EI	#REF!
RMSE	35.29
WB	-14.43%

Date	Simulated	Observed
01/01/2003		
02/01/2003		
03/01/2003	3618.90	3523.50
04/01/2003	3613.20	3522.70
05/01/2003	3618.00	3514.40
06/01/2003	3280.40	3499.70
07/01/2003	2913.60	3493.60
08/01/2003	2895.60	2804.50
09/01/2003	2893.10	2790.30
10/01/2003	2890.50	2788.70
11/01/2003	2887.80	2782.90
12/01/2003	2884.90	2783.00
13/01/2003	2882.00	2776.00
14/01/2003	2879.10	2779.20
15/01/2003	2876.30	2774.30
16/01/2003	2873.50	2769.10
17/01/2003	2870.70	2767.10
18/01/2003	2868.00	2762.30

The plot window displays the location name in the title bar. Axis labels and a color-coded legend identify the data contained in the plot. The blue line is energy data result from simulation and red line is energy actual data record from 2003-2012.This test uses water elevation simulation to compare with actual data by considering R^2 (Root Square), EI (Efficiency Index), RMSE (Root Mean Square Error) which are detailed as following items:

If Station Use and Hydraulic loss 1.5, get the R^2 = 0.906 and EI= 89.84%

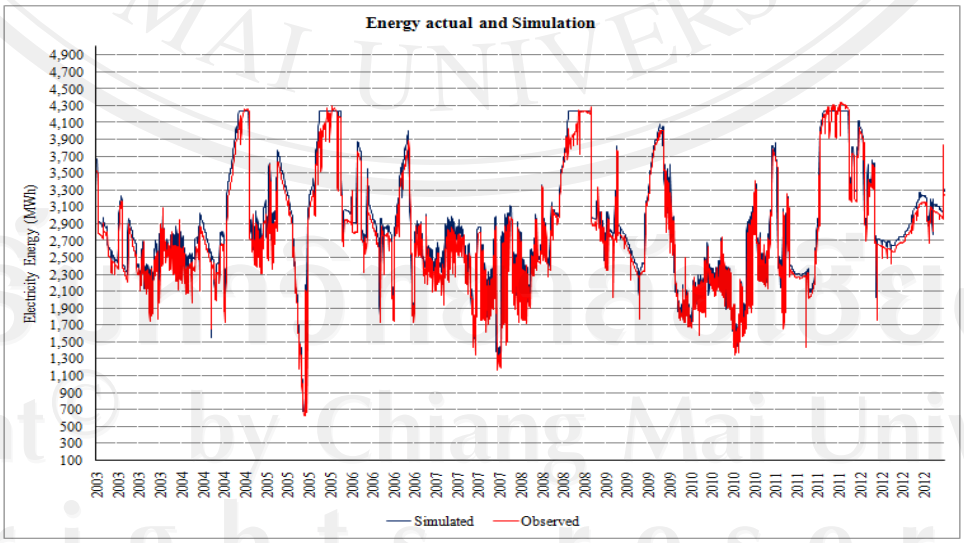


Figure A.37 Comparison water elevation simulation and actual data

Due to comparison of simulation result and actual energy not highly reliable, then calibration in the next step.

A.2.3 Third calibration model for power

Due to data **Station Use** and **Hydraulic loss** of NamNgum-1 hydropower plant have no recorded, use the method which makes a guess for the value, which is from guess data Station Use and Hydraulic loss these data are used for NamNgum-1' reservoir to try , increasing 1.0,1.5,and 2.0. Constant efficiency 97% the detail is shown as below:

Table A.17 Station Use, Hydraulic loss (2.0)

Station Use(cms)	Hydraulic loss(m)	Efficiency(%)
2.0	2.0	97

After having created a reservoir network or having opened an existing reservoir network. Select Network the list of model displays the name of the window or dialog box currently. The name of opened reservoir network displays next to. Select and click **Open** and dialog box will open as illustrated in Figure A.38.

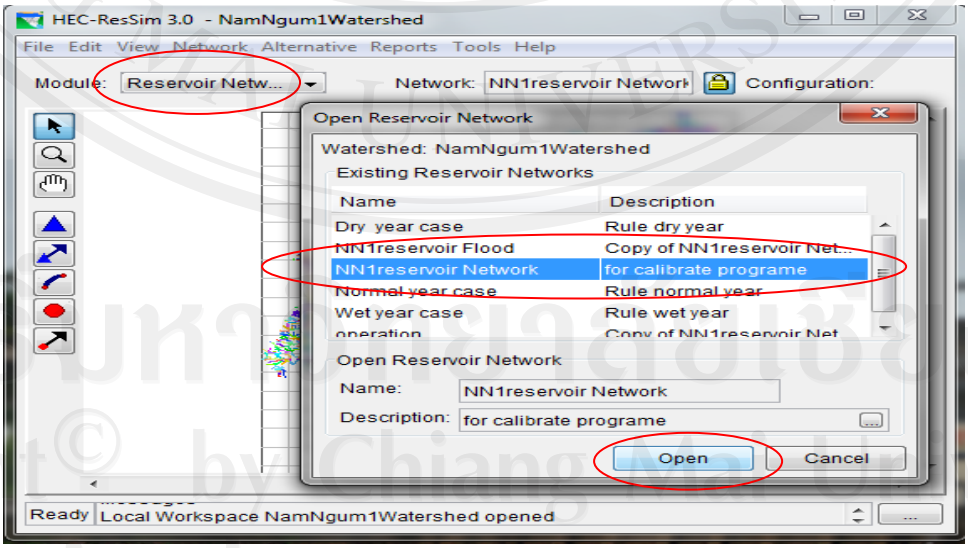


Figure A.38 Show open the model

Select the **Model.** Right-click on the picture and select **Edit Reservoir Properties** to open editing power plant physical data, as shown in Figure A.39.

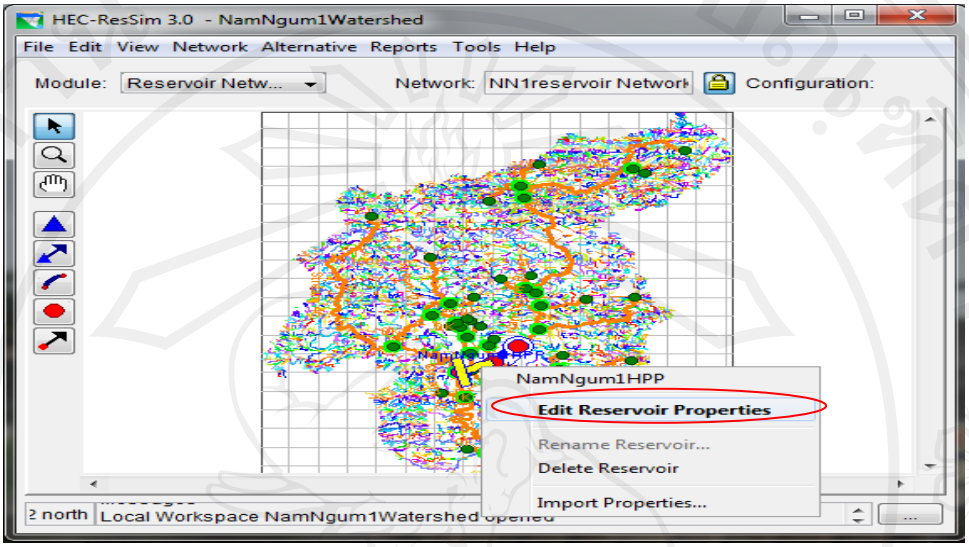


Figure A.39 Show opens the model

On the **Power plant** tree, enter Station Use and Hydraulic loss data. Then click **Apply** and click **Ok** , as shown in Figure A.40.

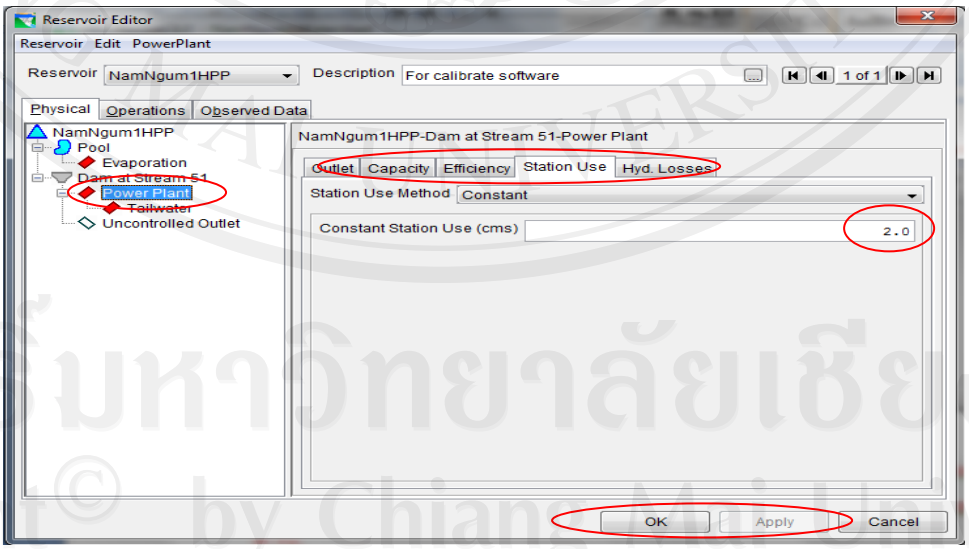


Figure A.40 Step input parameter into model

After inputting all data and parameters as desired, a Simulation can be computed. In the Simulation Control Panel of the main window of the Simulation Module, the simulation tree displays the current Simulation as a folder, beneath which is a list of the Alternatives associated with the Simulation. Also shown in the Simulation Control Panel is the time information associated with the Simulation.
Select the **New simulation** and select case simulation to be opens inputting time interval data and click **Compute NN1Alterna**, as shown in Figure A.41.

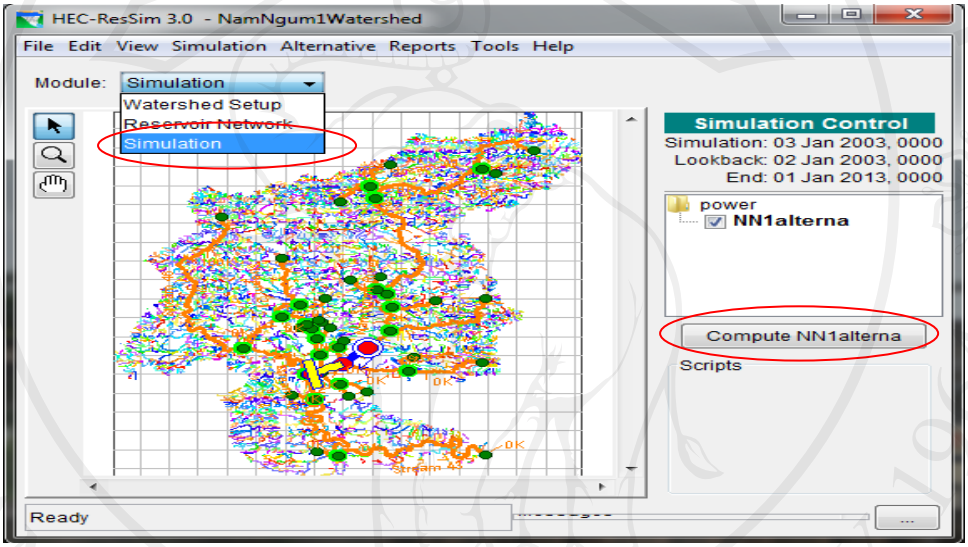


Figure A.41 Step of run simulation model

When computing a Simulation, a **Compute** window opens. The **Compute** window provides **Message Output** that contains information regarding the status of each step of the computation process. The **Progress Bar** indicates the percentage of completion for each step. When the computation is finished, the **Progress Bar** is completely filled in and reads “100%” along with the message “Compute Complete” in the **Message Bar** of the **Compute** window.

If there are errors or any problems during the execution process, review the Message Output Text area of the compute window. Also the **Compute Log** can provide information regarding the type of problem that exists. Click **Close** to close the Compute window, as shown in Figure A.42.

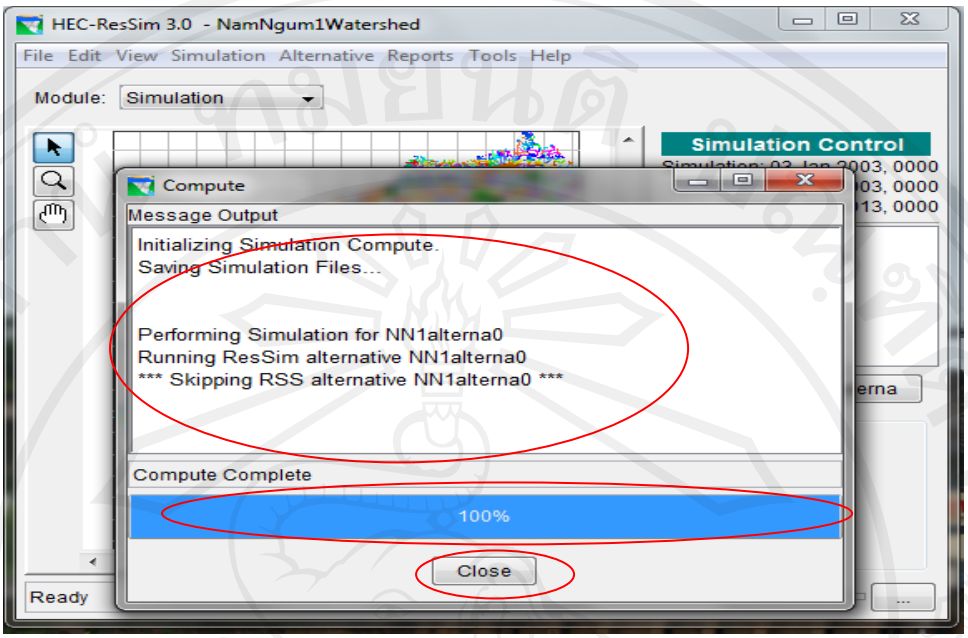


Figure A.42 Run simulation model

Plots and tables in the Simulation Module offer detailed views of data and model results. Access plots using shortcut menus in the Simulation Module's display area. To access a **Plot** from the display area, right-click on a model element in the map display. The shortcut menu will provide a list of one or more plot options, as illustrated in Figure A.43.

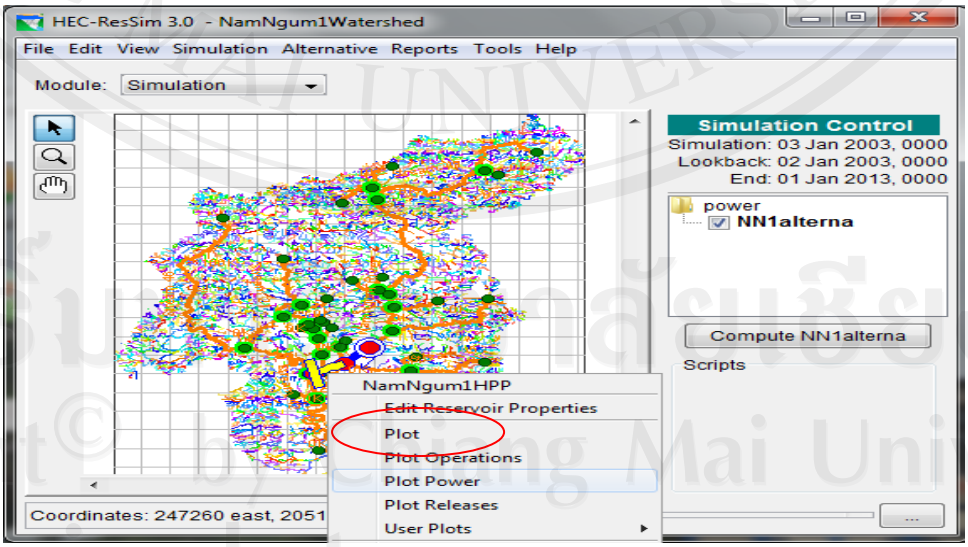


Figure A.43 To access result of simulation model

Once having opened a plot, also tabulate values by selecting **Select Variables** from the plot and from **File** menu select **Tabulate.**

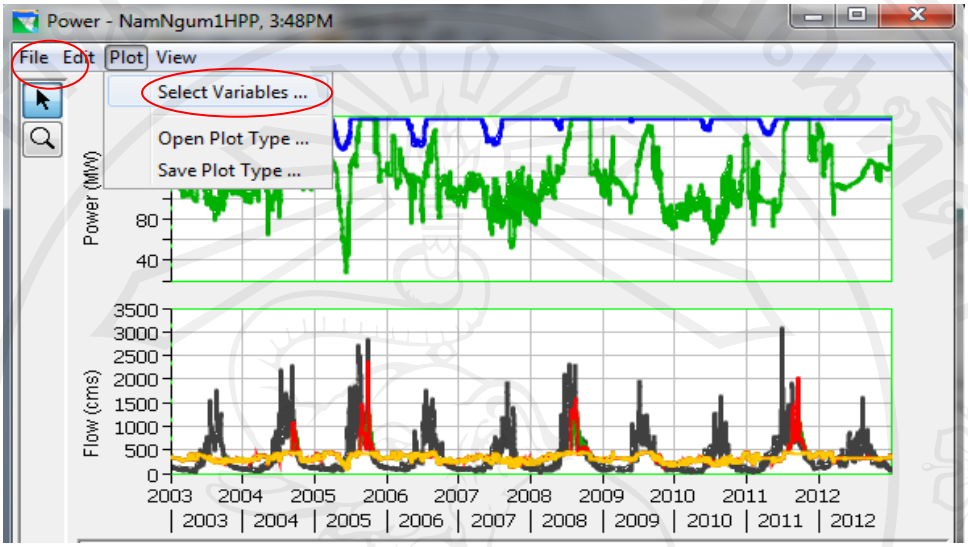


Figure A.44 To access result of simulation model

Select **Variables** from the **Plot** Menu. The **Select Plot Variables** dialog box will appear (Figure A.45). Select the Power Generated Power Capability and Power Required. Click the **Remove** button for changing of units from MW to MWh. Then select the Apply button and click Ok as illustrated in Figure A.45.

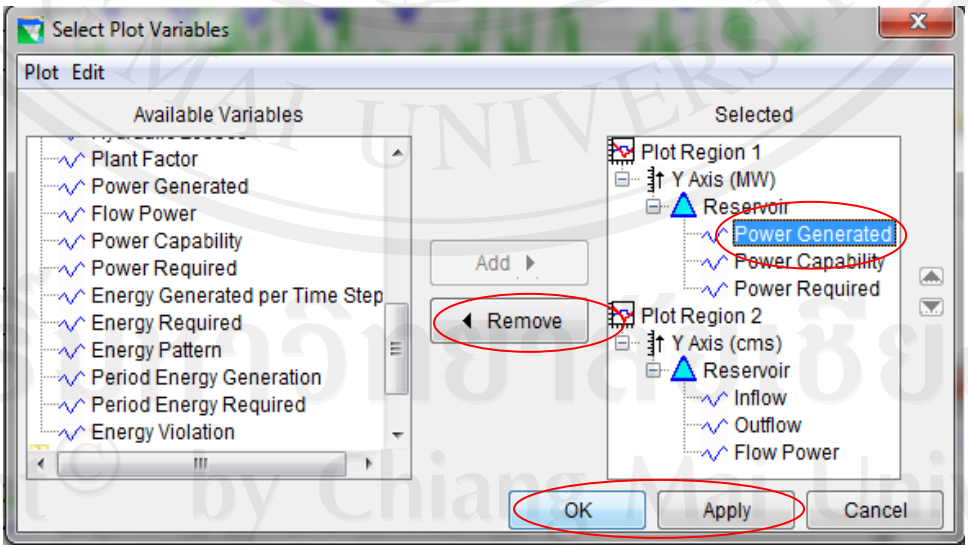


Figure A.45 To access result of simulation model

Select **Variables** from the **Plot** Menu. The **Select Plot Variables** dialog box will appear (Figure A.46). Select the **Energy Generate per Time Step**. Click the **Add** button for keep MWh. Then select the Apply button and click Ok as illustrated in Figure A.46.

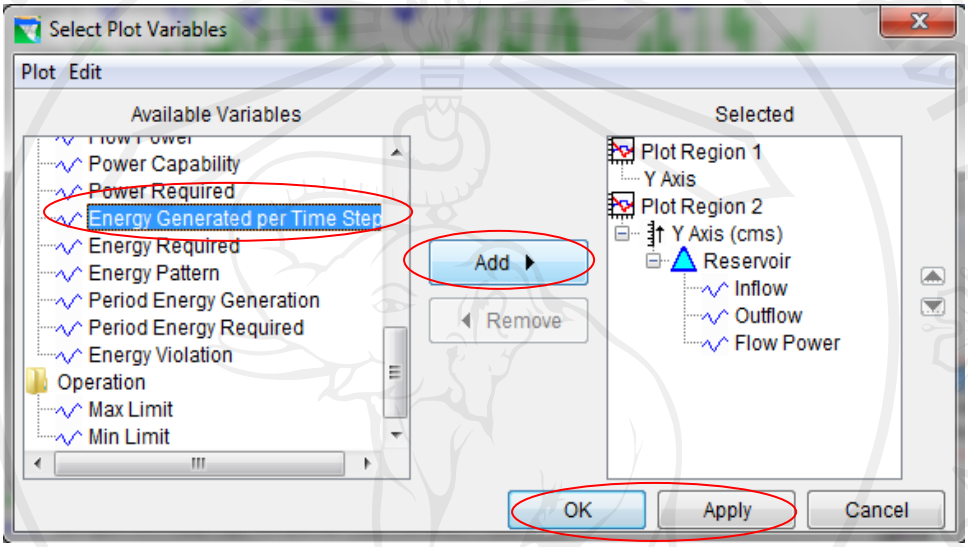


Figure A.46 To access result of simulation model

Once having opened a plot, also tabulate values by selecting **Select Variables** from the plot and from **File** menu select **Tabulate.**

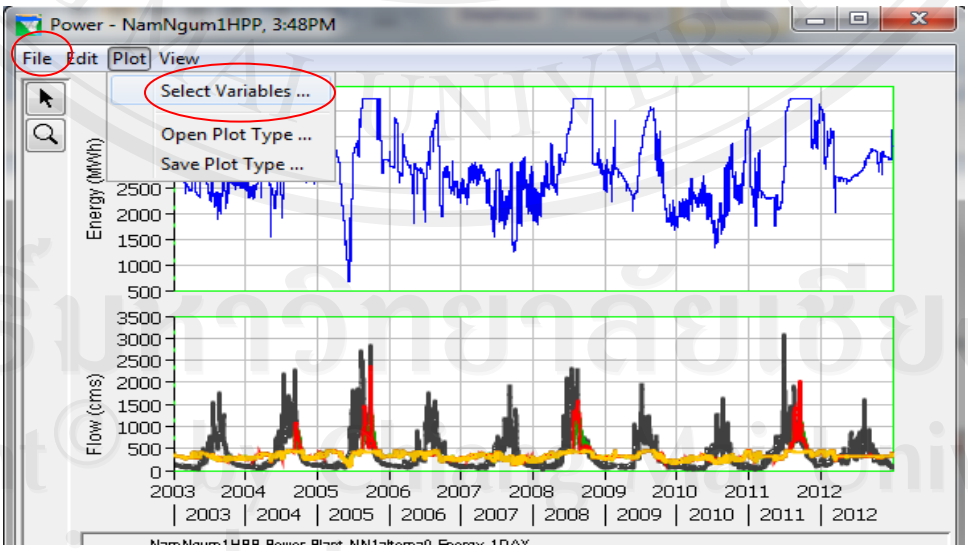
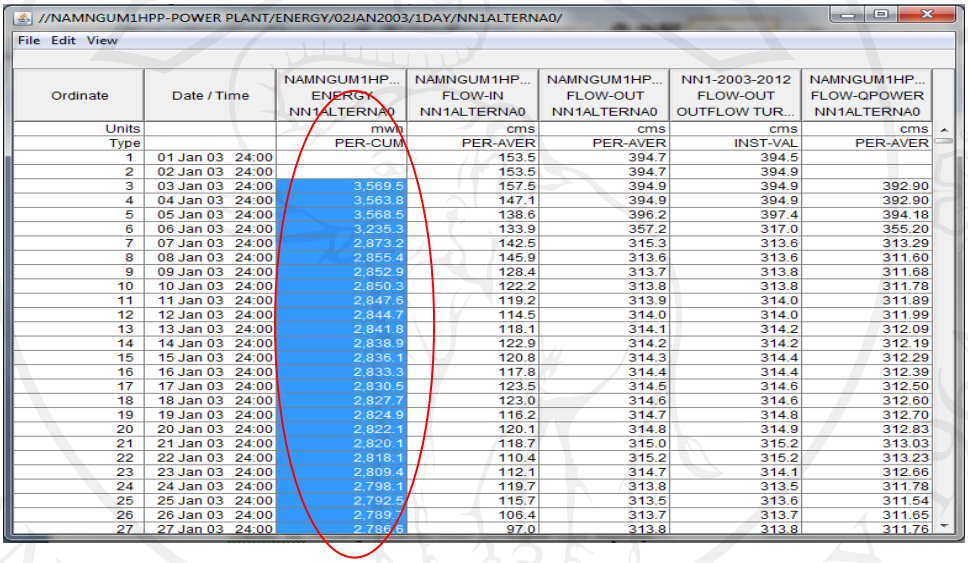


Figure A.47 To access result of simulation model

HEC-ResSim3.0 plots offer a variety of information that will assist with reviewing the results of a Simulation. Included in the information available from the default plots are energy, flow-in, flow-out and total release values as well as regulated and unregulated (without reservoirs and other projects) energy values. View plotted data in tabular form by selecting **Tabulate** from the **File** menu of the plot. Select **Tabulate** the **Result table** dialog box will open as illustrated in Table A.18

Table A.18 Views the graph result of model



//NAMNGUM1HPP-POWER PLANT/ENERGY/02JAN2003/1DAY/NN1ALTERNA0/

File Edit View

Ordinate	Date / Time	NAMNGUM1HP... ENERGY NN1ALTERNA0	NAMNGUM1HP... FLOW-IN NN1ALTERNA0	NAMNGUM1HP... FLOW-OUT NN1ALTERNA0	NN1-2003-2012 FLOW-OUT OUTFLOW TUR...	NAMNGUM1HP... FLOW-QPOWER NN1ALTERNA0
Units		mwh	cms	cms	cms	cms
Type		PER-CUM	PER-AVER	PER-AVER	INST-VAL	PER-AVER
1	01 Jan 03 24:00		153.5	394.7	394.5	
2	02 Jan 03 24:00		153.5	394.7	394.9	
3	03 Jan 03 24:00	3,569.5	157.5	394.9	394.9	392.90
4	04 Jan 03 24:00	3,563.8	147.1	394.9	394.9	392.90
5	05 Jan 03 24:00	3,568.5	138.6	396.2	397.4	394.18
6	06 Jan 03 24:00	3,235.3	133.9	357.2	317.0	355.20
7	07 Jan 03 24:00	2,873.2	142.5	315.3	313.6	313.29
8	08 Jan 03 24:00	2,855.4	145.9	313.6	313.6	311.60
9	09 Jan 03 24:00	2,852.9	128.4	313.7	313.8	311.68
10	10 Jan 03 24:00	2,850.3	122.2	313.8	313.8	311.78
11	11 Jan 03 24:00	2,847.6	119.2	313.9	314.0	311.89
12	12 Jan 03 24:00	2,844.7	114.5	314.0	314.0	311.99
13	13 Jan 03 24:00	2,841.8	118.1	314.1	314.2	312.09
14	14 Jan 03 24:00	2,838.9	122.9	314.2	314.2	312.19
15	15 Jan 03 24:00	2,836.1	120.8	314.3	314.4	312.29
16	16 Jan 03 24:00	2,833.3	117.8	314.4	314.4	312.39
17	17 Jan 03 24:00	2,830.5	123.5	314.5	314.6	312.50
18	18 Jan 03 24:00	2,827.7	123.0	314.6	314.6	312.60
19	19 Jan 03 24:00	2,824.9	116.2	314.7	314.8	312.70
20	20 Jan 03 24:00	2,822.1	120.1	314.8	314.9	312.83
21	21 Jan 03 24:00	2,820.1	118.7	315.0	315.2	313.03
22	22 Jan 03 24:00	2,818.1	110.4	315.2	315.2	313.23
23	23 Jan 03 24:00	2,809.4	112.1	314.7	314.1	312.66
24	24 Jan 03 24:00	2,798.1	119.7	313.8	313.5	311.78
25	25 Jan 03 24:00	2,792.5	115.7	313.5	313.6	311.54
26	26 Jan 03 24:00	2,789.	106.4	313.7	313.7	311.65
27	27 Jan 03 24:00	2,786.6	97.0	313.8	313.8	311.76

To copy row select or result of simulation model to the Microsoft excel for comparison with actual data record and consider the R^2 and EI value the detail are shown as below, dialog box will open as illustrated in Table A.19.

R^2 =1, the simulation test is highly reliable

EI = 100%, the simulation test is highly reliable

Table A.19 Comparison result of model and actual data record

Station Use ,Hydraulic loss (2.0)

Calibration	
R^2	0.907
EI	90.41%
RMSE	382.31
WB	318362.41%

Vertification	
R^2	0.787
EI	#REF!
RMSE	35.29
WB	-14.43%

Date	Simulated	Observed
01/01/2003		
02/01/2003		
03/01/2003	3569.50	3523.50
04/01/2003	3563.80	3522.70
05/01/2003	3568.50	3514.40
06/01/2003	3235.30	3499.70
07/01/2003	2873.20	3493.60
08/01/2003	2855.40	2804.50
09/01/2003	2852.90	2790.30
10/01/2003	2850.30	2788.70
11/01/2003	2847.60	2782.90
12/01/2003	2844.70	2783.00
13/01/2003	2841.80	2776.00
14/01/2003	2838.90	2779.20
15/01/2003	2836.10	2774.30
16/01/2003	2833.30	2769.10
17/01/2003	2830.50	2767.10
18/01/2003	2827.70	2762.30
19/01/2003	2824.90	2758.10

The plot window displays the location name in the title bar. Axis labels and a color-coded legend identify the data contained in the plot. The blue line is energy data result from simulation and red line is energy actual data record from 2003-2012.This test uses water elevation simulation to compare with actual data by considering R^2 (Root Square), EI (Efficiency Index), RMSE (Root Mean Square Error) which are detailed as following items:

If Station Use and Hydraulic loss 2.0, get the $R^2 = 0.907$ and EI= 90.41%

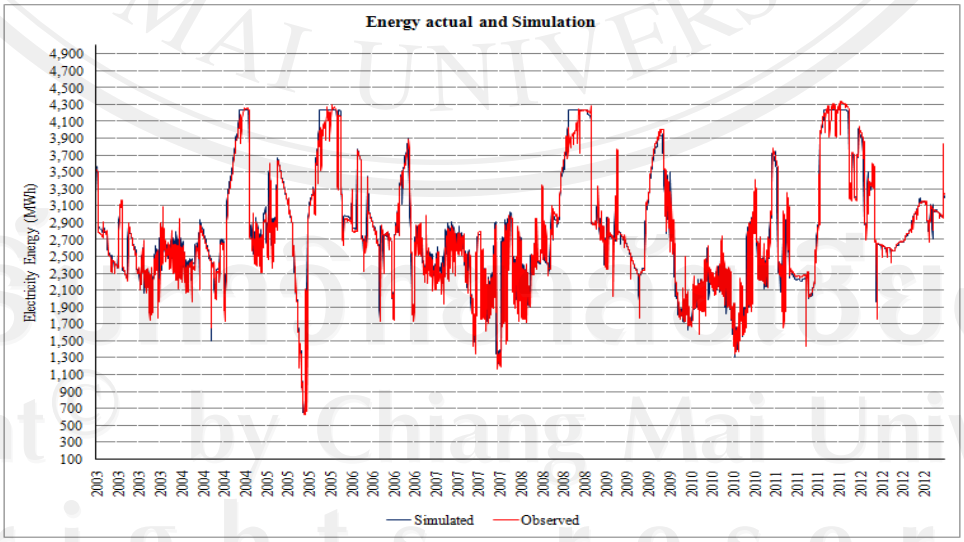


Figure A.48. Comparison water elevation simulation and actual data

From simulation result shows evaporation of 7% for water data calibration and station use equals to 2 cms and hydraulic loss equals to 2 m for power data calibration, the simulation can provide the elevation and energy closely with actual data. Therefore, the next step, the simulation model will be used for water management of NamNgum-1 hydropower plant.

Appendix B

HEC-DSSVue2.0 Software and Step of Input Data to Model

The hydrologic engineering center's data storage system visual utility engine (HEC-DSSVue2.0) is graphical user interface program for viewing, editing, and manipulating data in the HEC Data Storage System (HEC-DSS) database files. With HEC-DSSVue2.0, data can be plotted, tabulated and edited, as well as manipulate data with over fifty mathematical functions. Along with these functions, into a database, rename dataset names, copy data sets to other HEC-DSS files, and delete datasets. Typically, datasets will be selected from a stored / filtered list of names in a HEC-DSSVue2.0, also incorporate the standard scripting language that allow to specify a routine sequence of steps in a text format and then execute the sequence from a user defined button or a "batch" process. The main screen's software is shown in Figure B.1.

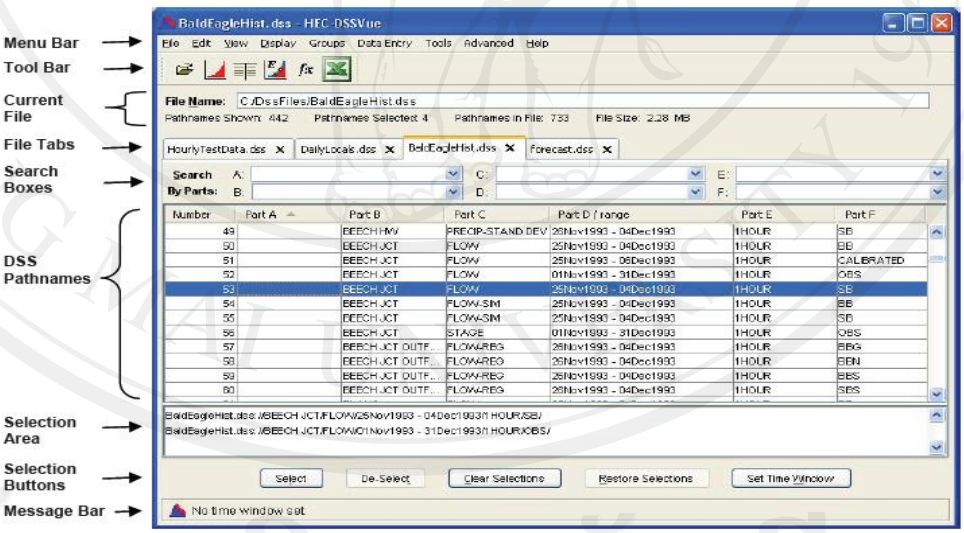


Figure B.1 HEC-DssVue2.0 main window

HEC-DSSVue2.0 was written using the Java programming language that allows it to be run under a variety of different operating systems. Fully supported systems include Microsoft Windows, Sun Solaris (UNIX), Red Had Linux and other systems.

B.1 Create database in HEC-DSSVue2.0 software

Included within the framework of HEC-ResSim3.0 is HEC-DssVue2.0, a tool that allows to access data stored in HEC-DSS database files. With HEC-DssVue2.0, data may be plotted, tabulated, edited, and manipulated with over fifty mathematical functions. In addition to these functions, HEC-DssVue2.0 provides several utility functions, such as entering data sets into a database, renaming data sets, copying data sets to other DSS database files, and deleting data sets. HEC-DssVue2.0 can be launched from any HEC-ResSim3.0 module by choosing HEC-DssVue2.0 from the **Tools** menu. DSS files refer to time-series data by **pathnames** representing records. **Pathnames** are separated into six parts (delimited by slashes "/") labeled "A" through "F." For "regular" time-series records, the naming conventions for describing the contents of the six pathname parts are:

A Project name

B Location or gage identifier

C Data variable, such as FLOW or PRECIP

D Starting date in the format 01JAN2013

E Time interval

F Additional user-defined descriptive information.

The dialog box will appear in Figure B.2.

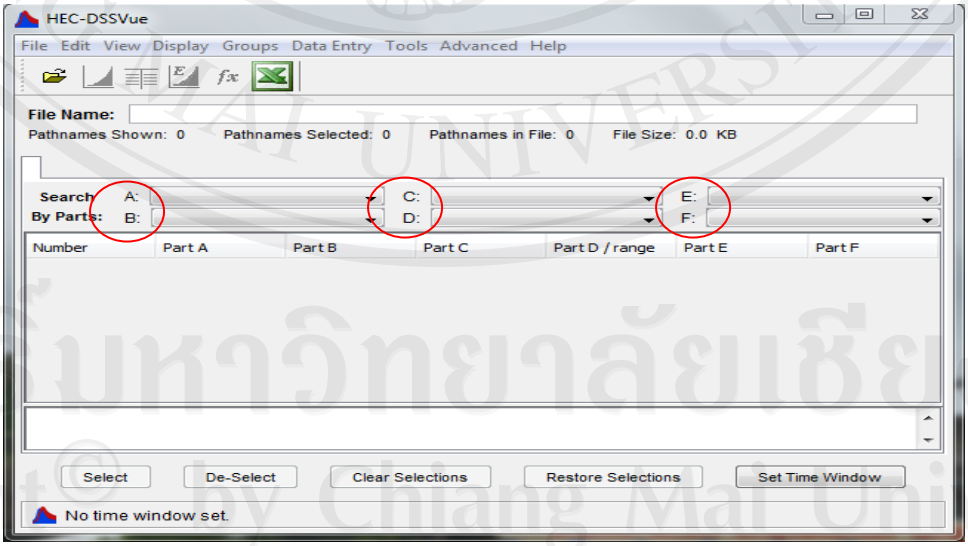


Figure B.2 HEC-DSSVue2.0 programs

To create a new folder: From the **File** menu, select **New**. The **Create New HEC-DSS file** dialog box will appear. Specify a **Name** for the folder and select a **files of type**. Click the button **Create** to access. The detail is shown in Figure B.3.

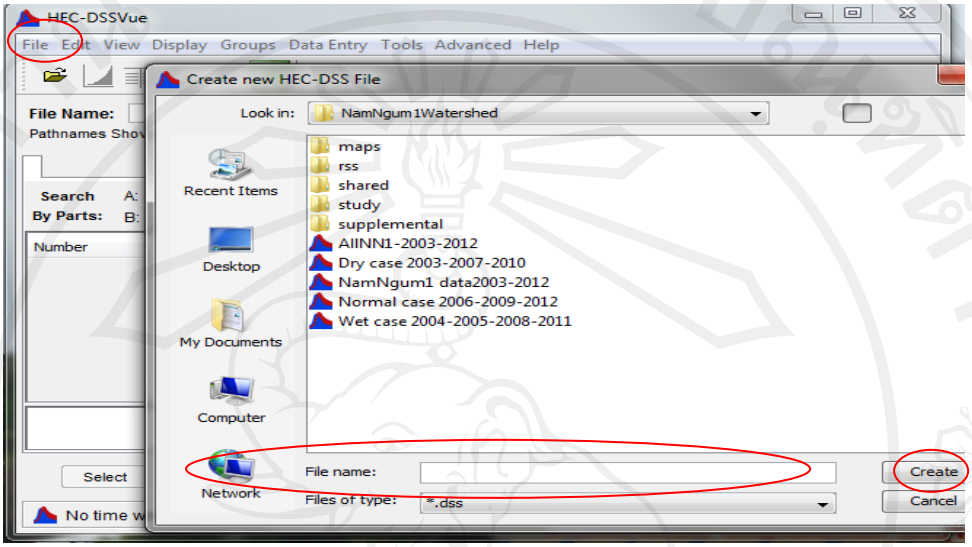


Figure B.3 Create folders on HEC-DSSVue2.0 programs

To create a new data base: From the **Data Entry** menu, select **New**. The **Manual Time Series…** dialog box will appear in Figure B.4.

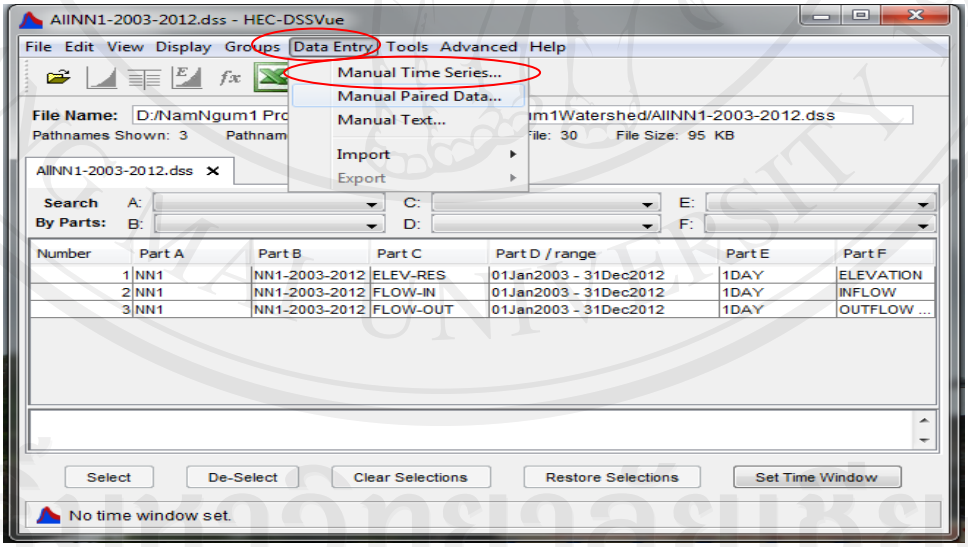


Figure B.4 Create database on HEC-DSSVue2.0 programs

To enter Time-Series data manually: From the **Utilities** menu, choose **Manual Data Entry**, then select **Time Series....**The **Manual Time Series Data Entry** editor. To create a new names for parameter **A, B (A** Project name, **B** Location or gage identifier). But parameter **C** is data variable, such as FLOW-IN, FLOW-OUT and

ELEV-RES, parameter D starting date in the format **01JAN2003**, parameter **E** Time interval or **1Day** and parameter **F** additional user-defined descriptive information.

To create a **start date** for example **1Jan2003** and **start time** for example **24:00**. But water inflow, outflow units are **cms** , But water elevation units is **msl**. Next, from the **Type** dialog box, select **PER-AVER** the dialog box will appear. To copy data preparation from **excel files** (Figure B.5) and put at the **Value** row, Click the button **paste** to access. Click the button **Save** to keep the data base dialog box is shown in Figure B.6.

	Inflow wet years (m3)		(cms)
1	8,407,896	Jan	97.31
2	8,294,308	Jan	96.00
3	9,481,005	Jan	109.73
4	7,180,915	Jan	83.11
5	8,217,449	Jan	95.11
6	8,140,544	Jan	94.22
7	6,908,369	Jan	79.96
8	7,924,042	Jan	91.71
9	8,330,607	Jan	96.42
10	8,670,079	Jan	100.35
11	6,736,507	Jan	77.97
12	7,261,673	Jan	84.05
13	7,314,887	Jan	84.66
14	6,960,051	Jan	80.56
15	8,612,728	Jan	99.68
16	7,977,109	Jan	92.33
17	6,921,639	Jan	80.11
18	7,766,337	Jan	89.89

Figure B.5 Data preparation in excel file

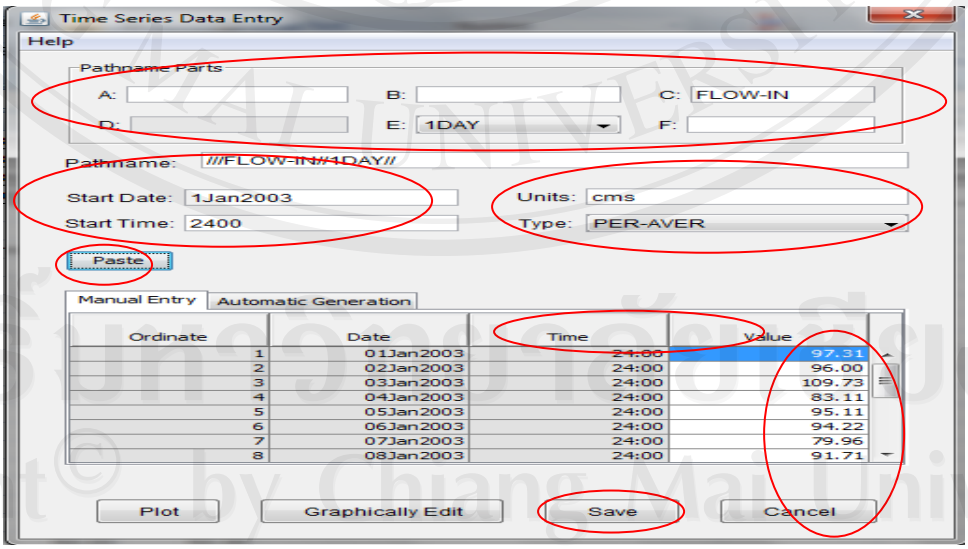


Figure B.6 Create database on HEC-DSSVue2.0 programs

B.2 Step of input data to model

If the name of the HEC-ResSim3.0 Model database **File** is known, then select the **File** name (e.g., NamNgum1Watershed) directly into the **File Name** box in the HEC-ResSim3.0 Model Data Selection List to open the Model file. Otherwise, choose **Open** from the **File** menu or click the button to select the Model name database **File** wanted. A NamNgum1Watershed browser window will open, as shown in Figure B.7.

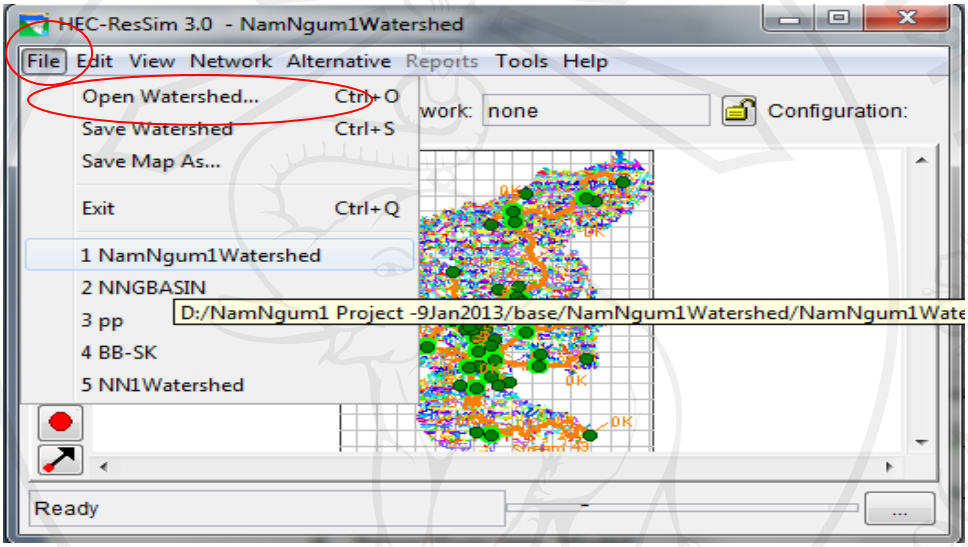


Figure B.7 Input Hec-DssVue2.0 file into model

Once a Model file has been opened, the HEC-ResSim3.0 data. Selection **Network** and **Open** List window displays the filename, the number of case shown in the list, the number of cases selected, the case model number of reservoir net work in the database file, and the size of the database file. The individual cases display in a list beneath the search area. Click the button **Open** to open the alternative dialog box. The detail is show in Figure B.8.

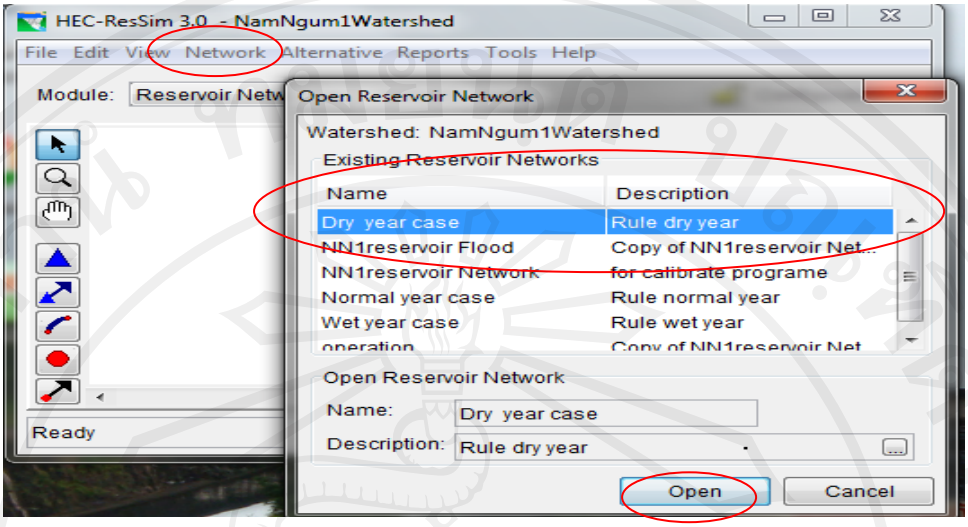


Figure B.8 Input HEC-DSSVue2.0 file into model

To create a new alternative. From the **Alternative** menu of the Alternative Editor, select **New**. The **New Alternative** dialog box will open. Enter a **Name** and **Description**. Use the ... button to open a larger editing window for the description. Select a **Configuration** by choosing from the list of available configurations. Click **OK** to close the New Alternative dialog box. The name and description entered will now appear in the **Name** and **Description** fields of the Alternative Editor. The detail is show in Figure B.9.

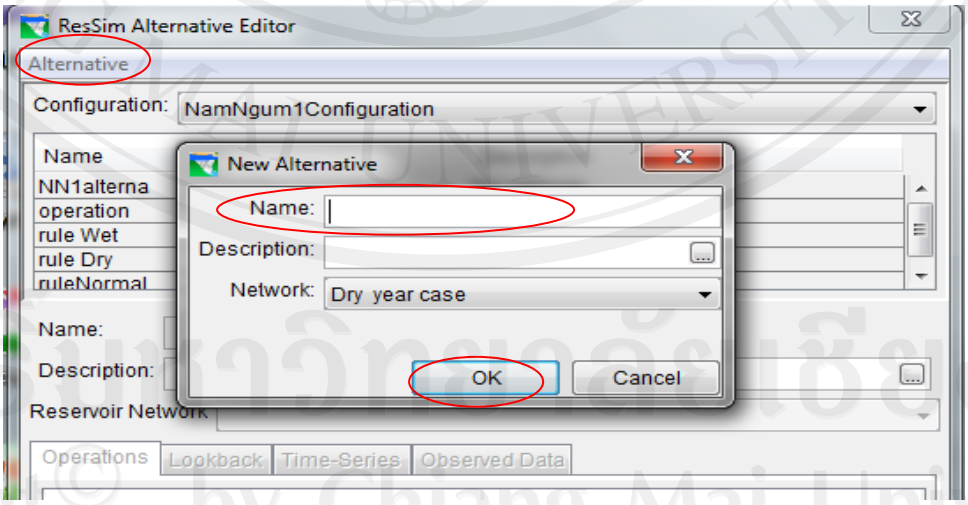


Figure B.9 Input HEC-DSSVue2.0 file into model

In the open **HEC-ResSim3.0 Alternative** browser window, select name alternative (e.g., NN1 alterna), choose **Time series** and put cursor in the **row** of **DSS file** that is wanted to input time series, then click **Select DSS Path…**. The detail is show in Figure B.10.

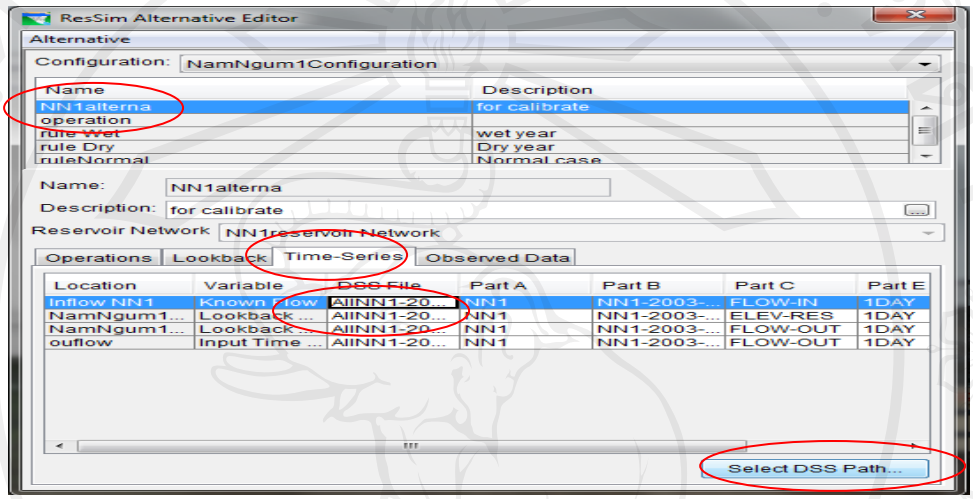


Figure B.10 Input HEC-DSSVue2.0 file into model

After clicking the **Select DSS Path…**button. The data bases from HEC-DSSVue2.0 will be linked to HEC-ResSim3.0 model. Data time series can be chosen (e.g., water inflow, outflow and elevation).Then put the cursor in column and click the **Select** button. The data to move column blue below. Next, click the **Set Pathname** file **that** is wanted to input time series is completed. The detail is show in Figure B.11.

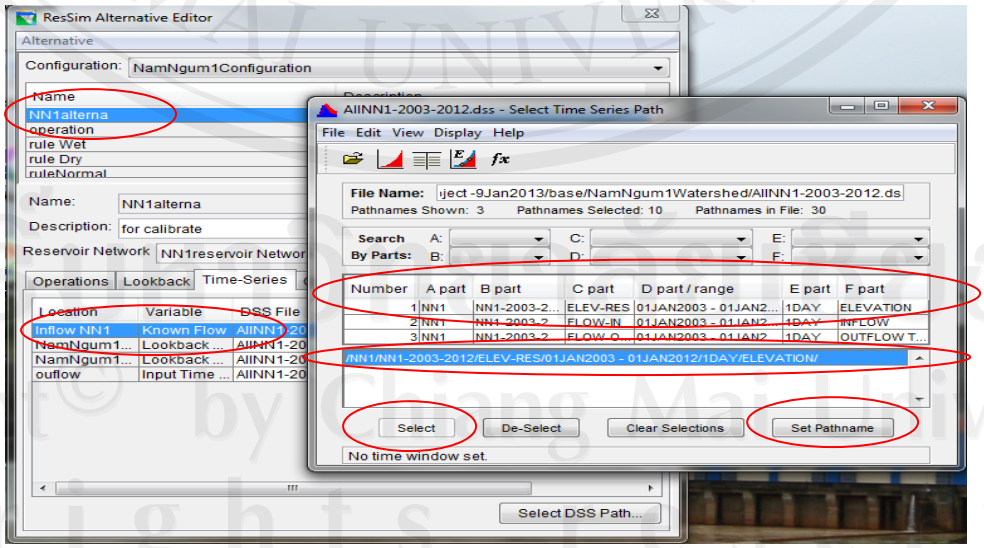


Figure B.11 Input HEC-DSSVue2.0 file into model

Appendix C
HEC-ResSim3.0 Model Setup

In this study, the corps of engineers software, HEC-ResSim3.0 model is used to perform the operational modeling or simulation analysis of Nam Ngum-1 and reservoir. HEC-ResSim3.0 is the reservoir simulation program developed by the hydrologic engineering center of the corps of engineers available on line (USACE, HEC-ResSim3.0,2007, http://www.hec.usace.army.mil/software/hecressim/hecressim-hecressim.htm). HEC-ResSim3.0 is a graphical user interface (GUI) software. Its hydropower simulation capabilities include analysis of run - of - river generation, peak power generation, pumped storage and system power operation. To simulate hydropower operation, the reservoir releases are determined to meet power production goals which may vary on a monthly, daily or hourly basis. Additionally, the hydropower component takes into account the penstock capacity and losses, as well as leakage parameters.

The model allows the user to define alternatives and run simulations simultaneously to compare results. Schematic elements in HEC-ResSim3.0 allow the representation of watershed, reservoir network and simulation data visually in a geo-referenced context that interacts with associated data. In addition to that, HEC-ResSim3.0 is compatible with Arc-GIS shape files, which can be used as a background layer and facilitate the better representation of the physical system. Watershed boundaries, reservoirs, channel networks, diversions, etc. can be superimposed over the shape file.

HEC-ResSim3.0 program is divided into three modules which are the watershed setup, the reservoir network definition and the simulation scenario management, respectively. The relationships of tree module are shown in Figure C.1.

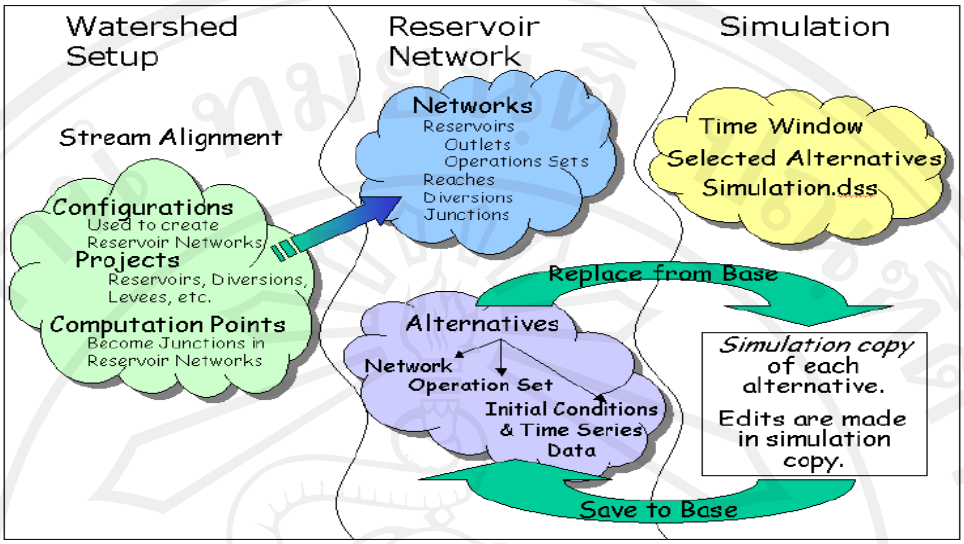


Figure C.1 General HEC-ResSim3.0 modules concepts

C.1 Watershed setup module

The purpose of the Watershed Setup module is to provide a common framework for watershed creation and definition among different modeling applications. This module is currently common to HECResSim3.0, a watershed is associated with a geographic region for which multiple models and area coverage can be configured. A watershed may include all of the streams, projects (e.g., reservoirs, levees), gage locations, impact areas, time-series locations and hydrologic and hydraulic data for a specific area. All of these details together, once configured, form a watershed framework. In the Watershed Setup module, items that describe a watershed's physical arrangement are assembled. Once a new watershed, has been created, it will able to import maps from external sources, specify the units of measure for viewing the watershed, add layers containing additional information about the watershed, create a common stream alignment and configure elements. Projects can also be added and create time-series icons within the Watershed Setup module. The main screen's software is shown in Figure C.2.

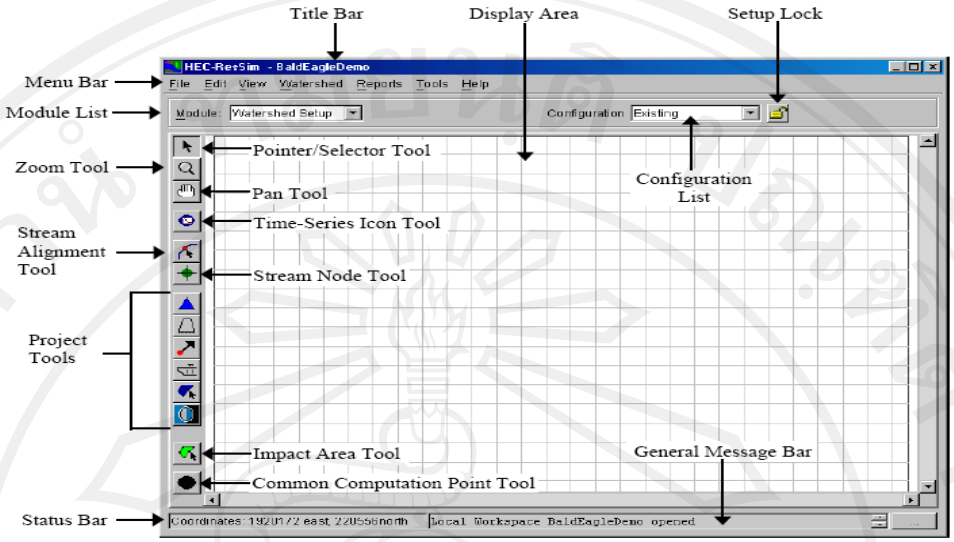


Figure C.2 Watershed setup module

Once the working directory has been established, a new watershed can be created. To create a new watershed: Select **New Watershed** from the **File** menu. The **Create New Watershed** dialog box opens. The detail is shown in Figure C.3.

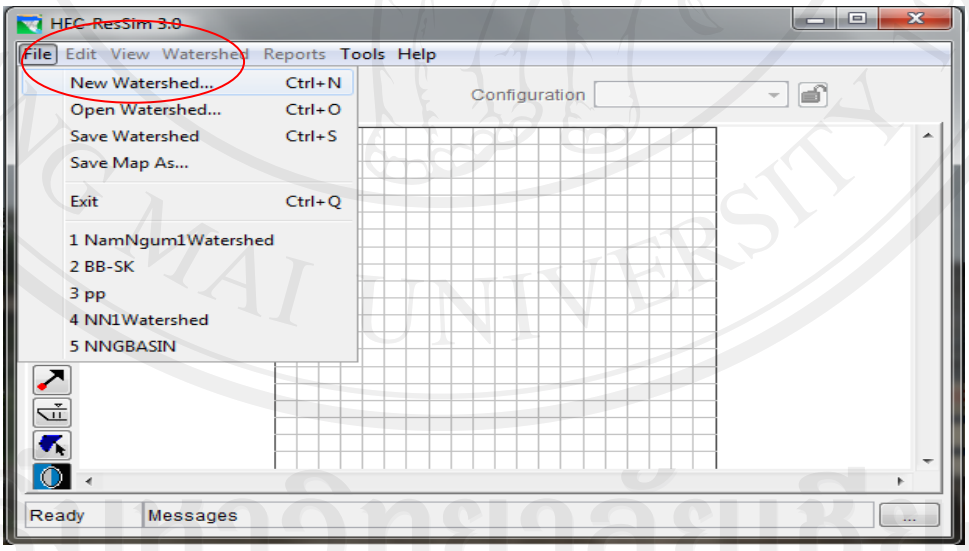


Figure C.3 Create new watershed dialog box

Type a **Name** for the new watershed. The watershed name must be less than 32 characters and cannot contain any of the following characters:
(e.g., | / : * ? ” < > - \ .). Type a **Description** for the new watershed that clearly explains what it is. Select a **Location** (working directory) for the new watershed’s directory from the list of available locations. Specify either **English** (U.S. customary units) or **SI** (SystemInternational) as the **Units of Measure**. After clicking ok, it cannot be changed. Specify the **Time Zone** of the new watershed by selecting from the list of standard time zones (e.g.,GMT+7:00) Asia / Bangkok). Click **OK** to close the Create New Watershed dialog box. The detail is shown in Figure C.4.

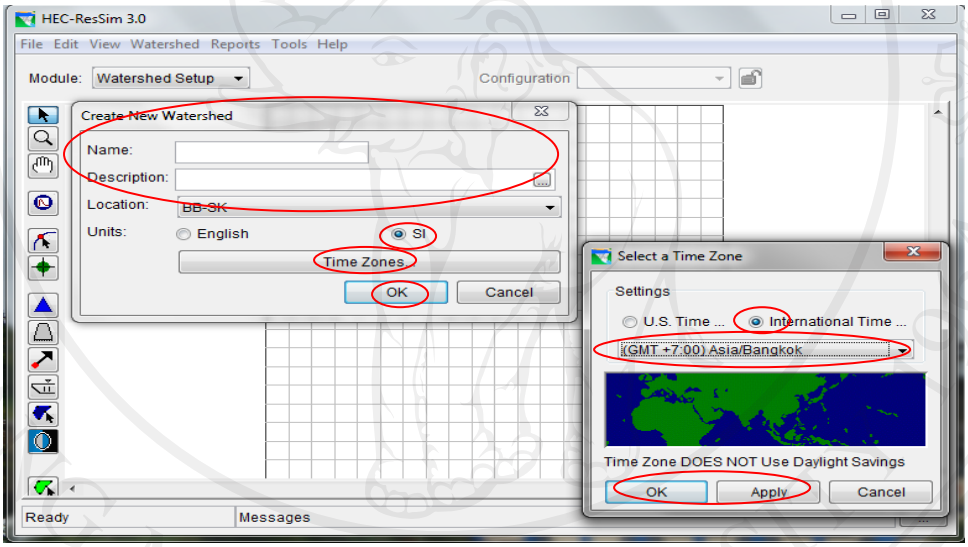


Figure C.4 Create new watershed dialog box

The background maps used in the watershed will come from sources outside of HEC-ResSim3.0. To import a map file for use in the watershed, copy the appropriate map files to the “maps” directory of the watershed. HEC-ResSim3.0 does not perform coordinate transformation for background maps. Therefore, all of the map layers to be used in a watershed should be referenced to the same coordinate system. Table C.1 shows the file formats HEC-ResSim3.0 supports and each format is described in the paragraphs that follow.

Table C.1 Map layer formats supported by Hec- ResSim3.0

Description	Common **File** Name **Extension**
ArcView® Shapefile	.shp
AutoCAD® DXF	.dxf
Raster image	.img, .gif, .jpg
USGS* Digital Line Graph	.dlg
USGS* Digital Elevation Model	.dem
ASCII NET TIN	.net
ArcInfo® DEM	.asc
*US Geological Survey	

This layer type is the native data structure for the Arc View® GIS program. Shape files store non-topological geometry and attribute information for the spatial features of a data set. Usually there are three files: *.dbf, *.shp, and *.shx. The .shp file contains the shapes (point, plotlines, or polygons) that display in the layer. Each shape has a record in the .dbf file containing descriptive data called “attributes.” The .shx file contains an index that links each shape to its record in the .dbf file. To make map files accessible in the watershed, first make sure that the map files are in the “maps” directory of the watershed, as previously. Select **Layers** from the View menu. The **Layer Selector** dialog box will appear in Figure C.5.

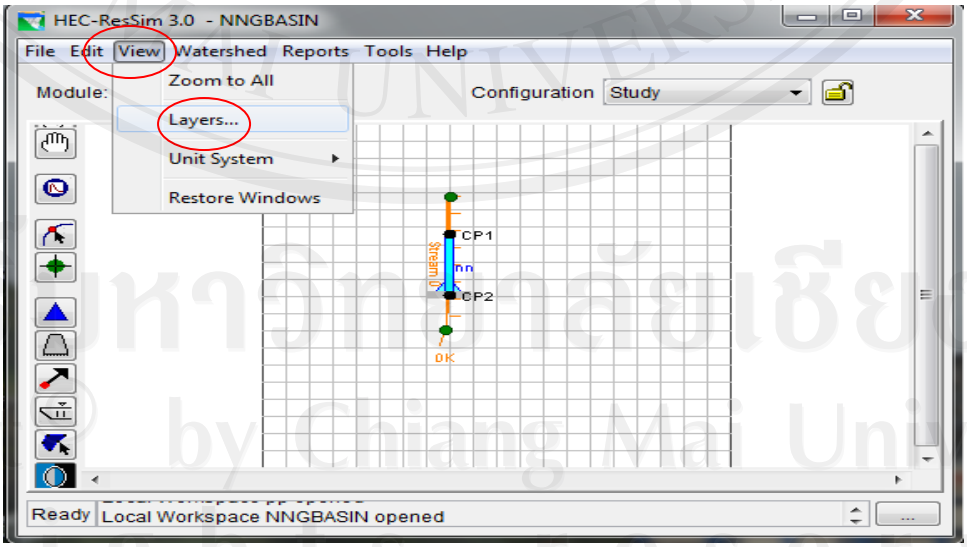


Figure C.5 Layer selector dialog box

Also, ensure that all maps which are added to a watershed share the same coordinate system before adding them to the watershed. From the **Edit** menu, select **Allow Layer Editing** and click OK. The detail is shown in Figure C.6.

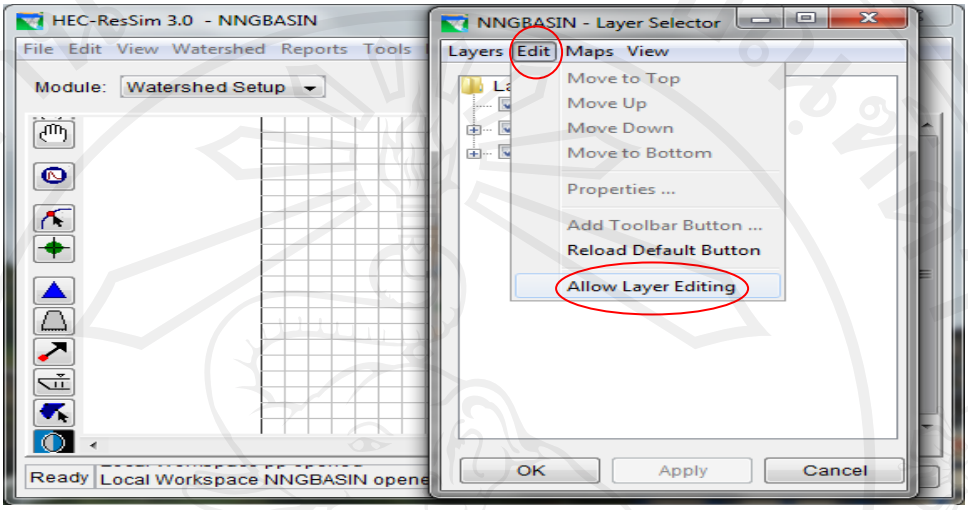


Figure C.6 Layer selector dialog box

Next, from the **Maps** menu, select **Add Map Layer**. The **Open File** dialog box will open. The detail is shown in Figure C.7.

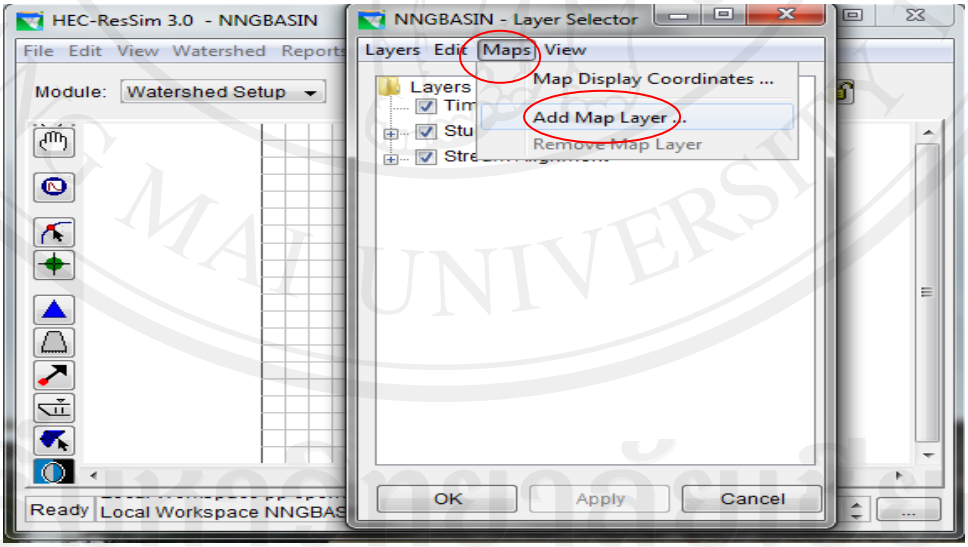


Figure C.7 Layer selector dialog box

Locate the map file to be used on local computer (for example, “river.shp”). After having selected the map to use, click **OK**. The **Open File** dialog box will open. The detail is shown in Figure C.8.

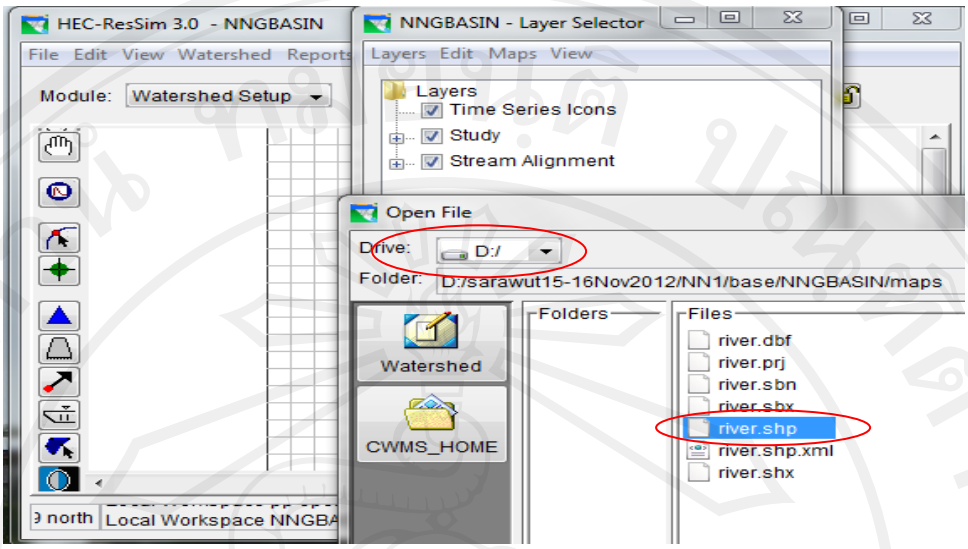


Figure C.8 Layer selector dialog box

The new map will now appear in the Layer Selector, dialog box will open. The detail is shown in Figure C.9.

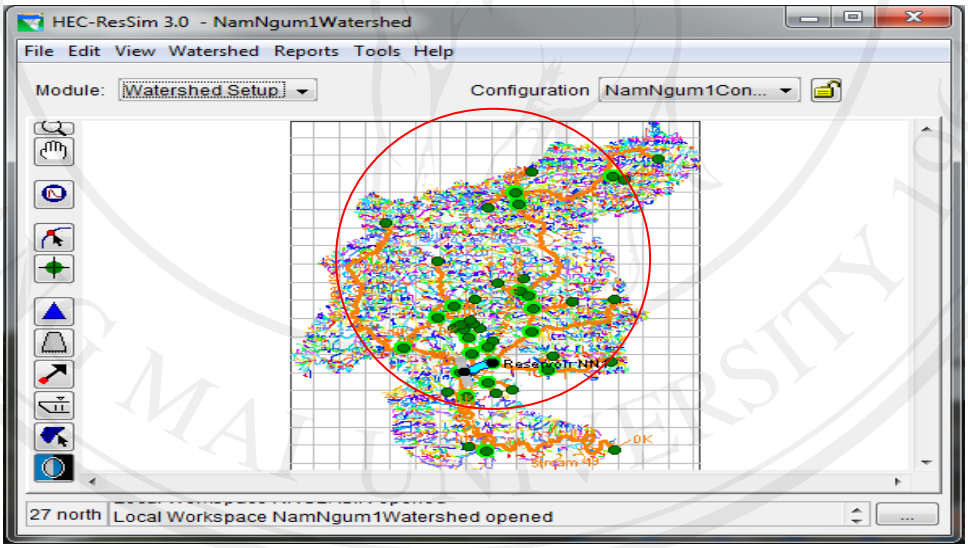


Figure C.9 Show map of watershed from Arc View GIS file

C.2 Reservoir network module

The **Reservoir Network** module is used for editing element data and placing additional elements onto the stream alignment. From the **Module** list, select **Reservoir Network**. The main window and the different components for the **Reservoir Network** module are illustrated in Figure C.10.

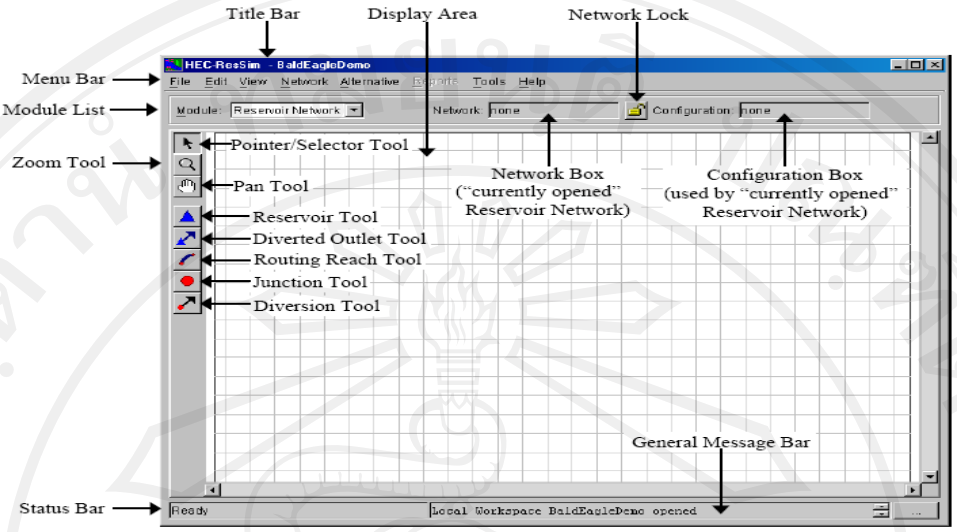


Figure C.10 Show reservoir network module

Select **Update Network from Configuration** from the **Net work** menu. The Link map data from **watershed setup module** to **reservoir setup**. The detail is shown in Figure C.11.

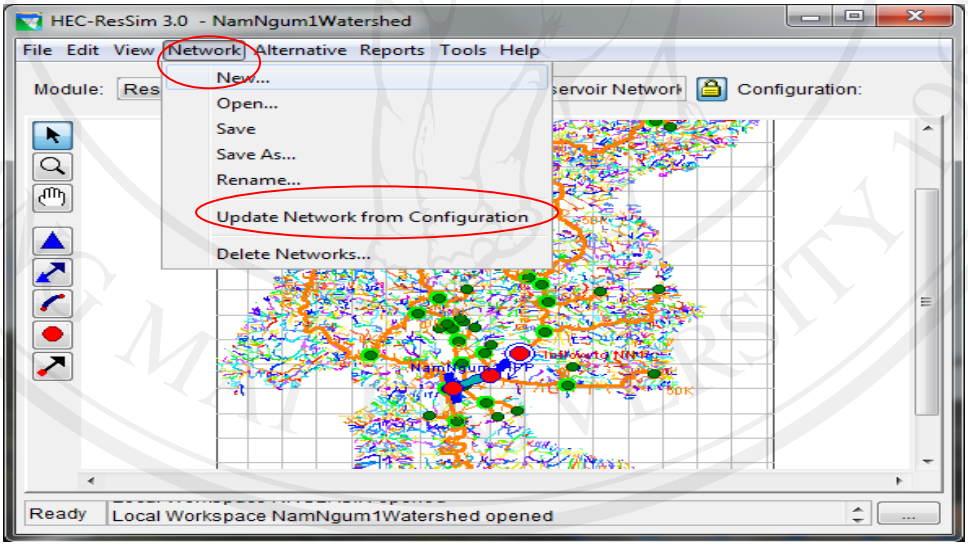


Figure C.11 Show reservoir network module update network

To create a new reservoir network: From the **Network** menu, select **New**. The **Create New Reservoir Network** dialog box will appear. Specify a **Name** for the network and enter a **Description**. Click the button to access a larger text field for description. From the **Configuration** list, choose the configuration on which this network will be based and Click **New.** The detail is shown in Figure C.12.

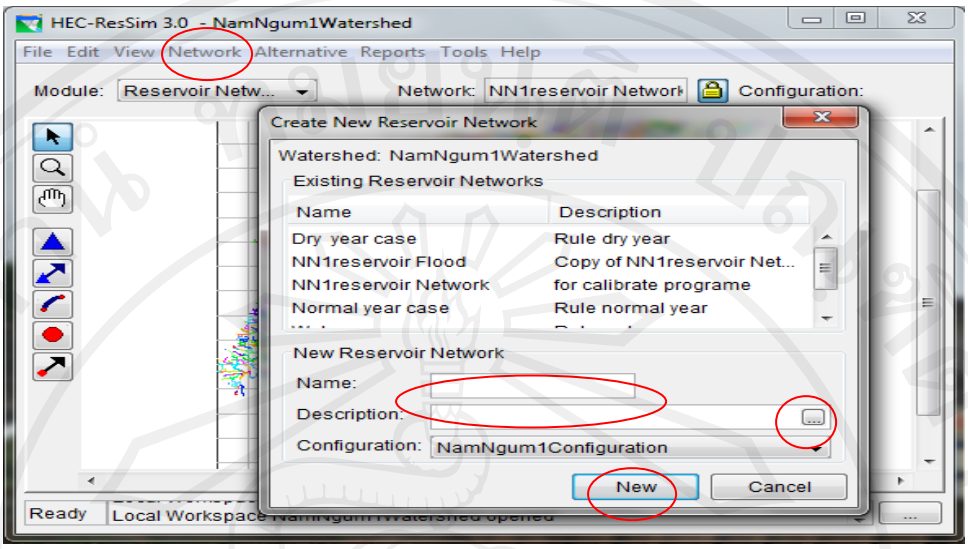


Figure C.12 Show new reservoir network

An alternative consists of a Configuration, a Reservoir Network, an Operation Set for each reservoir in the network, a Storage Balance Operation Set for each reservoir system in the network (if applicable), a definition of initial conditions, and a mapping of all time-series records to identify local inflows. To develop an alternative, the **Alternative Editor** to name the alternative and give it a description, select reservoir operation sets, select system operation Sets (if applicable), select a look back type, associate time-series data with locations, define observed data, and save the alternative which has been created. The first step in creating an alternative is to give it a name and description, associate it with a configuration, and then select the reservoir network is shown in Figure C.13.

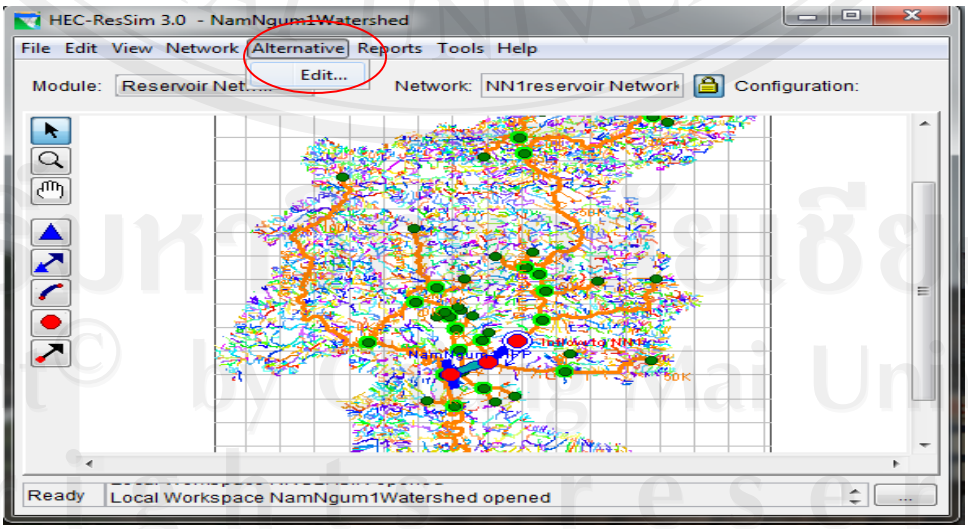


Figure C.13 New alternative dialog box

To create a New Alternative: From the **Alternative** menu of the Alternative Editor, select **New**. The **New Alternative** dialog box will open. Enter a **Name** and **Description**. Use the ... button to open a larger editing window for the description. Select a **Configuration** by choosing from the list of available configurations. Click **OK** to close the New Alternative dialog box. The name and description entered will now appear in the **Name** and **Description** fields of the Alternative Editor.

Next, choose the **Reservoir Network** if want to use for this alternative. The selection list contains only those networks have defined for the selected configuration. The **dialog** box will open. The detail is shown in Figure C.14.

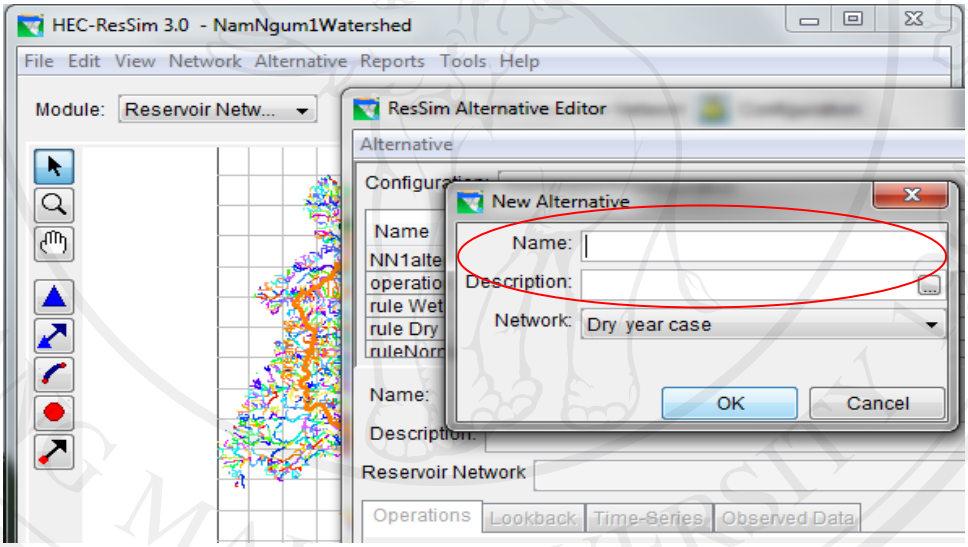


Figure C.14 New alternative dialog box

Once having given alternative a name and description and have chosen the configuration and reservoir network, select the **Operation Set for** each reservoir to follow for the alternative. Create the operation set(s) using the Reservoir Editor. To select a reservoir operation set for an alternative:

In the **Alternative Editor**, select the **Operations** tab. Select an Operation Set (for each reservoir in the network) by double-clicking on the white **Operation Set** field and choosing from the list. The detail is shown in Figure C.15.

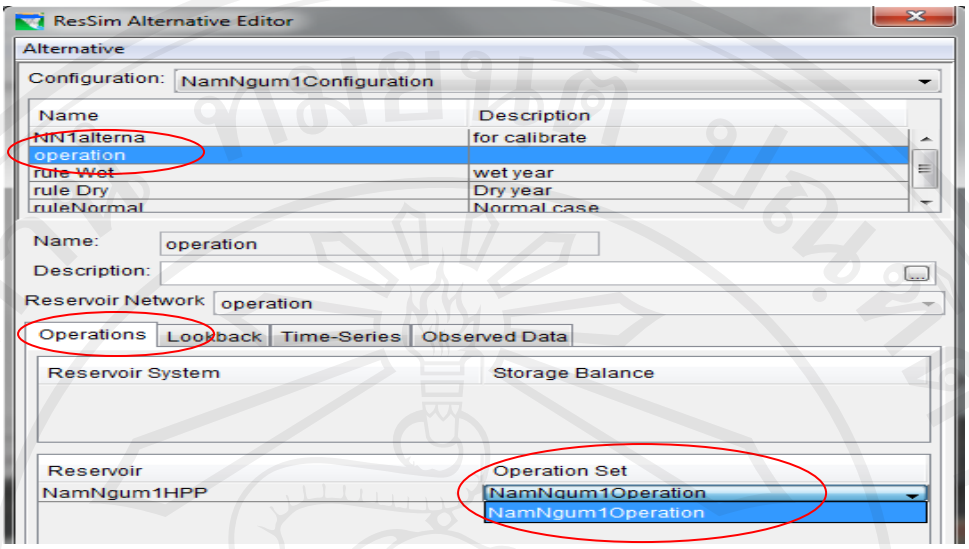


Figure C.15 Alternative editor operations tab, reservoir

After specifying the operation set for each of reservoirs, specify the initial (or starting) conditions for the alternative. This is referred to in HEC-ResSim3.0 as the **Look back** (or warm up) period. Specify whether constant or "mapped" time-series data will define each element and parameter during the look back period. To set the look back **Type** for locations in reservoir network: In the **Alternative Editor**, select the **Look back** tab. For each location or parameter, double-click in the white **Type** cell and select either **Constant** or **Time-Series**. For locations or parameters after having selected **Constant** as the look back type, enter the value for the constant in the **Default Value** field as shown in Figure C.16.

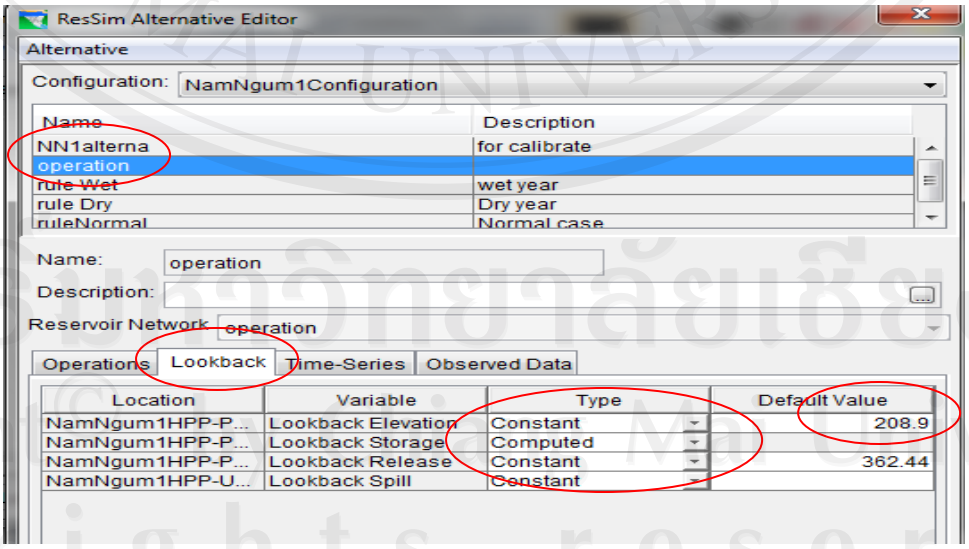


Figure C.16 Alternative editor look back tab

Associating Time-Series data with a Location. Next, associate a time-series record to each location or parameter for which Time-Series data are needed. To associate Time-Series data with a Location: In the **Alternative Editor**, select the **Time-Series** tab is shown in Figure C.17.

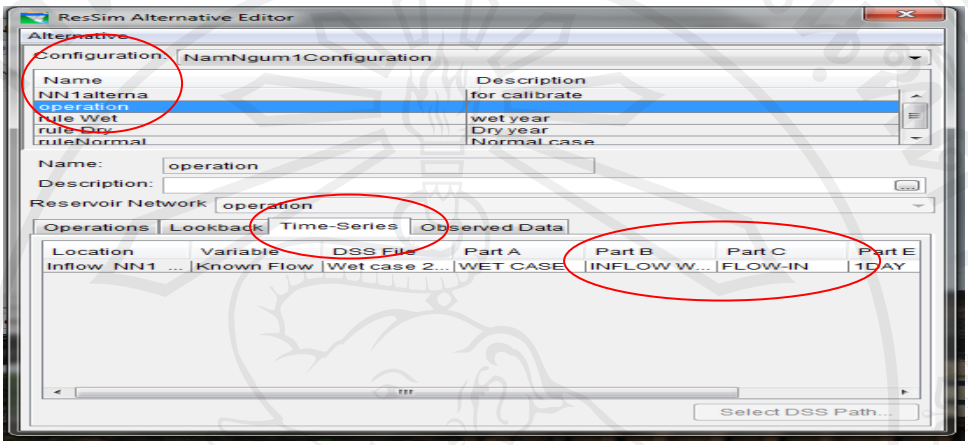


Figure C.17 Alternative editor-time-series tab

Each row in the Time-Series table is a local flow location (specified in the Local Flow tab within the Junction editor in the Reservoir Network module), an element/parameter which has been defined on the Look back tab as Time Series, or a Time Series that is referenced in the Operation rules. Select each row, one at a time, and click the **Select DSS Path** button to access the **Select Time-Series Path** dialog box is shown in Figure C.18.

The **Select Time-Series Path** dialog box allows selecting records from a list of pathnames (or catalog) in the database. From the **View** menu, choose to display a straight list of pathnames or a list of pathnames separated into parts, and refine the list by searching for either a string in the pathnames or for specific pathname parts. For detailed information about working with DSS files.

To select time-series records for a location or element/parameter in alternative, open the DSS file wishing to browse. If the name of the file is known, type the file name (including the path) directly into the **File Name** box to open the DSS file. Otherwise, choose **Open** from the **File** menu or click the button to select the DSS database file wanted.

Once having selected a file, the **Select Time-Series Path** dialog box displays the filename, the number of pathnames in the list, the number of pathnames selected,

the total number of pathnames in. The database file, and the size of the database file. The individual pathnames display in a table beneath the search area.

When satisfied with the DSS record which has been chosen for a location or element/parameter, click on the **Set Pathname** button and the selected pathname will appear in the Time-Series tab of the Alternative editor.

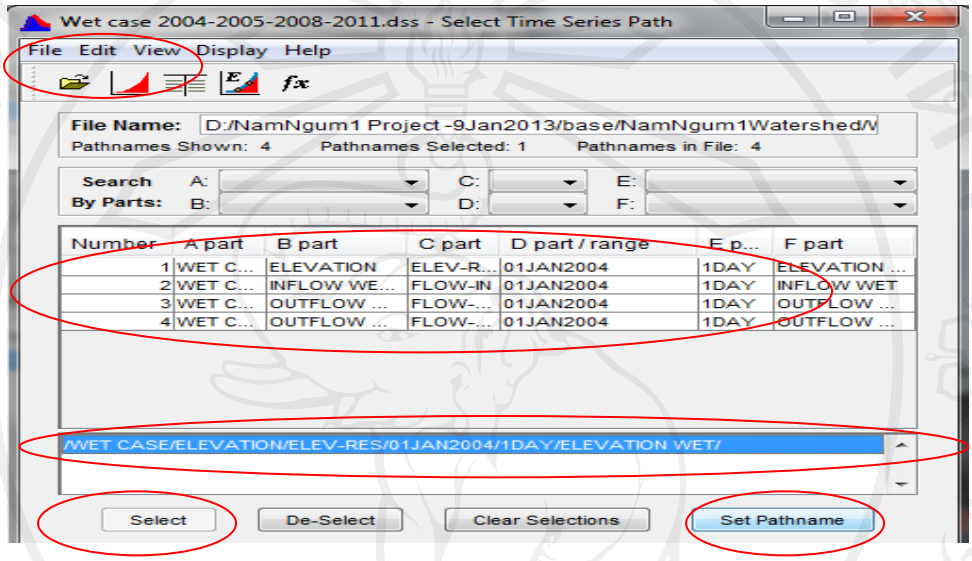


Figure C.18 Select time-series path dialog box

Select the **Model** . Right-click on the picture and select **Edit Reservoir Properties** to open editing pool physical data is shown in Figure C.19.

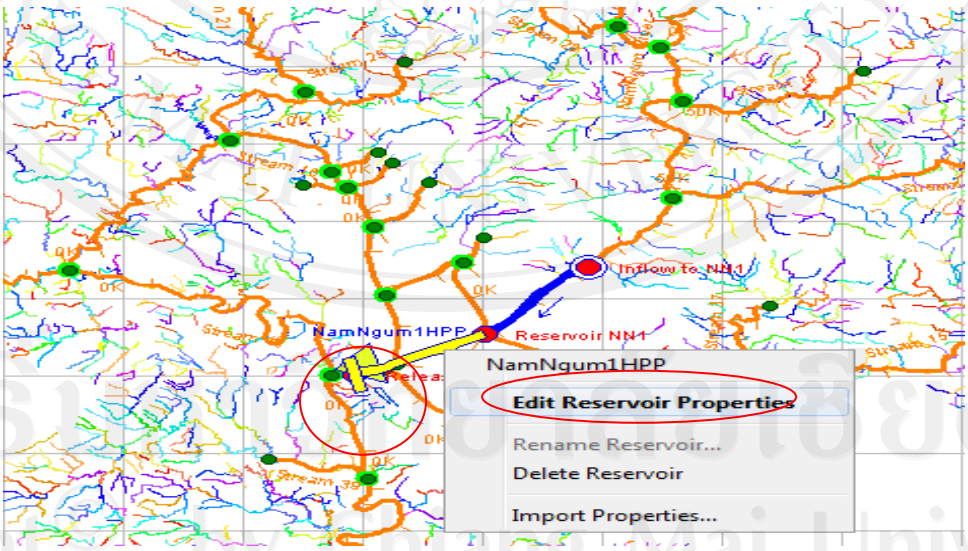


Figure C.19 Select model dialog box

To edit physical data for a reservoir Pool, select the **Pool** in the reservoir tree. The Reservoir Editor's Pool data editor. The table in this Editor allows choosing

either Linear or Conic Interpolation and entering the **Elevation**, **Storage, Area** data. Two plots visually represent Storage and Area values in relation to Elevation are shown in Figure C.20.

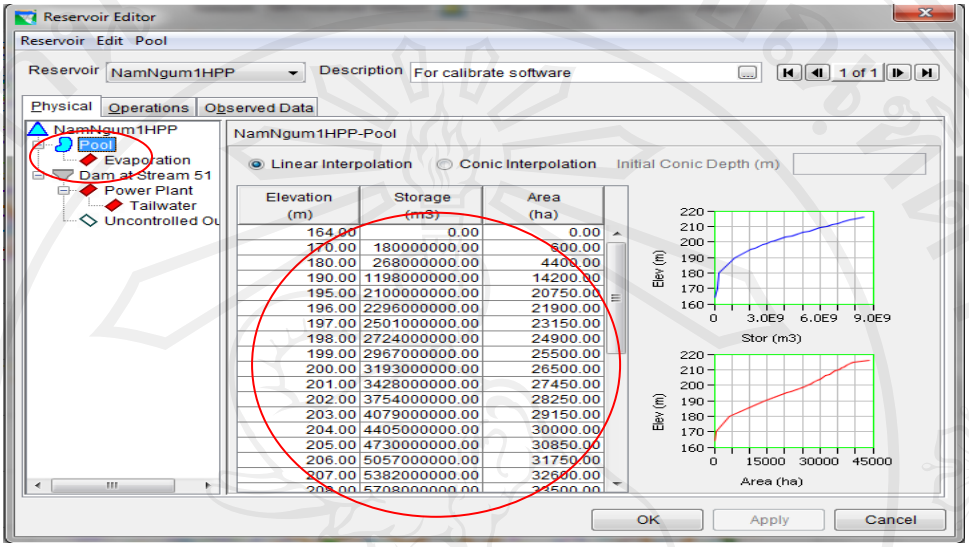


Figure C.20 Reservoir editor physical data pool

Editing power plant physical data, a Power Plant is a component of a Controlled Outlet. To edit data for a Power Plant, select the **Power Plant** in the reservoir tree. The Reservoir Editor's Power Plant data editor has four tabs that allow to edit data for **Capacity**, **Efficiency**, **Station Use**, and **Hydraulic Losses**, as described in the following Figure C.21.

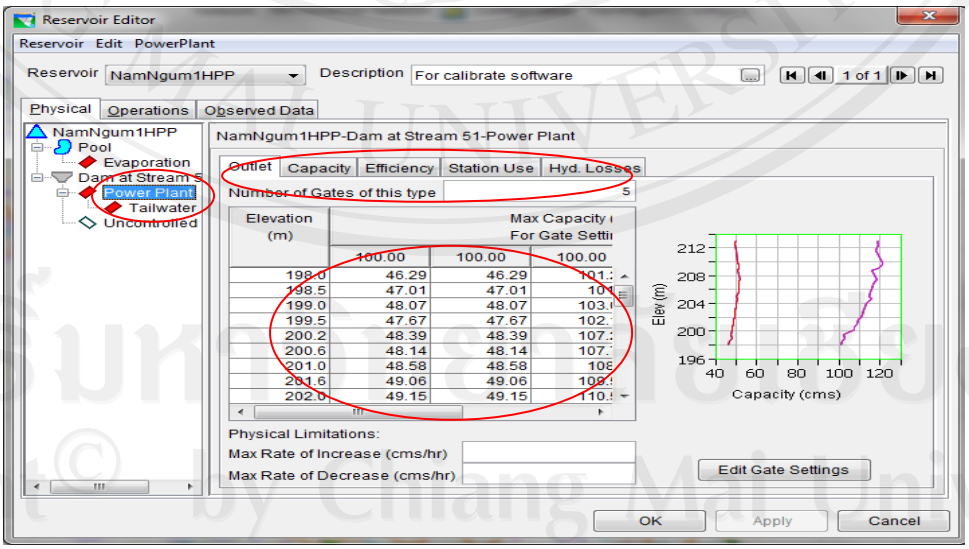


Figure C.21 Power plant physical data editor

Editing tail water physical data, a tail water is a component of a Controlled Outlet. To edit data for a tail water, select the **tail water** in the power plant tree. The power plant Editor's tail water data editor has two tabs that allow editing data for **Stage**, and **Discharge**, as show in the following Figure C.22.

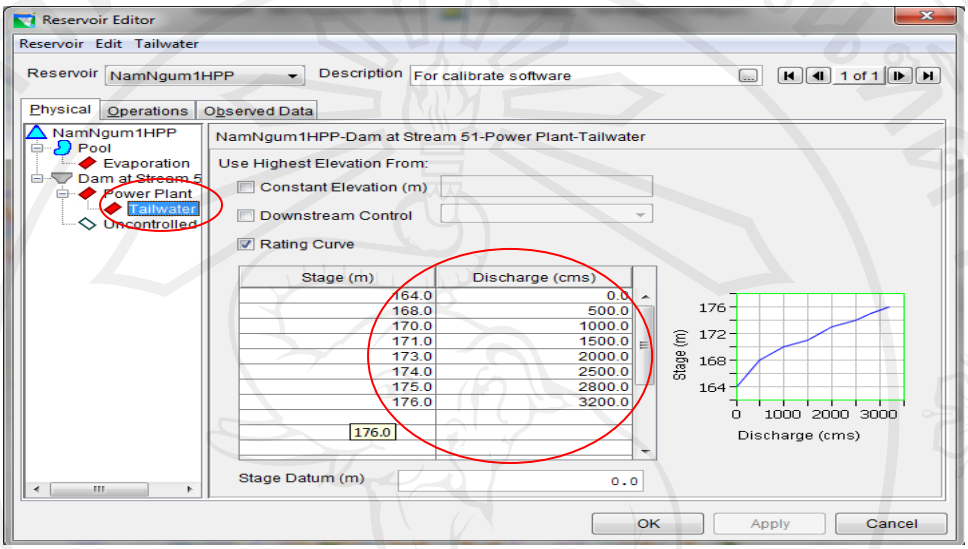


Figure C.22 Tail water physical data editor

Editing spillway discharge physical data, a spillway discharge is a component of an uncontrolled Outlet. To edit data for a spillway discharge, select the **Uncontrolled Outlet** in the power plant tree. The power plant Editor's uncontrolled Outlet data editor has two tabs that allow to edit data for **Elevation**, and **Outflow**, as show in the following Figure C.23.

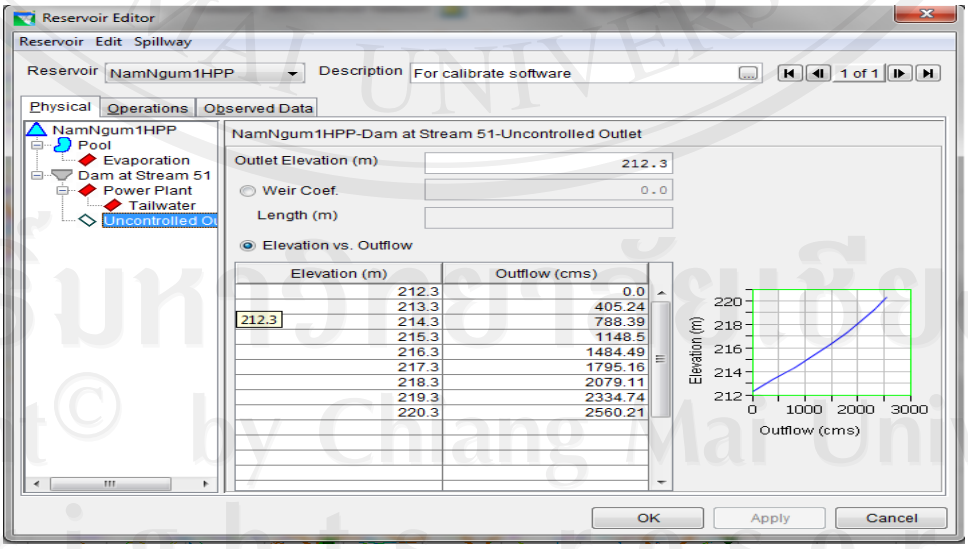


Figure C.23 Spillway discharge physical data editor

To edit Evaporation data, select **Evaporation** in the reservoir tree. Figure C.24 shows the Reservoir Editor's Evaporation data editor and its corresponding mini-plot. The mini-plot will reflect the values entered and can be viewed in full size when double-clicked on it. Either Monthly Average Evaporation or Evaporation Time-Series data can be chosen.

Monthly Average Evaporation: Enter Evaporation values by month. To enter data into the table, either copy or paste it from a spreadsheet application or type in the values manually.

Evaporation Time Series: If select this option, it is needed to specify the time-series data source when creating an Alternative.

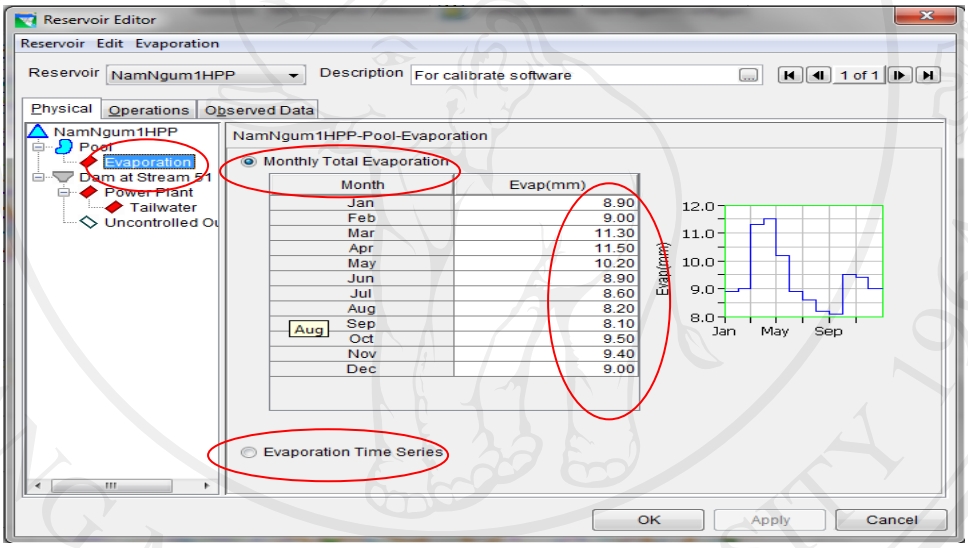


Figure C.24 Evaporation loss physical data editor

As illustrated in Figure C.25, when creating a new Operation Set, HEC-ResSim3.0 automatically creates three default reservoir operation zones: **Flood Control**, **Conservation**, and **Inactive**. Rename these default zones and add descriptions. Define additional zones as well. This section will detail how to edit the zone definitions of the operation set.

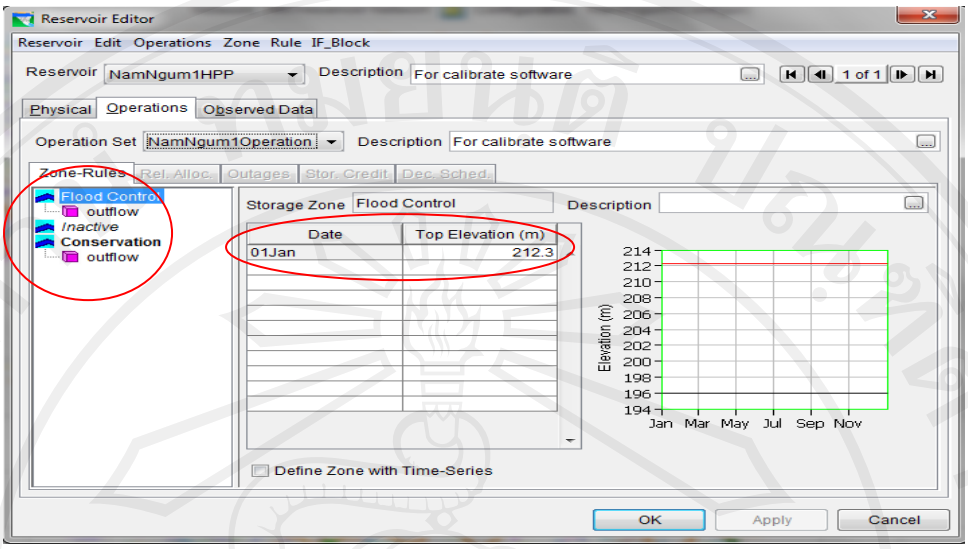


Figure C.25 Reservoir editor flood control point

Define the curves representing the top of each zone which have been created. A table of dates and elevations defines each curve. The first date in the table is always 01Jan. The curve is defined by straight lines connecting the points defined in the table, as show in the following Figure C.26.

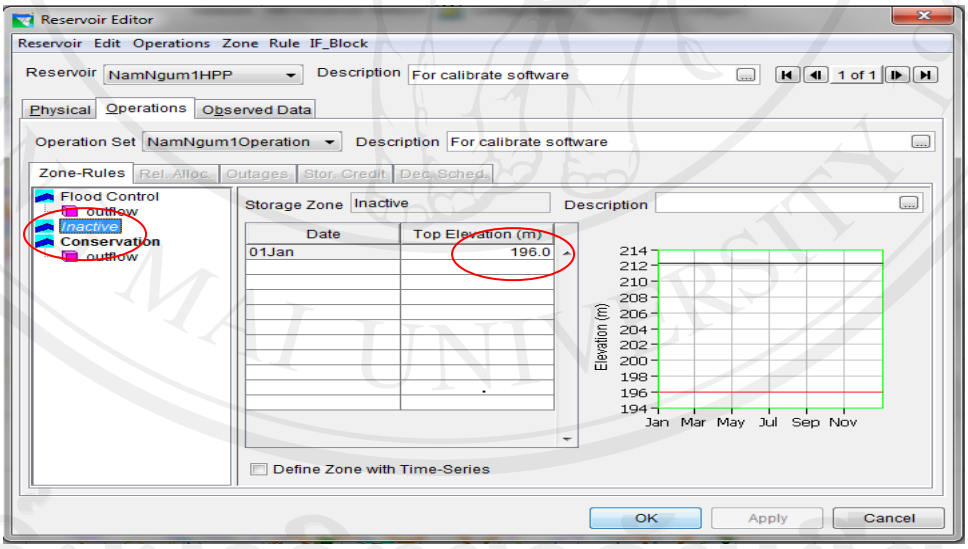


Figure C.26 Reservoir editor inactive points

When creating a rule, it must be named, assign the rule to a specific sub-element of the reservoir, and select the rule type. The list of available sub-elements includes: the reservoir **Pool** (identified by the name of the reservoir); the **Dam** (identified by the reservoir name hyphenated with the dam name), **Outlet Groups**, and **Diverted Outlets**; and, all user-defined **Controlled Outlets**.

To create a new rule: From the **Rule** menu, select **New**. The **New Operating Rule** dialog box will appear. Specify a **Rule Name** for the **Operates Release From** and select a **Rule type**. Click the button to access a larger text field for description. From the **Configuration** list, choose the **Release Function** on which this rule will be based and Click **Ok.** The detail is shown in Figure C.27.

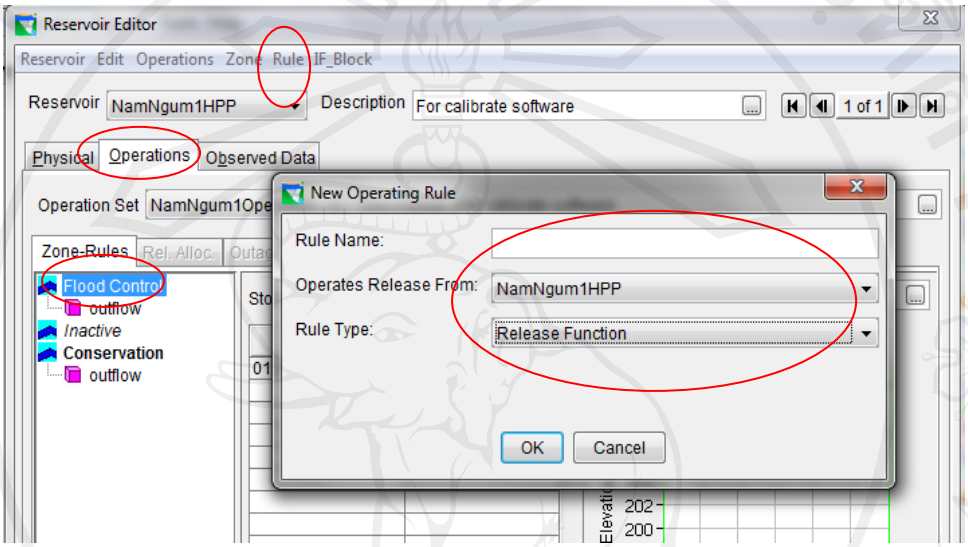


Figure C.27 Reservoir editor new rule

To create a Release Function: From the **flood control** menu, select **Define**. The **independent variable definition** dialog box will appear. Specify a **New Name** (e.g Outflow) for the **Variable name ,** select **External Variable** for **Release is function of** and select a **Current value** for the Function and Click **Ok**. Then type 1.0 and 10.000 for Outflow, Release table and Click **Ok** the detail is shown in Figure C.28.

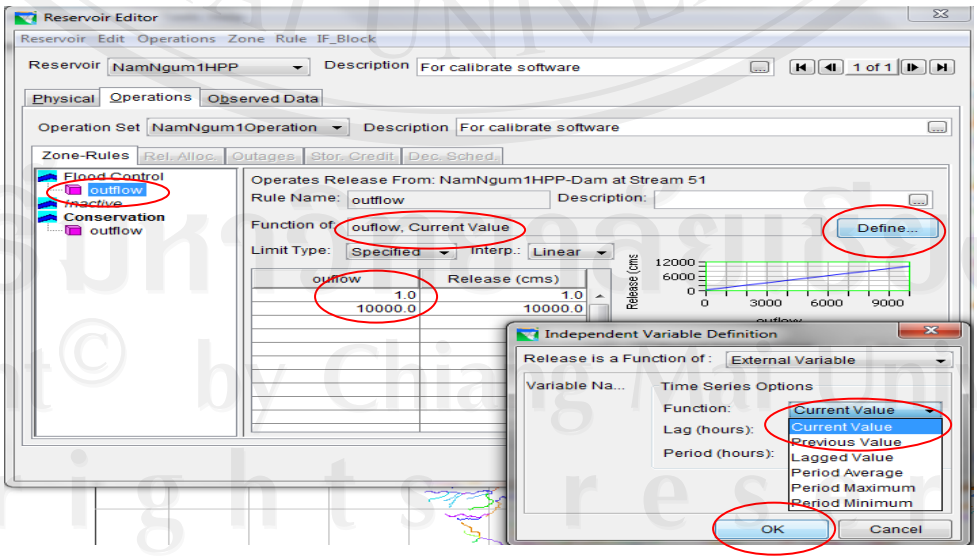


Figure C.28 Reservoir editor function release

Once having created a rule in a zone, may want to use that same rule in another zone, so do not have to create a new rule in the other zone. To add an existing operation rule to a zone: Right click on the **Outflow**, select **Add Rule to All Zones** in the operations tree and click the **Ok** to complete the new process. The new zone created now appears in the operations tree, as show in the following Figure C.29.

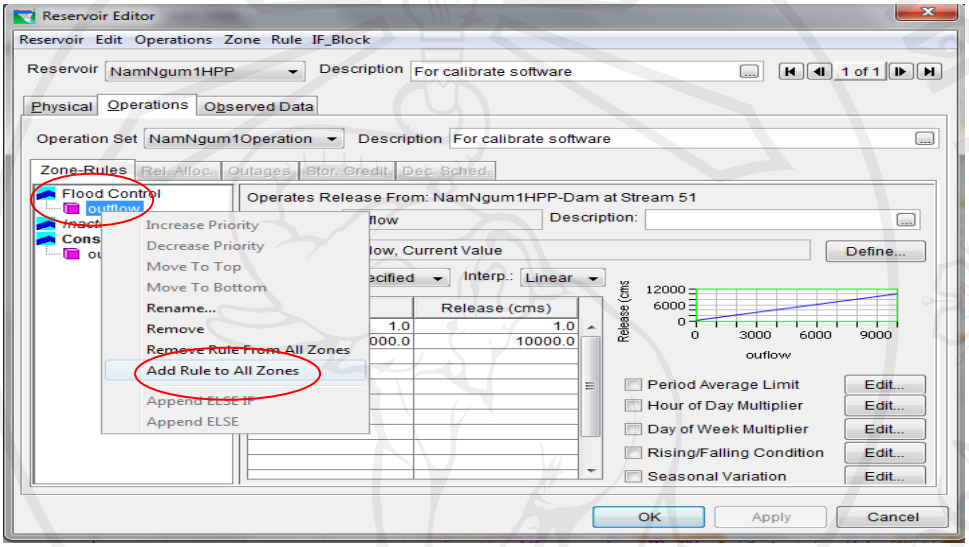


Figure C.29 Reservoir editor new zone dialog box

C.3 Simulation module

The purpose of the Simulation Module is to isolate output analysis from the model development process. Once the reservoir model is completed and the alternatives have been defined, the Simulation Module is used to configure the simulation. The computations are performed and results are viewed within the Simulation Module.

When creating a simulation, a simulation time window must be specified, a computation interval and the alternatives to be analyzed. Then, HEC-ResSim3.0 creates a directory structure within the rss folder of the watershed that represents the simulation. The main screen's simulation module is shown in Figure C.30.

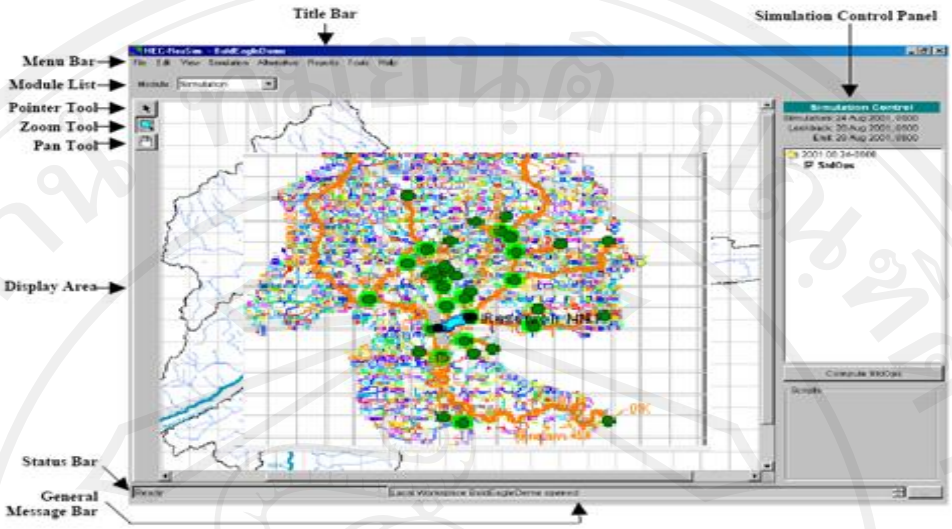


Figure C.30 Simulation module main window

The relationships between of t reservoir module and simulation module are shown in Figure C.31.

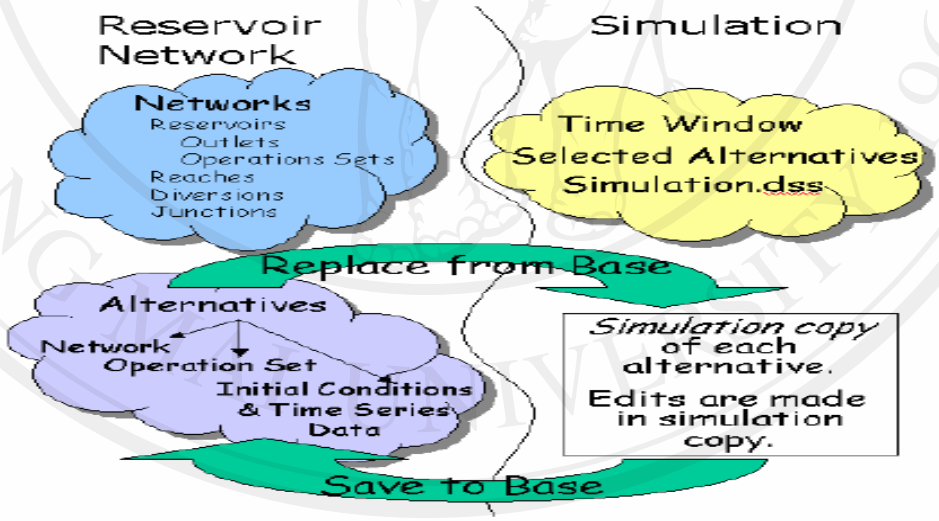


Figure C.31 Relationships between reservoir network and simulation modules

Once having created a reservoir network, entered element data, and developed alternatives in the Reservoir Network Module, configure the model for a Simulation in the Simulation Model.

To create a new Simulation: From the **Simulation** menu, select **New**. Or, in the **Simulation Control Panel**, right-click on the currently active Simulation or **No**

Simulation folder to access the shortcut menu select **New**. The **Simulation Period,** dialog box will open is shown in Figure C.32.

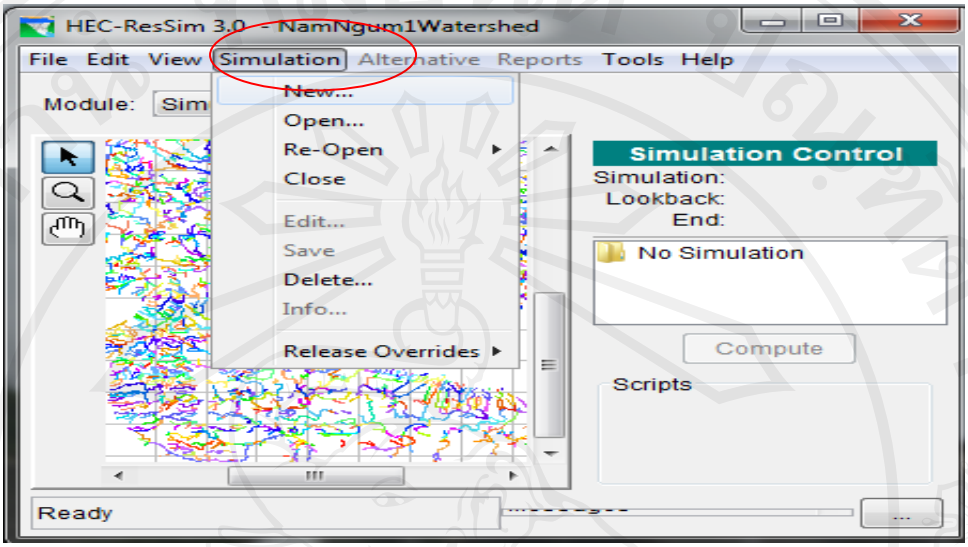


Figure C.32 Create simulation files

The **Name** field contains a default name for the Simulation based on the current date and time. Either accept the default or enter a name that is more meaningful to work. Enter a **Start Date** and **Time** specifying when wanted the Simulation to begin. It must occur after the Look back Date. Enter a **Look back Date** and **Time**.

The Look back is the "warm-up" period before the Simulation begins.

Enter an **End Date** and **Time** specifying when wanting the Simulation to conclude. Choose a **Time Step** from the list. The Time Step is the computation interval and can be 15 Minutes, 30 Minutes, 1 Hour, 3 Hours, 6 Hours, 12 Hours, or 1 Day.

The **Alternatives** table includes all of the Alternatives have which been defined in the Reservoir Network Module. Select one or more applicable Alternatives for the Simulation by checking the boxes beside them in the **Select** column. Ensure the Alternatives selected include time-series data for the entire Simulation period.

Click **OK** to close the Simulation Period dialog box. The **Creating Simulation** window will inform of the status as HEC-ResSim3.0 creates the Simulation having defined. The Simulation created will now appear in the Simulation Control Panel. The detail is shown in Figure C.33.

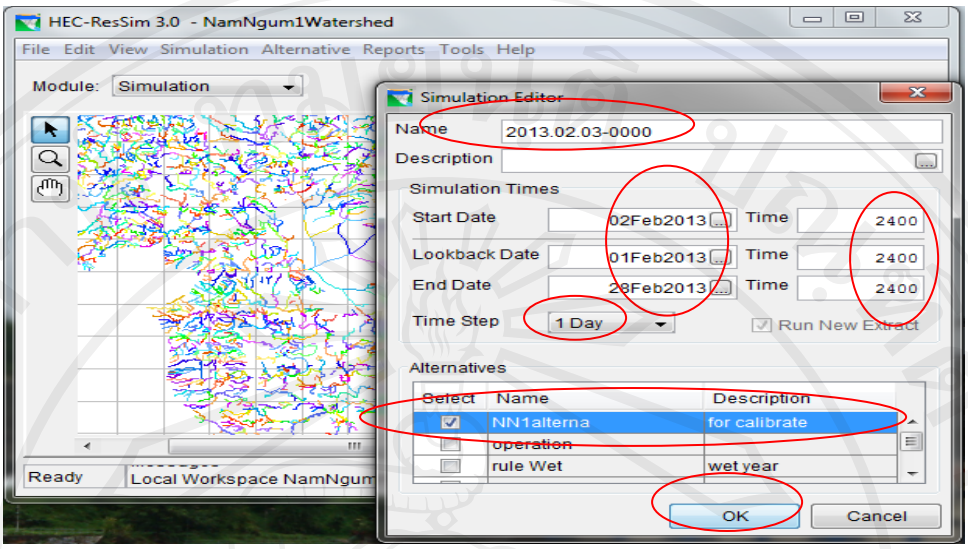


Figure C.33 Step for creating simulation files

After inputting all data and parameters as desired, a simulation. In the Simulation can be computed Control Panel of the main window of the Simulation Module, the simulation tree displays the current Simulation as a folder, beneath which is a list of the Alternatives associated with the Simulation. Also shown in the Simulation Control Panel is the time information associated with the Simulation.

To execute a Simulation, first set an Alternative as Active. Right-click on an Alternative in the Simulation Control Panel and, from the shortcut menu, select **Set as Active** dialog box will open. The detail is shown in Figure C.34.

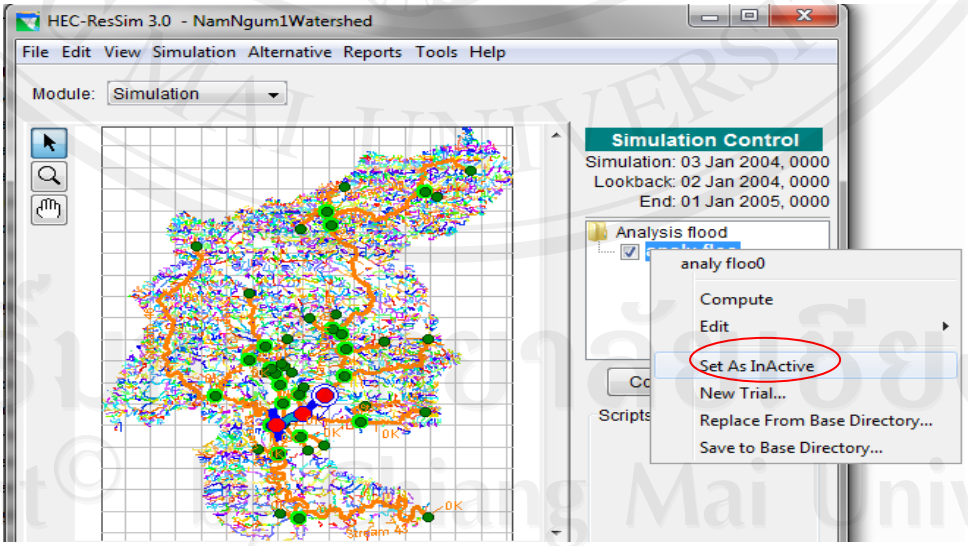


Figure C.34 Simulation control panel shortcut menu compute

The name of the active Alternative appears in bold in the simulation tree and the **Compute** button becomes available. Also, the model schematic for the active Alternative will appear in the display area.

To compute a Simulation, either click the **Compute** button in the Simulation Control Panel or, in the simulation tree, right-click on the Alternative and select **Compute** from the shortcut menu.

When computing a Simulation, a **Compute** window opens, as shown in Figure C.35. The **Compute** window provides **Message Output** that contains information regarding the status of each step of the computation process. The **Progress Bar** indicates the percentage of completion for each step. When the computation is finished, the **Progress Bar** is completely filled in and reads "100%" along with the message "Compute Complete" in the **Message Bar** of the **Compute** window.

If there are errors or any problems during the execution process, the Message Output Text area of the compute window can be reviewed. Also the **Compute Log** can provide information regarding the type of problem that exists. Click **Close** to close the Compute window, dialog box will show in Figure C.35.

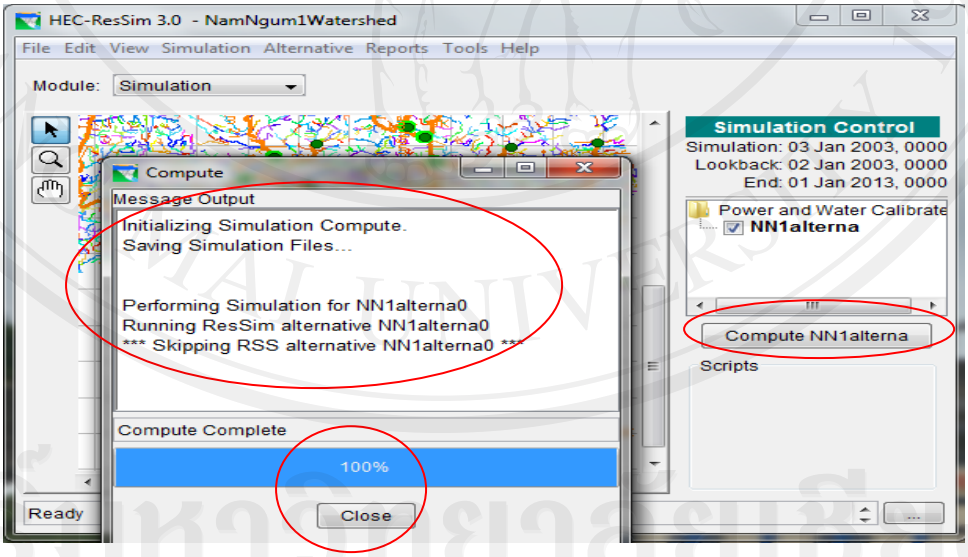


Figure E.35 Compute window

Plots and tables in the Simulation Module offer detailed views of data and model results. Access plots using shortcut menus in the Simulation Module's display area. To access a **Plot** from the display area, **right-click** on a model element in the map display. The shortcut menu will provide a list of one or more plot options, as illustrated in Figure C.36.

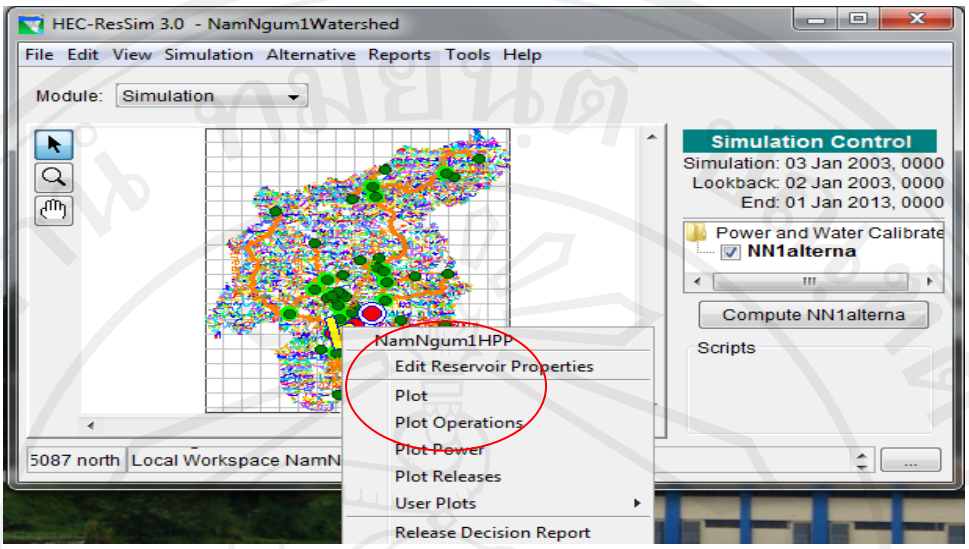


Figure C.36 Reservoir shortcut menu plot simulation results

HEC-ResSim3.0 plots offer a variety of information that will assist with reviewing the results of a Simulation. Included in the information available from the default plots are reservoir elevation, storage, and release values as well as regulated and unregulated (without reservoirs and other projects) flow values. Figure C.37 shows a sample plot illustrating reservoir results from a Simulation.

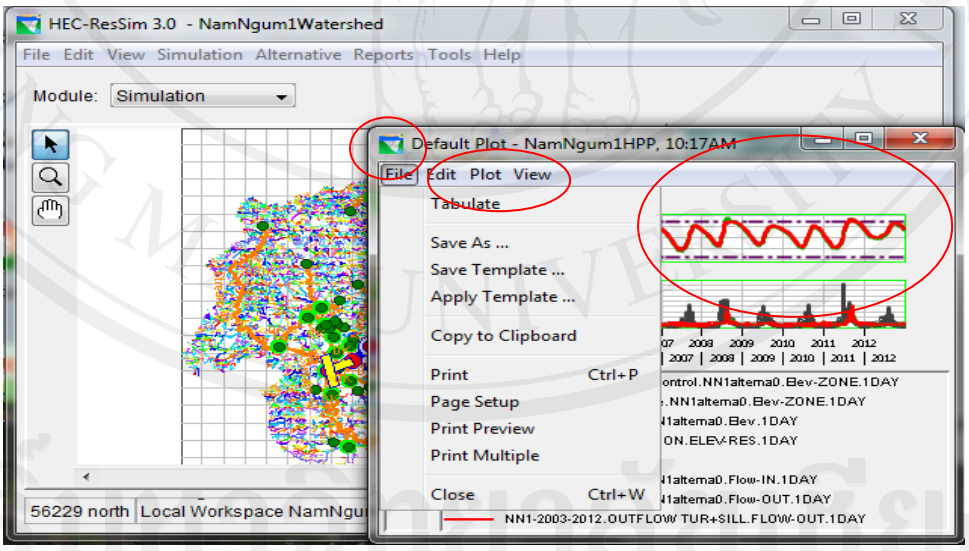


Figure C.37 Sample plot of reservoir results

Appendix D

Actual Data

The data are recorded from 2003-2012 years of Nam Ngum-1 hydropower plant. There are three cases as wet, drought and normal cases. The water elevation, energy production, water inflow, water turbine discharge, water spillway discharge and old upper and lower rule curve. All data are used for the HEC-ResSim3.0 model to simulation the reservoir management of Nam Ngum-1 hydropower plant to optimize electricity production. The detail data is shown in the following Table D.1, 2, and 3:

Appendix D1 Actual data in wet case

Table D.1 Actual data in wet case

Month	Actual data in wet case							
	Items	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(m.a.s.l)	(m.a.s.l)	(m.a.s.l)	(GWh)	(cms)	(cms)	(cms)
Jan	1	207.87	212.00	208.26	2,887.83	97.31	335.08	0.00
	2	207.81	212.00	208.22	2,832.33	96.00	337.06	0.00
	3	207.75	212.00	208.17	2,817.90	109.73	326.72	0.00
	4	207.69	212.00	208.13	2,700.60	83.11	314.11	0.00
	5	207.63	212.00	208.08	2,657.25	95.11	309.71	0.00
	6	207.57	212.00	208.04	2,639.35	94.22	306.23	0.00
	7	207.51	212.00	208.00	2,859.73	79.96	331.81	0.00
	8	207.45	212.00	207.95	2,849.90	91.71	333.00	0.00
	9	207.39	212.00	207.91	2,728.88	96.42	317.52	0.00
	10	207.32	212.00	207.87	2,780.80	100.35	326.54	0.00
	11	207.27	212.00	207.82	2,454.63	77.97	287.63	0.00
	12	207.21	212.00	207.78	2,497.10	84.05	292.12	0.00
	13	207.15	212.00	207.73	2,556.55	84.66	298.86	0.00
	14	207.10	212.00	207.69	2,649.38	80.56	307.26	0.00
	15	207.04	212.00	207.65	2,604.80	99.68	305.41	0.00
	16	206.99	212.00	207.60	2,442.93	92.33	286.27	0.00

Month	Actual data in wet case							
	Items	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(m.a.s.l)	(m.a.s.l)	(m.a.s.l)	(GWh)	(cms)	(cms)	(cms)
	17	206.93	212.00	207.56	2,550.20	80.11	300.05	0.00
	18	206.87	212.00	207.51	2,615.33	89.89	307.71	0.00
	19	206.82	212.00	207.47	2,429.25	77.42	284.48	0.00
	20	206.77	212.00	207.43	2,332.78	87.06	269.94	0.00
	21	206.71	212.00	207.38	2,475.83	73.52	291.51	0.00
	22	206.66	212.00	207.34	2,432.90	89.11	289.57	0.00
	23	206.51	212.00	207.29	2,303.25	78.22	259.87	0.00
	24	206.55	212.00	207.25	2,413.75	78.66	282.41	0.00
	25	206.51	212.00	207.21	2,451.90	114.15	290.57	0.00
	26	206.45	212.00	207.16	2,328.35	65.79	275.68	0.00
	27	206.40	212.00	207.12	2,347.33	94.25	279.71	0.00
	28	206.35	212.00	207.08	2,483.70	75.31	292.35	0.00
	29	206.29	212.00	207.03	2,345.38	86.58	279.11	0.00
	30	206.24	212.00	206.99	2,244.65	90.55	266.30	0.00
	31	206.20	212.00	206.94	2,395.90	112.54	286.29	0.00
Feb	1	206.15	212.00	206.90	2,405.03	80.66	288.13	0.00
	2	206.10	212.00	206.82	2,401.60	107.51	286.05	0.00
	3	206.05	212.00	206.75	2,551.30	94.65	305.54	0.00
	4	205.99	212.00	206.67	2,607.40	75.15	313.33	0.00
	5	205.93	212.00	206.60	2,251.18	82.49	269.57	0.00
	6	205.89	212.00	206.52	2,225.78	143.84	269.08	0.00
	7	205.85	212.00	206.45	2,596.53	106.82	314.56	0.00
	8	205.79	212.00	206.37	2,433.83	102.43	294.97	0.00
	9	205.74	212.00	206.30	2,415.18	85.91	292.43	0.00
	10	205.68	212.00	206.22	2,410.50	73.59	292.89	0.00
	11	205.63	212.00	206.14	2,398.08	112.36	291.91	0.00
	12	205.57	212.00	206.07	2,227.53	57.24	271.11	0.00
	13	205.52	212.00	205.99	2,430.18	97.35	295.46	0.00
	14	205.47	212.00	205.92	2,665.25	100.75	326.63	0.00

Month	Actual data in wet case							
	Items	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(m.a.s.l)	(m.a.s.l)	(m.a.s.l)	(GWh)	(cms)	(cms)	(cms)
	15	205.41	212.00	205.84	2,437.83	97.00	298.80	0.00
	16	205.35	212.00	205.77	2,542.30	78.07	311.28	0.00
	17	205.28	212.00	205.69	2,680.95	74.68	329.56	0.00
	18	205.21	212.00	205.62	2,940.35	91.27	363.89	0.00
	19	205.14	212.00	205.54	2,814.38	61.27	343.01	0.00
	20	205.07	212.00	205.47	2,842.23	70.25	351.67	0.00
	21	204.99	212.00	205.39	2,915.63	91.70	358.00	0.00
	22	204.93	212.00	205.31	2,908.45	2.44	361.96	0.00
	23	204.85	212.00	205.24	2,859.30	82.47	356.51	0.00
	24	204.76	212.00	205.16	2,844.75	86.51	356.62	0.00
	25	204.69	212.00	205.09	2,896.68	67.51	362.29	0.00
	26	204.61	212.00	205.01	2,743.80	85.99	339.70	0.00
	27	204.55	212.00	204.94	2,766.08	141.14	348.19	0.00
	28	204.52	212.00	204.86	2,900.95	67.61	364.28	0.00
	29	204.51	212.00	204.71	2,900.43	75.20	305.01	0.00
Mar	1	204.38	212.00	204.71	2,708.55	83.55	339.56	0.00
	2	204.31	211.90	204.63	2,736.80	80.90	344.14	0.00
	3	204.24	211.80	204.55	2,829.13	86.48	358.13	0.00
	4	204.16	211.70	204.48	2,845.25	86.93	359.44	0.00
	5	204.09	211.60	204.40	2,812.38	68.82	352.60	0.00
	6	204.02	211.50	204.32	2,831.58	71.97	359.36	0.00
	7	203.94	211.40	204.24	2,822.88	80.08	359.61	0.00
	8	203.86	211.30	204.17	2,721.20	69.64	343.68	0.00
	9	203.80	211.21	204.09	2,666.25	82.78	344.26	0.00
	10	203.73	211.11	204.01	2,797.63	76.13	358.80	0.00
	11	203.65	211.01	203.93	2,804.13	96.53	358.95	0.00
	12	203.59	210.91	203.85	2,669.55	112.27	343.28	0.00
	13	203.52	210.81	203.78	2,710.90	113.96	350.31	0.00
	14	203.44	210.71	203.70	2,667.83	85.04	345.57	0.00

Month	Actual data in wet case							
	Items	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(m.a.s.l)	(m.a.s.l)	(m.a.s.l)	(GWh)	(cms)	(cms)	(cms)
	15	203.37	210.61	203.62	2,669.93	86.19	346.22	0.00
	16	203.31	210.51	203.54	2,683.33	90.20	347.36	0.00
	17	203.26	210.41	203.47	2,724.70	94.56	354.10	0.00
	18	203.19	210.31	203.39	2,566.48	102.40	335.60	0.00
	19	203.13	210.21	203.31	2,533.58	94.46	330.50	0.00
	20	203.06	210.11	203.23	2,595.63	50.14	339.42	0.00
	21	203.00	210.01	203.16	2,715.70	121.76	356.66	0.00
	22	202.94	209.91	203.08	2,709.10	156.97	354.88	0.00
	23	202.89	209.81	203.00	2,704.30	138.31	354.55	0.00
	24	202.82	209.71	202.92	2,695.35	78.90	354.51	0.00
	25	202.71	209.62	202.84	2,674.98	72.46	353.33	0.00
	26	202.64	209.52	202.77	2,686.70	62.06	356.52	0.00
	27	202.58	209.42	202.69	2,714.25	100.38	361.66	0.00
	28	202.53	209.32	202.61	2,706.13	97.13	360.14	0.00
	29	202.42	209.22	202.53	2,699.48	97.43	360.17	0.00
	30	202.35	209.12	202.46	2,686.15	104.09	359.56	0.00
	31	202.30	209.02	202.38	2,678.85	119.71	360.04	0.00
April	1	202.23	208.92	202.30	2,802.63	169.74	376.00	0.00
	2	202.19	208.83	202.19	2,866.65	150.06	385.16	0.00
	3	202.14	208.74	202.08	2,861.78	203.75	384.64	0.00
	4	202.07	208.65	201.97	2,854.30	150.07	384.87	0.00
	5	202.02	208.56	201.87	2,619.90	171.03	358.33	0.00
	6	201.97	208.47	201.76	2,655.50	132.98	357.66	0.00
	7	201.91	208.37	201.65	2,743.48	142.85	373.26	0.00
	8	201.85	208.28	201.54	2,719.05	151.39	369.28	0.00
	9	201.79	208.19	201.43	2,715.73	139.95	370.72	0.00
	10	201.73	208.10	201.32	2,719.40	171.50	371.49	0.00
	11	201.65	208.01	201.21	2,711.30	66.04	370.96	0.00
	12	201.59	207.92	201.10	2,613.93	142.12	358.59	0.00

Month	Actual data in wet case							
	Items	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(m.a.s.l)	(m.a.s.l)	(m.a.s.l)	(GWh)	(cms)	(cms)	(cms)
	13	201.53	207.83	201.00	2,589.45	104.66	356.25	0.00
	14	201.47	207.74	200.89	2,586.15	130.28	356.17	0.00
	15	201.40	207.65	200.78	2,575.18	150.03	356.01	0.00
	16	201.34	207.56	200.67	2,559.78	130.40	353.11	0.00
	17	201.26	207.46	200.56	2,666.23	198.70	368.30	0.00
	18	201.21	207.37	200.45	2,653.25	155.24	367.13	0.00
	19	201.14	207.28	200.34	2,621.13	222.24	362.58	0.00
	20	201.08	207.19	200.24	2,582.35	194.88	356.79	0.00
	21	201.02	207.10	200.13	2,553.98	177.57	355.85	0.00
	22	200.97	207.01	200.02	2,528.08	172.18	353.62	0.00
	23	200.93	206.92	199.91	2,438.73	191.40	340.25	0.00
	24	200.88	206.83	199.80	2,435.08	159.13	340.54	0.00
	25	200.82	206.74	199.69	2,426.55	153.76	339.90	0.00
	26	200.76	206.65	199.58	2,451.95	157.78	344.01	0.00
	27	200.70	206.55	199.47	2,445.05	194.24	343.91	0.00
	28	200.68	206.46	199.37	2,408.18	204.86	341.07	0.00
	29	200.63	206.37	199.26	2,426.35	174.89	333.25	0.00
	30	200.54	206.28	199.15	2,418.10	192.38	338.32	0.00
May	1	200.51	206.19	199.04	2,349.50	193.11	326.98	0.00
	2	200.45	206.12	198.95	2,344.38	195.23	330.95	0.00
	3	200.41	206.04	198.87	2,364.90	220.81	335.70	0.00
	4	200.38	205.97	198.78	2,287.95	176.37	323.21	0.00
	5	200.34	205.90	198.69	2,315.60	252.90	328.33	0.00
	6	200.30	205.83	198.61	2,411.50	268.56	339.96	0.00
	7	200.27	205.75	198.52	2,378.80	253.76	336.96	0.00
	8	200.25	205.68	198.43	2,179.73	228.58	305.09	0.00
	9	200.18	205.61	198.35	2,257.90	236.06	292.08	0.00
	10	200.18	205.53	198.26	2,356.25	232.32	335.26	0.00
	11	200.16	205.46	198.17	2,345.93	268.31	333.40	0.00

Month	Actual data in wet case							
	Items	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(m.a.s.l)	(m.a.s.l)	(m.a.s.l)	(GWh)	(cms)	(cms)	(cms)
	12	200.11	205.39	198.09	2,430.25	252.93	344.94	0.00
	13	200.07	205.32	198.00	2,425.40	239.11	345.75	0.00
	14	200.03	205.24	197.91	2,203.90	212.66	314.30	0.00
	15	200.00	205.17	197.83	2,286.83	271.23	324.92	0.00
	16	199.97	205.10	197.74	2,401.93	217.09	342.34	0.00
	17	199.93	205.02	197.65	2,241.80	229.40	320.50	0.00
	18	199.92	204.95	197.56	2,238.73	301.76	318.95	0.00
	19	199.91	204.88	197.48	2,318.78	307.88	331.69	0.00
	20	199.92	204.80	197.39	2,292.63	436.64	330.44	0.00
	21	199.92	204.73	197.30	2,316.08	325.83	325.86	0.00
	22	199.90	204.66	197.22	2,162.28	268.15	304.97	0.00
	23	199.89	204.59	197.13	2,203.43	267.58	311.78	0.00
	24	199.88	204.51	197.04	2,174.45	287.94	308.51	0.00
	25	199.86	204.44	196.96	2,094.15	262.08	297.05	0.00
	26	199.86	204.37	196.87	2,091.68	300.31	297.94	0.00
	27	199.85	204.29	196.78	2,089.50	294.04	297.43	0.00
	28	199.86	204.22	196.70	2,088.23	292.12	297.56	0.00
	29	199.80	204.15	196.61	2,083.65	343.30	296.08	0.00
	30	199.84	204.08	196.52	2,086.65	307.40	295.98	0.00
	31	199.87	204.00	196.44	2,103.98	413.34	298.70	0.00
June	1	199.92	203.93	196.35	2,101.35	498.80	297.24	0.00
	2	199.97	203.88	196.34	2,082.95	437.82	294.45	0.00
	3	200.01	203.82	196.33	2,056.43	386.04	289.35	0.00
	4	200.06	203.77	196.32	2,091.48	507.64	293.67	0.00
	5	200.14	203.71	196.30	2,091.75	650.82	292.19	0.00
	6	200.23	203.66	196.29	2,064.50	624.50	288.36	0.00
	7	200.32	203.60	196.28	2,079.43	669.82	289.18	0.00
	8	200.41	203.55	196.27	2,026.48	538.13	277.64	0.00
	9	200.45	203.50	196.26	1,997.63	571.91	275.95	0.00

Month	Actual data in wet case							
	Items	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(m.a.s.l)	(m.a.s.l)	(m.a.s.l)	(GWh)	(cms)	(cms)	(cms)
	10	200.58	203.44	196.25	1,982.70	528.68	275.78	0.00
	11	200.64	203.39	196.23	2,027.15	427.02	276.58	0.00
	12	200.70	203.33	196.22	1,973.55	493.44	269.98	0.00
	13	200.77	203.28	196.21	2,012.30	562.28	276.11	0.00
	14	200.85	203.22	196.20	2,042.93	576.81	280.90	0.00
	15	200.94	203.17	196.19	2,104.10	683.12	290.15	0.00
	16	201.10	203.12	196.18	2,226.45	935.15	302.32	0.00
	17	201.28	203.06	196.16	2,400.55	823.71	330.83	0.00
	18	201.43	203.01	196.15	2,558.93	895.61	347.20	0.00
	19	201.61	202.95	196.14	2,570.03	994.85	350.25	0.00
	20	201.77	202.90	196.13	2,592.53	813.11	351.81	0.00
	21	201.87	202.84	196.12	2,676.60	700.85	361.22	0.00
	22	201.95	202.79	196.11	2,540.13	641.23	340.15	0.00
	23	202.02	202.73	196.09	2,503.20	583.08	334.52	0.00
	24	202.11	202.68	196.08	2,350.38	642.20	307.76	0.00
	25	202.31	202.63	196.07	2,550.60	1245.67	339.00	0.00
	26	202.65	202.57	196.06	2,872.23	1491.92	388.31	0.00
	27	202.83	202.52	196.05	2,873.35	823.76	389.23	0.00
	28	202.92	202.46	196.04	2,916.88	756.66	389.77	0.00
	29	203.04	202.41	196.02	2,963.23	707.54	390.83	0.00
	30	203.16	202.35	196.01	2,990.55	865.27	392.78	0.00
July	1	203.42	202.30	196.00	2,997.75	1686.25	390.33	0.00
	2	203.73	202.33	196.14	2,825.15	1393.93	361.44	0.00
	3	203.94	202.35	196.28	2,833.65	990.49	363.41	0.00
	4	204.08	202.38	196.42	2,817.55	776.34	356.19	0.00
	5	204.19	202.41	196.56	2,874.85	707.87	362.98	0.00
	6	204.33	202.43	196.70	2,892.28	905.00	363.68	0.00
	7	204.49	202.46	196.84	2,934.85	826.44	364.96	0.00
	8	204.65	202.49	196.98	3,090.03	924.86	381.34	0.00

Month	Actual data in wet case							
	Items	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(m.a.s.l)	(m.a.s.l)	(m.a.s.l)	(GWh)	(cms)	(cms)	(cms)
	9	204.86	202.51	197.13	2,952.40	1221.39	368.17	0.00
	10	205.06	202.54	197.27	3,263.85	1011.54	401.97	0.00
	11	205.24	202.57	197.41	3,277.85	1054.52	401.17	0.00
	12	205.42	202.59	197.55	3,301.05	1161.82	401.73	0.00
	13	205.63	202.62	197.69	3,410.20	1258.53	408.14	0.00
	14	205.88	202.65	197.83	3,462.13	1315.93	427.33	0.00
	15	206.07	202.67	197.97	3,514.23	1032.10	427.42	0.00
	16	206.22	202.70	198.11	3,551.10	948.24	430.17	0.00
	17	206.36	202.73	198.25	3,568.58	951.58	430.25	0.00
	18	206.55	202.76	198.39	3,579.45	1313.31	418.81	0.00
	19	206.73	202.78	198.53	3,558.48	983.97	431.54	0.00
	20	206.87	202.81	198.67	3,552.68	938.16	431.59	0.00
	21	207.00	202.84	198.81	3,587.15	942.64	432.78	0.00
	22	207.19	202.86	198.95	3,642.75	1338.51	433.94	0.00
	23	207.42	202.89	199.09	3,655.08	1189.54	433.85	0.00
	24	207.60	202.92	199.23	3,653.63	1168.13	431.61	17.57
	25	207.80	202.94	199.38	3,605.60	1206.50	424.48	107.36
	26	207.94	202.97	199.52	3,586.15	1043.09	426.33	174.42
	27	208.05	203.00	199.66	3,589.95	1002.61	422.37	222.61
	28	208.14	203.02	199.80	3,601.83	949.92	421.03	222.34
	29	208.21	203.05	199.94	3,594.30	1008.84	418.58	239.38
	30	208.29	203.08	200.08	3,600.83	832.61	419.03	241.81
	31	208.38	203.10	200.22	3,749.30	1330.16	439.03	248.61
Aug	1	208.58	203.13	200.36	3,732.50	1390.13	438.54	157.58
	2	208.72	203.25	200.52	3,726.38	1134.81	438.02	158.66
	3	208.83	203.37	200.69	3,720.70	1022.58	437.54	160.00
	4	208.91	203.49	200.85	3,756.25	911.08	435.81	160.79
	5	208.97	203.62	201.02	3,800.25	965.17	435.63	121.07
	6	209.05	203.74	201.18	3,833.25	888.89	440.01	81.21

Month	Actual data in wet case							
	Items	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(m.a.s.l)	(m.a.s.l)	(m.a.s.l)	(GWh)	(cms)	(cms)	(cms)
	7	209.17	203.86	201.35	3,852.30	1221.55	440.57	81.39
	8	209.32	203.98	201.51	3,866.55	1230.61	441.43	81.59
	9	209.44	204.10	201.68	3,771.00	1038.67	427.51	135.67
	10	209.52	204.22	201.84	3,890.48	992.63	442.24	162.80
	11	209.60	204.35	202.01	3,899.95	1086.11	441.69	163.66
	12	209.83	204.47	202.17	3,908.35	1881.75	442.79	176.66
	13	210.09	204.59	202.33	3,873.83	1555.29	443.12	206.52
	14	210.25	204.71	202.50	3,868.90	1310.34	441.53	207.29
	15	210.36	204.83	202.66	3,908.15	1125.49	442.72	207.71
	16	210.48	204.95	202.83	3,959.28	1140.92	443.30	208.08
	17	210.66	205.08	202.99	3,969.15	1518.31	440.63	208.82
	18	210.86	205.20	203.16	3,981.85	1458.81	443.32	264.38
	19	211.05	205.32	203.32	3,963.88	1497.66	444.41	459.25
	20	211.27	205.44	203.49	3,900.48	1629.87	431.93	866.24
	21	211.38	205.56	203.65	3,924.20	1205.65	442.51	972.81
	22	211.47	205.68	203.81	3,967.45	1330.05	444.07	925.03
	23	211.55	205.81	203.98	3,856.45	1198.53	431.92	994.58
	24	211.56	205.93	204.14	3,885.43	1075.82	432.86	879.95
	25	211.58	206.05	204.31	3,890.13	986.49	432.12	819.78
	26	211.58	206.17	204.47	3,959.48	952.82	438.50	816.65
	27	211.57	206.29	204.64	4,013.95	912.05	443.69	770.58
	28	211.57	206.41	204.80	4,026.30	873.64	439.70	646.40
	29	211.58	206.54	204.97	4,006.33	876.54	439.26	575.94
	30	211.59	206.66	205.13	4,009.90	921.98	438.94	468.17
	31	211.52	206.78	205.30	4,035.55	888.54	438.72	251.64
Sep	1	211.69	206.90	205.46	4,073.78	978.46	441.56	274.53
	2	211.77	207.03	205.60	4,053.08	950.92	435.17	213.50
	3	211.85	207.16	205.73	4,150.95	918.56	445.55	213.55
	4	211.92	207.29	205.87	4,155.20	1004.77	443.80	213.27

Month	Actual data in wet case							
	Items	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(m.a.s.l)	(m.a.s.l)	(m.a.s.l)	(GWh)	(cms)	(cms)	(cms)
	5	212.00	207.42	206.01	4,167.18	881.61	445.77	184.56
	6	212.08	207.55	206.14	4,150.80	936.99	445.81	164.28
	7	212.15	207.68	206.28	4,157.68	824.56	446.45	164.37
	8	212.24	207.81	206.42	4,168.70	1064.25	435.86	177.33
	9	212.36	207.94	206.55	4,170.18	1098.89	445.44	187.58
	10	212.48	208.07	206.69	4,021.43	1089.56	435.49	223.62
	11	212.57	208.20	206.83	4,071.00	1009.16	442.40	289.28
	12	212.63	208.33	206.96	4,077.20	932.88	444.85	341.36
	13	212.66	208.46	207.10	4,100.80	892.50	444.33	344.24
	14	212.66	208.59	207.24	4,136.78	708.29	444.73	321.55
	15	212.65	208.72	207.37	4,165.43	905.11	444.79	293.68
	16	212.73	208.86	207.51	4,181.00	1030.75	444.89	312.25
	17	212.79	208.99	207.65	4,168.25	977.89	444.79	389.25
	18	212.79	209.12	207.78	4,137.38	907.63	443.40	514.13
	19	212.82	209.25	207.92	4,134.53	1051.58	441.03	474.58
	20	212.86	209.38	208.06	4,157.40	939.24	442.70	361.27
	21	212.90	209.51	208.19	4,186.05	877.54	444.65	321.13
	22	212.90	209.64	208.33	4,198.98	741.74	443.52	300.88
	23	212.91	209.77	208.47	4,185.70	791.63	439.98	354.13
	24	212.89	209.90	208.60	4,185.80	678.86	442.14	295.02
	25	212.87	210.03	208.74	4,221.50	657.89	443.04	284.65
	26	212.84	210.16	208.88	4,229.18	639.20	443.84	289.25
	27	212.82	210.29	209.01	4,235.30	682.18	444.09	283.77
	28	212.91	210.42	209.15	4,192.13	1321.56	438.80	505.21
	29	212.89	210.55	209.29	4,149.85	956.32	442.68	640.98
	30	212.86	210.68	209.42	4,159.55	809.72	443.46	584.65
Oct	1	212.81	210.81	209.56	4,181.45	742.39	443.59	434.66
	2	212.78	210.85	209.60	4,197.40	639.68	444.15	306.60
	3	212.76	210.89	209.64	4,214.28	577.87	443.59	229.34

Month	Actual data in wet case							
	Items	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(m.a.s.l)	(m.a.s.l)	(m.a.s.l)	(GWh)	(cms)	(cms)	(cms)
	4	212.74	210.93	209.68	4,231.60	590.67	443.41	206.40
	5	212.71	210.96	209.72	4,245.68	543.88	444.16	189.57
	6	212.70	211.00	209.76	4,138.98	541.79	431.60	183.51
	7	212.68	211.04	209.80	4,264.53	573.78	443.55	175.36
	8	212.66	211.08	209.84	4,268.58	476.84	444.30	161.42
	9	212.63	211.12	209.88	4,271.45	490.68	444.30	150.11
	10	212.59	211.16	209.92	4,271.93	440.81	444.45	135.73
	11	212.56	211.19	209.96	4,270.40	444.68	444.03	116.66
	12	212.53	211.23	210.00	4,263.88	432.60	442.92	111.93
	13	212.49	211.27	210.04	4,260.68	422.20	443.29	105.50
	14	212.46	211.31	210.08	4,256.35	406.28	443.02	96.36
	15	212.43	211.35	210.12	4,254.00	432.82	442.64	88.99
	16	212.40	211.39	210.16	4,251.65	380.67	442.64	79.14
	17	212.36	211.42	210.21	4,253.60	347.56	442.26	61.48
	18	212.32	211.46	210.25	4,060.05	339.23	414.39	54.20
	19	212.29	211.50	210.29	3,876.30	322.30	401.28	41.44
	20	212.26	211.54	210.33	3,870.73	340.81	401.20	36.54
	21	212.23	211.58	210.37	3,871.93	299.60	401.06	29.67
	22	212.20	211.62	210.41	3,870.08	289.05	401.11	15.58
	23	212.16	211.65	210.45	3,868.45	302.08	403.53	10.42
	24	212.13	211.69	210.49	3,867.85	300.84	404.50	10.15
	25	212.10	211.73	210.53	3,864.35	283.88	401.28	0.00
	26	212.07	211.77	210.57	3,862.20	280.01	401.72	0.00
	27	212.04	211.81	210.61	3,883.75	265.26	402.13	0.00
	28	212.00	211.85	210.65	3,802.48	258.15	400.39	0.00
	29	211.97	211.88	210.69	3,816.85	277.97	398.33	0.00
	30	211.94	211.92	210.73	3,627.98	286.70	378.20	0.00
	31	211.97	211.96	210.77	3,530.85	260.40	366.12	0.00

Month	Actual data in wet case							
	Items	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(m.a.s.l)	(m.a.s.l)	(m.a.s.l)	(GWh)	(cms)	(cms)	(cms)
Nov	1	211.88	212.00	210.81	3,464.40	275.34	361.93	0.00
	2	211.86	212.00	210.79	3,308.43	266.61	342.60	0.00
	3	211.84	212.00	210.77	3,302.98	270.50	344.29	0.00
	4	211.82	212.00	210.75	3,368.33	275.71	348.76	0.00
	5	211.80	212.00	210.73	3,294.65	238.97	344.68	0.00
	6	211.78	212.00	210.71	3,304.95	252.46	343.67	0.00
	7	211.75	212.00	210.69	3,313.35	229.59	342.93	0.00
	8	211.72	212.00	210.67	3,476.50	266.24	364.79	0.00
	9	211.69	212.00	210.64	3,502.00	257.56	367.36	0.00
	10	211.66	212.00	210.62	3,499.98	246.91	368.01	0.00
	11	211.62	212.00	210.60	3,497.35	230.04	367.31	0.00
	12	211.59	212.00	210.58	3,496.85	265.98	367.89	0.00
	13	211.56	212.00	210.56	3,481.75	209.46	367.17	0.00
	14	211.52	212.00	210.54	3,153.50	210.54	332.39	0.00
	15	211.49	212.00	210.52	3,250.05	205.01	341.89	0.00
	16	211.45	212.00	210.50	3,273.95	212.13	347.02	0.00
	17	211.41	212.00	210.48	3,248.78	200.92	340.94	0.00
	18	211.38	212.00	210.46	3,027.23	185.00	321.35	0.00
	19	211.35	212.00	210.44	3,071.93	215.18	323.78	0.00
	20	211.31	212.00	210.42	3,032.25	159.34	322.34	0.00
	21	211.27	212.00	210.40	2,915.03	172.15	306.63	0.00
	22	211.24	212.00	210.38	2,884.88	175.40	307.84	0.00
	23	211.21	212.00	210.36	2,873.85	194.83	303.48	0.00
	24	211.17	212.00	210.33	2,939.10	182.94	309.06	0.00
	25	211.14	212.00	210.31	2,982.30	162.24	312.28	0.00
	26	211.10	212.00	210.29	2,966.13	200.12	311.08	0.00
	27	211.07	212.00	210.27	2,930.00	149.09	305.48	0.00
	28	211.03	212.00	210.25	3,069.10	202.46	323.09	0.00
	29	210.99	212.00	210.23	3,028.00	152.09	319.89	0.00

Month	Actual data in wet case							
	Items	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(m.a.s.l)	(m.a.s.l)	(m.a.s.l)	(GWh)	(cms)	(cms)	(cms)
	30	210.95	212.00	210.21	3,019.38	183.09	319.11	0.00
Dec	1	210.91	212.00	210.19	3,045.05	151.59	322.02	0.00
	2	210.87	212.00	210.14	2,969.65	149.12	314.63	0.00
	3	210.82	212.00	210.08	3,033.50	134.56	322.86	0.00
	4	210.77	212.00	210.03	3,046.23	138.55	323.84	0.00
	5	210.72	212.00	209.98	2,945.03	109.98	313.66	0.00
	6	210.67	212.00	209.93	2,881.75	160.49	309.49	0.00
	7	210.63	212.00	209.87	2,896.18	137.21	309.11	0.00
	8	210.58	212.00	209.82	2,931.68	149.29	314.91	0.00
	9	210.54	212.00	209.77	2,932.05	156.45	313.49	0.00
	10	210.49	212.00	209.72	2,926.80	108.54	313.74	0.00
	11	210.44	212.00	209.66	2,980.13	137.41	316.84	0.00
	12	210.39	212.00	209.61	2,818.93	100.85	302.56	0.00
	13	210.34	212.00	209.56	2,870.50	101.58	305.65	0.00
	14	210.29	212.00	209.51	2,843.20	142.50	306.48	0.00
	15	210.24	212.00	209.45	2,875.80	131.17	312.24	0.00
	16	210.19	212.00	209.40	2,885.58	114.88	311.39	0.00
	17	210.14	212.00	209.35	2,883.13	141.13	312.03	0.00
	18	210.09	212.00	209.30	2,909.88	110.78	314.61	0.00
	19	210.04	212.00	209.24	3,021.38	149.06	327.19	0.00
	20	209.99	212.00	209.19	3,052.98	107.36	331.64	0.00
	21	209.93	212.00	209.14	3,047.10	109.34	332.24	0.00
	22	209.88	212.00	209.08	3,088.60	130.42	337.20	0.00
	23	209.82	212.00	209.03	3,092.00	125.15	332.49	0.00
	24	209.76	212.00	208.98	3,077.18	111.78	336.99	0.00
	25	209.71	212.00	208.93	3,048.73	131.27	334.57	0.00
	26	209.65	212.00	208.87	3,141.25	147.16	345.22	0.00
	27	209.59	212.00	208.82	3,055.35	130.90	336.17	0.00
	28	209.54	212.00	208.77	3,075.93	120.74	339.01	0.00

Month	Actual data in wet case							
	Items	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(m.a.s.l)	(m.a.s.l)	(m.a.s.l)	(GWh)	(cms)	(cms)	(cms)
	29	209.48	212.00	208.72	3,151.20	111.44	348.03	0.00
	30	209.42	212.00	208.66	3,148.35	105.79	348.42	0.00
	31	209.36	212.00	208.61	3,143.43	118.84	348.92	0.00

Note: HWL (Head water level)

Old URC (Old upper rule curve)

Old LRC (Old lower rule curve)

EE (Electricity energy)

Qin (Quantity inflow)

Qt (Quantity turbine discharge)

Qs (Quantity spillway discharge)

Appendix D.2 Actual data in drought case

Table D.2 Actual data in drought case

Month	Actual data in drought case							
	Item	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
Jan	1	208.91	212.00	208.26	2,446.97	99.95	271.23	0
	2	208.86	212.00	208.22	2,560.00	127.09	286.13	0
	3	208.82	212.00	208.17	2,547.23	94.12	284.24	0
	4	208.77	212.00	208.13	2,560.03	129.30	285.72	0
	5	208.73	212.00	208.08	2,500.10	111.29	278.59	0
	6	208.69	212.00	208.04	2,290.43	92.64	255.12	0
	7	208.65	212.00	208.00	2,227.70	134.71	248.43	0
	8	208.62	212.00	207.95	2,301.83	131.45	255.00	0
	9	208.58	212.00	207.91	2,401.87	118.74	268.46	0
	10	208.54	212.00	207.87	2,403.47	99.14	269.55	0
	11	208.49	212.00	207.82	2,457.83	100.96	276.85	0
	12	208.44	212.00	207.78	2,429.53	109.26	273.64	0
	13	208.40	212.00	207.73	2,452.93	90.12	281.35	0
	14	208.35	212.00	207.69	2,408.47	103.67	267.89	0
	15	208.31	212.00	207.65	2,407.90	100.13	272.47	0
	16	208.26	212.00	207.60	2,315.30	92.27	261.01	0
	17	208.22	212.00	207.56	2,313.37	102.57	261.48	0
	18	208.17	212.00	207.51	2,400.00	100.05	269.57	0
	19	208.13	212.00	207.47	2,400.43	95.31	270.72	0
	20	208.08	212.00	207.43	2,394.97	101.37	272.86	0
	21	208.04	212.00	207.38	2,358.73	118.30	267.23	0
	22	208.00	212.00	207.34	2,394.73	138.01	273.12	0
	23	207.97	212.00	207.29	2,298.43	150.62	262.23	0
	24	207.94	212.00	207.25	2,301.30	118.48	261.97	0
	25	207.90	212.00	207.21	2,304.87	102.05	262.98	0
	26	207.85	212.00	207.16	2,385.27	116.69	269.13	0

Month	Actual data in drought case							
	Item	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	27	207.81	212.00	207.12	2,380.60	99.15	274.34	0
	28	207.76	212.00	207.08	2,394.70	75.97	270.99	0
	29	207.71	212.00	207.03	2,434.77	90.45	278.84	0
	30	207.66	212.00	206.99	2,367.50	107.83	272.55	0
	31	207.62	212.00	206.94	2,377.50	87.37	272.94	0
Feb	1	207.56	212.00	206.90	2,365.70	68.25	278.99	0
	2	207.52	212.00	206.82	2,416.77	111.53	276.07	0
	3	207.47	212.00	206.75	2,365.20	77.52	270.80	0
	4	207.42	212.00	206.67	2,298.63	87.81	264.99	0
	5	207.37	212.00	206.60	2,408.73	88.32	276.77	0
	6	207.32	212.00	206.52	2,203.03	71.02	266.30	0
	7	207.27	212.00	206.45	2,509.77	103.72	276.97	0
	8	207.22	212.00	206.37	2,496.27	96.28	287.45	0
	9	207.17	212.00	206.30	2,490.80	87.68	287.65	0
	10	207.12	212.00	206.22	2,465.70	96.04	285.85	0
	11	207.07	212.00	206.14	2,396.33	88.45	277.57	0
	12	207.01	212.00	206.07	2,555.03	69.94	298.24	0
	13	206.96	212.00	205.99	2,473.47	107.50	287.99	0
	14	206.91	212.00	205.92	2,440.17	101.17	285.71	0
	15	206.86	212.00	205.84	2,558.93	90.76	300.83	0
	16	206.80	212.00	205.77	2,551.63	89.57	297.72	0
	17	206.75	212.00	205.69	2,489.90	90.48	291.79	0
	18	206.69	212.00	205.62	2,315.20	61.26	266.47	0
	19	206.64	212.00	205.54	2,476.50	95.35	293.43	0
	20	206.52	212.00	205.47	2,357.10	92.35	277.87	0
	21	206.54	212.00	205.39	2,394.57	80.48	281.50	0
	22	206.49	212.00	205.31	2,503.63	96.60	297.20	0
	23	206.43	212.00	205.24	2,506.50	73.83	296.98	0
	24	206.37	212.00	205.16	2,502.17	61.02	296.44	0

Month	Actual data in drought case							
	Item	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	25	206.31	212.00	205.09	2,296.07	57.52	271.10	0
	26	206.26	212.00	205.01	2,492.50	92.04	296.94	0
	27	206.21	212.00	204.94	2,377.80	112.32	282.82	0
	28	206.15	212.00	204.86	2,368.63	87.02	282.20	0
Mar	1	206.10	212.00	204.71	2,578.07	94.89	307.01	0
	2	206.04	212.00	204.71	2,565.37	66.85	305.83	0
	3	205.98	211.90	204.63	2,511.87	77.95	300.04	0
	4	205.92	211.80	204.55	2,350.07	91.74	281.45	0
	5	205.87	211.70	204.48	2,436.23	67.60	290.39	0
	6	205.81	211.60	204.40	2,246.20	72.61	269.86	0
	7	205.76	211.50	204.32	2,288.23	59.05	275.35	0
	8	205.70	211.40	204.24	2,481.80	97.31	300.22	0
	9	205.64	211.30	204.17	2,575.83	71.11	313.17	0
	10	205.59	211.21	204.09	2,563.57	104.40	305.21	0
	11	205.53	211.11	204.01	2,382.47	59.65	282.85	0
	12	205.46	211.01	203.93	2,560.80	74.52	308.59	0
	13	205.40	210.91	203.85	2,485.63	73.63	301.82	0
	14	205.35	210.81	203.78	2,443.60	79.73	295.68	0
	15	205.29	210.71	203.70	2,622.73	92.47	319.58	0
	16	205.22	210.61	203.62	2,611.33	72.16	318.48	0
	17	205.15	210.51	203.54	2,553.60	61.05	312.48	0
	18	205.09	210.41	203.47	2,369.03	59.21	290.43	0
	19	205.03	210.31	203.39	2,528.83	58.53	310.22	0
	20	204.96	210.21	203.31	2,469.47	49.24	301.76	0
	21	204.90	210.11	203.23	2,457.03	71.09	285.51	0
	22	204.84	210.01	203.16	2,512.93	49.39	309.66	0
	23	204.78	209.91	203.08	2,505.30	96.21	308.74	0
	24	204.72	209.81	203.00	2,457.87	69.15	301.16	0
	25	204.66	209.71	202.92	2,341.17	65.07	288.70	0

Month	Actual data in drought case							
	Item	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	26	204.59	209.62	202.84	2,442.33	58.79	302.31	0
	27	204.53	209.52	202.77	2,375.03	59.77	294.50	0
	28	204.46	209.42	202.69	2,428.83	45.49	301.36	0
	29	204.40	209.32	202.61	2,420.40	60.02	301.45	0
	30	204.35	209.22	202.53	2,419.37	90.59	302.08	0
	31	204.28	209.12	202.46	2,432.73	79.95	303.64	0
April	1	204.24	209.02	202.38	2,441.23	69.22	305.56	0
	2	204.16	208.92	202.30	2,467.97	66.64	309.53	0
	3	204.09	208.83	202.19	2,390.27	55.51	301.35	0
	4	204.03	208.74	202.08	2,540.03	56.92	321.58	0
	5	203.95	208.65	201.97	2,544.40	56.14	316.84	0
	6	203.88	208.56	201.87	2,540.53	45.78	321.55	0
	7	203.81	208.47	201.76	2,578.20	57.99	327.27	0
	8	203.74	208.37	201.65	2,601.43	69.33	331.91	0
	9	203.66	208.28	201.54	2,604.67	60.86	332.65	0
	10	203.59	208.19	201.43	2,615.47	78.48	338.55	0
	11	203.53	208.10	201.32	2,655.07	98.93	340.09	0
	12	203.46	208.01	201.21	2,713.43	60.27	348.86	0
	13	203.38	207.92	201.10	2,701.67	69.55	348.04	0
	14	203.30	207.83	201.00	2,638.30	54.01	340.46	0
	15	203.23	207.74	200.89	2,577.13	51.17	333.85	0
	16	203.15	207.65	200.78	2,645.90	49.18	346.09	0
	17	203.08	207.56	200.67	2,629.47	47.70	342.11	0
	18	203.01	207.46	200.56	2,636.33	57.93	345.90	0
	19	202.93	207.37	200.45	2,696.80	84.98	351.47	0
	20	202.86	207.28	200.34	2,696.63	71.00	351.17	0
	21	202.79	207.19	200.24	2,630.13	63.10	348.71	0
	22	202.71	207.10	200.13	2,472.03	68.55	318.57	0
	23	202.64	207.01	200.02	2,454.50	56.90	321.16	0

Month	Actual data in drought case							
	Item	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	24	202.58	206.92	199.91	2,408.63	76.10	319.42	0
	25	202.51	206.83	199.80	2,397.77	45.32	309.78	0
	26	202.44	206.74	199.69	2,443.73	59.24	320.98	0
	27	202.45	206.65	199.58	2,417.63	49.80	319.28	0
	28	202.30	206.55	199.47	2,405.67	66.20	319.16	0
	29	202.23	206.46	199.37	2,339.70	74.57	309.92	0
	30	202.17	206.37	199.26	2,437.17	74.23	324.66	0
May	1	202.10	206.28	199.15	2,313.87	60.87	310.05	0
	2	202.03	206.19	199.04	2,321.57	58.58	308.80	0
	3	201.96	206.12	198.95	2,401.13	86.54	321.21	0
	4	201.90	206.04	198.87	2,398.60	56.74	322.42	0
	5	201.83	205.97	198.78	2,401.00	86.12	321.79	0
	6	201.77	205.90	198.69	2,273.50	99.64	305.24	0
	7	201.71	205.83	198.61	2,367.90	82.48	320.79	0
	8	201.64	205.75	198.52	2,292.67	50.66	309.19	0
	9	201.57	205.68	198.43	2,281.23	73.90	309.53	0
	10	201.50	205.61	198.35	2,387.53	39.44	324.63	0
	11	201.44	205.53	198.26	2,379.07	58.31	324.25	0
	12	201.37	205.46	198.17	2,352.10	72.66	321.97	0
	13	201.36	205.39	198.09	2,356.80	152.97	322.52	0
	14	201.24	205.32	198.00	2,393.33	69.53	312.42	0
	15	201.18	205.24	197.91	2,270.23	126.81	310.65	0
	16	201.11	205.17	197.83	2,303.30	114.37	316.74	0
	17	201.04	205.10	197.74	2,643.77	146.86	357.01	0
	18	200.98	205.02	197.65	2,548.17	150.32	350.89	0
	19	200.91	204.95	197.56	2,491.10	119.22	344.34	0
	20	200.83	204.88	197.48	2,509.10	127.75	349.07	0
	21	200.77	204.80	197.39	2,595.63	152.26	363.07	0
	22	200.69	204.73	197.30	2,465.63	127.78	347.56	0

Month	Actual data in drought case							
	Item	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	23	200.62	204.66	197.22	2,539.97	166.93	352.63	0
	24	200.55	204.59	197.13	2,599.40	107.27	371.77	0
	25	200.49	204.51	197.04	2,582.77	186.62	365.62	0
	26	200.44	204.44	196.96	2,537.40	142.58	359.89	0
	27	200.37	204.37	196.87	2,489.80	154.49	350.51	0
	28	200.31	204.29	196.78	2,538.37	141.32	364.00	0
	29	200.26	204.22	196.70	2,230.10	169.95	316.71	0
	30	200.22	204.15	196.61	2,227.13	215.18	317.91	0
	31	200.20	204.08	196.52	2,367.27	212.19	329.93	0
June	1	200.16	204.00	196.44	2,363.70	447.34	337.05	0
	2	200.12	203.93	196.35	2,291.23	242.60	325.35	0
	3	200.08	203.88	196.34	2,285.53	194.59	324.40	0
	4	200.05	203.82	196.33	2,348.10	298.04	335.24	0
	5	200.06	203.77	196.32	2,180.03	293.18	299.41	0
	6	200.06	203.71	196.30	2,174.67	358.79	306.13	0
	7	200.05	203.66	196.29	2,315.87	260.97	331.44	0
	8	200.02	203.60	196.28	2,304.47	239.92	328.67	0
	9	199.99	203.55	196.27	2,234.47	303.17	318.07	0
	10	199.97	203.50	196.26	2,118.83	196.40	301.35	0
	11	199.92	203.44	196.25	2,225.37	163.62	319.63	0
	12	199.88	203.39	196.23	2,095.07	261.47	299.81	0
	13	199.86	203.33	196.22	2,075.80	213.04	298.74	0
	14	199.82	203.28	196.21	2,153.73	172.75	304.89	0
	15	199.79	203.22	196.20	2,155.17	313.22	311.02	0
	16	199.79	203.17	196.19	2,179.40	282.80	312.81	0
	17	199.81	203.12	196.18	2,063.93	334.67	296.35	0
	18	199.84	203.06	196.16	2,150.73	408.08	308.46	0
	19	199.84	203.01	196.15	2,048.40	256.03	294.46	0
	20	199.82	202.95	196.14	2,110.60	236.74	305.26	0
	21	199.78	202.90	196.13	2,317.03	212.78	335.63	0

Month	Actual data in drought case							
	Item	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	22	199.76	202.84	196.12	2,408.53	363.79	348.22	0
	23	199.80	202.79	196.11	1,946.27	399.32	278.47	0
	24	199.84	202.73	196.09	1,951.97	446.30	281.40	0
	25	199.89	202.68	196.08	2,186.57	381.75	315.61	0
	26	199.90	202.63	196.07	2,205.43	366.01	317.19	0
	27	199.92	202.57	196.06	2,243.83	376.98	320.31	0
	28	199.94	202.52	196.05	2,267.50	395.00	323.97	0
	29	199.99	202.46	196.04	2,276.10	498.86	325.63	0
	30	200.04	202.41	196.02	2,275.37	490.24	325.39	0
July	1	200.11	202.35	196.01	2,240.00	505.25	318.44	0
	2	200.21	202.30	196.00	2,246.73	689.53	315.64	0
	3	200.32	202.33	196.14	2,245.03	620.03	316.12	0
	4	200.39	202.35	196.28	2,218.50	468.49	312.27	0
	5	200.44	202.38	196.42	2,237.23	420.19	313.85	0
	6	200.46	202.41	196.56	2,104.70	344.99	306.16	0
	7	200.49	202.43	196.70	2,331.50	489.14	315.70	0
	8	200.52	202.46	196.84	2,245.27	361.29	314.40	0
	9	200.55	202.49	196.98	2,335.33	427.01	326.16	0
	10	200.57	202.51	197.13	2,137.13	323.70	299.21	0
	11	200.60	202.54	197.27	2,142.53	456.30	297.08	0
	12	200.65	202.57	197.41	2,232.77	428.51	291.88	0
	13	200.70	202.59	197.55	2,108.43	455.04	284.56	0
	14	200.73	202.62	197.69	1,939.70	317.40	267.35	0
	15	200.75	202.65	197.83	1,986.07	357.12	275.33	0
	16	200.75	202.67	197.97	2,195.33	281.21	307.00	0
	17	200.76	202.70	198.11	2,132.60	368.98	298.58	0
	18	200.86	202.73	198.25	2,133.43	829.47	298.15	0
	19	200.98	202.76	198.39	2,179.97	595.72	303.18	0
	20	201.04	202.78	198.53	2,305.80	531.21	321.58	0

Month	Actual data in drought case							
	Item	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	21	201.08	202.81	198.67	1,937.50	377.57	266.68	0
	22	201.12	202.84	198.81	1,935.87	483.33	260.93	0
	23	201.31	202.86	198.95	2,129.47	975.74	296.51	0
	24	201.50	202.89	199.09	2,103.10	971.35	283.96	0
	25	201.66	202.92	199.23	1,980.10	800.44	269.20	0
	26	201.75	202.94	199.38	2,021.10	444.51	265.66	0
	27	201.81	202.97	199.52	2,123.50	531.56	278.74	0
	28	201.89	203.00	199.66	1,870.33	538.61	252.38	0
	29	201.96	203.02	199.80	1,911.90	523.12	253.24	0
	30	202.02	203.05	199.94	2,099.37	564.47	281.43	0
	31	202.23	203.08	200.08	2,059.73	779.59	273.52	0
Aug	1	202.29	203.10	200.22	2,091.73	698.11	279.96	0
	2	202.41	203.13	200.36	2,102.43	705.27	267.54	0
	3	202.54	203.25	200.52	2,062.37	748.28	270.29	0
	4	202.66	203.37	200.69	2,033.37	651.72	266.49	0
	5	202.76	203.49	200.85	1,928.53	586.64	253.07	0
	6	202.88	203.62	201.02	2,062.07	696.48	271.73	0
	7	202.97	203.74	201.18	2,039.57	618.79	266.59	0
	8	203.06	203.86	201.35	2,048.43	618.35	271.77	0
	9	203.16	203.98	201.51	2,125.90	671.66	275.31	0
	10	203.27	204.10	201.68	2,137.10	734.81	274.15	0
	11	203.43	204.22	201.84	2,053.43	893.24	261.93	0
	12	203.56	204.35	202.01	1,955.10	677.37	249.16	0
	13	203.68	204.47	202.17	2,071.90	678.32	263.73	0
	14	203.77	204.59	202.33	1,997.53	580.44	253.78	0
	15	203.85	204.71	202.50	1,956.73	580.97	243.43	0
	16	203.98	204.83	202.66	1,899.40	743.47	241.65	0
	17	204.12	204.95	202.83	1,861.97	836.67	235.41	0
	18	204.29	205.08	202.99	1,902.00	878.82	238.08	0

Month	Actual data in drought case							
	Item	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	19	204.43	205.20	203.16	1,903.13	700.50	244.03	0
	20	204.55	205.32	203.32	2,051.70	670.17	255.58	0
	21	204.65	205.44	203.49	2,007.67	619.61	249.23	0
	22	204.75	205.56	203.65	2,024.13	691.79	247.68	0
	23	204.89	205.68	203.81	2,039.83	950.43	251.86	0
	24	205.08	205.81	203.98	1,945.97	889.11	236.79	0
	25	205.35	205.93	204.14	2,011.77	1,422.64	244.04	0
	26	205.59	206.05	204.31	1,960.77	924.41	235.75	0
	27	205.72	206.17	204.47	2,119.60	666.11	255.46	0
	28	205.82	206.29	204.64	2,017.20	620.71	243.81	0
	29	205.92	206.41	204.80	2,037.83	628.37	245.19	0
	30	206.06	206.54	204.97	2,043.83	804.14	245.48	0
	31	206.18	206.66	205.13	1,986.53	913.96	230.92	0
Sep	1	206.36	206.78	205.30	2,249.57	681.13	266.54	0
	2	206.46	206.90	205.46	2,284.67	570.87	269.76	0
	3	206.58	207.03	205.60	2,443.90	887.19	288.02	0
	4	206.78	207.16	205.73	2,141.97	1,164.05	253.09	0
	5	207.01	207.29	205.87	2,188.40	1,077.67	261.04	0
	6	207.25	207.42	206.01	2,574.17	1,234.10	304.40	0
	7	207.45	207.55	206.14	2,550.23	905.67	302.61	0
	8	207.57	207.68	206.28	2,454.53	687.01	284.98	0
	9	207.68	207.81	206.42	2,483.53	691.51	276.91	0
	10	207.81	207.94	206.55	2,702.83	908.68	312.00	0
	11	207.97	208.07	206.69	2,400.23	866.07	275.59	0
	12	208.14	208.20	206.83	2,410.77	880.92	277.87	0
	13	208.30	208.33	206.96	2,739.77	930.83	315.14	0
	14	208.46	208.46	207.10	2,676.33	906.30	309.54	0
	15	208.60	208.59	207.24	2,376.17	749.21	267.60	0
	16	208.72	208.72	207.37	2,291.30	668.93	264.81	0

Month	Actual data in drought case							
	Item	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	17	208.81	208.86	207.51	2,651.43	568.94	305.10	0
	18	208.89	208.99	207.65	2,425.93	699.63	278.75	0
	19	209.03	209.12	207.78	1,866.43	706.89	208.54	0
	20	209.14	209.25	207.92	2,136.83	634.07	236.23	0
	21	209.23	209.38	208.06	2,002.73	495.10	220.80	0
	22	209.30	209.51	208.19	2,127.00	518.69	225.54	0
	23	209.37	209.64	208.33	2,122.87	481.24	230.60	0
	24	209.44	209.77	208.47	2,176.07	531.72	233.33	0
	25	209.51	209.90	208.60	1,828.30	424.55	198.41	0
	26	209.58	210.03	208.74	1,832.00	437.42	199.14	0
	27	209.65	210.16	208.88	2,192.83	492.04	237.00	0
	28	209.70	210.29	209.01	2,105.80	448.07	227.80	0
	29	209.75	210.42	209.15	2,194.63	380.23	236.37	0
	30	209.78	210.55	209.29	2,375.93	326.34	258.26	0
Oct	1	209.80	210.68	209.42	2,347.90	371.02	251.17	0
	2	209.83	210.81	209.56	2,174.00	330.16	233.16	0
	3	209.85	210.85	209.60	2,161.07	285.06	229.71	0
	4	209.87	210.89	209.64	2,463.77	323.55	260.09	0
	5	209.90	210.93	209.68	2,501.87	415.53	264.91	0
	6	209.97	210.96	209.72	2,283.73	630.81	241.44	0
	7	210.08	211.00	209.76	2,341.60	647.26	243.65	0
	8	210.17	211.04	209.80	2,352.27	581.84	250.93	0
	9	210.25	211.08	209.84	2,177.17	487.89	230.47	0
	10	210.30	211.12	209.88	2,769.73	452.69	298.88	0
	11	210.33	211.16	209.92	2,922.90	379.26	311.38	0
	12	210.34	211.19	209.96	2,794.50	326.33	294.92	0
	13	210.36	211.23	210.00	2,336.87	327.63	250.65	0
	14	210.38	211.27	210.04	2,338.33	339.61	250.75	0
	15	210.40	211.31	210.08	2,672.00	331.59	287.49	0

Month	Actual data in drought case							
	Item	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	16	210.41	211.35	210.12	2,498.93	272.15	265.61	0
	17	210.41	211.39	210.16	2,496.50	264.99	265.91	0
	18	210.40	211.42	210.21	2,708.17	258.95	288.15	0
	19	210.39	211.46	210.25	2,664.73	226.95	284.83	0
	20	210.38	211.50	210.29	2,316.47	250.58	244.63	0
	21	210.38	211.54	210.33	2,305.63	203.51	245.81	0
	22	210.37	211.58	210.37	2,514.37	244.50	267.82	0
	23	210.36	211.62	210.41	2,469.53	183.99	262.27	0
	24	210.34	211.65	210.45	2,461.57	214.50	263.25	0
	25	210.32	211.69	210.49	2,647.70	200.66	279.15	0
	26	210.30	211.73	210.53	2,674.63	210.95	288.70	0
	27	210.28	211.77	210.57	2,336.77	201.52	246.59	0
	28	210.27	211.81	210.61	2,207.20	183.07	234.64	0
	29	210.26	211.85	210.65	2,436.63	206.25	261.82	0
	30	210.24	211.88	210.69	2,051.50	162.98	218.80	0
	31	210.22	211.92	210.73	2,510.03	205.04	267.22	0
Nov	1	210.20	211.96	210.77	2,639.97	192.33	282.48	0
	2	210.18	212.00	210.81	2,665.73	208.53	285.12	0
	3	210.16	212.00	210.79	2,266.90	156.48	244.53	0
	4	210.14	212.00	210.77	2,162.70	157.28	228.59	0
	5	210.12	212.00	210.75	2,616.53	179.23	274.44	0
	6	210.09	212.00	210.73	2,538.27	183.86	270.22	0
	7	210.07	212.00	210.71	2,575.47	169.00	270.57	0
	8	210.04	212.00	210.69	2,620.47	176.06	284.80	0
	9	210.01	212.00	210.67	2,592.33	166.11	278.44	0
	10	209.98	212.00	210.64	2,374.77	146.88	260.54	0
	11	209.95	212.00	210.62	2,485.87	156.43	259.76	0
	12	209.92	212.00	210.60	2,557.80	136.90	274.65	0
	13	209.92	212.00	210.58	2,551.97	121.52	270.87	0

Month	Actual data in drought case							
	Item	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	14	209.85	212.00	210.56	2,511.60	126.58	263.96	0
	15	209.81	212.00	210.54	2,631.63	151.20	280.85	0
	16	209.77	212.00	210.52	2,561.90	146.39	278.09	0
	17	209.73	212.00	210.50	2,624.43	89.21	282.03	0
	18	209.69	212.00	210.48	2,732.73	163.27	294.41	0
	19	209.65	212.00	210.46	2,641.37	119.93	290.88	0
	20	209.63	212.00	210.44	2,579.23	120.71	279.38	0
	21	209.56	212.00	210.42	2,580.33	118.99	280.50	0
	22	209.52	212.00	210.40	2,612.70	142.05	288.59	0
	23	209.48	212.00	210.38	2,541.63	118.73	280.06	0
	24	209.44	212.00	210.36	2,719.03	117.50	300.12	0
	25	209.39	212.00	210.33	2,364.17	103.19	260.81	0
	26	209.35	212.00	210.31	2,553.37	101.55	282.79	0
	27	209.30	212.00	210.29	2,378.13	124.34	262.18	0
	28	209.27	212.00	210.27	2,373.67	132.09	262.56	0
	29	209.23	212.00	210.25	2,427.23	122.08	266.74	0
	30	209.19	212.00	210.23	2,434.93	135.00	268.47	0
Dec	1	209.16	212.00	210.21	2,467.40	127.77	273.47	0
	2	209.12	212.00	210.19	2,422.30	113.45	267.26	0
	3	209.07	212.00	210.14	2,544.20	109.72	282.46	0
	4	209.03	212.00	210.08	2,514.23	131.92	278.49	0
	5	208.99	212.00	210.03	2,497.40	109.85	277.46	0
	6	208.94	212.00	209.98	2,528.17	111.32	281.14	0
	7	208.90	212.00	209.93	2,393.90	96.56	265.27	0
	8	208.86	212.00	209.87	2,406.93	98.58	267.11	0
	9	208.81	212.00	209.82	2,516.27	80.17	282.29	0
	10	208.76	212.00	209.77	2,648.27	136.60	301.34	0
	11	208.71	212.00	209.72	2,660.03	100.60	299.94	0
	12	208.65	212.00	209.66	2,680.37	96.91	300.12	0

Month	Actual data in drought case							
	Item	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	13	208.60	212.00	209.61	2,621.07	108.49	294.89	0
	14	208.56	212.00	209.56	2,569.63	111.18	285.14	0
	15	208.50	212.00	209.51	2,478.80	75.31	282.43	0
	16	208.45	212.00	209.45	2,503.37	96.70	282.09	0
	17	208.40	212.00	209.40	2,662.40	102.92	301.84	0
	18	208.35	212.00	209.35	2,787.90	110.01	316.00	0
	19	208.29	212.00	209.30	2,771.07	136.80	335.78	0
	20	208.24	212.00	209.24	3,192.73	118.90	344.63	0
	21	208.18	212.00	209.19	2,905.60	124.02	332.99	0
	22	208.12	212.00	209.14	2,698.33	106.27	311.06	0
	23	208.07	212.00	209.08	2,771.60	108.14	320.55	0
	24	208.01	212.00	209.03	2,981.93	89.99	347.66	0
	25	207.94	212.00	208.98	3,048.53	110.12	349.99	0
	26	207.88	212.00	208.93	2,982.87	108.77	346.00	0
	27	207.81	212.00	208.87	2,911.63	91.59	337.63	0
	28	207.75	212.00	208.82	2,869.87	103.26	331.79	0
	29	207.68	212.00	208.77	2,760.10	66.62	320.58	0
	30	207.62	212.00	208.72	2,758.03	110.74	321.63	0
	31	207.56	212.00	208.66	2,984.93	86.38	351.47	0

Note: HWL (Head water level)

Old URC (Old upper rule curve)

Old LRC (Old lower rule curve)

EE (Electricity energy)

Qin (Quantity inflow)

Qt (Quantity turbine discharge)

Qs (Quantity spillway discharge)

Appendix D.3 Actual data in normal case

Table D.3 Actual data in normal case

Month	Actual data in normal case							
	Item	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
Jan	1	209.40	212.00	208.26	3,189.03	155.56	351.73	0
	2	209.34	212.00	208.22	3,181.60	160.70	351.51	0
	3	209.28	212.00	208.17	3,207.90	134.12	354.39	0
	4	209.23	212.00	208.13	3,052.63	147.01	337.55	0
	5	209.18	212.00	208.08	3,144.97	172.71	348.18	0
	6	209.13	212.00	208.04	3,156.57	141.66	349.80	0
	7	209.08	212.00	208.00	3,238.77	180.97	358.32	0
	8	209.03	212.00	207.95	3,226.93	112.19	357.80	0
	9	208.97	212.00	207.91	3,225.03	150.08	359.06	0
	10	208.91	212.00	207.87	3,021.87	123.18	336.34	0
	11	208.83	212.00	207.82	3,012.90	124.66	336.03	0
	12	208.79	212.00	207.78	3,208.07	120.95	358.60	0
	13	208.73	212.00	207.73	3,204.80	102.11	359.15	0
	14	208.67	212.00	207.69	3,088.97	179.80	342.67	0
	15	208.62	212.00	207.65	3,156.20	125.69	352.28	0
	16	208.56	212.00	207.60	3,149.97	107.62	352.26	0
	17	208.50	212.00	207.56	3,133.40	138.84	351.51	0
	18	208.45	212.00	207.51	2,821.53	149.76	314.69	0
	19	208.40	212.00	207.47	2,817.03	144.16	314.46	0
	20	208.35	212.00	207.43	2,818.63	105.05	315.11	0
	21	208.30	212.00	207.38	2,809.03	101.53	315.19	0
	22	208.24	212.00	207.34	2,808.70	95.48	315.61	0
	23	208.18	212.00	207.29	2,801.27	88.59	315.59	0
	24	208.13	212.00	207.25	2,791.43	106.27	314.90	0
	25	208.07	212.00	207.21	2,788.00	121.88	314.88	0
	26	208.01	212.00	207.16	2,972.93	95.75	339.73	0
	27	207.95	212.00	207.12	3,062.77	135.59	349.77	0

Month	Actual data in normal case							
	Item	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	28	207.89	212.00	207.08	3,118.40	109.99	356.65	0
	29	207.82	212.00	207.03	3,111.83	100.29	357.22	0
	30	207.76	212.00	206.99	3,107.23	137.33	357.19	0
	31	207.70	212.00	206.94	3,088.73	108.53	356.03	0
Feb	1	207.63	212.00	206.90	3,050.10	126.84	353.61	0
	2	207.57	212.00	206.82	3,052.83	92.69	351.78	0
	3	207.51	212.00	206.75	3,276.83	125.10	378.03	0
	4	207.44	212.00	206.67	3,136.27	171.08	390.33	0
	5	207.38	212.00	206.60	3,260.50	108.15	378.83	0
	6	207.31	212.00	206.52	3,259.77	112.93	378.29	0
	7	207.25	212.00	206.45	3,255.97	136.64	378.64	0
	8	207.17	212.00	206.37	3,249.03	128.55	379.20	0
	9	207.10	212.00	206.30	3,378.37	112.58	392.52	0
	10	207.05	212.00	206.22	3,305.17	110.63	384.95	0
	11	206.95	212.00	206.14	3,401.90	105.07	398.85	0
	12	206.88	212.00	206.07	3,396.20	120.68	398.54	0
	13	206.80	212.00	205.99	3,116.90	119.43	366.93	0
	14	206.74	212.00	205.92	2,916.87	119.54	341.55	0
	15	206.69	212.00	205.84	2,915.37	122.11	342.65	0
	16	206.63	212.00	205.77	3,081.87	131.65	362.50	0
	17	206.56	212.00	205.69	3,090.07	121.86	355.76	0
	18	206.49	212.00	205.62	3,261.70	158.11	384.56	0
	19	206.42	212.00	205.54	3,254.97	115.97	385.13	0
	20	206.35	212.00	205.47	3,166.27	113.34	376.34	0
	21	206.28	212.00	205.39	3,299.70	129.91	393.33	0
	22	206.21	212.00	205.31	3,079.57	126.00	370.36	0
	23	206.15	212.00	205.24	2,885.83	147.41	344.92	0
	24	206.10	212.00	205.16	3,014.17	144.02	356.70	0
	25	206.04	212.00	205.09	2,917.76	129.97	350.65	0

Month	Actual data in normal case							
	Item	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	26	205.99	212.00	205.01	2,942.31	156.22	360.10	0
	27	205.93	212.00	204.94	2,961.00	178.31	356.96	0
	28	205.89	212.00	204.86	2,997.76	186.12	360.73	0
	29	205.72	212.00	204.71	3,568.89	347.81	430.01	0
Mar	1	205.83	212.00	204.71	2,994.57	184.64	360.87	0
	2	205.79	211.90	204.63	3,025.62	182.47	360.83	0
	3	205.73	211.80	204.55	2,954.18	178.79	360.89	0
	4	205.69	211.70	204.48	2,973.39	150.28	361.21	0
	5	205.64	211.60	204.40	2,679.75	137.18	324.55	0
	6	205.59	211.50	204.32	2,702.22	140.77	327.78	0
	7	205.54	211.40	204.24	2,680.84	148.62	314.48	0
	8	205.48	211.30	204.17	2,676.35	133.01	325.11	0
	9	205.43	211.21	204.09	2,723.52	124.21	331.88	0
	10	205.37	211.11	204.01	2,830.28	124.85	346.14	0
	11	205.38	211.01	203.93	2,941.24	121.54	362.66	0
	12	205.26	210.91	203.85	2,762.31	155.51	339.46	0
	13	205.22	210.81	203.78	2,559.47	118.91	313.49	0
	14	205.16	210.71	203.70	2,632.98	156.97	323.37	0
	15	205.12	210.61	203.62	2,795.50	159.60	343.64	0
	16	205.06	210.51	203.54	2,793.65	165.98	354.84	0
	17	205.01	210.41	203.47	2,788.36	155.69	351.48	0
	18	204.96	210.31	203.39	2,785.00	119.63	343.48	0
	19	204.90	210.21	203.31	2,777.31	150.63	343.27	0
	20	204.87	210.11	203.23	2,777.27	271.96	343.06	0
	21	204.83	210.01	203.16	2,773.71	143.79	343.66	0
	22	204.78	209.91	203.08	2,742.21	145.67	344.13	0
	23	204.73	209.81	203.00	2,784.85	158.88	343.60	0
	24	204.68	209.71	202.92	2,758.02	146.63	343.49	0
	25	204.64	209.62	202.84	2,753.38	133.77	343.91	0

Month	Actual data in normal case							
	Item	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	26	204.58	209.52	202.77	2,749.08	144.89	344.08	0
	27	204.54	209.42	202.69	2,743.99	212.06	342.97	0
	28	204.48	209.32	202.61	2,736.90	135.25	342.51	0
	29	204.44	209.22	202.53	2,730.84	174.49	342.81	0
	30	204.40	209.12	202.46	2,725.93	206.41	342.53	0
	31	204.33	209.02	202.38	2,724.66	154.82	342.64	0
April	1	204.29	208.92	202.30	2,716.26	123.28	342.18	0
	2	204.24	208.83	202.19	2,711.69	132.76	342.26	0
	3	204.18	208.74	202.08	2,705.24	121.92	342.86	0
	4	204.13	208.65	201.97	2,697.69	133.58	341.92	0
	5	204.08	208.56	201.87	2,642.33	172.34	334.41	0
	6	204.03	208.47	201.76	2,685.73	126.58	340.35	0
	7	203.97	208.37	201.65	2,678.19	146.33	340.88	0
	8	203.92	208.28	201.54	2,670.84	140.28	341.11	0
	9	203.79	208.19	201.43	2,664.78	182.72	340.54	0
	10	203.84	208.10	201.32	2,658.59	240.05	339.49	0
	11	203.81	208.01	201.21	2,657.62	144.98	339.13	0
	12	203.76	207.92	201.10	2,651.44	186.92	339.39	0
	13	203.71	207.83	201.00	2,646.46	157.73	339.77	0
	14	203.66	207.74	200.89	2,637.57	141.67	339.63	0
	15	203.60	207.65	200.78	2,650.61	66.62	340.74	0
	16	203.53	207.56	200.67	2,641.81	120.86	340.83	0
	17	203.48	207.46	200.56	2,634.41	162.09	340.18	0
	18	203.43	207.37	200.45	2,627.06	169.14	339.17	0
	19	203.39	207.28	200.34	2,510.83	169.99	323.47	0
	20	203.35	207.19	200.24	2,589.05	166.67	335.47	0
	21	203.30	207.10	200.13	2,576.14	158.06	335.70	0
	22	203.26	207.01	200.02	2,579.85	179.20	336.23	0
	23	203.22	206.92	199.91	2,569.53	140.63	335.31	0

Month	Actual data in normal case							
	Item	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	24	203.17	206.83	199.80	2,566.87	215.66	333.15	0
	25	203.13	206.74	199.69	2,532.67	168.87	329.21	0
	26	203.10	206.65	199.58	2,557.63	177.06	332.75	0
	27	203.05	206.55	199.47	2,553.28	209.13	332.48	0
	28	203.04	206.46	199.37	2,509.04	182.65	327.84	0
	29	203.01	206.37	199.26	2,544.01	251.52	332.57	0
	30	203.01	206.28	199.15	2,538.73	269.78	332.42	0
May	1	202.96	206.19	199.04	2,531.60	216.12	332.45	0
	2	202.90	206.12	198.95	2,527.21	183.31	332.83	0
	3	202.82	206.04	198.87	2,316.47	175.36	300.65	0
	4	202.80	205.97	198.78	2,231.83	214.25	288.29	0
	5	202.82	205.90	198.69	2,234.30	205.92	289.65	0
	6	202.77	205.83	198.61	2,269.33	183.80	294.76	0
	7	202.73	205.75	198.52	2,256.15	173.26	293.38	0
	8	202.70	205.68	198.43	2,320.50	198.89	304.05	0
	9	202.66	205.61	198.35	2,602.22	203.83	344.57	0
	10	202.59	205.53	198.26	2,591.78	154.48	344.64	0
	11	202.53	205.46	198.17	2,588.07	168.80	345.33	0
	12	202.48	205.39	198.09	2,580.58	156.11	344.67	0
	13	202.42	205.32	198.00	2,521.06	122.76	338.27	0
	14	202.35	205.24	197.91	2,564.10	160.22	344.10	0
	15	202.29	205.17	197.83	2,554.65	211.28	341.17	0
	16	202.24	205.10	197.74	2,548.66	163.17	340.96	0
	17	202.18	205.02	197.65	2,540.45	139.50	340.79	0
	18	202.12	204.95	197.56	2,532.31	193.54	341.45	0
	19	202.07	204.88	197.48	2,525.78	221.55	343.31	0
	20	202.03	204.80	197.39	2,381.47	161.47	318.39	0
	21	201.98	204.73	197.30	2,375.70	133.93	318.77	0
	22	201.94	204.66	197.22	2,368.99	272.07	317.82	0

Month	Actual data in normal case							
	Item	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	23	201.99	204.59	197.13	2,438.45	441.42	329.21	0
	24	202.04	204.51	197.04	2,358.42	416.77	317.82	0
	25	202.07	204.44	196.96	2,471.12	323.89	334.49	0
	26	202.10	204.37	196.87	2,526.71	322.73	339.57	0
	27	202.14	204.29	196.78	2,523.65	413.62	339.03	0
	28	202.20	204.22	196.70	2,531.98	461.89	339.60	0
	29	202.27	204.15	196.61	2,536.05	586.35	339.75	0
	30	202.31	204.08	196.52	2,540.29	707.50	339.07	0
	31	202.35	204.00	196.44	2,541.76	641.95	339.55	0
June	1	202.42	203.93	196.35	2,547.37	613.66	339.00	0
	2	202.51	203.88	196.34	2,558.97	628.94	339.07	0
	3	202.57	203.82	196.33	2,568.00	571.11	339.79	0
	4	202.64	203.77	196.32	2,571.89	455.43	340.22	0
	5	202.66	203.71	196.30	2,575.26	413.25	340.15	0
	6	202.68	203.66	196.29	2,577.77	377.18	339.87	0
	7	202.71	203.60	196.28	2,581.10	713.71	340.84	0
	8	202.77	203.55	196.27	2,582.81	340.78	341.81	0
	9	202.80	203.50	196.26	2,581.94	496.21	341.86	0
	10	202.80	203.44	196.25	2,519.09	365.57	332.26	0
	11	202.80	203.39	196.23	2,581.11	364.25	341.55	0
	12	202.80	203.33	196.22	2,578.60	316.27	341.12	0
	13	202.78	203.28	196.21	2,576.94	272.53	340.83	0
	14	202.77	203.22	196.20	2,571.42	334.63	340.46	0
	15	202.75	203.17	196.19	2,568.34	345.39	340.25	0
	16	202.73	203.12	196.18	2,566.03	267.36	340.81	0
	17	202.76	203.06	196.16	2,566.38	492.00	338.48	0
	18	202.76	203.01	196.15	2,564.92	394.13	340.03	0
	19	202.77	202.95	196.14	2,633.22	370.39	348.02	0
	20	202.75	202.90	196.13	2,714.61	291.61	358.76	0

Month	Actual data in normal case							
	Item	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	21	202.72	202.84	196.12	2,827.47	283.26	374.37	0
	22	202.70	202.79	196.11	2,733.84	304.54	361.37	0
	23	202.68	202.73	196.09	2,779.94	290.86	373.05	0
	24	202.66	202.68	196.08	2,813.68	329.98	373.45	0
	25	202.63	202.63	196.07	2,702.31	283.38	356.87	0
	26	202.61	202.57	196.06	2,591.52	265.02	339.60	0
	27	202.60	202.52	196.05	2,584.42	317.69	338.10	0
	28	202.62	202.46	196.04	2,608.91	450.42	342.44	0
	29	202.63	202.41	196.02	2,597.26	397.56	342.74	0
	30	202.64	202.35	196.01	2,601.03	422.63	340.12	0
July	1	202.64	202.30	196.00	2,527.80	792.85	326.85	0
	2	202.88	202.33	196.14	2,543.57	826.11	328.33	0
	3	202.96	202.35	196.28	2,545.83	546.71	328.00	0
	4	203.02	202.38	196.42	2,546.14	523.71	326.58	0
	5	203.18	202.41	196.56	2,737.15	1,122.06	352.80	0
	6	203.43	202.43	196.70	2,803.00	1,170.43	362.77	0
	7	203.63	202.46	196.84	2,909.65	951.62	374.74	0
	8	203.77	202.49	196.98	2,938.57	818.57	377.24	0
	9	203.89	202.51	197.13	2,953.41	765.28	377.54	0
	10	203.98	202.54	197.27	2,972.72	790.18	377.60	0
	11	204.16	202.57	197.41	2,994.17	968.51	377.78	0
	12	204.34	202.59	197.55	3,014.14	845.26	380.08	0
	13	204.49	202.62	197.69	3,002.62	997.80	379.92	0
	14	204.64	202.65	197.83	3,086.37	871.09	379.86	0
	15	204.75	202.67	197.97	3,067.06	720.46	381.25	0
	16	204.82	202.70	198.11	3,077.35	617.60	382.84	0
	17	204.90	202.73	198.25	3,089.74	703.90	383.92	0
	18	205.04	202.76	198.39	3,107.85	1,167.47	382.67	0
	19	205.28	202.78	198.53	3,134.61	1,173.12	384.52	0

Month	Actual data in normal case							
	Item	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	20	205.43	202.81	198.67	3,141.95	827.21	384.53	0
	21	205.56	202.84	198.81	3,169.77	887.90	385.71	0
	22	205.70	202.86	198.95	3,188.03	978.61	386.35	0
	23	205.83	202.89	199.09	3,107.14	801.45	373.96	0
	24	205.95	202.92	199.23	3,070.72	854.55	369.20	0
	25	206.07	202.94	199.38	3,075.01	799.65	368.12	0
	26	206.21	202.97	199.52	3,128.09	951.30	374.16	0
	27	206.33	203.00	199.66	3,242.27	791.25	389.67	0
	28	206.41	203.02	199.80	3,271.89	627.34	390.52	0
	29	206.48	203.05	199.94	3,289.16	646.40	391.78	0
	30	206.59	203.08	200.08	3,304.43	930.46	391.70	0
	31	206.75	203.10	200.22	3,323.14	1,042.55	392.38	0
Aug	1	206.90	203.13	200.36	3,340.23	873.34	393.21	0
	2	207.00	203.25	200.52	3,353.36	763.81	393.81	0
	3	207.09	203.37	200.69	3,360.64	691.26	394.34	0
	4	207.16	203.49	200.85	3,370.24	608.30	394.30	0
	5	207.21	203.62	201.02	3,376.98	582.69	393.72	0
	6	207.27	203.74	201.18	3,369.14	636.90	394.11	0
	7	207.32	203.86	201.35	3,382.62	562.87	393.67	0
	8	207.40	203.98	201.51	3,401.96	798.34	394.63	0
	9	207.52	204.10	201.68	3,412.98	930.33	394.11	0
	10	207.70	204.22	201.84	3,348.25	942.75	359.05	0
	11	207.81	204.35	202.01	3,419.97	773.76	395.63	0
	12	207.88	204.47	202.17	3,445.85	587.36	396.07	0
	13	207.94	204.59	202.33	3,448.83	691.21	395.34	0
	14	208.04	204.71	202.50	3,468.49	882.60	396.39	0
	15	208.16	204.83	202.66	3,460.44	770.06	397.03	0
	16	208.25	204.95	202.83	3,429.08	667.27	389.62	0
	17	208.33	205.08	202.99	3,496.43	690.67	397.00	0

Month	Actual data in normal case							
	Item	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	18	208.43	205.20	203.16	3,507.99	866.19	396.74	0
	19	208.57	205.32	203.32	3,494.49	978.39	398.39	0
	20	208.70	205.44	203.49	3,525.63	825.59	397.91	0
	21	208.79	205.56	203.65	3,500.98	703.08	401.24	0
	22	208.87	205.68	203.81	3,549.06	744.83	399.55	0
	23	208.99	205.81	203.98	3,571.13	842.15	399.29	0
	24	209.09	205.93	204.14	3,558.70	759.85	394.81	0
	25	209.17	206.05	204.31	3,551.26	714.89	395.22	0
	26	209.27	206.17	204.47	3,560.73	766.76	394.95	0
	27	209.37	206.29	204.64	3,573.48	760.44	394.89	0
	28	209.46	206.41	204.80	3,580.69	729.62	394.46	0
	29	209.55	206.54	204.97	3,587.35	727.60	394.48	0
	30	209.63	206.66	205.13	3,601.52	733.88	395.35	0
	31	209.74	206.78	205.30	3,611.75	785.86	395.72	0
Sep	1	209.86	206.90	205.46	3,576.12	830.63	392.73	0
	2	209.93	207.03	205.60	3,611.02	590.84	397.58	0
	3	209.98	207.16	205.73	3,611.39	552.83	396.68	0
	4	210.01	207.29	205.87	3,616.39	406.25	396.15	0
	5	210.05	207.42	206.01	3,643.32	625.93	380.67	0
	6	210.08	207.55	206.14	3,613.51	524.55	395.00	0
	7	210.12	207.68	206.28	3,448.36	527.12	374.92	0
	8	210.16	207.81	206.42	3,453.40	543.68	375.58	0
	9	210.19	207.94	206.55	3,300.03	411.17	358.20	0
	10	210.23	208.07	206.69	3,310.91	577.24	343.93	0
	11	210.28	208.20	206.83	3,231.82	483.92	348.62	0
	12	210.32	208.33	206.96	2,945.50	488.52	316.23	0
	13	210.36	208.46	207.10	2,950.61	467.77	315.71	0
	14	210.40	208.59	207.24	3,141.83	460.16	338.74	0
	15	210.44	208.72	207.37	3,127.50	552.61	339.19	0

Month	Actual data in normal case							
	Item	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	16	210.48	208.86	207.51	3,010.05	395.44	320.47	0
	17	210.53	208.99	207.65	3,011.29	527.80	320.74	0
	18	210.60	209.12	207.78	2,913.68	655.14	311.74	0
	19	210.67	209.25	207.92	2,585.86	530.03	274.16	0
	20	210.73	209.38	208.06	2,602.27	477.07	270.19	0
	21	210.78	209.51	208.19	2,772.37	506.40	292.83	0
	22	210.84	209.64	208.33	2,775.17	494.11	292.57	0
	23	210.89	209.77	208.47	2,803.47	457.37	300.45	0
	24	210.94	209.90	208.60	2,794.01	464.45	296.93	0
	25	210.97	210.03	208.74	2,811.45	396.68	292.76	0
	26	210.99	210.16	208.88	2,609.77	389.57	273.20	0
	27	211.02	210.29	209.01	2,647.20	312.44	280.98	0
	28	211.03	210.42	209.15	2,790.69	322.61	293.55	0
	29	211.03	210.55	209.29	2,786.22	284.74	294.06	0
	30	211.02	210.68	209.42	2,759.19	266.47	289.86	0
Oct	1	211.01	210.81	209.56	2,970.33	251.53	306.03	0
	2	211.00	210.85	209.60	3,022.35	309.09	318.32	0
	3	211.00	210.89	209.64	2,787.93	311.25	294.02	0
	4	210.99	210.93	209.68	2,843.29	236.62	299.05	0
	5	211.01	210.96	209.72	2,935.66	374.96	296.37	0
	6	211.02	211.00	209.76	3,028.19	350.44	318.72	0
	7	211.02	211.04	209.80	3,033.20	340.13	345.10	0
	8	211.02	211.08	209.84	2,912.17	305.50	305.30	0
	9	211.03	211.12	209.88	2,958.44	419.46	311.03	0
	10	211.05	211.16	209.92	2,818.15	360.02	297.02	0
	11	211.08	211.19	209.96	2,821.87	383.53	295.77	0
	12	211.09	211.23	210.00	2,939.47	337.24	310.77	0
	13	211.09	211.27	210.04	2,886.55	295.71	304.52	0
	14	211.09	211.31	210.08	2,973.71	285.48	313.12	0

Month	Actual data in normal case							
	Item	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	15	211.08	211.35	210.12	2,774.17	267.87	292.39	0
	16	211.08	211.39	210.16	2,833.75	301.59	296.73	0
	17	211.08	211.42	210.21	2,710.28	280.82	282.94	0
	18	211.08	211.46	210.25	2,767.19	301.71	284.36	0
	19	211.08	211.50	210.29	2,825.82	249.67	294.23	0
	20	211.07	211.54	210.33	2,837.44	294.70	295.78	0
	21	211.07	211.58	210.37	2,905.26	256.98	304.10	0
	22	211.06	211.62	210.41	2,709.35	248.89	283.41	0
	23	211.04	211.65	210.45	2,749.67	241.93	299.83	0
	24	211.03	211.69	210.49	2,508.00	220.23	261.84	0
	25	211.02	211.73	210.53	2,556.42	255.69	272.69	0
	26	211.02	211.77	210.57	2,591.48	257.44	266.54	0
	27	211.01	211.81	210.61	2,751.34	241.55	288.85	0
	28	210.99	211.85	210.65	2,671.09	184.97	269.86	0
	29	210.97	211.88	210.69	2,533.11	183.11	264.05	0
	30	210.95	211.92	210.73	2,655.65	188.21	278.94	0
	31	210.93	211.96	210.77	2,612.65	172.68	269.14	0
Nov	1	210.89	212.00	210.81	2,628.49	160.86	274.83	0
	2	210.86	212.00	210.79	2,604.73	142.96	274.45	0
	3	210.83	212.00	210.77	2,584.75	171.03	272.55	0
	4	210.81	212.00	210.75	2,592.75	190.56	274.03	0
	5	210.78	212.00	210.73	2,460.99	158.59	259.76	0
	6	210.76	212.00	210.71	2,509.65	178.29	265.38	0
	7	210.74	212.00	210.69	2,460.08	185.26	259.24	0
	8	210.72	212.00	210.67	2,467.31	183.83	259.91	0
	9	210.70	212.00	210.64	2,403.31	166.32	236.24	0
	10	210.68	212.00	210.62	2,313.47	168.26	243.36	0
	11	210.66	212.00	210.60	2,460.07	174.16	260.19	0
	12	210.63	212.00	210.58	2,382.40	162.02	255.44	0

Month	Actual data in normal case							
	Item	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	13	210.61	212.00	210.56	2,393.81	159.88	252.59	0
	14	210.58	212.00	210.54	2,382.47	144.07	250.89	0
	15	210.56	212.00	210.52	2,384.70	167.67	252.11	0
	16	210.53	212.00	210.50	2,415.40	146.05	254.95	0
	17	210.50	212.00	210.48	2,434.27	141.82	254.36	0
	18	210.47	212.00	210.46	2,357.58	119.41	253.59	0
	19	210.44	212.00	210.44	2,479.28	174.19	264.55	0
	20	210.40	212.00	210.42	2,611.61	140.05	278.02	0
	21	210.37	212.00	210.40	2,520.37	128.24	267.65	0
	22	210.34	212.00	210.38	2,385.45	164.07	253.53	0
	23	210.32	212.00	210.36	2,418.39	158.12	258.99	0
	24	210.29	212.00	210.33	2,463.00	161.65	260.49	0
	25	210.19	212.00	210.31	2,415.34	147.73	259.91	0
	26	210.23	212.00	210.29	2,353.52	135.59	250.62	0
	27	210.20	212.00	210.27	2,462.21	171.02	263.34	0
	28	210.17	212.00	210.25	2,525.49	163.82	271.04	0
	29	210.15	212.00	210.23	2,583.84	187.84	271.73	0
	30	210.12	212.00	210.21	2,375.89	146.29	259.70	0
Dec	1	210.09	212.00	210.19	2,413.09	115.45	259.02	0
	2	210.05	212.00	210.14	2,410.15	135.56	259.09	0
	3	210.03	212.00	210.08	2,347.18	146.49	249.54	0
	4	210.00	212.00	210.03	2,407.90	140.42	259.21	0
	5	209.96	212.00	209.98	2,487.63	126.23	267.59	0
	6	209.92	212.00	209.93	2,403.31	119.77	259.00	0
	7	209.89	212.00	209.87	2,408.47	146.76	259.32	0
	8	209.86	212.00	209.82	2,380.56	116.79	256.87	0
	9	209.82	212.00	209.77	2,658.08	147.18	286.20	0
	10	209.78	212.00	209.72	2,445.06	109.99	258.36	0
	11	209.74	212.00	209.66	2,509.37	135.49	270.91	0

Month	Actual data in normal case							
	Item	HWL (ave)	Old URC	Old LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	12	209.71	212.00	209.61	2,415.20	125.85	261.56	0
	13	209.67	212.00	209.56	2,420.87	105.13	262.17	0
	14	209.63	212.00	209.51	2,492.37	101.48	270.06	0
	15	209.58	212.00	209.45	2,493.00	109.56	269.99	0
	16	209.54	212.00	209.40	2,465.54	107.74	267.68	0
	17	209.50	212.00	209.35	2,368.34	117.19	256.76	0
	18	209.46	212.00	209.30	2,455.06	101.96	267.03	0
	19	209.42	212.00	209.24	2,321.05	111.63	251.85	0
	20	209.38	212.00	209.19	2,318.30	100.27	253.15	0
	21	209.34	212.00	209.14	2,328.18	80.10	255.70	0
	22	209.30	212.00	209.08	2,326.92	112.96	251.48	0
	23	209.25	212.00	209.03	2,324.32	85.73	251.45	0
	24	209.21	212.00	208.98	2,371.06	108.85	256.98	0
	25	209.16	212.00	208.93	2,658.64	77.50	295.14	0
	26	209.11	212.00	208.87	2,512.87	116.79	274.08	0
	27	209.07	212.00	208.82	2,406.97	80.33	264.31	0
	28	209.02	212.00	208.77	2,424.02	88.69	266.46	0
	29	208.98	212.00	208.72	2,419.85	100.18	266.42	0
	30	208.93	212.00	208.66	2,433.29	74.36	268.05	0
	31	208.88	212.00	208.61	2,385.26	93.22	262.10	0

Note: HWL (Head water level)

Old URC (Old upper rule curve)

Old LRC (Old lower rule curve)

EE (Electricity energy)

Qin (Quantity inflow)

Qt (Quantity turbine discharge)

Qs (Quantity spillway discharge)

Appendix E

Result Data

The data are result simulation model. There are three cases aswet, drought and normal cases. The water elevation, energy production, water inflow, water turbine discharge, spillway discharge and new upper and lower rule curve. All result data are used for reservoir management of Nam Ngum-1 hydropower plant to optimize electricity production. The detail data is shownin the following table E.1, 2, and 3:

Appendix E.1Result data in wet case

Table E.1Result data in wet case

Month	Result from simulation model in wet case							
	Items	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(m.a.s.l)	(m.a.s.l)	(m.a.s.l)	(GWh)	(cms)	(cms)	(cms)
Jan	1	207.87	212.20	207.23	3,199.40	97.30	361.80	0
	2	207.87	212.20	207.15	3,199.40	96.00	361.80	0
	3	207.80	212.20	207.08	3,199.40	109.70	361.80	0
	4	207.73	212.20	207.00	3,193.90	83.10	361.80	0
	5	207.66	212.20	206.93	3,187.80	95.10	361.80	0
	6	207.59	212.20	206.85	3,181.90	94.20	361.80	0
	7	207.51	212.20	206.78	3,176.10	80.00	361.80	0
	8	207.44	212.20	206.71	3,169.90	91.70	361.80	0
	9	207.37	212.20	206.63	3,164.00	96.40	361.80	0
	10	207.30	212.20	206.56	3,158.20	100.30	361.80	0
	11	207.22	212.20	206.48	3,152.50	78.00	361.80	0
	12	207.15	212.20	206.41	3,146.30	84.10	361.80	0
	13	207.08	212.20	206.34	3,140.30	84.70	361.80	0
	14	207.00	212.20	206.26	3,134.20	80.60	361.80	0
	15	206.93	212.20	206.19	3,128.10	99.70	361.80	0
	16	206.86	212.20	206.11	3,122.30	92.30	361.80	0
	17	206.78	212.20	206.04	3,116.40	80.10	361.80	0

Month	Result from simulation model in wet case							
	Items	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(m.a.s.l)	(m.a.s.l)	(m.a.s.l)	(GWh)	(cms)	(cms)	(cms)
	18	206.71	212.20	205.96	3,110.30	89.90	361.80	0
	19	206.64	212.20	205.89	3,104.30	77.40	361.80	0
	20	206.56	212.20	205.82	3,098.10	87.10	361.80	0
	21	206.49	212.20	205.74	3,092.00	73.50	361.80	0
	22	206.41	212.20	205.67	3,085.70	89.10	361.80	0
	23	206.34	212.20	205.59	3,079.80	78.20	361.80	0
	24	206.26	212.20	205.52	3,073.50	78.70	361.80	0
	25	206.20	212.20	205.45	3,067.30	114.20	361.80	0
	26	206.12	212.20	205.37	3,061.90	65.80	361.80	0
	27	206.05	212.20	205.30	3,055.40	94.20	361.80	0
	28	205.97	212.20	205.22	3,049.60	75.30	361.80	0
	29	205.90	212.20	205.15	3,043.30	86.60	361.80	0
	30	205.82	212.20	205.07	3,037.30	90.60	361.80	0
	31	205.76	212.20	205.00	3,031.40	112.50	361.80	0
Feb	1	205.68	212.13	204.93	3,026.00	80.70	361.80	0
	2	205.62	212.06	204.86	3,019.90	107.50	361.80	0
	3	205.54	211.99	204.79	3,014.30	94.70	361.80	0
	4	205.47	211.91	204.71	3,008.50	75.20	361.80	0
	5	205.39	211.84	204.64	3,002.30	82.50	361.80	0
	6	205.34	211.77	204.57	2,996.20	143.80	361.80	0
	7	205.27	211.70	204.50	2,991.40	106.80	361.80	0
	8	205.20	211.63	204.43	2,985.90	102.40	361.80	0
	9	205.13	211.56	204.36	2,980.20	85.90	361.80	0
	10	205.05	211.49	204.29	2,974.20	73.60	361.80	0
	11	204.98	211.41	204.21	2,967.90	112.40	361.80	0
	12	204.90	211.34	204.14	2,962.50	57.20	361.80	0
	13	204.83	211.27	204.07	2,955.80	97.30	361.80	0
	14	204.76	211.20	204.00	2,950.00	100.80	361.80	0
	15	204.69	211.13	203.93	2,944.30	97.00	361.80	0

Month	Result from simulation model in wet case							
	Items	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(m.a.s.l)	(m.a.s.l)	(m.a.s.l)	(GWh)	(cms)	(cms)	(cms)
	16	204.62	211.06	203.86	2,938.50	78.10	361.80	0
	17	204.54	210.99	203.79	2,932.30	74.70	361.80	0
	18	204.47	210.91	203.71	2,926.00	91.30	361.80	0
	19	204.39	210.84	203.64	2,920.10	61.30	361.80	0
	20	204.31	210.77	203.57	2,913.50	70.20	361.80	0
	21	204.24	210.70	203.50	2,907.10	91.70	361.80	0
	22	204.14	210.63	203.43	2,901.20	2.40	361.80	0
	23	204.07	210.56	203.36	2,893.30	82.50	361.80	0
	24	203.99	210.49	203.29	2,887.20	86.50	361.80	0
	25	203.92	210.41	203.21	2,881.20	67.50	361.80	0
	26	203.84	210.34	203.14	2,874.70	86.00	361.80	0
	27	203.78	210.27	203.07	2,868.70	141.10	361.80	0
	28	203.70	210.20	203.00	2,863.90	67.60	361.80	0
	29	203.63	210.09	202.92	2,857.50	75.20	361.80	0
Mar	1	203.55	209.99	202.84	2,851.20	83.60	361.80	0
	2	203.48	209.88	202.76	2,845.10	80.90	361.80	0
	3	203.41	209.77	202.68	2,839.00	86.50	361.80	0
	4	203.33	209.67	202.60	2,833.00	86.90	361.80	0
	5	203.26	209.56	202.52	2,827.00	68.80	361.80	0
	6	203.18	209.45	202.44	2,820.60	72.00	361.80	0
	7	203.10	209.35	202.35	2,814.20	80.10	361.80	0
	8	203.03	209.24	202.27	2,808.10	69.60	361.80	0
	9	202.95	209.14	202.19	2,801.70	82.80	361.80	0
	10	202.87	209.03	202.11	2,795.60	76.10	361.80	0
	11	202.80	208.92	202.03	2,789.30	96.50	361.80	0
	12	202.74	208.82	201.95	2,783.50	112.30	361.80	0
	13	202.67	208.71	201.87	2,778.00	114.00	361.80	0
	14	202.60	208.60	201.79	2,772.60	85.00	361.80	0
	15	202.52	208.50	201.71	2,766.50	86.20	361.80	0

Month	Result from simulation model in wet case							
	Items	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(m.a.s.l)	(m.a.s.l)	(m.a.s.l)	(GWh)	(cms)	(cms)	(cms)
	16	202.45	208.39	201.63	2,760.50	90.20	361.80	0
	17	202.38	208.28	201.55	2,754.50	94.60	361.80	0
	18	202.31	208.18	201.47	2,748.70	102.40	361.80	0
	19	202.24	208.07	201.39	2,743.00	94.50	361.80	0
	20	202.16	207.96	201.31	2,737.10	50.10	361.80	0
	21	202.09	207.86	201.23	2,730.30	121.80	361.80	0
	22	202.04	207.75	201.15	2,725.00	157.00	361.80	0
	23	201.98	207.65	201.06	2,720.50	138.30	361.80	0
	24	201.90	207.54	200.98	2,715.60	78.90	361.80	0
	25	201.82	207.43	200.90	2,709.50	72.50	361.80	0
	26	201.75	207.33	200.82	2,703.10	62.10	361.80	0
	27	201.68	207.22	200.74	2,696.90	100.40	361.84	0
	28	201.60	207.11	200.66	2,696.40	97.10	362.62	0
	29	201.53	207.01	200.58	2,696.40	97.40	363.47	0
	30	201.46	206.90	200.50	2,696.40	104.10	364.33	0
	31	201.40	206.79	200.43	2,696.50	119.70	365.19	0
April	1	201.35	206.67	200.35	2,668.20	169.70	361.80	0
	2	201.29	206.56	200.28	2,664.00	150.10	361.80	0
	3	201.25	206.45	200.21	2,659.40	203.80	361.80	0
	4	201.19	206.33	200.13	2,655.90	150.10	361.80	0
	5	201.14	206.22	200.06	2,651.30	171.00	361.80	0
	6	201.08	206.11	199.99	2,647.10	133.00	361.80	0
	7	201.02	205.99	199.91	2,642.10	142.90	361.80	0
	8	200.95	205.88	199.84	2,637.30	151.40	361.80	0
	9	200.87	205.77	199.77	2,631.60	139.90	361.80	0
	10	200.80	205.65	199.69	2,624.90	171.50	361.80	0
	11	200.69	205.54	199.62	2,619.10	66.00	361.80	0
	12	200.61	205.43	199.55	2,610.20	142.10	361.80	0
	13	200.52	205.31	199.47	2,603.50	104.70	361.80	0

Month	Result from simulation model in wet case							
	Items	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(m.a.s.l)	(m.a.s.l)	(m.a.s.l)	(GWh)	(cms)	(cms)	(cms)
	14	200.43	205.20	199.40	2,595.70	130.30	361.80	0
	15	200.35	205.09	199.33	2,593.40	150.00	362.53	0
	16	200.27	204.97	199.25	2,593.30	130.40	363.50	0
	17	200.20	204.86	199.18	2,593.30	198.70	364.59	0
	18	200.13	204.75	199.11	2,593.50	155.20	365.41	0
	19	200.07	204.63	199.03	2,593.40	222.20	366.39	0
	20	200.01	204.52	198.96	2,593.60	194.90	367.11	0
	21	199.94	204.41	198.89	2,593.60	177.60	367.94	0
	22	199.86	204.29	198.81	2,593.50	172.20	368.88	0
	23	199.79	204.18	198.74	2,593.50	191.40	369.87	0
	24	199.71	204.07	198.67	2,593.60	159.10	370.79	0
	25	199.63	203.95	198.59	2,593.50	153.80	371.86	0
	26	199.54	203.84	198.52	2,593.60	157.80	372.98	0
	27	199.48	203.73	198.45	2,593.60	194.20	374.10	0
	28	199.41	203.61	198.37	2,593.70	204.90	375.06	0
	29	199.33	203.50	198.30	2,593.80	174.90	375.96	0
	30	199.26	203.47	198.27	2,593.70	192.40	377.01	0
May	1	199.20	203.44	198.24	2,492.70	193.10	361.80	0
	2	199.13	203.40	198.21	2,487.40	195.20	361.80	0
	3	199.08	203.37	198.18	2,482.10	220.80	361.80	0
	4	199.01	203.34	198.15	2,477.70	176.40	361.80	0
	5	198.97	203.31	198.13	2,471.80	252.90	361.80	0
	6	198.93	203.27	198.10	2,468.60	268.60	361.80	0
	7	198.90	203.24	198.07	2,465.80	253.80	361.80	0
	8	198.85	203.21	198.04	2,462.60	228.60	361.80	0
	9	198.80	203.18	198.01	2,458.70	236.10	361.80	0
	10	198.76	203.15	197.98	2,455.00	232.30	361.80	0
	11	198.72	203.11	197.95	2,451.20	268.30	361.80	0
	12	198.68	203.08	197.92	2,448.50	252.90	361.80	0

Month	Result from simulation model in wet case							
	Items	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(m.a.s.l)	(m.a.s.l)	(m.a.s.l)	(GWh)	(cms)	(cms)	(cms)
	13	198.64	203.05	197.89	2,445.30	239.10	361.80	0
	14	198.59	203.02	197.86	2,441.70	212.70	361.80	0
	15	198.55	202.98	197.84	2,437.30	271.20	361.80	0
	16	198.50	202.95	197.81	2,434.60	217.10	361.80	0
	17	198.45	202.92	197.78	2,430.30	229.40	361.80	0
	18	198.43	202.89	197.75	2,426.50	301.80	361.80	0
	19	198.41	202.85	197.72	2,424.70	307.90	361.80	0
	20	198.44	202.82	197.69	2,423.10	436.60	361.80	0
	21	198.43	202.79	197.66	2,425.20	325.80	361.80	0
	22	198.39	202.76	197.63	2,424.20	268.10	361.80	0
	23	198.36	202.73	197.60	2,421.40	267.60	361.80	0
	24	198.33	202.69	197.57	2,418.60	287.90	361.80	0
	25	198.30	202.66	197.55	2,416.40	262.10	361.80	0
	26	198.27	202.63	197.52	2,413.50	300.30	361.80	0
	27	198.25	202.60	197.49	2,411.70	294.00	361.80	0
	28	198.22	202.56	197.46	2,409.70	292.10	361.80	0
	29	198.22	202.53	197.43	2,407.60	343.30	361.80	0
	30	198.20	202.50	197.40	2,407.00	307.40	361.80	0
	31	198.22	202.57	197.42	2,405.40	413.30	361.80	0
June	1	198.26	202.63	197.44	2,406.90	498.80	361.80	0
	2	198.29	202.70	197.46	2,410.90	437.80	361.80	0
	3	198.30	202.77	197.48	2,413.10	386.00	361.80	0
	4	198.35	202.83	197.50	2,413.70	507.60	361.80	0
	5	198.45	202.90	197.52	2,418.00	650.80	361.80	0
	6	198.55	202.97	197.54	2,426.40	624.50	361.80	0
	7	198.66	203.03	197.56	2,434.00	669.80	361.80	0
	8	198.72	203.10	197.58	2,443.00	538.10	361.80	0
	9	198.79	203.17	197.60	2,448.10	571.90	361.80	0
	10	198.85	203.23	197.62	2,454.20	528.70	361.80	0

Month	Result from simulation model in wet case							
	Items	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(m.a.s.l)	(m.a.s.l)	(m.a.s.l)	(GWh)	(cms)	(cms)	(cms)
	11	198.87	203.30	197.64	2,459.10	427.00	361.80	0
	12	198.92	203.37	197.66	2,460.90	493.40	361.80	0
	13	198.99	203.43	197.68	2,464.80	562.30	361.80	0
	14	199.07	203.50	197.70	2,470.60	576.80	361.80	0
	15	199.20	203.57	197.72	2,477.30	683.10	361.80	0
	16	199.41	203.63	197.74	2,487.30	935.20	361.80	0
	17	199.59	203.70	197.76	2,505.30	823.70	361.80	0
	18	199.79	203.77	197.78	2,519.70	895.60	361.80	0
	19	200.03	203.83	197.80	2,536.50	994.80	361.80	0
	20	200.20	203.90	197.82	2,556.20	813.10	361.80	0
	21	200.32	203.97	197.84	2,569.80	700.80	361.80	0
	22	200.43	204.03	197.86	2,580.00	641.20	361.80	0
	23	200.51	204.10	197.88	2,588.40	583.10	361.80	0
	24	200.61	204.17	197.90	2,595.00	642.20	361.80	0
	25	200.94	204.23	197.92	2,603.50	1245.70	361.80	0
	26	201.25	204.30	197.94	2,630.10	1491.90	361.80	0
	27	201.37	204.37	197.96	2,656.20	823.80	361.80	0
	28	201.48	204.43	197.98	2,666.20	756.70	361.80	0
	29	201.57	204.50	198.00	2,674.80	707.50	361.80	0
	30	201.68	204.67	198.08	3,273.60	865.30	450.91	0
July	1	201.99	204.84	198.15	3,656.10	1686.20	508.39	0
	2	202.23	205.01	198.23	3,704.60	1393.90	510.21	0
	3	202.36	205.18	198.31	3,707.00	990.50	506.60	0
	4	202.43	205.35	198.39	3,706.30	776.30	504.36	0
	5	202.48	205.53	198.46	3,705.80	707.90	503.10	0
	6	202.59	205.70	198.54	3,705.60	905.00	502.19	0
	7	202.67	205.87	198.62	3,705.90	826.40	500.48	0
	8	202.79	206.04	198.70	3,706.20	924.90	499.05	0
	9	202.98	206.21	198.77	3,706.70	1221.40	497.19	0

Month	Result from simulation model in wet case							
	Items	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(m.a.s.l)	(m.a.s.l)	(m.a.s.l)	(GWh)	(cms)	(cms)	(cms)
	10	203.12	206.38	198.85	3,707.70	1011.50	494.07	0
	11	203.27	206.55	198.93	3,707.00	1054.50	491.66	0
	12	203.44	206.72	199.01	3,707.00	1161.80	489.18	0
	13	203.65	206.89	199.08	3,707.30	1258.50	486.29	0
	14	203.87	207.06	199.16	3,707.50	1315.90	483.01	0
	15	204.02	207.24	199.24	3,707.50	1032.10	479.51	0
	16	204.14	207.41	199.32	3,706.50	948.20	477.06	0
	17	204.27	207.58	199.39	3,706.10	951.60	475.05	0
	18	204.49	207.75	199.47	3,706.00	1313.30	473.09	0
	19	204.63	207.92	199.55	3,706.90	984.00	469.83	0
	20	204.75	208.09	199.63	3,706.00	938.20	467.64	0
	21	204.88	208.26	199.70	3,705.60	942.60	465.74	0
	22	205.11	208.43	199.78	3,705.50	1338.50	463.86	0
	23	205.30	208.60	199.86	3,706.60	1189.50	460.63	0
	24	205.49	208.77	199.94	3,706.10	1168.10	457.81	0
	25	205.69	208.95	200.01	3,705.90	1206.50	455.13	0
	26	205.84	209.12	200.09	3,705.80	1043.10	452.35	0
	27	205.99	209.29	200.17	3,705.30	1002.60	450.13	0
	28	206.12	209.46	200.25	3,705.00	949.90	448.11	0
	29	206.27	209.63	200.32	3,704.80	1008.80	446.28	0
	30	206.37	209.80	200.40	3,704.90	832.60	444.28	0
	31	206.61	209.88	200.58	3,704.40	1330.20	442.85	0
Aug	1	206.86	209.95	200.76	3,705.40	1390.10	439.90	0
	2	207.05	210.03	200.94	3,705.50	1134.80	436.65	0
	3	207.20	210.11	201.12	3,704.80	1022.60	434.19	0
	4	207.33	210.19	201.30	3,704.40	911.10	432.17	0
	5	207.47	210.26	201.48	3,704.00	965.20	430.54	0
	6	207.59	210.34	201.66	3,704.00	888.90	428.79	0
	7	207.80	210.42	201.85	3,703.80	1221.60	427.27	0

Month	Result from simulation model in wet case							
	Items	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(m.a.s.l)	(m.a.s.l)	(m.a.s.l)	(GWh)	(cms)	(cms)	(cms)
	8	208.02	210.50	202.03	3,704.40	1230.60	424.79	0
	9	208.18	210.57	202.21	3,704.30	1038.70	422.23	0
	10	208.33	210.65	202.39	3,703.80	992.60	420.23	0
	11	208.51	210.73	202.57	3,703.60	1086.10	418.42	0
	12	208.90	210.81	202.75	3,703.70	1881.80	416.37	0
	13	209.20	210.88	202.93	3,705.10	1555.30	412.10	0
	14	209.44	210.96	203.11	3,704.40	1310.30	408.62	0
	15	209.63	211.04	203.29	3,703.70	1125.50	405.90	0
	16	209.83	211.12	203.47	3,703.10	1140.90	403.77	0
	17	210.12	211.19	203.65	3,703.00	1518.30	401.66	0
	18	210.40	211.27	203.83	3,703.60	1458.80	398.59	0
	19	210.69	211.35	204.01	3,703.30	1497.70	395.64	0
	20	211.02	211.43	204.19	3,703.20	1629.90	392.64	0
	21	211.24	211.50	204.37	3,703.20	1205.70	389.34	0
	22	211.49	211.58	204.55	3,702.40	1330.10	387.09	0
	23	211.66	211.66	204.74	4,240.80	1198.50	558.26	0
	24	211.79	211.74	204.92	4,240.80	1075.80	590.46	0
	25	211.89	211.81	205.10	4,240.80	986.50	591.25	0
	26	211.99	211.89	205.28	4,240.80	952.80	592.15	0
	27	212.07	211.97	205.46	4,240.80	912.00	592.96	0
	28	212.15	212.05	205.64	4,240.80	873.60	593.68	0
	29	212.22	212.12	205.82	4,240.80	876.50	594.34	17.23
	30	212.31	212.20	206.00	4,240.80	922.00	595.07	49.76
	31	212.38	212.20	206.13	4,240.80	888.50	613.00	82.18
Sep	1	212.47	212.20	206.27	4,240.80	978.50	645.88	108.31
	2	212.54	212.20	206.40	4,240.80	950.90	677.53	134.58
	3	212.60	212.20	206.53	4,240.80	918.60	703.05	156.36
	4	212.67	212.20	206.67	4,240.80	1004.80	728.69	172.50
	5	212.70	212.20	206.80	4,240.80	881.60	749.95	184.13

Month	Result from simulation model in wet case							
	Items	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(m.a.s.l)	(m.a.s.l)	(m.a.s.l)	(GWh)	(cms)	(cms)	(cms)
	6	212.75	212.20	206.93	4,240.80	937.00	765.71	201.07
	7	212.76	212.20	207.07	4,240.80	824.60	777.06	230.28
	8	212.83	212.20	207.20	4,240.80	1064.20	793.61	257.72
	9	212.90	212.20	207.33	4,240.80	1098.90	823.26	277.70
	10	212.97	212.20	207.47	4,240.80	1089.60	851.87	287.59
	11	213.00	212.20	207.60	4,240.80	1009.20	872.68	290.50
	12	213.02	212.20	207.73	4,240.80	932.90	882.99	281.67
	13	213.02	212.20	207.87	4,240.80	892.50	886.02	274.40
	14	212.97	212.20	208.00	4,240.80	708.30	876.80	284.33
	15	212.98	212.20	208.13	4,240.80	905.10	869.24	296.92
	16	213.02	212.20	208.27	4,240.80	1030.80	879.59	301.92
	17	213.04	212.20	208.40	4,240.80	977.90	892.69	310.17
	18	213.05	212.20	208.53	4,240.80	907.60	897.68	319.19
	19	213.08	212.20	208.67	4,240.80	1051.60	906.02	318.39
	20	213.09	212.20	208.80	4,240.80	939.20	915.04	307.59
	21	213.08	212.20	208.93	4,240.80	877.50	914.24	293.50
	22	213.04	212.20	209.07	4,240.80	741.70	903.36	277.72
	23	213.01	212.20	209.20	4,240.80	791.60	889.04	256.81
	24	212.96	212.20	209.33	4,240.80	678.90	872.68	236.11
	25	212.91	212.20	209.47	4,240.80	657.90	850.89	218.83
	26	212.86	212.20	209.60	4,240.80	639.20	829.32	238.06
	27	212.82	212.20	209.73	4,240.80	682.20	811.45	269.24
	28	212.95	212.20	209.87	4,240.80	1321.60	831.38	271.07
	29	212.98	212.20	210.00	4,240.80	956.30	863.86	261.82
	30	212.96	212.20	210.00	4,240.80	809.70	865.76	244.90
Oct	1	212.93	212.20	210.00	4,240.80	742.40	856.12	221.40
	2	212.88	212.20	210.00	4,240.80	639.70	838.48	197.84
	3	212.81	212.20	210.00	4,240.80	577.90	814.11	174.93
	4	212.76	212.20	210.00	4,240.80	590.70	790.46	151.80

Month	Result from simulation model in wet case							
	Items	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(m.a.s.l)	(m.a.s.l)	(m.a.s.l)	(GWh)	(cms)	(cms)	(cms)
	5	212.70	212.20	210.00	4,240.80	543.90	768.09	132.50
	6	212.65	212.20	210.00	4,240.80	541.80	745.52	111.82
	7	212.61	212.20	210.00	4,240.80	573.80	726.68	88.96
	8	212.55	212.20	210.00	4,240.80	476.80	706.49	66.53
	9	212.49	212.20	210.00	4,240.80	490.70	684.16	44.00
	10	212.43	212.20	210.00	4,240.80	440.80	662.27	23.34
	11	212.38	212.20	210.00	4,240.80	444.70	640.17	4.31
	12	212.33	212.20	210.00	4,240.80	432.60	619.23	-
	13	212.29	212.20	210.00	4,240.80	422.20	599.78	-
	14	212.23	212.20	210.00	4,240.80	406.30	595.04	0
	15	212.20	212.20	210.00	4,240.80	432.80	563.06	0
	16	212.20	212.20	210.00	3,801.70	380.70	388.71	0
	17	212.19	212.20	210.00	3,707.40	347.60	378.42	0
	18	212.18	212.20	210.00	3,700.70	339.20	377.78	0
	19	212.16	212.20	210.00	3,700.30	322.30	377.82	0
	20	212.15	212.20	210.00	3,700.20	340.80	377.96	0
	21	212.13	212.20	210.00	3,700.30	299.60	378.06	0
	22	212.11	212.20	210.00	3,700.20	289.00	378.25	0
	23	212.09	212.20	210.00	3,700.20	302.10	378.48	0
	24	212.07	212.20	210.00	3,700.20	300.80	378.67	0
	25	212.04	212.20	210.00	3,700.20	283.90	378.87	0
	26	212.01	212.20	210.00	3,700.20	280.00	379.11	0
	27	211.98	212.20	210.00	3,700.20	265.30	379.36	0
	28	211.95	212.20	210.00	3,700.20	258.10	379.65	0
	29	211.92	212.20	210.00	3,700.20	278.00	379.96	0
	30	211.90	212.20	210.00	3,700.20	286.70	380.22	0
	31	211.87	212.20	209.98	3,700.30	260.40	380.47	0
Nov	1	211.84	212.20	209.95	3,700.30	275.30	380.77	0
	2	211.81	212.20	209.93	3,700.30	266.60	381.04	0

Month	Result from simulation model in wet case							
	Items	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(m.a.s.l)	(m.a.s.l)	(m.a.s.l)	(GWh)	(cms)	(cms)	(cms)
	3	211.78	212.20	209.91	3,700.30	270.50	381.34	0
	4	211.75	212.20	209.88	3,700.30	275.70	381.63	0
	5	211.71	212.20	209.86	3,700.30	239.00	381.90	0
	6	211.68	212.20	209.84	3,700.30	252.50	382.26	0
	7	211.63	212.20	209.81	3,700.30	229.60	382.60	0
	8	211.60	212.20	209.79	3,700.30	266.20	383.00	0
	9	211.57	212.20	209.77	3,700.40	257.60	383.31	0
	10	211.53	212.20	209.74	3,700.40	246.90	383.63	0
	11	211.49	212.20	209.72	3,700.40	230.00	383.99	0
	12	211.46	212.20	209.70	3,700.40	266.00	384.39	0
	13	211.41	212.20	209.67	3,700.40	209.50	384.71	0
	14	211.37	212.20	209.65	3,700.40	210.50	385.16	0
	15	211.32	212.20	209.63	3,700.40	205.00	385.61	0
	16	211.27	212.20	209.60	3,700.40	212.10	386.09	0
	17	211.22	212.20	209.58	3,700.40	200.90	386.55	0
	18	211.17	212.20	209.56	3,700.40	185.00	387.04	0
	19	211.12	212.20	209.53	3,700.40	215.20	387.57	0
	20	211.06	212.20	209.51	3,700.50	159.30	388.04	0
	21	211.00	212.20	209.49	3,700.40	172.10	388.64	0
	22	210.94	212.20	209.46	3,700.50	175.40	389.22	0
	23	210.89	212.20	209.44	3,700.50	194.80	389.80	0
	24	210.84	212.20	209.42	3,700.60	182.90	390.32	0
	25	210.78	212.20	209.39	3,700.60	162.20	390.88	0
	26	210.73	212.20	209.37	3,700.60	200.10	391.49	0
	27	210.67	212.20	209.35	3,530.10	149.10	372.67	0
	28	210.62	212.20	209.32	3,428.90	202.50	361.80	0
	29	210.57	212.20	209.30	3,425.40	152.10	361.80	0
	30	210.52	212.20	209.24	3,420.80	183.10	361.80	0
Dec	1	210.46	212.20	209.17	3,416.90	151.60	361.80	0

Month	Result from simulation model in wet case							
	Items	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(m.a.s.l)	(m.a.s.l)	(m.a.s.l)	(GWh)	(cms)	(cms)	(cms)
	2	210.41	212.20	209.11	3,412.30	149.10	361.80	0
	3	210.35	212.20	209.04	3,407.60	134.60	361.80	0
	4	210.29	212.20	208.98	3,402.60	138.60	361.80	0
	5	210.22	212.20	208.91	3,397.70	110.00	361.80	0
	6	210.17	212.20	208.85	3,392.20	160.50	361.80	0
	7	210.11	212.20	208.78	3,387.80	137.20	361.80	0
	8	210.05	212.20	208.72	3,382.90	149.30	361.80	0
	9	209.99	212.20	208.65	3,378.30	156.40	361.80	0
	10	209.93	212.20	208.59	3,373.80	108.50	361.80	0
	11	209.87	212.20	208.53	3,368.20	137.40	361.80	0
	12	209.80	212.20	208.46	3,363.30	100.80	361.80	0
	13	209.73	212.20	208.40	3,357.60	101.60	361.80	0
	14	209.67	212.20	208.33	3,352.00	142.50	361.80	0
	15	209.61	212.20	208.27	3,347.20	131.20	361.80	0
	16	209.54	212.20	208.20	3,342.10	114.90	361.80	0
	17	209.48	212.20	208.14	3,336.70	141.10	361.80	0
	18	209.42	212.20	208.07	3,331.90	110.80	361.80	0
	19	209.36	212.20	208.01	3,326.40	149.10	361.80	0
	20	209.29	212.20	207.95	3,321.70	107.40	361.80	0
	21	209.23	212.20	207.88	3,316.20	109.30	361.80	0
	22	209.16	212.20	207.82	3,310.70	130.40	361.80	0
	23	209.10	212.20	207.75	3,305.60	125.20	361.80	0
	24	209.03	212.20	207.69	3,300.40	111.80	361.80	0
	25	208.97	212.20	207.62	3,295.00	131.30	361.80	0
	26	208.92	212.20	207.56	3,289.90	147.20	361.80	0
	27	208.85	212.20	207.49	3,285.20	130.90	361.80	0
	28	208.79	212.20	207.43	3,280.20	120.70	361.80	0
	29	208.72	212.20	207.36	3,274.90	111.40	361.80	0
	30	208.65	212.20	207.30	3,269.40	105.80	361.80	0
	31	208.59	212.20	207.30	3,263.80	118.80	361.80	0

Note: HWL (Head water level)
New URC (New upper rule curve)
New LRC (New lower rule curve)
EE (Electricity energy)
Qin (Quantity inflow)
Qt (Quantity turbine discharge)
Qs (Quantity spillway discharge)

Appendix E.2 Result data in normal case

Table E.2 Result data in normal case

Month	Result from simulation model in normal case							
	Item	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
Jan	1	209.40	212.00	207.45	3,065.30	155.60	331.74	0
	2	209.40	212.00	207.40	3,065.30	160.70	331.74	0
	3	209.35	212.00	207.35	3,065.30	134.10	331.74	0
	4	209.30	212.00	207.31	3,061.30	147.00	331.74	0
	5	209.26	212.00	207.26	3,057.60	172.70	331.74	0
	6	209.20	212.00	207.21	3,054.40	141.70	331.74	0
	7	209.16	212.00	207.16	3,050.60	181.00	331.74	0
	8	209.11	212.00	207.11	3,047.60	112.20	331.74	0
	9	209.06	212.00	207.06	3,043.20	150.10	331.74	0
	10	209.00	212.00	207.02	3,039.50	123.20	331.74	0
	11	208.95	212.00	206.97	3,035.30	124.70	331.74	0
	12	208.89	212.00	206.92	3,031.20	120.90	331.74	0
	13	208.83	212.00	206.87	3,030.30	102.10	332.14	0
	14	208.79	212.00	206.82	3,030.30	179.80	332.67	0
	15	208.73	212.00	206.77	3,030.40	125.70	333.05	0
	16	208.67	212.00	206.73	3,030.40	107.60	333.53	0
	17	208.62	212.00	206.68	3,030.40	138.80	334.07	0
	18	208.57	212.00	206.63	3,030.40	149.80	334.54	0
	19	208.52	212.00	206.58	3,030.50	144.20	334.99	0
	20	208.46	212.00	206.53	3,030.50	105.10	335.45	0
	21	208.40	212.00	206.48	3,030.50	101.50	336.00	0
	22	208.33	212.00	206.44	3,030.50	95.50	336.56	0
	23	208.26	212.00	206.39	3,030.50	88.60	337.15	0
	24	208.20	212.00	206.34	3,030.50	106.30	337.75	0
	25	208.15	212.00	206.29	3,030.60	121.90	338.32	0
	26	208.08	212.00	206.24	3,030.60	95.80	338.86	0

Month	Result from simulation model in normal case							
	Item	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	27	208.03	212.00	206.19	3,030.60	135.60	339.46	0
	28	207.96	212.00	206.15	3,030.70	110.00	339.97	0
	29	207.90	212.00	206.10	3,030.70	100.30	340.53	0
	30	207.85	212.00	206.05	3,030.70	137.30	341.13	0
	31	207.78	212.00	206.00	3,030.80	108.50	341.64	0
Feb	1	207.72	211.96	205.95	3,233.10	126.80	366.77	0
	2	207.65	211.93	205.89	3,248.30	92.70	369.28	0
	3	207.58	211.89	205.84	3,249.40	125.10	370.17	0
	4	207.53	211.86	205.79	3,249.60	171.10	370.87	0
	5	207.46	211.82	205.73	3,249.70	108.20	371.43	0
	6	207.39	211.79	205.68	3,249.60	112.90	372.15	0
	7	207.33	211.75	205.62	3,249.60	136.60	372.88	0
	8	207.26	211.71	205.57	3,249.70	128.60	373.54	0
	9	207.19	211.68	205.52	3,249.70	112.60	374.23	0
	10	207.12	211.64	205.46	3,249.70	110.60	374.97	0
	11	207.05	211.61	205.41	3,249.70	105.10	375.72	0
	12	206.98	211.57	205.36	3,249.80	120.70	376.49	0
	13	206.91	211.54	205.30	3,249.80	119.40	377.23	0
	14	206.84	211.50	205.25	3,249.80	119.50	377.97	0
	15	206.77	211.46	205.20	3,249.90	122.10	378.72	0
	16	206.71	211.43	205.14	3,249.90	131.60	379.47	0
	17	206.64	211.39	205.09	3,250.00	121.90	380.20	0
	18	206.58	211.36	205.04	3,250.00	158.10	380.95	0
	19	206.51	211.32	204.98	3,250.10	116.00	381.62	0
	20	206.44	211.29	204.93	3,250.00	113.30	382.40	0
	21	206.37	211.25	204.88	3,250.00	129.90	383.20	0
	22	206.30	211.21	204.82	3,250.10	126.00	383.96	0
	23	206.24	211.18	204.77	3,250.10	147.40	384.73	0
	24	206.17	211.14	204.71	3,250.20	144.00	385.45	0

Month	Result from simulation model in normal case							
	Item	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	25	206.10	211.11	204.66	3,250.20	130.00	386.18	0
	26	206.04	211.07	204.61	3,250.20	156.20	386.96	0
	27	205.99	211.04	204.55	3,250.30	178.30	387.67	0
	28	205.93	211.00	204.50	3,250.40	186.10	388.31	0
Mar	1	205.94	210.94	204.45	2,804.40	347.80	331.74	0
	2	205.90	210.87	204.40	2,804.70	184.60	331.74	0
	3	205.86	210.81	204.35	2,801.70	182.50	331.74	0
	4	205.82	210.74	204.31	2,798.70	178.80	331.74	0
	5	205.77	210.68	204.26	2,795.70	150.30	331.74	0
	6	205.72	210.61	204.21	2,792.00	137.20	331.74	0
	7	205.67	210.55	204.16	2,788.10	140.80	331.74	0
	8	205.62	210.48	204.11	2,784.30	148.60	331.74	0
	9	205.56	210.42	204.06	2,780.60	133.00	331.74	0
	10	205.51	210.35	204.02	2,776.70	124.20	331.74	0
	11	205.45	210.29	203.97	2,772.50	124.80	331.74	0
	12	205.40	210.23	203.92	2,768.40	121.50	331.74	0
	13	205.35	210.16	203.87	2,764.20	155.50	331.74	0
	14	205.29	210.10	203.82	2,760.60	118.90	331.74	0
	15	205.25	210.03	203.77	2,759.70	157.00	332.17	0
	16	205.20	209.97	203.73	2,759.70	159.60	332.62	0
	17	205.16	209.90	203.68	2,759.70	166.00	333.08	0
	18	205.11	209.84	203.63	2,759.80	155.70	333.51	0
	19	205.05	209.77	203.58	2,759.80	119.60	333.98	0
	20	205.00	209.71	203.53	2,759.70	150.60	334.54	0
	21	204.99	209.65	203.48	2,759.80	272.00	335.03	0
	22	204.94	209.58	203.44	2,760.00	143.80	335.22	0
	23	204.88	209.52	203.39	2,759.80	145.70	335.71	0
	24	204.84	209.45	203.34	2,759.90	158.90	336.22	0
	25	204.79	209.39	203.29	2,759.90	146.60	336.70	0

Month	Result from simulation model in normal case							
	Item	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	26	204.73	209.32	203.24	2,759.90	133.80	337.21	0
	27	204.68	209.26	203.19	2,759.90	144.90	337.76	0
	28	204.65	209.19	203.15	2,759.90	212.10	338.28	0
	29	204.59	209.13	203.10	2,760.10	135.20	338.64	0
	30	204.55	209.06	203.05	2,760.00	174.50	339.18	0
	31	204.51	209.00	203.00	2,760.00	206.40	339.64	0
April	1	204.46	208.94	202.95	2,697.50	154.80	331.74	0
	2	204.41	208.88	202.90	2,694.00	123.30	331.74	0
	3	204.36	208.82	202.85	2,689.80	132.80	331.74	0
	4	204.30	208.76	202.80	2,685.80	121.90	331.74	0
	5	204.25	208.70	202.75	2,681.50	133.60	331.74	0
	6	204.20	208.64	202.70	2,677.60	172.30	331.74	0
	7	204.15	208.58	202.65	2,674.30	126.60	331.74	0
	8	204.10	208.52	202.60	2,670.20	146.30	331.74	0
	9	204.05	208.46	202.55	2,666.50	140.30	331.74	0
	10	204.01	208.40	202.50	2,662.60	182.70	331.74	0
	11	203.98	208.34	202.45	2,659.60	240.10	331.74	0
	12	203.93	208.28	202.40	2,657.80	145.00	331.74	0
	13	203.89	208.22	202.35	2,654.00	186.90	331.74	0
	14	203.85	208.16	202.30	2,651.10	157.70	331.74	0
	15	203.80	208.10	202.25	2,647.60	141.70	331.74	0
	16	203.73	208.04	202.20	2,643.80	66.60	331.74	0
	17	203.67	207.98	202.15	2,638.50	120.90	331.74	0
	18	203.63	207.92	202.10	2,634.20	162.10	331.74	0
	19	203.58	207.86	202.05	2,630.80	169.10	331.74	0
	20	203.54	207.80	202.00	2,627.60	170.00	331.74	0
	21	203.49	207.74	201.95	2,624.30	166.70	331.74	0
	22	203.45	207.68	201.90	2,621.00	158.10	331.74	0
	23	203.41	207.62	201.85	2,617.50	179.20	331.74	0

Month	Result from simulation model in normal case							
	Item	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	24	203.36	207.56	201.80	2,614.40	140.60	331.74	0
	25	203.33	207.50	201.75	2,610.60	215.70	331.74	0
	26	203.28	207.44	201.70	2,608.30	168.90	331.74	0
	27	203.24	207.38	201.65	2,605.00	177.10	331.74	0
	28	203.21	207.32	201.60	2,604.20	209.10	332.06	0
	29	203.17	207.26	201.55	2,604.20	182.60	332.40	0
	30	203.15	207.20	201.50	2,604.20	251.50	332.82	0
May	1	203.13	207.16	201.47	2,594.70	269.80	331.74	0
	2	203.10	207.12	201.44	2,593.50	216.10	331.74	0
	3	203.06	207.07	201.40	2,591.20	183.30	331.74	0
	4	203.02	207.03	201.37	2,588.20	175.40	331.74	0
	5	202.98	206.99	201.34	2,585.00	214.20	331.74	0
	6	202.95	206.95	201.31	2,582.70	205.90	331.74	0
	7	202.91	206.91	201.27	2,580.10	183.80	331.74	0
	8	202.87	206.86	201.24	2,577.10	173.30	331.74	0
	9	202.83	206.82	201.21	2,574.00	198.90	331.74	0
	10	202.80	206.78	201.18	2,571.30	203.80	331.74	0
	11	202.75	206.74	201.15	2,568.70	154.50	331.74	0
	12	202.71	206.70	201.11	2,565.10	168.80	331.74	0
	13	202.66	206.65	201.08	2,561.80	156.10	331.74	0
	14	202.61	206.61	201.05	2,558.30	122.80	331.74	0
	15	202.56	206.57	201.02	2,554.10	160.20	331.74	0
	16	202.53	206.53	200.98	2,550.70	211.30	331.74	0
	17	202.48	206.49	200.95	2,548.20	163.20	331.74	0
	18	202.43	206.45	200.92	2,544.80	139.50	331.74	0
	19	202.39	206.40	200.89	2,541.00	193.50	331.74	0
	20	202.36	206.36	200.85	2,538.20	221.60	331.74	0
	21	202.32	206.32	200.82	2,536.00	161.50	331.74	0
	22	202.27	206.28	200.79	2,532.50	133.90	331.74	0

Month	Result from simulation model in normal case							
	Item	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	23	202.25	206.24	200.76	2,528.50	272.10	331.74	0
	24	202.28	206.19	200.73	2,527.30	441.40	331.74	0
	25	202.30	206.15	200.69	2,529.50	416.80	331.74	0
	26	202.30	206.11	200.66	2,531.20	323.90	331.74	0
	27	202.30	206.07	200.63	2,531.00	322.70	331.74	0
	28	202.32	206.03	200.60	2,530.80	413.60	331.74	0
	29	202.35	205.98	200.56	2,532.40	461.90	331.74	0
	30	202.42	205.94	200.53	2,535.00	586.30	331.74	0
	31	202.52	205.90	200.50	2,540.10	707.50	331.74	0
June	1	202.60	205.91	200.52	2,594.70	642.00	338.36	0
	2	202.67	205.93	200.53	2,598.90	613.70	338.09	0
	3	202.75	205.94	200.55	2,599.20	628.90	337.34	0
	4	202.81	205.95	200.57	2,599.20	571.10	336.52	0
	5	202.84	205.97	200.58	2,599.00	455.40	335.84	0
	6	202.86	205.98	200.60	2,598.80	413.20	335.48	0
	7	202.87	205.99	200.62	2,598.70	377.20	335.25	0
	8	202.97	206.01	200.63	2,598.70	713.70	335.12	0
	9	202.98	206.02	200.65	2,599.20	340.80	334.13	0
	10	203.02	206.03	200.67	2,598.60	496.20	334.04	0
	11	203.03	206.05	200.68	2,598.80	365.60	333.62	0
	12	203.03	206.06	200.70	2,598.60	364.20	333.50	0
	13	203.03	206.07	200.72	2,598.60	316.30	333.42	0
	14	203.01	206.09	200.73	2,598.50	272.50	333.46	0
	15	203.01	206.10	200.75	2,598.40	334.60	333.62	0
	16	203.02	206.11	200.77	2,598.50	345.40	333.63	0
	17	203.00	206.13	200.78	2,598.50	267.40	333.61	0
	18	203.04	206.14	200.80	2,598.40	492.00	333.78	0
	19	203.06	206.15	200.82	2,598.80	394.10	333.39	0
	20	203.07	206.17	200.83	2,598.60	370.40	333.20	0

Month	Result from simulation model in normal case							
	Item	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	21	203.05	206.18	200.85	2,598.60	291.60	333.10	0
	22	203.04	206.19	200.87	2,598.40	283.30	333.20	0
	23	203.03	206.21	200.88	2,598.40	304.50	333.34	0
	24	203.02	206.22	200.90	2,598.50	290.90	333.42	0
	25	203.02	206.23	200.92	2,598.50	330.00	333.54	0
	26	203.01	206.25	200.93	2,598.50	283.40	333.56	0
	27	202.99	206.26	200.95	2,598.50	265.00	333.70	0
	28	202.98	206.27	200.97	2,598.40	317.70	333.89	0
	29	203.01	206.29	200.98	2,598.50	450.40	333.95	0
	30	203.03	206.30	201.00	2,598.70	397.60	333.65	0
July	1	203.04	206.36	201.11	2,960.80	422.60	384.17	0
	2	203.15	206.42	201.22	2,993.10	792.80	388.63	0
	3	203.26	206.47	201.33	2,996.80	826.10	387.82	0
	4	203.31	206.53	201.44	2,997.10	546.70	386.43	0
	5	203.34	206.59	201.55	2,996.50	523.70	385.83	0
	6	203.54	206.65	201.66	2,996.40	1,122.10	385.37	0
	7	203.75	206.71	201.77	2,997.50	1,170.40	383.14	0
	8	203.90	206.76	201.88	2,997.60	951.60	380.64	0
	9	204.01	206.82	201.99	2,997.10	818.60	378.78	0
	10	204.12	206.88	202.10	2,996.70	765.30	377.35	0
	11	204.23	206.94	202.21	2,996.50	790.20	376.13	0
	12	204.38	207.00	202.32	2,996.50	968.50	374.85	0
	13	204.51	207.05	202.43	2,996.80	845.30	373.07	0
	14	204.67	207.11	202.54	2,996.50	997.80	371.61	0
	15	204.81	207.17	202.65	2,996.70	871.10	369.75	0
	16	204.90	207.23	202.75	2,996.40	720.50	368.23	0
	17	204.97	207.29	202.86	2,996.00	617.60	367.15	0
	18	205.06	207.35	202.97	2,995.80	703.90	366.38	0
	19	205.27	207.40	203.08	2,995.90	1,167.50	365.42	0

Month	Result from simulation model in normal case							
	Item	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	20	205.48	207.46	203.19	2,996.60	1,173.10	363.21	0
	21	205.60	207.52	203.30	2,996.50	827.20	360.91	0
	22	205.74	207.58	203.41	2,995.90	887.90	359.53	0
	23	205.91	207.64	203.52	2,995.80	978.60	358.06	0
	24	206.03	207.69	203.63	2,995.90	801.50	356.36	0
	25	206.16	207.75	203.74	2,995.60	854.50	355.11	0
	26	206.28	207.81	203.85	2,995.60	799.70	353.75	0
	27	206.44	207.87	203.96	2,995.40	951.30	352.53	0
	28	206.55	207.93	204.07	2,995.60	791.20	350.95	0
	29	206.63	207.98	204.18	2,995.30	627.30	349.75	0
	30	206.70	208.04	204.29	2,994.90	646.40	348.98	0
	31	206.86	208.10	204.40	2,994.90	930.50	348.20	0
Aug	1	207.03	208.18	204.50	3,418.00	1,042.60	399.82	0
	2	207.15	208.25	204.60	3,453.80	873.30	402.38	0
	3	207.25	208.33	204.70	3,456.40	763.80	401.28	0
	4	207.33	208.41	204.80	3,456.30	691.30	400.18	0
	5	207.38	208.49	204.90	3,456.20	608.30	399.28	0
	6	207.43	208.56	205.00	3,456.00	582.70	398.62	0
	7	207.49	208.64	205.10	3,455.90	636.90	398.06	0
	8	207.54	208.72	205.20	3,455.90	562.90	397.36	0
	9	207.64	208.80	205.30	3,455.80	798.30	396.85	0
	10	207.78	208.87	205.40	3,456.20	930.30	395.72	0
	11	207.93	208.95	205.50	3,456.40	942.80	394.17	0
	12	208.03	209.03	205.60	3,456.40	773.80	392.57	0
	13	208.08	209.11	205.70	3,456.00	587.40	391.43	0
	14	208.16	209.18	205.80	3,455.60	691.20	390.81	0
	15	208.29	209.26	205.90	3,455.70	882.60	389.97	0
	16	208.39	209.34	206.00	3,456.00	770.10	388.60	0
	17	208.47	209.42	206.10	3,455.80	667.30	387.49	0

Month	Result from simulation model in normal case							
	Item	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	18	208.55	209.49	206.20	3,455.50	690.70	386.67	0
	19	208.68	209.57	206.30	3,455.50	866.20	385.82	0
	20	208.83	209.65	206.40	3,455.80	978.40	384.51	0
	21	208.95	209.73	206.50	3,455.90	825.60	382.89	0
	22	209.04	209.80	206.60	3,455.60	703.10	381.63	0
	23	209.13	209.88	206.70	3,455.30	744.80	380.73	0
	24	209.25	209.96	206.80	3,455.30	842.20	379.74	0
	25	209.35	210.04	206.90	3,455.40	759.80	378.51	0
	26	209.44	210.11	207.00	3,455.20	714.90	377.48	0
	27	209.55	210.19	207.10	3,455.10	766.80	376.57	0
	28	209.65	210.27	207.20	3,455.10	760.40	375.54	0
	29	209.74	210.35	207.30	3,455.00	729.60	374.52	0
	30	209.84	210.42	207.40	3,454.90	727.60	373.59	0
	31	209.93	210.50	207.50	3,454.90	733.90	372.66	0
Sep	1	210.05	210.54	207.58	3,105.30	785.90	331.74	0
	2	210.18	210.59	207.67	3,114.30	830.60	331.74	0
	3	210.25	210.63	207.75	3,124.20	590.80	331.74	0
	4	210.31	210.67	207.83	3,129.40	552.80	331.74	0
	5	210.33	210.72	207.92	3,133.70	406.20	331.74	0
	6	210.41	210.76	208.00	3,135.20	625.90	331.74	0
	7	210.46	210.80	208.08	3,141.10	524.50	331.74	0
	8	210.51	210.85	208.17	3,144.90	527.10	331.74	0
	9	210.57	210.89	208.25	3,148.70	543.70	331.74	0
	10	210.59	210.93	208.33	3,153.00	411.20	331.74	0
	11	210.65	210.98	208.42	3,154.50	577.20	331.74	0
	12	210.69	211.02	208.50	3,159.40	483.90	331.74	0
	13	210.73	211.06	208.58	3,162.40	488.50	331.74	0
	14	210.77	211.11	208.67	3,165.50	467.80	331.74	0
	15	210.80	211.15	208.75	3,168.20	460.20	331.74	0

Month	Result from simulation model in normal case							
	Item	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	16	210.86	211.19	208.83	3,170.70	552.60	331.74	0
	17	210.88	211.24	208.92	3,175.10	395.40	331.74	0
	18	210.93	211.28	209.00	3,176.40	527.80	331.74	0
	19	211.01	211.32	209.08	3,180.20	655.10	331.74	0
	20	211.07	211.37	209.17	3,186.70	530.00	331.74	0
	21	211.10	211.41	209.25	3,190.60	477.10	331.74	0
	22	211.15	211.45	209.33	3,193.50	506.40	331.74	0
	23	211.19	211.50	209.42	3,197.00	494.10	331.74	0
	24	211.23	211.54	209.50	3,200.20	457.40	331.74	0
	25	211.26	211.58	209.58	3,202.70	464.50	331.74	0
	26	211.28	211.63	209.67	3,205.30	396.70	331.74	0
	27	211.29	211.67	209.75	3,206.60	389.60	331.74	0
	28	211.29	211.71	209.83	3,207.70	312.40	331.74	0
	29	211.29	211.76	209.92	3,207.30	322.60	331.74	0
	30	211.27	211.80	210.00	3,207.10	284.70	331.74	0
Oct	1	211.26	211.81	209.99	3,206.10	266.50	331.74	0
	2	211.23	211.81	209.99	3,204.80	251.50	331.74	0
	3	211.23	211.82	209.98	3,203.20	309.10	331.74	0
	4	211.22	211.83	209.97	3,202.70	311.20	331.74	0
	5	211.20	211.83	209.97	3,202.30	236.60	331.74	0
	6	211.21	211.84	209.96	3,200.30	375.00	331.74	0
	7	211.21	211.85	209.95	3,201.20	350.40	331.74	0
	8	211.21	211.85	209.95	3,201.50	340.10	331.74	0
	9	211.21	211.86	209.94	3,201.70	305.50	331.74	0
	10	211.23	211.86	209.94	3,201.10	419.50	331.74	0
	11	211.24	211.87	209.93	3,202.90	360.00	331.74	0
	12	211.25	211.88	209.92	3,203.40	383.50	331.74	0
	13	211.25	211.88	209.92	3,204.40	337.20	331.74	0
	14	211.24	211.89	209.91	3,204.50	295.70	331.74	0

Month	Result from simulation model in normal case							
	Item	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	15	211.23	211.90	209.90	3,203.70	285.50	331.74	0
	16	211.21	211.90	209.90	3,202.80	267.90	331.74	0
	17	211.20	211.91	209.89	3,201.50	301.60	331.74	0
	18	211.19	211.92	209.88	3,200.90	280.80	331.74	0
	19	211.18	211.92	209.88	3,199.80	301.70	331.74	0
	20	211.16	211.93	209.87	3,199.20	249.70	331.74	0
	21	211.15	211.94	209.86	3,197.50	294.70	331.74	0
	22	211.13	211.94	209.86	3,196.80	257.00	331.74	0
	23	211.11	211.95	209.85	3,195.20	248.90	331.74	0
	24	211.08	211.95	209.85	3,193.60	241.90	331.74	0
	25	211.05	211.96	209.84	3,191.70	220.20	331.74	0
	26	211.03	211.97	209.83	3,189.50	255.70	331.74	0
	27	211.01	211.97	209.83	3,187.90	257.40	331.74	0
	28	210.99	211.98	209.82	3,186.40	241.60	331.74	0
	29	210.95	211.99	209.81	3,184.60	185.00	331.74	0
	30	210.91	211.99	209.81	3,181.60	183.10	331.74	0
	31	210.87	212.00	209.80	3,178.60	188.20	331.74	0
Nov	1	210.83	212.00	209.76	3,175.80	172.70	331.74	0
	2	210.78	212.00	209.71	3,172.60	160.90	331.74	0
	3	210.73	212.00	209.67	3,169.10	143.00	331.74	0
	4	210.69	212.00	209.63	3,165.30	171.00	331.74	0
	5	210.65	212.00	209.58	3,162.10	190.60	331.74	0
	6	210.60	212.00	209.54	3,159.30	158.60	331.74	0
	7	210.56	212.00	209.50	3,155.80	178.30	331.74	0
	8	210.52	212.00	209.45	3,152.70	185.30	331.74	0
	9	210.48	212.00	209.41	3,149.80	183.80	331.74	0
	10	210.44	212.00	209.37	3,146.80	166.30	331.74	0
	11	210.40	212.00	209.32	3,143.50	168.30	331.74	0
	12	210.35	212.00	209.28	3,140.20	174.20	331.74	0

Month	Result from simulation model in normal case							
	Item	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	13	210.31	212.00	209.24	3,137.00	162.00	331.74	0
	14	210.26	212.00	209.19	3,133.60	159.90	331.74	0
	15	210.21	212.00	209.15	3,130.10	144.10	331.74	0
	16	210.17	212.00	209.11	3,126.40	167.70	331.74	0
	17	210.12	212.00	209.06	3,123.10	146.10	331.74	0
	18	210.07	212.00	209.02	3,119.40	141.80	331.74	0
	19	210.01	212.00	208.98	3,115.50	119.40	331.74	0
	20	209.97	212.00	208.93	3,111.30	174.20	331.74	0
	21	209.92	212.00	208.89	3,108.10	140.10	331.74	0
	22	209.86	212.00	208.85	3,104.30	128.20	331.74	0
	23	209.82	212.00	208.80	3,100.20	164.10	331.74	0
	24	209.77	212.00	208.76	3,096.80	158.10	331.74	0
	25	209.73	212.00	208.72	3,093.30	161.60	331.74	0
	26	209.68	212.00	208.67	3,089.90	147.70	331.74	0
	27	209.63	212.00	208.63	3,086.20	135.60	331.74	0
	28	209.58	212.00	208.59	3,082.30	171.00	331.74	0
	29	209.54	212.00	208.54	3,079.10	163.80	331.74	0
	30	209.50	212.00	208.50	3,075.70	187.80	331.74	0
Dec	1	209.45	212.00	208.47	3,072.80	146.30	331.74	0
	2	209.39	212.00	208.44	3,069.10	115.40	331.74	0
	3	209.34	212.00	208.40	3,064.70	135.60	331.74	0
	4	209.29	212.00	208.37	3,060.80	146.50	331.74	0
	5	209.24	212.00	208.34	3,057.10	140.40	331.74	0
	6	209.19	212.00	208.31	3,053.20	126.20	331.74	0
	7	209.13	212.00	208.27	3,049.10	119.80	331.74	0
	8	209.08	212.00	208.24	3,044.90	146.80	331.74	0
	9	209.02	212.00	208.21	3,041.20	116.80	331.74	0
	10	208.97	212.00	208.18	3,036.90	147.20	331.74	0
	11	208.91	212.00	208.15	3,033.10	110.00	331.74	0

Month	Result from simulation model in normal case							
	Item	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	12	208.86	212.00	208.11	3,028.70	135.50	331.74	0
	13	208.81	212.00	208.08	3,024.70	125.80	331.74	0
	14	208.75	212.00	208.05	3,020.60	105.10	331.74	0
	15	208.68	212.00	208.02	3,016.00	101.50	331.74	0
	16	208.62	212.00	207.98	3,011.40	109.60	331.74	0
	17	208.57	212.00	207.95	3,007.00	107.70	331.74	0
	18	208.51	212.00	207.92	3,002.40	117.20	331.74	0
	19	208.45	212.00	207.89	2,998.10	102.00	331.74	0
	20	208.39	212.00	207.85	2,993.50	111.60	331.74	0
	21	208.33	212.00	207.82	2,989.10	100.30	331.74	0
	22	208.26	212.00	207.79	2,984.40	80.10	331.74	0
	23	208.20	212.00	207.76	2,979.40	113.00	331.74	0
	24	208.13	212.00	207.73	2,975.00	85.70	331.74	0
	25	208.07	212.00	207.69	2,970.00	108.80	331.74	0
	26	208.01	212.00	207.66	2,965.60	77.50	331.74	0
	27	207.95	212.00	207.63	2,960.50	116.80	331.74	0
	28	207.88	212.00	207.60	2,956.10	80.30	331.74	0
	29	207.82	212.00	207.56	2,951.10	88.70	331.74	0
	30	207.76	212.00	207.53	2,946.20	100.20	331.74	0
	31	207.69	212.00	207.50	2,941.60	74.40	331.74	0

Note: HWL (Head water level)

New URC (New upper rule curve)

New LRC (New lower rule curve)

EE (Electricity energy)

Qin (Quantity inflow)

Qt (Quantity turbine discharge)

Qs (Quantity spillway discharge)

Appendix E.3 Result data in drought case

Table x E.3 Result data in drought case

Month	Result from simulation model in drought case							
	Item	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
Jan	1	208.91	211.00	205.48	2,664.90	99.90	289.76	0
	2	208.91	211.00	205.47	2,664.90	127.10	289.76	0
	3	208.86	211.00	205.45	2,664.90	94.10	289.76	0
	4	208.81	211.00	205.44	2,661.50	129.30	289.76	0
	5	208.77	211.00	205.42	2,658.60	111.30	289.76	0
	6	208.71	211.00	205.40	2,655.50	92.60	289.76	0
	7	208.67	211.00	205.39	2,652.00	134.70	289.76	0
	8	208.63	211.00	205.37	2,649.30	131.40	289.76	0
	9	208.58	211.00	205.35	2,646.50	118.70	289.76	0
	10	208.53	211.00	205.34	2,643.50	99.10	289.76	0
	11	208.48	211.00	205.32	2,640.20	101.00	289.76	0
	12	208.43	211.00	205.31	2,636.90	109.30	289.76	0
	13	208.38	211.00	205.29	2,633.70	90.10	289.76	0
	14	208.33	211.00	205.27	2,630.20	103.70	289.76	0
	15	208.28	211.00	205.26	2,626.90	100.10	289.76	0
	16	208.23	211.00	205.24	2,623.60	92.30	289.76	0
	17	208.18	211.00	205.23	2,620.10	102.60	289.76	0
	18	208.13	211.00	205.21	2,616.80	100.10	289.76	0
	19	208.08	211.00	205.19	2,613.50	95.30	289.76	0
	20	208.03	211.00	205.18	2,610.10	101.40	289.76	0
	21	207.98	211.00	205.16	2,606.80	118.30	289.76	0
	22	207.94	211.00	205.15	2,603.80	138.00	289.76	0
	23	207.90	211.00	205.13	2,601.10	150.60	289.76	0
	24	207.86	211.00	205.11	2,598.70	118.50	289.76	0
	25	207.81	211.00	205.10	2,595.70	102.10	289.76	0
	26	207.76	211.00	205.08	2,592.40	116.70	289.76	0

Month	Result from simulation model in drought case							
	Item	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	27	207.71	211.00	205.06	2,589.40	99.20	289.76	0
	28	207.65	211.00	205.05	2,586.00	76.00	289.76	0
	29	207.60	211.00	205.03	2,582.30	90.40	289.76	0
	30	207.55	211.00	205.02	2,578.80	107.80	289.76	0
	31	207.50	211.00	205.00	2,575.60	87.40	289.76	0
Feb	1	207.44	210.96	204.95	2,572.10	68.20	289.76	0
	2	207.39	210.93	204.89	2,568.20	111.50	289.76	0
	3	207.33	210.89	204.84	2,565.10	77.50	289.76	0
	4	207.28	210.86	204.79	2,561.40	87.80	289.76	0
	5	207.23	210.82	204.73	2,557.80	88.30	289.76	0
	6	207.17	210.79	204.68	2,554.30	71.00	289.76	0
	7	207.12	210.75	204.62	2,550.50	103.70	289.76	0
	8	207.07	210.71	204.57	2,547.20	96.30	289.76	0
	9	207.01	210.68	204.52	2,543.80	87.70	289.76	0
	10	206.96	210.64	204.46	2,540.30	96.00	289.76	0
	11	206.91	210.61	204.41	2,536.90	88.40	289.76	0
	12	206.85	210.57	204.36	2,533.40	69.90	289.76	0
	13	206.80	210.54	204.30	2,529.50	107.50	289.76	0
	14	206.75	210.50	204.25	2,526.30	101.20	289.76	0
	15	206.70	210.46	204.20	2,523.00	90.80	289.76	0
	16	206.64	210.43	204.14	2,519.50	89.60	289.76	0
	17	206.59	210.39	204.09	2,516.00	90.50	289.76	0
	18	206.53	210.36	204.04	2,512.50	61.30	289.76	0
	19	206.48	210.32	203.98	2,508.50	95.30	289.76	0
	20	206.42	210.29	203.93	2,505.10	92.30	289.76	0
	21	206.37	210.25	203.88	2,501.60	80.50	289.76	0
	22	206.32	210.21	203.82	2,497.90	96.60	289.76	0
	23	206.26	210.18	203.77	2,494.50	73.80	289.76	0
	24	206.20	210.14	203.71	2,490.70	61.00	289.76	0

Month	Result from simulation model in drought case							
	Item	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	25	206.13	210.11	203.66	2,486.70	57.50	289.76	0
	26	206.08	210.07	203.61	2,482.70	92.00	289.76	0
	27	206.03	210.04	203.55	2,479.20	112.30	289.76	0
	28	205.98	210.00	203.50	2,476.10	87.00	289.76	0
Mar	1	205.93	209.96	203.45	2,472.50	94.90	289.76	0
	2	205.87	209.93	203.40	2,469.10	66.80	289.76	0
	3	205.81	209.89	203.35	2,465.20	77.90	289.76	0
	4	205.76	209.86	203.31	2,461.50	91.70	289.76	0
	5	205.70	209.82	203.26	2,458.10	67.60	289.76	0
	6	205.64	209.79	203.21	2,454.20	72.60	289.76	0
	7	205.58	209.75	203.16	2,450.40	59.00	289.76	0
	8	205.53	209.72	203.11	2,448.00	97.30	289.96	0
	9	205.47	209.68	203.06	2,447.90	71.10	290.37	0
	10	205.42	209.65	203.02	2,447.90	104.40	290.86	0
	11	205.36	209.61	202.97	2,447.90	59.70	291.28	0
	12	205.30	209.57	202.92	2,447.90	74.50	291.79	0
	13	205.24	209.54	202.87	2,448.00	73.60	292.27	0
	14	205.19	209.50	202.82	2,448.00	79.70	292.76	0
	15	205.13	209.47	202.77	2,448.00	92.50	293.25	0
	16	205.08	209.43	202.73	2,448.10	72.20	293.70	0
	17	205.01	209.40	202.68	2,448.10	61.00	294.20	0
	18	204.95	209.36	202.63	2,448.10	59.20	294.73	0
	19	204.89	209.33	202.58	2,448.10	58.50	295.27	0
	20	204.82	209.29	202.53	2,448.10	49.20	295.82	0
	21	204.76	209.25	202.48	2,448.20	71.10	296.39	0
	22	204.70	209.22	202.44	2,448.20	49.40	296.92	0
	23	204.64	209.18	202.39	2,448.20	96.20	297.49	0
	24	204.58	209.15	202.34	2,448.30	69.20	297.97	0
	25	204.52	209.11	202.29	2,448.30	65.10	298.51	0

Month	Result from simulation model in drought case							
	Item	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	26	204.45	209.08	202.24	2,448.30	58.80	299.06	0
	27	204.39	209.04	202.19	2,448.30	59.80	299.63	0
	28	204.32	209.01	202.15	2,448.40	45.50	300.20	0
	29	204.26	208.97	202.10	2,448.40	60.00	300.81	0
	30	204.20	208.94	202.05	2,448.40	90.60	301.39	0
	31	204.14	208.90	202.00	2,448.50	79.90	301.90	0
April	1	204.08	208.81	201.90	2,522.00	69.20	312.12	0
	2	204.01	208.72	201.80	2,527.10	66.60	313.41	0
	3	203.94	208.63	201.70	2,527.50	55.50	314.08	0
	4	203.87	208.54	201.60	2,527.50	56.90	314.74	0
	5	203.80	208.45	201.50	2,527.60	56.10	315.40	0
	6	203.73	208.36	201.40	2,527.60	45.80	316.07	0
	7	203.66	208.27	201.30	2,527.60	58.00	316.76	0
	8	203.60	208.18	201.20	2,527.70	69.30	317.43	0
	9	203.53	208.09	201.10	2,527.70	60.90	318.08	0
	10	203.46	208.00	201.00	2,527.70	78.50	318.75	0
	11	203.41	207.91	200.90	2,527.80	98.90	319.38	0
	12	203.34	207.82	200.80	2,527.80	60.30	319.97	0
	13	203.27	207.73	200.70	2,527.80	69.60	320.65	0
	14	203.20	207.64	200.60	2,527.80	54.00	321.32	0
	15	203.13	207.55	200.50	2,527.90	51.20	322.03	0
	16	203.05	207.46	200.40	2,527.90	49.20	322.75	0
	17	202.98	207.37	200.30	2,527.90	47.70	323.49	0
	18	202.91	207.28	200.20	2,527.90	57.90	324.23	0
	19	202.84	207.19	200.10	2,528.00	85.00	324.96	0
	20	202.78	207.10	200.00	2,528.00	71.00	325.63	0
	21	202.71	207.01	199.90	2,528.10	63.10	326.33	0
	22	202.64	206.92	199.80	2,528.10	68.60	327.05	0
	23	202.57	206.83	199.70	2,528.10	56.90	327.77	0

Month	Result from simulation model in drought case							
	Item	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	24	202.50	206.74	199.60	2,528.10	76.10	328.53	0
	25	202.42	206.65	199.50	2,528.20	45.30	329.24	0
	26	202.35	206.56	199.40	2,528.20	59.20	330.03	0
	27	202.27	206.47	199.30	2,528.20	49.80	330.80	0
	28	202.20	206.38	199.20	2,528.20	66.20	331.60	0
	29	202.13	206.29	199.10	2,528.30	74.60	332.37	0
	30	202.07	206.20	199.00	2,528.30	74.20	333.11	0
May	1	202.00	206.13	198.95	2,408.90	60.90	316.90	0
	2	201.93	206.05	198.90	2,399.90	58.60	316.32	0
	3	201.87	205.98	198.85	2,399.20	86.50	316.92	0
	4	201.80	205.90	198.79	2,399.20	56.70	317.55	0
	5	201.74	205.83	198.74	2,399.20	86.10	318.26	0
	6	201.68	205.75	198.69	2,399.30	99.60	318.91	0
	7	201.61	205.68	198.64	2,399.30	82.50	319.52	0
	8	201.54	205.61	198.59	2,399.30	50.70	320.18	0
	9	201.48	205.53	198.54	2,399.30	73.90	320.93	0
	10	201.40	205.46	198.48	2,399.40	39.40	321.62	0
	11	201.33	205.38	198.43	2,399.40	58.30	322.41	0
	12	201.27	205.31	198.38	2,399.40	72.70	323.17	0
	13	201.22	205.24	198.33	2,399.50	153.00	323.89	0
	14	201.15	205.16	198.28	2,399.60	69.50	324.40	0
	15	201.10	205.09	198.23	2,399.50	126.80	325.11	0
	16	201.04	205.01	198.17	2,399.60	114.40	325.70	0
	17	200.99	204.94	198.12	2,399.60	146.90	326.31	0
	18	200.93	204.86	198.07	2,399.70	150.30	326.86	0
	19	200.85	204.79	198.02	2,399.60	119.20	327.57	0
	20	200.78	204.72	197.97	2,399.60	127.80	328.41	0
	21	200.71	204.64	197.92	2,399.60	152.30	329.24	0
	22	200.64	204.57	197.86	2,399.70	127.80	329.97	0

Month	Result from simulation model in drought case							
	Item	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	23	200.58	204.49	197.81	2,399.70	166.90	330.81	0
	24	200.49	204.42	197.76	2,399.80	107.30	331.50	0
	25	200.44	204.35	197.71	2,399.70	186.60	332.42	0
	26	200.37	204.27	197.66	2,399.90	142.60	333.07	0
	27	200.30	204.20	197.61	2,399.90	154.50	333.86	0
	28	200.23	204.12	197.55	2,399.90	141.30	334.63	0
	29	200.17	204.05	197.50	2,399.90	169.90	335.45	0
	30	200.12	203.97	197.45	2,400.00	215.20	336.17	0
	31	200.08	203.90	197.40	2,400.10	212.20	336.71	0
June	1	200.13	203.85	197.39	2,200.70	447.30	307.04	0
	2	200.11	203.79	197.37	2,185.60	242.60	304.24	0
	3	200.07	203.74	197.36	2,184.00	194.60	304.25	0
	4	200.06	203.69	197.35	2,183.80	298.00	304.64	0
	5	200.06	203.63	197.33	2,184.00	293.20	304.70	0
	6	200.08	203.58	197.32	2,184.00	358.80	304.74	0
	7	200.06	203.53	197.31	2,184.10	261.00	304.56	0
	8	200.04	203.47	197.29	2,184.00	239.90	304.70	0
	9	200.04	203.42	197.28	2,183.90	303.20	304.95	0
	10	200.00	203.37	197.27	2,184.00	196.40	304.98	0
	11	199.94	203.31	197.25	2,183.90	163.60	305.37	0
	12	199.92	203.26	197.24	2,183.80	261.50	305.93	0
	13	199.89	203.21	197.23	2,184.00	213.00	306.14	0
	14	199.84	203.15	197.21	2,183.90	172.80	306.51	0
	15	199.84	203.10	197.20	2,183.90	313.20	307.04	0
	16	199.83	203.05	197.19	2,184.10	282.80	307.06	0
	17	199.84	202.99	197.17	2,184.10	334.70	307.16	0
	18	199.88	202.94	197.16	2,184.20	408.10	307.06	0
	19	199.86	202.89	197.15	2,184.30	256.00	306.68	0
	20	199.83	202.83	197.13	2,184.00	236.70	306.85	0

Month	Result from simulation model in drought case							
	Item	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	21	199.79	202.78	197.12	2,184.00	212.80	307.12	0
	22	199.82	202.73	197.11	2,184.00	363.80	307.50	0
	23	199.85	202.67	197.09	2,184.30	399.30	307.32	0
	24	199.90	202.62	197.08	2,184.30	446.30	306.97	0
	25	199.93	202.57	197.07	2,184.40	381.80	306.42	0
	26	199.95	202.51	197.05	2,184.30	366.00	306.11	0
	27	199.98	202.46	197.04	2,184.20	377.00	305.86	0
	28	200.01	202.41	197.03	2,184.20	395.00	305.58	0
	29	200.09	202.35	197.01	2,184.30	498.90	305.24	0
	30	200.15	202.30	197.00	2,184.40	490.20	304.53	0
July	1	200.23	202.36	197.08	2,116.20	505.20	293.65	0
	2	200.38	202.42	197.15	2,111.10	689.50	292.13	0
	3	200.50	202.47	197.23	2,111.00	620.00	290.69	0
	4	200.56	202.53	197.31	2,112.60	468.50	289.76	0
	5	200.61	202.59	197.39	2,116.90	420.20	289.76	0
	6	200.63	202.65	197.46	2,120.00	345.00	289.76	0
	7	200.70	202.71	197.54	2,121.30	489.10	289.76	0
	8	200.73	202.76	197.62	2,126.10	361.30	289.76	0
	9	200.78	202.82	197.70	2,127.80	427.00	289.76	0
	10	200.79	202.88	197.77	2,131.10	323.70	289.76	0
	11	200.85	202.94	197.85	2,131.90	456.30	289.76	0
	12	200.90	203.00	197.93	2,135.90	428.50	289.76	0
	13	200.96	203.05	198.01	2,139.20	455.00	289.76	0
	14	200.97	203.11	198.08	2,143.20	317.40	289.76	0
	15	201.00	203.17	198.16	2,143.80	357.10	289.76	0
	16	200.99	203.23	198.24	2,145.40	281.20	289.76	0
	17	201.02	203.29	198.32	2,145.20	369.00	289.76	0
	18	201.16	203.35	198.39	2,146.70	829.50	289.76	0
	19	201.24	203.40	198.47	2,156.10	595.70	289.76	0

Month	Result from simulation model in drought case							
	Item	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	20	201.30	203.46	198.55	2,161.40	531.20	289.76	0
	21	201.33	203.52	198.63	2,165.60	377.60	289.76	0
	22	201.38	203.58	198.70	2,167.10	483.30	289.76	0
	23	201.56	203.64	198.78	2,170.40	975.70	289.76	0
	24	201.74	203.69	198.86	2,182.30	971.30	289.76	0
	25	201.88	203.75	198.94	2,194.20	800.40	289.76	0
	26	201.92	203.81	199.01	2,203.10	444.50	289.76	0
	27	201.98	203.87	199.09	2,205.70	531.60	289.76	0
	28	202.05	203.93	199.17	2,209.90	538.60	289.76	0
	29	202.11	203.98	199.25	2,214.20	523.10	289.76	0
	30	202.18	204.04	199.32	2,218.30	564.50	289.76	0
	31	202.31	204.10	199.40	2,223.10	779.60	289.76	0
Aug	1	202.42	204.25	199.53	2,231.60	698.10	289.76	0
	2	202.53	204.41	199.66	2,238.70	705.30	289.76	0
	3	202.65	204.56	199.80	2,246.00	748.30	289.76	0
	4	202.75	204.72	199.93	2,254.00	651.70	289.76	0
	5	202.83	204.87	200.06	2,260.30	586.60	289.76	0
	6	202.93	205.03	200.19	2,265.40	696.50	289.76	0
	7	203.02	205.18	200.33	2,272.50	618.80	289.76	0
	8	203.11	205.34	200.46	2,278.20	618.30	289.76	0
	9	203.21	205.49	200.59	2,283.90	671.70	289.76	0
	10	203.33	205.65	200.72	2,290.60	734.80	289.76	0
	11	203.49	205.80	200.85	2,298.30	893.20	289.76	0
	12	203.59	205.96	200.99	2,308.80	677.40	289.76	0
	13	203.69	206.11	201.12	2,315.50	678.30	289.76	0
	14	203.77	206.27	201.25	2,322.20	580.40	289.76	0
	15	203.84	206.42	201.38	2,327.30	581.00	289.76	0
	16	203.96	206.58	201.52	2,332.30	743.50	289.76	0
	17	204.11	206.73	201.65	2,340.20	836.70	289.76	0

Month	Result from simulation model in drought case							
	Item	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	18	204.27	206.89	201.78	2,349.70	878.80	289.76	0
	19	204.37	207.04	201.91	2,360.00	700.50	289.76	0
	20	204.48	207.20	202.05	2,367.20	670.20	289.76	0
	21	204.56	207.35	202.18	2,373.80	619.60	289.76	0
	22	204.67	207.51	202.31	2,379.50	691.80	289.76	0
	23	204.85	207.66	202.44	2,386.50	950.40	289.76	0
	24	205.00	207.82	202.57	2,398.00	889.10	289.76	0
	25	205.30	207.97	202.71	2,408.50	1,422.60	289.76	0
	26	205.47	208.13	202.84	2,428.10	924.40	289.76	0
	27	205.57	208.28	202.97	2,439.10	666.10	289.76	0
	28	205.66	208.44	203.10	2,445.60	620.70	289.76	0
	29	205.75	208.59	203.24	2,451.30	628.40	289.76	0
	30	205.88	208.75	203.37	2,457.20	804.10	289.76	0
	31	206.05	208.90	203.50	2,466.10	914.00	289.76	0
Sep	1	206.15	208.97	203.63	2,476.90	681.10	289.76	0
	2	206.23	209.04	203.77	2,483.70	570.90	289.76	0
	3	206.38	209.11	203.90	2,488.60	887.20	289.76	0
	4	206.62	209.18	204.03	2,499.00	1,164.10	289.76	0
	5	206.83	209.25	204.17	2,514.30	1,077.70	289.76	0
	6	207.08	209.32	204.30	2,528.00	1,234.10	289.76	0
	7	207.24	209.39	204.43	2,544.50	905.70	289.76	0
	8	207.34	209.46	204.57	2,555.20	687.00	289.76	0
	9	207.45	209.53	204.70	2,562.10	691.50	289.76	0
	10	207.61	209.60	204.83	2,569.00	908.70	289.76	0
	11	207.77	209.67	204.97	2,579.80	866.10	289.76	0
	12	207.92	209.74	205.10	2,589.80	880.90	289.76	0
	13	208.09	209.81	205.23	2,600.10	930.80	289.76	0
	14	208.26	209.88	205.37	2,611.20	906.30	289.76	0
	15	208.38	209.95	205.50	2,622.00	749.20	289.76	0

Month	Result from simulation model in drought case							
	Item	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	16	208.48	210.02	205.63	2,630.00	668.90	289.76	0
	17	208.55	210.09	205.77	2,636.60	568.90	289.76	0
	18	208.66	210.16	205.90	2,641.40	699.60	289.76	0
	19	208.77	210.23	206.03	2,648.50	706.90	289.76	0
	20	208.86	210.30	206.17	2,655.80	634.10	289.76	0
	21	208.92	210.37	206.30	2,661.80	495.10	289.76	0
	22	208.98	210.44	206.43	2,665.40	518.70	289.76	0
	23	209.03	210.51	206.57	2,669.30	481.20	289.76	0
	24	209.09	210.58	206.70	2,672.70	531.70	289.76	0
	25	209.13	210.65	206.83	2,676.80	424.50	289.76	0
	26	209.17	210.72	206.97	2,679.20	437.40	289.76	0
	27	209.22	210.79	207.10	2,681.70	492.00	289.76	0
	28	209.26	210.86	207.23	2,685.20	448.10	289.76	0
	29	209.29	210.93	207.37	2,688.00	380.20	289.76	0
	30	209.29	211.00	207.50	2,689.50	326.30	289.76	0
Oct	1	209.32	211.00	207.50	2,690.10	371.00	289.76	0
	2	209.33	211.00	207.50	2,691.50	330.20	289.76	0
	3	209.32	211.00	207.50	2,692.20	285.10	289.76	0
	4	209.33	211.00	207.50	2,692.10	323.50	289.76	0
	5	209.37	211.00	207.50	2,692.70	415.50	289.76	0
	6	209.46	211.00	207.50	2,694.80	630.80	289.76	0
	7	209.55	211.00	207.50	2,700.70	647.30	289.76	0
	8	209.63	211.00	207.50	2,706.90	581.80	289.76	0
	9	209.68	211.00	207.50	2,712.00	487.90	289.76	0
	10	209.72	211.00	207.50	2,715.40	452.70	289.76	0
	11	209.75	211.00	207.50	2,718.20	379.30	289.76	0
	12	209.76	211.00	207.50	2,719.80	326.30	289.76	0
	13	209.77	211.00	207.50	2,720.40	327.60	289.76	0
	14	209.78	211.00	207.50	2,721.00	339.60	289.76	0

Month	Result from simulation model in drought case							
	Item	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	15	209.79	211.00	207.50	2,721.90	331.60	289.76	0
	16	209.78	211.00	207.50	2,722.60	272.10	289.76	0
	17	209.78	211.00	207.50	2,722.30	265.00	289.76	0
	18	209.77	211.00	207.50	2,721.80	259.00	289.76	0
	19	209.75	211.00	207.50	2,721.20	226.90	289.76	0
	20	209.74	211.00	207.50	2,720.10	250.60	289.76	0
	21	209.72	211.00	207.50	2,719.40	203.50	289.76	0
	22	209.71	211.00	207.50	2,717.90	244.50	289.76	0
	23	209.68	211.00	207.50	2,717.10	184.00	289.76	0
	24	209.66	211.00	207.50	2,715.20	214.50	289.76	0
	25	209.63	211.00	207.50	2,713.90	200.70	289.76	0
	26	209.61	211.00	207.50	2,712.30	210.90	289.76	0
	27	209.59	211.00	207.50	2,710.90	201.50	289.76	0
	28	209.56	211.00	207.50	2,709.40	183.10	289.76	0
	29	209.54	211.00	207.50	2,707.50	206.20	289.76	0
	30	209.50	211.00	207.50	2,706.00	163.00	289.76	0
	31	209.48	211.00	207.50	2,703.80	205.00	289.76	0
Nov	1	209.45	211.00	207.47	2,702.30	192.30	289.76	0
	2	209.43	211.00	207.43	2,700.60	208.50	289.76	0
	3	209.40	211.00	207.40	2,699.20	156.50	289.76	0
	4	209.36	211.00	207.37	2,696.80	157.30	289.76	0
	5	209.33	211.00	207.33	2,694.50	179.20	289.76	0
	6	209.30	211.00	207.30	2,692.50	183.90	289.76	0
	7	209.27	211.00	207.27	2,690.70	169.00	289.76	0
	8	209.24	211.00	207.23	2,688.60	176.10	289.76	0
	9	209.21	211.00	207.20	2,686.60	166.10	289.76	0
	10	209.17	211.00	207.17	2,684.40	146.90	289.76	0
	11	209.13	211.00	207.13	2,681.90	156.40	289.76	0
	12	209.09	211.00	207.10	2,679.50	136.90	289.76	0

Month	Result from simulation model in drought case							
	Item	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	13	209.05	211.00	207.07	2,676.90	121.50	289.76	0
	14	209.00	211.00	207.03	2,673.90	126.60	289.76	0
	15	208.97	211.00	207.00	2,671.00	151.20	289.76	0
	16	208.93	211.00	206.97	2,668.60	146.40	289.76	0
	17	208.87	211.00	206.93	2,666.10	89.20	289.76	0
	18	208.84	211.00	206.90	2,662.60	163.30	289.76	0
	19	208.80	211.00	206.87	2,660.30	119.90	289.76	0
	20	208.75	211.00	206.83	2,657.30	120.70	289.76	0
	21	208.70	211.00	206.80	2,654.40	119.00	289.76	0
	22	208.66	211.00	206.77	2,651.40	142.10	289.76	0
	23	208.62	211.00	206.73	2,648.80	118.70	289.76	0
	24	208.57	211.00	206.70	2,645.80	117.50	289.76	0
	25	208.52	211.00	206.67	2,642.70	103.20	289.76	0
	26	208.47	211.00	206.63	2,639.50	101.60	289.76	0
	27	208.43	211.00	206.60	2,636.20	124.30	289.76	0
	28	208.39	211.00	206.57	2,633.20	132.10	289.76	0
	29	208.34	211.00	206.53	2,630.50	122.10	289.76	0
	30	208.30	211.00	206.50	2,627.50	135.00	289.76	0
Dec	1	208.25	211.00	206.47	2,673.60	127.80	295.44	0
	2	208.21	211.00	206.44	2,676.30	113.40	296.11	0
	3	208.16	211.00	206.40	2,676.40	109.70	296.51	0
	4	208.11	211.00	206.37	2,676.50	131.90	296.91	0
	5	208.06	211.00	206.34	2,676.50	109.80	297.26	0
	6	208.01	211.00	206.31	2,676.50	111.30	297.66	0
	7	207.96	211.00	206.27	2,676.50	96.60	298.06	0
	8	207.90	211.00	206.24	2,676.50	98.60	298.48	0
	9	207.85	211.00	206.21	2,676.60	80.20	298.91	0
	10	207.80	211.00	206.18	2,676.60	136.60	299.38	0
	11	207.75	211.00	206.15	2,676.70	100.60	299.74	0

Month	Result from simulation model in drought case							
	Item	HWL (ave)	New URC	New LRC	EE (ave)	Qin (ave)	Qt(ave)	Qs (ave)
	Date	(msl)	(msl)	(msl)	(GWh)	(cms)	(cms)	(cms)
	12	207.70	211.00	206.11	2,676.70	96.90	300.16	0
	13	207.64	211.00	206.08	2,676.70	108.50	300.60	0
	14	207.59	211.00	206.05	2,676.70	111.20	301.02	0
	15	207.53	211.00	206.02	2,676.70	75.30	301.44	0
	16	207.48	211.00	205.98	2,676.70	96.70	301.93	0
	17	207.43	211.00	205.95	2,676.80	102.90	302.38	0
	18	207.37	211.00	205.92	2,676.80	110.00	302.82	0
	19	207.33	211.00	205.89	2,676.80	136.80	303.25	0
	20	207.28	211.00	205.85	2,676.90	118.90	303.62	0
	21	207.23	211.00	205.82	2,676.90	124.00	304.03	0
	22	207.18	211.00	205.79	2,676.90	106.30	304.43	0
	23	207.13	211.00	205.76	2,676.90	108.10	304.87	0
	24	207.07	211.00	205.73	2,676.90	90.00	305.31	0
	25	207.02	211.00	205.69	2,676.90	110.10	305.79	0
	26	206.97	211.00	205.66	2,677.00	108.80	306.24	0
	27	206.91	211.00	205.63	2,677.00	91.60	306.68	0
	28	206.85	211.00	205.60	2,677.00	103.30	307.17	0
	29	206.79	211.00	205.56	2,677.10	66.60	307.64	0
	30	206.74	211.00	205.53	2,677.00	110.70	308.18	0
	31	206.68	211.00	205.50	2,677.10	86.40	308.64	0

Note: HWL (Head water level)

New URC (New upper rule curve)

New LRC (New lower rule curve)

EE (Electricity energy)

Qin (Quantity inflow)

Qt (Quantity turbine discharge)

Qs (Quantity spillway discharge)

CURRICULUM VITAE

Name Mr. Daovieng Sounanthalath

Date of Birth 3 May 1972

Education From 1979 to 1989, studied at primary school and secondary school in Hatxayfong district, Vientiane capital.
From 1990 to 1993, studied at Lao-German Technical School.
From 2001 to 2006, studied at National University of Laos in Vientiane Capital of Lao PDR. Gradated a Bachelor's degree of Electronic Engineering at academic year 2001-2006.
From 25 October 2011 to 25 October 2013, studied at Chiang Mai University (CMU), Thailand, under the Technical and Academic Collaboration Project between Electricity Generating Authority of Thailand (EGAT) and Chiang Mai University and Electricité Du Laos (EDL), respectively.

Employment History From 1994 to 2011, worked at Operation and Control Department, Nam Ngum-1 hydropower plant
Electicite Du Laos – Generation Public Company (EDL-Gen).

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