A COMPARATIVE STUDY OF FLOW FORECASTING IN THE HUMBER RIVER BASIN USING A DETERMINISTIC HYDROLOGIC MODEL AND A DYNAMIC REGRESSION STATISTICAL MODEL

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A Comparative Study of Flow Forecasting in the Humber River Basin using a Deterministic Hydrologic Model and a Dynamic Regression Statistical Model

by

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Abstract

Since 1995 the Water Resources Management Division of the Department of Environment and Labour has generated flow forecasts for the Humber River Basin. These forecasts are required to provide a flood warning for residents living in the downstream sections of the basin. Information is also useful to the Deer Lake Power Company for the safe and efficient operation of the hydroelectric development that controls over two thirds of the basin.

Flow forecasts for river systems can be generated using two approaches. One approach is to use a deterministic model that tries to construct a mathematical model by accounting for some, or all of, hydrologic factors responsible for runoff in the basin. The second approach is to develop a statistically based model that uses the historic flows and climate data from the basin to generate a forecast. For any model to be effective in an operational environment, it must be compatible with hydrometeorologic input data collected in near real time.

The current method of generating forecasts uses the SSARR (Streamflow Synthesis and Reservoir Regulation) hydrologic model, a continuous simulation model that has reservoir routing capabilities, plus the ability to account for the areal distribution of meteorologic inputs, including snowmelt. This model defines the water budget using hydrometeorological inputs.

In this study a forecast method based on the dynamic regression technique was developed to produce one, two and three day forecasts for the five gauged sub basins results. Also, forecasts for the same time periods were produced using the SSARR model. The results of both methods were compared using the mean absolute percentage error (MAPE) criterion.

The results of the comparison showed that the dynamic regression performed better than the SSARR model for all basins, particularly for the larger basins.

Acknowledgements

I would like to take this opportunity to thank a number of people who provided advice, assistance and support during my pursuit of a Masters of Engineering degree. First of all, I would like to thank the Newfoundland Department of Environment and Labour for providing access to the data used in the analysis. In particular, I would like to thank Dr. Wasi Ullah (now retired) for his encouragement to start the program.

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Abbreviations

ACF	Autocorrelation Function
AES	Atmospheric Environment Service of Environment Canada
ARIMA	Autoregressive integrated moving average
BII	Baseflow Infiltration Index
DCP	Data Collection Platform
ETI	Evapotranspiration Index
NDOEL	Newfoundland Department of Environment and Labour
SMI	Soil Moisture Index
SSARR	Streamflow Synthesis and Reservoir Regulation Model
S-SS	Sub Surface Infiltration
WSC	Water Survey of Canada, branch of Environment Canada

1. INTRODUCTION

1.1 Background

The Humber River Basin is the second largest river system on the island of Newfoundland with a drainage area of over 8000 km^2. Over half the basin is regulated for hydroelectric power generation by the Deer Lake Power Company (DLPC). Since the early 1900's, the communities, including Deer Lake and Steady Brook, have developed along the Humber River. As part of this development many residents were drawn to the scenic areas and flat lands along the flood plain areas of the Humber River and Deer Lake. Each year some flooding occurs at Steady Brook and Deer Lake. While the flooding is usually minor, the potential for flooding that affects large areas of the communities exists, as occurred in 1969 and 1981.

In an effort to reduce flood damage caused by this annual problem, these areas were included in the Canada-Newfoundland Flood Damage Reduction Program. A hydrotechnical study completed in 1984 (Cumming Cockburn, 1984) identified the flood risk areas corresponding to the 1:20 and 1:100 year interval floods. The hydrologic modelling was carried out using the Streamflow Synthesis and Reservoir Regulation (SSARR) model. Additional studies (Cumming Cockburn, 1985 & 1986) recommended that a flood forecasting system be developed to warn residents of impending flood events and did a preliminary evaluation of a forecasting system. This would allow residents to take preventative action to move valuables or take other appropriate actions. Such a system would also provide the

Deer Lake Power Company with information to operate the hydroelectric generating station with additional efficiency and safety.

Even before the completion of these studies, the need for an accurate 'near real time' flow forecasting and flood warning system for this basin was recognized by the Department of Environment and Labour (NDOEL) and the Power Company. The Department's goal is to provide a flood warning system with up to 72 hours advance warning of an impending flood. The Power Company requires accurate flow forecasts for safe and efficient operation of the hydroelectric development at Deer Lake. Based on this common interest, the Department of Environment and Labour and the Power Company cost shared the expansion of the data collection network required to implement the flow forecasting and flood warning system for the basin.

1.2 Objectives of the Study

The primary objective of this study is to develop and evaluate an alternate method of forecasting based on dynamic regression modelling to forecast flows for the Humber River Basin in western Newfoundland. This model will be compared, using a statistically sound method, with the deterministic model currently in use. As well, descriptive and other background information on the basin and the development of the SSARR method will be presented.

1.3 Outline of Thesis

This thesis document is composed of six chapters. The first chapter provides the background and explains the need for flow forecasting in the study area. Chapter 2 describes the study area in terms of the physiographic and hydrologic parameters relevant to the study objectives and lists the hydrometric and climate data available for the study area. The procedure used to describe, analyse and prepare the data for development of the two forecasting methods used in the study is presented in Chapter 3. The first section of Chapter 4 discusses the deterministic hydrologic model presently used by NDOEL while the second part discusses the background and development of the dynamic regression model. In Chapter 5, the forecasted flows calculated by each of the modelling methods are presented and compared. The conclusions and recommendations are presented in Chapter 6.

2. DESCRIPTION OF THE STUDY AREA

2.1 General

The Humber River Basin is located on the western side of the island of Newfoundland as shown in Figure 1. The total drainage area measured at the hydrometric station on the Humber River at Humber Village Bridge is 7860 km^2. The watershed is drained by two main branches - the Upper Humber River and Grand Lake, both of which drain into Deer Lake and then into the Bay of Islands via the Humber River. The Upper Humber River basin, with a drainage area of 2110 km^2 measured at the hydrometric station near Reidville, originates in Gros Morne National Park and flows in a southerly direction. This section of the basin is in a relatively natural state and flows uncontrolled. The Grand Lake section of the basin has a drainage area of over 5000 km^2. This section of the basin is regulated to produce hydroelectricity with a generating plant that operates at Deer Lake. A second, smaller hydroelectric development operates within the basin at Hinds Lake.

The areas in the basin with concentrations of residential development are located near the confluence of the two main subbasins at Deer Lake, or downstream along the Humber River between Deer Lake and Corner Brook. The presence of residential areas with a history of flooding in vulnerable downstream reaches, coupled with the presence of the hydroelectric developments, provides the basis for the necessity of accurate flow forecasting in the basin.

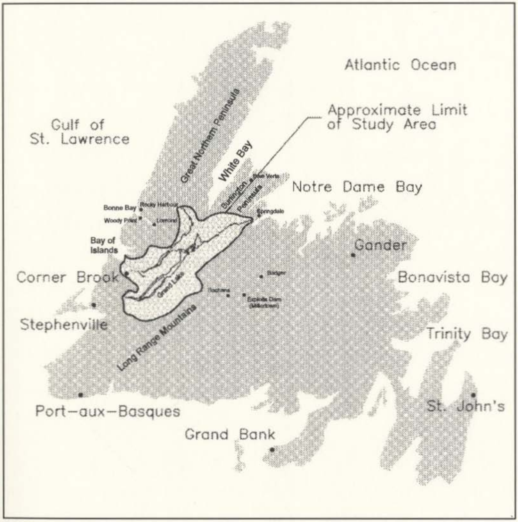

Figure 1- General Location of Study Area

2.2 Physiography

The Humber River Basin is, for the most part, situated in a physiographic region called the Newfoundland Highlands (Bostock, 1970). This area is further broken down into four sub-regions called the Great Northern Highlands, Blow Me Down Mountains, Atlantic Upland of Newfoundland and the Grand Lake Lowlands. These areas are shown on Figure 2. (Sanford et al, 1976)

The Great Northern Highlands form a barren mountainous plateau that extends northward along the Great Northern Peninsula from Bonne Bay and the Lomond River Valley with elevations ranging to 180 to 800 m. The inland surface of the highlands slopes gently in a southeasterly direction towards the Humber Valley and White Bay. The Upper Humber River and the Main River flow along this slope flowing in a southeastwardly direction.

The Blow Me Down Highlands form an area of dissected plateaus and mountains that rise abruptly from the coast along the Gulf of St. Lawrence in the Bay of Islands to Trout River area. The elevations in the area range from 550 m to 700 m. Drainage from this area flows in a westerly direction to the Gulf of St. Lawrence.

The Atlantic Upland of Newfoundland is a barren to sparsely forested plateau located between Grand Lake and Red Indian Lake and extending northward to the Burlington Peninsula. Elevations in this area range from 400 m to 600 m. The area forms the drainage divide for the two largest drainage basins on the island - the Humber River to the west and the Exploits River to the east.

The Grand Lake Lowlands are located towards the centre of the Humber River basin. These lowlands include the largest water bodies in the basin: Grand Lake, Sandy Lake and Deer Lake.

2.3 Surficial Geology

The surficial geology within the Humber River watershed ranges from bed rock outcropping, areas of glacial tills, and areas of sands and gravels to areas of organic soils. Based on the available information, (Golder, 1983) bedrock is the most common surficial geology classification type. Exposed bedrock forms extensive rock plains, knolls and ridges throughout much of the watershed. The rock, in most cases, is covered by a thin veneer of till soils or concealed by vegetation of either forest, scrub or peat bog. The area that comprises the highlands of the Long Range Mountains, Topsail Uplands and Burlington Peninsula is mostly exposed with rock talus or alluvium occurring on the mountain slopes. The soil types in the watershed, with some exceptions along the Humber River near Deer Lake and along the Humber River, are generally not suitable for agricultural uses due to excessive soil moisture, and adverse relief because of steepness or pattern of slopes, stoniness and shallowness to bedrock.

The glacial tills are found throughout the watershed with large variability in thickness from one area to another. The soils may be found as a thin veneer or extensive moraine deposit overlying the bedrock. The composition of the tills vary from grey silty sand or sand silt within the Long Range Mountains and Topsail Uplands, to red clayey silt within the

Humber River Valley. There are various local areas of till cover which are comprised of unsubdivided deposits of ice contact sand and gravel. In general, the composition of all tills closely resemble the lithology of the underlying bedrock.

The sand and gravel deposits found within the study area are outwash and fluvial in origin and are generally confined to stream and river valleys, The major sand and gravel deposits are found in the Deer Lake, Upper Humber River Valley, and the Sandy Lake-Birchy Lake areas. Additional buried deposits of sand and gravel occur at various points interstratified within the till deposits.

Peat deposits are found commonly throughout the watershed in areas with poor surface drainage. These deposits occur extensively on the barren Topsail Uplands just south of Grand Lake. Peat accumulations in the form of high moor bogs and string bogs are found on the highland plateaus of the Long Range Mountains. Peat deposits can attain thicknesses of several metres overlying bedrock or till deposits. Figure 2 shows the surficial geology and the major soil types found within the watershed.

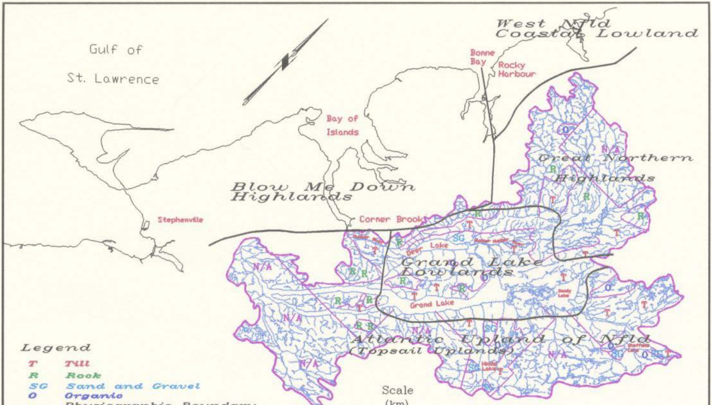

Figure 2
Physiography & Surficial Geology
Humber River Basin

2.4 Climate

The Humber River Basin has a temperate, marine climate that is influenced by the Gulf of St. Lawrence to the west and the Long Range Mountains to the east. Based on data from the long term climate stations in the basin (Atmospheric Environment Service, 1981& 1991) the average annual temperatures range from a low of 2.9°C at Baie Verte to a high of 5.1°C at Corner Brook. A summary of the average daily temperatures and average annual precipitation for the long term stations in and around the basin are shown in Table 1.

The annual precipitation ranges from a low of 943.5 mm at Badger, to a high of 1470 mm at Woody Point. Woody Point is located on the western coast while Badger is located far inland away from the coastal influence. The upland areas of the Long Range Mountains and the Topsails have greater precipitation due to orographic effects. The amount of precipitation decreases in the northeastern direction as indicated by Badger and Springdale with 943.5 and 967.1 mm respectively. For all stations, precipitation is lowest during the months of April and May while the highest amounts are recorded in the fall.

Table 1 - Long Term Climate Data - Humber River Basin

Station	Annual Precipitation (mm)		Average Daily Temperature (°C)	
	1951-1980	1961-1990	1951-1980	1961-1990
Badger	943.5	n/a	3.9	n/a
Baie Verte	1064.7	1100.8	2.9	3.0
Buchans	1071.5	1128.8	3.5	3.4
Corner Brook	1133.5	1186.0	5.1	5.2
Deer Lake	1033.1	1067.5	4.1	4.1
Deer Lake Airport	1023.2	1034.3	3.3	3.4
Exploits Dam	1099.0	1099.5	3.2	3.2
Rocky Harbour	1199.7	n/a	4.2	n/a
Springdale	967.1	1010.3	3.9	3.8
Stephenville	1166.5	1272.1	4.8	4.7
Woody Point	1470.0	n/a	4.6	n/a

(Station locations are shown on Figures 1 or 9)

2.5 Forest Cover

The Humber River Basin is within a classification band called the Boreal Forest Region of Canada (Rowe, 1972). This general region is subdivided into two subregions, Predominantly Forest Boreal Region and Forest and Barren Boreal Region. The Humber River watershed contains areas within both of these subregions. Figure 3 illustrates the forest and vegetative cover within the basin.

The dominant tree species include White Spruce, Black Spruce, Balsam Fir with areas of Tamarack, White Pine, White Birch, Yellow birch, Trembling Aspen and Balsam Poplar.

The forest cover in the Humber Basin is divided into four major classes: mature forest, scrub land, barren and peat bog, Mature forest is the most common forest cover class within the study area. This forest classification generally occurs in the areas that have the thickest glacial till layer above the bedrock. However, most of the tree cover is fairly sparse due to the thin veneer till soils and exposed bedrock. The dominant tree species within this class are Balsam Fir and Black Spruce, with White Birch, Trembling Aspen and Balsam Poplar also being found. Overall, sparse, mature forest cover is found in all subwatersheds. The most densely treed area within the watershed is located downstream of Deer Lake to the Community of Steady Brook where Balsam Fir and Black Spruce dominate with softwood scrub land, White Birch and peat bog also being found. Extensive logging has been carried out, and continues to be carried out, in the basin to support the paper mill in Corner Brook.

The remainder of the study area contains softwood and hardwood scrub lands, rock barrens and peat bogs. As can be expected, the vegetation classes are closely related to the soil type, soil depth and moisture regime. Well vegetated areas are usually small in area and scattered. Peat bogs are common in the highland plateaus, along river valleys and around lakes within the lowlands.

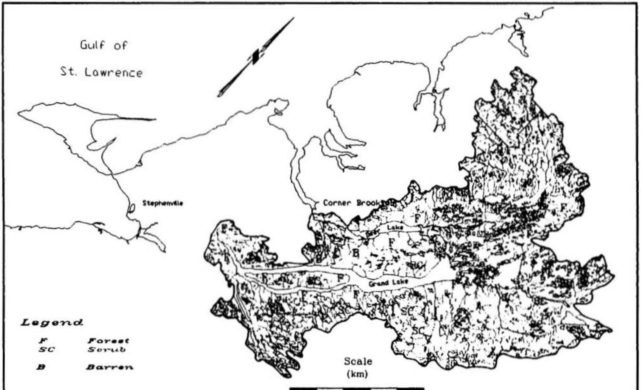

Figure 3
Forest Cover & Vegetation

3. DATA PREPARATION

3.1 Available Data

3.1.1 AES Climate Data

The long term climate stations in and near the basin are listed in Table 1 in Chapter 2.4. These stations are operated by Environment Canada's Atmospheric Environment Service (AES), and for the most part, are located outside the boundaries of the basin and consequently are not suitably located for short term flow forecasting. Also, the data available from these stations is not available in near real time since the gauges, except the Airport sites, are read manually by observers. Arrangements can be made with AES to obtain the data but the data must be manually entered into the computer.

3.1.2 WSC Flow/Stage

Environment Canada, through its Water Survey of Canada (WSC) branch operates a series of hydrometric stations in and around the basin under a cost sharing agreement with NDOEL. The flow data is published yearly in CD-ROM format following a comprehensive quality control review. The data is not readily available through WSC in near real time. A summary of the long term stations in the basin is presented in Table 2. One important observation from this data is that all of the maximum instantaneous flows occurred during the spring snowmelt runoff period.

Table 2 - Summary of Hydrometric Data - Humber River Basin

Station Name	WSC Code	Area (km^2)	Period of Record	Mean Annual Discharge (m^3/s)	Maximum Instantaneous Flow (m^3/s)
Lewaseechjeech Brook **(LEWA)**	02YK002	470	1952-1967 1972 - present	17.6	175 (04/93)
Hinds Lake at Outlet **(HIND)**	02YK004	630	1956-1979	16.5	136 (04/71)
Sheffield Brook at Sheffield Lake (SHEF)	02YK003/	380	1955-1966	9.9	93.4 (05/60)
Sheffield Brook near TCH **(SHEF)**	02YK005	391	1972-present	12.0	121 (05/87)
Indian Brook Diversion to Birchy Lake **(INDI)**	02YM002	238	1963-1978	5.7	46.7 (05/75)
Indian Brook above Birchy Lake **(INDI)**	02YM004	238	1990-present	6.5	51.4 (05/93)
Upper Humber River near Reidville **(REID)**	02YL001	2108	1940-present	82.2	1060 (06/84)
Upper Humber River above Black Brook **(BLAC)**	02YL008	471	1988-present	26.4	302 (06/95)
Humber River at Humber Village **(VILL)**	02YL003	7860	1982-present	257	887 (06/95)

(See Figure 9 for station locations)

3.1.3 Near Real Time Data

Near real time data are collected at the stations using Data Collection Platforms (DCP)'s. The data are telemetered via satellite to an earth receiving station where they are retrieved by NDOEL via modem. These stations are operated and maintained by Environment Canada under a cost sharing agreement between Environment Canada, NDOEL and the Deer Lake Power Company. The data retrieval, processing, and dissemination of the near real time data is carried out by NDOEL.

The raw data from the sites are given only a brief quality control review prior to archiving in database files.

3.2 Data Review

As noted above, the data available for the Humber River Basin originate from three sources, namely AES for long term climate data, WSC for long term hydrometric data, and NDOEL for near real time climate and hydrometric data. The AES data is not readily accessible on a real time basis and WSC does not publish the data until about six months after the data are collected.

Since any flow forecasting system for the basin will require near real time data, the data from NDOEL was selected as the basis for the model development. The main cause for concern in using this data is that it is not subject to the extensive quality control review and correction like the AES and WSC data. For this reason, the data review for the NDOEL data will concentrate on identifying any problems with the data

The first step in reviewing any data set is to plot the data. A sample plot of the data for the Upper Humber River near Reidville is shown in Figure 4 and a plot of the precipitation and temperature data for Grand Lake on Glover Island is shown in Figure 5. This initial review aided in the task of identifying incorrect data due to instrument error, outliers or the presence of missing data. Any problems noted were corrected in the data files. Figures 4 and 5 are illustrative of the nature of the data. The data review was done primarily using the computer display screen. Plots for the remainder of the stations used in this study are presented in Appendix A.

The next step in the data review was to calculate the descriptive statistics for the data. SYSTAT software (SYSTAT Inc, 1991) was used for this purpose. The results of this analysis is given in Tables 3-6.

The next step in the review of the data was to compare the quality controlled data from the WSC with NDOEL's near real time data. As shown in the example in Figure 6, there is a definite difference in the two data sets that occurs during the winter season. The apparent higher flows during the winter season were believed, and were later confirmed, (Baker, 1996) to be a result of an ice cover in the stream. The instrument at the site measures water level which is converted to a flow based on a rating curve developed using open water conditions. This causes an erroneously high water level and consequently an erroneously higher flow. The effect was noted at all of the gauges, with the exception of two, the

Lewaseechjeech Brook and Humber River at Humber Village Bridge. The comparison plots for the remainder of the stations is presented in Appendix B.

At this point the possibility of correcting for the ice cover was investigated. The procedure used by Environment Canada to correct for this backwater effect involves a graphical technique supported by on site reconnaissance and knowledge of nearby basins to adjust for the ice effect. Since this type of correction cannot be carried out on real time data due to the unavailability of field information and time constraints, the only choice was to proceed with the analysis using the real time data, with the knowledge that there is an inaccuracy in the data.

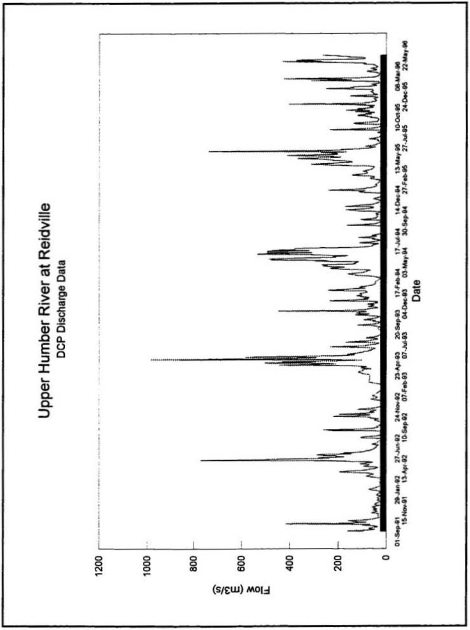

Figure 4 - Sample Flow Data from DCP Station

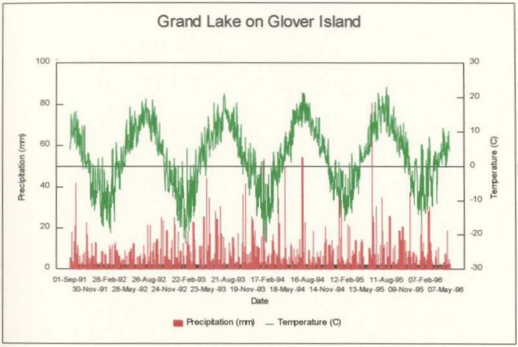

Figure 5 - Sample Temperature and Precipitation Data

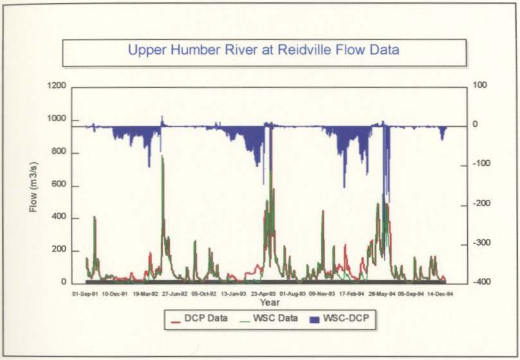

Figure 6 - WSC and DCP Data Comparison

Table 3 Descriptive Statistics - Flow and Climate Data

Upper Humber River above Black Brook

	FLOW	TOTPRE	TEMPAVG	PRERAIN	PRESNOW	TEMPMAX	TEMPMIN
N OF CASES	1666	1659	1659	1659	1659	1659	1659
MINIMUM	1.140	0.000	-30.280	0.000	0.000	-22.700	-39.500
MAXIMUM	275.290	70.880	21.210	70.880	55.410	28.900	18.700
RANGE	274.150	70.880	51.490	70.880	55.410	51.600	58.200
MEAN	40.717	3.854	0.197	2.350	1.502	5.110	-5.262
STANDARD DEV	37.891	6.769	10.272	5.889	3.880	10.516	11.206
STD. ERROR	0.928	0.166	0.252	0.145	0.095	0.258	0.275
SKEWNESS(G1)	1.877	3.741	-0.223	4.960	5.175	0.021	-0.503
KURTOSIS(G2)	5.052	20.418	-0.604	34.448	39.916	-0.692	-0.341
C.V.	0.931	1.756	52.026	2.506	2.583	2.058	-2.130

Indian Brook Diversion to Birchy Lake

	FLOW	PRECRAIN	PRECSNOW	TEMPAVG	TEMPMAX	TEMPMIN	TOTPREC
N OF CASES	1728	1728	1728	1728	1728	1728	1728
MINIMUM	0.490	0.000	0.000	-27.650	-19.700	-36.800	0.000
MAXIMUM	72.560	117.710	53.680	22.730	32.200	18.400	117.710
RANGE	72.070	117.710	53.680	50.380	51.900	55.200	117.710
MEAN	11.192	2.238	0.982	2.125	7.321	-3.561	3.220
VARIANCE	119.828	38.638	11.410	101.405	110.612	115.657	48.453
STANDARD DEV	10.947	6.216	3.378	10.070	10.517	10.754	6.961
STD. ERROR	0.263	0.150	0.081	0.242	0.253	0.259	0.167
SKEWNESS(G1)	1.820	7.692	6.663	-0.322	-0.034	-0.619	6.001
KURTOSIS(G2)	3.596	103.787	63.756	-0.550	-0.751	-0.272	66.345
C.V.	0.978	2.778	3.439	4.738	1.437	-3.020	2.162

Table 4 - Descriptive Statistics - Climate Stations

Burgeo Road near Buchan's Access

	PRECRAIN	PRECSNOW	TEMPAVG	TEMPMAX	TEMPMIN	TOTPREC
N OF CASES	1728	1728	1728	1728	1728	1728
MINIMUM	0.000	0.000	-26.600	-23.000	-35.600	0.000
MAXIMUM	110.030	56.140	22.010	29.800	19.300	110.030
RANGE	110.030	56.140	48.610	52.800	54.900	110.030
MEAN	2.750	1.183	1.769	6.057	-2.661	3.932
VARIANCE	46.443	14.552	94.482	102.742	100.641	57.887
STANDARD DEV	6.815	3.815	9.720	10.136	10.032	7.608
SKEWNESS(G1)	5.312	6.582	-0.274	-0.139	-0.418	4.321
KURTOSIS(G2)	48.544	58.099	-0.694	-0.695	-0.532	31.983
C.V.	2.478	3.225	5.495	1.674	-3.770	1.935

Corner Brook Lake at Outlet

	PRECRAIN	PRECSNOW	TEMPAVG	TEMPMAX	TEMPMIN	TOTPREC
N OF CASES	1706	1706	1706	1706	1706	1719
MINIMUM	0.000	0.000	-28.910	-22.400	-37.400	0.000
MAXIMUM	106.230	76.580	20.950	28.600	17.500	106.230
RANGE	106.230	76.580	49.860	51.000	54.900	106.230
MEAN	3.120	1.463	1.277	5.384	-3.254	4.617
VARIANCE	61.745	13.885	94.869	98.437	107.898	72.686
STANDARD DEV	7.858	3.726	9.740	9.922	10.387	8.526
SKEWNESS(G1)	4.725	7.131	-0.309	-0.119	-0.534	4.067
KURTOSIS(G2)	33.871	104.804	-0.612	-0.713	-0.283	26.187
C.V.	2.518	2.547	7.628	1.843	-3.193	1.847

Grand Lake on Glover Island

	PRECRAIN	PRECSNOW	TEMPAVG	TEMPMAX	TEMPMIN	TOTPREC
N OF CASES	1728	1728	1728	1728	1728	1728
MINIMUM	0.000	0.000	-22.360	-19.100	-26.900	0.000
MAXIMUM	80.740	33.600	23.010	31.000	17.500	80.740
RANGE	80.740	33.600	45.370	50.100	44.400	80.740
MEAN	2.340	0.737	2.685	6.888	-1.265	3.077
VARIANCE	32.849	4.886	82.353	97.715	77.139	37.103
STANDARD DEV	5.731	2.210	9.075	9.885	8.783	6.091
SKEWNESS(G1)	5.152	5.901	-0.220	-0.059	-0.373	4.548
KURTOSIS(G2)	39.735	52.572	-0.679	-0.731	-0.548	31.727
C.V.	2.449	2.998	3.379	1.435	-6.941	1.979

Table 5 - Descriptive Statistics Climate Stations

Grand Lake at Southwest End

	PRECRAIN	PRECSNOW	TEMPAVG	TEMPMAX	TEMPMIN	TOTPREC
N OF CASES	1725	1725	1725	1725	1725	1725
MINIMUM	0.000	0.000	-25.510	-21.200	-34.400	0.000
MAXIMUM	78.230	63.550	22.600	32.800	17.200	78.230
RANGE	78.230	63.550	48.110	54.000	51.600	78.230
MEAN	2.197	0.841	2.320	7.355	-2.847	3.038
VARIANCE	30.647	8.799	94.501	109.767	99.611	37.344
STANDARD DEV	5.536	2.966	9.721	10.477	9.981	6.111
STD. ERROR	0.133	0.071	0.234	0.252	0.240	0.147
SKEWNESS(G1)	5.553	10.118	-0.296	0.011	-0.552	4.900
KURTOSIS(G2)	48.132	163.922	-0.580	-0.693	-0.366	37.590
C.V.	2.520	3.529	4.190	1.425	-3.506	2.012

Sandy Lake at Howley Road

	PRECRAIN	PRECSNOW	TEMPAVG	TEMPMAX	TEMPMIN	TOTPREC
N OF CASES	1725	1725	1725	1725	1725	1725
MINIMUM	0.000	0.000	-25.510	-21.200	-34.400	0.000
MAXIMUM	78.230	63.550	22.600	32.800	17.200	78.230
RANGE	78.230	63.550	48.110	54.000	51.600	78.230
MEAN	2.197	0.841	2.320	7.355	-2.847	3.038
VARIANCE	30.647	8.799	94.501	109.767	99.611	37.344
STANDARD DEV	5.536	2.966	9.721	10.477	9.981	6.111
STD. ERROR	0.133	0.071	0.234	0.252	0.240	0.147
SKEWNESS(G1)	5.553	10.118	-0.296	0.011	-0.552	4.900
KURTOSIS(G2)	48.132	163.922	-0.580	-0.693	-0.366	37.590
C.V.	2.520	3.529	4.190	1.425	-3.506	2.012

Table 6 - Descriptive Statistics - Flow Only Stations

Sheffield River near TCH

	FLOW
N OF CASES	1365
MINIMUM	1.490
MAXIMUM	107.000
RANGE	105.510
MEAN	12.622
VARIANCE	119.756
STANDARD DEV	10.943
STD. ERROR	0.296
SKEWNESS(G1)	2.581
KURTOSIS(G2)	10.055
C.V.	0.867
MEDIAN	8.490

Upper Humber River near Reidville

	FLOW
N OF CASES	1728
MINIMUM	9.910
MAXIMUM	989.000
RANGE	979.090
MEAN	97.733
VARIANCE	10856.951
STANDARD DEV	104.197
STD. ERROR	2.507
SKEWNESS(G1)	2.905
KURTOSIS(G2)	11.535
C.V.	1.066
MEDIAN	61.160

Lewaseechjeech Brook

	FLOW
N OF CASES	1712
MINIMUM	1.590
MAXIMUM	174.630
RANGE	173.040
MEAN	20.167
VARIANCE	497.957
STANDARD DEV	22.315
STD. ERROR	0.539
SKEWNESS(G1)	2.953
KURTOSIS(G2)	11.035
C.V.	1.107
MEDIAN	12.130

Humber River at Village Bridge

	FLOW
N OF CASES	1727
MINIMUM	132.540
MAXIMUM	837.580
RANGE	705.040
MEAN	279.265
VARIANCE	14224.584
STANDARD DEV	119.267
STD. ERROR	2.870
SKEWNESS(G1)	1.923
KURTOSIS(G2)	3.778
C.V.	0.427
MEDIAN	241.290

4. METHODOLOGY

This section will discuss the two methods used in this study to forecast flows for one, two and three days ahead for the Humber River Basin. Part one will focus on the deterministic model (SSARR), its history, application to the study basin and the flow forecasts for specific events.. The second section will provide similar information for the dynamic regression method.

4.1 Deterministic Model (SSARR)

4.1.1 Model Description

4.1.1.1 History

The SSARR model was developed in 1956 by the US Corps of Engineers to analyse and forecast flows for the natural hydrologic and controlled reservoir systems in the North Pacific Division area. This area included the Columbia River System in the US and Canada, coastal rivers in Western Oregon and Washington, and the State of Alaska. Since that time, the SSARR Model has been updated and made compatible for PC use and has been widely applied throughout the world.

One application that is similar to the Humber Basin in terms of geographic, climatic and operational characteristics is the St. John River Basin in New Brunswick. SSARR was selected for this basin in 1973 because it was believed to be the best available at that time

(Tang & Lockhart, 1983). The model continues to be used for flow forecasting for that basin up to the present day.

The model was selected for the Humber River basin for the following reasons: (Cumming Cockburn, 1984)

- The model is simple in structure and uses readily available data compared with many other continuous simulation models;
- The relatively fast simulation time which allows for low computational time compared with other models;
- The benefit of transferring model parameters and experience from other Canadian applications such as the St. John River noted above;
- The excellent reservoir routing capabilities;
- Variable computational time steps are possible, ie. a mixture of weekly and/or daily;
- The capability to account for the areal distribution of snowmelt;
- The model is non-proprietary and has been well proven in a number of practical applications;
- The model is widely used in flood forecasting; and
- An interactive version of the model is available.

4.1.1.2 General Description

The SSARR model has been developed to describe the main components of the hydrologic cycle. It was conceived as a closed hydrologic system in which the water budget is defined by meteorologic inputs (rainfall and/or snowmelt) and hydrologic outputs such as runoff, soil storage and evapotranspiration losses. The model is derived so that the main components of the hydrologic cycle are represented in a simplified but rigorously applied manner. The parameters used in the model allow for an extremely flexible means of representing the various hydrologic components. This unique feature allows the SSARR model to be applied to virtually any drainage basin or hydrologic system. A detailed discussion of the algorithms and data processing techniques utilized in the SSARR model is found in the Users Manual (Davis, 1991).

A schematic representation of the basic elements of the SSARR watershed model is presented in Figure 7.

The SSARR program carries out the following three distinct functions:

- It calculates the natural discharges for each of the elementary sub-basins within a subwatershed that is selected by the user for its relatively homogeneous hydrological characteristics.
- It calculates the natural discharges as well as routing and adding hydrographs through river reaches and natural lakes, up to the exit point of the entire watershed.

- It calculates the variations in discharge caused by the regulation of artificial reservoirs for hydroelectric generation or flood control operations.

4.1.1.3 Hydrologic Principles Utilized in the SSARR Model

The representation of hydrologic runoff processes in a watershed model is highly subjective. No two hydrologists look at watershed runoff processes in exactly the same light. Nevertheless, there are some underlying principles that must be preserved in the formulation of a deterministic hydrologic watershed model. These include the logical accounting of each of the basic elements in the hydrologic cycle, including rainfall, snowmelt, interception, soil moisture, interflow, groundwater recharge, evapotranspiration, and the various time delay processes. These elements must be accounted for while including the ability to maintain continuity of each of the processes and to represent each by objective functions that relate them to observed hydrometeorological parameters. The main difference between the ways various models account for these processes lies in the level of complexity that each model uses to represent a particular process.

The streamflow routing functions contained in the SSARR model provide a generalized system for solving the unsteady flow conditions in river channels where streamflow and channel storage effects are related, either at one point or at a series of points along a river system. In principle, the method involves a direct solution of a storage-flow relationship involved in maintaining continuity of streamflow and storage in each element of the river, using a procedure that solves the relationships in finite elements of time and river reach. This involves a completely general and flexible method for solving the flow routing equations which can be applied in many ways depending upon the type of basic data available, and the conditions of the river system with respect to backwater effects from variable stage discharge effects, such as tidal fluctuations or reservoir fluctuations.

The SSARR model was designed to include the effects of reservoirs or other water control elements within the streamflow simulation process. Reservoirs may be described for any location in a river system, whereby inflows are defined from single or multiple tributaries, derived either from watershed simulation for river basins upstream, or from specified flows as a time series, or a combination of the two.

Outflows from reservoirs are determined on the basis of specified operating conditions. In order to provide a once-through process for the system as a whole, including all natural effects and those related to human intervention, the processing of hydraulic conditions at reservoirs is performed sequentially with all other elements in the river basin simulation.

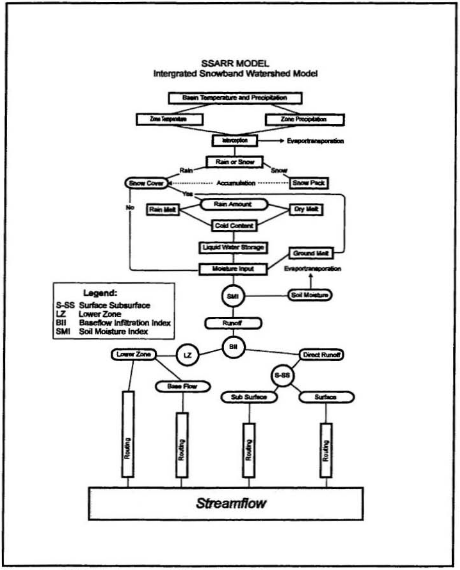

Figure 7 - SSARR Schematic with Snowband Option

4.1.1.4 Structure

This section defines and discusses hydrologic input parameters in general terms. The specific data input and parameter values used for various sub-watersheds of the Humber River in this study are presented and discussed in Chapter 4.1.2.

Net precipitation input (WP) - The average net precipitation value for a drainage basin or hydrologic unit is derived as a weighted daily or period amount from a series of individually reported or observed values. The weighting is generalized, and each station may be assigned its individual weighting value. The station weights may be determined on the basis of previously derived relationships between station and basin normal annual or normal seasonal precipitation; or the weighting values may be derived on an areal basis using the Thiessen Polygon or other similar technique.

The total precipitation on a watershed is computed from period precipitation amounts at one or more stations by:

$$WP_n = \frac{P^1 * W_1 + P_2 * W_2 + \ldots\ldots\ldots P_n * W_n}{n} \qquad (1)$$

Where

$P_1, P_2 \ldots\ldots P_n$ = Period precipitation amounts at Stations 1, 2, ... n respectively, in inches

$W_1, W_2 \ldots\ldots W_n$ = Weights applied to the station precipitation n = Total number of stations, a maximum of 30 stations

Wp_n = weighted period Net Watershed Precipitation inches

Basically, there are two general options for the of snow melt, namely:

- the temperature index method; and
- the use of generalized equations of snowmelt as determined by the thermal budget of heat loss and gain to the snowpack.

The temperature index method is usually used for daily forecasting applications, whereas the detailed energy budget approach is more appropriate for design flood calculations when extensive watershed data is available. By either method, daily or period values of effective snowmelt runoff values are computed as a time series, as a function of appropriate meteorological values.

The second option has the advantage of being more precise and detailed, but also has the disadvantage of requiring some data which is available at only a very limited number of stations. Examples of such data are:

- Difference between air temperature measured at 3 metres above the snow surface and snow surface temperature in degrees Celsius (°C). The snow surface temperature is assumed to be 0°C;
- Difference between the dewpoint temperature measured 3 metres above the surface of the snow and the temperature of the snow surface (0°C);
- Above the surface of the snow and the temperature of the snow surface (0°C);

- Wind velocity at 15 metres above the snow, in kilometres per hour;
- Solar radiation on a horizontal surface, in langleys;
- Average snow surface albedo;
- Basin shortwave radiation melt factor;
- Average forest canopy cover; and
- Convection-condensation melt factor.

In addition to the two options of snowmelt equations available to the user, two additional options for the simulation of snow cover are also available. These are:

- Snow Cover Depletion; and
- Snow Band Option.

With the snow cover depletion option, snow cover is diminished in thickness, and in surface area during the snowmelt season. However, two disadvantages of this option are that snowfall during the calculation period is not added to the existing snow cover and secondly, it is necessary to enter at the beginning of the period of calculation, the quantity of snow which will effectively run off after the melt. However, this option has been shown to be useful in the flood forecasting mode. The snow band option allows the user to separate the subwatershed into different "bands" according to elevation with the temperatures being lowered systematically with increased elevations, as illustrated in Figure 7

Soil Moisture Index (SMI) - The soil moisture index used in the SSARR model represents a weighted mean basin value of the water stored in the soil mantle that can be removed by plant roots through transpiration and natural evaporation. It does not include the part of the soil moisture content that exists at the permanent wilting point. The computation of the changes in soil moisture index values are based on the increases resulting from rainfall snowmelt, and the decreases by the evapotranspiration process. Increases in the soil moisture index values result in a "permanent" loss to runoff in the water balance for the basin as a whole. The upper limit of the soil moisture index is considered to be its field capacity, which is equivalent to the capillary moisture holding capacity, or the total amount of water which can be held under the force of gravity under natural conditions. Thus, the soil moisture index is a continuously varying parameter that may range from a value of zero when the soil moisture has been reduced to the "wilting point" by the evapotranspiration process, to a maximum value represented by the field capacity of the soil for the basin as a whole.

Evapotranspiration Index (ETI) - The evapotranspiration index (ETI) used in the SSARR model is a weighted basin mean daily value of the water lost to the atmosphere by the evapotranspiration process. Transpiration, soil evaporation and evaporation of free water from the plant or forest cover are considered to act together to produce the losses by evapotranspiration. Since the evapotranspiration loss is physically the result of change of state of water from the liquid to vapour phase, the process of evapotranspiration requires energy for the transformation, and is, therefore, dependent upon a source of energy, from the atmosphere.

In the model, the potential evapotranspiration may be computed by either of two basic methods, namely:

- mean daily amounts based on mean monthly values which are typical for a given hydrologic regime; or
- mean daily air temperature or dew point temperatures, or daily solar radiation amounts.

The daily computed amounts are adjusted in either case by a function to account for daily or the selected period rainfall that would reduce the potential rate of evapotranspiration. In the application of the SSARR model, the mean daily amounts computed through use of mean monthly amounts are most commonly used.

Baseflow Infiltration Index (BII) - The Baseflow Infiltration Index used in the SSARR watershed model provides a means for computing the relative proportion of the water available in the surface layers of the soil mantle that enters the ground water aquifers as deep percolation. Under the principle of "generated runoff", as defined above, all water which is not lost to the atmosphere by evapotranspiration, or the permanent loss by soil moisture increase, is available to runoff with a time delay function. Conceptually, the model considers the time delay to occur in three zones, namely surface, sub-surface and baseflow. The long time delay caused by base flow infiltration represents that portion of the water which is in transitory storage for several months (or possibly years under certain circumstances).

Surface-Sub-Surface Flow Index (S-SS) - In the model, the surface sub-surface (S- SS) flow separation index deals with the water excess which is generated from the residual after soil moisture and transpiration losses and base flow infiltration have been satisfied. Normally, the "direct" runoff is considered to be the result of the percolation of "free" water through the upper layers of the soil mantle. This could be in the zone up to a maximum of depth of 50 cm below the ground surface termed as sub-surface flow. When the water input rate exceeds the capacity of the sub-surface zone to transmit water under gravitational force, the residual water excess amount is considered to occur directly on the ground surface or the upper few centimetres of the soil mantle. The surface-sub-surface (S-SS) flow separation is a means for defining the relative portion of the direct runoff that contributes to each portion, as a function of input rate.

The S-SS function is usually specified as a nonlinear function whereby the lower rates of input provide water excess primarily in sub-surface zones while high input rates are predominantly on the surface runoff. The time delay functions for routing surface and sub-surface flow are specified to represent the difference in storage times for each of the two zones.

Watershed outflow transformation by polyphase routing for each flow component input (NP, TS) - The water excess values computed for each time period in each of the three flow components (surface, sub-surface and baseflow) must be transformed from values computed as input rates to time-distributed values of streamflow. In the SSARR model, this transformation is accomplished by polyphase routing, whereby the input rates expressed as cm per period are converted to equivalent values of steady-state outflow, expressed as cubic metres per second for the particular drainage area. The routing is performed through the use of the flow continuity equations set forth in the SSARR users manual (Davis, 1991).

The use of polyphase routing for this type of transformation has several advantages for computerized simulation of streamflow from watersheds. These include:

- simplicity of computation;
- ease of application in trial and error reconstitution studies for determining basin runoff characteristics;
- the relatively small amount of information required to store in the computer, in order to represent the basin runoff characteristics;
- the completely flexible means for representing time delays to runoff either for short term flood runoff on relatively small tributaries, or for long-term base flow on ground water discharge for large river system;
- the convenient means for preserving the continuity of flow at any specified point in time, for "stop action" or "instant replay" capabilities, particularly in its use for day-to-day streamflow forecasting;
- the flexibility of providing virtually any desired shape of runoff characteristics such as a unit distribution of known characteristics;
- the assured preservation of continuity of flow for any computed runoff excess, and;
- the ability to represent non-linear response for runoff from a watershed.

4.1.1.5 Methodology for Calibration and Validation

When using the snow band option in the SSARR model a typical subbasin requires up to 68 parameters to describe its hydrologic characteristics. Of these parameters, up to 47 are permanent characteristics of the model and include the station name and other parameters that can be measured, such as the drainage area. The remaining parameters must be calibrated or the defaults in the model accepted.

In general, the optimization of the various parameters is normally accomplished by trial-and-error reconstitution studies of historical streamflow data. These studies are generally performed using several years of historical data. The various parameters are tested to achieve the best fit of computed and observed streamflow. It is normally assumed that the physical factors affecting runoff are nonchanging over a period of years, so that the parameters and functions used in the model are fixed as a given set of values for the entire study period. The degree of fit between computed and historical streamflow is determined either visually by inspection of graphical plots of the data or by graphical or statistical methods. The principal objective is to achieve consistency over a wide range of hydrologic conditions to eliminate bias between high and low periods of streamflow and to achieve relatively uniform consistency for the years being studied.

The overall water balance for particular study areas should represent as closely as possible the known or expected values of precipitation, evapotranspiration, soil moisture and ground water condition that are characteristic for the climatological and hydrological regime of the area. The main objective of reconstitution studies is first to achieve a water balance by adjusting the following parameters:

- precipitation weighting for estimating basin precipitation from index station values;
- SMI function, in terms of total soil moisture index values and the shape of the SMI function;
- ETI values, based on observed or estimated amounts which properly reflect the seasonal or daily variation; and
- BII function, representing the portion of water input which contributes to base flow.

When the overall water balance is achieved, the refinements in timing can be taken into account by adjusting the polyphase routing parameters for each component (surface, subsurface and base flow), and by adjusting the S-SS flow separation function.

Once a simulated flow series is obtained using this procedure it is compared with the actual hydrograph for the basin. This comparison is then reviewed and the parameters are adjusted using the following guidelines:

- If the simulated hydrograph is consistently higher (or lower) than the actual and the difference is more pronounced over time, then the estimation for evaporation may be too high (or low). The slope of the SMI curve should be increased (or decreased).

- If the slope of the simulated hydrograph recession curve is higher (or lower) than the actual hydrograph, then the base flow is too low (or high). The slope of the BII curve should be reduced (or increased).
- If the simulated maximum discharge is higher (or lower) than the recorded maximum discharges and, if the runoff volumes are close (indicating that the SMI curve is good), then surface runoff is too large (or too small) with respect to the subsurface flow. The slope of the SS-S curve should be reduced (or increased).
- If the simulated hydrograph is obviously higher than the recorded hydrograph following a light rainfall in the simulation period, then the initial SMI should be reduced.
- If the shape of the simulated hydrograph is sharper than the recorded hydrograph following a light rainfall in the simulation period, then the maximum for the BII curve should be increased.

Once the model has been calibrated for rainfall only events, the snowmelt parameters are adjusted using the following additional guidelines:

- If the upward slope of the simulated hydrograph is too flat (or too sharp), then the melt rate should be increased (or decreased).
- If the simulated flood starts later than the recorded flows, then the base temperature should be increased.

- If the volume of the simulated hydrograph is too large (or too small), then the weighting of the snow course or precipitation stations may need to be decreased (or increased).

This description is a brief description of the steps necessary to calibrate the SSARR model. However, it is obvious that an adequate calibration of the model requires a great deal of knowledge about the model and about the watershed. It should also be noted that the calibration is user driven and requires frequent adjustments to be used effectively in an operational forecasting mode.

4.1.1.6 Model Setup for the Humber River Basin

The initial setup for the SSARR model was carried out as part of the study to develop flood risk areas (Cumming Cockburn, 1984). Further development was carried out to assess the possibility of using the SSARR model to forecast flows on the Humber River using the high flow event that occurred in June 1984 (Cumming Cockburn, 1985). Both of these studies recommended that the data collection network required improvement if the model was to produce accurate flow forecasts. In 1990 under a cost sharing agreement between Environment Canada, Newfoundland Department of Environment and Lands and the Deer Lake Power Company the data collection network was improved. These improvements included the installation of additional stations, the addition of temperature and precipitation sensors to existing stations and the installation of transmitters for near real time data acquisition. Once data collection network expansion was completed, additional work was carried out to develop the procedures to implement the SSARR model for flow forecasting (Cumming Cockburn, 1995). The study also used the April 1991 version of the SSARR model. The changes in this version included microcomputer processing and the use of metric units. Also included was a recalibration of the model to utilise the new data provided by the expanded data collection network. The following paragraphs summarize the setup procedures carried out through all of these studies.

The first step in applying the SSARR model to the basin was to identify and isolate the various subwatersheds, reservoirs and channel reaches required to facilitate model calibration and validation using observed discharge data. Subwatersheds were selected by separating the total watershed into relatively homogeneous hydrologic units. Consideration was also given to the meteorologic and hydrometric data available for a given subwatershed to aid in the calibration and validation of the model. In addition to the selection of the sub-watersheds, the reservoirs and river reaches which have a significant impact on the flows to downstream hydrometric gauges were also identified and modelled in order to give an accurate representation of the hydrologic and hydraulic response of the system. Figure 8 is the basin map with the SSARR subbasin discretization.

The main elements of the Humber River watershed are represented in the SSARR model by 11 subbasins, two reservoirs and one lake. Figure 10 shows a schematic representation of the basin.

Meteorologic Input Data

One of the useful features of the SSARR model is that it allows the distribution of data from a number of meteorologic stations to the subbasins defined in the model. This capability is particularly helpful in representing the hydrologic regimes of large basins, like the Humber River, since it accounts for the spatial variations of the meteorologic parameters.

The initial hydrotechnical study for the basin found that there was "a marginally sufficient amount of meteorologic data available for the Humber River watershed which is considered to be suitable for hydrologic modelling via the SSARR model." (Cumming Cockburn, 1984) At that time none of the data was telemetered to a central locationrequiring the upgrading of the system to permit using the SSARR model for operational flow forecasting. The climate station locations are listed in Table 7 and shown on Figure 9.

Hydrologic Input Data

Many of the hydrologic parameters in the SSARR model are determined during the initial model setup. Some of these parameters are considered permanent characteristic of the model, including such things as the drainage area, and the altitude-area relationship as shown in Table 8. The snowband model option was used rather than the depletion option used in the 1984 study. The snowband option better represents the snowpack accumulation-depletion characteristics of the Humber Basin and was recommended by the model developer. (Cumming Cockburn, 1995).

Table 7 - Climate Station Locations - Humber River Basin

Atmospheric Environment Service			Department of Environment and Labour		
Station Name	AES ID No.	SSARR Code	Station Name	DCP Platform ID	SSARR Code
Deer Lake	8401500	1500	Upper Humber above Black Brook	4812C702	BLAC
Buchans	8400698	0698	Grand Lake on Glover Island	480FC3FA	GLGI
			Corner Brook Lake at Outlet	480D1066	CORN
			Burgeo Road near Buchan's Access	480FB56A	BURG
			Grand Lake at Southwest End	4812B192	GLSW
			Indian Brook Diversion	480CF16E	INDI
			Sandy Lake at Howley Road	4812A2E4	SAND

The mean daily evaporation amounts were based on the mean monthly values. The mean monthly amounts were obtained from isohyetal maps. (Environment Canada, 1970). The values ranged from 0.25 mm/day to 3.3 mm/day with an average of 1.4 mm/day. These values were adjusted as recommended in the SSARR manual using a function to account for daily rainfall which would tend to reduce potential evaporation amounts.

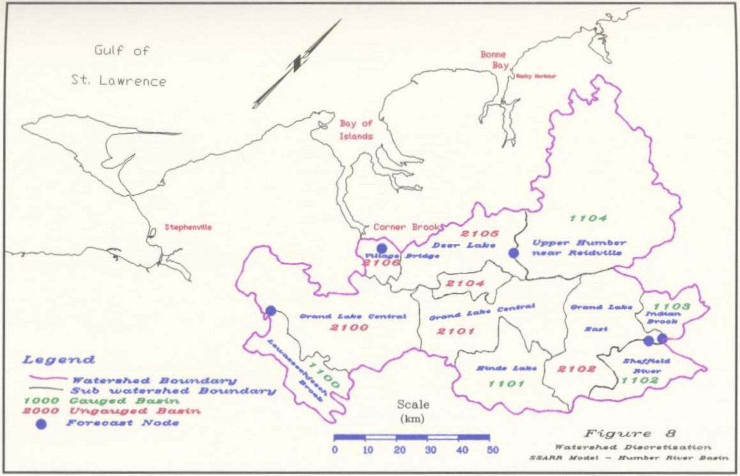

Figure 8
Watershed Discretization
SSARR Model – Humber River Basin

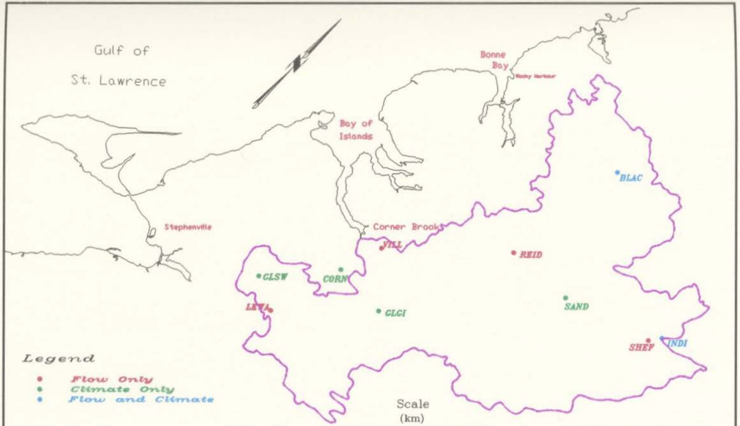

Figure 9
Hydrometric Station Locations
SSARR Model – Humber River Basin

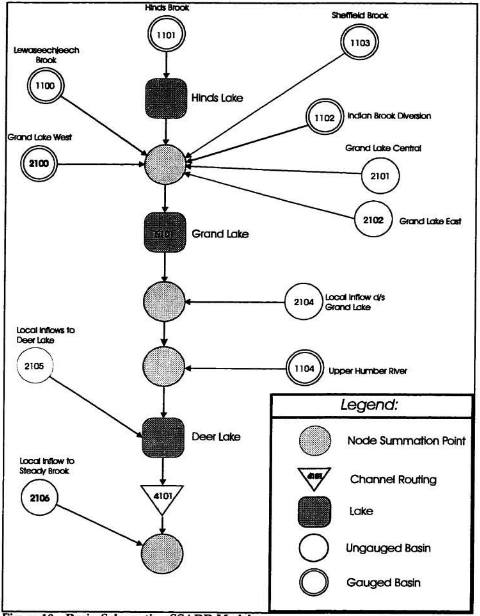

Figure 10 - Basin Schematic - SSARR Model

Table 8 - Subbasin Characteristics

Sub-basin Code and Name	Area (km^2)	Elevation Range (m)
W1100 - Lewaseechjeech Brook	470	145 - 700
W1101 - Hinds Lake	630	198 - 650
W1102 - Sheffield River	380	99 - 540
W1103 - Indian Brook Diversion	238	122 - 390
W1104 - Upper Humber River above Reidville	2108	15 - 685
W2100 - Grand Lake West	1298	85 - 640
W2101 - Grand Lake Central	690	85 - 640
W2102 - Grand Lake East	1180	85 - 568
W2104 - Local Inflow Downstream of Grand Lake	199	50 - 108
W2105 - Local Inflow to Deer Lake	640	4.5 - 458
W2106 - Local Inflow to Corner Brook	148	2 - 546

Area-Elevation Relationship

The area elevation relationship is input to the SSARR model to allow adjustments in the model for changes in the temperature as elevations in the basin change relative to climate stations. The relationship is shown in Figure 11.

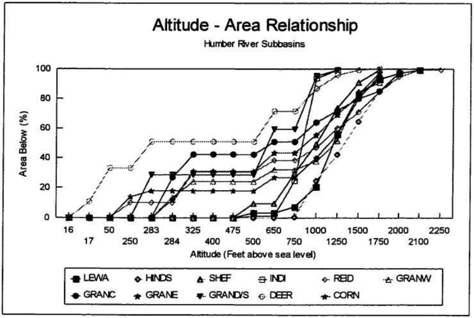

Figure 11 - Altitude-Area Relationship

4.1.1.7 Calibration and Verification

The calibrated parameters developed by Cumming Cockburn (Cumming Cockburn, 1995) were used as a basis for this study. The calibration procedure used data for the period from August 1991 to August 1992 using the available climate and hydrometric data. The model was verified using data from the period August 1992 to June 1993. Due to the problem with the data related to the ice effect on winter flows discussed in Chapter 3, no further calibration was undertaken for this study. However, a simulation run using the first two years of the data was carried out to visually evaluate the calibration. A sample of the results is presented in Figure 12.

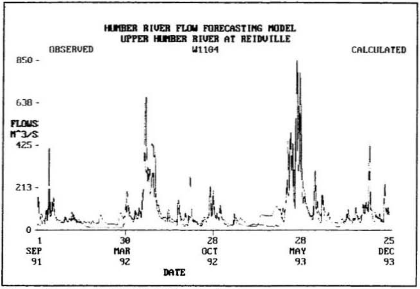

Figure 12 - Sample SSARR Calibration Run

Weighting of Meteorologic Stations

The SSARR model allows the user the option of assigning data available for several meteorologic stations to any of the subbasins defined in the model. Also, the user has the option of weighting meteorologic stations applied to each subbasin. The initial weights were determined by the consultant for the initial study (Cumming Cockburn, 1984) using Theissen polygons. In this process the temperature and precipitation data were first given the same weights. The weightings used in this study are based on the (Cumming Cockburn, 1995) study and are shown in Table 9.

Snowmelt Coefficients

Once the model yields good results for rainfall only events the calibration spring snowmelt events can be initiated. The parameters that require initial estimates are:

- rain freeze temperature;
- base temperature;
- lapse rate; and
- melt rate (for degree day method only).

The snowmelt coefficients used in this study are given in Table 10.

Routing Coefficients

The routing parameters were determined for the gauged watersheds then these values were transferred to the ungauged basins. The initial values were determined using runoff conditions that were independent of snowmelt. The routing coefficients are given in Table 11.

Table 9 - Precipitation Gauge Weights Applied to Sub-basins (Cumming Cockburn, 1995)

Sub-basin Code and Name	Climate Station								
	BLAC	GLSW	BURG	GLGI	SAND	INDI	0698	CORN	1500
W1100 - Lewaseechjeech Brook	n/a	150	150	175	n/a	n/a	n/a	n/a	n/a
W1101 - Hinds Lake	n/a	n/a	n/a	n/a	150	n/a	130	n/a	n/a
W1102 - Sheffield Brook	n/a	n/a	n/a	n/a	n/a	150	n/a	n/a	n/a
W1103 - Indian Brook Diversion	n/a	n/a	n/a	n/a	n/a	125	125	n/a	n/a
W1104 - Upper Humber River above Reidville	175	n/a	n/a	n/a	150	n/a	n/a	n/a	175
W2100 - Grand Lake West	n/a	150	n/a	140	n/a	n/a	n/a	n/a	n/a
W2101 - Grand Lake Central	n/a	n/a	n/a	140	150	n/a	n/a	n/a	135
W2102 - Grand Lake East	n/a	n/a	n/a	n/a	140	150	130	n/a	n/a
W2104 - Local Inflow Downstream of Grand Lake	n/a	n/a	n/a	150	140	n/a	n/a	n/a	120
W2105 - Local Inflow to Deer Lake	n/a	n/a	n/a	140	120	n/a	n/a	n/a	140
W2106 - Local Inflow to Corner Brook	n/a	n/a	n/a	140	n/a	n/a	n/a	140	n/a

(See Figure 9 for locations)

Table 10 - Snowmelt Coefficients (Cumming Cockburn, 1995)

Sub-basin Code and Name	Melt Rate (in/°F days)	Base Temperature (°F)	Freezing Temperature (°F) of rain	Lapse Rate (°F/1000 ft)
W1100 - Lewaseechjeech Brook	0.08	32	30	3
W1101 - Hinds Lake	0.09	30	32	3
W1102 - Sheffield River	0.07	28	35	3
W1103 - Indian Brook Diversion	0.05	28	35	3
W1104 - Upper Humber River above Reidville	0.07	32	35	3
W2100 - Grand Lake West	0.05	28	35	3
W2101 - Grand Lake Central	0.05	28	35	3
W2102 - Grand Lake East	0.05	28	35	3
W2104 - Local Inflow Downstream of Grand Lake	0.05	28	35	3
W2105 - Local Inflow to Deer Lake	0.06	28	35	3
W2106 - Local Inflow to Corner Brook	0.06	28	35	3

(See Figure 9 for locations)

Table 11 - Routing Coefficients (Cumming Cockburn, 1995)

Sub-basin Code and Name	Surface		Subsurface		Baseflow	
	NP	TS	NP	TS	NP	TS
W1100 - Lewaseechjeech Brook	3	15	2	40	2	300
W1101 - Hinds Lake	3	20	5	50	2	400
W1102 - Sheffield River	3	20	5	50	2	450
W1103 - Indian Brook Diversion	4	15	3	20	2	200
W1104 - Upper Humber River above Reidville	4	15	3	20	2	200
W2100 - Grand Lake West	3	15	3	20	2	200
W2101 - Grand Lake Central	3	15	3	20	2	200
W2102 - Grand Lake East	3	15	3	20	2	200
W2104 - Local Inflow Downstream of Grand Lake	3	10	2	20	2	200
W2105 - Local Inflow to Deer Lake	3	15	3	20	2	200
W2106 - Local Inflow to Corner Brook	3	10	3	15	2	100

(See Figure 9 for locations)

4.1.1.8 Data Format

The input data files for the SSARR model use a "card image" format. The format is based on the punch cards used when the model was developed in the 1950's. The card is divided into groups of columns specific to the type of card. For example, precipitation data is entered on a "Z4" card. In the example, in Table 12 the "Z4" identifies the card type, "BLAC" identifies the station, the next six columns the data, the "3" the time period for the data (daily in this case) and the remaining columns the actual data.

With the PC version of the program the control cards are placed in a separate data file in card format. The organization of the control card file is shown in Table 13.

Table 12 - SSARR Input Data

```
Z4 BLAC 010795 3   0.054  0.324  0.378  0.324  0.000  0.108  0.054  0.000
Z4 BLAC 090795 3   0.000  1.403  0.000  0.000  0.054  2.483  0.000  0.270
Z4 BLAC 170795 3   0.108  0.054  0.593  0.648  0.000  1.349  0.108  0.216
Z4 BLAC 250795 3   0.432  0.000  0.324  0.000  0.054  0.378  0.215
```

4.1.2 Forecasts for Specific Events

The selection of events was based on the period of record available for the DCP stations and the presence of suitable events to forecast. The spring snowmelt season was selected for the three years with data records outside of the calibration period.

The input files for each day were prepared and the model was run. Each of the input files was structured to provide a forecast three days beyond the forecast date for each of the five gauged subbasins. The results for one station are presented graphically in Figure 13.

Appendix C contains sample input and output files for the SSARR model as well as sample plots of the forecasts for each of the basins.

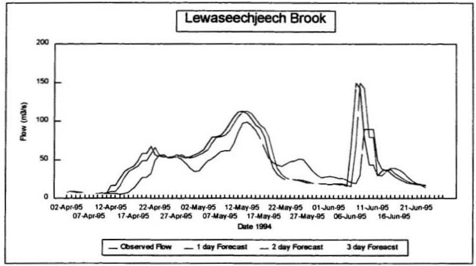

Figure 13 - Sample SSARR Flow Forecast Output

Table 13 - SSARR Control Card Organization

	Card	Description
Permanent characteristics of the model	J	Run characteristics
	CP	Characteristics of meteorologic stations
	CT	Tables of variations of basin parameters
	CB	Basin characteristics
	C3	Altitude-Area relationship
	CR	Reach characteristics
	CL	Lake and river characteristics
	C1	Reservoir storage curves
	CC	Node characteristics
	P	Network configuration
Initial conditions and input data	T	Duration of the simulation
	2B	Initial conditions of the basins
	2R	Initial conditions of the reaches
	3B	Revision of initial basin conditions
	4D	meteorologic data (observed and forecast)
	5	Temporal distribution of rain and temperature
	6	Hydrometric data
Control of Output	PR	Printing format for numeric output
	PQ	Printing format for graphic output
	END	end of file

4.2 Statistical Model (Dynamic Regression)

Dynamic regression models denote single equation regression models that combine time series oriented dynamic features with the effects of explanatory variables (Goodrich, 1989). The ARIMA type of model is purely dynamic. Its forecasts depend solely on the propagation of random shocks forwards in time. In addition to modelling this propagation process, a dynamic regression model must also account for the casual influences of the explanatory variables.

Dynamic regression may be used when:

- the datasets are long enough and stable enough to support a correlational model, and
- the explanatory variables increase the accuracy of fit in a meaningful way

4.2.1 Model Background

Much of the current theory and development of time series modelling goes back to Box and Jenkins (Box and Jenkins, 1976). In this text, Box and Jenkins referred a technique called the "combined transfer function-disturbance" model. Pankratz (Pankratz, 1991) used Box-Jenkins modelling technique calling it "dynamic regression".

The ordinary least squares dynamic regression model takes the form shown in Equation 2:

$$\phi(b)Y_t = \beta Z_t + \epsilon_t \qquad \textbf{(2)}$$

where $\phi(b)$ = autoregressive polynomial

Y_t = dependant variable at time t

β = coefficient of i'th exogenous variable $Z_t^{(i)}$

Z_t = vector of exogenous variables at time t

ϵ_t = errors where the errors are $NID(0, \sigma^2)$, ie. normally and independently distributed with variance σ^2

Often the residuals from Eq (1) are correlated, contrary to the assumption of independence. A significant correlation in the residuals indicates that the historical data are related to current data and may be useful in predicting future values. With streamflows, it is quite conceivable that tomorrows flows are related to flows and precipitation that occurred one, two or three days ago. For this reason, error autocorrelation must be seriously considered in model construction.

Error autocorrelation can be detected by examining the autocorrelation function (ACF) results, using the Ljung-Box Q-test, the Durbin-Watson test, or by using other tests. The ACF determines the If autocorrelations are found this may indicate that one or more lags should be added to the model or that additional exogenous variables should be added. In the modelling process exogenous variables are variables, such as temperature or precipitation that may not be initially included in the model. In some cases, both may be required.

One method to improve the model dynamics is to use the Cochrane-Orcutt (Goodrich, 1989) model to add new parameters. With this method. Equation 1 is replaced by the following pair of equations:

$$\phi(b)Y_t = \beta Z_t + \omega_t \qquad (3)$$

$$R(b)\omega_t = \epsilon_t \qquad (4)$$

where $\phi(b)$ = autoregressive polynomial

Y_t = dependant variable at time t

β = coefficient of i'th exogenous variable $Z_t^{(i)}$

Z_t = vector of exogenous variables at time t

R(b) = polynomial in the backward shift operator

ω_t = raw residual at time t

ϵ_t = errors where the errors are $NID(0, \sigma^2)$, ie. normally and independently distributed with variance σ^2

These two equations can also be written as a single equation as shown in Equation 5:

$$R(b)(\phi(b)Y_t - \beta Z_t) = \epsilon_t \qquad (5)$$

4.2.2 Forecast Model Development

The objective of this section is to create a dynamic regression based model for each of the five gauged basins within the Humber River Basin. Each of the basin models, in addition to being able to provide a reasonably accurate flow forecast, must conform to the theory of parsimony. In other words, the model should use the fewest number of coefficients that provide an adequate explanation of the data.

This section will describe the procedure used to develop the dynamic regression models. For this model process, the basin was represented by the schematic shown in Figure 14. The procedure was carried out using the Forecast Pro Software package (Business Forecast Systems Inc, 1993) using data prepared as described in Chapter 3. The step by step procedure used to develop the models is shown in Figure 15. The first step was to select an initial model. Since runoff is related to precipitation, the closest precipitation station was selected as the first independent variable. The next step is to fit the regression coefficients. The significance level of the variables are listed, with insignificant correlation flagged. If all the variables are significant the diagnostics are run. The diagnostics are checked for lagged variables and autoregressive terms. As part of the diagnostics, the software suggests a new lagged variable or autoregressive terms to add to the model. The procedure is continued until a satisfactory results is achieved. Figure 16 shows the change in the ACF using from: 1) just 0the precipitation term, 2) adding the flow lagged by one time step; and then 3) adding the precipitation lagged by one time step and an autoregressive term.

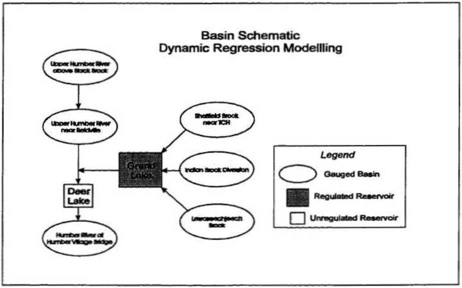

Figure 14 - Basin Schematic - Dynamic Regression Model

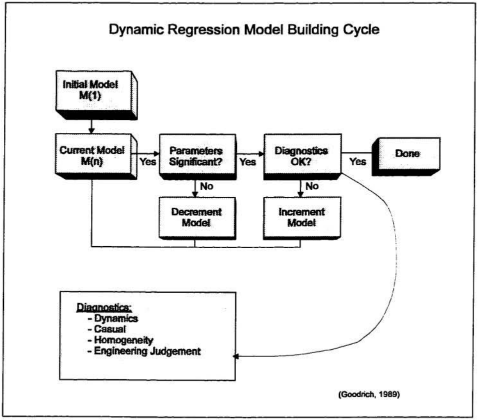

Figure 15 - Dynamic Regression Model Building Cycle

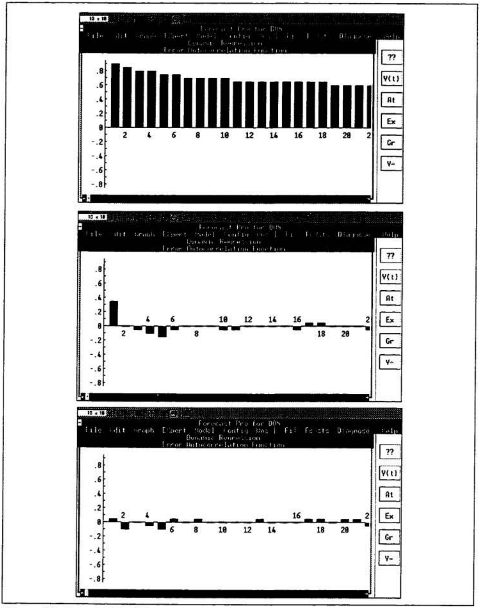

Figure 16 - Sample ACF Changes

4.2.3 Model Diagnostics

This section briefly describes the diagnostic tests that are performed by the Forecast Pro software during model development. The test can be performed each time a model is fitted to the data and the results can be use to add or remove terms from the model. The first group looks at the terms related to the dynamics of the model - the lags and the autoregressive terms. The second group looks at the inclusion or exclusion of variables. The variables can be either the inactive independent variables, the time related variables or a constant term.

4.2.3.1 Dynamics Specifications:

_AUTO[-n] This test determines whether a Cochrane-Orcutt autocorrelation error term of lag **n** should be added to the model. The test is performed for the first twelve lags and the first two seasonal lags. If the term is already in the model the test is omitted.

Y[-n] This test determines **n**'th lag of the dependent variable term should be added to the model. The test is performed for the first twelve lags and the first two seasonal lags. As with the previous test, the test is omitted if the term is already in the model.

The software provides a recommendation to add a specific new term to the model. The process can be repeated until the modeller is satisfied with the results.

4.2.3.2 Variable Specification

Excluded Variables: Each inactive variable in the tableau is evaluated tested with a Lagrange multiplier test.

Time Trend: This test uses alternative hypothesis testing to determine whether a linear time trend improves the fit of the model. A significant test result does not necessarily indicate that a time trend variable should be added but may indicate that there is a problem with the model's dynamics or with an excluded term.

Constant Term This test evaluates whether a constant term improves the fit of the model.

Lagged independent variables Each of the independent variables in the current model is tested.

4.2.3.3 Custom excluded variable tests

This test allows the user to test whether groups of excluded terms will improve the fit of the model. Sometimes combinations of excluded variables will be significant even if they are insignificant separately.

4.2.3.4 Standard diagnostics

Each time a model is fitted, a group of standard diagnostics are displayed. A typical set of data is displayed in Table 14. Included in the this group are the mean, standard deviation. Others are described below:

Table 14 - Sample Diagnostics from Dynamic Regression Model

```
Forecast Pro for DOS Version 2.00A
Sun Jul 06 19:03:30 1997

Forecast Model for FLOW
Regression(3 regressors, 0 lagged errors)

Term            Coefficient  Std. Error  t-Statistic  Significance
------------------------------------------------------------------
----
FLOW[-1]          1.344443    0.021865    61.488101     1.000000
FLOW[-2]         -0.387660    0.021795   -17.786622     1.000000
TOT_PREC          0.113747    0.009149    12.432964     1.000000

Standard Diagnostics
------------------------------------------------------------------
----
Sample size 1626                   Number of parameters 3
Mean 11.25                         Standard deviation 11.19
R-square 0.9398                    Adjusted R-square 0.9398
Durbin-Watson 1.979                ** Ljung-Box(18)=53.38 P=1
Forecast error 2.746               BIC 2.762 (Best so far)
MAPE 0.1313                        RMSE 2.743
MAD 1.32
```

Mean Absolute Deviation: This value is the measure of the average of the absolute discrepancies between the actual and fitted values in a given time series. The value is calculated using Equation 6:

$$MAD = \frac{\sum_{t=1}^{n} |Y - \hat{Y}|}{n} \tag{6}$$

Standard Forecast Error: The standard error is the root mean square of the actual data minus the fitted values given by Equation 7:

$$SE = \sum_{t=1}^{n} (Y - \hat{Y})^2 \tag{7}$$

R-square: This is a measure of the variance that is explained by the model. In the example, 93.98% of the variance is explained by the model.

Bayesian Information Criterion : The BIC statistic is a measure that is used to evaluate the parsimony of a model. This statistic reward for goodness of fit based on the mean square error and penalizing for complexity based on the number of parameters. The object of model building is to minimize the BIC. The form of the equation used in Forecast Pro is given in Equation 8:

$$BIC = sT^{\frac{n}{2T}} \tag{8}$$

where T = number of sample points

s = mean square error

n = number of parameters

Durbin-Watson test: The Durbin Watson statistic is a standard test for the presence of autocorrelation in regression residuals. Some of the assumptions for the use of this statistic (Pankratz, 1991) are:

- a constant term is present in the model,
- the series follows a AR(1) process

- the regression does not include any time lagged Y values
- there are no missing values

This statistic was not very useful for this study since a number of the assumption were violated. The form of the equation for the Durbin Watson d use in Forecast Pro is shown in Equation 9:

$$d = \frac{\sum_{t=2}^{r}(e_t - e_{t-1})^2}{\sum_{t=1}^{r} e_t^2} \quad \textbf{(9)}$$

Ljung-Box test: The Ljung-Box Q statistic (Pankratz, 1991) is used to test the overall autocorrelation of the fitted errors of a model. This test is an improvement of the Box-Pierce (portmanteau) test. The statistic is a weighted sum of squared autocorrelations and consequently zero only when every autocorrelation is zero. The value of Q increases with more autocorrelation. The weights are so that Q approximates $X^2(L - n)$, which is the Chi-square with $L - n$ degrees of freedom. The form of the equation used in Forecasts Pro is given in Equation 10:

$$Q = T(T + 2)\sum_{i=1}^{L} \frac{r_i^2}{(T - i)} \quad \textbf{(10)}$$

where T = number of sample points

r_i = i'th autocorrelation coefficient

L = number of correlation coefficients

4.2.4 Model Results

As discussed in Chapter 3.1, the data used in the analysis was obtained from NDOEL files. For this part of the analysis, the data was formatted in a Lotus 1-2-3 spreadsheet for each basin so that they were compatible with the Forecast Pro software. The procedure used was to start with the simplest form of the regression relationship and build on that relationship until the best fit to the data was obtained. Data for the period of record from 1991 to 1994 was used in the analysis to develop the dynamic regression relationship for each basin. The final set of coefficients developed in the analysis are presented in Table 15. A sample of the historic data and the data fitted with using the dynamic regression model for one of the gauged basins is presented in Figure 17.

4.2.5 Generation of Forecasts

Once the coefficients for the dynamic regression models were selected as described in the previous section, forecasts were generated. The nature of the basin had to be taken into account to set up the order for generation. The Sheffield, Lewaseechjeech and Indian Brook Diversion basins could be generated independently. Since three of the gauges, the Upper Humber River above Black Brook, the Upper Humber River near Reidville and the Humber River near Village Bridge are linked physically as described in the basin schematic

Table 15 - Form of Dynamic Regression Models

Sub-basin Name	Form of Dynamic Regression Equation
Lewaseechjeech Brook	_CONST + a PREGLGI + b FLOW[-1] + c FLOW[-2] + d FLOW[-3]; where: _CONST = 0.149490 a = 0.244776; b = 1.664595; c = -1.046278 d = 0.336051
Sheffield Brook	_CONST + a PREINDI + b FLOW[-1] + c FLOW[-2]; where: _CONST = 0.348126 a = 0.041432; b = 1.432156 c = -0.462627
Indian Brook Diversion	_CONST + a PRECINDI + b FLOW[-1] + c FLOW[-2]; where _CONST = 0.448615 a = 0.118321; b = 1.297039; c = -0.362822
Upper Humber River above Reidville	_CONST + a PRESAND + b FLOW[-1] + c FLOW[-2] + d FLOBLAC + e _AUTO[- 1]; where: _CONST =14.380586 a = -0.210896; b = 0.739059; c = -0.376750 d = 1.055177; e = 0.884608
Upper Humber River above Black Brook	_CONST + a PRECBLAC + b FLOW[-1] + c FLOW[-2]; where: _CONST = 1.254866 a = 0.558944; b = 1.238943; c = -0.315646
Humber River at Humber Village Bridge	_CONST + a PREBLAC + b FLOW[-1] + c FLOREID + d FLOBLAC + e _AUTO[- 1]; where: _CONST = 21.697851 a = 0.187210; b = 0.859492; c = 0.196181 d = -0.055710; e = 0.525336

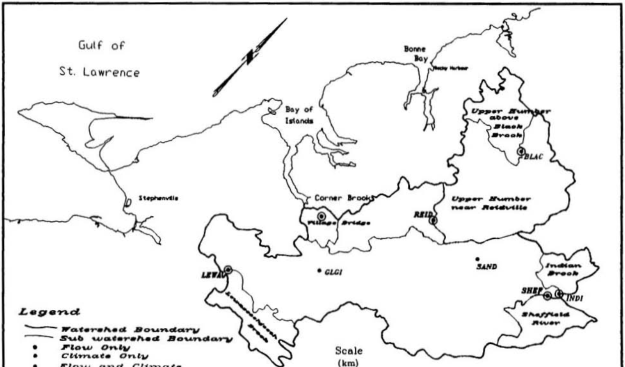

Figure 17
Dynamic Regression Model
Humber River Basin

and basin map, Figures 14 and 17 respectively, forecasts for these stations had to be generated in an upstream to downstream order. That is, the forecasts for the Black Brook basin were used to generate forecasts for the Reidville basin and the Reidville forecasts were then used to generate forecasts at Humber Village Bridge.

Forecasts were generated for the same time periods used for the SSARR forecasts discussed in Section 4.1. However, for this analysis, the Upper Humber River above Black Brook basin was added. This basin was not set up separately in the SSARR model since a forecast was not required for this area. Since the flow and climate data was available and the model development for the dynamic regression equations described earlier in this chapter showed that flows from this basin were significant in forecasting downstream flows, it was included here.

The forecasts were generated for one day, two day and three day lead times using data up to the forecast data. The model was setup so that it did not update. That is, the forecasts for the one two and three day lead times used data up to the forecast date only. The results for the one, two and three day forecasts for the Humber River at Humber Village Bridge and the Upper Humber River at Reidville sites are shown in Figures 18-21. A sample output file from Forecast Pro as well as forecast plots from the other stations are presented in Appendix D.

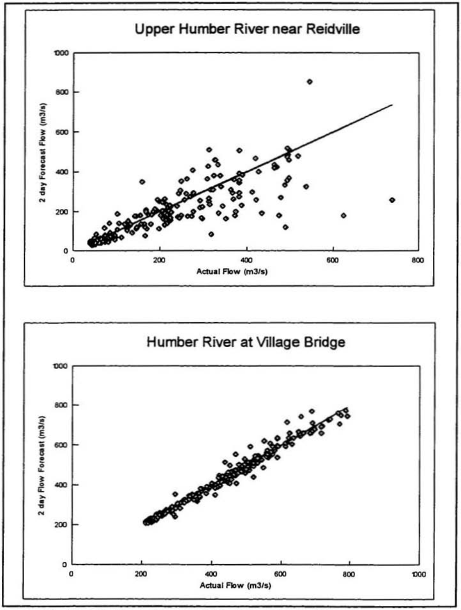

Figure 18 - Dynamic Regression Model Results vs Recorded Flows

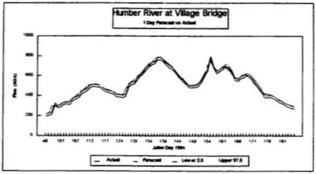

Figure 19 - Sample One day Forecast

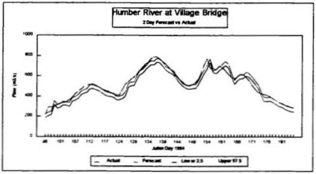

Figure 20 - Sample Two day Forecast

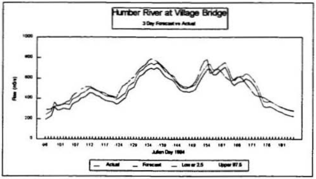

Figure 21 - Sample three Day Forecast

5. COMPARISON OF MODELLING RESULTS

The main objective of this study was to develop a flow forecast model based on dynamic regression and to compare the results with forecasts from the SSARR model. The previous chapter described the methodology used to develop the flow forecasts by the two methods under comparison. The chapter compares the results of the two methods, discusses the significance of the results and outlines some of the reasons why the SSARR model may have performed poorly compared with the dynamic regression model

5.1 Analysis of Results

A detailed survey (Mahmoud, 1984) reviewed the relevant literature and tested many of the accuracy measures used to compare forecasts, including the mean square error, the mean percentage error, the mean absolute percentage error, Theil's U-statistic, the root mean square error, the mean error and others. Since it is important to consider forecast bias in time series analysis, the mean absolute percentage error (MAPE) method was selected to measure the accuracy of the two forecasting methods. The equation describing this method is presented in Equation 11. The results from the two methods are presented in Tables 16 and 17.

$$MAPE = \frac{100}{m}\sum_{t=1}^{m} \left|\frac{e_t}{z_t}\right|, \qquad t = 1, 2, \ldots\ldots m \qquad (11)$$

Where e_t	=	forecast error
z_t	=	observed value
m	=	total number of observed values

Table 16 - MAPE Dynamic Regression Model

MAPE for Dynamic Regression Method				
Upper Humber River Above Black Brook				
	t (Julian Day)	One Day	Two Day	Three Day
1994	121-180	17.8	32.7	40.2
1995	121-176	14.0	29.1	37.6
1996	80-140	18.1	33.4	41.2
Lewaseechjeech Brook Flow Data				
	t (Julian Day)	One Day	Two Day	Three Day
1994	66-166	9.2	17.4	23.4
1995	96-176	7.5	17.2	26.0
1996	36-71	9.4	19.6	27.8
Sheffield Brook Flow Data				
	t (Julian Day)	One Day	Two Day	Three Day
1994	96-176	5.9	10.4	14.9
1995	101-181	5.9	11.8	17.1
1996	36-73	6.3	12.1	17.7
Indian Brook Diversion Flow Data				
	t (Julian Day)	One Day	Two Day	Three Day
1994	56-176	10.5	18.9	25.9
1995	121-171	8.6	17.1	24.3
1996	46-81	10.5	19.8	27.9
Upper Humber River at Reidville Flow Data				
	t (Julian Day)	One Day	Two Day	Three Day
1994	121-179	13.8	25.0	33.6
1995	91-175	9.0	19.3	28.5
1996	81-140	11.0	22.1	31.1
Humber River at Village Bridge Flow Data				
	t (Julian Day)	One Day	Two Day	Three Day
1994	96-185	2.4	4.6	6.4
1995	91-180	1.2	2.8	4.3
1996	80-140	1.7	3.5	5.4

Table 17 - MAPE Results for SSARR Model

MAPE for SSARR Model				
Lewaseechjeech Brook Flow Data				
	t (Julian Day)	One Day	Two Day	Three Day
1994	66-166	36.5	30.0	27.1
1995	96-176	46.1	47.9	50.3
1996	36-71	109.1	94.2	84.4
Sheffield Brook Flow Data				
	t (Julian Day)	One Day	Two Day	Three Day
1994	96-176	46.7	46.8	47.2
1995	101-181	29.0	29.1	28.1
1996	36-73	50.5	49.0	48.6
Indian Brook Diversion Flow Data				
	t (Julian Day)	One Day	Two Day	Three Day
1994	56-176	37.8	38.5	40.7
1995	121-171	85.7	88.1	90.5
1996	46-81	71.1	67.5	63.4
Upper Humber River at Reidville Flow Data				
	t (Julian Day)	One Day	Two Day	Three Day
1994	121-179	43.1	39.1	38.0
1995	91-175	51.1	52.0	53.4
1996	81-140	107.1	95.8	87.8
Humber River at Village Bridge Flow Data				
	t (Julian Day)	One Day	Two Day	Three Day
1994	96-185	22.8	23.3	23.5
1995	91-180	22.0	22.4	22.6
1996	80-140	31.8	31.9	32.4

5.2 Discussion of Results

The most obvious observation based on the MAPE criterion is that the dynamic regression model was consistently more accurate. The SSARR results, especially for the 1996 data set at Humber River near Reidville and Lewaseechjeech Brook, were far less accurate. However, as shown in Figure 22, the SSARR model was reasonably close in estimating the magnitude of the maximum flood flow, still the time of the peak is off by several days.

While the results from the SSARR model were disappointing, other studies have produced similar, and often variable, results. Figure 23 shows the results from a study (Manitoba, 1985) that compared several different deterministic models, including SSARR. In the top graph, the results are very good, while in lower graph the forecasted flows are not at all close to the actual flows.

The dynamic regression model has an advantage during time periods with consistent flows dynamic updating capabilities. This is the time when the SSARR model is at its greatest disadvantage since an inaccuracy in the SMI will carry through the whole time period.

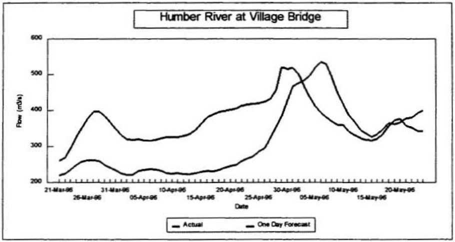

Figure 22 - SSARR Results for 1996 Data

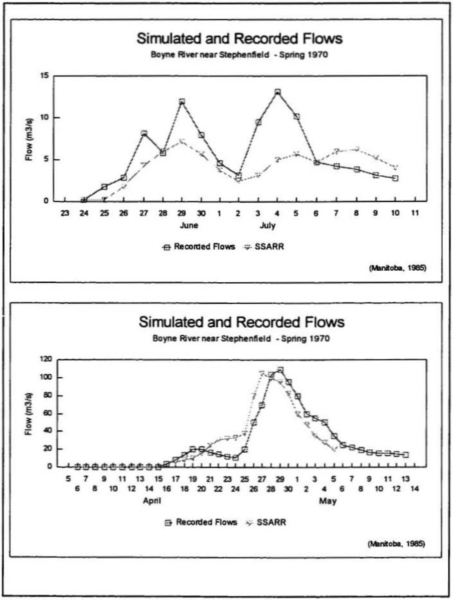

Figure 23 - Results of Manitoba Model Comparison

Another problem with the SSARR model, and to some extent all deterministic models, is the lack of calibration data. In this study, the basin was divided into eleven subbasins. Of these subbasins, six have no flow records at all. The combined drainage area of these subbasins totals 4150 km^2, or about 50 percent of the total drainage area. Also, many of the parameters, such as the ETI, are based on empirical relationships that have very little field data on which to base a calibration. The real problem with these empirical relationships is separating the effects of one parameter from another during the calibration process. As discussed in Chapter 4.1.1, the calibration process is essentially a trial and error process to fit the model to measured hydrologic events. Usually only the flow, the temperature and precipitation are known at a small number of points in or near the basin. The model must take these point measurements and distribute the values over some or all of a subbasins. The location of the climate stations may not be in the optimal location to distribute the data. Many of the climate stations, such as the Indian Brook Diversion site and the Upper Humber River above Black Brook were installed at the hydrometric station for convenience of maintenance and operation. These locations are at the extreme downstream end of the basin at the lowest elevation in the basin so the climate data collected at these sites may not accurately represent the conditions upstream. Generally lower elevations tend to receive more precipitation than higher elevations. This is compensated for in the model using the meteorologic weighting factors. Adjustments in the SMI or the other parameters could achieve the same result for some events.

The dynamic regression model seemed to handle the problem with the erroneous flow values due to the ice effect discussed in Chapter 3. The initial data analysis in the dynamic regression model development identified the data as stationary but seasonal. Since the ice cover is a seasonal phenomenon the fitted model compensated for the differences. The SSARR model may also forecast for this season provided that calibration is carried out during the same season.

The modeller requires a thorough knowledge of the basin's hydrology to calibrate the SSARR model. It is essential to determine which parameters in the model to adjust to improve the fit. While the SSARR manual presents a step by step procedure for parameters adjustments, some require "dry" periods or rainfall events following a dry period to isolate specific parameters. With the variability of Newfoundland weather conditions, this is not an easy task. With the dynamic regression model, a reasonable knowledge of the basin's hydrology and a good statistical software package can provide good results with ease and economy. Fewer parameters are needed and the calibration can be easily updated as new data becomes available.

One factor that was not explored with the dynamic regression model was a method to account for spills that may occur from the Grand Lake Reservoir. These areincluded in the SSARR model and may present a difficulty with the regression model.

6. CONCLUSIONS AND RECOMMENDATIONS

The results of the dynamic regression model and the deterministic model were compared in the preceding Chapter. This Chapter presents the conclusions and recommendations.

6.1 Conclusions

The conclusions of the study are as follows:

1. The dynamic regression model provides a good alternative to the SSARR model for near real time flow forecasting for the Humber River Basin based on the results of this study. The results indicate that the dynamic regression model should be further evaluated under operational conditions.
2. The SSARR model provided a reasonable estimate of peak discharge at the Reidville and Village Bridge sites where these discharges are important for flood forecasting
3. More work needs to be done to improve the calibration of the SSARR model. Initially the present calibration parameters should be reevaluated to determine the areas that need improvement. Possibly more data collection stations, or the relocation of the existing stations would improve the model.

4. The SSARR model requires a higher level of knowledge in terms of the basins hydrology and the model application to provide good results compared with the dynamic regression model.

5. The dynamic regression models provided accurate forecasts in spite of the problem with the flow data related to ice effects discussed in Chapter 3.

6. The dynamic regression model requires less data and effort in calibration.

7. Confidence limits are given in the dynamic regression model.

6.2 Recommendations

The results of this study show that the dynamic regression model can produce accurate flow forecasts for the Humber River Basin. Since the dynamic regression model is less complicated and requires less effort to calibrate, the Department of Environment and Labour should include use of a dynamic regression model in its operational forecasting activities. Initially the dynamic regression model could be added on a trial basis to confirm that the model can reproduce results similar to this study. Once its effectiveness is confirmed in actual operations the model can be implemented, either on its own or concurrently with the SSARR model.

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APPENDICES

A Comparative Study of Flow Forecasting in the Humber River Basin using a Deterministic Hydrologic Model and a Dynamic Regression Statistical Model

by

Robert C. Picco

A thesis submitted to the

School of Graduate Studies

in partial fulfilment of the

requirements for the degree of

Master of Engineering

Faculty of Engineering and Applied Science

University of Newfoundland

August 1997

St. John's Newfoundland

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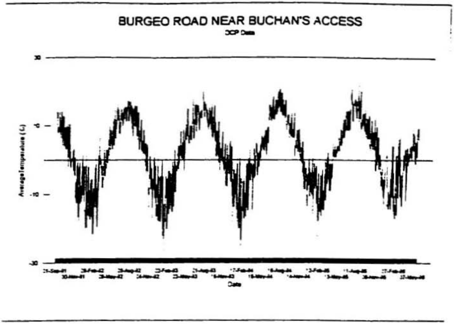
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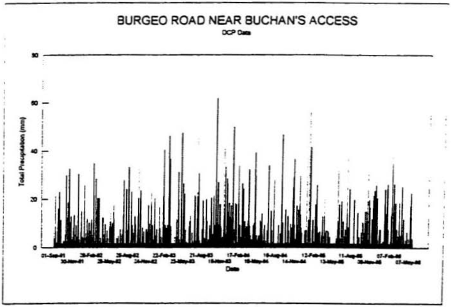
Date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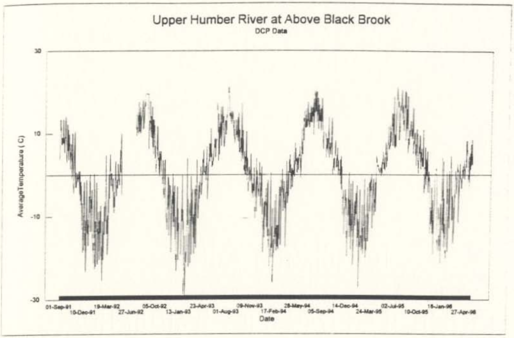
Total Precipitation (mm)
Date



Upper Humber River at Above Black Brook
DCP Data
Average Temperature (C)
30
10
-10
-30
01-Sep-91
10-Dec-91
19-Mar-92
27-Jun-92
05-Oct-92
13-Jan-93
23-Apr-93
01-Aug-93
09-Nov-93
17-Feb-94
28-May-94
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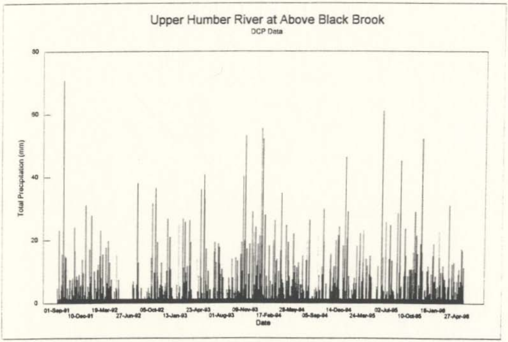
14-Dec-94
24-Mar-95
02-Jul-95
10-Oct-95
18-Jan-96
27-Apr-96
Date



Upper Humber River at Above Black Brook
DCP Data
Total Precipitation (mm)
80
60
40
20
0
01-Sep-91
10-Dec-91
19-Mar-92
27-Jun-92
05-Oct-92
13-Jan-93
23-Apr-93
01-Aug-93
09-Nov-93
17-Feb-94
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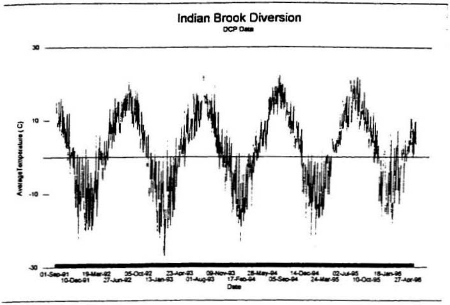
18-Jan-96
27-Apr-96
Date



Indian Brook Diversion
DCP Data
Average Temperature (C)
30
10
-10
-30
01-Sep-91
10-Dec-91
19-Mar-92
27-Jun-92
05-Oct-92
13-Jan-93
23-Apr-93
01-Aug-93
09-Nov-93
17-Feb-94
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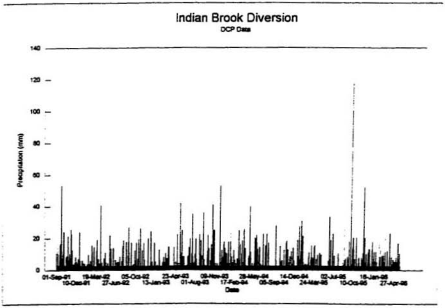
18-Jan-96
27-Apr-96
Date



Indian Brook Diversion
DCP Data
Precipitation (mm)
140
120
100
80
60
40
20
0
01-Sep-91
10-Dec-91
19-Mar-92
27-Jun-92
05-Oct-92
13-Jan-93
23-Apr-93
01-Aug-93
09-Nov-93
17-Feb-94
28-May-94
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14-Dec-94
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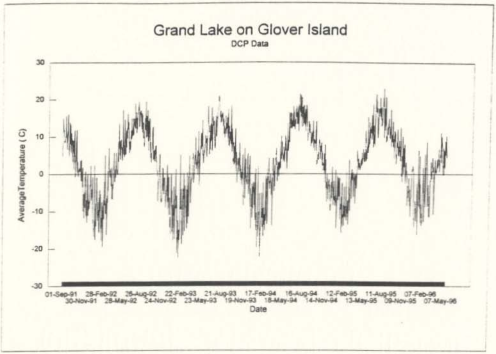
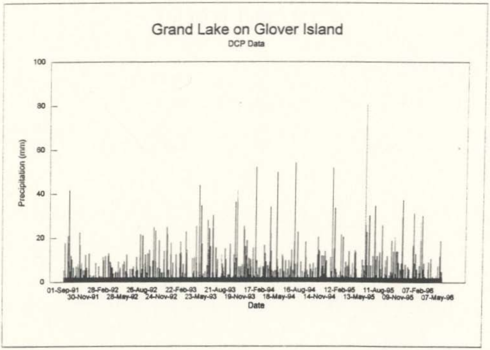
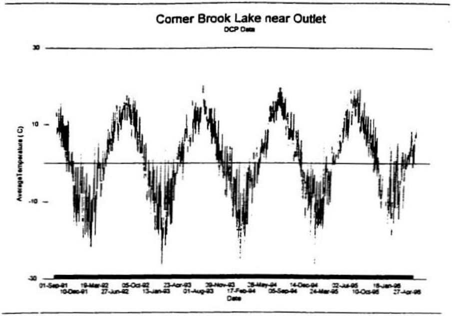
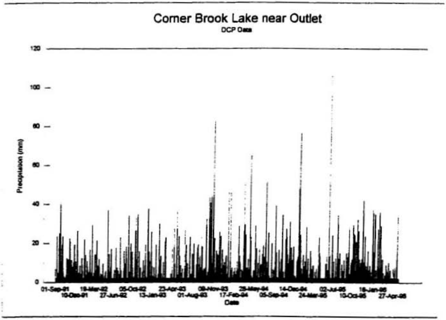
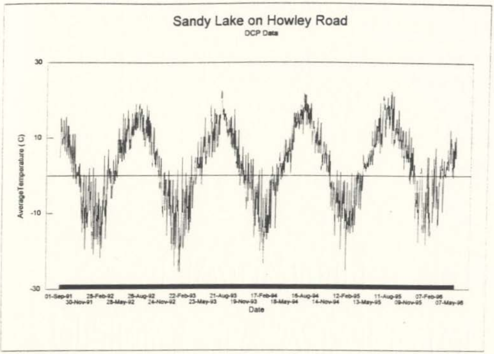
10-Oct-95
18-Jan-96
27-Apr-96
Date


Grand Lake on Glover Island
DCP Data
Average Temperature (C)
30
20
10
0
-10
-20
-30
01-Sep-91 28-Feb-92 26-Aug-92 22-Feb-93 21-Aug-93 17-Feb-94 16-Aug-94 12-Feb-95 11-Aug-95 07-Feb-96
30-Nov-91 28-May-92 24-Nov-92 23-May-93 19-Nov-93 18-May-94 14-Nov-94 13-May-95 09-Nov-95 07-May-96
Date


Grand Lake on Glover Island
DCP Data
Precipitation (mm)
100
80
60
40
20
0
01-Sep-91 28-Feb-92 26-Aug-92 22-Feb-93 21-Aug-93 17-Feb-94 16-Aug-94 12-Feb-95 11-Aug-95 07-Feb-96
30-Nov-91 28-May-92 24-Nov-92 23-May-93 19-Nov-93 18-May-94 14-Nov-94 13-May-95 09-Nov-95 07-May-96
Date


Corner Brook Lake near Outlet
DCP Data
30
10
-10
-30
AverageTemperature (C)
01-Sep-91
10-Dec-91
19-Mar-92
27-Jun-92
05-Oct-92
13-Jan-93
23-Apr-93
01-Aug-93
09-Nov-93
17-Feb-94
28-May-94
05-Sep-94
14-Dec-94
24-Mar-95
02-Jul-95
10-Oct-95
18-Jan-96
27-Apr-96
Date


Corner Brook Lake near Outlet
DCP Data
120
100
80
60
40
20
0
Precipitation (mm)
01-Sep-91
10-Dec-91
19-Mar-92
27-Jun-92
05-Oct-92
13-Jan-93
23-Apr-93
01-Aug-93
09-Nov-93
17-Feb-94
28-May-94
05-Sep-94
14-Dec-94
24-Mar-95
02-Jul-95
10-Oct-95
18-Jan-96
27-Apr-96
Date


Sandy Lake on Howley Road
DCP Data
AverageTemperature (C)
30
10
-10
-30
01-Sep-91
30-Nov-91
28-Feb-92
28-May-92
26-Aug-92
24-Nov-92
22-Feb-93
23-May-93
21-Aug-93
19-Nov-93
17-Feb-94
18-May-94
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07-Feb-96
07-May-96
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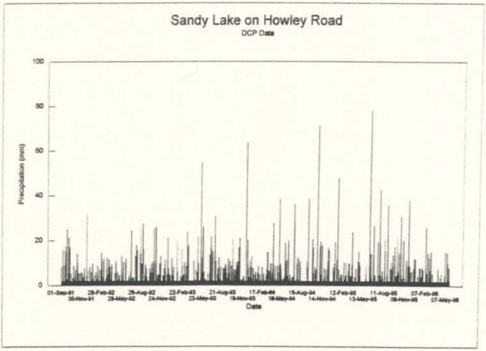
Sandy Lake on Howley Road
DCP Data
Precipitation (mm)
100
80
60
40
20
0
01-Sep-91
30-Nov-91
28-Feb-92
28-May-92
26-Aug-92
24-Nov-92
22-Feb-93
23-May-93
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18-May-94
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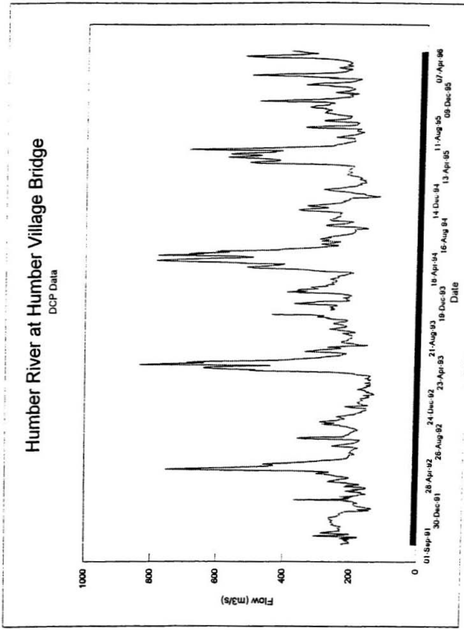
07-Feb-96
07-May-96
Date


Humber River at Humber Village Bridge
DCP Data
Flow (m3/s)
1000
800
600
400
200
0
01-Sep-91
30-Dec-91
28-Apr-92
26-Aug-92
24-Dec-92
23-Apr-93
21-Aug-93
19-Dec-93
18-Apr-94
16-Aug-94
14-Dec-94
13-Apr-95
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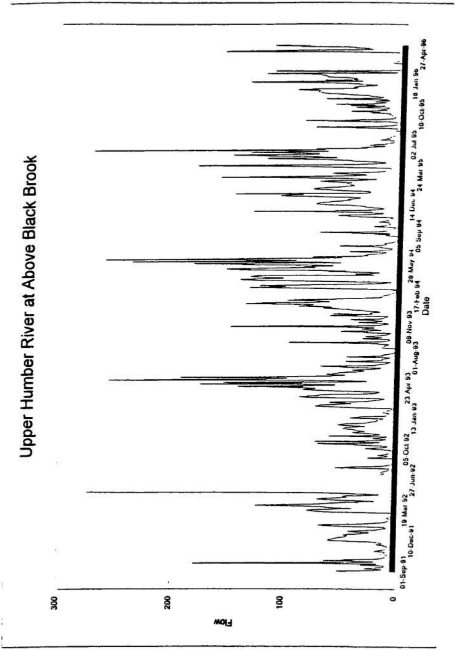
09-Dec-95
07-Apr-96
Date


Upper Humber River at Above Black Brook
Flow
300
200
100
0
01-Sep-91
10-Dec-91
19 Mar 92
27 Jun 92
05 Oct 92
13 Jan 93
23 Apr 93
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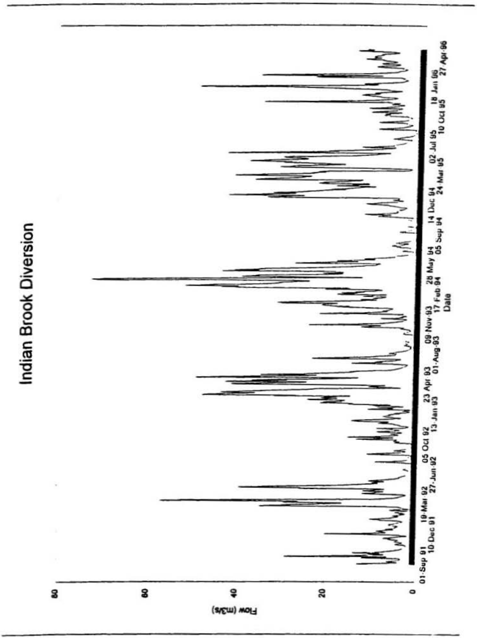
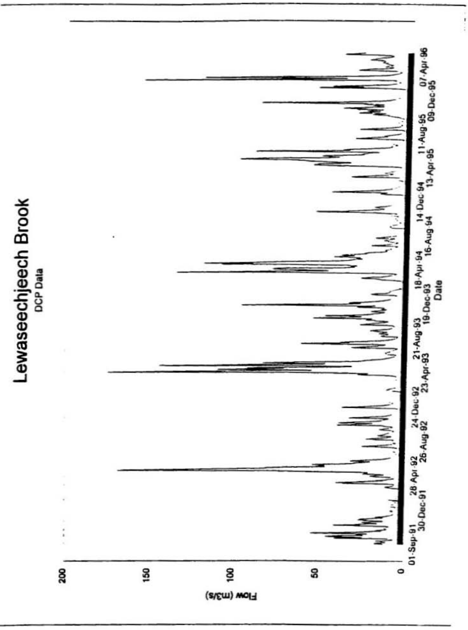
18 Jan 96
27 Apr 96
Date


Indian Brook Diversion
Flow (m3/s)
40
20
0
01-Sep-91
10-Dec-91
19-Mar-92
27-Jun-92
05 Oct 92
13-Jan-93
23 Apr 93
01-Aug-93
09-Nov-93
17 Feb 94
28 May 94
05 Sep 94
14 Dec 94
24 Mar 95
02 Jul 95
10 Oct 95
18 Jan 96
27 Apr 96
Date


Lewaseechjeech Brook
DCP Data
Flow (m3/s)
200
150
100
50
0
01-Sep-91
30-Dec-91
28-Apr-92
26-Aug-92
24-Dec-92
23-Apr-93
21-Aug-93
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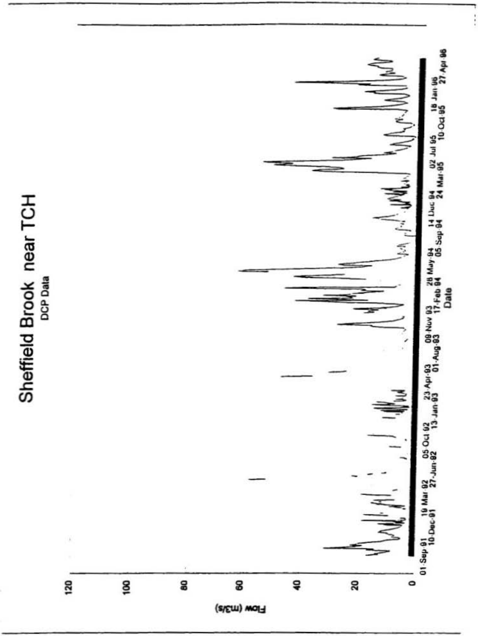
09-Dec-95
07-Apr-96
Date


Sheffield Brook near TCH
DCP Data
Flow (m3/s)
120
100
80
60
40
20
0
01-Sep-91
10-Dec-91
19 Mar 92
27-Jun-92
05 Oct 92
13-Jan-93
23-Apr-93
01-Aug-93
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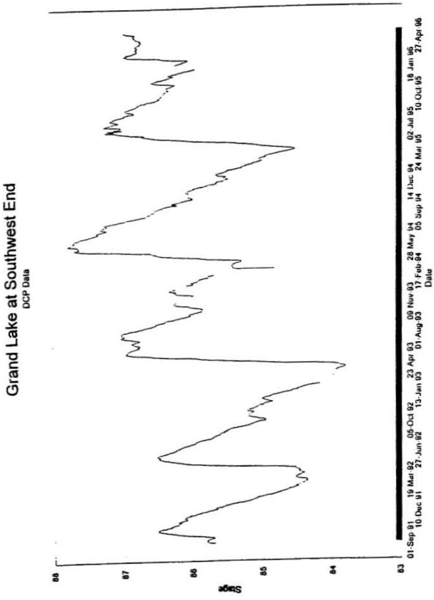
18 Jan 96
27-Apr-96
Date



Grand Lake at Southwest End
DCP Data
Stage
88
87
86
85
84
83
01-Sep-91
10-Dec-91
19-Mar-92
27-Jun-92
05-Oct-92
13-Jan-93
23-Apr-93
01-Aug-93
09-Nov-93
17-Feb-94
28-May-94
05-Sep-94
14-Dec-94
24-Mar-95
02-Jul-95
10-Oct-95
18-Jan-96
27-Apr-96
Date

Upper Humber River above Black Brook

WARNING: There are too many cases to calculate medians. You could choose fewer variables.

TOTAL OBSERVATIONS: 1728

	FLOW	TOTPRE	TEMPAVG	PRERAIN	PRESNOW	TEMPMAX	TEMPMIN
N OF CASES	1666	1659	1659	1659	1659	1659	1659
MINIMUM	1.140	0.000	-30.280	0.000	0.000	-22.700	-39.500
MAXIMUM	275.290	70.880	21.210	70.880	55.410	28.900	18.700
RANGE	274.150	70.880	51.490	70.880	55.410	51.600	58.200
MEAN	40.717	3.854	0.197	2.350	1.502	5.110	-5.262
STANDARD DEV	37.891	6.769	10.272	5.889	3.880	10.516	11.206
STD. ERROR	0.928	0.166	0.252	0.145	0.095	0.258	0.275
SKEWNESS(G1)	1.877	3.741	-0.223	4.960	5.175	0.021	-0.503
KURTOSIS(G2)	5.052	20.418	-0.604	34.448	39.916	-0.692	-0.341
C.V.	0.931	1.756	52.026	2.506	2.583	2.058	-2.130

Burgeo Road near Buchan's Access

WARNING: There are too many cases to calculate medians. You could choose fewer variables.

TOTAL OBSERVATIONS: 1728

	PRECRAIN	PRECSNOW	TEMPAVG	TEMPMAX	TEMPMIN	TOTPREC
N OF CASES	1728	1728	1728	1728	1728	1728
MINIMUM	0.000	0.000	-26.600	-23.000	-35.600	0.000
MAXIMUM	110.030	56.140	22.010	29.800	19.300	110.030
RANGE	110.030	56.140	48.610	52.800	54.900	110.030
MEAN	2.750	1.183	1.769	6.057	-2.661	3.932
VARIANCE	46.443	14.552	94.482	102.742	100.641	57.887
STANDARD DEV	6.815	3.815	9.720	10.136	10.032	7.608
SKEWNESS(G1)	5.312	6.582	-0.274	-0.139	-0.418	4.321
KURTOSIS(G2)	48.544	58.099	-0.694	-0.695	-0.532	31.383
C.V.	2.478	3.225	5.495	1.674	-3.770	1.935

Corner Brook Lake at Outlet

WARNING: There are too many cases to calculate medians. You could choose fewer variables.

TOTAL OBSERVATIONS: 1728

	PRECRAIN	PRECSNOW	TEMPAVG	TEMPMAX	TEMPMIN	TOTPREC
N OF CASES	1706	1706	1706	1706	1706	1719
MINIMUM	0.000	0.000	-28.910	-22.400	-37.400	0.000
MAXIMUM	106.230	76.580	20.950	28.600	17.500	106.230
RANGE	106.230	76.580	49.860	51.000	54.900	106.230
MEAN	3.120	1.463	1.277	5.384	-3.254	4.617
VARIANCE	61.745	13.885	94.869	98.437	107.898	72.686
STANDARD DEV	7.858	3.726	9.740	9.922	10.387	8.526
SKEWNESS(G1)	4.725	7.131	-0.309	-0.119	-0.534	4.067
KURTOSIS(G2)	33.871	104.804	-0.612	-0.713	-0.283	26.187
C.V.	2.518	2.547	7.628	1.843	-3.193	1.847

Grand Lake on Glover Island

WARNING: There are too many cases to calculate medians. You could choose fewer variables.

TOTAL OBSERVATIONS: 1728

	PRECRAIN	PRECSNOW	TEMPAVG	TEMPMAX	TEMPMIN	TOTPREC
N OF CASES	1728	1728	1728	1728	1728	1728
MINIMUM	0.000	0.000	-22.360	-19.100	-26.900	0.000
MAXIMUM	80.740	33.600	23.010	31.000	17.500	80.740
RANGE	80.740	33.600	45.370	50.100	44.400	80.740
MEAN	2.340	0.737	2.685	6.888	-1.265	3.077
VARIANCE	32.849	4.886	82.353	97.715	77.139	37.103
STANDARD DEV	5.731	2.210	9.075	9.885	8.783	6.091
SKEWNESS(G1)	5.152	5.901	-0.220	-0.359	-0.373	4.548
KURTOSIS(G2)	39.735	52.572	-0.679	-0.731	-0.548	31.727
C.V.	2.449	2.998	3.379	1.435	-6.941	1.979

Grand Lake at Southwest End

WARNING: There are too many cases to calculate medians. You could choose fewer variables.

TOTAL OBSERVATIONS: 1728

	PRECRAIN	PRECSNOW	TEMPAVG	TEMPMAX	TEMPMIN	TOTPREC
N OF CASES	1725	1725	1725	1725	1725	1725
MINIMUM	0.000	0.000	-25.510	-21.200	-34.400	0.000
MAXIMUM	78.230	63.550	22.600	32.800	17.200	78.230
RANGE	78.230	63.550	48.110	54.000	51.600	78.230
MEAN	2.197	0.841	2.320	7.355	-2.847	3.038
VARIANCE	30.647	8.799	94.501	109.767	99.611	37.344
STANDARD DEV	5.536	2.966	9.721	10.477	9.981	6.111
STD. ERROR	0.133	0.071	0.234	0.252	0.240	0.147
SKEWNESS(G1)	5.553	10.118	-0.296	0.011	-0.552	4.900
KURTOSIS(G2)	48.132	163.922	-0.580	-0.693	-0.366	37.590
C.V.	2.520	3.529	4.190	1.425	-3.506	2.012

Sandy Lake at Howley Road

WARNING: There are too many cases to calculate medians. You could choose fewer variables.

TOTAL OBSERVATIONS: 1725

	PRECRAIN	PRECSNOW	TEMPAVG	TEMPMAX	TEMPMIN	TOTPREC
N OF CASES	1725	1725	1725	1725	1725	1725
MINIMUM	0.000	0.000	-25.510	-21.200	-34.400	0.000
MAXIMUM	78.230	63.550	22.600	32.800	17.200	78.230
RANGE	78.230	63.550	48.110	54.000	51.600	78.230
MEAN	2.197	0.841	2.320	7.355	-2.847	3.038
VARIANCE	30.647	8.799	94.501	109.767	99.611	37.344
STANDARD DEV	5.536	2.966	9.721	10.477	9.981	6.111
STD. ERROR	0.133	0.071	0.234	0.252	0.240	0.147
SKEWNESS(G1)	5.553	10.118	-0.296	0.011	-0.552	4.900

KURTOSIS(G2)	48.132	163.922	-0.580	-0.693	-0.366	37.590
C.V.	2.520	3.529	4.190	1.425	-3.506	2.012

Sheffield River near TCH

TOTAL OBSERVATIONS: 1728

	FLOW
N OF CASES	1365
MINIMUM	1.490
MAXIMUM	107.000
RANGE	105.510
MEAN	12.622
VARIANCE	119.756
STANDARD DEV	10.943
STD. ERROR	0.296
SKEWNESS(G1)	2.581
KURTOSIS(G2)	10.055
C.V.	0.867
MEDIAN	8.490

Lewaseechjeech Brook

TOTAL OBSERVATIONS: 1728

	FLOW
N OF CASES	1712
MINIMUM	1.590
MAXIMUM	174.630
RANGE	173.040
MEAN	20.167
VARIANCE	497.957
STANDARD DEV	22.315
STD. ERROR	0.539
SKEWNESS(G1)	2.953
KURTOSIS(G2)	11.035
C.V.	1.107
MEDIAN	12.130

Upper Humber River near Reidville

TOTAL OBSERVATIONS: 1728

	FLOW
N OF CASES	1728
MINIMUM	9.910
MAXIMUM	989.000
RANGE	979.090
MEAN	97.733
VARIANCE	10856.951
STANDARD DEV	104.197
STD. ERROR	2.507
SKEWNESS(G1)	2.905
KURTOSIS(G2)	11.535
C.V.	1.066
MEDIAN	61.160

TOTAL OBSERVATIONS: 1728

Humber River at Village Bridge

	FLOW
N OF CASES	1727
MINIMUM	132.540
MAXIMUM	837.580
RANGE	705.040
MEAN	279.265
VARIANCE	14224.584
STANDARD DEV	119.267
STD. ERROR	2.870
SKEWNESS(G1)	1.923
KURTOSIS(G2)	3.778
C.V.	0.427
MEDIAN	241.290

Indian Brook Diversion to Birchy Lake

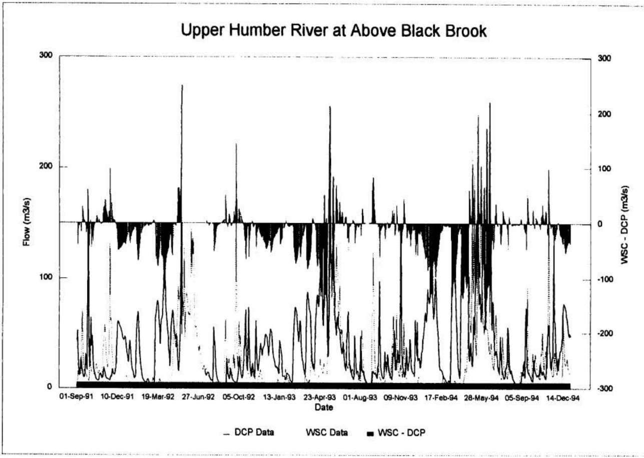
WARNING: There are too many cases to calculate medians. You could choose fewer variables.

TOTAL OBSERVATIONS: 1728

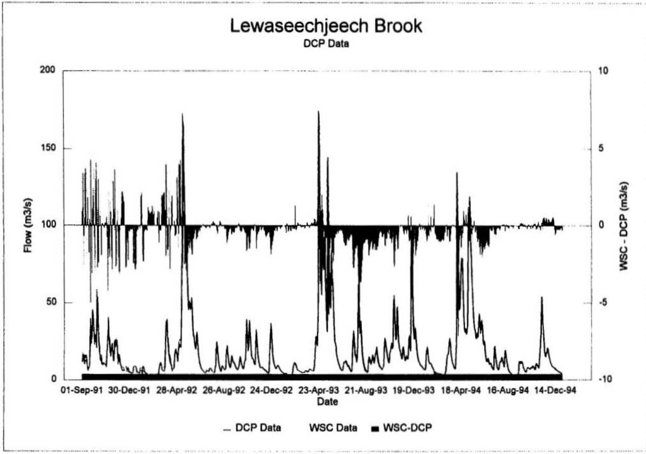
	FLOW	PRECRAIN	PRECSNOW	TEMPAVG	TEMPMAX	TEMPMIN	TOTPREC
N OF CASES	1728	1728	1728	1728	1728	1728	1728
MINIMUM	0.490	0.000	0.000	-27.650	-19.700	-36.800	0.000
MAXIMUM	72.560	117.710	53.680	22.730	32.200	18.400	117.710
RANGE	72.070	117.710	53.680	50.380	51.900	55.200	117.710
MEAN	11.192	2.238	0.982	2.125	7.321	-3.561	3.220
VARIANCE	119.828	38.638	11.410	101.405	110.612	115.657	48.453
STANDARD DEV	10.947	6.216	3.378	10.070	10.517	10.754	6.961
STD. ERROR	0.263	0.150	0.081	0.242	0.253	0.259	0.167
SKEWNESS(G1)	1.820	7.692	6.663	-0.322	-0.034	-0.619	6.001
KURTOSIS(G2)	3.596	103.787	63.756	-0.550	-0.751	-0.272	66.345
C.V.	0.978	2.778	3.439	4.738	1.437	-3.020	2.162

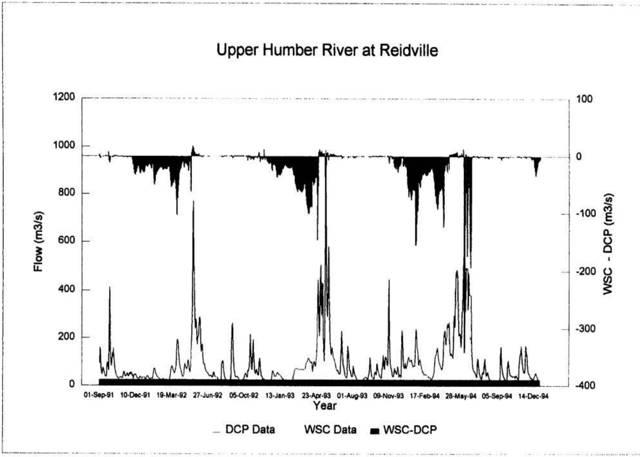
Appendix B

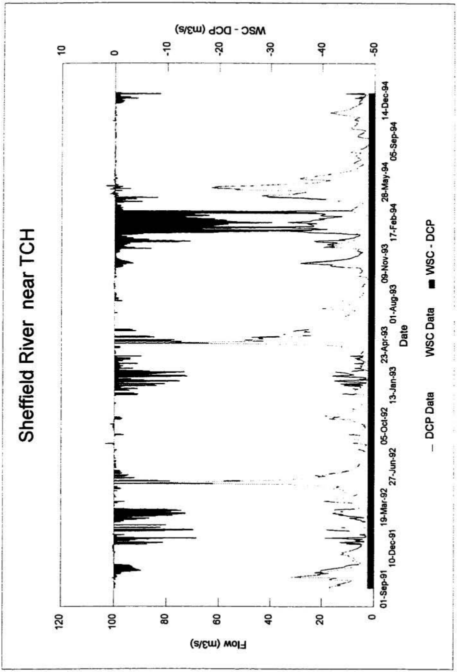
Flow Comparison Plots -
WSC and NDOEL Data

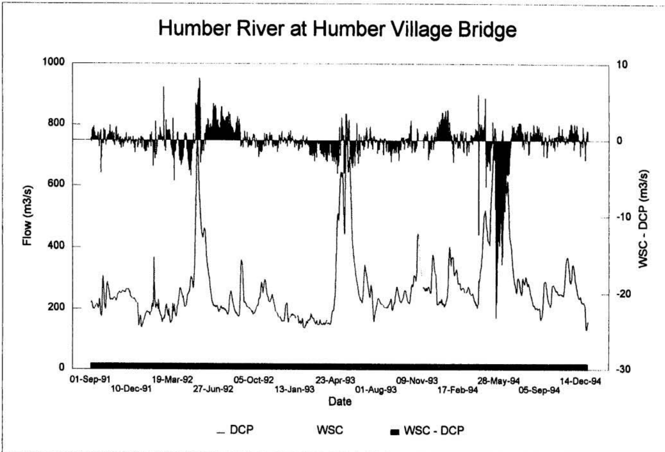


Upper Humber River at Above Black Brook
Flow (m3/s)
300
200
100
0
WSC - DCP (m3/s)
300
200
100
0
-100
-200
-300
01-Sep-91
10-Dec-91
19-Mar-92
27-Jun-92
05-Oct-92
13-Jan-93
23-Apr-93
01-Aug-93
09-Nov-93
17-Feb-94
28-May-94
05-Sep-94
14-Dec-94
Date
DCP Data
WSC Data
WSC - DCP


Lewaseechjeech Brook
DCP Data
200
150
100
50
0
Flow (m3/s)
10
5
0
-5
-10
WSC - DCP (m3/s)
01-Sep-91
30-Dec-91
28-Apr-92
26-Aug-92
24-Dec-92
23-Apr-93
21-Aug-93
19-Dec-93
18-Apr-94
16-Aug-94
14-Dec-94
Date
DCP Data
WSC Data
WSC-DCP


Upper Humber River at Reidville
1200
1000
800
600
400
200
0
Flow (m3/s)
100
0
-100
-200
-300
-400
WSC - DCP (m3/s)
01-Sep-91
10-Dec-91
19-Mar-92
27-Jun-92
05-Oct-92
13-Jan-93
23-Apr-93
01-Aug-93
09-Nov-93
17-Feb-94
28-May-94
05-Sep-94
14-Dec-94
Year
DCP Data
WSC Data
WSC-DCP


Sheffield River near TCH
Flow (m3/s)
WSC - DCP (m3/s)
Date
01-Sep-91
10-Dec-91
19-Mar-92
27-Jun-92
05-Oct-92
13-Jan-93
23-Apr-93
01-Aug-93
09-Nov-93
17-Feb-94
28-May-94
05-Sep-94
14-Dec-94
120
100
80
60
40
20
0
10
0
-10
-20
-30
-40
-50
— DCP Data
WSC Data
WSC - DCP


Humber River at Humber Village Bridge
Flow (m3/s)
1000
800
600
400
200
0
WSC - DCP (m3/s)
10
0
-10
-20
-30
01-Sep-91
10-Dec-91
19-Mar-92
27-Jun-92
05-Oct-92
13-Jan-93
23-Apr-93
01-Aug-93
09-Nov-93
17-Feb-94
28-May-94
05-Sep-94
14-Dec-94
Date
DCP
WSC
WSC - DCP

Appendix C

SSARR Input and Output File Example

SAMPLE SSARR DATA FILE: CONTROL

```
J L METRIC MPLUSR IA FCST NOTRACE PRT=2400 JOB=HUMBER FF CALIBRATION

IA
T 1 010794
345 24

ZC1 W1100       COMPUTED FLOW, LEWASEECHJEECH BROOK
ZC2 W1100 470 1 3,15 2,40 2,300 2,2500 40 3.5 .203 20 .1
ZC3 W1100 ,, 8300 .98 .84 .1 .03 .9 2000 6.4
ZC4 W1100 1001 1002 1004 8900 8800 9000 9100
ZC5 W1100 .5 -3.1 -1.4 .022 .084 8600 9400 2 90 1
ZC6 W1100 9300 02YK002
ZCH W1100 4 GRAN 125 4 GLOV 100 4 BURG 100
ZCH W1100 3 GRAN 150 3 GLOV 175 3 BURG 150
ZCA W1100 100
ZCP W1100 145 0 152 3.2 228 7.2 304 20.6 381 55.9 457 82.7 533 93
ZCP W1100 648 97.2 700 100 99999 100
      NO CATCH-DEFICIENCY
ZH GRAN 90 100 -1
ZH GLOV 115 100 -1
ZH BURG 300 100 -1

      RELATION TABLES
ZCT 1001 2 0 20 10 60 18 90 999 90 SMI V ROP
ZCT 1002 2 0 80 .4 60 1.5 30 999 30 BII VS BFP
ZCT 1004 2 0 0 .03 .01 .05 .03 .13 .08 .25 .18 .38 .28 .51 .43 999 .43 SSS
ZCT 8300 3 0 .18 .04 20 .23 .04 100 .32 .04 300 .35 .04 9999 .35 .04 ATIMR
VS MR CR
ZCT 8600 2 1 .03 2 .04 9 .04 10 .02 9999 .02 MO VS GMLT PER DAY
ZCT 8900 2  0 100  2.5 100  10 0  999 0  RAIN/DAY VS EKE
      TEMPERATURE VS. PET/DAY FOR BASE=-1
ZCT 8800 2  -20 .01 -2 .02 3 .05 8 .12 18 .3 28 .5 38 .74 9999 .74
ZCT 9000 2 0 0 9 50 15 90 20 100 9999 100  SMI VS DKE
       49 DEGREE N. LATITUDE
ZCT 9100 2  1 73 2 78 3 102 4 114 5 133 6 134 7 135
ZCT 9100     8 124 105 10 93 11 76 12 71 13 75 999 75  MO VS ETMO
ZCT 9300 2 1 31 2 50 3 75 4 100 5 100 6 100 7 100 8 100 9 100 10 100
ZCT 9300    11 85 12 50 13 31 9999 31  MO VS MR EFFECTIVENESS
ZCT 9400 2 0 100 1000 100 EL/ETIPCT


ZC1 W1101       COMPUTED FLOW, HINDS BROOK
ZC2 W1101 630 1 3,20 5,50 2,450 2,2500 50 3.5 .203 20 .1
ZC3 W1101 ,, 8300 .98 .84 .1 .03 .9 2000 6.4
ZC4 W1101 1101 1102 1104 8900 8800 9000 9100
ZC5 W1101 .1 -2 0 .022 .084 8600 9400 2 90 1
ZC6 W1101 9300
ZCH W1101 4 SAND 100 4 0698 100
ZCH W1101 3 SAND 150 3 0698 130
ZCA W1101 100
ZCP W1101 198 0 228 0.5 304 24.8 381 42.2 457 64.3 533 85.1
ZCP W1101 610 98 640 99.1 650 100 99999 100
```

```
ZH SAND 260 100 0
ZH 0698 280 100 0
     RELATION TABLES
ZCT 1101 2 0 20 10 60 18 100 999 100 SMI V ROP
ZCT 1102 2 0 90 .4 70 1.5 40 999 40 BII VS BFP
ZCT 1104 2 0 0 .03 .01 .1 .03 .2 .08 .3 .15 .38 .23 .51 .36 999.6 999.0 SSS

ZC1 W1102         COMPUTED FLOW, SHEFFIELD BROOK
ZC2 W1102 380 1 3,30 5,30 2,350 2,2500 20 3.5 .203 20 .1
ZC3 W1102 ,, 8301 .98 .84 .1 .03 .9 2000 6.4
ZC4 W1102 1201 1202 1204 8900 8800 9000 9100
ZC5 W1102 .5 -3 1 .022 .084 8600 9400 1 90 1
ZC6 W1102 9301 02YK005
ZCH W1102 4 INDI 100 4 0698 100
ZCH W1102 3 INDI 125 3 0698 125
ZCA W1102 100
ZCP W1102 99 0 152 9.4 228 30.1 304 49.3 381 73.4 457 90.8 533 99.0
ZCP W1102 540 100 99999 100
ZH INDI 366 100 1
ZH 0698 280 100 0

     RELATION TABLES
ZCT 1201 2 0 20 10 60 18 100 999 100 SMI V ROP
ZCT 1202 2 0 80 .4 60 1.5 30 999 30 BII VS BFP
ZCT 1204 2 0 0 .03 .01 .05 .03 .13 .08 .25 .18 .38 .28 .51 .43 999.3 999.0
SSS
ZCT 8301 3 0 .09 .04 20 .10 .04 100 .17 .04 300 .18 .04 9999 .18 .04 ATIMR
VS MR CR
ZCT 9301 2 1 31 2 50 3 55 4 65 5 100 6 100 7 100 8 100 9 100 10 100
ZCT 9301   11 85 12 50 13 31 9999 31 MO VS MR EFFECTIVENESS

ZC1 W1103         COMPUTED FLOW, INDIAN BROOK
ZC2 W1103 238 1 4,15 3,20 2,200 2,2000 20 3.5 .203 20 .1
ZC3 W1103 ,, 8300 .98 .84 .1 .03 .9 2000 6.4
ZC4 W1103 1301 1302 1304 8900 8800 9000 9100
ZC5 W1103 .5 -3 1 .022 .084 8600 9400 1 90 1
ZC6 W1103 9300 02YM004
ZCH W1103 4 INDI 100
ZCH W1103 3 INDI 125
ZCA W1103 100
ZCP W1103 122 0 152 1.0 228 24.7 304 93.7 381 99.0 390 100 9999 100
ZH INDI 366 100 1
     RELATION TABLES
ZCT 1301 2 0 20 10 60 18 100 999 100 SMI V ROP
ZCT 1302 2 0 90 .4 70 1.5 40 999 40 BII VS BFP
ZCT 1304 2 0 0 .03 .01 .05 .03 .13 .08 .25 .18 .38 .28 .51 .43 999.3 999.0
SSS

ZC1 W1104         COMPUTED FLOW, UPPER HUMBER
ZC2 W1104 2108 1 3,15 3,20 2,200 2,2000 20 3.5 .203 20 .1
ZC3 W1104 ,, 8301 .98 .84 .15 .03 .9 2000 6.4
ZC4 W1104 1401 1402 1404 8900 8800 9000 9100
ZC5 W1104 .3 -3 0 .022 .084 8600 9400 2 90 1
ZC6 W1104 9300 02YL001
ZCH W1104 4 BLAC 100 4 SAND 100 4 1500 100
```

```
ZCH W1104 3 BLAC 175 3 SAND 150 3 1500 175
ZCA W1104 100
ZCP W1104 15 0 76 10.0 152 30.6 228 38.5 304 46.8 381 59.7 457 70.8
ZCP W1104 533 84.4 610 94.8 685 100 9999 100
ZH BLAC 450 100 1
ZH SAND 260 100 1
ZH 1500 10 100 1
      RELATION TABLES
ZCT 1401 2 0 30 10 70 15 100 999 100 SMI VS ROP
ZCT 1402 2 0 90 .4 70 1.5 40 999 40 BII VS BFP
ZCT 1404 2 0 0 .03 .01 .05 .03 .13 .08 .25 .20 .38 .33 .51 .45 100 88  SSS

ZC1 W2100        COMPUTED FLOW, GRAND LAKE WEST
ZC2 W2100 1298 1 3,15 3,20 2,200 2,2000 20 3.5 .203 20 .1
ZC3 W2100 ,, 8300 .98 .84 .1 .03 .9 2000 6.4
ZC4 W2100 2001 2002 2004 8900 8800 9000 9100
ZC5 W2100 .1 -3 1 .022 .084 8600 9400 2 90 1
ZC6 W2100 9300
ZCH W2100 4 GRAN 100 4 GLOV 100
ZCH W2100 3 GRAN 150 3 GLOV 140
ZCA W2100 100
ZCP W2100 85.3 0 86.5 13.2 152 24.3 228 32.4 304 37.4 381 51.4
ZCP W2100 457 84.5 533 90.4 640 100 9999 100

ZH GRAN 90 100 1
ZH GLOV 115 100 1
      RELATION TABLES
ZCT 2001 2 0 20 10 60 18 100 999 100 SMI V ROP
ZCT 2002 2 0 90 .4 70 1.5 40 999 40 BII VS BFP
ZCT 2004 2 0 0 .03 .01 .05 .03 .13 .08 .25 .18 .38 .28 .51 .43 999.3 999.0
SSS

ZC1 W2101        COMPUTED FLOW, GRAND LAKE CENTRAL
ZC2 W2101 690 1 3,15 3,20 2,200 2,2000 20 3.5 .203 20 .1
ZC3 W2101 ,, 8300 .98 .84 .1 .03 .9 2000 6.4
ZC4 W2101 2101 2102 2104 8900 8800 9000 9100
ZC5 W2101 .1 -3 1 .022 .084 8600 9400 2 90 1
ZC6 W2101 9300
ZCH W2101 4 SAND 100 4 GLOV 100 4 1500 100
ZCH W2101 3 SAND 150 3 GLOV 140 3 1500 135
ZCA W2101 100
ZCP W2101 85.3 0 86.5 13.2 152 24.3 228 32.4 304 37.4 381 51.4
ZCP W2101 457 84.5 533 90.4 640 100 9999 100
ZH GRAN 90 100 1
ZH GLOV 115 100 1
ZH 1500 10 100 1
      RELATION TABLES
ZCT 2101 2 0 20 10 60 18 100 999 100 SMI V ROP
ZCT 2102 2 0 90 .4 70 1.5 40 999 40 BII VS BFP
ZCT 2104 2 0 0 .03 .01 .05 .03 .13 .08 .25 .18 .38 .28 .51 .43 999.3 999.0
SSS

ZC1 W2102        COMPUTED FLOW, GRAND LAKE EAST
ZC2 W2102 1180 1 3,15 3,20 2,200 2,2000 20 3.5 .203 20 .1
```

```
ZC3 W2102 ,, 8300 .98 .84 .1 .03 .9 2000 6.4
ZC4 W2102 2201 2202 2204 8900 8800 9000 9100
ZC5 W2102 .1 -3 1 .022 .084 8600 9400 2 90 1
ZC6 W2102 9300
ZCH W2102 4 SAND 100 4 INDI 100 4 0698 100
ZCH W2102 3 SAND 140 3 INDI 150 3 0698 130
ZCA W2102 100
ZCP W2102 85.3 0 86.5 11.6 152 31.2 228 43.6 304 55.2 381 69.2
ZCP W2102 457 82.4 533 97.4 568 100 9999 100
ZH SAND 260 100 1
ZH INDI 366 100 1
ZH 0698 280 100 1
     RELATION TABLES
ZCT 2201 2 0 20 10 60 18 100 999 100 SMI V ROP
ZCT 2202 2 0 90 .4 70 1.5 40 999 40 BII VS BFP
ZCT 2204 2 0 0 .03 .01 .05 .03 .13 .08 .25 .18 .38 .28 .51 .43 999.3 999.0
SSS

ZC1 W2104        COMPUTED FLOW, LOCAL INFLOW D/S OF GRAND LAKE
ZC2 W2104 199 1 3,10 2,20 2,200 2,2000 20 3.5 .203 20 .1
ZC3 W2104 ,, 8300 .98 .84 .1 .03 .9 2000 6.4
ZC4 W2104 2401 2402 2404 8900 8800 9000 9100
ZC5 W2104 .1 -3 1 .022 .084 8600 9400 2 90 1
ZC6 W2104 9300
ZCH W2104 4 SAND 100 4 1500 100 4 GLOV 100
ZCH W2104 3 SAND 140 3 1500 120 3 GLOV 150
ZCA W2104 100
ZCP W2104 85.3 0 86.5 11.6 152 31.2 228 43.6 304 55.2 381 69.2
ZCP W2104 457 82.4 533 97.4 568 100 9999 100
ZH SAND 260 100 1
ZH 1500 10 100 1
ZH GLOV 115 100 1
     RELATION TABLES
ZCT 2401 2 0 20 10 60 18 100 999 100 SMI V ROP
ZCT 2402 2 0 90 .4 70 1.5 40 999 40 BII VS BFP
ZCT 2404 2 0 0 .03 .01 .05 .03 .13 .08 .25 .18 .38 .28 .51 .43 999.3 999.0
SSS

ZC1 W2105        COMPUTED FLOW,  LOCAL INFLOW TO DEER LAKE
ZC2 W2105 640 1 3,15 2,20 2,200 2,2000 20 3.5 .203 20 .1
ZC3 W2105 ,, 8300 .98 .84 .1 .03 .9 2000 6.4
ZC4 W2105 2501 2502 2504 8900 8800 9000 9100
ZC5 W2105 .1 -3 1 .022 .084 8600 9400 2 90 1
ZC6 W2105 9300
ZCH W2105 4 SAND 100 4 1500 100 4 GLOV 100
ZCH W2105 3 SAND 120 3 1500 140 3 GLOV 140
ZCA W2105 100
ZCP W2105 4.5 0 5.2 12 30.5 19.6 91.4 36.8
ZCP W2105 152 49 213 83 305 86 458 100 9999 100
ZH SAND 260 100 1
ZH 1500 10 100 1
ZH GLOV 115 100 1
     RELATION TABLES
```

```
ZCT 2501 2 0 20 10 60 18 100 999 100 SMI V ROP
ZCT 2502 2 0 90 .4 70 1.5 40 999 40 BII VS BFP
ZCT 2504 2 0 0 .03 .01 .05 .03 .13 .08 .25 .18 .38 .28 .51 .43 999.3 999.0
SSS

ZC1 W2106        COMPUTED FLOW,  LOCAL INFLOW TO CORNERBROOK
ZC2 W2106 148 1 3,15 2,20 2,200 2,2000 20 3.5 .203 20 .1
ZC3 W2106 ,, 8300 .98 .84 .1 .03 .9 2000 6.4
ZC4 W2106 2501 2502 2504 8900 8800 9000 9100
ZC5 W2106 .1 -3 1 .022 .084 8600 9400 2 90 1
ZC6 W2106 9300
ZCH W2106 4 CORN 100 4 GLOV 100
ZCH W2106 3 CORN 140 3 GLOV 140
ZCA W2106 100
ZCP W2106 2 0 61 13.1 152 18.6 305 45
ZCP W2106 457 80.5 546 100 9999 100
ZH CORN 330 100 1
ZH GLOV 115 100 1
     RELATION TABLES
ZCT 2601 2 0 20 10 60 18 100 999 100 SMI V ROP
ZCT 2602 2 0 90 .4 70 1.5 40 999 40 BII VS BFP
ZCT 2604 2 0 0 .03 .01 .05 .03 .13 .08 .25 .18 .38 .28 .51 .43 999.3 999.0
SSS

CL01    H5100        1            HINDS LAKE RESERVOIR
CL02    H5100                            310900 306000
C101    H5100   306000                        0 307020                50600
C102    H5100   308020                   102210 309020               153840
C103    H5100   310020                   205450 310910               251920
C104    H5100   313940                   4084609999999999999999999999999999999999
CL01    G5101                     GRAND LK. WATERLEVELS
CL02    G5101                             87650  82880
C101    G5101    82880                        0  83180               140180
C102    G5101    83490                   280820  83790               421910
C103    G5101    84100                   563450  84400               705450
C104    G5101    84710                   847910  85010               990870
C105    G5101    85320                  1134560  85620              1279140
C106    G5101    85920                  1424600  86230              1570940
C107    G5101    86530                  1718460  86840              1863250
C108    G5101    87100                  2026940  87650              2284986
C109    G5101   999999                  99999999999999999999999999999999999999999
CL01    D5102                     DEER LAKE  HINTONS
CL02    D5102                              8685   4385
C101    D5102     4385    74               9000   4685    110         31510
C101    D5102     4985   159              54020   5285    212         81290
C103    D5102     5585   286              99040   5885    354        121930
C104    D5102     6185   430             144050   6485    513        162570
C105    D5102     6785   600             189070   7085    691        203210
C106    D5102     7385   736             234080   7685    906        243860
C107    D5102     8085  1014             279110   8385   1133        284500
C108    D5102     8685  1246             3241209999999999999999999999999999999999
CR01 D4101          2               REACH ROUTING D/S DEER LAKE
CR02 D4101                 2   0     0
C101 D4101                 550   217                       5750    43
C102 D4101                9500    31                      13250    26
```

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C103 D4101                    17000    23                    20750    21
C104 D4101                    24500    20                    28250    18
C105 D4101                    32000    17           9999999999999999999999999999
CC01 IG3100                      GRAND LAKE INFLOW
CC01 OG3101                      GRAND LAKE OUTFLOW
CC01 ID3102                        DEER LAKE INFLOW
CC01 HV3103                        DISCHARGE AT D/S STUDY AREA
CC01 02YK005                     SHEFFIELD BROOK OBSERVED
CC01 02YK002                     LEWASEECHJEECH BROOK OBSERVED
CC01 02YL001                     UPPER HUMBER OBSERVED
CC01 02YM004                     INDIAN BROOK DIVERSION OBSERVED
CC01 02YK010                     GRAND LAKE ELEVATIONS OBSERVED
CC01 02YL007                     DEER LAKE ELEVATIONS OBSERVED
CC01 02YL003                     HUMBER RIVER OBSERVED
CC01 S7500                       DUMMY NODE
N    HUMFOR
P        W1100    IG3100
P        W1101     H5100
P        H5100    IG3100
P        W1102    IG3100
P        W1103    IG3100
P        W2100    IG3100
P        W2101    IG3100
P        W2102    IG3100
P       IG3100     G5101
P        G5101    OG3101
P       OG3101    ID3102
P        W2104    ID3102
P        W1104    ID3102
P        W2105    ID3102
P       ID3102     D5102
P        D5102     D4101
P        D4101    HV3103
P        W2106    HV3103
P       HV3103     S7500
P      02YK002
P      02YK005
P      02YL001
P      02YK010
P      02YM004
P      02YL007
P      02YL003
       INITIAL CONDITIONS ( 1994)
Z21 W1100,,40,90
Z2SS W1100,,.7 .7
Z2B  W1100,,2 2 2
Z2LZ W1100,,.3 .4
       INITIAL CONDITIONS ( 1994)
Z21 W1101,,40,90
Z2SS W1101,,7 6 6 5 5
Z2B  W1101,,3 3
Z2LZ W1101,,2 2

       INITIAL CONDITIONS ( 1994)
Z21 W1102,,50,90
```

```
Z2SS W1102,,1.5 1.5 1.5 1.2 1
Z2B  W1102,,1.5 0
Z2LZ W1102,,.3 .3

       INITIAL CONDITIONS (1994)
Z21 W1103,,40,90
Z2SS W1103,,5 5 5
Z2B  W1103,,3 3
Z2LZ W1103,,1 1

       INITIAL CONDITIONS ( 1994)
Z21 W1104,,40,90
Z2SS W1104,,5 5 5
Z2B  W1104,,20 20
Z2LZ W1104,,1 1

       INITIAL CONDITIONS (1994)
Z21 W2100,,40,90
Z2SS W2100,,5 5 5
Z2B  W2100,,3 3
Z2LZ W2100,,1 1

       INITIAL CONDITIONS (1994)
Z21 W2101,,40,90
Z2SS W2101,,5 5 5
Z2B  W2101,,3 3
Z2LZ W2101,,1 1

       INITIAL CONDITIONS (1994)
Z21 W2102,,40,90
Z2SS W2102,,7 7 5
Z2B  W2102,,2 2
Z2LZ W2102,,1 .5

       INITIAL CONDITIONS ( 1994)
Z21 W2104,,40,90
Z2SS W2104,,7 7 5
Z2B  W2104,,2 2
Z2LZ W2104,,1 .5

       INITIAL CONDITIONS ( 1994)
Z21 W2105,,40,90
Z2SS W2105,,7 7 5
Z2B  W2105,,2 2
Z2LZ W2105,,1 .5

       INITIAL CONDITIONS (1994)
Z21 W2106,,40,90
Z2SS W2106,,7 7 5
Z2B  W2106,,2 2
Z2LZ W2106,,1 .5

2L      H5100   010794          311260
2L      G5101   010794           87492
2L      D5102   010794            5405
```

```
         READ IN MET DATA
INU=1
         READ IN HYDRO DATA
INU=2

      HINDS BROOK RULE CURVE
Z6       H5100  010794 2  310.11
Z6       H5100  010894 2  309.56
Z6       H5100  010994 2  309.26
Z6       H5100  011094 2  309.93
Z6       H5100  011194 2  310.06
Z6       H5100  011294 2  310.65
Z6       H5100  010195 2  310.13
Z6       H5100  010295 2  308.98
Z6       H5100  010395 2  307.95
Z6       H5100  010495 2  308.99
Z6       H5100  010595 2  311.15
Z6       H5100  010695 2  311.18
Z6       H5100  010795 2  311.26

     GRAND LAKE RULE CURVE
Z6       G5101  010794 2  87.492
Z6       G5101  020794 1   167.5
Z6       G5101  010894 1   167.5
Z6       G5101  020994 1   167.5
Z6       G5101  011094 1   167.5
Z6       G5101  011194 1   167.5
Z6       G5101  011294 1   167.5
Z6       G5101  010195 1   160
Z6       G5101  010295 1   160
Z6       G5101  010395 1   160
Z6       G5101  010495 1   160
Z6       G5101  010595 1   166
Z6       G5101  010695 1   166
Z6       G5101  010795 1   166

IA
T 1 010794
345 24

BASIN HUMFOR
ZR S

IA
T 1 010794
345 24
RIVER HUMFOR
RETURN

IA
T 1 010794
345 24

ZS 02YK002,W1100,,,P,A470,1,2,5,6,7,8,9,10,12,16,18
ZS 02YK005,W1102,,,P,A391,1,2,5,6,7,8,9,10,12,16,18
```

```
ZS 02YL001,W1104,,,P,A2110,1,2,5,6,7,8,9,10,12,16,18
ZS 02YL003,HV3103,,,P,A7300,1,2,5,6,7,8,9,10,12,16,18
ZS 02YK010,G5101,,,P,A5020,1,2,5,6,7,8,9,10,12,16,18

      SAVE STATION HV3103 DOWN STREAM OF STEADY BROOK
ZSQ IG3100 GRNDIN
ZSQ OG3101 GRNDOUT
ZSQ HV3103 HUMBER
ZSE G5101  GRANDLVL
ZSE D5102  DEERLKLV

PR 8 ID3102  1 D5102   2 HV3103  1 D5102   2
11

END
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```
Z4 0698 010794 3    0.040  0.000  0.080  0.000  0.380  0.340  0.000  0.000
Z4 0698 090794 3    0.500  2.260  0.040  0.000  1.640  0.000  0.000  0.040
Z4 0698 170794 3    0.000  0.000  0.280  0.440  0.380  1.080  0.600  4.800
Z4 0698 250794 3    0.120  0.420  0.360  0.000  0.860  0.000  0.140
Z4 0698 010894 3    0.000  0.020  0.000  0.000  0.150  1.100  1.740  0.820
Z4 0698 090894 3    0.000  0.000  0.000  0.000  0.000  0.000  0.000  0.000
Z4 0698 170894 3    0.000  0.000  0.000  0.000  0.220  0.000  0.000  0.000
Z4 0698 250894 3    0.000  0.000  0.120  0.000  0.740  0.000  0.000
Z4 0698 010994 3    0.000  0.000  0.000  0.000  0.000  1.560  0.800  0.320
Z4 0698 090994 3    0.000  1.200  6.000  0.300  0.500  0.040  0.000  0.000
Z4 0698 170994 3    0.700  0.000  0.320  0.000  0.000  0.000  0.000  0.000
Z4 0698 250994 3    0.100  0.000  0.000  0.000  0.000  2.800
Z4 0698 011094 3    0.360  0.000  0.620  0.060  0.140  0.000  0.000  0.000
Z4 0698 091094 3    0.000  0.740  0.600  0.000  0.000  0.100  0.000  0.140
Z4 0698 171094 3    0.040  0.000  0.000  0.000  0.000  0.000  2.700  0.040
Z4 0698 251094 3    0.020  0.000  0.320  0.000  0.000  0.000  0.000
Z4 0698 011194 3    2.020  1.360  0.000  0.000  1.340  0.080  1.520  0.000
Z4 0698 091194 3    0.060  0.200  0.500  0.000  0.000  0.000  0.000  0.800
Z4 0698 171194 3    0.000  0.000  1.020  0.000  0.000  1.800  0.700  0.000
Z4 0698 251194 3    0.100  0.200  0.000  2.500  0.200  0.800
Z4 0698 011294 3    0.100  0.100  0.800  0.000  2.000  2.800  1.700  1.000
Z4 0698 091294 3    0.500  1.500  0.500  0.500  0.000  0.000  0.000  0.000
Z4 0698 171294 3    0.000  0.000  0.000  0.000  0.000  0.000  0.000  0.000
Z4 0698 251294 3    0.000  0.000  0.000  0.000  2.000  1.000  0.000
Z4 0698 010195 3    0.000  1.200  1.800  0.000  0.000  0.000  3.800  0.000
Z4 0698 090195 3    0.000  0.000  0.000  0.500  1.000  1.000  1.540  0.800
Z4 0698 170195 3    1.500  0.000  0.000  0.000  0.000  1.000  1.000  1.000
Z4 0698 250195 3    0.000  0.000  0.500  0.500  0.000  0.800  0.000
Z4 0698 010295 3    0.000  0.000  0.000  0.000  1.200  1.600  0.000  0.000
Z4 0698 090295 3    0.000  0.000  0.500  0.800  0.000  0.000  0.500  1.700
Z4 0698 170295 3    0.000  0.000  0.000  0.000  2.800  0.000  0.000  2.500
Z4 0698 250295 3    0.000  0.000  0.000  0.800
Z4 0698 010395 3    0.000  0.000  0.000  0.000  0.000  1.200  0.000  0.600
Z4 0698 090395 3    1.540  0.500  0.500  0.000  0.000  0.000  2.000  0.000
Z4 0698 170395 3    0.000  0.000  0.000  0.000  0.600  2.060  1.100  1.000
Z4 0698 250395 3    0.000  0.000  0.000  0.000  0.000  0.000  0.000
Z4 0698 010495 3    0.500  1.200  0.000  0.200  0.000  0.000  0.000  0.000
Z4 0698 090495 3    1.200  0.000  0.000  0.000  0.000  0.000  0.000  0.440
Z4 0698 170495 3    0.520  1.800  1.350  0.500  0.000  0.000  1.020  0.000
Z4 0698 250495 3    0.000  0.560  0.500  0.000  0.000  0.000
Z4 0698 010595 3    0.000  0.000  0.000  0.000  0.000  0.000  0.000  0.220
Z4 0698 090595 3    0.000  0.000  0.000  0.050  0.000  0.000  0.100  0.000
Z4 0698 170595 3    0.000  0.200  0.280  0.000  0.000  0.120  0.440  0.940
Z4 0698 250595 3    0.140  0.000  0.000  0.000  0.100  1.660  0.000
Z4 0698 010695 3    0.000  0.180  0.280  0.680  0.000  0.000  0.220  3.540

Z4 0698 010794 4   20.000 17.800 18.800 15.500 12.800 13.500 11.800 16.000
Z4 0698 090794 4   16.000 13.000 18.800 17.000 20.000 17.000 16.800 15.000
Z4 0698 170794 4   15.300 16.500 18.800 14.500 18.000 20.000 22.500 11.000
Z4 0698 250794 4   12.800 19.300 21.000 21.000 19.800 17.800 19.300
Z4 0698 010894 4   23.300 20.500 15.000 18.500 20.000 18.300 13.500 19.800
Z4 0698 090894 4   17.800 22.000 15.500 14.000 13.800 18.000 21.300 14.500
```

Z4	0698	170894	4	15.800	17.000	14.800	15.800	17.000	19.300	15.300	13.500
Z4	0698	250894	4	16.000	17.500	19.300	18.500	17.000	15.800	13.300	
Z4	0698	010994	4	12.000	10.300	9.500	11.500	12.800	13.000	13.800	15.300
Z4	0698	090994	4	14.000	12.800	13.000	13.300	10.500	10.500	11.000	8.800
Z4	0698	170994	4	8.500	13.300	9.800	9.300	11.800	9.500	9.300	14.800
Z4	0698	250994	4	15.800	16.500	13.500	6.300	8.000	9.500		
Z4	0698	011094	4	9.000	11.500	9.300	6.300	8.800	10.800	9.500	13.000
Z4	0698	091094	4	15.300	11.500	11.500	3.300	3.000	5.000	3.000	5.300
Z4	0698	171094	4	5.000	3.000	7.300	5.000	5.800	7.000	7.800	11.500
Z4	0698	251094	4	8.000	9.800	9.000	3.500	4.000	8.300	7.500	
Z4	0698	011194	4	6.500	10.000	9.500	5.000	7.300	3.000	4.000	2.500
Z4	0698	091194	4	3.000	4.500	1.800	1.500	-0.300	1.800	2.500	0.000
Z4	0698	171194	4	1.000	3.800	5.800	-2.800	-3.300	2.800	-2.300	-4.500
Z4	0698	251194	4	-2.800	-3.000	-8.000	-8.500	-3.300	-0.800		
Z4	0698	011294	4	-3.300	-6.300	-4.000	-9.800	-5.300	-5.800	-3.800	-2.800
Z4	0698	091294	4	-4.300	-6.300	-5.000	-5.000	-8.500	-8.500	-11.300	-11.800
Z4	0698	171294	4	-12.800	-6.800	-1.800	-4.800	-6.300	-2.500	2.500	-2.800
Z4	0698	251294	4	-4.500	-6.000	-7.300	-7.800	-10.000	-3.000	-4.000	
Z4	0698	010195	4	-6.250	-6.000	-10.000	-6.500	-11.500	-10.750	-1.000	-5.750
Z4	0698	090195	4	-5.000	-7.250	-17.500	-18.250	-12.250	-9.000	-1.250	-5.000
Z4	0698	170195	4	-7.000	-6.250	-9.000	-2.750	-7.000	-7.250	-4.500	-2.750
Z4	0698	250195	4	-2.000	-4.500	-7.000	-13.000	-9.500	-4.500	-13.500	
Z4	0698	010295	4	-9.750	-10.250	-14.000	-19.000	-14.000	-2.750	-17.500	-21.250
Z4	0698	090295	4	-16.750	-13.500	-12.750	-14.500	-14.750	-15.750	-9.500	-10.250
Z4	0698	170295	4	-13.500	-12.000	-10.500	-16.750	-7.500	-11.000	-3.000	-0.500
Z4	0698	250295	4	-7.500	-13.500	-13.500	-13.500				
Z4	0698	010395	4	-11.250	-9.250	-12.000	-12.750	-7.250	-15.750	-11.750	-5.250
Z4	0698	090395	4	3.500	-1.000	-11.250	-9.250	-12.250	-7.500	-3.500	-1.750
Z4	0698	170395	4	-0.750	2.250	-6.500	-7.250	0.250	2.250	1.750	-0.250
Z4	0698	250395	4	1.500	0.250	-0.750	-5.250	-8.500	-6.500	-6.250	
Z4	0698	010495	4	-4.250	0.500	1.500	0.250	-3.000	-12.500	-3.250	-4.500
Z4	0698	090495	4	-0.250	1.250	-3.500	-4.750	-4.750	5.000	4.750	4.750
Z4	0698	170495	4	4.000	2.750	3.750	3.000	3.250	2.000	2.750	5.500
Z4	0698	250495	4	4.500	2.000	1.500	1.250	0.250	2.250		
Z4	0698	010595	4	4.250	3.250	3.000	2.000	5.250	4.750	3.500	3.250
Z4	0698	090595	4	5.000	5.750	5.500	6.750	6.000	5.000	4.000	3.750
Z4	0698	170595	4	4.000	5.750	4.000	5.500	8.250	9.500	8.750	12.000
Z4	0698	250595	4	5.250	7.000	6.250	4.500	7.750	7.750	10.250	
Z4	0698	010695	4	12.250	14.000	12.750	9.250	9.250	7.000	6.000	9.500

Z4	1500	010794	3	2.220	0.000	0.000	0.000	0.300	0.680	0.000	0.000
Z4	1500	090794	3	0.340	5.140	0.030	0.000	0.340	0.000	0.000	0.500
Z4	1500	170794	3	0.000	0.000	0.080	0.250	0.210	1.110	2.980	2.600
Z4	1500	250794	3	0.090	0.000	0.040	1.090	0.980	0.000	1.400	
Z4	1500	010894	3	0.000	0.000	0.040	0.000	0.340	2.680	0.020	0.000
Z4	1500	090894	3	0.390	0.020	0.000	0.000	0.000	0.040	0.000	0.000
Z4	1500	170894	3	0.000	0.000	0.000	0.000	0.720	0.000	0.000	0.000
Z4	1500	250894	3	0.000	0.000	0.270	0.000	0.640	0.150	0.080	
Z4	1500	010994	3	0.000	0.000	0.000	0.000	0.000	2.560	0.110	0.280
Z4	1500	090994	3	0.000	0.700	2.900	1.170	0.000	0.050	0.040	0.000
Z4	1500	170994	3	0.620	0.000	0.080	0.000	0.000	0.000	0.000	0.000
Z4	1500	250994	3	0.000	0.000	0.000	0.000	0.000	3.380		
Z4	1500	011094	3	0.580	3.080	0.720	0.040	0.100	0.120	0.000	0.000
Z4	1500	091094	3	0.000	1.060	0.160	0.000	0.000	0.140	1.210	0.000
Z4	1500	171094	3	0.000	0.000	0.000	0.000	0.000	0.100	1.560	0.020

Z4	1500	251094	3	0.000	0.060	0.000	0.000	0.000	0.000	0.000	
Z4	1500	011194	3	2.710	1.170	0.380	0.040	2.240	0.000	0.960	0.410
Z4	1500	091194	3	0.070	0.210	0.130	0.000	0.000	0.000	0.320	0.060
Z4	1500	171194	3	0.000	0.000	0.980	0.000	0.000	0.710	0.200	0.000
Z4	1500	251194	3	0.100	0.250	0.000	0.000	0.000	0.500		
Z4	1500	011294	3	0.350	0.400	0.100	1.000	0.000	1.960	0.340	0.030
Z4	1500	091294	3	0.560	0.510	0.200	0.000	0.100	0.000	0.150	0.000
Z4	1500	171294	3	0.000	0.000	0.200	0.100	0.250	0.000	0.050	0.000
Z4	1500	251294	3	0.050	0.000	0.000	0.000	0.400	1.300	0.000	
Z4	1500	010195	3	0.000	1.100	0.700	1.100	0.380	0.220	1.600	0.020
Z4	1500	090195	3	0.000	0.000	0.000	0.330	0.720	0.560	2.200	1.000
Z4	1500	170195	3	1.400	0.000	0.800	0.300	0.000	0.900	0.600	0.410
Z4	1500	250195	3	0.040	0.100	0.050	0.240	0.020	0.050	0.000	
Z4	1500	010295	3	0.050	0.350	0.100	0.000	0.200	0.500	0.050	0.050
Z4	1500	090295	3	0.250	0.050	0.100	0.500	0.200	0.000	0.100	1.400
Z4	1500	170295	3	0.000	0.000	0.200	0.000	0.700	0.000	0.000	1.300
Z4	1500	250295	3	0.000	0.100	0.000	0.000				
Z4	1500	010395	3	0.080	0.000	0.000	0.000	0.000	0.700	0.000	1.700
Z4	1500	090395	3	0.900	1.300	0.000	0.100	0.000	0.000	1.100	0.400
Z4	1500	170395	3	0.500	0.200	0.000	0.000	0.250	1.250	1.150	0.350
Z4	1500	250395	3	0.900	0.000	0.050	0.100	0.000	0.000	0.000	
Z4	1500	010495	3	0.000	0.560	0.040	0.000	0.840	0.000	0.000	0.000
Z4	1500	090495	3	0.380	1.120	0.000	0.000	0.000	0.000	0.000	0.060
Z4	1500	170495	3	0.000	2.190	0.000	0.260	2.940	0.000	0.560	0.460
Z4	1500	250495	3	0.000	0.380	0.180	0.020	0.000	0.000		
Z4	1500	010595	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.030
Z4	1500	090595	3	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Z4	1500	170595	3	0.140	0.000	0.540	0.000	0.000	0.380	0.400	1.370
Z4	1500	250595	3	0.180	0.000	0.000	0.000	0.000	1.280	0.000	
Z4	1500	010695	3	0.000	0.000	0.810	0.000	0.030	0.000	0.550	7.700

Z4	1500	010794	4	19.500	14.800	16.800	13.800	13.500	14.000	12.000	14.000
Z4	1500	090794	4	14.500	14.800	19.500	16.000	18.800	17.300	16.500	15.800
Z4	1500	170794	4	13.800	16.800	19.300	14.300	19.800	16.500	19.800	11.800
Z4	1500	250794	4	14.500	20.300	22.300	20.800	18.500	17.300	18.800	
Z4	1500	010894	4	21.500	19.300	16.800	18.800	19.800	15.500	14.000	18.300
Z4	1500	090894	4	17.000	19.500	17.800	13.500	15.300	17.300	19.800	15.000
Z4	1500	170894	4	17.800	15.300	15.000	16.300	14.800	18.000	14.800	13.300
Z4	1500	250894	4	14.300	16.500	19.500	18.800	16.800	11.000	12.800	
Z4	1500	010994	4	13.500	11.500	9.000	10.300	12.500	12.800	14.300	16.000
Z4	1500	090994	4	15.000	12.000	13.000	12.500	12.300	11.800	11.500	8.000
Z4	1500	170994	4	10.000	12.500	8.000	10.800	12.500	9.800	8.000	14.300
Z4	1500	250994	4	13.300	16.300	12.500	7.000	9.300	9.800		
Z4	1500	011094	4	9.800	10.800	9.800	8.000	9.500	10.500	9.800	13.000
Z4	1500	091094	4	16.000	12.800	8.000	4.300	2.300	2.300	4.300	7.500
Z4	1500	171094	4	6.500	4.000	6.300	5.300	5.000	4.000	7.300	10.000
Z4	1500	251094	4	9.300	8.800	8.800	5.800	6.300	10.300	8.500	
Z4	1500	011194	4	7.300	8.800	8.800	5.000	6.000	3.000	4.000	2.300
Z4	1500	091194	4	3.500	4.300	4.000	4.000	1.800	2.800	4.500	3.000
Z4	1500	171194	4	3.500	6.500	6.300	-0.500	0.000	5.500	-0.800	-2.500
Z4	1500	251194	4	-0.300	-1.000	-7.000	-5.000	-1.300	0.800		
Z4	1500	011294	4	-1.800	-5.500	-3.500	-10.000	-4.300	-4.500	-3.000	-1.300
Z4	1500	091294	4	-3.000	-2.000	-2.500	-1.800	-5.300	-7.000	-11.800	-10.500
Z4	1500	171294	4	-15.000	-10.800	-6.800	-4.000	-4.300	0.800	3.500	-3.000
Z4	1500	251294	4	-8.300	-4.500	-5.000	-7.500	-9.000	-0.500	-2.300	

Z4	1500	010195	4	-6.750	-11.500	-10.500	-5.250	-9.000	-6.500	1.500	-2.750
Z4	1500	090195	4	-4.500	-5.750	-18.000	-18.000	-14.000	-7.500	0.000	-5.000
Z4	1500	170195	4	-7.000	-10.000	-8.500	-0.250	-4.250	-7.500	-3.750	-3.500
Z4	1500	250195	4	0.500	-3.500	-9.000	-15.000	-10.000	-8.250	-9.500	
Z4	1500	010295	4	-6.750	-12.500	-15.750	-26.000	-10.750	-1.000	-13.000	-15.250
Z4	1500	090295	4	-11.500	-11.500	-10.500	-11.000	-14.000	-13.500	-16.000	-4.250
Z4	1500	170295	4	-8.750	-12.000	-12.750	-11.000	-17.250	-7.500	-12.500	-3.000
Z4	1500	250295	4	-4.000	-9.500	-13.250	-7.500				
Z4	1500	010395	4	-9.500	-7.750	-8.750	-15.500	-10.000	-16.500	-9.750	-3.000
Z4	1500	090395	4	-0.750	-3.500	-6.250	-14.500	-12.500	-9.500	-2.000	1.000
Z4	1500	170395	4	-0.500	1.500	-6.250	-7.750	-0.500	-1.000	-2.000	-2.000
Z4	1500	250395	4	-0.750	1.500	0.500	-0.500	-2.000	-8.500	-4.500	
Z4	1500	010495	4	-5.800	-0.700	1.000	-1.600	-8.400	-10.300	-4.400	-5.100
Z4	1500	090495	4	-1.700	-1.100	-7.100	-5.600	-3.100	5.000	4.300	5.600
Z4	1500	170495	4	3.800	2.100	1.800	3.400	3.000	3.000	2.900	3.300
Z4	1500	250495	4	3.800	1.700	3.600	0.700	2.400	2.600		
Z4	1500	010595	4	2.750	3.500	3.500	0.500	5.750	6.250	4.000	3.250
Z4	1500	090595	4	6.750	6.250	8.750	8.000	8.500	7.000	4.750	4.500
Z4	1500	170595	4	3.000	7.500	4.000	4.750	9.750	11.250	9.250	11.000
Z4	1500	250595	4	5.000	7.000	6.250	5.250	6.000	7.500	10.500	
Z4	1500	010695	4	11.000	15.300	7.000	11.000	6.500	7.250	9.500	15.250
Z4	BLAC	010794	3	0.592	0.000	0.538	0.592	0.054	0.000	0.161	0.323
Z4	BLAC	090794	3	0.107	0.000	1.507	0.753	0.161	0.162	0.430	0.108
Z4	BLAC	170794	3	0.269	0.377	0.053	0.000	0.000	0.000	0.054	0.162
Z4	BLAC	250794	3	0.000	1.398	1.345	0.969	0.753	1.991	0.107	
Z4	BLAC	010894	3	0.377	0.376	0.000	0.000	0.538	0.538	0.216	2.636
Z4	BLAC	090894	3	0.000	0.000	0.000	0.108	0.108	0.000	0.000	0.107
Z4	BLAC	170894	3	0.000	0.054	0.215	0.054	0.108	0.053	0.216	0.215
Z4	BLAC	250894	3	0.000	0.000	0.000	0.000	0.000	0.000	0.323	
Z4	BLAC	010994	3	0.430	0.000	0.161	0.000	0.000	0.500	0.660	0.250
Z4	BLAC	090994	3	0.800	0.360	2.750	1.240	2.156	0.000	0.108	0.000
Z4	BLAC	170994	3	0.000	0.896	0.050	0.360	0.000	0.090	0.410	0.000
Z4	BLAC	250994	3	0.000	0.000	0.000	0.000	0.000	0.090		
Z4	BLAC	011094	3	1.150	0.760	0.250	0.000	0.910	2.996	1.453	1.937
Z4	BLAC	091094	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Z4	BLAC	171094	3	0.000	0.000	0.620	0.000	0.000	0.000	0.000	0.000
Z4	BLAC	251094	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Z4	BLAC	011194	3	0.000	0.000	0.486	1.079	0.648	1.511	1.566	0.971
Z4	BLAC	091194	3	0.432	0.054	0.054	0.378	0.000	0.270	0.000	0.539
Z4	BLAC	171194	3	0.594	0.810	0.215	1.134	0.000	1.188	0.540	0.485
Z4	BLAC	251194	3	0.216	0.648	0.000	0.000	1.997	0.270		
Z4	BLAC	011294	3	0.539	0.108	0.162	0.108	0.486	0.756	0.108	2.158
Z4	BLAC	091294	3	0.216	0.324	0.432	2.429	0.270	0.431	0.000	0.054
Z4	BLAC	171294	3	0.000	0.054	0.000	0.162	0.054	0.162	0.000	0.108
Z4	BLAC	251294	3	0.000	0.054	0.000	0.108	0.000	1.835	0.702	
Z4	BLAC	010195	3	0.809	0.000	0.270	0.702	1.403	0.054	4.642	0.378
Z4	BLAC	090195	3	0.269	0.378	0.000	0.108	0.054	0.702	2.051	0.971
Z4	BLAC	170195	3	2.915	0.971	0.054	0.000	0.000	0.000	0.863	0.594
Z4	BLAC	250195	3	0.432	0.161	0.108	0.108	0.162	0.054	0.162	
Z4	BLAC	010295	3	0.000	0.054	0.162	0.000	0.000	0.432	0.216	0.054
Z4	BLAC	090295	3	0.270	0.108	0.053	0.324	0.648	0.108	0.108	0.809
Z4	BLAC	170295	3	0.270	0.108	0.108	0.432	0.324	0.648	0.000	0.539
Z4	BLAC	250295	3	1.835	0.000	0.108	0.000				

Z4	BLAC	010395	3	0.108	0.054	0.054	0.054	0.000	0.054	0.863	1.350
Z4	BLAC	090395	3	1.295	2.213	0.540	0.431	0.000	0.000	0.000	0.000
Z4	BLAC	170395	3	0.162	0.702	0.108	0.054	0.000	0.971	1.296	2.321
Z4	BLAC	250395	3	0.809	0.270	0.108	0.000	0.108	0.054	0.000	
Z4	BLAC	010495	3	0.000	0.108	0.054	0.108	1.403	0.486	0.054	0.000
Z4	BLAC	090495	3	0.000	1.187	0.108	0.000	0.000	0.000	0.000	0.000
Z4	BLAC	170495	3	0.378	0.917	0.810	0.054	1.511	0.000	0.540	0.863
Z4	BLAC	250495	3	0.108	0.540	0.810	0.647	0.000	0.000		
Z4	BLAC	010595	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.108
Z4	BLAC	090595	3	0.000	0.000	0.000	0.000	0.000	0.054	0.000	0.054
Z4	BLAC	170595	3	0.054	0.000	0.378	0.540	0.000	0.000	0.432	0.269
Z4	BLAC	250595	3	1.188	0.000	0.000	0.000	0.000	0.000	0.000	
Z4	BLAC	010695	3	0.000	0.000	0.000	0.000	0.108	0.054	0.216	6.099
Z4	GLOV	010794	3	0.109	0.325	0.055	0.000	0.054	0.706	0.163	0.000
Z4	GLOV	090794	3	0.000	0.869	1.466	0.054	0.000	0.054	0.109	0.054
Z4	GLOV	170794	3	0.543	0.054	0.000	0.000	0.163	0.923	1.847	5.430
Z4	GLOV	250794	3	0.162	0.055	0.054	0.163	0.814	0.163	0.000	
Z4	GLOV	010894	3	0.000	0.109	0.000	0.217	0.000	0.869	2.280	0.000
Z4	GLOV	090894	3	0.055	0.271	0.055	0.000	0.054	0.000	0.108	0.163
Z4	GLOV	170894	3	0.055	0.000	0.054	0.000	0.000	0.923	0.163	0.000
Z4	GLOV	250894	3	0.000	0.000	0.000	0.000	0.489	0.163	0.217	
Z4	GLOV	010994	3	0.163	0.054	0.000	0.000	0.000	0.326	0.434	0.109
Z4	GLOV	090994	3	0.597	0.163	1.846	0.652	1.140	0.000	0.217	0.109
Z4	GLOV	170994	3	0.163	0.543	0.108	0.217	0.000	0.000	0.326	0.000
Z4	GLOV	250994	3	0.000	0.000	0.000	0.000	0.000	0.000		
Z4	GLOV	011094	3	0.815	0.380	0.163	0.108	0.598	0.217	0.163	0.000
Z4	GLOV	091094	3	0.000	0.000	0.489	0.434	0.109	0.000	0.868	0.055
Z4	GLOV	171094	3	0.054	0.015	0.108	0.000	0.055	0.000	0.054	0.054
Z4	GLOV	251094	3	0.650	0.054	0.000	0.000	0.055	0.000	0.000	
Z4	GLOV	011194	3	0.108	1.246	0.813	0.217	2.059	0.108	1.463	1.463
Z4	GLOV	091194	3	0.380	0.054	1.409	0.162	0.055	0.054	0.054	0.271
Z4	GLOV	171194	3	0.271	0.162	0.163	0.596	0.000	1.192	0.325	0.379
Z4	GLOV	251194	3	0.000	0.705	0.054	0.163	1.192	0.000		
Z4	GLOV	011294	3	0.379	0.054	0.217	0.000	0.596	1.409	0.054	0.867
Z4	GLOV	091294	3	0.000	0.217	0.000	0.975	0.054	0.271	0.000	0.000
Z4	GLOV	171294	3	0.109	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Z4	GLOV	251294	3	0.000	0.000	0.000	0.000	0.000	0.000	1.138	
Z4	GLOV	010195	3	0.216	0.055	0.162	0.488	0.379	0.325	5.202	0.271
Z4	GLOV	090195	3	0.000	0.163	0.054	0.162	0.000	0.109	1.517	0.867
Z4	GLOV	170195	3	0.379	3.360	0.000	0.162	0.000	0.000	0.596	0.434
Z4	GLOV	250195	3	0.054	0.433	0.271	0.000	0.000	0.109	0.108	
Z4	GLOV	010295	3	0.163	0.000	0.108	0.163	0.054	0.325	0.108	0.000
Z4	GLOV	090295	3	0.163	0.000	0.108	0.163	0.487	0.109	0.000	2.167
Z4	GLOV	170295	3	0.109	0.271	0.054	0.000	0.162	0.325	0.000	0.055
Z4	GLOV	250295	3	2.059	0.108	0.054	0.054				
Z4	GLOV	010395	3	0.271	0.054	0.109	0.000	0.054	0.000	0.650	0.596
Z4	GLOV	090395	3	0.596	0.922	0.270	0.163	0.108	0.055	0.271	0.704
Z4	GLOV	170395	3	0.000	0.759	0.162	0.000	0.000	0.434	0.758	1.409
Z4	GLOV	250395	3	0.054	0.596	0.109	0.000	0.216	0.000	0.000	
Z4	GLOV	010495	3	0.000	0.000	0.326	0.108	0.217	0.216	0.000	0.055
Z4	GLOV	090495	3	0.000	0.867	0.054	0.000	0.000	0.000	0.000	0.000
Z4	GLOV	170495	3	0.054	0.434	1.300	0.108	1.463	0.380	0.108	1.355
Z4	GLOV	250495	3	0.054	0.163	0.596	0.379	0.000	0.054		
Z4	GLOV	010595	3	0.000	0.054	0.000	0.000	0.000	0.000	0.000	0.000

Z4 GLOV 090595 3	0.055	0.000	0.162	0.054	0.000	0.000	0.000	0.000
Z4 GLOV 170595 3	0.000	0.054	0.000	0.217	0.054	0.000	0.380	0.054
Z4 GLOV 250595 3	1.029	0.217	0.054	0.000	0.000	0.217	0.758	
Z4 GLOV 010695 3	0.000	0.000	0.542	0.271	0.054	0.000	0.109	8.074
Z4 GRAN 010794 3	0.214	2.727	0.107	0.000	0.000	0.160	0.054	0.000
Z4 GRAN 090794 3	0.000	0.535	3.102	0.053	0.054	0.000	0.000	0.000
Z4 GRAN 170794 3	0.000	0.000	0.000	0.000	0.000	0.000	1.818	2.246
Z4 GRAN 250794 3	0.696	0.053	1.230	0.000	1.765	0.107	0.000	
Z4 GRAN 010894 3	0.000	0.000	0.000	0.000	0.000	1.284	1.765	0.053
Z4 GRAN 090894 3	0.000	0.000	0.160	0.000	0.000	0.000	0.000	0.000
Z4 GRAN 170894 3	0.000	0.000	0.000	0.000	0.000	1.872	0.000	0.000
Z4 GRAN 250894 3	0.054	0.106	0.054	0.160	1.230	0.375	0.267	
Z4 GRAN 010994 3	0.000	0.000	0.000	0.000	0.000	0.428	0.107	0.321
Z4 GRAN 090994 3	0.909	0.214	5.669	0.856	2.941	0.107	0.054	0.000
Z4 GRAN 170994 3	1.818	0.000	0.107	0.268	0.053	0.054	1.818	0.374
Z4 GRAN 250994 3	0.000	0.000	0.000	0.000	0.000	0.482		
Z4 GRAN 011094 3	0.321	0.320	0.214	0.054	0.053	0.642	0.214	0.160
Z4 GRAN 091094 3	0.054	0.642	1.230	0.000	0.000	0.000	1.979	0.053
Z4 GRAN 171094 3	0.107	0.295	0.000	0.054	0.000	0.000	0.482	0.053
Z4 GRAN 251094 3	0.000	0.000	0.000	0.161	0.000	0.321	0.000	
Z4 GRAN 011194 3	0.214	1.766	0.053	0.107	2.783	0.803	1.552	1.338
Z4 GRAN 091194 3	0.535	0.160	0.910	0.000	0.107	0.000	0.161	0.374
Z4 GRAN 171194 3	0.268	0.000	2.408	0.482	0.000	1.285	0.428	0.107
Z4 GRAN 251194 3	1.284	0.375	0.428	0.160	1.231	0.054		
Z4 GRAN 011294 3	0.214	0.481	0.321	0.268	0.375	0.374	0.107	0.535
Z4 GRAN 091294 3	0.054	0.482	0.321	1.231	0.000	0.107	0.000	0.000
Z4 GRAN 171294 3	0.428	0.535	0.160	0.000	0.000	0.214	0.000	0.000
Z4 GRAN 251294 3	0.000	0.000	0.000	0.054	0.375	0.214	0.374	
Z4 GRAN 010195 3	0.107	0.000	0.000	1.713	0.963	0.000	5.138	0.588
Z4 GRAN 090195 3	0.000	0.375	0.000	0.053	0.000	0.000	1.338	2.194
Z4 GRAN 170195 3	0.482	1.177	0.268	1.177	0.107	0.054	0.374	0.214
Z4 GRAN 250195 3	0.054	0.161	0.160	0.054	0.000	0.000	0.000	
Z4 GRAN 010295 3	0.160	0.428	0.535	0.643	0.107	0.000	0.000	0.000
Z4 GRAN 090295 3	0.000	0.053	0.749	0.857	1.391	0.375	0.000	1.016
Z4 GRAN 170295 3	0.750	0.321	0.107	0.374	0.107	0.000	0.000	0.375
Z4 GRAN 250295 3	0.000	0.482	0.481	0.000				
Z4 GRAN 010395 3	0.000	0.481	0.268	0.053	0.054	0.053	0.429	0.214
Z4 GRAN 090395 3	0.267	0.803	0.267	1.071	0.000	0.000	0.535	0.160
Z4 GRAN 170395 3	0.000	0.000	0.750	0.000	0.000	0.000	0.000	1.177
Z4 GRAN 250395 3	0.054	0.214	0.160	0.214	0.000	0.321	0.000	
Z4 GRAN 010495 3	0.000	0.000	0.000	0.000	0.000	0.535	0.054	0.000
Z4 GRAN 090495 3	0.000	0.000	0.161	0.214	0.000	0.000	0.000	0.000
Z4 GRAN 170495 3	0.053	0.910	0.535	0.107	1.391	0.107	0.000	0.268
Z4 GRAN 250495 3	0.054	0.160	0.749	0.535	0.000	0.000		
Z4 GRAN 010595 3	0.000	0.000	0.000	0.482	0.054	0.053	0.054	0.000
Z4 GRAN 090595 3	0.053	0.054	0.053	0.000	0.000	0.000	0.000	0.000
Z4 GRAN 170595 3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.696
Z4 GRAN 250595 3	0.642	0.321	0.000	0.000	0.000	0.321	0.482	
Z4 GRAN 010695 3	0.000	0.267	0.372	0.428	0.000	0.000	0.053	12.416
Z4 INDI 010794 3	0.060	0.000	0.000	0.000	0.000	0.179	0.298	0.000
Z4 INDI 090794 3	0.239	2.266	1.611	0.000	0.000	0.000	0.000	0.000
Z4 INDI 170794 3	0.000	0.059	0.060	0.060	0.000	1.252	1.551	1.253
Z4 INDI 250794 3	0.000	0.000	0.239	0.000	2.266	0.179	0.000	

Z4	INDI	010894	3	0.000	0.000	0.000	0.000	0.000	1.253	1.730	0.000
Z4	INDI	090894	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Z4	INDI	170894	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Z4	INDI	250894	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Z4	INDI	010994	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Z4	INDI	090994	3	0.000	0.000	2.804	0.596	0.597	0.298	0.060	0.059
Z4	INDI	170994	3	0.179	0.179	0.000	0.000	0.000	0.000	0.000	0.000
Z4	INDI	250994	3	0.000	0.000	0.000	0.000	0.000	0.000		
Z4	INDI	011094	3	0.656	1.492	1.491	0.179	0.000	0.537	0.179	0.119
Z4	INDI	091094	3	0.000	0.000	0.597	0.119	0.000	0.000	0.596	0.000
Z4	INDI	171094	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.278
Z4	INDI	251094	3	0.213	0.000	0.000	0.107	0.053	0.160	0.000	
Z4	INDI	011194	3	0.000	1.704	0.586	0.000	1.864	0.160	0.799	0.000
Z4	INDI	091194	3	0.000	0.266	1.278	0.746	0.000	0.000	0.266	0.160
Z4	INDI	171194	3	0.053	0.000	0.480	0.106	0.000	0.852	0.214	0.053
Z4	INDI	251194	3	0.053	0.160	0.053	0.000	1.172	0.000		
Z4	INDI	011294	3	0.266	0.160	0.000	0.373	0.319	2.024	0.373	1.385
Z4	INDI	091294	3	0.106	0.213	0.320	0.586	0.000	0.000	0.000	0.000
Z4	INDI	171294	3	0.000	0.000	0.000	0.160	0.159	0.000	0.000	0.000
Z4	INDI	251294	3	0.000	0.000	0.000	0.000	0.000	1.918	0.479	
Z4	INDI	010195	3	0.053	0.000	0.852	0.107	0.266	0.000	2.770	0.053
Z4	INDI	090195	3	0.160	0.106	0.054	0.053	0.693	0.000	1.172	0.958
Z4	INDI	170195	3	0.213	3.089	0.054	0.000	0.000	0.000	0.000	2.077
Z4	INDI	250195	3	2.130	0.000	0.107	0.479	0.320	0.000	0.106	
Z4	INDI	010295	3	0.000	0.053	0.213	0.107	0.320	0.372	0.107	0.053
Z4	INDI	090295	3	0.107	0.000	0.106	0.320	0.053	0.053	0.000	0.426
Z4	INDI	170295	3	0.054	0.106	0.053	0.000	0.213	0.799	0.000	0.000
Z4	INDI	250295	3	1.119	0.000	0.000	0.106				
Z4	INDI	010395	3	0.054	0.266	0.000	0.000	0.053	0.053	0.639	0.107
Z4	INDI	090395	3	0.746	1.544	0.480	0.532	0.427	0.106	0.373	0.799
Z4	INDI	170395	3	0.319	0.693	0.053	0.000	0.000	0.320	1.438	1.171
Z4	INDI	250395	3	0.107	1.544	0.213	0.000	0.107	0.266	0.000	
Z4	INDI	010495	3	0.000	0.053	0.693	0.266	0.266	0.214	0.000	0.053
Z4	INDI	090495	3	0.213	0.958	0.000	0.000	0.000	0.000	0.000	0.000
Z4	INDI	170495	3	0.000	1.066	0.639	0.000	1.065	0.053	0.533	0.373
Z4	INDI	250495	3	0.053	0.799	0.959	0.958	0.000	0.000		
Z4	INDI	010595	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.160
Z4	INDI	090595	3	0.107	0.000	0.000	0.213	0.000	0.000	0.000	0.000
Z4	INDI	170595	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Z4	INDI	250595	3	0.213	0.000	0.213	0.000	0.053	0.160	0.053	
Z4	INDI	010695	3	0.107	0.000	0.586	0.000	0.000	0.000	0.000	3.355
Z4	SAND	010794	3	0.272	0.326	0.380	0.054	0.109	0.434	0.163	0.109
Z4	SAND	090794	3	0.000	3.639	2.770	0.326	0.000	0.109	0.163	0.217
Z4	SAND	170794	3	0.217	0.000	0.000	0.000	0.000	0.054	0.978	1.195
Z4	SAND	250794	3	0.000	0.000	0.271	0.000	1.249	0.272	0.054	
Z4	SAND	010894	3	0.000	0.000	0.000	0.000	0.000	1.087	0.760	0.054
Z4	SAND	090894	3	0.163	0.218	0.054	0.054	0.000	0.000	0.000	0.000
Z4	SAND	170894	3	0.000	0.000	0.000	0.000	0.000	0.109	0.000	0.000
Z4	SAND	250894	3	0.000	0.000	0.000	0.000	0.000	0.163	0.000	
Z4	SAND	010994	3	0.000	0.000	0.000	0.000	0.000	1.086	0.054	0.000
Z4	SAND	090994	3	0.055	0.760	3.857	0.488	0.163	0.055	0.000	0.000
Z4	SAND	170994	3	0.163	0.108	0.055	0.000	0.000	0.000	0.000	0.000
Z4	SAND	250994	3	0.000	0.000	0.000	0.000	0.000	2.064		
Z4	SAND	011094	3	0.760	0.597	1.684	0.217	0.055	0.543	0.109	0.000

Z4	SAND	091094	3	0.000	0.108	0.815	0.000	0.054	0.000	0.706	0.218
Z4	SAND	171094	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Z4	SAND	251094	3	0.000	0.000	0.055	0.054	0.054	0.000	0.000	
Z4	SAND	011194	3	0.218	1.738	0.652	0.163	1.956	0.163	0.489	0.326
Z4	SAND	091194	3	0.054	0.163	1.793	0.163	0.000	0.163	0.108	0.163
Z4	SAND	171194	3	0.163	0.055	0.326	0.271	0.000	0.761	0.054	0.217
Z4	SAND	251194	3	0.000	0.163	0.435	0.000	0.706	0.000		
Z4	SAND	011294	3	0.163	0.000	0.109	0.163	0.489	1.086	0.652	1.684
Z4	SAND	091294	3	0.109	0.109	0.271	1.576	0.000	0.108	0.000	0.055
Z4	SAND	171294	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Z4	SAND	251294	3	0.000	0.000	0.000	0.054	0.000	0.815	0.652	
Z4	SAND	010195	3	0.435	0.000	0.488	0.978	0.544	0.054	1.956	0.054
Z4	SAND	090195	3	0.217	0.218	0.163	0.000	0.163	0.108	1.141	1.032
Z4	SAND	170195	3	0.326	4.781	0.000	0.000	0.000	0.000	0.000	0.706
Z4	SAND	250195	3	0.109	0.163	0.326	0.000	0.000	0.000	0.163	
Z4	SAND	010295	3	0.489	0.054	0.380	0.218	0.000	0.000	0.489	0.000
Z4	SAND	090295	3	0.000	0.000	0.000	0.000	0.054	0.054	0.055	1.032
Z4	SAND	170295	3	0.163	0.108	0.272	0.000	0.000	0.435	0.000	0.108
Z4	SAND	250295	3	1.033	0.054	0.489	0.000				
Z4	SAND	010395	3	0.000	0.000	0.217	0.109	0.000	0.000	0.652	0.000
Z4	SAND	090395	3	0.978	0.814	0.978	0.978	0.055	0.000	0.272	0.434
Z4	SAND	170395	3	0.163	0.435	0.163	0.054	0.000	0.326	0.869	2.391
Z4	SAND	250395	3	0.869	0.598	0.054	0.163	0.054	0.000	0.000	
Z4	SAND	010495	3	0.055	0.000	0.108	0.109	0.380	0.217	0.055	0.000
Z4	SAND	090495	3	0.054	0.761	0.054	0.000	0.000	0.000	0.000	0.000
Z4	SAND	170495	3	0.000	1.086	0.707	0.163	1.521	0.109	0.380	1.032
Z4	SAND	250495	3	0.163	0.380	0.869	0.435	0.000	0.000		
Z4	SAND	010595	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Z4	SAND	090595	3	0.000	0.000	0.000	0.000	0.000	0.054	0.000	0.000
Z4	SAND	170595	3	0.000	0.109	0.054	0.055	0.217	0.054	0.326	0.544
Z4	SAND	250595	3	0.869	0.326	0.054	0.000	0.054	0.000	0.000	
Z4	SAND	010695	3	0.054	0.000	0.163	0.109	0.054	0.000	0.109	7.823
Z4	BURG	010794	3	0.000	0.054	0.000	0.000	0.000	0.701	0.000	0.000
Z4	BURG	090794	3	0.000	0.000	3.395	0.216	0.000	0.000	0.054	0.000
Z4	BURG	170794	3	0.000	0.000	0.000	0.161	0.000	0.162	0.593	1.508
Z4	BURG	250794	3	0.378	1.293	0.000	0.215	0.701	0.054	0.000	
Z4	BURG	010894	3	0.054	0.161	0.054	0.216	0.161	1.240	2.802	0.215
Z4	BURG	090894	3	0.000	0.108	0.054	0.054	0.000	0.000	0.000	0.108
Z4	BURG	170894	3	0.000	0.000	0.000	0.054	0.000	0.108	0.054	0.054
Z4	BURG	250894	3	0.000	0.000	0.000	0.215	0.916	0.000	0.108	
Z4	BURG	010194	3	0.269	0.000	0.593	0.000	1.239	0.647	0.054	0.108
Z4	BURG	090194	3	1.724	0.054	0.377	0.000	0.000	0.000	1.132	0.215
Z4	BURG	170194	3	0.162	5.011	0.216	0.053	0.000	0.054	0.755	0.000
Z4	BURG	250194	3	0.161	0.161	0.054	0.000	1.832	0.162	0.054	
Z4	BURG	010294	3	0.215	0.000	1.778	0.054	0.216	0.431	0.054	0.215
Z4	BURG	090294	3	0.000	0.000	0.000	0.000	0.270	3.395	0.377	0.000
Z4	BURG	170294	3	0.000	0.000	0.000	0.269	0.916	0.216	0.108	0.000
Z4	BURG	250294	3	0.431	0.161	0.000	0.216				
Z4	BURG	010394	3	0.000	0.431	0.269	2.641	0.592	1.832	0.108	0.000
Z4	BURG	090394	3	0.054	0.539	2.425	0.592	0.432	1.023	0.000	0.000
Z4	BURG	170394	3	0.862	1.078	0.323	0.000	0.000	0.000	0.000	0.000
Z4	BURG	250394	3	0.378	0.862	0.323	0.862	0.216	0.377	0.162	
Z4	BURG	010494	3	0.000	0.000	0.000	1.077	0.324	0.000	3.233	0.916
Z4	BURG	090494	3	0.000	0.592	0.863	0.269	0.000	0.485	0.054	0.054

Z4	BURG	170494	3	0.000	0.108	0.000	0.108	0.323	0.054	0.108	0.053
Z4	BURG	250494	3	0.000	0.000	0.324	0.916	0.054	0.000		
Z4	BURG	010594	3	0.000	1.023	0.324	0.000	0.108	3.933	1.132	0.431
Z4	BURG	090594	3	2.963	0.108	0.323	0.108	0.108	0.269	0.485	0.000
Z4	BURG	170594	3	0.000	0.324	0.000	0.000	0.000	0.000	0.377	0.054
Z4	BURG	250594	3	0.161	0.485	0.162	0.377	0.000	0.054	0.485	
Z4	BURG	010694	3	0.054	1.132	0.215	1.078	0.161	0.054	1.024	0.162
Z4	BURG	090694	3	0.215	1.401	0.162	0.108	0.000	0.539	0.000	0.269
Z4	BURG	170694	3	0.000	0.000	0.000	0.108	0.000	0.754	0.593	0.916
Z4	BURG	250694	3	0.269	0.108	0.000	0.000	0.108	0.269		
Z4	BURG	010794	3	0.000	0.054	0.000	0.000	0.000	0.701	0.000	0.000
Z4	BURG	090794	3	0.000	0.000	3.395	0.216	0.000	0.000	0.054	0.000
Z4	BURG	170794	3	0.000	0.000	0.000	0.161	0.000	0.162	0.593	1.508
Z4	BURG	250794	3	0.378	1.293	0.000	0.215	0.701	0.054	0.000	
Z4	BURG	010894	3	0.054	0.161	0.054	0.216	0.161	1.240	2.802	0.215
Z4	BURG	090894	3	0.000	0.108	0.054	0.054	0.000	0.000	0.000	0.108
Z4	BURG	170894	3	0.000	0.000	0.000	0.054	0.000	0.108	0.054	0.054
Z4	BURG	250894	3	0.000	0.000	0.000	0.215	0.916	0.000	0.108	
Z4	BURG	010994	3	0.000	0.000	0.000	0.000	0.000	0.593	0.269	0.000
Z4	BURG	090994	3	0.485	0.162	4.688	0.485	2.532	0.108	0.054	0.000
Z4	BURG	170994	3	1.024	0.000	0.161	0.162	0.000	0.054	0.000	0.000
Z4	BURG	250994	3	0.054	0.000	0.000	0.000	0.108	1.562		
Z4	BURG	011094	3	0.647	0.215	0.108	0.162	0.000	0.215	0.216	0.000
Z4	BURG	091094	3	0.000	0.108	1.293	0.108	0.054	0.000	0.700	0.000
Z4	BURG	171094	3	0.108	0.000	0.000	0.000	11.003	0.054	0.432	0.972
Z4	BURG	251094	3	0.540	0.539	0.000	0.810	0.000	0.000	0.000	
Z4	BURG	011194	3	0.216	2.483	0.432	0.108	2.915	0.000	3.671	0.971
Z4	BURG	091194	3	0.270	0.000	0.918	0.378	0.000	0.000	0.216	0.324
Z4	BURG	171194	3	0.108	0.000	0.270	0.539	0.000	1.728	0.864	0.054
Z4	BURG	251194	3	0.054	0.377	0.000	0.000	1.566	0.270		
Z4	BURG	011294	3	0.162	0.270	0.216	0.215	0.594	2.969	0.162	1.350
Z4	BURG	091294	3	0.162	0.216	0.324	0.809	0.000	0.594	0.000	0.216
Z4	BURG	171294	3	0.054	0.000	0.000	0.000	0.000	0.000	0.000	0.054
Z4	BURG	251294	3	0.108	0.000	0.000	0.162	0.540	0.701	0.270	
Z4	BURG	010195	3	0.000	0.054	0.702	0.324	0.378	0.054	3.994	0.216
Z4	BURG	090195	3	0.000	0.000	0.000	0.000	0.810	0.000	1.134	0.864
Z4	BURG	170195	3	0.809	5.614	0.000	0.000	0.000	0.000	0.162	4.157
Z4	BURG	250195	3	0.054	0.270	0.378	0.108	0.000	0.000	0.162	
Z4	BURG	010295	3	0.054	0.000	0.755	0.054	1.134	0.270	0.810	0.000
Z4	BURG	090295	3	0.000	0.000	0.269	0.054	0.216	0.108	0.000	1.782
Z4	BURG	170295	3	0.216	0.324	0.161	0.540	0.216	2.591	0.216	0.000
Z4	BURG	250295	3	0.864	0.108	0.000	0.054				
Z4	BURG	010395	3	0.486	0.594	0.377	0.108	0.000	0.000	0.594	0.324
Z4	BURG	090395	3	0.162	0.648	0.000	0.270	0.108	0.000	0.000	0.000
Z4	BURG	170395	3	0.000	0.000	0.486	0.000	0.000	0.701	0.702	1.296
Z4	BURG	250395	3	0.270	0.485	0.054	0.162	0.000	0.000	0.000	
Z4	BURG	010495	3	0.000	1.998	0.593	0.270	0.594	0.108	0.000	0.000
Z4	BURG	090495	3	0.000	0.702	0.108	0.108	0.000	0.000	0.000	0.000
Z4	BURG	170495	3	0.000	0.702	0.539	0.000	0.648	0.162	0.054	0.108
Z4	BURG	250495	3	0.054	0.054	0.432	0.108	0.000	0.000		
Z4	BURG	010595	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Z4	BURG	090595	3	0.000	0.000	0.000	0.000	0.000	0.000	0.054	0.000
Z4	BURG	170595	3	0.000	0.000	0.000	0.162	0.000	0.054	0.324	0.054
Z4	BURG	250595	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Z4	BURG	010695	3	0.270	0.756	0.000	0.378	0.162	0.162	0.054	3.185

Z4	CORN	010794	3	0.215	0.215	0.107	0.054	0.000	1.451	0.000	0.000
Z4	CORN	090794	3	0.000	1.182	1.881	0.054	0.000	0.054	0.054	1.290
Z4	CORN	170794	3	0.107	0.000	0.000	0.323	0.000	1.720	2.204	5.160
Z4	CORN	250794	3	0.000	0.161	0.806	0.000	1.021	0.054	0.000	
Z4	CORN	010894	3	0.054	0.430	0.000	0.753	0.053	2.527	1.451	0.054
Z4	CORN	090894	3	0.000	0.322	0.000	0.054	0.000	0.000	0.000	0.107
Z4	CORN	170894	3	0.054	0.000	0.000	0.000	0.000	1.989	0.000	0.000
Z4	CORN	250894	3	0.000	0.215	0.161	0.054	0.645	0.161	0.591	
Z4	CORN	010194	3	0.537	0.591	0.431	0.215	0.860	1.236	1.344	0.430
Z4	CORN	090194	3	0.967	2.096	0.000	0.215	0.108	0.322	0.430	0.484
Z4	CORN	170194	3	0.538	4.622	1.075	0.000	0.000	0.000	0.215	0.054
Z4	CORN	250194	3	0.054	0.322	0.108	1.021	6.558	0.161	0.645	
Z4	CORN	010294	3	0.000	0.000	0.591	0.108	0.161	0.753	0.215	0.376
Z4	CORN	090294	3	0.000	0.000	0.000	0.000	0.107	0.377	0.268	0.538
Z4	CORN	170294	3	0.000	0.000	0.000	0.215	0.752	0.269	0.430	0.054
Z4	CORN	250294	3	0.054	0.161	0.054	0.591				
Z4	CORN	010394	3	0.322	0.000	0.054	1.075	0.323	0.161	0.000	0.538
Z4	CORN	090394	3	0.645	1.720	2.902	1.021	0.162	0.483	1.344	0.108
Z4	CORN	170394	3	1.021	0.914	0.215	0.000	0.000	0.054	0.053	0.000
Z4	CORN	250394	3	0.645	0.377	0.268	0.592	0.000	0.268	0.215	
Z4	CORN	010494	3	0.538	0.161	0.000	2.634	0.322	0.000	5.859	1.827
Z4	CORN	090494	3	0.162	2.956	0.699	0.322	0.000	2.419	0.000	0.000
Z4	CORN	170494	3	0.699	0.000	0.000	0.376	0.753	0.000	0.591	0.161
Z4	CORN	250494	3	0.000	0.000	0.108	1.182	0.054	0.000		
Z4	CORN	010594	3	0.107	0.645	0.430	0.484	0.377	6.503	0.430	0.000
Z4	CORN	090594	3	2.097	0.000	2.311	0.000	0.053	0.323	0.000	0.000
Z4	CORN	170594	3	0.000	0.054	0.000	0.000	0.000	0.000	0.591	0.000
Z4	CORN	250594	3	0.107	0.162	1.128	0.054	0.054	0.322	2.903	
Z4	CORN	010694	3	0.161	1.720	0.968	0.161	0.000	0.054	1.720	0.322
Z4	CORN	090694	3	0.000	0.162	0.107	0.000	0.269	0.967	0.699	0.108
Z4	CORN	170694	3	0.215	0.000	0.053	0.000	0.000	3.279	0.162	0.860
Z4	CORN	250694	3	0.000	0.053	0.054	0.376	0.323	0.914		
Z4	CORN	010794	3	0.215	0.215	0.107	0.054	0.000	1.451	0.000	0.000
Z4	CORN	090794	3	0.000	1.182	1.881	0.054	0.000	0.054	0.054	1.290
Z4	CORN	170794	3	0.107	0.000	0.000	0.323	0.000	1.720	2.204	5.160
Z4	CORN	250794	3	0.000	0.161	0.806	0.000	1.021	0.054	0.000	
Z4	CORN	010894	3	0.054	0.430	0.000	0.753	0.053	2.527	1.451	0.054
Z4	CORN	090894	3	0.000	0.322	0.000	0.054	0.000	0.000	0.000	0.107
Z4	CORN	170894	3	0.054	0.000	0.000	0.000	0.000	1.989	0.000	0.000
Z4	CORN	250894	3	0.000	0.215	0.161	0.054	0.645	0.161	0.591	
Z4	CORN	010994	3	0.000	0.000	0.215	0.000	0.000	1.075	0.323	0.107
Z4	CORN	090994	3	0.215	0.753	3.924	0.161	0.322	0.269	0.108	0.053
Z4	CORN	170994	3	1.505	0.108	0.107	0.269	0.054	0.000	0.000	0.000
Z4	CORN	250994	3	0.000	0.000	0.000	0.000	0.000	1.666		
Z4	CORN	011094	3	0.108	0.215	1.021	0.537	0.054	0.323	0.215	0.000
Z4	CORN	091094	3	0.000	0.699	1.182	0.000	0.000	0.591	3.440	1.452
Z4	CORN	171094	3	0.107	4.792	0.000	0.000	0.000	0.000	0.539	0.000
Z4	CORN	251094	3	0.054	0.000	0.108	0.108	0.000	0.054	0.000	
Z4	CORN	011194	3	0.593	2.211	0.485	0.162	2.750	0.054	2.319	1.672
Z4	CORN	091194	3	1.024	0.270	1.402	0.054	0.000	0.000	0.054	0.970
Z4	CORN	171194	3	0.054	0.000	1.187	0.809	0.000	3.127	1.079	0.971
Z4	CORN	251194	3	0.323	0.378	0.161	0.270	1.780	1.240		
Z4	CORN	011294	3	0.000	0.216	0.809	0.107	0.324	1.132	0.000	0.594
Z4	CORN	091294	3	0.053	0.809	0.594	1.833	0.270	0.377	0.000	0.216
Z4	CORN	171294	3	0.000	0.000	0.000	0.216	0.323	0.108	0.000	0.000

Z4	CORN	251294	3	0.000	0.000	0.216	0.108	0.161	1.025	1.132	
Z4	CORN	010195	3	0.108	0.054	1.294	1.295	0.970	0.701	4.800	0.000
Z4	CORN	090195	3	0.000	0.000	7.658	0.000	0.809	0.053	1.618	2.427
Z4	CORN	170195	3	1.833	0.486	0.000	0.000	0.000	0.000	0.701	0.108
Z4	CORN	250195	3	0.431	0.270	0.269	0.000	0.054	0.000	0.432	
Z4	CORN	010295	3	1.402	0.000	0.269	0.162	0.809	0.270	0.162	0.000
Z4	CORN	090295	3	0.808	1.079	0.324	0.000	0.647	0.323	0.108	2.858
Z4	CORN	170295	3	0.809	0.647	0.162	0.431	0.162	0.000	0.162	0.485
Z4	CORN	250295	3	1.241	0.323	0.378	0.161				
Z4	CORN	010395	3	0.162	0.000	0.108	0.108	0.000	0.000	0.431	0.971
Z4	CORN	090395	3	1.618	1.186	1.294	0.540	0.000	0.000	0.701	0.108
Z4	CORN	170395	3	0.000	0.323	0.054	0.054	0.162	0.863	0.862	0.594
Z4	CORN	250395	3	0.431	0.162	0.162	0.000	0.000	0.161	0.000	
Z4	CORN	010495	3	0.000	0.216	0.539	0.162	0.270	0.323	0.054	0.054
Z4	CORN	090495	3	0.054	1.672	0.108	0.000	0.000	0.054	0.000	0.000
Z4	CORN	170495	3	0.269	0.809	0.863	0.054	2.319	0.108	0.000	1.510
Z4	CORN	250495	3	0.107	0.000	1.349	1.024	0.000	0.000		
Z4	CORN	010595	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Z4	CORN	090595	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Z4	CORN	170595	3	0.000	0.000	0.000	0.000	0.000	0.000	0.270	0.970
Z4	CORN	250595	3	0.917	0.000	0.000	0.000	0.000	1.348	0.054	
Z4	CORN	010695	3	0.000	0.054	0.593	0.647	0.162	0.054	0.108	10.623

Z4	BLAC	010794	4	17.500	12.810	14.880	12.260	12.390	12.080	11.410	14.690
Z4	BLAC	090794	4	14.840	12.700	16.690	12.670	16.130	14.960	16.100	13.340
Z4	BLAC	170794	4	12.570	14.810	17.280	14.250	16.140	14.040	18.300	9.620
Z4	BLAC	250794	4	13.260	19.610	20.310	19.140	16.470	15.010	18.150	
Z4	BLAC	010894	4	20.340	15.950	15.320	15.310	20.010	13.660	12.740	15.470
Z4	BLAC	090894	4	14.780	18.450	14.650	11.400	10.990	15.900	16.840	12.960
Z4	BLAC	170894	4	15.620	14.310	13.080	12.810	14.530	15.980	12.030	10.570
Z4	BLAC	250894	4	12.320	16.010	18.390	17.020	13.850	13.000	11.040	
Z4	BLAC	010994	4	9.350	7.530	6.310	10.370	6.370	5.800	14.810	14.480
Z4	BLAC	090994	4	13.090	12.210	12.440	11.820	10.740	9.100	7.190	4.130
Z4	BLAC	170994	4	5.660	8.760	6.200	7.710	8.690	6.570	5.090	10.190
Z4	BLAC	250994	4	10.560	13.860	8.700	4.050	5.710	6.640		
Z4	BLAC	011094	4	6.500	7.660	6.330	4.340	6.450	6.740	7.470	12.480
Z4	BLAC	091094	4	13.650	11.590	4.870	1.640	0.450	0.100	1.800	3.830
Z4	BLAC	171094	4	3.160	1.590	4.070	0.930	1.940	3.600	5.760	7.000
Z4	BLAC	251094	4	8.240	4.550	4.250	1.790	2.070	1.850	4.810	
Z4	BLAC	011194	4	3.500	4.450	6.420	1.860	2.450	-0.250	3.450	0.010
Z4	BLAC	091194	4	1.110	1.360	1.140	0.450	-0.810	0.140	3.610	-0.170
Z4	BLAC	171194	4	-2.330	1.680	4.460	-3.000	-3.580	1.960	-2.800	-5.260
Z4	BLAC	251194	4	-5.800	-5.380	-9.500	-9.890	-4.980	-3.770		
Z4	BLAC	011294	4	-5.750	-7.640	-10.500	-14.250	-9.000	-7.440	-4.800	-3.560
Z4	BLAC	091294	4	-4.760	-7.750	-8.290	-5.660	-11.690	-15.280	-13.580	-16.440
Z4	BLAC	171294	4	-19.760	-13.240	-8.820	-5.800	-10.040	-1.150	0.580	-6.780
Z4	BLAC	251294	4	-12.240	-6.130	-7.860	-14.950	-12.260	-2.160	-4.650	
Z4	BLAC	010195	4	-12.940	-17.940	-11.890	-9.450	-13.560	-12.000	-1.520	-6.860
Z4	BLAC	090195	4	-8.240	-12.140	-21.790	-20.630	-16.350	-9.700	-7.210	-6.440
Z4	BLAC	170195	4	-9.030	-12.270	-7.550	-4.470	-8.890	-9.460	-6.860	-4.010
Z4	BLAC	250195	4	-2.600	-5.800	-13.420	-17.410	-10.770	-11.000	-15.250	
Z4	BLAC	010295	4	-11.320	-13.290	-18.880	-27.070	-15.190	-3.590	-15.630	-16.900
Z4	BLAC	090295	4	-17.490	-15.020	-14.580	-14.590	-15.610	-17.380	-18.290	-7.240
Z4	BLAC	170295	4	-11.160	-16.310	-17.830	-12.830	-18.970	-12.040	-12.300	-7.450
Z4	BLAC	250295	4	-1.010	-12.650	-16.050	-14.420				

Z4	BLAC	010395	4	-12.730	-9.690	-15.620	-19.970	-15.360	-18.150	-14.130	-6.940
Z4	BLAC	090395	4	-3.040	-5.190	-10.200	-16.060	-15.890	-11.940	-3.660	-2.080
Z4	BLAC	170395	4	-2.990	-1.680	-8.860	-7.960	-0.600	-2.260	-3.840	-1.710
Z4	BLAC	250395	4	-0.850	0.170	-1.810	-2.600	-8.550	-12.860	-7.200	
Z4	BLAC	010495	4	-6.970	-2.270	-1.000	-3.010	-6.030	-9.800	-5.960	-6.270
Z4	BLAC	090495	4	-6.600	-1.810	-8.910	-8.890	-5.190	4.610	3.060	3.960
Z4	BLAC	170495	4	1.850	1.880	2.050	2.410	2.180	1.970	1.030	1.340
Z4	BLAC	250495	4	1.570	0.500	0.990	0.700	0.240	0.750		
Z4	BLAC	010595	4	1.760	1.040	1.500	-0.290	2.020	3.060	0.310	2.260
Z4	BLAC	090595	4	3.750	2.540	5.550	5.300	4.580	2.590	1.430	1.700
Z4	BLAC	170595	4	2.790	4.190	1.160	3.500	6.530	7.810	4.810	7.230
Z4	BLAC	250595	4	1.890	3.400	4.220	3.360	5.420	7.240	7.410	
Z4	BLAC	010695	4	9.450	11.590	7.140	6.960	6.120	6.140	6.780	12.250

Z4	GLOV	010794	4	17.160	12.710	16.620	12.750	13.200	12.910	11.890	14.030
Z4	GLOV	090794	4	14.510	13.390	17.310	15.840	18.290	15.210	16.440	14.790
Z4	GLOV	170794	4	13.390	16.710	18.050	13.400	16.110	15.400	18.670	11.380
Z4	GLOV	250794	4	14.270	19.360	21.540	21.090	17.030	16.400	17.690	
Z4	GLOV	010894	4	21.130	17.640	15.340	16.810	20.540	16.420	12.630	16.860
Z4	GLOV	090894	4	16.150	18.000	16.350	12.820	13.470	18.290	18.260	13.600
Z4	GLOV	170894	4	16.350	15.820	13.190	13.450	17.300	16.420	12.450	11.430
Z4	GLOV	250894	4	13.510	16.550	18.450	17.410	16.610	13.960	11.400	
Z4	GLOV	010994	4	11.390	10.690	8.760	10.760	10.690	12.060	14.010	13.680
Z4	GLOV	090994	4	12.650	11.010	13.290	12.110	10.300	10.130	8.790	7.410
Z4	GLOV	170994	4	9.610	11.270	8.090	9.100	10.880	8.340	8.880	11.310
Z4	GLOV	250994	4	11.750	14.290	11.470	6.940	8.110	8.910		
Z4	GLOV	011094	4	9.240	9.300	7.470	6.140	8.300	8.890	8.110	11.710
Z4	GLOV	091094	4	13.920	14.110	6.690	3.610	2.440	3.020	2.790	5.200
Z4	GLOV	171094	4	5.110	3.900	5.730	3.710	4.540	5.990	8.570	9.200
Z4	GLOV	251094	4	8.490	8.220	7.000	4.060	5.240	7.440	7.580	
Z4	GLOV	011194	4	5.940	7.670	8.350	3.690	5.900	2.180	5.430	0.890
Z4	GLOV	091194	4	1.940	2.900	2.440	2.460	0.800	1.440	5.390	1.550
Z4	GLOV	171194	4	0.200	3.630	7.840	-1.200	-2.260	3.790	-1.210	-3.790
Z4	GLOV	251194	4	-2.940	-2.250	-5.820	-7.440	-0.930	-0.190		
Z4	GLOV	011294	4	-2.610	-4.050	-4.290	-6.890	-3.910	-1.960	-2.380	-1.410
Z4	GLOV	091294	4	-2.870	-3.610	-4.950	-3.000	-8.540	-9.790	-8.200	-9.950
Z4	GLOV	171294	4	-8.610	-5.550	-2.310	-4.610	-6.470	1.000	1.900	-0.900
Z4	GLOV	251294	4	-3.480	-3.790	-5.660	-8.330	-4.950	-1.950	-3.480	
Z4	GLOV	010195	4	-6.960	-7.240	-6.640	-6.030	-8.640	-7.900	1.090	-3.300
Z4	GLOV	090195	4	-5.630	-7.550	-14.640	-14.350	-10.440	-6.590	-0.640	-1.610
Z4	GLOV	170195	4	-4.980	-7.000	-3.080	-1.110	-5.370	-6.080	-3.930	-2.200
Z4	GLOV	250195	4	-1.190	-4.060	-10.100	-12.160	-8.880	-8.170	-9.530	
Z4	GLOV	010295	4	-8.310	-6.190	-13.630	-15.840	-7.440	-2.460	-13.280	-14.200
Z4	GLOV	090295	4	-10.930	-11.580	-10.940	-8.440	-11.890	-13.780	-11.410	-3.470
Z4	GLOV	170295	4	-7.610	-11.350	-9.520	-8.740	-11.790	-8.940	-8.640	-3.500
Z4	GLOV	250295	4	0.930	-10.240	-12.490	-10.490				
Z4	GLOV	010395	4	-8.890	-7.110	-9.750	-10.640	-7.320	-13.550	-10.540	-3.590
Z4	GLOV	090395	4	3.800	-3.760	-7.760	-9.860	-7.610	-5.250	-2.510	-0.790
Z4	GLOV	170395	4	-0.800	0.260	-6.650	-5.190	1.210	0.940	-1.050	-1.700
Z4	GLOV	250395	4	-0.940	0.410	-0.130	-1.140	-4.900	-6.130	-2.600	
Z4	GLOV	010495	4	-1.690	-0.980	-0.090	-0.490	-4.890	-7.940	-3.150	-1.810
Z4	GLOV	090495	4	-0.330	-0.310	-3.860	-2.630	0.260	6.280	3.480	5.140
Z4	GLOV	170495	4	2.730	1.110	2.100	4.130	2.850	2.210	1.680	2.440
Z4	GLOV	250495	4	2.950	1.140	1.650	1.530	1.800	1.990		
Z4	GLOV	010595	4	3.680	2.740	3.900	2.360	4.090	5.710	2.900	2.810

Z4	GLOV	090595	4	4.210	4.030	5.010	6.640	5.440	4.100	3.790	3.440
Z4	GLOV	170595	4	3.520	5.890	3.270	4.300	9.640	11.600	8.340	9.630
Z4	GLOV	250595	4	3.530	5.710	6.150	4.090	7.240	6.880	7.690	
Z4	GLOV	010695	4	11.550	15.330	5.740	7.470	7.240	7.910	9.890	13.920
Z4	GRAN	010794	4	15.970	11.520	14.000	12.390	12.250	13.200	11.590	13.050
Z4	GRAN	090794	4	13.600	14.010	15.590	15.720	17.700	14.690	15.240	13.530
Z4	GRAN	170794	4	13.690	15.590	16.500	12.830	17.210	15.170	17.730	12.470
Z4	GRAN	250794	4	14.240	18.230	20.250	19.810	15.900	16.300	17.850	
Z4	GRAN	010894	4	19.900	16.500	14.090	16.340	19.630	16.860	11.160	16.430
Z4	GRAN	090894	4	14.660	17.510	16.810	13.100	13.410	17.330	17.910	13.660
Z4	GRAN	170894	4	14.910	15.890	12.710	11.990	15.650	15.950	11.510	10.100
Z4	GRAN	250894	4	11.110	13.880	17.010	16.200	17.260	13.190	11.410	
Z4	GRAN	010994	4	11.010	9.070	7.330	8.340	8.490	12.560	13.420	13.540
Z4	GRAN	090994	4	12.130	11.440	14.040	12.230	10.460	10.190	8.410	6.130
Z4	GRAN	170994	4	9.410	11.100	6.960	8.120	10.650	5.550	6.590	11.240
Z4	GRAN	250994	4	8.970	12.240	12.110	8.340	9.190	10.110		
Z4	GRAN	011094	4	10.150	9.250	7.860	6.390	7.840	8.540	6.780	10.660
Z4	GRAN	091094	4	12.290	12.880	7.080	3.050	1.080	1.350	2.520	5.880
Z4	GRAN	171094	4	5.700	5.000	5.380	3.300	1.820	5.590	9.340	9.300
Z4	GRAN	251094	4	8.590	8.200	7.280	2.960	4.610	6.500	6.830	
Z4	GRAN	011194	4	5.660	9.790	8.560	3.830	6.950	2.030	6.100	1.050
Z4	GRAN	091194	4	1.100	2.410	2.250	2.440	0.760	1.210	5.220	1.880
Z4	GRAN	171194	4	0.080	3.590	7.500	-0.450	-1.790	4.430	-1.100	-3.330
Z4	GRAN	251194	4	-2.740	-2.520	-6.500	-7.340	-0.360	-0.300		
Z4	GRAN	011294	4	-3.310	-4.150	-3.960	-7.490	-3.490	-0.930	-1.560	-0.850
Z4	GRAN	091294	4	-2.100	-3.630	-4.870	-2.850	-8.560	-11.540	-9.230	-13.600
Z4	GRAN	171294	4	-14.050	-5.320	-2.200	-5.150	-5.920	0.540	0.680	-0.760
Z4	GRAN	251294	4	-1.410	-2.900	-6.530	-9.710	-3.800	-1.660	-3.690	
Z4	GRAN	010195	4	-8.300	-8.870	-6.480	-6.020	-8.450	-7.850	1.780	-2.610
Z4	GRAN	090195	4	-4.750	-7.060	-15.850	-15.810	-9.290	-6.790	-0.460	-0.540
Z4	GRAN	170195	4	-3.400	-6.510	-4.540	-1.340	-4.580	-4.900	-2.500	-0.950
Z4	GRAN	250195	4	-0.610	-4.140	-11.300	-15.380	-9.640	-7.670	-9.990	
Z4	GRAN	010295	4	-9.960	-5.690	-12.670	-20.940	-6.350	-2.010	-13.710	-13.240
Z4	GRAN	090295	4	-10.840	-12.250	-11.900	-8.540	-11.720	-13.990	-14.160	-3.060
Z4	GRAN	170295	4	-7.890	-11.880	-11.660	-9.460	-12.770	-8.300	-10.610	-2.160
Z4	GRAN	250295	4	0.690	-10.310	-12.460	-10.780				
Z4	GRAN	010395	4	-7.960	-7.010	-11.360	-15.330	-9.950	-12.140	-9.610	-2.620
Z4	GRAN	090395	4	7.880	-2.290	-7.680	-11.710	-11.360	-8.730	-1.310	0.410
Z4	GRAN	170395	4	0.250	1.000	-5.860	-5.290	-1.090	2.610	1.030	-0.970
Z4	GRAN	250395	4	-0.510	0.580	0.010	-0.140	-4.990	-8.080	-4.150	
Z4	GRAN	010495	4	-1.240	-0.200	0.210	-0.610	-4.460	-8.690	-2.790	-2.740
Z4	GRAN	090495	4	-1.490	-0.340	-5.260	-4.810	-0.680	6.280	5.340	3.180
Z4	GRAN	170495	4	3.290	1.200	1.160	3.390	2.270	2.480	1.680	1.360
Z4	GRAN	250495	4	2.200	1.860	1.660	2.880	2.210	1.950		
Z4	GRAN	010595	4	3.390	2.240	2.090	2.540	4.000	3.750	3.790	4.350
Z4	GRAN	090595	4	4.390	5.540	5.990	6.330	5.580	6.060	4.990	3.880
Z4	GRAN	170595	4	3.540	5.590	4.370	5.040	9.350	10.590	8.290	8.990
Z4	GRAN	250595	4	5.160	5.890	5.850	4.820	7.990	7.050	7.930	
Z4	GRAN	010695	4	10.700	14.710	6.490	8.360	8.050	7.690	9.970	13.110
Z4	INDI	010794	4	17.860	15.100	17.900	14.290	14.110	13.410	11.350	14.250
Z4	INDI	090794	4	16.080	14.130	19.080	16.540	19.260	16.950	17.760	15.160
Z4	INDI	170794	4	14.260	17.440	19.510	15.090	15.300	14.270	18.560	10.790
Z4	INDI	250794	4	15.080	21.460	22.340	21.380	18.210	17.370	19.450	

Z4	INDI	010894	4	22.300	18.830	16.410	18.530	20.110	16.730	13.040	17.160
Z4	INDI	090894	4	16.050	19.410	16.870	12.740	13.940	17.500	19.800	14.890
Z4	INDI	170894	4	16.760	16.990	14.600	14.230	17.280	17.510	14.020	11.590
Z4	INDI	250894	4	15.030	17.570	18.810	17.760	15.950	14.900	12.750	
Z4	INDI	010994	4	12.350	10.440	8.070	11.750	12.700	11.280	14.810	14.480
Z4	INDI	090994	4	13.090	12.210	12.440	11.820	10.740	9.580	7.780	6.150
Z4	INDI	170994	4	8.470	12.190	8.980	10.410	10.950	7.560	7.800	13.390
Z4	INDI	250994	4	12.590	15.650	10.450	5.090	7.400	8.800		
Z4	INDI	011094	4	7.860	9.700	7.740	6.290	8.860	8.230	9.090	12.950
Z4	INDI	091094	4	13.860	13.790	7.050	2.920	2.540	2.210	3.250	5.690
Z4	INDI	171094	4	4.590	3.510	4.950	1.610	3.160	4.570	7.310	8.750
Z4	INDI	251094	4	9.750	8.200	7.440	3.850	4.560	8.330	7.250	
Z4	INDI	011194	4	5.400	6.200	9.300	3.700	4.110	0.530	4.930	1.950
Z4	INDI	091194	4	3.060	3.260	2.410	2.640	1.100	1.910	5.550	1.560
Z4	INDI	171194	4	-0.250	4.030	7.480	-0.950	-2.580	4.380	-0.210	-3.080
Z4	INDI	251194	4	-2.910	-2.130	-9.960	-9.510	-2.310	-1.550		
Z4	INDI	011294	4	-4.520	-6.720	-7.810	-10.790	-7.260	-5.640	-3.800	-2.140
Z4	INDI	091294	4	-2.850	-3.850	-6.960	-2.910	-9.390	-11.720	-12.410	-15.820
Z4	INDI	171294	4	-16.760	-9.890	-5.950	-3.670	-7.780	0.900	1.840	-4.710
Z4	INDI	251294	4	-8.000	-4.810	-6.740	-13.540	-10.400	-1.170	-4.400	
Z4	INDI	010195	4	-9.200	-13.380	-9.250	-7.210	-11.950	-12.690	1.050	-3.510
Z4	INDI	090195	4	-7.130	-10.900	-21.590	-21.530	-15.290	-8.090	-6.100	-5.160
Z4	INDI	170195	4	-7.360	-12.260	-8.790	-2.330	-7.390	-7.460	-4.480	-2.310
Z4	INDI	250195	4	-1.210	-4.520	-10.620	-14.060	-9.560	-9.900	-14.280	
Z4	INDI	010295	4	-10.740	-11.780	-16.990	-25.550	-13.390	-1.600	-14.090	-16.100
Z4	INDI	090295	4	-13.960	-13.910	-12.920	-14.110	-12.780	-16.110	-16.780	-4.130
Z4	INDI	170295	4	-9.130	-16.660	-15.360	-10.000	-16.240	-9.320	-8.990	-7.280
Z4	INDI	250295	4	1.630	-9.990	-13.550	-12.260				
Z4	INDI	010395	4	-10.900	-8.050	-12.630	-15.510	-11.310	-16.050	-13.540	-5.390
Z4	INDI	090395	4	-1.110	-3.110	-8.390	-14.380	-13.110	-9.470	-3.020	-1.090
Z4	INDI	170395	4	-1.760	0.050	-8.690	-8.510	0.520	-0.750	-1.790	-0.430
Z4	INDI	250395	4	0.030	1.080	0.160	-1.510	-6.430	-10.290	-4.790	
Z4	INDI	010495	4	-5.200	-0.950	-0.230	-1.380	-5.090	-10.340	-3.990	-2.110
Z4	INDI	090495	4	-1.250	-0.250	-5.380	-3.670	-2.120	4.780	4.730	5.450
Z4	INDI	170495	4	3.710	2.070	2.380	4.250	3.360	1.350	1.880	3.240
Z4	INDI	250495	4	2.710	1.140	1.560	1.290	1.630	2.740		
Z4	INDI	010595	4	3.570	1.890	2.560	1.040	4.530	4.690	1.080	2.300
Z4	INDI	090595	4	4.480	3.670	5.040	5.650	4.780	4.000	2.830	3.000
Z4	INDI	170595	4	3.950	6.900	3.670	5.090	9.510	11.700	8.390	9.990
Z4	INDI	250595	4	3.240	5.480	5.660	4.710	6.910	9.250	8.490	
Z4	INDI	010695	4	12.240	16.210	7.790	7.850	7.690	7.690	8.090	14.440

Z4	SAND	010794	4	16.450	14.090	16.160	13.730	14.350	12.200	12.140	15.200
Z4	SAND	090794	4	16.290	13.440	17.390	15.760	18.740	15.800	17.340	15.250
Z4	SAND	170794	4	13.510	16.990	18.610	14.840	16.650	15.520	17.910	10.890
Z4	SAND	250794	4	14.850	20.510	21.840	21.090	17.690	16.690	18.880	
Z4	SAND	010894	4	21.440	17.320	17.160	17.900	21.250	15.760	13.290	17.340
Z4	SAND	090894	4	16.980	19.080	16.800	13.390	13.640	18.670	18.500	14.870
Z4	SAND	170894	4	16.570	16.250	13.790	14.590	17.750	16.860	12.780	12.350
Z4	SAND	250894	4	14.580	16.910	19.190	17.790	16.380	14.180	11.660	
Z4	SAND	010994	4	11.730	11.510	8.180	10.640	12.090	12.060	14.380	14.100
Z4	SAND	090994	4	12.720	12.360	12.760	11.470	10.850	10.100	8.290	5.790
Z4	SAND	170994	4	8.920	10.960	8.610	10.210	11.580	7.900	8.260	12.360
Z4	SAND	250994	4	12.630	15.320	10.690	6.000	8.340	9.000		
Z4	SAND	011094	4	8.260	9.410	7.850	5.840	7.940	8.610	8.110	12.310

Z4	SAND	091094	4	13.570	13.940	5.960	2.700	1.340	1.660	2.560	5.500
Z4	SAND	171094	4	4.800	3.430	5.800	2.600	4.390	5.380	7.730	8.800
Z4	SAND	251094	4	8.960	7.700	6.950	3.160	4.290	4.800	6.110	
Z4	SAND	011194	4	5.600	7.610	8.350	3.200	4.780	1.030	5.650	0.800
Z4	SAND	091194	4	2.400	2.630	2.190	2.210	0.660	1.460	5.410	1.250
Z4	SAND	171194	4	-0.110	2.860	6.630	-1.290	-2.940	3.770	-1.300	-3.460
Z4	SAND	251194	4	-3.010	-1.850	-8.290	-7.700	-1.940	-1.420		
Z4	SAND	011294	4	-2.950	-4.960	-6.950	-9.240	-7.450	-3.750	-2.920	-1.800
Z4	SAND	091294	4	-3.150	-3.880	-6.310	-3.250	-9.420	-12.050	-10.390	-14.700
Z4	SAND	171294	4	-15.940	-7.550	-5.110	-4.250	-7.380	0.730	1.440	-3.190
Z4	SAND	251294	4	-7.140	-4.670	-7.140	-11.220	-7.570	-1.210	-3.810	
Z4	SAND	010195	4	-9.190	-12.400	-7.160	-6.660	-10.890	-8.690	0.950	-4.230
Z4	SAND	090195	4	-6.740	-9.750	-19.590	-19.250	-12.760	-7.580	-3.950	-4.760
Z4	SAND	170195	4	-7.150	-11.450	-7.530	-1.650	-6.920	-7.430	-4.710	-2.330
Z4	SAND	250195	4	-1.200	-4.300	-10.960	-14.140	-9.140	-8.660	-12.140	
Z4	SAND	010295	4	-9.250	-10.170	-16.650	-25.090	-10.300	-1.810	-13.400	-14.380
Z4	SAND	090295	4	-12.210	-13.060	-12.920	-11.190	-12.570	-15.080	-13.850	-3.340
Z4	SAND	170295	4	-8.690	-13.280	-12.330	-9.430	-15.300	-9.060	-9.100	-4.640
Z4	SAND	250295	4	0.680	-10.060	-13.790	-11.590				
Z4	SAND	010395	4	-10.000	-7.900	-12.010	-13.190	-8.500	-15.020	-11.850	-3.920
Z4	SAND	090395	4	-0.370	-3.240	-8.290	-13.110	-11.350	-8.320	-2.350	-0.390
Z4	SAND	170395	4	-1.040	0.310	-7.930	-7.190	1.380	0.200	-1.960	-0.900
Z4	SAND	250395	4	-0.160	0.900	0.600	-1.110	-5.220	-8.660	-4.110	
Z4	SAND	010495	4	-2.660	-0.610	0.580	-0.050	-4.690	-9.160	-3.450	-2.340
Z4	SAND	090495	4	-0.400	-0.040	-3.990	-3.300	-1.180	5.730	5.070	5.210
Z4	SAND	170495	4	3.150	1.700	2.330	3.630	3.340	2.010	1.930	2.710
Z4	SAND	250495	4	3.170	1.160	2.150	1.830	2.090	2.730		
Z4	SAND	010595	4	3.850	2.510	3.290	2.710	3.660	5.710	2.310	2.790
Z4	SAND	090595	4	4.690	3.800	5.760	6.690	5.320	4.380	2.910	3.580
Z4	SAND	170595	4	4.190	6.830	3.710	4.820	9.400	11.790	7.990	9.940
Z4	SAND	250595	4	2.850	5.490	5.930	5.610	8.140	7.650	8.400	
Z4	SAND	010695	4	12.240	14.910	7.460	8.210	7.710	7.770	8.720	13.390
Z4	BURG	010794	4	18.710	18.900	15.980	11.980	11.930	11.810	11.740	13.610
Z4	BURG	090794	4	14.600	13.140	16.280	15.730	17.560	14.190	15.790	14.240
Z4	BURG	170794	4	13.310	15.490	17.310	14.060	18.040	19.810	19.900	15.510
Z4	BURG	250794	4	15.190	19.310	19.490	20.540	19.560	15.700	17.790	
Z4	BURG	010894	4	21.220	17.480	13.390	17.140	18.140	16.740	13.940	17.730
Z4	BURG	090894	4	16.150	19.450	14.360	12.000	13.380	17.270	17.450	12.860
Z4	BURG	170894	4	15.160	14.190	13.690	14.040	16.040	15.630	12.150	10.960
Z4	BURG	250894	4	12.820	15.610	17.550	17.570	16.990	13.810	10.270	
Z4	BURG	010994	4	10.430	9.630	7.550	8.580	10.400	11.390	12.830	13.150
Z4	BURG	090994	4	12.380	10.660	13.130	11.600	9.880	9.110	7.850	6.340
Z4	BURG	170994	4	8.490	10.700	7.660	8.250	10.010	7.390	6.990	12.190
Z4	BURG	250994	4	12.610	15.610	10.960	6.490	7.440	8.390		
Z4	BURG	011094	4	8.830	8.290	6.530	5.270	7.190	8.100	6.850	10.940
Z4	BURG	091094	4	13.740	12.220	5.630	2.450	1.040	2.070	1.030	4.160
Z4	BURG	171094	4	4.070	3.810	5.740	3.200	3.840	5.460	7.730	8.800
Z4	BURG	251094	4	8.190	7.220	5.830	2.320	3.750	6.040	5.690	
Z4	BURG	011194	4	4.840	9.560	7.190	2.510	5.760	1.290	4.790	-0.310
Z4	BURG	091194	4	0.780	1.640	1.300	1.240	-0.390	-0.090	3.460	0.350
Z4	BURG	171194	4	-0.910	2.270	5.270	-2.240	-3.680	2.740	-2.810	-4.860
Z4	BURG	251194	4	-3.970	-3.450	-7.840	-9.050	-0.470	-1.260		
Z4	BURG	011294	4	-4.720	-5.700	-4.860	-8.560	-4.250	-2.910	-3.710	-2.400
Z4	BURG	091294	4	-4.080	-4.770	-6.200	-4.390	-10.150	-12.300	-12.500	-13.580

Z4	BURG	171294	4	-15.660	-5.060	-3.930	-6.300	-7.440	0.090	0.720	-2.400
Z4	BURG	251294	4	-3.090	-4.490	-8.280	-10.570	-6.010	-3.690	-5.210	
Z4	BURG	010195	4	-8.650	-9.350	-7.340	-7.250	-10.080	-9.800	0.780	-3.500
Z4	BURG	090195	4	-7.300	-9.450	-17.320	-16.660	-11.500	-3.060	-1.310	-1.010
Z4	BURG	170195	4	-5.510	-8.310	-6.160	-2.550	-6.700	-7.620	-4.650	-2.740
Z4	BURG	250195	4	-1.860	-5.710	-11.990	-16.630	-11.100	-9.430	-12.790	
Z4	BURG	010295	4	-11.050	-7.750	-14.000	-22.480	-8.400	-3.950	-17.250	-17.760
Z4	BURG	090295	4	-13.010	-13.260	-12.980	-11.140	-13.650	-15.190	-13.820	-4.550
Z4	BURG	170295	4	-9.250	-13.120	-13.040	-3.300	-16.390	-9.460	-11.400	-3.100
Z4	BURG	250295	4	-0.540	-11.340	-14.490	-12.630				
Z4	BURG	010395	4	-10.720	-8.370	-11.460	-14.710	-10.150	-14.390	-11.040	-4.520
Z4	BURG	090395	4	5.200	-0.820	-8.340	-11.740	-11.630	-8.090	-2.850	-0.960
Z4	BURG	170395	4	-0.760	0.590	-6.970	-6.350	-1.150	2.100	0.890	-1.680
Z4	BURG	250395	4	-1.360	-1.680	-1.290	-2.160	-5.790	-9.060	-4.360	
Z4	BURG	010495	4	-3.300	-1.680	-1.040	-1.540	-6.910	-12.040	-3.990	-3.420
Z4	BURG	090495	4	-2.600	-1.390	-5.360	-5.110	-2.760	5.320	4.240	4.190
Z4	BURG	170495	4	0.990	0.990	1.150	2.930	1.930	2.990	0.350	1.560
Z4	BURG	250495	4	4.010	1.940	1.160	1.410	0.790	0.950		
Z4	BURG	010595	4	2.310	2.000	3.010	2.110	3.810	4.060	1.640	2.730
Z4	BURG	090595	4	4.730	5.660	7.150	6.620	6.090	6.200	3.980	3.040
Z4	BURG	170595	4	2.460	5.040	4.250	4.430	9.200	8.310	6.940	8.690
Z4	BURG	250595	4	4.180	5.400	5.680	4.950	7.180	6.370	10.760	
Z4	BURG	010695	4	10.260	13.170	9.130	11.750	6.710	6.680	7.550	13.090

Z4	CORN	010794	4	16.110	16.010	14.040	10.580	12.030	11.560	9.990	11.340
Z4	CORN	090794	4	13.610	13.400	15.900	13.390	18.130	13.390	15.030	13.240
Z4	CORN	170794	4	10.970	14.460	16.600	13.040	16.940	18.330	18.150	13.520
Z4	CORN	250794	4	15.200	13.710	20.760	19.330	17.120	14.960	17.310	
Z4	CORN	010894	4	19.710	16.170	14.610	16.160	19.600	15.750	13.380	15.060
Z4	CORN	090894	4	17.010	18.460	14.790	11.340	11.300	17.230	16.430	12.240
Z4	CORN	170894	4	14.690	14.130	10.990	11.340	15.670	14.720	10.610	8.700
Z4	CORN	250894	4	11.540	14.050	16.710	15.890	17.100	12.650	9.690	
Z4	CORN	010994	4	9.700	8.790	6.030	7.340	10.560	12.220	12.510	12.790
Z4	CORN	090994	4	12.170	12.440	13.200	11.980	10.140	8.040	6.510	4.310
Z4	CORN	170994	4	8.310	9.110	6.070	7.380	8.860	6.110	6.430	9.210
Z4	CORN	250994	4	10.960	14.640	10.890	6.560	7.640	8.330		
Z4	CORN	011094	4	8.500	8.390	5.880	4.670	6.650	8.230	6.040	6.600
Z4	CORN	091094	4	12.700	12.760	5.320	1.930	0.420	2.200	0.460	2.920
Z4	CORN	171094	4	2.080	3.090	2.940	1.500	2.550	5.730	9.450	7.800
Z4	CORN	251094	4	7.310	6.560	4.910	1.660	4.090	6.040	5.390	
Z4	CORN	011194	4	4.360	3.700	6.500	2.030	5.130	0.680	4.600	-0.540
Z4	CORN	091194	4	0.300	1.090	0.570	0.390	-1.170	0.230	3.510	-0.060
Z4	CORN	171194	4	-2.480	1.230	5.960	-3.170	-3.670	2.810	-2.690	-4.750
Z4	CORN	251194	4	-4.360	-4.550	-9.410	-8.390	-1.740	-2.150		
Z4	CORN	011294	4	-4.740	-5.590	-6.650	-0.330	-6.250	-2.280	-3.180	-2.700
Z4	CORN	091294	4	-4.510	-6.100	-5.310	-4.830	-10.610	-13.700	-11.610	-17.550
Z4	CORN	171294	4	-15.380	-5.040	-3.170	-7.010	-8.100	-0.350	-0.330	-3.140
Z4	CORN	251294	4	-6.660	-5.400	-8.100	-12.380	-5.690	-3.420	-5.640	
Z4	CORN	010195	4	-10.900	-11.660	-9.190	-7.530	-10.900	-9.580	0.390	-5.840
Z4	CORN	090195	4	-7.690	-10.100	-19.260	-19.660	-11.010	-9.640	-1.520	-2.700
Z4	CORN	170195	4	-5.700	-8.910	-4.020	-3.890	-7.330	-7.770	-4.940	-3.200
Z4	CORN	250195	4	-2.270	-6.300	-14.250	-13.690	-10.900	-10.330	-12.630	
Z4	CORN	010295	4	-12.590	-8.060	-17.100	-26.190	-7.990	-4.660	-15.910	-15.790
Z4	CORN	090295	4	-12.720	-14.330	-13.720	-9.530	-13.760	-16.820	-16.040	-4.310
Z4	CORN	170295	4	-9.950	-14.240	-16.090	-12.030	-16.160	-11.700	-14.450	-4.450

Z4	CORN	250295	4	-1.420	-12.690	-15.690	-12.840				
Z4	CORN	010395	4	-10.560	-9.050	-14.640	-19.350	-11.250	-14.810	-12.280	-3.640
Z4	CORN	090395	4	6.160	-2.700	-9.990	-17.270	-15.680	-11.110	-2.980	-1.360
Z4	CORN	170395	4	-1.620	0.160	-8.460	-7.610	-2.290	1.930	-0.660	-2.260
Z4	CORN	250395	4	-2.160	-1.400	-2.350	-2.710	-8.060	-10.850	-5.700	
Z4	CORN	010495	4	-3.100	-2.240	-1.990	-3.400	-6.390	-11.190	-6.060	-5.720
Z4	CORN	090495	4	-3.010	-2.170	-8.600	-10.180	-3.880	4.910	4.330	4.080
Z4	CORN	170495	4	1.430	-0.590	-0.230	1.600	2.150	1.700	-0.230	0.510
Z4	CORN	250495	4	2.950	0.530	-0.360	0.500	-0.380	-0.100		
Z4	CORN	010595	4	0.890	-0.080	0.990	1.900	2.260	2.250	1.850	1.590
Z4	CORN	090595	4	3.700	4.470	5.550	5.860	5.850	5.300	3.170	1.850
Z4	CORN	170595	4	1.070	3.560	3.240	3.110	7.290	8.110	6.850	7.460
Z4	CORN	250595	4	2.510	3.030	4.130	3.330	5.410	6.240	9.120	
Z4	CORN	010695	4	9.490	13.640	8.090	9.150	5.320	5.560	8.050	11.860

SAMPLE SSARR DATA FILE: HYDROLOGIC DATA

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Z6 02YK002 010794 1    10.75   11.22   11.29   10.54    9.69    9.01    8.28    7.60
Z6 02YK002 090794 1     7.11    7.01   11.90   22.51   22.37   18.89   16.14   14.03
Z6 02YK002 170794 1    11.94   10.47    9.30    8.18    7.39    6.87    7.13    7.74
Z6 02YK002 250794 1    10.75   12.33   12.55   11.77   12.01   14.29   15.30
Z6 02YK002 010894 1    14.48   13.00   11.99   10.43    9.60    8.71   12.56   19.52
Z6 02YK002 090894 1    20.15   18.18   15.89   13.53   11.97   10.68    9.07    7.93
Z6 02YK002 170894 1     7.09    6.41    5.84    5.40    4.97    4.82    4.57    4.32
Z6 02YK002 250894 1     4.09    3.84    3.59    3.51    3.47    3.25    3.14
Z6 02YK002 010994 1     3.01    2.87    2.76    2.67    2.55    2.54    2.49    2.49
Z6 02YK002 090994 1     2.80    3.01    3.83    8.70   12.54   13.12   12.63   11.73
Z6 02YK002 170994 1    10.63   11.67   12.61   12.36   11.36   10.23    9.19    8.24
Z6 02YK002 250994 1     7.48    6.84    6.39    5.98    5.54    5.21
Z6 02YK002 011094 1     5.61    6.98    8.04    8.48    8.58    8.39    8.03    7.83
Z6 02YK002 091094 1     7.41    7.18    7.35    8.31    8.82    8.57    7.95    8.49
Z6 02YK002 171094 1     9.55    9.60    9.03    8.57    7.84    7.30    6.86    7.43
Z6 02YK002 251094 1    10.63   11.41   11.01   10.32    9.86    9.03    8.34
Z6 02YK002 011194 1     7.81    8.52   12.38   16.74   19.03   26.66   30.65   48.23
Z6 02YK002 091194 1    54.42   47.30   38.41   34.21   31.57   26.70   22.78   19.23
Z6 02YK002 171194 1    17.53   15.86   15.22   17.09   18.07   17.62   19.84   21.27
Z6 02YK002 251194 1    20.18   18.82   16.58   14.45   14.20   12.78
Z6 02YK002 011294 1    11.89   11.13   10.46    9.61    9.31    9.22    8.93    8.75
Z6 02YK002 091294 1     8.46    8.19    8.44    8.46    7.83    7.54    7.34    7.01
Z6 02YK002 171294 1     6.73    6.42    6.34    6.22    5.75    5.81    5.63    5.41
Z6 02YK002 251294 1     5.33    5.19    4.93    4.74    4.67    4.67    4.59
Z6 02YK002 010195 1     4.41    4.32    4.38    4.41    4.37    4.42    4.71    7.37
Z6 02YK002 090195 1    12.48   16.83   18.00   16.77   15.93   15.04   13.87   21.02
Z6 02YK002 170195 1    40.08   45.69   41.54   35.97   29.68   24.85   21.31   18.30
Z6 02YK002 250195 1    16.24   14.85   13.52   11.49   10.95   10.26    9.68
Z6 02YK002 010295 1     9.02    8.53    8.11    7.18    6.75    7.10    6.69    6.40
Z6 02YK002 090295 1     6.05    5.87    5.61    5.53    5.36    5.20    5.01    5.17
Z6 02YK002 170295 1     5.21    4.97    4.65    4.78    4.52    4.78    4.62    4.59
Z6 02YK002 250295 1     4.93    5.61    6.56    7.64
Z6 02YK002 010395 1     8.38    8.41    8.26    7.05    7.39    6.94    6.81    6.75
Z6 02YK002 090395 1     7.29   13.17   25.16   33.81   34.70   30.94   26.84   22.74
Z6 02YK002 170395 1    19.05   16.35   14.24   12.68   11.27   10.60   10.85   13.33
Z6 02YK002 250395 1    15.21   15.70   15.17   14.28   13.07   11.88   10.94
Z6 02YK002 010495 1    10.02    9.31    8.91    8.30    8.02    7.60    7.25    6.86
Z6 02YK002 090495 1     6.58    6.69    6.56    6.06    6.01    5.81    6.09    8.33
Z6 02YK002 170495 1    13.47   19.97   27.02   32.55   40.30   50.20   56.22   56.80
Z6 02YK002 250495 1    52.73   53.05   54.11   50.30   45.20   39.76
Z6 02YK002 010595 1    35.03   36.33   42.97   49.22   51.92   55.90   61.33   61.63
Z6 02YK002 090595 1    62.28   71.35   86.31   97.75   99.08   94.54   88.54   77.46
Z6 02YK002 170595 1    64.31   52.45   46.43   43.90   41.70   44.41   47.92   48.70
Z6 02YK002 250595 1    51.74   50.49   42.83   36.03   30.57   27.46   28.01
Z6 02YK002 010695 1    28.85   27.75   26.02   25.25   23.88   21.52   19.08   29.91

Z6 02YK005 010794 1     6.72    6.54    6.24    5.81    5.47    5.27    5.03    4.71
Z6 02YK005 090794 1     4.42    4.77    8.54    8.18    7.94    7.73    7.39    7.06
Z6 02YK005 170794 1     6.72    6.15    5.79    5.66    5.40    5.38    5.48    6.16
Z6 02YK005 250794 1     6.89    6.77    6.69    6.59    7.23    7.57    7.19
Z6 02YK005 010894 1     6.91    6.62    6.38    5.88    5.56    5.57    9.32    9.27
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Z6	02YK005	090894	1	8.97	8.65	8.04	7.34	6.71	6.27	5.71	5.13
Z6	02YK005	170894	1	4.66	4.25	3.95	3.67	3.42	3.42	3.22	2.98
Z6	02YK005	250894	1	2.74	2.56	2.44	2.35	2.31	2.29	2.09	
Z6	02YK005	010994	1	1.95	1.84	1.72	1.57	1.49	1.62	1.84	1.70
Z6	02YK005	090994	1	1.65	1.66	2.07	4.93	5.31	6.56	6.67	6.62
Z6	02YK005	170994	1	6.54	6.51	6.26	5.90	5.62	5.34	5.00	4.70
Z6	02YK005	250994	1	4.48	4.33	4.15	3.93	3.71	3.67		
Z6	02YK005	011094	1	4.58	5.81	8.27	9.05	8.86	8.75	9.29	8.90
Z6	02YK005	091094	1	8.45	8.00	7.86	7.96	7.56	7.17	6.84	7.39
Z6	02YK005	171094	1	7.15	6.90	6.90	6.86	6.65	6.45	6.29	6.72
Z6	02YK005	251094	1	7.92	7.84	7.72	7.36	6.97	6.58	6.18	
Z6	02YK005	011194	1	5.83	7.75	8.77	8.70	9.96	12.38	12.33	14.57
Z6	02YK005	091194	1	14.90	14.88	14.93	17.37	16.66	15.73	14.66	13.92
Z6	02YK005	171194	1	12.88	11.63	10.93	11.12	10.10	9.51	9.50	9.28
Z6	02YK005	251194	1	8.86	8.47	8.03	7.56	7.48	7.05		
Z6	02YK005	011294	1	6.83	6.55	6.24	5.86	5.77	5.80	6.03	6.12
Z6	02YK005	091294	1	6.08	5.95	5.88	5.86	5.48	5.21	5.00	4.81
Z6	02YK005	171294	1	5.28	7.80	4.69	4.32	6.08	4.09	3.97	3.91
Z6	02YK005	251294	1	3.82	3.71	3.63	6.88	11.34	4.02	4.10	
Z6	02YK005	010195	1	6.18	5.09	5.92	4.67	4.57	7.03	4.17	8.43
Z6	02YK005	090195	1	7.13	7.08	10.93	11.64	8.44	7.67	7.44	10.89
Z6	02YK005	170195	1	11.64	12.18	12.13	11.84	11.21	10.51	10.10	9.85
Z6	02YK005	250195	1	9.57	9.11	8.55	8.06	7.83	7.30	7.01	
Z6	02YK005	010295	1	9.58	6.43	6.29	11.29	13.38	5.96	5.40	5.70
Z6	02YK005	090295	1	7.25	8.75	10.49	7.87	5.40	6.50	9.14	11.21
Z6	02YK005	170295	1	11.78	12.51	13.26	10.50	10.47	14.70	9.51	6.14
Z6	02YK005	250295	1	4.83	5.23	6.05	7.67				
Z6	02YK005	010395	1	4.53	4.41	4.45	6.08	6.07	6.18	4.59	5.13
Z6	02YK005	090395	1	4.79	6.47	6.19	6.49	6.57	6.36	5.51	5.68
Z6	02YK005	170395	1	5.53	5.48	5.44	7.69	4.89	4.86	5.71	6.95
Z6	02YK005	250395	1	6.94	7.09	7.04	6.84	6.67	6.81	6.16	
Z6	02YK005	010495	1	5.92	5.72	5.72	5.56	5.41	5.75	5.10	4.91
Z6	02YK005	090495	1	4.74	4.76	4.60	4.50	4.55	4.32	5.30	7.19
Z6	02YK005	170495	1	10.04	13.84	18.28	21.92	29.40	33.94	35.69	37.68
Z6	02YK005	250495	1	38.56	38.27	36.59	35.92	32.88	30.08		
Z6	02YK005	010595	1	28.35	27.95	27.48	27.73	28.15	29.93	32.16	32.16
Z6	02YK005	090595	1	33.92	37.20	40.10	43.79	47.51	49.94	51.37	50.41
Z6	02YK005	170595	1	47.52	45.68	44.88	44.96	45.86	49.19	52.48	53.59
Z6	02YK005	250595	1	55.10	52.47	48.04	43.13	38.04	33.85	31.00	
Z6	02YK005	010695	1	28.57	26.68	25.03	23.77	21.85	19.93	18.03	21.33

Z6	02YL003	010794	1	324.21	310.92	303.13	292.75	283.38	278.92	271.08	258.04
Z6	02YL003	090794	1	253.54	253.33	279.33	299.13	303.04	302.46	297.67	288.29
Z6	02YL003	170794	1	278.88	268.63	261.29	255.71	252.00	246.75	255.96	291.75
Z6	02YL003	250794	1	303.00	294.46	289.83	283.10	280.83	287.79	296.96	
Z6	02YL003	010894	1	308.33	305.13	298.08	287.91	279.62	275.13	284.50	282.92
Z6	02YL003	090894	1	275.54	269.67	262.17	255.75	248.71	244.75	241.29	235.42
Z6	02YL003	170894	1	227.48	221.08	214.50	210.79	211.04	213.17	208.54	204.88
Z6	02YL003	250894	1	201.83	202.92	205.04	206.29	202.92	198.79	200.42	
Z6	02YL003	010994	1	202.25	202.14	204.17	203.54	193.83	166.75	165.29	170.63
Z6	02YL003	090994	1	173.54	178.81	190.79	211.43	230.13	261.04	282.42	289.92
Z6	02YL003	170994	1	291.38	292.46	285.50	274.46	263.58	254.21	244.38	236.67
Z6	02YL003	250994	1	231.04	225.83	221.13	217.75	213.96	208.67		
Z6	02YL003	011094	1	214.58	218.50	239.71	267.17	278.53	279.00	280.65	278.83
Z6	02YL003	091094	1	275.50	272.63	270.33	265.46	261.63	257.92	257.46	262.38

Z6	02YL003	171094	1	259.71	254.33	250.21	248.83	248.92	247.92	247.54	250.17
Z6	02YL003	251094	1	250.25	251.38	250.24	248.67	245.33	247.62	246.42	
Z6	02YL003	011194	1	243.29	251.08	266.08	273.50	292.46	320.21	335.25	357.33
Z6	02YL003	091194	1	365.08	372.04	371.63	367.25	356.63	345.33	331.08	317.46
Z6	02YL003	171194	1	299.29	288.33	285.83	290.88	297.75	322.96	344.00	344.14
Z6	02YL003	251194	1	346.88	344.13	335.22	318.76	311.43	234.73		
Z6	02YL003	011294	1	286.71	280.46	272.67	263.88	257.25	248.00	247.08	241.92
Z6	02YL003	091294	1	235.96	235.79	234.21	242.96	241.00	233.71	227.96	222.29
Z6	02YL003	171294	1	220.75	220.83	220.13	223.96	220.46	216.88	215.50	209.67
Z6	02YL003	251294	1	181.58	152.38	132.54	133.17	140.67	148.29	160.71	
Z6	02YL003	010195	1	167.25	169.67	174.58	177.13	174.71	174.54	180.63	202.67
Z6	02YL003	090195	1	206.83	209.17	214.21	222.58	227.46	235.17	238.58	263.79
Z6	02YL003	170195	1	272.54	273.46	280.50	291.83	300.17	300.00	295.04	283.50
Z6	02YL003	250195	1	272.17	261.04	250.96	243.00	239.21	233.58	228.21	
Z6	02YL003	010295	1	222.54	211.79	203.17	199.92	197.63	196.58	198.75	195.88
Z6	02YL003	090295	1	186.50	185.75	186.46	187.04	193.58	184.13	173.92	174.88
Z6	02YL003	170295	1	174.21	173.58	172.13	177.08	175.75	179.38	176.13	175.42
Z6	02YL003	250295	1	189.08	190.79	193.00	190.88				
Z6	02YL003	010395	1	188.08	190.83	184.17	185.46	190.42	189.54	193.38	194.17
Z6	02YL003	090395	1	200.63	212.44	217.54	216.04	217.83	222.71	227.88	231.42
Z6	02YL003	170395	1	227.38	227.96	226.92	227.50	223.25	216.96	215.96	217.88
Z6	02YL003	250395	1	222.38	225.29	224.17	224.29	227.46	227.08	227.21	
Z6	02YL003	010495	1	226.00	225.54	224.54	221.33	219.92	219.88	216.42	215.17
Z6	02YL003	090495	1	213.67	214.88	213.08	210.83	210.25	210.92	217.29	227.63
Z6	02YL003	170495	1	242.08	258.58	283.58	310.42	358.38	410.00	451.58	487.38
Z6	02YL003	250495	1	507.63	518.13	510.88	500.17	492.21	478.08		
Z6	02YL003	010595	1	456.71	440.42	432.08	429.08	430.33	436.17	446.00	454.71
Z6	02YL003	090595	1	463.54	476.33	495.29	519.79	542.75	567.25	582.08	579.62
Z6	02YL003	170595	1	559.79	533.29	503.33	487.29	481.75	488.00	504.67	526.54
Z6	02YL003	250595	1	558.83	568.75	574.42	559.08	532.13	507.46	488.79	
Z6	02YL003	010695	1	465.17	448.33	440.96	446.04	451.04	441.00	421.25	457.96

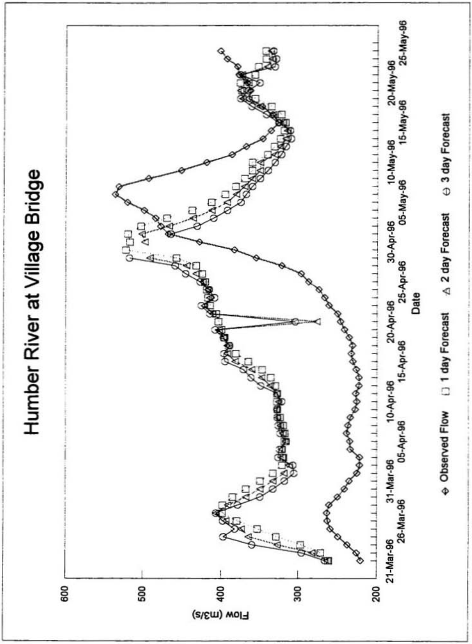
Z6	02YL001	010794	1	62.22	62.69	62.15	58.63	53.93	49.80	46.13	40.44
Z6	02YL001	090794	1	36.62	37.95	88.65	116.50	107.07	87.57	70.91	59.06
Z6	02YL001	170794	1	52.91	46.16	39.95	35.25	31.60	29.22	30.10	43.27
Z6	02YL001	250794	1	58.42	58.75	53.59	51.02	63.92	92.55	116.63	
Z6	02YL001	010894	1	104.91	81.73	64.11	52.12	45.50	42.64	53.44	61.06
Z6	02YL001	090894	1	56.35	47.15	43.17	35.05	30.64	27.27	24.07	21.80
Z6	02YL001	170894	1	20.02	17.90	16.45	14.99	13.65	13.24	13.00	12.14
Z6	02YL001	250894	1	11.40	10.68	10.24	10.17	10.03	10.07	9.91	
Z6	02YL001	010994	1	9.97	10.15	10.36	13.77	19.46	20.34	21.39	22.11
Z6	02YL001	090994	1	25.63	26.22	27.16	50.40	133.60	167.50	138.50	102.65
Z6	02YL001	170994	1	77.65	63.11	53.83	47.36	42.59	38.42	35.24	32.52
Z6	02YL001	250994	1	29.90	27.53	25.12	22.62	20.71	19.63		
Z6	02YL001	011094	1	27.06	53.73	95.61	109.79	96.80	77.05	66.12	58.82
Z6	02YL001	091094	1	52.21	45.58	43.75	46.09	45.78	42.26	39.29	38.20
Z6	02YL001	171094	1	38.57	41.06	43.35	43.45	40.53	36.77	34.38	36.42
Z6	02YL001	251094	1	42.91	45.44	42.22	40.07	35.31	32.10	29.57	
Z6	02YL001	011194	1	27.63	37.27	68.84	104.09	110.04	134.00	137.90	146.33
Z6	02YL001	091194	1	170.21	145.42	116.29	100.93	88.30	75.75	64.71	57.38
Z6	02YL001	171194	1	55.63	57.37	58.85	81.87	171.33	161.96	132.50	136.50
Z6	02YL001	251194	1	123.50	99.87	75.78	59.75	54.92	53.14		
Z6	02YL001	011294	1	50.05	44.59	40.93	38.39	34.73	36.31	34.48	34.89
Z6	02YL001	091294	1	30.27	28.34	28.86	30.04	28.81	32.38	40.59	41.48
Z6	02YL001	171294	1	47.56	53.50	55.40	49.95	44.19	41.76	37.59	32.62

Z6	02YL001	251294	1	28.35	26.17	24.23	23.02	21.08	20.53	20.34	
Z6	02YL001	010195	1	20.82	21.12	21.57	21.36	21.68	22.72	22.94	33.40
Z6	02YL001	090195	1	52.05	80.18	102.15	115.38	116.38	106.63	95.01	91.39
Z6	02YL001	170195	1	100.81	155.25	241.33	215.46	183.83	146.96	119.38	100.86
Z6	02YL001	250195	1	90.93	83.93	77.47	70.08	62.17	56.94	53.39	
Z6	02YL001	010295	1	50.33	47.03	44.10	42.07	42.41	42.30	41.83	47.15
Z6	02YL001	090295	1	48.91	46.24	44.38	43.40	41.07	38.12	36.29	36.78
Z6	02YL001	170295	1	35.03	32.34	31.58	31.09	29.73	31.20	31.43	31.43
Z6	02YL001	250295	1	32.71	37.18	44.58	54.23				
Z6	02YL001	010395	1	63.12	68.64	68.46	65.33	60.67	56.18	52.66	49.71
Z6	02YL001	090395	1	52.97	62.95	71.28	85.34	114.78	147.13	147.79	134.67
Z6	02YL001	170395	1	119.13	107.58	99.04	92.93	86.28	82.20	80.88	81.08
Z6	02YL001	250395	1	81.50	85.05	91.67	96.82	97.73	94.81	88.49	
Z6	02YL001	010495	1	82.07	77.04	72.26	68.05	64.95	62.42	57.95	57.44
Z6	02YL001	090495	1	55.30	55.07	54.87	55.16	53.67	52.38	58.99	72.81
Z6	02YL001	170495	1	97.69	135.75	169.71	212.67	249.33	291.33	314.50	313.17
Z6	02YL001	250495	1	290.83	256.71	214.24	207.46	207.29	170.42		
Z6	02YL001	010595	1	145.29	145.75	146.46	155.71	165.71	179.50	216.79	223.88
Z6	02YL001	090595	1	219.71	241.29	263.79	296.83	343.79	369.79	363.92	322.33
Z6	02YL001	170595	1	258.88	206.46	191.50	204.83	216.21	225.00	334.56	373.75
Z6	02YL001	250595	1	389.92	412.96	340.92	261.42	223.42	204.46	205.08	
Z6	02YL001	010695	1	201.92	216.04	245.63	277.04	239.38	197.50	167.58	222.13
Z6	02YK010	010794	2	87.492	87.492	87.465	87.438	87.422	87.413	87.403	87.380
Z6	02YK010	090794	2	87.362	87.351	87.367	87.369	87.382	87.367	87.350	87.345
Z6	02YK010	170794	2	87.331	87.310	87.294	87.274	87.257	87.244	87.229	87.257
Z6	02YK010	250794	2	87.318	87.318	87.315	87.296	87.296	87.280	87.274	
Z6	02YK010	010894	2	87.286	87.272	87.256	87.254	87.245	87.222	87.228	87.247
Z6	02YK010	090894	2	87.272	87.261	87.232	87.203	87.181	87.172	87.127	87.103
Z6	02YK010	170894	2	87.087	87.069	87.054	87.032	87.005	86.978	86.975	86.967
Z6	02YK010	250894	2	86.939	86.911	86.887	86.855	86.840	86.814	86.775	
Z6	02YK010	010994	2	86.764	86.745	86.717	86.687	86.664	86.662	86.662	86.662
Z6	02YK010	090994	2	86.651	86.631	86.625	86.598	86.598	86.598	86.598	86.598
Z6	02YK010	170994	2	86.598	86.575	86.542	86.542	86.542	86.542	86.547	86.553
Z6	02YK010	250994	2	86.538	86.524	86.518	86.504	86.489	86.481		
Z6	02YK010	011094	2	86.463	86.444	86.435	86.427	86.412	86.412	86.386	86.364
Z6	02YK010	091094	2	86.354	86.339	86.250	86.212	86.273	86.296	86.242	86.229
Z6	02YK010	171094	2	86.287	86.292	86.260	86.234	86.200	86.179	86.177	86.163
Z6	02YK010	251094	2	86.143	86.129	86.111	86.083	86.071	86.041	86.000	
Z6	02YK010	011194	2	85.992	86.025	86.001	85.991	85.999	86.022	86.055	86.038
Z6	02YK010	091194	2	86.044	86.045	86.046	86.046	86.046	86.046	86.046	86.046
Z6	02YK010	171194	2	86.047	86.047	86.047	86.047	86.047	86.066	86.086	86.088
Z6	02YK010	251194	2	86.087	86.077	86.070	86.059	86.060	86.037		
Z6	02YK010	011294	2	86.035	86.017	86.002	85.985	85.968	85.992	85.977	85.966
Z6	02YK010	091294	2	85.940	85.907	85.907	85.855	85.829	85.823	85.806	85.797
Z6	02YK010	171294	2	85.782	85.770	85.759	85.696	85.677	85.664	85.648	85.653
Z6	02YK010	251294	2	85.666	85.652	85.654	85.639	85.650	85.617	85.579	
Z6	02YK010	010195	2	85.562	85.557	85.542	85.527	85.515	85.496	85.494	85.537
Z6	02YK010	090195	2	85.547	85.552	85.543	85.536	85.560	85.532	85.521	85.570
Z6	02YK010	170195	2	85.626	85.645	85.631	85.641	85.661	85.655	85.657	85.651
Z6	02YK010	250195	2	85.629	85.605	85.589	85.569	85.550	85.544	85.529	
Z6	02YK010	010295	2	85.508	85.516	85.506	85.481	85.510	85.460	85.427	85.408
Z6	02YK010	090295	2	85.394	85.376	85.355	85.358	85.294	85.311	85.301	85.293
Z6	02YK010	170295	2	85.285	85.270	85.253	85.230	85.252	85.225	85.204	85.209
Z6	02YK010	250295	2	85.174	85.154	85.139	85.140				

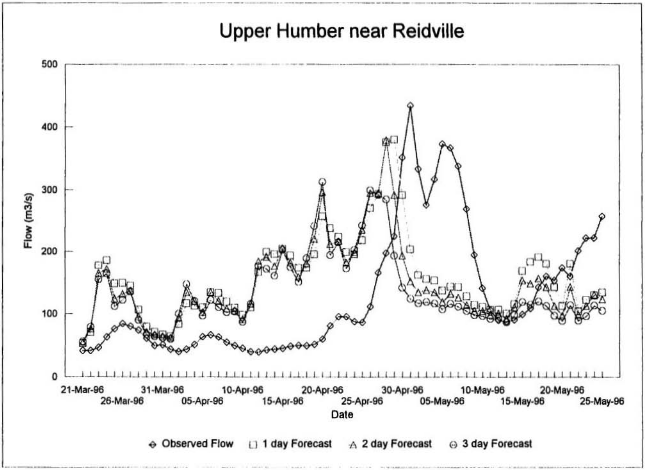
Z6	02YK010	010395	2	85.147	85.117	85.097	85.075	85.051	85.067	85.043	85.014
Z6	02YK010	090395	2	85.022	85.041	85.048	85.053	85.046	85.041	85.048	85.052
Z6	02YK010	170395	2	85.039	85.028	85.007	84.968	84.957	84.964	84.978	84.972
Z6	02YK010	250395	2	84.954	84.936	84.929	84.916	84.885	84.867	84.851	
Z6	02YK010	010495	2	84.839	84.820	84.797	84.779	84.770	84.735	84.712	84.689
Z6	02YK010	090495	2	84.671	84.646	84.627	84.606	84.590	84.579	84.561	84.545
Z6	02YK010	170495	2	84.559	84.557	84.580	84.613	84.666	84.731	84.769	84.825
Z6	02YK010	250495	2	84.879	84.924	84.956	85.020	85.040	85.057		
Z6	02YK010	010595	2	85.079	85.113	85.144	85.189	85.219	85.263	85.343	85.374
Z6	02YK010	090595	2	85.411	85.484	85.555	85.644	85.736	85.830	85.904	85.962
Z6	02YK010	170595	2	86.002	86.042	86.099	86.122	86.154	86.215	86.285	86.350
Z6	02YK010	250595	2	86.429	86.483	86.527	86.559	86.569	86.604	86.636	
Z6	02YK010	010695	2	86.646	86.673	86.683	86.719	86.706	86.675	86.694	86.805

Z6	02YM004	010794	1	2.94	2.81	2.69	2.56	2.32	2.15	2.10	1.92
Z6	02YM004	090794	1	1.76	1.89	3.79	4.46	4.27	3.75	3.21	2.78
Z6	02YM004	170794	1	2.58	2.74	2.77	2.60	2.43	2.45	2.71	3.97
Z6	02YM004	250794	1	5.33	5.60	5.13	4.65	5.55	6.83	6.43	
Z6	02YM004	010894	1	5.54	4.75	3.99	3.53	3.15	3.00	5.54	5.86
Z6	02YM004	090894	1	5.50	4.99	4.43	3.80	3.27	2.90	2.66	2.38
Z6	02YM004	170894	1	2.13	1.93	1.78	1.64	1.51	1.63	1.50	1.40
Z6	02YM004	250894	1	1.27	1.16	1.09	1.05	0.98	0.92	0.83	
Z6	02YM004	010994	1	0.76	0.68	0.63	0.53	0.49	0.49	0.58	0.55
Z6	02YM004	090994	1	0.55	0.54	0.70	2.91	3.75	5.07	4.95	4.32
Z6	02YM004	170994	1	3.72	3.48	3.08	2.74	2.50	2.30	2.09	1.94
Z6	02YM004	250994	1	1.79	1.73	1.63	1.48	1.34	1.24		
Z6	02YM004	011094	1	1.60	2.13	3.19	3.64	3.68	3.57	3.63	3.54
Z6	02YM004	091094	1	3.35	3.08	3.11	3.23	3.17	2.88	2.79	3.00
Z6	02YM004	171094	1	3.03	3.01	2.94	2.73	2.52	2.41	2.31	2.54
Z6	02YM004	251094	1	3.27	3.04	2.86	2.71	2.48	2.34	2.22	
Z6	02YM004	011194	1	2.05	3.42	4.97	5.78	7.10	9.90	9.57	9.42
Z6	02YM004	091194	1	8.17	7.30	6.96	11.65	12.78	10.89	8.87	7.61
Z6	02YM004	171194	1	6.64	5.68	5.41	5.86	5.62	5.29	5.77	5.76
Z6	02YM004	251194	1	5.45	4.97	4.65	4.56	5.28	4.10		
Z6	02YM004	011294	1	3.87	3.79	3.65	3.47	3.81	4.68	5.21	5.31
Z6	02YM004	091294	1	5.54	6.15	6.80	7.53	7.39	7.64	9.02	10.41
Z6	02YM004	171294	1	11.65	12.36	12.31	11.05	9.62	9.87	8.03	6.76
Z6	02YM004	251294	1	5.74	5.38	5.28	4.34	4.61	6.15	6.79	
Z6	02YM004	010195	1	5.31	5.11	5.41	5.39	5.38	5.09	6.17	20.00
Z6	02YM004	090195	1	26.93	33.40	34.15	31.69	28.95	28.45	25.87	33.29
Z6	02YM004	170195	1	36.85	42.78	40.26	37.04	32.13	28.24	27.72	30.70
Z6	02YM004	250195	1	33.01	31.11	28.14	26.16	26.19	24.95	23.33	
Z6	02YM004	010295	1	21.94	21.51	19.82	17.49	16.99	19.97	18.29	16.19
Z6	02YM004	090295	1	16.47	14.72	14.04	13.88	11.71	10.34	12.90	15.13
Z6	02YM004	170295	1	18.96	16.30	14.17	14.35	11.77	15.58	13.77	11.87
Z6	02YM004	250295	1	20.58	22.80	22.15	22.05				
Z6	02YM004	010395	1	21.60	19.60	18.45	16.71	15.79	13.69	14.82	13.23
Z6	02YM004	090395	1	26.57	34.55	36.90	36.46	35.11	32.36	29.29	29.26
Z6	02YM004	170395	1	26.95	26.47	25.72	24.81	24.37	24.76	32.20	36.18
Z6	02YM004	250395	1	38.71	41.37	38.13	34.02	30.36	27.88	25.47	
Z6	02YM004	010495	1	23.70	24.28	23.18	21.29	21.45	22.85	21.71	13.87
Z6	02YM004	090495	1	4.26	2.98	2.71	2.62	2.49	2.68	4.11	6.52
Z6	02YM004	170495	1	9.80	15.62	20.62	23.55	29.23	31.35	28.96	28.25
Z6	02YM004	250495	1	28.30	26.99	24.25	23.52	19.99	17.18		
Z6	02YM004	010595	1	17.18	19.62	21.48	23.71	24.98	27.73	30.57	28.78

Z6	02YM004	090595	1	28.88	32.52	34.60	36.73	38.08	37.05	34.60	31.18
Z6	02YM004	170595	1	27.55	25.40	25.16	25.48	25.70	28.49	30.11	29.55
Z6	02YM004	250595	1	30.63	28.58	23.41	19.53	16.64	14.45	13.30	
Z6	02YM004	010695	1	12.08	11.16	10.32	9.95	9.25	8.30	7.33	20.87
Z6	02YL007	010794	2	5.405	5.348	5.315	5.281	5.240	5.218	5.172	5.131
Z6	02YL007	090794	2	5.107	5.105	5.202	5.299	5.319			5.240
Z6	02YL007	170794	2	5.215	5.169	5.133	5.113	5.086	5.058	5.074	5.140
Z6	02YL007	250794	2	5.229	5.237	5.233	5.214	5.206	5.248	5.284	
Z6	02YL007	010894	2	5.335	5.315	5.276	5.229	5.203	5.173	5.182	5.196
Z6	02YL007	090894	2	5.173	5.144	5.119	5.096	5.067	5.042	5.042	5.011
Z6	02YL007	170894	2	4.970	4.944	4.907	4.899	4.899	4.898	4.884	4.867
Z6	02YL007	250894	2	4.855	4.858	4.869	4.877	4.843	4.842	4.854	
Z6	02YL007	010994	2	4.853	4.860	4.864	4.865	4.806	4.668	4.675	4.696
Z6	02YL007	090994	2	4.720	4.748	4.775	4.854	4.965	5.107	5.204	5.238
Z6	02YL007	170994	2	5.242	5.244	5.214	5.169	5.124	5.083	5.043	5.014
Z6	02YL007	250994	2	4.985	4.963	4.935	4.917	4.902	4.878		
Z6	02YL007	011094	2	4.895	4.924	5.031	5.147	5.196	5.202	5.199	5.192
Z6	02YL007	091094	2	5.178	5.161	5.150	5.133	5.118	5.109	5.106	5.101
Z6	02YL007	171094	2	5.082	5.063	5.061	5.062	5.065	5.065	5.060	5.071
Z6	02YL007	251094	2	5.075	5.080	5.078	5.068	5.058	5.063	5.058	
Z6	02YL007	011194	2	5.046	5.064	5.121	5.174	5.242	5.354	5.423	5.497
Z6	02YL007	091194	2	5.557	5.593	5.587	5.564	5.523	5.476	5.405	5.332
Z6	02YL007	171194	2	5.273	5.231	5.211	5.225	5.295	5.393	5.463	5.479
Z6	02YL007	251194	2	5.492	5.482	5.442	5.376	5.329	5.273		
Z6	02YL007	011294	2	5.238	5.211	5.177	5.142	5.111	5.072	5.066	5.040
Z6	02YL007	091294	2	5.022	5.024	5.016	5.041	5.036	5.015	4.992	4.974
Z6	02YL007	171294	2	4.966	4.967	4.966	4.977	4.960	4.942	4.937	4.908
Z6	02YL007	251294	2	4.759	4.615	4.514	4.534	4.578	4.614	4.680	
Z6	02YL007	010195	2	4.714	4.725	4.751	4.757	4.748	4.750	4.764	4.816
Z6	02YL007	090195	2	4.859	4.892	4.932	4.976	5.014	5.037	5.050	5.094
Z6	02YL007	170195	2	5.155	5.185	5.227	5.265				
Z6	02YL007	250195	2		5.110	5.095	5.067	5.046	5.018	4.996	
Z6	02YL007	010295	2	4.977	4.927	4.901	4.881	4.874	4.860	4.863	4.845
Z6	02YL007	090295	2	4.801	4.799	4.806	4.818	4.831	4.759	4.742	4.728
Z6	02YL007	170295	2	4.735	4.743	4.747	4.767	4.779	4.781	4.773	4.771
Z6	02YL007	250295	2	4.790	4.813	4.836	4.838				
Z6	02YL007	010395	2	4.842	4.839	4.806	4.820	4.834	4.846	4.857	4.862
Z6	02YL007	090395	2	4.882	4.906	4.932	4.946	4.964	4.991	5.026	5.043
Z6	02YL007	170395	2	5.031	5.023	5.032	5.012	4.985	4.976	4.969	4.981
Z6	02YL007	250395	2	4.988	4.996	5.009	5.017	5.018	5.016	5.017	
Z6	02YL007	010495	2	5.012	5.013	5.009	4.990	4.987	4.976	4.964	4.957
Z6	02YL007	090495	2	4.949	4.954	4.951	4.942	4.937	4.944	4.959	4.985
Z6	02YL007	170495	2	5.042	5.097		5.391	5.537	5.752	5.938	6.083
Z6	02YL007	250495	2	6.164	6.200	6.185	6.142	6.112	6.057		
Z6	02YL007	010595	2	5.960	5.895	5.859	5.849	5.851	5.865	5.907	5.955
Z6	02YL007	090595	2	5.987	6.023	6.083	6.166	6.260	6.358	6.425	6.429
Z6	02YL007	170595	2	6.363	6.250	6.124	6.069	6.039	6.039	6.104	6.184
Z6	02YL007	250595	2								
Z6	02YL007	010695	2	5.974	5.907	5.893	5.916	5.946	5.907	5.829	5.844

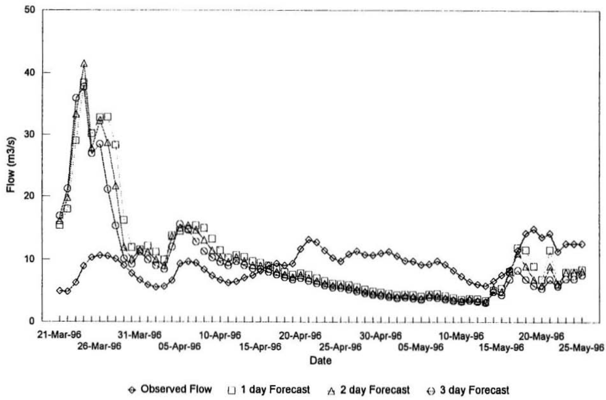


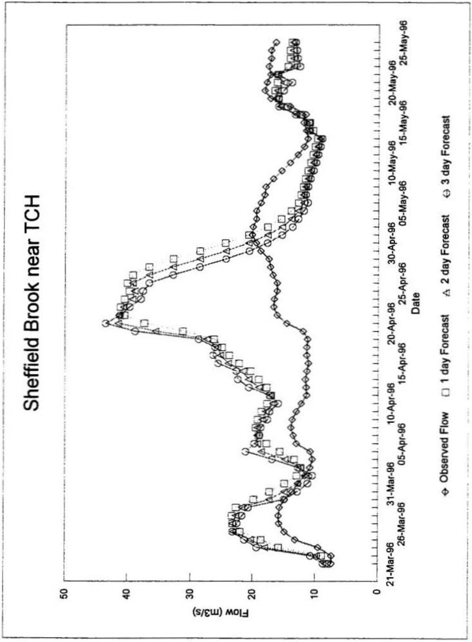
Humber River at Village Bridge
Flow (m3/s)
600
500
400
300
200
21-Mar-96
26-Mar-96
31-Mar-96
05-Apr-96
10-Apr-96
15-Apr-96
20-Apr-96
25-Apr-96
30-Apr-96
05-May-96
10-May-96
15-May-96
20-May-96
25-May-96
Date
Observed Flow
1 day Forecast
2 day Forecast
3 day Forecast



Upper Humber near Reidville
Flow (m3/s)
500
400
300
200
100
0
21-Mar-96
26-Mar-96
31-Mar-96
05-Apr-96
10-Apr-96
15-Apr-96
20-Apr-96
25-Apr-96
30-Apr-96
05-May-96
10-May-96
15-May-96
20-May-96
25-May-96
Date
Observed Flow
1 day Forecast
2 day Forecast
3 day Forecast

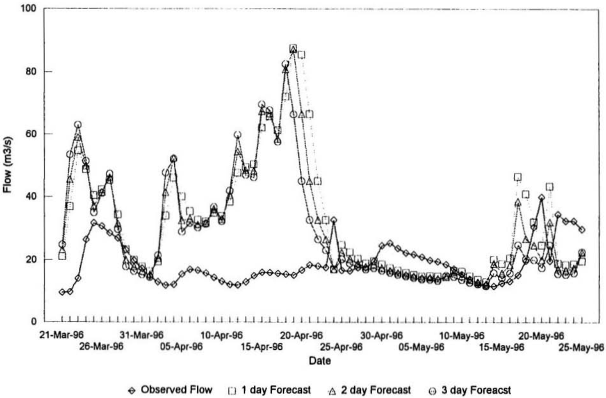
Indian Brook Diversion

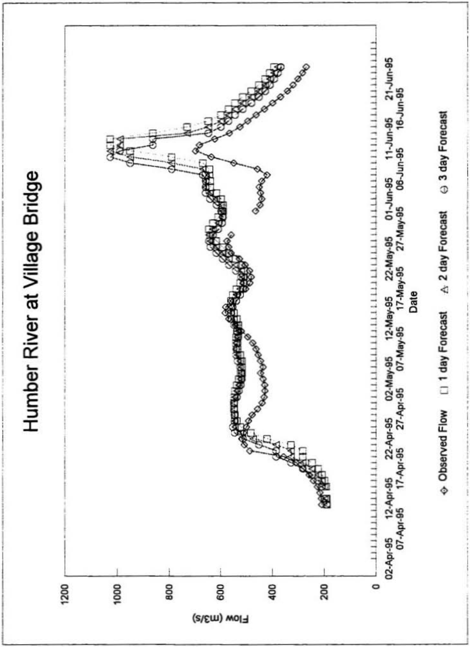




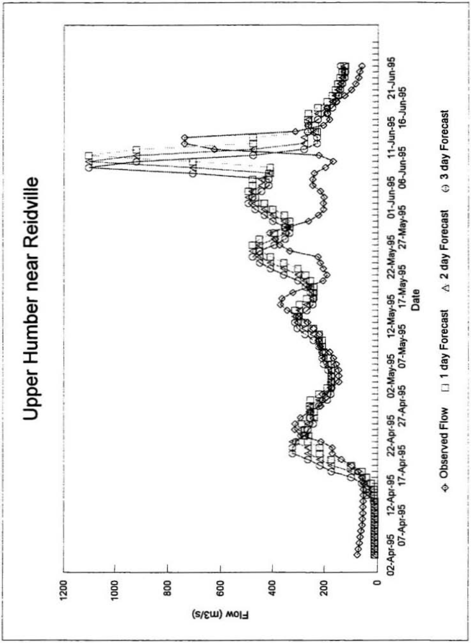
Sheffield Brook near TCH
Flow (m3/s)
0
10
20
30
40
50
21-Mar-96
26-Mar-96
31-Mar-96
05-Apr-96
10-Apr-96
15-Apr-96
20-Apr-96
25-Apr-96
30-Apr-96
05-May-96
10-May-96
15-May-96
20-May-96
25-May-96
Date
Observed Flow
1 day Forecast
2 day Forecast
3 day Forecast

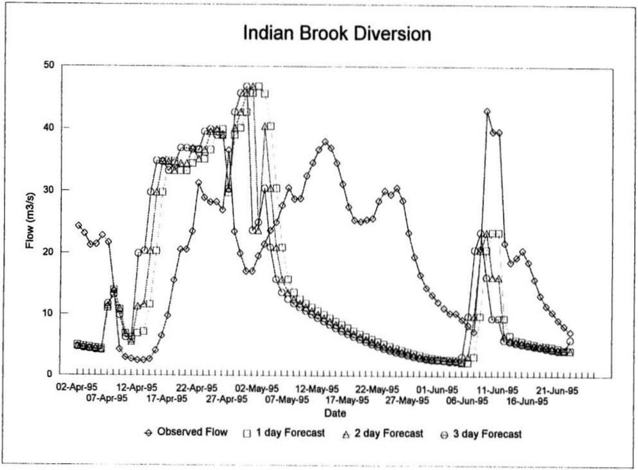
Lewaseechjeech Brook

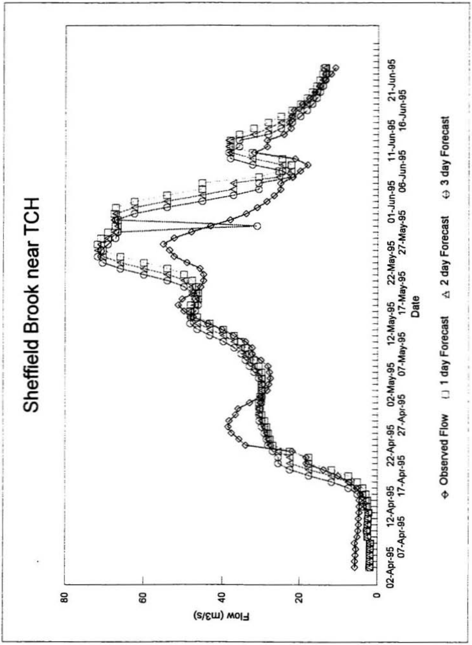


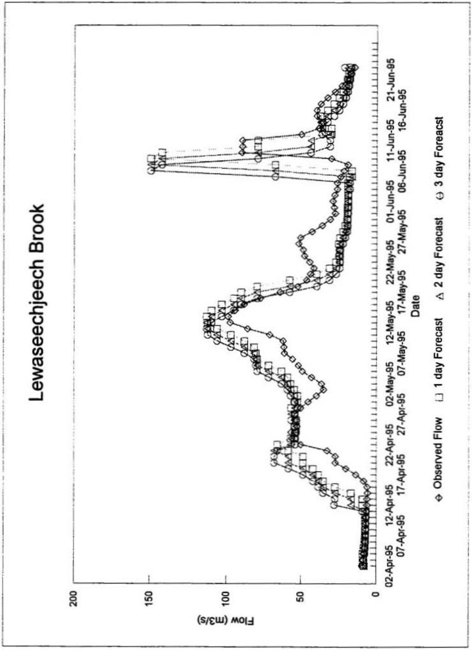


Humber River at Village Bridge
Flow (m3/s)
1200
1000
800
600
400
200
0
02-Apr-95
07-Apr-95
12-Apr-95
17-Apr-95
22-Apr-95
27-Apr-95
02-May-95
07-May-95
12-May-95
17-May-95
22-May-95
27-May-95
01-Jun-95
06-Jun-95
11-Jun-95
16-Jun-95
21-Jun-95
Date
Observed Flow
1 day Forecast
2 day Forecast
3 day Forecast

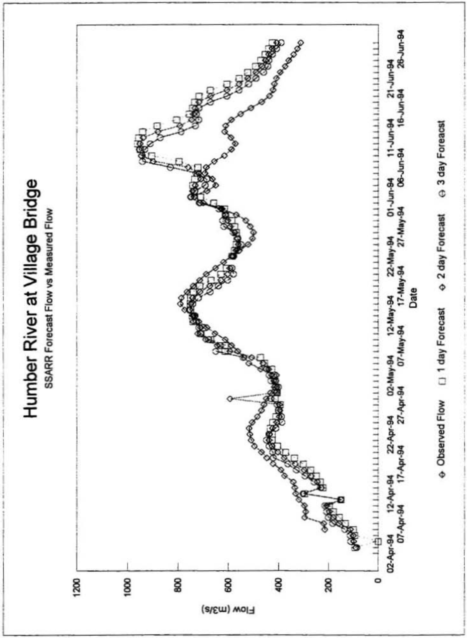

Upper Humber near Reidville
Flow (m3/s)
1200
1000
800
600
400
200
0
02-Apr-95
07-Apr-95
12-Apr-95
17-Apr-95
22-Apr-95
27-Apr-95
02-May-95
07-May-95
12-May-95
17-May-95
22-May-95
27-May-95
01-Jun-95
06-Jun-95
11-Jun-95
16-Jun-95
21-Jun-95
Date
Observed Flow
1 day Forecast
2 day Forecast
3 day Forecast

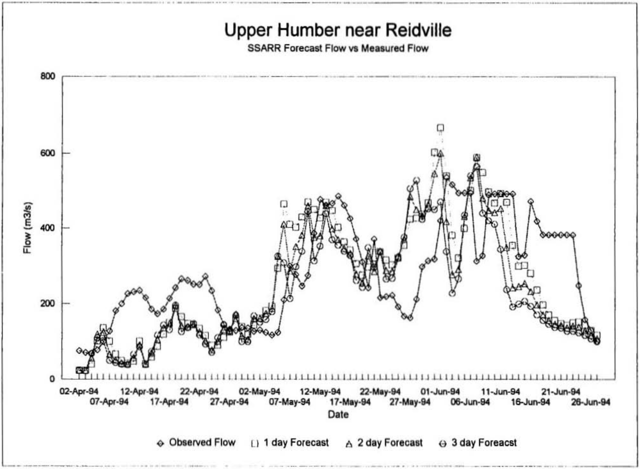

Indian Brook Diversion
Flow (m3/s)
50
40
30
20
10
0
02-Apr-95
07-Apr-95
12-Apr-95
17-Apr-95
22-Apr-95
27-Apr-95
02-May-95
07-May-95
12-May-95
17-May-95
22-May-95
27-May-95
01-Jun-95
06-Jun-95
11-Jun-95
16-Jun-95
21-Jun-95
Date
Observed Flow
1 day Forecast
2 day Forecast
3 day Forecast

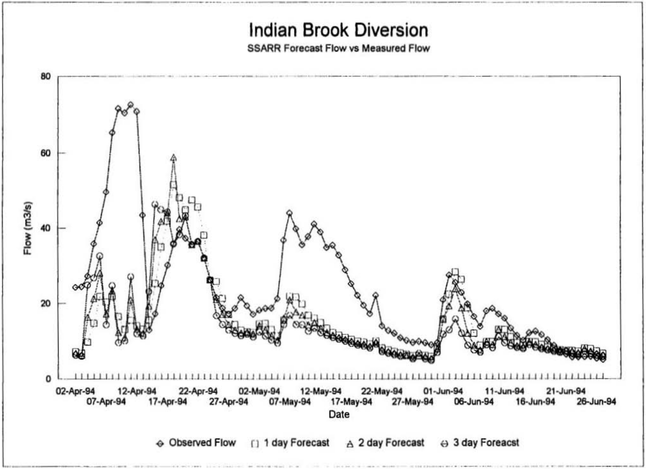

Sheffield Brook near TCH
Flow (m3/s)
0
20
40
60
80
02-Apr-95
07-Apr-95
12-Apr-95
17-Apr-95
22-Apr-95
27-Apr-95
02-May-95
07-May-95
12-May-95
17-May-95
22-May-95
27-May-95
01-Jun-95
06-Jun-95
11-Jun-95
16-Jun-95
21-Jun-95
Date
Observed Flow
1 day Forecast
2 day Forecast
3 day Forecast

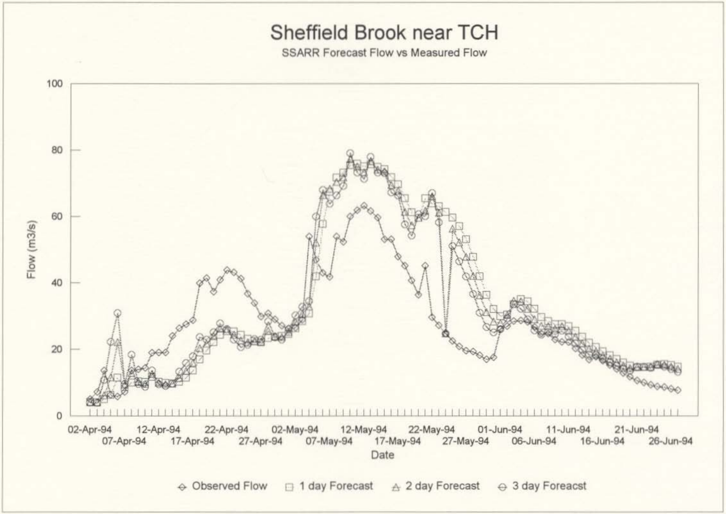


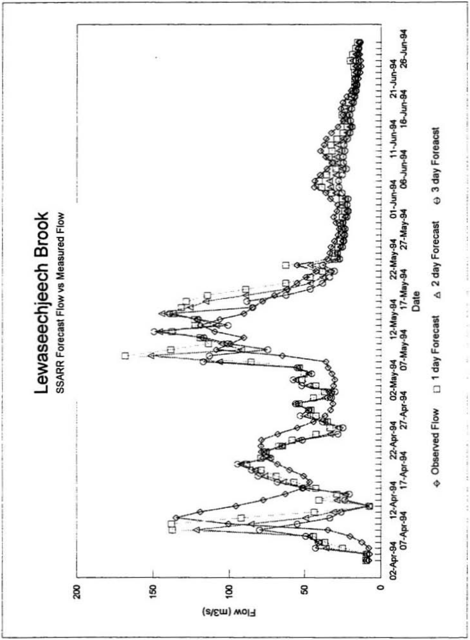
Lewaseechjeech Brook
Flow (m3/s)
200
150
100
50
0
02-Apr-95
07-Apr-95
12-Apr-95
17-Apr-95
22-Apr-95
27-Apr-95
02-May-95
07-May-95
12-May-95
17-May-95
22-May-95
27-May-95
01-Jun-95
06-Jun-95
11-Jun-95
16-Jun-95
21-Jun-95
Date
Observed Flow
1 day Forecast
2 day Forecast
3 day Foreacst


Humber River at Village Bridge
SSARR Forecast Flow vs Measured Flow
Flow (m3/s)
0
200
400
600
800
1000
1200
02-Apr-94
07-Apr-94
12-Apr-94
17-Apr-94
22-Apr-94
27-Apr-94
02-May-94
07-May-94
12-May-94
17-May-94
22-May-94
27-May-94
01-Jun-94
06-Jun-94
11-Jun-94
16-Jun-94
21-Jun-94
26-Jun-94
Date
Observed Flow
1 day Forecast
2 day Forecast
3 day Forecast


Upper Humber near Reidville
SSARR Forecast Flow vs Measured Flow
800
600
400
200
0
Flow (m3/s)
02-Apr-94
07-Apr-94
12-Apr-94
17-Apr-94
22-Apr-94
27-Apr-94
02-May-94
07-May-94
12-May-94
17-May-94
22-May-94
27-May-94
01-Jun-94
06-Jun-94
11-Jun-94
16-Jun-94
21-Jun-94
26-Jun-94
Date
Observed Flow
1 day Forecast
2 day Forecast
3 day Foreacst


Indian Brook Diversion
SSARR Forecast Flow vs Measured Flow
Flow (m3/s)
80
60
40
20
0
02-Apr-94
07-Apr-94
12-Apr-94
17-Apr-94
22-Apr-94
27-Apr-94
02-May-94
07-May-94
12-May-94
17-May-94
22-May-94
27-May-94
01-Jun-94
06-Jun-94
11-Jun-94
16-Jun-94
21-Jun-94
26-Jun-94
Date
Observed Flow
1 day Forecast
2 day Forecast
3 day Foreacst


Sheffield Brook near TCH
SSARR Forecast Flow vs Measured Flow
Flow (m3/s)
100
80
60
40
20
0
02-Apr-94
07-Apr-94
12-Apr-94
17-Apr-94
22-Apr-94
27-Apr-94
02-May-94
07-May-94
12-May-94
17-May-94
22-May-94
27-May-94
01-Jun-94
06-Jun-94
11-Jun-94
16-Jun-94
21-Jun-94
26-Jun-94
Date
Observed Flow
1 day Forecast
2 day Forecast
3 day Foreacst


Lewaseechjeech Brook
SSARR Forecast Flow vs Measured Flow
Flow (m3/s)
200
150
100
50
0
02-Apr-94
07-Apr-94
12-Apr-94
17-Apr-94
22-Apr-94
27-Apr-94
02-May-94
07-May-94
12-May-94
17-May-94
22-May-94
27-May-94
01-Jun-94
06-Jun-94
11-Jun-94
16-Jun-94
21-Jun-94
26-Jun-94
Date
Observed Flow
1 day Forecast
2 day Forecast
3 day Forecast

Appendix D

Dynamic Regression
Model Output

SAMPLE FORECAST PRO FILE FOR UPPER HUMBER RIVER AT REIDVILLE

```
Forecast Pro for DOS Version 2.00A
Sun Mar 09 21:57:05 1997

Expert data exploration of dependent variable FLOW
---------------------------------------------------------------------
Length 978  Minimum 11.930  Maximum 989.000
Mean 89.658 Standard deviation 97.806

Classical decomposition (multiplicative)
    Trend-cycle: 3.63%  Seasonal: 60.06%  Irregular: 36.31%

There are no strongly significant regressors, so I will choose
a univariate method.
Stationary series requires Box-Jenkins.

Series is stationary but seasonal.

Recommended model: Box-Jenkins

Expert data exploration of dependent variable FLOW
---------------------------------------------------------------------
Length 978  Minimum 11.930  Maximum 989.000
Mean 89.658 Standard deviation 97.806

Classical decomposition (multiplicative)
    Trend-cycle: 3.63%  Seasonal: 60.06%  Irregular: 36.31%

There are 2 strongly significant regressors.
    PRESAND
    PREBLAC

Series is stationary but seasonal.

Recommended model: Dynamic Regression

Expert data exploration of dependent variable FLOW
---------------------------------------------------------------------
Length 978  Minimum 11.930  Maximum 989.000
Mean 89.658 Standard deviation 97.806

Classical decomposition (multiplicative)
    Trend-cycle: 3.63%  Seasonal: 60.06%  Irregular: 36.31%

There are 2 strongly significant regressors.
    PRESAND
    PREBLAC

Series is stationary but seasonal.

Recommended model: Dynamic Regression

Forecast Model for FLOW
```

Regression(3 regressors, 0 lagged errors)

Term	Coefficient	Std. Error	t-Statistic	Significance
PRESAND	3.941113	0.786513	5.010868	0.999999
PREBLAC	4.417149	0.610751	7.232322	1.000000
TEMSAND	1.766996	0.387825	4.556164	0.999995

Standard Diagnostics

Sample size 978	Number of parameters 3
Mean 89.66	Standard deviation 97.86
R-square 0	Adjusted R-square 0
Durbin-Watson 0.3783	** Ljung-Box(18)=5786 P=1
Forecast error 119.9	BIC 121 (Best so far)
MAPE 0.8906	RMSE 119.7
MAD 75.58	

Rolling simulation results

H	N	MAD	Cumulative Average	MAPE	Cumulative Average
1	6	198.562	198.562	0.671	0.671
2	5	229.627	212.682	0.764	0.713
3	4	221.254	214.968	0.734	0.719
4	3	241.033	219.312	0.783	0.730
5	2	269.587	224.340	0.803	0.737
6	1	342.081	229.946	0.884	0.744

Forecast Model for FLOW
Regression(3 regressors, 0 lagged errors)

Term	Coefficient	Std. Error	t-Statistic	Significance
PRESAND	3.941113	0.786513	5.010868	0.999999
PREBLAC	4.417149	0.610751	7.232322	1.000000
TEMSAND	1.766996	0.387825	4.556164	0.999995

Standard Diagnostics

Sample size 978	Number of parameters 3
Mean 89.66	Standard deviation 97.86
R-square 0	Adjusted R-square 0
Durbin-Watson 0.3783	** Ljung-Box(18)=5786 P=1
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Rolling simulation results

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5	2	269.587	224.340	0.803	0.737

```
6  1    342.081    229.946    0.884    0.744

Forecasts of FLOW from base period 1994-126

   Period      Lower 2.5      Forecast    Upper 97.5         Actual
  1994-127      -68.168       166.842       401.852         210.080
  1994-128     -199.998        35.012       270.021         298.130
  1994-129     -121.216       113.794       348.803         275.710
  1994-130     -171.934        63.075       298.085         247.000
  1994-131     -158.812        76.197       311.207         273.290
  1994-132     -190.091        44.919       279.928         387.000

Dynamics test battery
-----------------------------------------------------------------------
FLOW[- 1]                         ChiSq( 1)=891.26  Percentile=1.0000 **
FLOW[- 2]                                   725.39             1.0000 **
FLOW[- 3]                                   587.28             1.0000 **
FLOW[- 4]                                   503.49             1.0000 **
FLOW[- 5]                                   463.49             1.0000 **
FLOW[- 6]                                   456.51             1.0000 **
FLOW[- 7]                                   468.41             1.0000 **
FLOW[- 8]                                   472.19             1.0000 **
FLOW[- 9]                                   449.61             1.0000 **

_AUTO[- 1]                        ChiSq( 1)=668.93  Percentile=1.0000 **
_AUTO[- 2]                                  474.13             1.0000 **
_AUTO[- 3]                                  378.97             1.0000 **
_AUTO[- 4]                                  332.32             1.0000 **
_AUTO[- 5]                                  316.54             1.0000 **
_AUTO[- 6]                                  323.09             1.0000 **
_AUTO[- 7]                                  343.16             1.0000 **
_AUTO[- 8]                                  335.46             1.0000 **
_AUTO[- 9]                                  313.63             1.0000 **


Try adding FLOW[-1] to model.

Forecast Model for FLOW
Regression(4 regressors, 0 lagged errors)

Term          Coefficient  Std. Error  t-Statistic  Significance
-----------------------------------------------------------------
PRESAND         0.669513    0.230533     2.904203     0.996318
PREBLAC         0.860228    0.180533     4.764931     0.999998
TEMSAND         0.071280    0.113719     0.626805     0.469213 <-
FLOW[-1]        0.935655    0.009084   103.002903     1.000000

Marked regressors are insignificant.

Standard Diagnostics
-----------------------------------------------------------------
Sample size 977                    Number of parameters 4
Mean 89.65                         Standard deviation 97.91
R-square 0.8741                    Adjusted R-square 0.8738
Durbin-Watson 1.01                 ** Ljung-Box(18)=584.4 P=1
Forecast error 34.79               BIC 35.21 (Best so far)
MAPE 0.1503                        RMSE 34.72
```

MAD 14.96

Rolling simulation results

H	N	Cumulative MAD	Average	Cumulative MAPE	Average
1	6	82.465	82.465	0.281	0.281
2	5	93.098	87.298	0.305	0.292
3	4	100.032	90.694	0.343	0.306
4	3	133.530	97.834	0.434	0.327
5	2	176.762	105.726	0.520	0.346
6	1	235.203	111.892	0.608	0.359

Forecasts of FLOW from base period 1994-126

Period	Lower 2.5	Forecast	Upper 97.5	Actual
1994-127	75.802	143.984	212.166	210.080
1994-128	47.546	140.919	234.291	298.130
1994-129	41.602	152.423	263.244	275.710
1994-130	28.438	152.536	276.635	247.000
1994-131	20.317	154.968	289.620	273.290
1994-132	8.543	151.797	295.050	387.000

Forecast Model for FLOW
Regression(3 regressors, 0 lagged errors)

Term	Coefficient	Std. Error	t-Statistic	Significance
PRESAND	0.680942	0.229739	2.963985	0.996963
PREBLAC	0.857154	0.180410	4.751140	0.999998
FLOW[-1]	0.936479	0.008985	104.222193	1.000000

Standard Diagnostics

Sample size 977	Number of parameters 3
Mean 89.65	Standard deviation 97.91
R-square 0.8741	Adjusted R-square 0.8738
Durbin-Watson 1.01	** Ljung-Box(18)=574.3 P=1
Forecast error 34.78	BIC 35.09 (Best so far)
MAPE 0.1463	RMSE 34.72
MAD 14.83	

Rolling simulation results

H	N	Cumulative MAD	Average	Cumulative MAPE	Average
1	6	82.489	82.489	0.281	0.281
2	5	92.972	87.254	0.304	0.291
3	4	100.239	90.717	0.344	0.305
4	3	133.902	97.914	0.435	0.327
5	2	177.322	105.855	0.522	0.347
6	1	235.755	112.041	0.609	0.359

Forecast Model for FLOW
Regression(3 regressors, 0 lagged errors)

Term	Coefficient	Std. Error	t-Statistic	Significance

PRESAND	0.680942	0.229739	2.963985	0.996963
PREBLAC	0.857154	0.180410	4.751140	0.999998
FLOW[-1]	0.936479	0.008985	104.222193	1.000000

Standard Diagnostics

Sample size 977	Number of parameters 3
Mean 89.65	Standard deviation 97.91
R-square 0.8741	Adjusted R-square 0.8738
Durbin-Watson 1.01	** Ljung-Box(18)=574.3 P=1
Forecast error 34.78	BIC 35.09 (Best so far)
MAPE 0.1463	RMSE 34.72
MAD 14.83	

Rolling simulation results

H	N	MAD	Cumulative Average	MAPE	Cumulative Average
1	6	82.489	82.489	0.281	0.281
2	5	92.972	87.254	0.304	0.291
3	4	100.239	90.717	0.344	0.305
4	3	133.902	97.914	0.435	0.327
5	2	177.322	105.855	0.522	0.347
6	1	235.755	112.041	0.609	0.359

Dynamics test battery

FLOW[- 2]	ChiSq(1)=362.21	Percentile=1.0000 **
FLOW[- 3]	111.93	1.0000 **
FLOW[- 4]	17.60	1.0000 **
FLOW[- 5]	0.00	0.0440
FLOW[- 6]	7.91	0.9951 **
FLOW[- 7]	19.86	1.0000 **
FLOW[- 8]	13.73	0.9999 **
FLOW[- 9]	0.67	0.5880
FLOW[-10]	2.23	0.8645

_AUTO[- 1]	ChiSq(1)=257.72	Percentile=1.0000 **
_AUTO[- 2]	15.50	0.9999 **
_AUTO[- 3]	102.43	1.0000 **
_AUTO[- 4]	64.82	1.0000 **
_AUTO[- 5]	33.09	1.0000 **
_AUTO[- 6]	9.19	0.9976 **
_AUTO[- 7]	5.79	0.9839 *
_AUTO[- 8]	44.45	1.0000 **
_AUTO[- 9]	25.72	1.0000 **
_AUTO[-10]	4.50	0.9661 *

Try adding FLOW[-2] to model.

Forecast Model for FLOW
Regression(4 regressors, 0 lagged errors)

Term	Coefficient	Std. Error	t-Statistic	Significance

PRESAND	0.599030	0.181788	3.295203	0.999016
PREBLAC	0.969619	0.142805	6.789806	1.000000
FLOW[-1]	1.502546	0.024625	61.016542	1.000000
FLOW[-2]	-0.589558	0.024536	-24.028231	1.000000

Standard Diagnostics

Sample size 976	Number of parameters 4
Mean 89.58	Standard deviation 97.93
R-square 0.9213	Adjusted R-square 0.9211
Durbin-Watson 1.559	** Ljung-Box(18)=368.6 P=1
Forecast error 27.51	BIC 27.85 (Best so far)
MAPE 0.1227	RMSE 27.46
MAD 11.72	

Rolling simulation results

H	N	MAD	Cumulative Average	MAPE	Cumulative Average
1	6	112.869	112.869	0.392	0.392
2	5	143.612	126.843	0.467	0.426
3	4	71.457	112.074	0.261	0.382
4	3	93.963	109.055	0.324	0.372
5	2	172.114	115.361	0.505	0.386
6	1	232.933	120.960	0.602	0.396

Forecasts of FLOW from base period 1994-126

Period	Lower 2.5	Forecast	Upper 97.5	Actual
1994-127	88.351	142.275	196.200	210.080
1994-128	49.551	146.878	244.206	298.130
1994-129	26.315	158.842	291.370	275.710
1994-130	2.715	161.459	320.204	247.000
1994-131	-14.997	161.395	338.987	273.290
1994-132	-34.860	154.067	342.995	387.000

Dynamics test battery

FLOW[- 3]	ChiSq(1)=289.18	Percentile=1.0000	**
FLOW[- 4]	185.69	1.0000	**
FLOW[- 5]	127.21	1.0000	**
FLOW[- 6]	107.42	1.0000	**
FLOW[- 7]	94.74	1.0000	**
FLOW[- 8]	57.69	1.0000	**
FLOW[- 9]	22.51	1.0000	**

_AUTO[- 1]	ChiSq(1)=111.05	Percentile=1.0000	**
_AUTO[- 2]	162.93	1.0000	**
_AUTO[- 3]	34.39	1.0000	**
_AUTO[- 4]	1.89	0.8309	
_AUTO[- 5]	1.52	0.7829	
_AUTO[- 6]	1.49	0.7773	
_AUTO[- 7]	5.49	0.9809	*
_AUTO[- 8]	56.89	1.0000	**
_AUTO[- 9]	44.45	1.0000	**

_AUTO[-10]	8.24	0.9959 **

Try adding FLOW[-3] to model.

Forecast Model for FLOW
Regression(5 regressors, 0 lagged errors)

Term	Coefficient	Std. Error	t-Statistic	Significance
PRESAND	0.541176	0.152330	3.552646	0.999618
PREBLAC	0.694695	0.120401	5.769823	1.000000
FLOW[-1]	1.814631	0.025699	70.610815	1.000000
FLOW[-2]	-1.384232	0.044152	-31.351386	1.000000
FLOW[-3]	0.520105	0.025624	20.297763	1.000000

Standard Diagnostics

Sample size 975	Number of parameters 5
Mean 89.51	Standard deviation 97.96
R-square 0.9449	Adjusted R-square 0.9446
Durbin-Watson 2.008	** Ljung-Box(18)=139.2 P=1
Forecast error 23.05	BIC 23.4 (Best so far)
MAPE 0.1115	RMSE 22.99
MAD 10.09	

Rolling simulation results

H	N	MAD	Cumulative Average	MAPE	Cumulative Average
1	6	105.036	105.036	0.379	0.379
2	5	153.661	127.138	0.484	0.426
3	4	103.294	120.780	0.335	0.402
4	3	99.516	117.236	0.331	0.390
5	2	165.716	122.094	0.485	0.400
6	1	225.947	127.030	0.584	0.409

Forecasts of FLOW from base period 1994-126

Period	Lower 2.5	Forecast	Upper 97.5	Actual
1994-127	104.405	149.582	194.759	210.080
1994-128	72.224	165.828	259.433	298.130
1994-129	47.521	174.789	302.056	275.710
1994-130	29.538	173.127	316.717	247.000
1994-131	17.646	167.806	317.965	273.290
1994-132	7.410	161.053	314.696	387.000

Forecast Model for FLOW
Regression(5 regressors, 0 lagged errors)

Term	Coefficient	Std. Error	t-Statistic	Significance
PRESAND	0.541176	0.152330	3.552646	0.999618
PREBLAC	0.694695	0.120401	5.769823	1.000000
FLOW[-1]	1.814631	0.025699	70.610815	1.000000
FLOW[-2]	-1.384232	0.044152	-31.351386	1.000000
FLOW[-3]	0.520105	0.025624	20.297763	1.000000

Standard Diagnostics

Sample size 975	Number of parameters 5
Mean 89.51	Standard deviation 97.96
R-square 0.9449	Adjusted R-square 0.9446
Durbin-Watson 2.008	** Ljung-Box(18)=139.2 P=1
Forecast error 23.05	BIC 23.4 (Best so far)
MAPE 0.1115	RMSE 22.99
MAD 10.09	

Rolling simulation results

H	N	MAD	Cumulative Average	MAPE	Cumulative Average
1	6	105.036	105.036	0.379	0.379
2	5	153.661	127.138	0.484	0.426
3	4	103.294	120.780	0.335	0.402
4	3	99.516	117.236	0.331	0.390
5	2	165.716	122.084	0.485	0.400
6	1	225.947	127.030	0.584	0.409

Forecasts of FLOW from base period 1994-126

Period	Lower 2.5	Forecast	Upper 97.5	Actual
1994-127	104.405	149.582	194.759	210.080
1994-128	72.224	165.828	259.433	298.130
1994-129	47.521	174.789	302.056	275.710
1994-130	29.538	173.127	316.717	247.000
1994-131	17.646	167.806	317.965	273.290
1994-132	7.410	161.053	314.696	387.000

Dynamics test battery

FLOW[- 4]	ChiSq(1)=28.67	Percentile=1.0000 **
FLOW[- 5]	3.69	0.3453
FLOW[- 6]	2.41	0.8798
FLOW[- 7]	11.86	0.9994 **
FLOW[- 8]	6.30	0.9879 *
FLOW[- 9]	0.33	0.4341
FLOW[-10]	0.13	0.2794

_AUTO[- 1]	ChiSq(1)=0.07	Percentile=0.2148
_AUTO[- 2]	44.02	1.0000 **
_AUTO[- 3]	9.66	0.9981 **
_AUTO[- 4]	6.55	0.9895 *
_AUTO[- 5]	1.71	0.8096
_AUTO[- 6]	22.46	1.0000 **
_AUTO[- 7]	4.49	0.9659 *
_AUTO[- 8]	8.74	0.9969 **
_AUTO[- 9]	23.88	1.0000 **
_AUTO[-10]	8.61	0.9966 **

Try adding _AUTO[-2] to model.

Forecast Model for FLOW

Regression(5 regressors, 1 lagged errors)

Term	Coefficient	Std. Error	t-Statistic	Significance
PRESAND	0.436946	0.142539	3.065450	0.997827
PREBLAC	0.615549	0.113326	5.431646	1.000000
FLOW[-1]	1.901275	0.028351	67.062051	1.000000
FLOW[-2]	-1.415899	0.047950	-29.528826	1.000000
FLOW[-3]	0.473583	0.027832	17.015790	1.000000
_AUTO[- 2]	-0.282044	0.037871	-7.447545	1.000000

Standard Diagnostics

Sample size 973	Number of parameters 6
Mean 89.5	Standard deviation 98.06
R-square 0.9475	Adjusted R-square 0.9473
Durbin-Watson 2.165	** Ljung-Box(18)=78.6 P=1
Forecast error 22.52	BIC 22.93 (Best so far)
MAPE 0.1095	RMSE 22.45
MAD 9.913	

Rolling simulation results

H	N	MAD	Cumulative Average	MAPE	Cumulative Average
1	6	99.651	99.651	0.361	0.361
2	5	159.644	126.921	0.509	0.428
3	4	116.831	124.230	0.396	0.420
4	3	95.014	119.361	0.332	0.405
5	2	174.585	124.883	0.506	0.415
6	1	220.792	129.450	0.571	0.423

Forecasts of FLOW from base period 1994-126

Period	Lower 2.5	Forecast	Upper 97.5	Actual
1994-127	101.824	145.958	190.093	210.080
1994-128	63.270	158.080	252.890	298.130
1994-129	40.064	167.132	294.200	275.710
1994-130	28.744	170.546	312.348	247.000
1994-131	22.488	170.704	318.921	273.290
1994-132	14.372	166.208	318.043	387.000

Forecast Model for FLOW
Regression(5 regressors, 1 lagged errors)

Term	Coefficient	Std. Error	t-Statistic	Significance
PRESAND	0.436946	0.142539	3.065450	0.997827
PREBLAC	0.615549	0.113326	5.431646	1.000000
FLOW[-1]	1.901275	0.028351	67.062051	1.000000
FLOW[-2]	-1.415899	0.047950	-29.528826	1.000000
FLOW[-3]	0.473583	0.027832	17.015790	1.000000
_AUTO[- 2]	-0.282044	0.037871	-7.447545	1.000000

Standard Diagnostics

Sample size 973	Number of parameters 6

Mean 89.5 | Standard deviation 98.06
R-square 0.9475 | Adjusted R-square 0.9473
Durbin-Watson 2.165 | ** Ljung-Box(18)=78.6 P=1
Forecast error 22.52 | BIC 22.93 (Best so far)
MAPE 0.1095 | RMSE 22.45
MAD 9.913

Rolling simulation results

H	N	MAD	Cumulative Average	MAPE	Cumulative Average
1	6	99.651	99.651	0.361	0.361
2	5	159.644	126.921	0.509	0.428
3	4	116.831	124.230	0.396	0.420
4	3	95.014	119.361	0.332	0.405
5	2	174.585	124.883	0.506	0.415
6	1	220.792	129.450	0.571	0.423

Dynamics test battery

FLOW[- 4]	ChiSq(1)=0.97	Percentile=0.6744
FLOW[- 5]	3.01	0.9173
FLOW[- 6]	6.03	0.9860 *
FLOW[- 7]	7.00	0.9918 **
FLOW[- 8]	2.96	0.9144
FLOW[- 9]	0.47	0.5059
FLOW[-10]	0.50	0.5205
_AUTO[- 1]	ChiSq(1)=29.48	Percentile=1.0000 **
_AUTO[- 3]	0.15	0.3009
_AUTO[- 4]	2.35	0.8750
_AUTO[- 5]	0.41	0.4756
_AUTO[- 6]	12.72	0.9996 **
_AUTO[- 7]	5.08	0.9757 *
_AUTO[- 8]	7.12	0.9924 **
_AUTO[- 9]	23.59	1.0000 **
_AUTO[-10]	8.56	0.9966 **

Try adding _AUTO[-1] to model.

Forecast Model for FLOW
Regression(5 regressors, 2 lagged errors)

Term	Coefficient	Std. Error	t-Statistic	Significance
PRESAND	0.488065	0.135462	3.602958	0.999685
PREBLAC	0.586069	0.109937	5.330935	1.000000
FLOW[-1]	2.026523	0.040728	49.757231	1.000000
FLOW[-2]	-1.624383	0.070254	-23.121675	1.000000
FLOW[-3]	0.560815	0.034600	16.208544	1.000000
_AUTO[- 2]	-0.347407	0.037898	-9.166868	1.000000
_AUTO[- 1]	-0.186557	0.046272	-4.031723	0.999944

Standard Diagnostics

Sample size 973
Mean 89.5
R-square 0.9486
Durbin-Watson 2.057
Forecast error 22.3
MAPE 0.1158
MAD 10.04

Number of parameters 7
Standard deviation 98.06
Adjusted R-square 0.9483
** Ljung-Box(18)=89.03 P=1
BIC 22.78 (Best so far)
RMSE 22.22

Rolling simulation results

H	N	Cumulative MAD	Average	Cumulative MAPE	Average
1	6	108.572	108.572	0.391	0.391
2	5	173.226	137.960	0.552	0.465
3	4	123.183	134.019	0.425	0.454
4	3	82.766	125.477	0.297	0.428
5	2	169.426	129.872	0.486	0.434
6	1	209.574	133.667	0.542	0.439

Forecasts of FLOW from base period 1994-126

Period	Lower 2.5	Forecast	Upper 97.5	Actual
1994-127	103.277	146.986	190.695	210.080
1994-128	71.220	162.754	254.288	298.130
1994-129	56.098	176.564	297.029	275.710
1994-130	49.933	183.619	317.304	247.000
1994-131	44.324	183.609	322.895	273.290
1994-132	35.655	177.426	319.197	387.000

Forecast Model for FLOW
Regression(5 regressors, 2 lagged errors)

Term	Coefficient	Std. Error	t-Statistic	Significance
PRESAND	0.567199	0.133056	4.262961	0.999980
PREBLAC	0.549020	0.109531	5.012468	0.999999
FLOW[-1]	2.025561	0.040772	49.679739	1.000000
FLOW[-2]	-1.624045	0.070314	-23.096925	1.000000
FLOW[-3]	0.561304	0.034639	16.204521	1.000000
_AUTO[- 2]	-0.345437	0.037999	-9.090789	1.000000
_AUTO[- 1]	-0.187411	0.046382	-4.040625	0.999946

Standard Diagnostics

Sample size 974
Mean 89.62
R-square 0.9483
Durbin-Watson 2.048
Forecast error 22.38
MAPE 0.118
MAD 10.14

Number of parameters 7
Standard deviation 98.08
Adjusted R-square 0.9479
** Ljung-Box(18)=89.51 P=1
BIC 22.86
RMSE 22.3

Rolling simulation results

H	N	Cumulative MAD	Average	Cumulative MAPE	Average
1	6	98.697	98.697	0.302	0.302

2	5	126.995	111.560	0.339	0.319
3	4	158.940	124.194	0.369	0.332
4	3	131.057	125.338	0.321	0.330
5	2	227.887	135.593	0.518	0.349
6	1	274.604	142.212	0.574	0.360

Forecasts of FLOW from base period 1994-127

Period	Lower 2.5	Forecast	Upper 97.5	Actual
1994-128	235.586	279.445	323.304	298.130
1994-129	199.684	291.462	383.240	275.710
1994-130	149.379	270.124	390.869	247.000
1994-131	108.306	242.261	376.216	273.290
1994-132	77.960	217.481	357.002	387.000
1994-133	61.917	203.896	345.875	478.500

Forecast Model for FLOW
Regression(5 regressors, 2 lagged errors)

Term	Coefficient	Std. Error	t-Statistic	Significance
PRESAND	0.570745	0.132964	4.292483	0.999982
PREBLAC	0.545438	0.109426	4.984529	0.999999
FLOW[-1]	2.027239	0.040662	49.855873	1.000000
FLOW[-2]	-1.626650	0.070178	-23.178969	1.000000
FLOW[-3]	0.562410	0.034600	16.254434	1.000000
_AUTO[- 2]	-0.345672	0.037935	-9.112238	1.000000
_AUTO[- 1]	-0.186645	0.046301	-4.031128	0.999944

Standard Diagnostics

Sample size 975	Number of parameters 7
Mean 89.83	Standard deviation 98.26
R-square 0.9485	Adjusted R-square 0.9482
Durbin-Watson 2.055	** Ljung-Box(18)=89.92 P=1
Forecast error 22.37	BIC 22.85
MAPE 0.118	RMSE 22.29
MAD 10.15	

Rolling simulation results

			Cumulative		Cumulative
H	N	MAD	Average	MAPE	Average
1	6	113.637	113.637	0.328	0.328
2	5	165.080	137.020	0.417	0.368
3	4	175.331	147.236	0.383	0.372
4	3	266.477	167.110	0.591	0.409
5	2	240.119	174.411	0.509	0.419
6	1	248.476	177.938	0.536	0.424

Forecasts of FLOW from base period 1994-128

Period	Lower 2.5	Forecast	Upper 97.5	Actual
1994-129	282.074	325.926	369.779	275.710
1994-130	211.974	303.832	395.690	247.000
1994-131	146.332	267.270	388.208	273.290
1994-132	100.145	234.364	368.583	387.000

1994-133	75.512	215.326	355.140	478.500
1994-134	73.123	215.404	357.685	463.880

Forecast Model for FLOW
Regression(5 regressors, 2 lagged errors)

Term	Coefficient	Std. Error	t-Statistic	Significance
PRESAND	0.556940	0.132993	4.187751	0.999972
PREBLAC	0.541248	0.109512	4.942346	0.999999
FLOW[-1]	2.025506	0.040783	49.664864	1.000000
FLOW[-2]	-1.625271	0.070318	-23.113188	1.000000
FLOW[-3]	0.562691	0.034637	16.245467	1.000000
_AUTO[- 2]	-0.349170	0.037990	-9.191087	1.000000
_AUTO[- 1]	-0.185254	0.046419	-3.990943	0.999934

Standard Diagnostics

Sample size 976	Number of parameters 7
Mean 90.02	Standard deviation 98.39
R-square 0.9484	Adjusted R-square 0.9481
Durbin-Watson 2.052	** Ljung-Box(18)=88.42 P=1
Forecast error 22.42	BIC 22.9
MAPE 0.1172	RMSE 22.34
MAD 10.18	

Rolling simulation results

H	N	MAD	Cumulative Average	MAPE	Cumulative Average
1	6	101.712	101.712	0.261	0.261
2	5	178.121	136.443	0.431	0.339
3	4	254.172	167.838	0.564	0.399
4	3	269.783	184.828	0.573	0.428
5	2	285.297	194.875	0.612	0.446
6	1	268.706	198.391	0.573	0.452

Forecasts of FLOW from base period 1994-129

Period	Lower 2.5	Forecast	Upper 97.5	Actual
1994-130	167.061	211.002	254.944	247.000
1994-131	84.575	176.606	268.638	273.290
1994-132	46.157	167.145	288.132	387.000
1994-133	35.784	169.863	303.941	478.500
1994-134	44.839	184.399	323.959	463.880
1994-135	58.020	200.004	341.988	468.710

Forecast Model for FLOW
Regression(5 regressors, 2 lagged errors)

Term	Coefficient	Std. Error	t-Statistic	Significance
PRESAND	0.564297	0.132848	4.247691	0.999978
PREBLAC	0.540068	0.109424	4.935565	0.999999
FLOW[-1]	2.026505	0.040610	49.902178	1.000000
FLOW[-2]	-1.624899	0.070137	-23.167638	1.000000
FLOW[-3]	0.561556	0.034577	16.240692	1.000000

_AUTO[- 2]	-0.351056	0.037965	-9.246929	1.000000
_AUTO[- 1]	-0.190346	0.046160	-4.123630	0.999962

Standard Diagnostics

Sample size 977	Number of parameters 7
Mean 90.19	Standard deviation 98.47
R-square 0.9484	Adjusted R-square 0.9481
Durbin-Watson 2.054	** Ljung-Box(18)=89.88 P=1
Forecast error 22.44	BIC 22.91
MAPE 0.1177	RMSE 22.36
MAD 10.21	

Rolling simulation results

H	N	MAD	Cumulative Average	MAPE	Cumulative Average
1	6	124.064	124.064	0.281	0.281
2	5	186.343	152.373	0.407	0.338
3	4	207.221	166.999	0.440	0.365
4	3	262.215	182.868	0.554	0.397
5	2	267.052	191.287	0.558	0.413
6	1	268.210	194.950	0.550	0.419

Forecasts of FLOW from base period 1994-130

Period	Lower 2.5	Forecast	Upper 97.5	Actual
1994-131	198.889	242.863	286.837	273.290
1994-132	139.560	231.502	323.443	337.000
1994-133	96.563	217.347	338.131	478.500
1994-134	82.633	216.535	350.438	463.880
1994-135	82.527	221.993	361.460	468.710
1994-136	77.803	219.750	361.697	487.960

Forecast Model for FLOW
Regression(5 regressors, 2 lagged errors)

Term	Coefficient	Std. Error	t-Statistic	Significance
PRESAND	0.552364	0.132648	4.164129	0.999969
PREBLAC	0.549131	0.109112	5.032725	0.999999
FLOW[-1]	2.026095	0.040659	49.830885	1.000000
FLOW[-2]	-1.622454	0.070244	-23.097382	1.000000
FLOW[-3]	0.559797	0.034622	16.168724	1.000000
_AUTO[- 2]	-0.355220	0.037819	-9.392563	1.000000
_AUTO[- 1]	-0.187389	0.046111	-4.063829	0.999952

Standard Diagnostics

Sample size 978	Number of parameters 7
Mean 90.37	Standard deviation 98.59
R-square 0.9485	Adjusted R-square 0.9482
Durbin-Watson 2.056	** Ljung-Box(18)=89.44 P=1
Forecast error 22.45	BIC 22.92
MAPE 0.1178	RMSE 22.36
MAD 10.24	

Rolling simulation results

H	N	MAD	Cumulative Average	MAPE	Cumulative Average
1	6	131.463	131.463	0.284	0.284
2	5	222.254	172.732	0.472	0.370
3	4	210.943	182.921	0.450	0.391
4	3	196.626	185.205	0.410	0.394
5	2	276.359	194.321	0.583	0.413
6	1	240.182	196.505	0.519	0.418

Forecasts of FLOW from base period 1994-131

Period	Lower 2.5	Forecast	Upper 97.5	Actual
1994-132	243.303	287.295	331.287	387.000
1994-133	179.269	271.347	363.425	478.500
1994-134	135.502	256.455	377.408	463.880
1994-135	115.229	249.311	383.393	468.710
1994-136	98.967	238.669	378.372	487.960
1994-137	80.491	222.738	364.984	462.920

Forecast Model for FLOW
Regression(5 regressors, 2 lagged errors)

Term	Coefficient	Std. Error	t-Statistic	Significance
PRESAND	0.582914	0.134740	4.326224	0.999985
PREBLAC	0.530951	0.110866	4.789107	0.999998
FLOW[-1]	2.018510	0.042100	47.945166	1.000000
FLOW[-2]	-1.611108	0.072398	-22.253446	1.000000
FLOW[-3]	0.556787	0.035490	15.688500	1.000000
_AUTO[- 2]	-0.340629	0.038390	-8.872756	1.000000
_AUTO[- 1]	-0.173082	0.047523	-3.642054	0.999729

Standard Diagnostics

Sample size 979	Number of parameters 7
Mean 90.68	Standard deviation 98.99
R-square 0.9479	Adjusted R-square 0.9476
Durbin-Watson 2.038	** Ljung-Box(18)=88.87 P=1
Forecast error 22.66	BIC 23.14
MAPE 0.1184	RMSE 22.58
MAD 10.34	

Rolling simulation results

H	N	MAD	Cumulative Average	MAPE	Cumulative Average
1	6	62.360	62.360	0.132	0.132
2	5	119.780	88.460	0.262	0.191
3	4	161.503	107.938	0.357	0.235
4	3	145.982	114.279	0.315	0.249
5	2	177.289	120.580	0.399	0.264
6	1	165.411	122.715	0.388	0.270

Forecasts of FLOW from base period 1994-132

Period	Lower 2.5	Forecast	Upper 97.5	Actual
1994-133	411.400	455.813	500.227	478.500
1994-134	343.873	437.095	530.317	463.880
1994-135	260.819	383.720	506.620	468.710
1994-136	194.349	330.828	467.306	487.960
1994-137	145.352	287.635	429.918	462.920
1994-138	116.243	261.219	406.194	426.630

Forecast Model for FLOW
Regression(5 regressors, 2 lagged errors)

Term	Coefficient	Std. Error	t-Statistic	Significance
PRESAND	0.577122	0.134774	4.282150	0.999981
PREBLAC	0.532759	0.110961	4.801322	0.999998
FLOW[-1]	2.019793	0.042163	47.904400	1.000000
FLOW[-2]	-1.612954	0.072528	-22.238995	1.000000
FLOW[-3]	0.557701	0.035551	15.687409	1.000000
_AUTO[- 2]	-0.338857	0.038358	-8.833964	1.000000
_AUTO[- 1]	-0.170190	0.047570	-3.577663	0.999653

Standard Diagnostics

Sample size 980	Number of parameters 7
Mean 91.07	Standard deviation 99.72
R-square 0.9487	Adjusted R-square 0.9484
Durbin-Watson 2.055	** Ljung-Box(18)=87.65 P=1
Forecast error 22.66	BIC 23.14
MAPE 0.1182	RMSE 22.58
MAD 10.35	

Rolling simulation results

H	N	MAD	Cumulative Average	MAPE	Cumulative Average
1	6	63.193	63.193	0.136	0.136
2	5	120.631	89.301	0.268	0.196
3	4	174.207	111.943	0.406	0.252
4	3	167.672	121.231	0.408	0.278
5	2	123.501	121.458	0.306	0.281
6	1	106.346	120.738	0.287	0.281

Forecasts of FLOW from base period 1994-133

Period	Lower 2.5	Forecast	Upper 97.5	Actual
1994-134	434.853	479.268	523.682	463.880
1994-135	331.895	425.282	518.669	468.710
1994-136	238.672	361.980	485.289	487.960
1994-137	172.123	309.171	446.219	462.920
1994-138	133.635	276.560	419.486	426.630
1994-139	119.130	264.784	410.439	371.130

Forecast Model for FLOW
Regression(5 regressors, 2 lagged errors)

Term	Coefficient	Std. Error	t-Statistic	Significance

PRESAND	0.582914	0.134740	4.326224	0.999985
PREBLAC	0.530951	0.110866	4.789107	0.999998
FLOW[-1]	2.018510	0.042100	47.945166	1.000000
FLOW[-2]	-1.611108	0.072398	-22.253446	1.000000
FLOW[-3]	0.556787	0.035490	15.688500	1.000000
_AUTO[- 2]	-0.340629	0.038390	-8.872756	1.000000
_AUTO[- 1]	-0.173082	0.047523	-3.642054	0.999729

Standard Diagnostics

Sample size 979
Mean 90.68
R-square 0.9479
Durbin-Watson 2.038
Forecast error 22.66
MAPE 0.1184
MAD 10.34

Number of parameters 7
Standard deviation 98.39
Adjusted R-square 0.9476
** Ljung-Box(18)=88.87 P=1
BIC 23.14
RMSE 22.58

Rolling simulation results

H	N	MAD	Cumulative Average	MAPE	Cumulative Average
1	6	62.360	62.360	0.132	0.132
2	5	119.780	88.460	0.262	0.191
3	4	161.503	107.938	0.357	0.235
4	3	145.982	114.279	0.315	0.249
5	2	177.289	120.580	0.399	0.264
6	1	165.411	122.715	0.388	0.270

Forecasts of FLOW from base period 1994-132

Period	Lower 2.5	Forecast	Upper 97.5	Actual
1994-133	411.400	455.813	500.227	478.500
1994-134	343.873	437.095	530.317	463.880
1994-135	260.819	383.720	506.620	468.710
1994-136	194.349	330.828	467.306	487.960
1994-137	145.352	287.635	429.918	462.920
1994-138	116.243	261.219	406.194	426.630

Forecast Model for FLOW
Regression(5 regressors, 2 lagged errors)

Term	Coefficient	Std. Error	t-Statistic	Significance
PRESAND	0.575803	0.134731	4.273714	0.999981
PREBLAC	0.534035	0.110907	4.815151	0.999998
FLOW[-1]	2.018386	0.042147	47.888790	1.000000
FLOW[-2]	-1.611400	0.072508	-22.223757	1.000000
FLOW[-3]	0.557311	0.035540	15.681132	1.000000
_AUTO[- 2]	-0.339511	0.038335	-8.856492	1.000000
_AUTO[- 1]	-0.169194	0.047589	-3.555311	0.999622

Standard Diagnostics

Sample size 981
Mean 91.45
R-square 0.9494

Number of parameters 7
Standard deviation 100.4
Adjusted R-square 0.9491

Durbin-Watson 2.056
Forecast error 22.65
MAPE 0.118
MAD 10.35

** Ljung-Box(18)=87.37 P=1
BIC 23.14
RMSE 22.57

Rolling simulation results

H	N	Cumulative MAD	Average	Cumulative MAPE	Average
1	6	74.377	74.377	0.175	0.175
2	5	108.983	90.107	0.243	0.206
3	4	144.243	104.543	0.350	0.244
4	3	159.719	113.739	0.436	0.276
5	2	108.069	113.172	0.318	0.280
6	1	55.643	110.433	0.180	0.276

Forecasts of FLOW from base period 1994-134

Period	Lower 2.5	Forecast	Upper 97.5	Actual
1994-135	352.227	396.629	441.031	468.710
1994-136	240.326	333.671	427.017	487.960
1994-137	164.768	287.947	411.126	462.920
1994-138	125.167	261.984	398.800	426.630
1994-139	111.894	254.520	397.146	371.130
1994-140	108.285	253.607	398.928	309.250

Forecast Model for FLOW
Regression(5 regressors, 2 lagged errors)

Term	Coefficient	Std. Error	t-Statistic	Significance
PRESAND	0.568535	0.134946	4.213047	0.999975
PREBLAC	0.536928	0.111133	4.831411	0.999999
FLOW[-1]	2.020620	0.042177	47.907943	1.000000
FLOW[-2]	-1.609038	0.072824	-22.094873	1.000000
FLOW[-3]	0.553877	0.035729	15.502044	1.000000
_AUTO[- 2]	-0.345128	0.038376	-8.993371	1.000000
_AUTO[- 1]	-0.173926	0.047598	-3.654035	0.999742

Standard Diagnostics

Sample size 982
Mean 91.84
R-square 0.9496
Durbin-Watson 2.046
Forecast error 22.76
MAPE 0.1185
MAD 10.42

Number of parameters 7
Standard deviation 101
Adjusted R-square 0.9493
** Ljung-Box(18)=89.42 P=1
BIC 23.24
RMSE 22.68

Rolling simulation results

H	N	Cumulative MAD	Average	Cumulative MAPE	Average
1	6	28.407	28.407	0.078	0.078
2	5	60.765	43.115	0.197	0.132
3	4	57.838	47.041	0.171	0.142
4	3	57.910	48.853	0.209	0.154

5	2	20.455	46.013	0.081	0.146
6	1	47.321	46.075	0.195	0.149

Forecasts of FLOW from base period 1994-135

Period	Lower 2.5	Forecast	Upper 97.5	Actual
1994-136	423.195	467.797	512.399	487.960
1994-137	326.771	420.438	514.104	462.920
1994-138	238.272	361.856	485.441	426.630
1994-139	186.531	323.997	461.462	371.130
1994-140	159.416	303.006	446.597	309.250
1994-141	143.546	290.071	436.595	242.750

Forecast Model for FLOW
Regression(5 regressors, 2 lagged errors)

Term	Coefficient	Std. Error	t-Statistic	Significance
PRESAND	0.564223	0.134940	4.181270	0.999971
PREBLAC	0.534848	0.111114	4.813515	0.999998
FLOW[-1]	2.020361	0.042329	47.729518	1.000000
FLOW[-2]	-1.607197	0.073064	-21.997238	1.000000
FLOW[-3]	0.552733	0.035822	15.430038	1.000000
_AUTO[- 2]	-0.346773	0.038326	-9.048075	1.000000
_AUTO[- 1]	-0.170225	0.047529	-3.581477	0.999658

Standard Diagnostics

Sample size 983	Number of parameters 7
Mean 92.24	Standard deviation 101.8
R-square 0.9503	Adjusted R-square 0.95
Durbin-Watson 2.056	** Ljung-Box(18)=89.15 P=1
Forecast error 22.75	BIC 23.24
MAPE 0.1183	RMSE 22.67
MAD 10.43	

Rolling simulation results

H	N	MAD	Cumulative Average	MAPE	Cumulative Average
1	6	30.202	30.202	0.107	0.107
2	5	46.765	37.731	0.174	0.137
3	4	66.019	45.274	0.291	0.178
4	3	51.275	46.274	0.225	0.186
5	2	70.894	48.736	0.318	0.199
6	1	82.641	50.351	0.393	0.208

Forecasts of FLOW from base period 1994-136

Period	Lower 2.5	Forecast	Upper 97.5	Actual
1994-137	413.352	457.949	502.547	462.920
1994-138	305.208	399.001	492.793	426.630
1994-139	228.553	352.384	476.215	371.130
1994-140	185.561	323.353	461.145	309.250
1994-141	161.028	305.026	449.024	242.750
1994-142	145.711	292.721	439.730	210.080

Forecast Model for FLOW
Regression(5 regressors, 2 lagged errors)

Term	Coefficient	Std. Error	t-Statistic	Significance
PRESAND	0.563853	0.134920	4.179164	0.999971
PREBLAC	0.534539	0.111103	4.811216	0.999998
FLOW[-1]	2.019952	0.042307	47.745539	1.000000
FLOW[-2]	-1.606512	0.072999	-22.007303	1.000000
FLOW[-3]	0.552547	0.035807	15.431085	1.000000
_AUTO[- 2]	-0.345814	0.038052	-9.087890	1.000000
_AUTO[- 1]	-0.169616	0.047452	-3.574472	0.999649

Standard Diagnostics

Sample size 984
Mean 92.61
R-square 0.951
Durbin-Watson 2.057
Forecast error 22.74
MAPE 0.1182
MAD 10.42

Number of parameters 7
Standard deviation 102.4
Adjusted R-square 0.9507
** Ljung-Box(18)=89.08 P=1
BIC 23.22
RMSE 22.66

Rolling simulation results

H	N	MAD	Cumulative Average	MAPE	Cumulative Average
1	6	38.737	38.737	0.149	0.149
2	5	50.781	44.212	0.213	0.178
3	4	69.674	51.002	0.315	0.214
4	3	94.184	58.199	0.427	0.250
5	2	71.693	59.548	0.337	0.259
6	1	68.512	59.975	0.317	0.261

Forecasts of FLOW from base period 1994-137

Period	Lower 2.5	Forecast	Upper 97.5	Actual
1994-138	363.699	408.275	452.851	426.630
1994-139	267.838	361.593	455.348	371.130
1994-140	206.597	330.406	454.216	309.250
1994-141	172.315	310.104	447.894	242.750
1994-142	152.482	296.490	440.497	210.080
1994-143	137.771	284.802	431.833	216.290

Forecast Model for FLOW
Regression(5 regressors, 2 lagged errors)

Term	Coefficient	Std. Error	t-Statistic	Significance
PRESAND	0.562549	0.134864	4.171228	0.999970
PREBLAC	0.531578	0.110981	4.789809	0.999998
FLOW[-1]	2.020397	0.042265	47.802902	1.000000
FLOW[-2]	-1.607084	0.072931	-22.035710	1.000000
FLOW[-3]	0.553100	0.035750	15.471338	1.000000
_AUTO[- 2]	-0.345448	0.038068	-9.074611	1.000000
_AUTO[- 1]	-0.170278	0.047390	-3.593093	0.999673

Standard Diagnostics

Sample size 985	Number of parameters 7
Mean 92.95	Standard deviation 102.9
R-square 0.9515	Adjusted R-square 0.9512
Durbin-Watson 2.055	** Ljung-Box(18)=87.15 P=1
Forecast error 22.74	BIC 23.22
MAPE 0.1181	RMSE 22.66
MAD 10.43	

Rolling simulation results

H	N	MAD	Cumulative Average	MAPE	Cumulative Average
1	6	38.617	38.617	0.157	0.157
2	5	64.741	50.492	0.272	0.209
3	4	74.851	56.987	0.338	0.244
4	3	70.234	59.195	0.329	0.258
5	2	81.251	61.401	0.373	0.269
6	1	64.404	61.544	0.294	0.271

Forecasts of FLOW from base period 1994-138

Period	Lower 2.5	Forecast	Upper 97.5	Actual
1994-139	351.262	395.830	440.397	371.130
1994-140	270.762	364.491	458.221	309.250
1994-141	212.502	336.294	460.085	242.750
1994-142	177.555	315.357	453.160	210.080
1994-143	154.781	298.336	442.391	216.290
1994-144	136.542	283.654	430.766	219.250

Forecast Model for FLOW
Regression(5 regressors, 2 lagged errors)

Term	Coefficient	Std. Error	t-Statistic	Significance
PRESAND	0.564112	0.134924	4.180963	0.999971
PREBLAC	0.537415	0.110917	4.845199	0.999999
FLOW[-1]	2.019578	0.042269	47.778690	1.000000
FLOW[-2]	-1.606036	0.072931	-22.021315	1.000000
FLOW[-3]	0.552262	0.035749	15.448424	1.000000
_AUTO[- 2]	-0.343998	0.038064	-9.037402	1.000000
_AUTO[- 1]	-0.170837	0.047430	-3.601879	0.999684

Standard Diagnostics

Sample size 986	Number of parameters 7
Mean 93.24	Standard deviation 103.2
R-square 0.9518	Adjusted R-square 0.9515
Durbin-Watson 2.054	** Ljung-Box(18)=86.89 P=1
Forecast error 22.74	BIC 23.22
MAPE 0.118	RMSE 22.66
MAD 10.44	

Rolling simulation results

H	N	MAD	Cumulative Average	MAPE	Cumulative Average

1	6	33.061	33.061	0.147	0.147
2	5	57.003	43.944	0.259	0.198
3	4	64.324	49.379	0.297	0.224
4	3	47.041	48.989	0.215	0.223
5	2	41.557	48.246	0.188	0.219
6	1	31.715	47.459	0.143	0.216

Forecasts of FLOW from base period 1994-139

Period	Lower 2.5	Forecast	Upper 97.5	Actual
1994-140	273.886	318.457	363.028	309.250
1994-141	196.797	290.480	384.163	242.750
1994-142	156.448	280.163	403.877	210.080
1994-143	135.814	273.518	411.223	216.290
1994-144	120.953	264.874	408.795	219.250
1994-145	107.322	254.255	401.188	222.540

Forecast Model for FLOW
Regression(5 regressors, 2 lagged errors)

Term	Coefficient	Std. Error	t-Statistic	Significance
PRESAND	0.564671	0.134819	4.188360	0.999972
PREBLAC	0.538300	0.110816	4.857620	0.999999
FLOW[-1]	2.019945	0.042213	47.850735	1.000000
FLOW[-2]	-1.606426	0.072863	-22.047204	1.000000
FLOW[-3]	0.552115	0.035725	15.454748	1.000000
_AUTO[- 2]	-0.344645	0.038000	-9.069532	1.000000
_AUTO[- 1]	-0.170986	0.047366	-3.609895	0.999693

Standard Diagnostics

Sample size 987	Number of parameters 7
Mean 93.45	Standard deviation 103.4
R-square 0.952	Adjusted R-square 0.9517
Durbin-Watson 2.055	** Ljung-Box(18)=86.41 P=1
Forecast error 22.73	BIC 23.21
MAPE 0.1179	RMSE 22.65
MAD 10.44	

Rolling simulation results

H	N	MAD	Cumulative Average	MAPE	Cumulative Average
1	6	33.011	33.011	0.152	0.152
2	5	58.864	44.762	0.277	0.208
3	4	68.724	51.152	0.324	0.239
4	3	47.165	50.488	0.225	0.237
5	2	42.375	49.676	0.211	0.234
6	1	40.632	49.246	0.211	0.233

Forecasts of FLOW from base period 1994-140

Period	Lower 2.5	Forecast	Upper 97.5	Actual
1994-141	228.778	273.330	317.882	242.750
1994-142	169.465	263.116	356.767	210.080

1994-143	136.799	260.469	384.140	216.290
1994-144	117.911	255.565	393.219	219.250
1994-145	103.585	247.450	391.316	222.540
1994-146	86.145	233.012	379.878	192.380

Forecast Model for FLOW
Regression(5 regressors, 2 lagged errors)

Term	Coefficient	Std. Error	t-Statistic	Significance
PRESAND	0.564112	0.134924	4.180963	0.999971
PREBLAC	0.537415	0.110917	4.845199	0.999999
FLOW[-1]	2.019578	0.042269	47.778690	1.000000
FLOW[-2]	-1.606036	0.072931	-22.021315	1.000000
FLOW[-3]	0.552262	0.035749	15.448424	1.000000
_AUTO[- 2]	-0.343998	0.038064	-9.037402	1.000000
_AUTO[- 1]	-0.170837	0.047430	-3.601879	0.999684

Standard Diagnostics

Sample size 986	Number of parameters 7
Mean 93.24	Standard deviation 103.2
R-square 0.9518	Adjusted R-square 0.9515
Durbin-Watson 2.054	** Ljung-Box(18)=86.89 P=1
Forecast error 22.74	BIC 23.22
MAPE 0.118	RMSE 22.66
MAD 10.44	

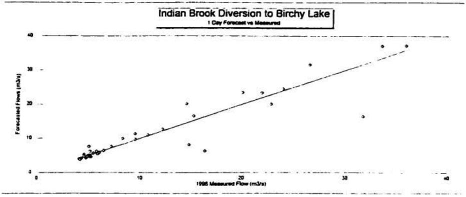
Rolling simulation results

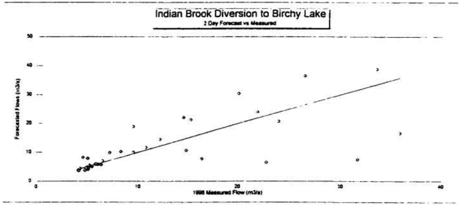
			Cumulative		Cumulative
H	N	MAD	Average	MAPE	Average
1	6	33.061	33.061	0.147	0.147
2	5	57.003	43.944	0.259	0.198
3	4	64.324	49.379	0.297	0.224
4	3	47.041	48.989	0.215	0.223
5	2	41.557	48.246	0.188	0.219
6	1	31.715	47.459	0.143	0.216

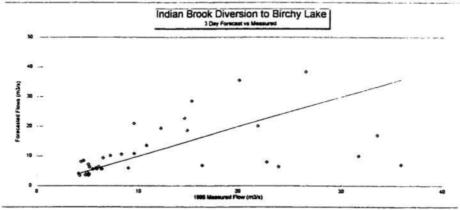
Forecasts of FLOW from base period 1994-139

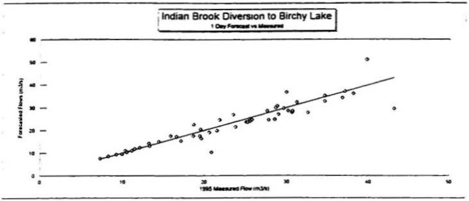
Period	Lower 2.5	Forecast	Upper 97.5	Actual
1994-140	273.886	318.457	363.028	309.250
1994-141	196.797	290.480	384.163	242.750
1994-142	156.448	280.163	403.877	210.080
1994-143	135.814	273.518	411.223	216.290
1994-144	120.953	264.874	408.795	219.250
1994-145	107.322	254.255	401.188	222.540

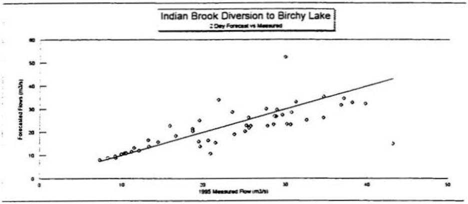
Exit

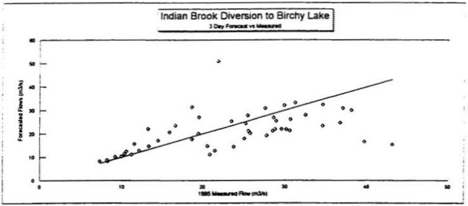

Indian Brook Diversion to Birchy Lake
1 Day Forecast vs Measured
Forecasted Flows (m3/s)
1996 Measured Flow (m3/s)

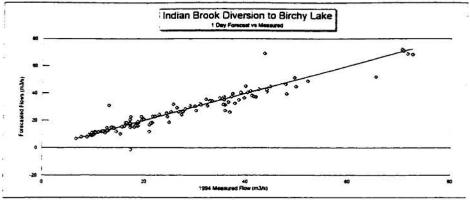

Indian Brook Diversion to Birchy Lake
2 Day Forecast vs Measured
Forecasted Flows (m3/s)
1996 Measured Flow (m3/s)

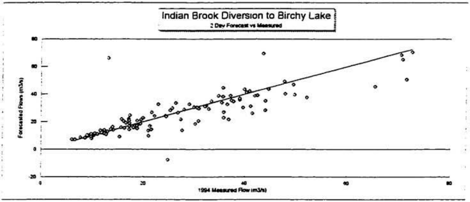

Indian Brook Diversion to Birchy Lake
3 Day Forecast vs Measured
Forecasted Flows (m3/s)
1996 Measured Flow (m3/s)

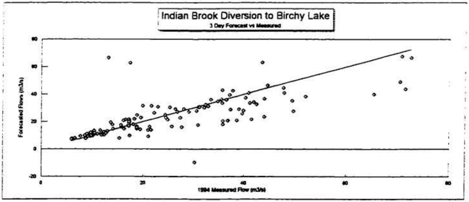

Indian Brook Diversion to Birchy Lake
1 Day Forecast vs Measured
Forecasted Flows (m3/s)
1995 Measured Flow (m3/s)

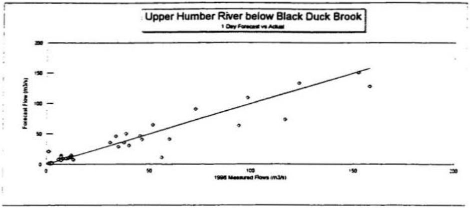

Indian Brook Diversion to Birchy Lake
2 Day Forecast vs Measured
Forecasted Flows (m3/s)
1995 Measured Flow (m3/s)

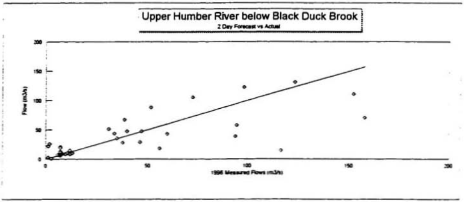

Indian Brook Diversion to Birchy Lake
3 Day Forecast vs Measured
Forecasted Flows (m3/s)
1995 Measured Flow (m3/s)

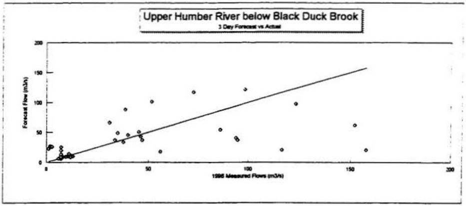

Indian Brook Diversion to Birchy Lake
1 Day Forecast vs Measured
Forecasted Flows (m3/s)
1994 Measured Flow (m3/s)

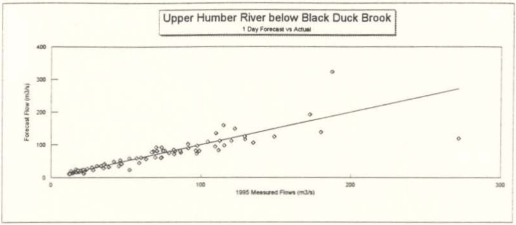

Indian Brook Diversion to Birchy Lake
2 Day Forecast vs Measured
Forecasted Flows (m3/s)
1994 Measured Flow (m3/s)

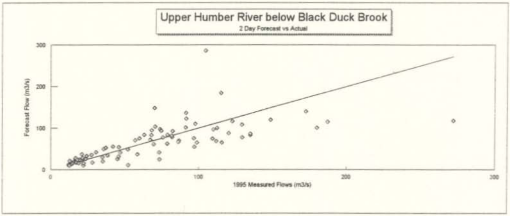

Indian Brook Diversion to Birchy Lake
3 Day Forecast vs Measured
Forecasted Flows (m3/s)
1994 Measured Flow (m3/s)

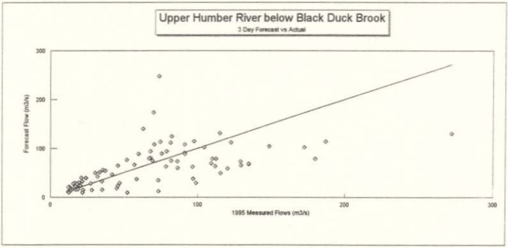

Upper Humber River below Black Duck Brook
1 Day Forecast vs Actual
Forecast Flow (m3/s)
1996 Measured Flows (m3/s)

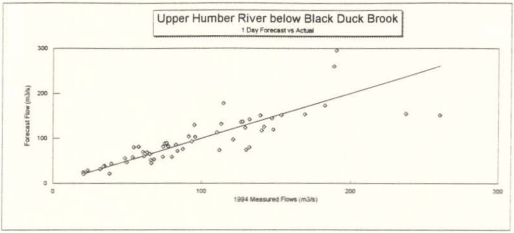

Upper Humber River below Black Duck Brook
2 Day Forecast vs Actual
Flow (m3/s)
1996 Measured Flows (m3/s)

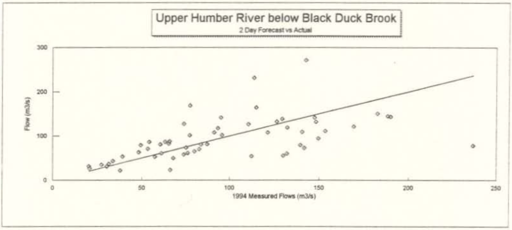

Upper Humber River below Black Duck Brook
3 Day Forecast vs Actual
Forecast Flow (m3/s)
1996 Measured Flows (m3/s)

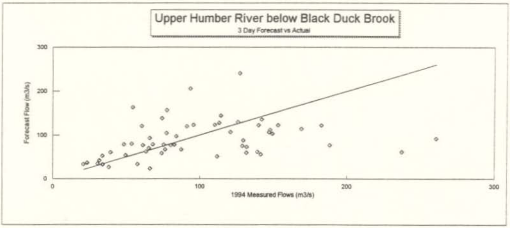

Upper Humber River below Black Duck Brook
1 Day Forecast vs Actual
Forecast Flow (m3/s)
1995 Measured Flows (m3/s)
0
100
200
300
400

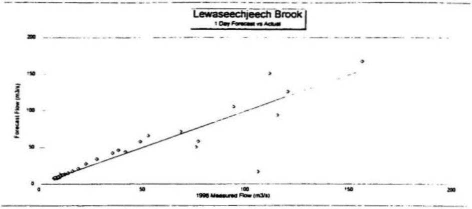

Upper Humber River below Black Duck Brook
2 Day Forecast vs Actual
Forecast Flow (m3/s)
1995 Measured Flows (m3/s)
0
100
200
300


Upper Humber River below Black Duck Brook
3 Day Forecast vs Actual
Forecast Flow (m3/s)
1995 Measured Flows (m3/s)
0
100
200
300

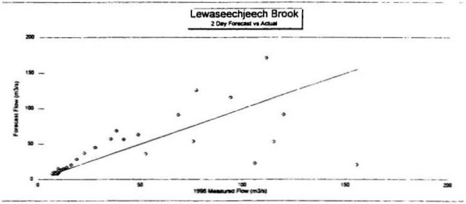

Upper Humber River below Black Duck Brook
1 Day Forecast vs Actual
Forecast Flow (m3/s)
1994 Measured Flows (m3/s)
0
100
200
300


Upper Humber River below Black Duck Brook
2 Day Forecast vs Actual
Flow (m3/s)
1994 Measured Flows (m3/s)
0
50
100
150
200
250
300

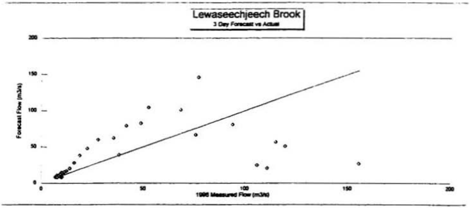

Upper Humber River below Black Duck Brook
3 Day Forecast vs Actual
Forecast Flow (m3/s)
1994 Measured Flows (m3/s)
0
100
200
300



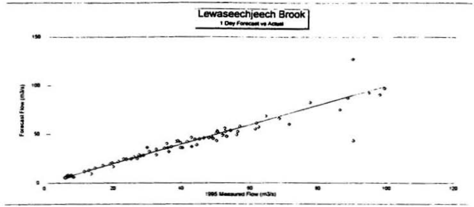
Lewaseechjeech Brook
1 Day Forecast vs Actual
Forecast Flow (m3/s)
1996 Measured Flow (m3/s)

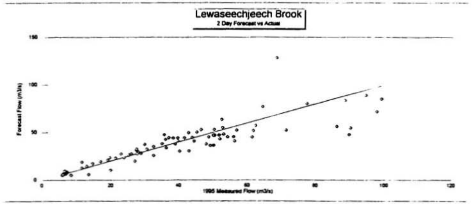


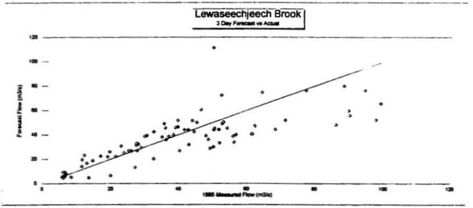
Lewaseechjeech Brook
2 Day Forecast vs Actual
Forecast Flow (m3/s)
1996 Measured Flow (m3/s)

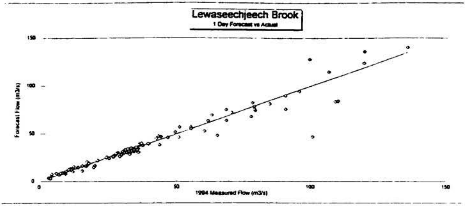


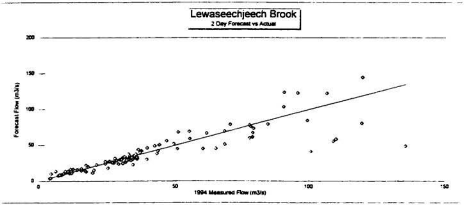
Lewaseechjeech Brook
3 Day Forecast vs Actual
Forecast Flow (m3/s)
1996 Measured Flow (m3/s)

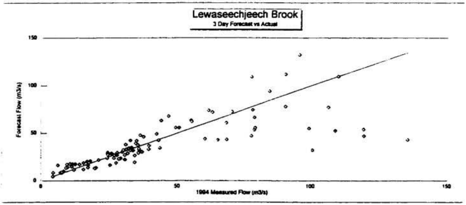

Lewaseechjeech Brook
1 Day Forecast vs Actual
Forecast Flow (m3/s)
1995 Measured Flow (m3/s)

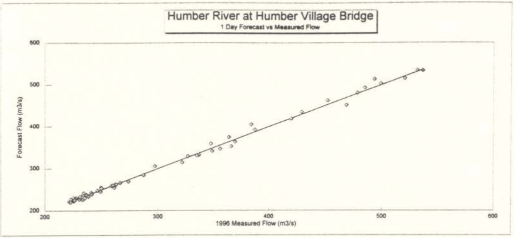

Lewaseechjeech Brook
2 Day Forecast vs Actual
Forecast Flow (m3/s)
1995 Measured Flow (m3/s)

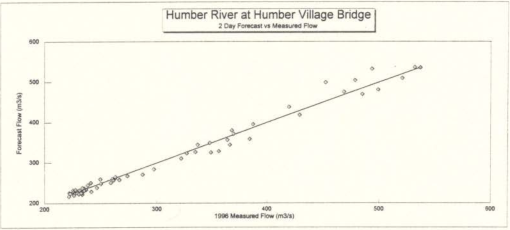

Lewaseechjeech Brook
3 Day Forecast vs Actual
Forecast Flow (m3/s)
1995 Measured Flow (m3/s)

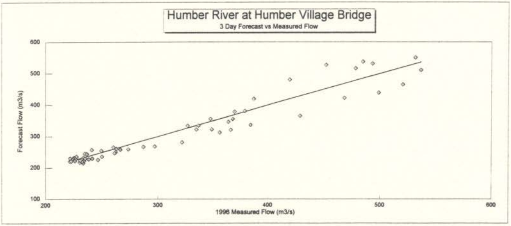

Lewaseechjeech Brook
1 Day Forecast vs Actual
Forecast Flow (m3/s)
1994 Measured Flow (m3/s)
0
50
100
150

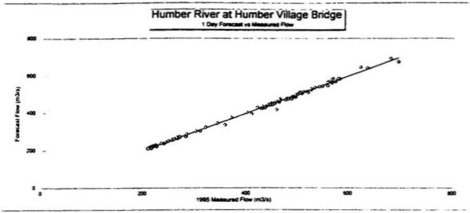

Lewaseechjeech Brook
2 Day Forecast vs Actual
Forecast Flow (m3/s)
1994 Measured Flow (m3/s)
0
50
100
150
200

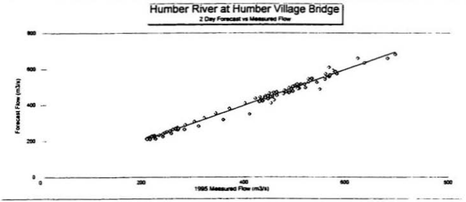

Lewaseechjeech Brook
3 Day Forecast vs Actual
Forecast Flow (m3/s)
1994 Measured Flow (m3/s)
0
50
100
150

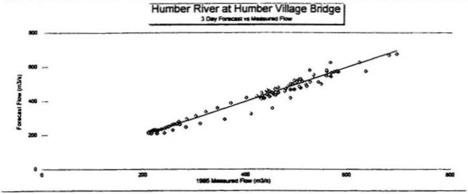

Humber River at Humber Village Bridge
1 Day Forecast vs Measured Flow
Forecast Flow (m3/s)
1996 Measured Flow (m3/s)
200
300
400
500
600

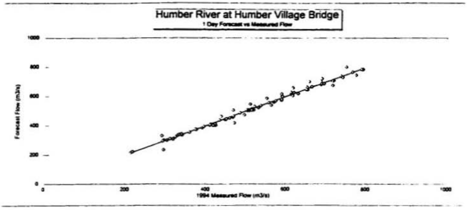

Humber River at Humber Village Bridge
2 Day Forecast vs Measured Flow
Forecast Flow (m3/s)
1996 Measured Flow (m3/s)
200
300
400
500
600


Humber River at Humber Village Bridge
3 Day Forecast vs Measured Flow
Forecast Flow (m3/s)
1996 Measured Flow (m3/s)
100
200
300
400
500
600

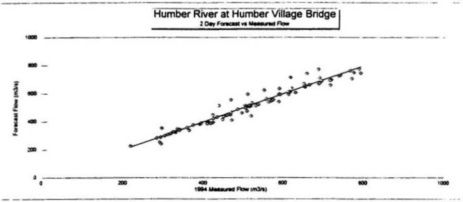

Humber River at Humber Village Bridge
1 Day Forecast vs Measured Flow
Forecast Flow (m3/s)
1995 Measured Flow (m3/s)


Humber River at Humber Village Bridge
2 Day Forecast vs Measured Flow
Forecast Flow (m3/s)
1995 Measured Flow (m3/s)

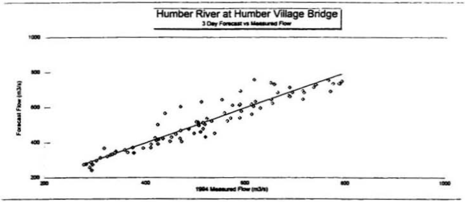

Humber River at Humber Village Bridge
3 Day Forecast vs Measured Flow
Forecast Flow (m3/s)
1995 Measured Flow (m3/s)



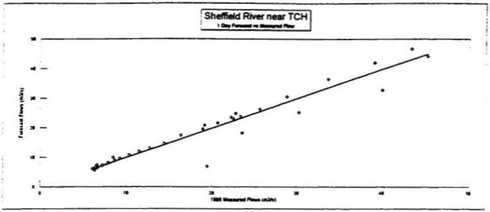
Humber River at Humber Village Bridge
1 Day Forecast vs Measured Flow
Forecast Flow (m3/s)
1994 Measured Flow (m3/s)
0
200
400
600
800
1000

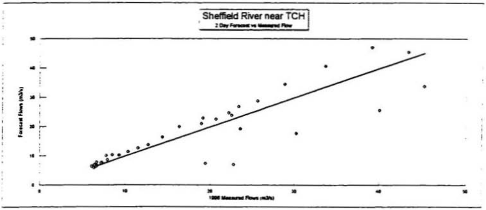


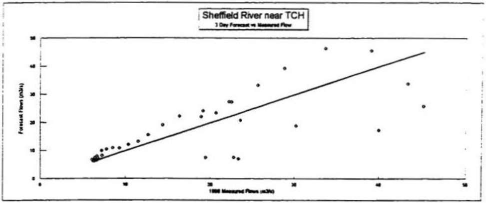
Humber River at Humber Village Bridge
2 Day Forecast vs Measured Flow
Forecast Flow (m3/s)
1994 Measured Flow (m3/s)
0
200
400
600
800
1000

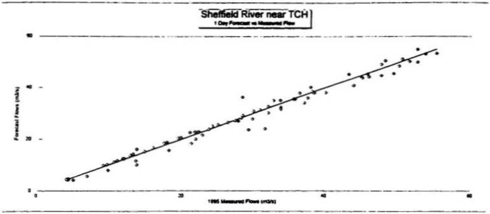


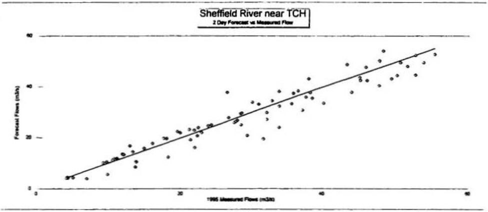
Humber River at Humber Village Bridge
3 Day Forecast vs Measured Flow
Forecast Flow (m3/s)
1994 Measured Flow (m3/s)
200
400
600
800
1000

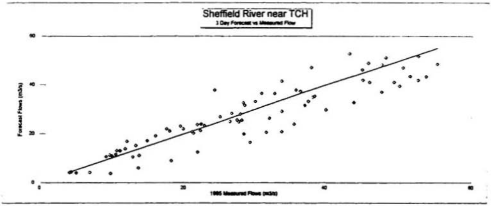

Sheffield River near TCH

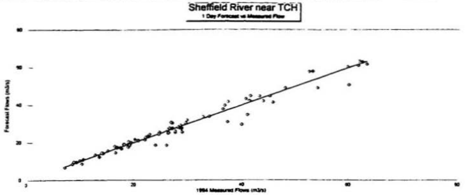

Sheffield River near TCH

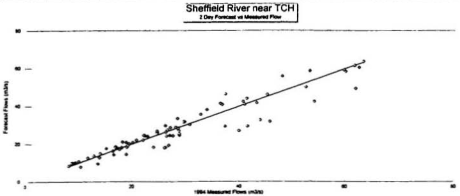

Sheffield River near TCH

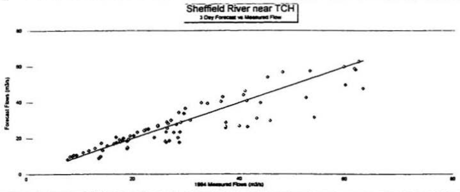

Sheffield River near TCH
1 Day Forecast vs Measured Flow
Forecast Flows (m3/s)
1995 Measured Flows (m3/s)
0
20
40
60

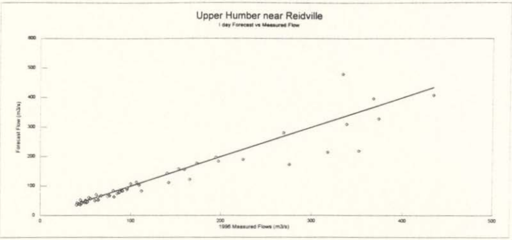

Sheffield River near TCH
2 Day Forecast vs Measured Flow
Forecast Flows (m3/s)
1995 Measured Flows (m3/s)
0
20
40
60


Sheffield River near TCH
3 Day Forecast vs Measured Flow
Forecast Flows (m3/s)
1995 Measured Flows (m3/s)
0
20
40
60

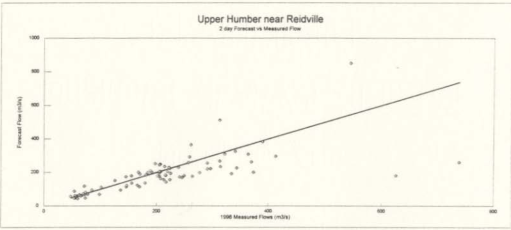

Sheffield River near TCH
1 Day Forecast vs Measured Flow
Forecast Flows (m3/s)
1994 Measured Flows (m3/s)


Sheffield River near TCH
2 Day Forecast vs Measured Flow
Forecast Flows (m3/s)
1994 Measured Flows (m3/s)

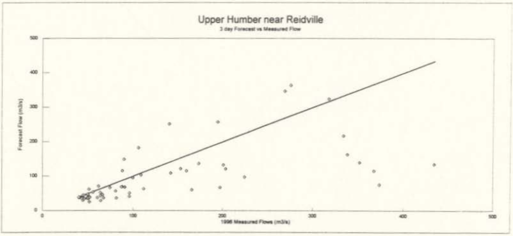

Sheffield River near TCH
3 Day Forecast vs Measured Flow
Forecast Flows (m3/s)
1994 Measured Flows (m3/s)



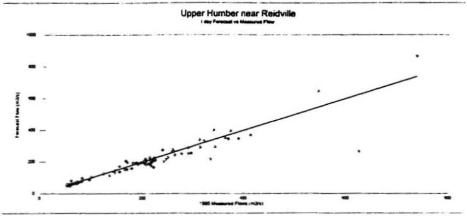
Upper Humber near Reidville
1 day Forecast vs Measured Flow
Forecast Flow (m3/s)
1996 Measured Flows (m3/s)
0
100
200
300
400
500
600

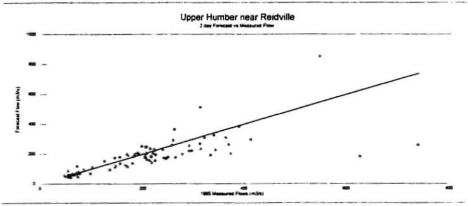


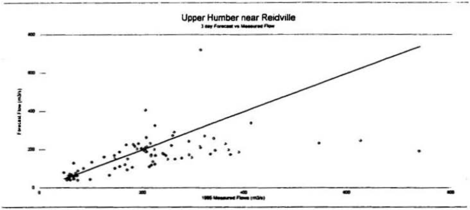
Upper Humber near Reidville
2 day Forecast vs Measured Flow
Forecast Flow (m3/s)
1996 Measured Flows (m3/s)
0
200
400
600
800
1000

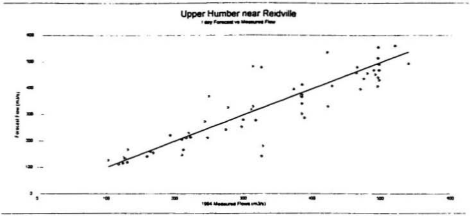


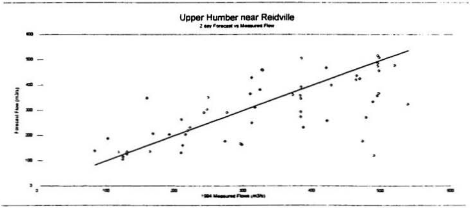
Upper Humber near Reidville
3 day Forecast vs Measured Flow
Forecast Flow (m3/s)
1996 Measured Flows (m3/s)
0
100
200
300
400
500

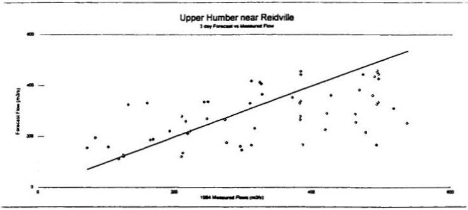

Upper Humber near Reidville
1 day Forecast vs Measured Flow

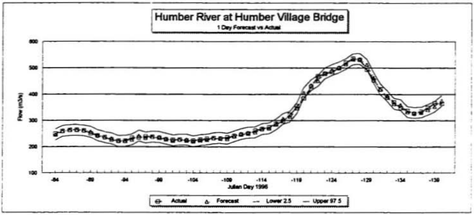

Upper Humber near Reidville
2 day Forecast vs Measured Flow


Upper Humber near Reidville
3 day Forecast vs Measured Flow

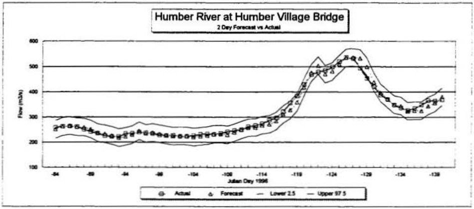

Upper Humber near Reidville
Forecast Flow (m3/s)
1984 Measured Flows (m3/s)


Upper Humber near Reidville
Forecast Flow (m3/s)
1984 Measured Flows (m3/s)

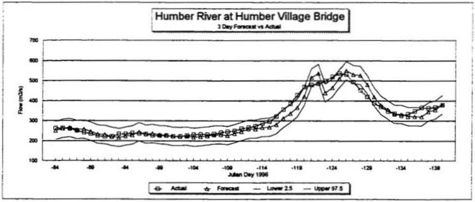

Upper Humber near Reidville
Forecast Flow (m3/s)
1984 Measured Flows (m3/s)



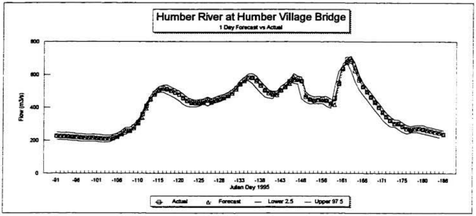
Humber River at Humber Village Bridge
1 Day Forecast vs Actual
Flow (m3/s)
Julian Day 1996
Actual
Forecast
Lower 2.5
Upper 97.5

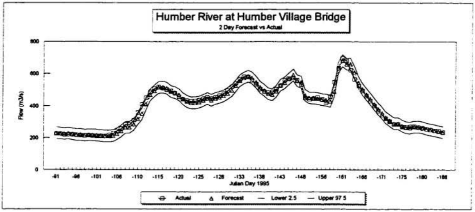


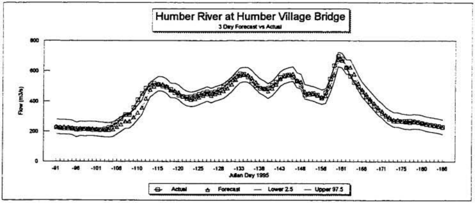
Humber River at Humber Village Bridge
2 Day Forecast vs Actual
Flow (m3/s)
Julian Day 1996
Actual
Forecast
Lower 2.5
Upper 97.5

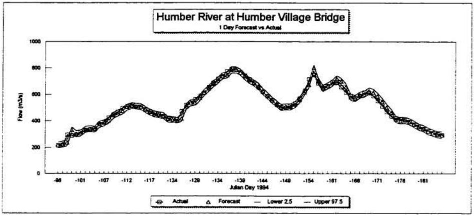


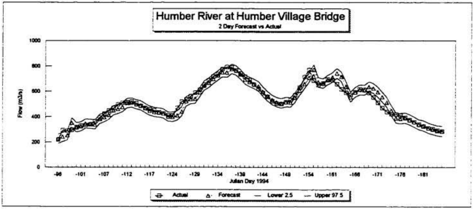
Humber River at Humber Village Bridge
3 Day Forecast vs Actual
Flow (m3/s)
Julian Day 1996
Actual
Forecast
Lower 2.5
Upper 97.5

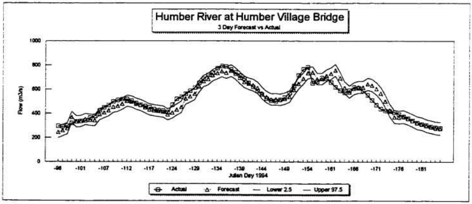

Humber River at Humber Village Bridge
1 Day Forecast vs Actual
Flow (m3/s)
800
600
400
200
0
-91
-96
-101
-106
-110
-115
-120
-125
-128
-133
-138
-143
-148
-156
-161
-166
-171
-175
-180
-186
Julian Day 1995
Actual
Forecast
Lower 2.5
Upper 97.5

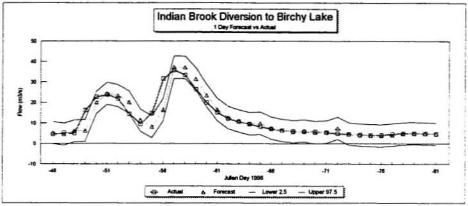

Humber River at Humber Village Bridge
2 Day Forecast vs Actual
Flow (m3/s)
800
600
400
200
0
-91
-96
-101
-106
-110
-115
-120
-125
-128
-133
-138
-143
-148
-156
-161
-166
-171
-175
-180
-186
Julian Day 1995
Actual
Forecast
Lower 2.5
Upper 97.5


Humber River at Humber Village Bridge
3 Day Forecast vs Actual
Flow (m3/s)
800
600
400
200
0
-91
-96
-101
-106
-110
-115
-120
-125
-128
-133
-138
-143
-148
-156
-161
-166
-171
-175
-180
-186
Julian Day 1995
Actual
Forecast
Lower 2.5
Upper 97.5

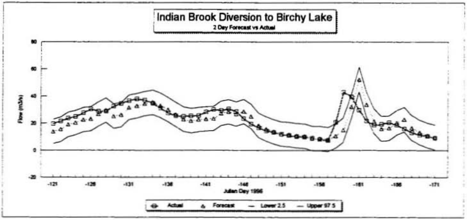

Humber River at Humber Village Bridge
1 Day Forecast vs Actual
1000
800
600
400
200
0
Flow (m3/s)
-96
-101
-107
-112
-117
-124
-129
-134
-139
-144
-149
-154
-161
-166
-171
-176
-181
Julian Day 1994
Actual
Forecast
Lower 2.5
Upper 97.5


Humber River at Humber Village Bridge
2 Day Forecast vs Actual
1000
800
600
400
200
0
Flow (m3/s)
-96
-101
-107
-112
-117
-124
-129
-134
-139
-144
-149
-154
-161
-166
-171
-176
-181
Julian Day 1994
Actual
Forecast
Lower 2.5
Upper 97.5

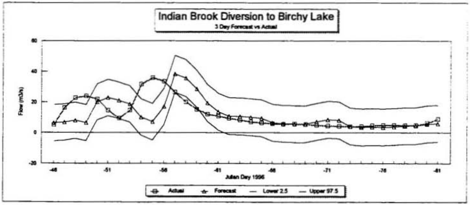

Humber River at Humber Village Bridge
3 Day Forecast vs Actual
1000
800
600
400
200
0
Flow (m3/s)
-96
-101
-107
-112
-117
-124
-129
-134
-139
-144
-149
-154
-161
-166
-171
-176
-181
Julian Day 1994
Actual
Forecast
Lower 2.5
Upper 97.5



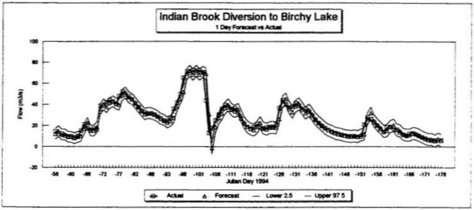
Indian Brook Diversion to Birchy Lake
1 Day Forecast vs Actual
Flow (m3/s)
Julian Day 1996
Actual
Forecast
Lower 2.5
Upper 97.5



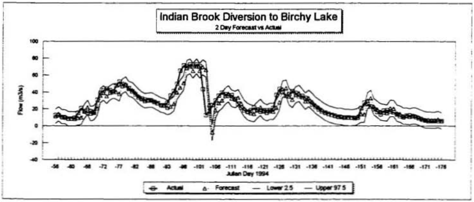
Indian Brook Diversion to Birchy Lake
2 Day Forecast vs Actual
Flow (m3/s)
Julian Day 1996
Actual
Forecast
Lower 2.5
Upper 97.5



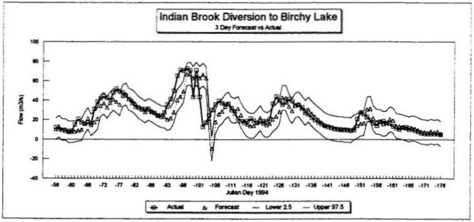
Indian Brook Diversion to Birchy Lake
3 Day Forecast vs Actual
Flow (m3/s)
Julian Day 1996
Actual
Forecast
Lower 2.5
Upper 97.5



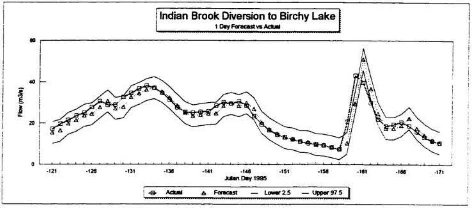
Indian Brook Diversion to Birchy Lake
1 Day Forecast vs Actual
Flow (m3/s)
Julian Day 1994
Actual
Forecast
Lower 2.5
Upper 97.5

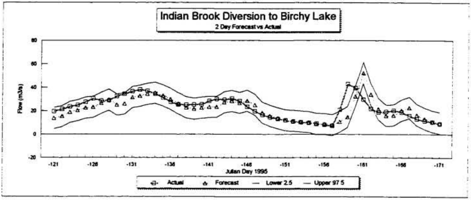


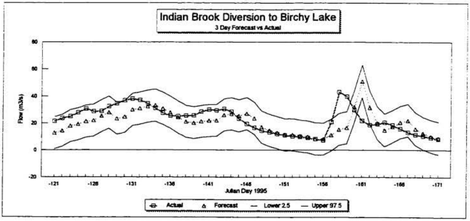
Indian Brook Diversion to Birchy Lake
2 Day Forecast vs Actual
Flow (m3/s)
Julian Day 1994
Actual
Forecast
Lower 2.5
Upper 97.5

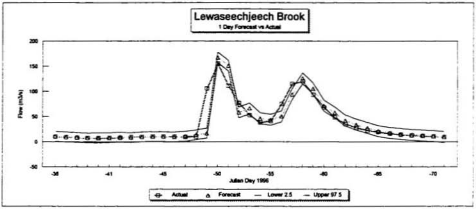


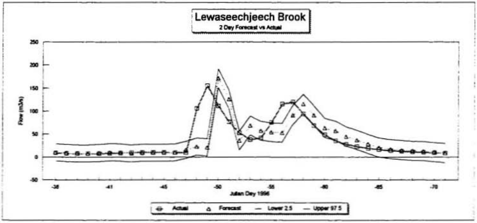
Indian Brook Diversion to Birchy Lake
3 Day Forecast vs Actual
Flow (m3/s)
Julian Day 1994
Actual
Forecast
Lower 2.5
Upper 97.5


Indian Brook Diversion to Birchy Lake
1 Day Forecast vs Actual
Flow (m3/s)
Julian Day 1995
Actual
Forecast
Lower 2.5
Upper 97.5


Indian Brook Diversion to Birchy Lake
2 Day Forecast vs Actual
Flow (m3/s)
Julian Day 1995
Actual
Forecast
Lower 2.5
Upper 97.5


Indian Brook Diversion to Birchy Lake
3 Day Forecast vs Actual
Flow (m3/s)
Julian Day 1995
Actual
Forecast
Lower 2.5
Upper 97.5


Lewaseechjeech Brook
1 Day Forecast vs Actual
Flow (m3/s)
Julian Day 1996
Actual
Forecast
Lower 2.5
Upper 97.5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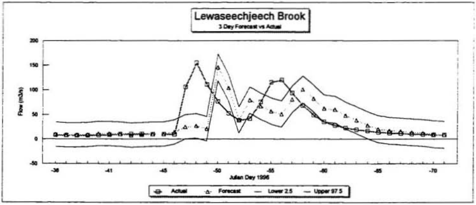
2 Day Forecast vs Actual
Flow (m3/s)
Julian Day 1996
Actual
Forecast
Lower 2.5
Upper 97.5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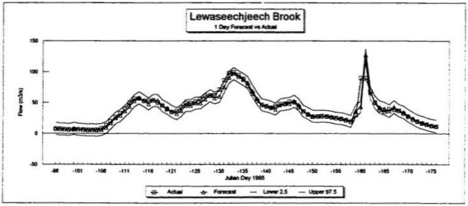
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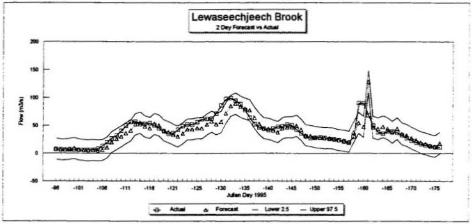
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Flow (m3/s)
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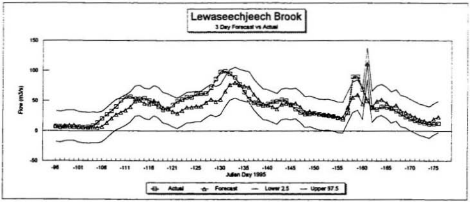
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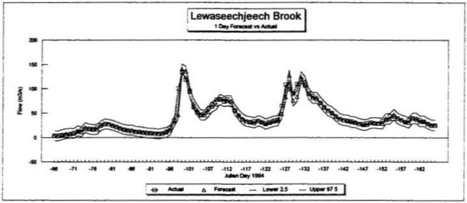

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Flow (m3/s)
Julian Day 1994
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Forecast
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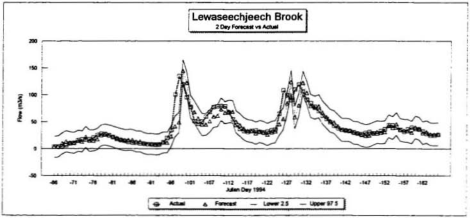

Lewaseechjeech Brook
2 Day Forecast vs Actual
Flow (m3/s)
Julian Day 1994
Actual
Forecast
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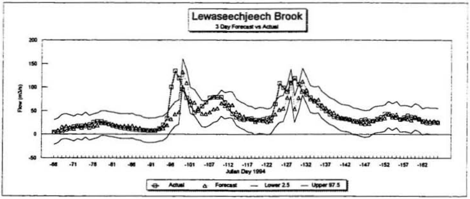
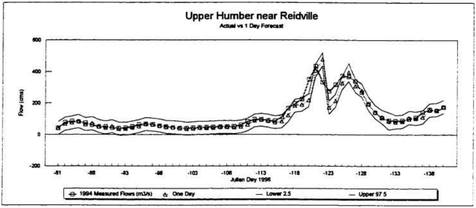
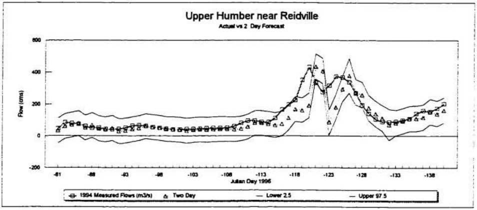
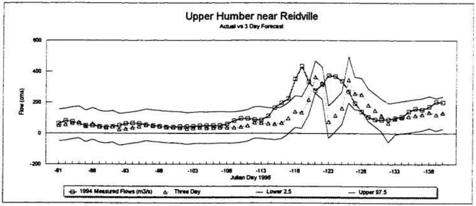
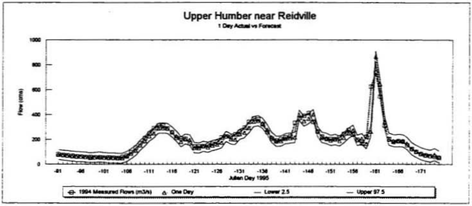


Lewaseechjeech Brook
3 Day Forecast vs Actual
Flow (m3/s)
Julian Day 1994
Actual
Forecast
Lower 2.5
Upper 97.5


Upper Humber near Reidville
Actual vs 1 Day Forecast
Flow (cms)
Julian Day 1996
1994 Measured Flows (m3/s)
One Day
Lower 2.5
Upper 97.5


Upper Humber near Reidville
Actual vs 2 Day Forecast
Flow (cms)
Julian Day 1996
1994 Measured Flows (m3/s)
Two Day
Lower 2.5
Upper 97.5


Upper Humber near Reidville
Actual vs 3 Day Forecast
Flow (cms)
Julian Day 1996
1994 Measured Flows (m3/s)
Three Day
Lower 2.5
Upper 97.5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Flow (cms)
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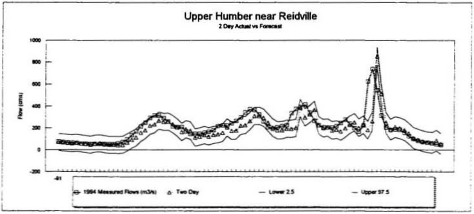
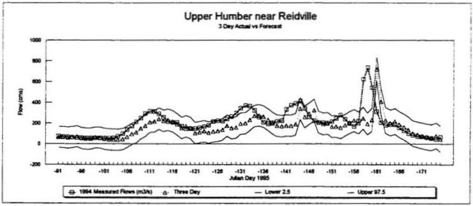

Upper Humber near Reidville
2 Day Actual vs Forecast
Flow (cms)
1994 Measured Flows (m3/s)
Two Day
Lower 2.5
Upper 97.5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1994 Measured Flows (m3/s)
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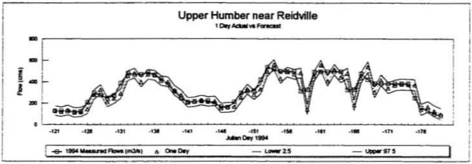
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1 Day Actual vs Forecast
Flow (cms)
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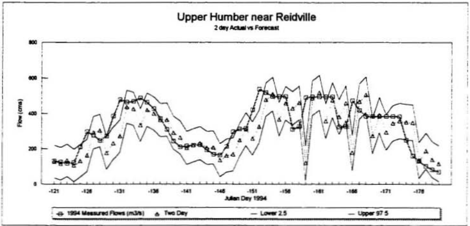
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Flow (cms)
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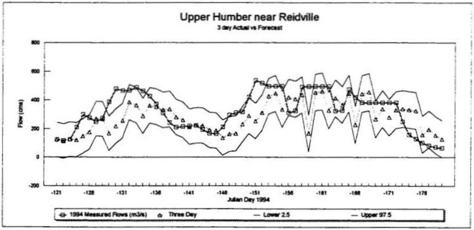
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Flow (cms)
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Lower 2.5
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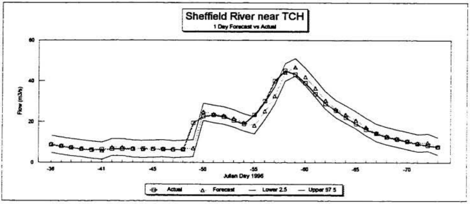
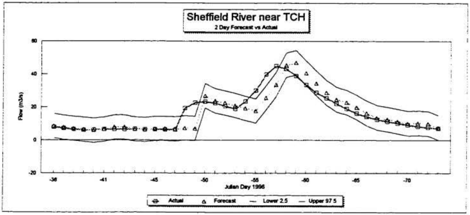
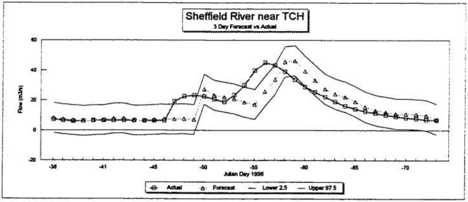

Sheffield River near TCH
1 Day Forecast vs Actual
Flow (m3/s)
Julian Day 1996
Actual
Forecast
Lower 2.5
Upper 97.5


Sheffield River near TCH
2 Day Forecast vs Actual
Flow (m3/s)
Julian Day 1996
Actual
Forecast
Lower 2.5
Upper 97.5


Sheffield River near TCH
3 Day Forecast vs Actual
Flow (m3/s)
Julian Day 1996
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Forecast
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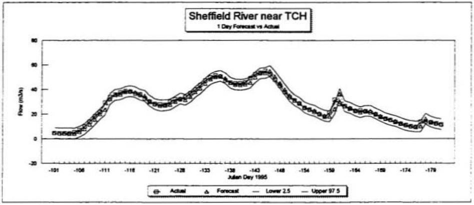
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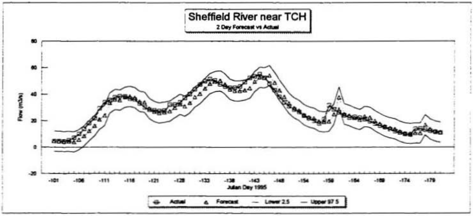
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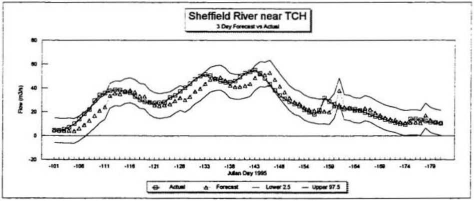
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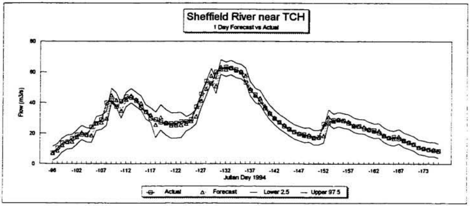
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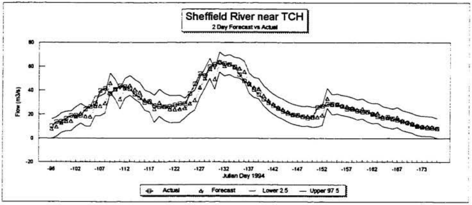
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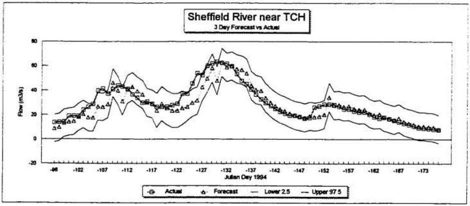
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3 Day Forecast vs Actual
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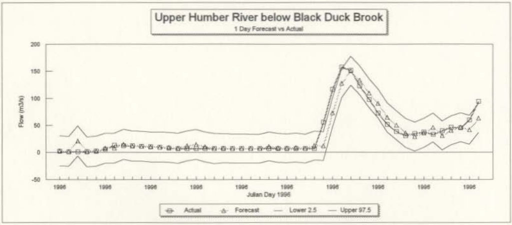
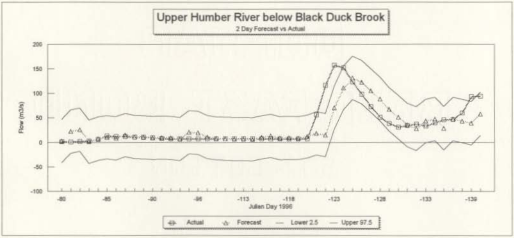


Upper Humber River below Black Duck Brook
1 Day Forecast vs Actual
Flow (m3/s)
Julian Day 1996
Actual
Forecast
Lower 2.5
Upper 97.5



Upper Humber River below Black Duck Brook
2 Day Forecast vs Actual
Flow (m3/s)
Julian Day 1996
Actual
Forecast
Lower 2.5
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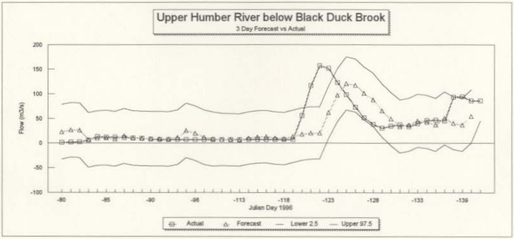

Upper Humber River below Black Duck Brook
3 Day Forecast vs Actual
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Forecast
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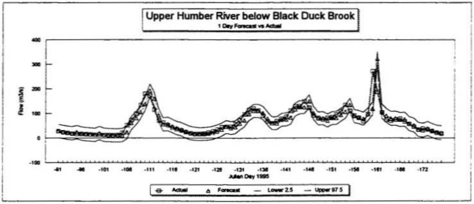
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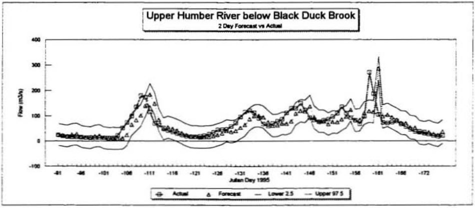
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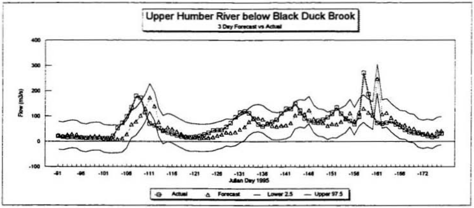
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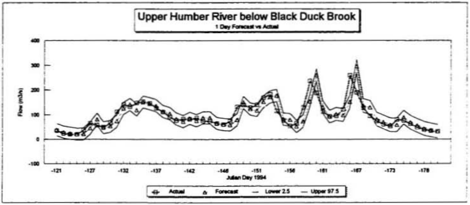
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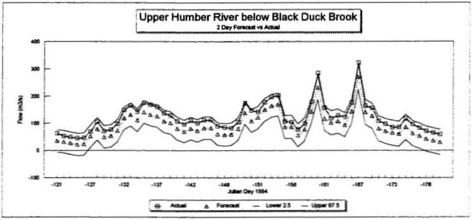
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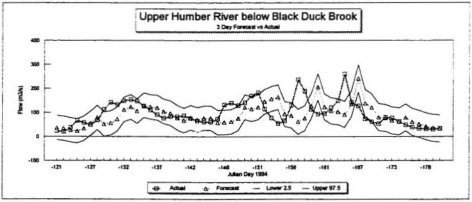
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