FLOOD FORECASTING MODEL FOR
THE TODD RIVER - ALICE SPRINGS

A Component of
Project Number 3009, Flood Warning Systems

Prepared by: V Sananikone
Darwin
February, 1986

20:HYDRO7
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ABSTRACT

This report outlines the procedures adopted in the development of a flood forecasting system for Alice Springs. A description of the catchment is presented and discussion of the flooding problem in Alice Springs provided. The methodology is developed. The flood forecasting model program is appended (Appendix 1).

The model uses the established parameters ($X$ and $K$), the rating curves for both stations, the estimated rate of rise at Wigley Gorge and the telemetered data to predict the water level at Wills Terrace for the next hour.
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1.0 INTRODUCTION

The development of a flood forecasting model has been initiated as part of Water Resources Division Project No. 3009 entitled "Flood Warning Systems". The objective of this part of the project is to establish and install a flood warning system on the Todd River.

The flood forecasting model, combined with the use of the automatic telemetry network which has recently been installed at Bond Springs (rainfall), Wigley Gorge (rainfall and stream height), and Wills Terrace (stream height), will increase the warning time available before major flooding. This model is an important measure to help protect human life and reduce the economic losses for the Alice Springs community.

Accuracy of the model depends on understanding the characteristics of the Todd River catchment as well as establishing an accurate flood-routing technique. The flood-routing method used in developing this model is the Muskingum equation. The model parameters X and K were fitted and verified using recorded data.
2.0 TODD RIVER CATCHMENT CHARACTERISTICS

2.1 Streams

The Todd River catchment above Wills Terrace (GS 006009) covers an area of 445 km² (Fig. 2.0). It can be divided into three parts:

(i) Todd River above Wigley Gorge (GS 006046), 356 km².

(ii) Charles River above Big Dipper (GS 006047), 39 km².

(iii) Balance of area providing lateral inflow to the Todd River above Wills Terrace, 50 km².

The lengths and slopes of the Todd and Charles Rivers are 40 km, 5 m/km and 14.5 km, 8 m/km respectively.

2.2 Climate

The climate of the catchment is typically arid continental with large daily temperature variations. Rain, which falls infrequently may occur at any time of the year and is often due to thunderstorm activity caused by convective processes. Average annual rainfall is about 280 mm and average monthly rainfalls range from 43 mm in February to 10 mm in September. The summer months have the higher average rainfalls.

A gauge is located at Bond Springs to measure rainfall and is incorporated into the telemetry system.

2.3 Landforms, Soils and Geology

The maximum catchment elevation exceeds 900 m (Australian Height Datum) on Bond Springs Station. Streams are generally very wide and shallow with a sandy bed.

The upper northern part of the catchment is composed of fairly flat red soil plains and the catchment boundary in this area is difficult to determine.

The Arunta Complex hills form the north-eastern and central part of the catchment above Alice Springs. This area is made up of rolling, occasionally steep, rocky hills into which the river and other drainage channels have cut steep-sided rocky gorges. The ground surface is mostly broken, angular, granite-gneiss rock with exposed rock outcrops and occasional sandy flats (Ref. 5).

20:HYDRO
Fig. 2.0

LEGEND

--- CATCHMENT BOUNDARY

Δ GS006046 GAUGE STATION

○ R006046 RAIN GAUGE STATION

TODD RIVER CATCHMENT TELEMETRY STATIONS
2.4 Vegetation

The vegetation cover is highly dependant on the amount of rainfall seasonally and annually but is generally sparse. Vegetation in the catchment area ranges from grasses and scrubs to low shrublands and woodlands.

2.5 Landuse

Landuses in the catchment area are mainly Pastoral Lease (Bond Springs) and National Park Reserves (Telegraph Station, Simpsons Gaps). These areas are the major contributors to streamflow in the Todd River. Some urban development is located near the outlet of the catchment (northern part of Alice Springs).
3.0 CHARACTERISTICS OF FLOODING IN ALICE SPRINGS

Alice Springs, located on the floodplain of the Todd River, is prone to flooding. For example the township was flooded in 1910, 1920, 1921, 1932, 1940, 1966, 1972, 1974, 1977, 1983, 1984. The 1983 flood claimed three lives and caused extensive damage to property.

Flooding in Alice Springs has two origins:

1) Riverine
2) Local Runoff

As this report concentrates on developing flood forecasting for Wills Terrace (upper end of town), only riverine flooding is considered.

Flood waters flow through Wigley Gorge station from the upper part of the catchment, down to Wills Terrace and are joined by the Charles River flow just above the High School. The flood then flows through the flood plains (which are situated in the town area) and is joined by four major drains (Bradshaw, Westside, Eastside and MT John) as it passes through Heavitree Gap. Once it leaves Heavitree Gap, it then flows into a relatively flat terrain through Alice Springs Farm area. Its channel soon becomes wider and shallower and eventually breaks up into a number of braided flood channels (Ref. 4,5).

It is very rare for major flows to occur in the Charles and Todd Rivers simultaneously and in any case the small Charles catchment contributes little to the maximum flood peak at Wills Terrace.

In this preliminary model only data from Wigley Gorge and Wills Terrace gauge stations will be used in the flood estimation. Further development of the model will include the use of rainfall telemetry data and other streamflow telemetry data.

Historically flood flows peak within six hours of a rainfall event in the upper catchment. This very rapid river rise accentuates the need for a flood warning system, but also makes the provision of a long warning time impossible.

Further details of flooding in Alice Springs are given by Marquardt (Ref. 5).
4.0 FLOOD FORECASTING MODEL

4.1 Model Structure

A flood forecasting model has been developed (Appendix 1) using the Muskingum Flood Routing method. The flow chart of the main program (Fig. 4.1(a)) shows the basis for the model (MUSK5). One-step forecasting is provided by incorporating into the program the historical rate of rise of flood peaks (see Section 4.5). With the known water level at Wigley Gorge, the model forecasts the stage of the flood downstream at Wills Terrace for the next time period. The model has been satisfactorily tested using data from the 1983 and 1984 floods. (Fig. 4.1(b), (c)).

Given the water level at the upstream station, this program will estimate the water level at the downstream station. The estimate is based on the historical record of flood events in the Todd River. Inflow and outflow hydrographs have been used to estimate the storage-time constant (K) and the weighting factor (X). The rating curves in the form of equations for both upstream and downstream stations are embodied in the main program. These rating curves translate the water levels in metres to discharges in cubic metres per second or vice versa.

The water levels (to be typed in manually) are real time data.

A manual of Flood Forecasting Model for Alice Springs has been prepared for system operators and included in Appendix 4.
FLOW CHART: PRELIMINARY FLOOD FORECASTING MODEL FOR ALICE SPRINGS

READ: PREVIOUS WATER LEVEL AT WIGLEY GORGE.

USE RATE OF RISE TO PREDICTED RANGE OF NEXT STAGE LEVEL AT WIGLEY GORGE.

CONVERT WATER LEVELS TO DISCHARGES USING THE RATING CURVE AT WIGLEY GORGE THEN, EQUATE TO DISCHARGES AT WILLS TCE. AND CONVERT BACK TO WATER LEVELS AT WILLS TCE.

\[ X = 0.1 \text{ and } K_I = 1.54 \]

CHANGE THESE VALUES?

- YES: NEW X & NEW K_I
- NO: I = 2, NT

READ: PRESENT WATER LEVELS OF WIGLEY GORGE AND WILLS TCE. FROM TELEMETRY DATA.

COMPARE PRESENT LEVEL (WILLS TCE.) WITH RANGE OF PREDICTED LEVELS OF PREVIOUS TIME. WHICHEVER LEVEL NEAREST TO THE ACTUAL WILL BE USED AS AN INDICATOR (LOW, MEDIUM, UPPER OR RECESSION) FOR THE NEXT ROUTING PERIOD.

USE RATE OF RISE AND RECESSION TO PREDICT RANGE OF NEXT STAGE LEVELS OF WIGLEY GORGE.

CONVERT WATER LEVELS TO DISCHARGES FOR PREDICTED INFLOWS.

ROUTE THESE INFLOWS BY MUSKINGUM EQUATION

\[ OFL(I) = C_0 \times IFL(I) + C_1 \times IFL(I-1) + C_2 \times OFL(I-1) \]

CONVERT OUTFLOWS TO STAGES USING RATING CURVE AT WILLS TCE.

PICK THE FORECASTING LEVEL AND PRINT TO OUTPUT USING INDICATOR ABOVE AND PRINT THE REAL TIME OF FORECAST.

\[ I + 1 \text{ NO --- } I = NT ? \text{ YES --- STOP} \]

NOTE: X, K_I = MUSKINGUM PARAMETERS

I = ROUTING TIME PERIOD
NT = NUMBER OF ROUTING PERIOD

Fig. 4.1(a)
RESULTS OF FLOOD FORECASTING MODEL FOR TODD RIVER AT WILLS TCE. (16/3/83)

Fig. 4.1 (b)
RESULTS OF FLOOD FORECASTING MODEL FOR TODD RIVER AT WILLS TCE. (25/1/84)

Fig. 4.1 (c)
4.2 Instrumentation

Stage one of the flood forecasting system being installed in Alice Springs consists of two water level recorders and two rainfall recorders communicating with the computer system in Alice Springs via data loggers and through Telecom public switch lines. A water level recorder is installed at Wills Terrace at the northern end of town and the other is 7 km upstream at Wigley Gorge. The rainfall recorder is installed high in the catchment at Bond Springs, approximately 20 Km north of Alice Springs and the other is about 100m from Wigley Gorge gauge station. The instruments are equipped with auto call - auto answer modems, which notify operating staff of any major rainfall or runoff events in the catchment. (Ref. 10).

Networks and instrumentation to acquire data for flood warning purposes have been discussed in detail by Vaarwerk (1984) (Ref. 9).

4.3 Rating Curves

The rating curve equations for Wigley Gorge and Wills Terrace have been included in the main program and are used to translate stream stage to discharge and vice versa. The curves were developed by fitting linear and polynomial regression in log-log space using the method of least squares. The equations derived for the curves for both locations are developed for this study only.

**Wigley Gorge:** Three equations have been derived from 1960-1985 data.

\[
\log Q = \log(H - 0.20) \times 2.948 + 0.344 \quad \ldots \quad (1)
\]
for \( H = 0.35 \text{ m to } 0.74 \text{ m} \).

\[
\log Q = \log(H - 0.20) \times 5.547 + 0.998 \quad \ldots \quad (2)
\]
for \( H = 0.75 \text{ m to } 1.18 \text{ m} \).

\[
\log Q = \log(H - 0.20) \times 2.523 + 0.998 \quad \ldots \quad (3)
\]
for \( H = 1.19 \text{ m to } 1.70 \text{ m} \).

Equation (3) may be extended up to about 6.0m.

**Wills Terrace:** Three equations have been derived from 1970-1985 data.

\[
\log Q = \log H \times 14.726 - 2.050 \quad \ldots \quad (4)
\]
for \( H = 1.14 \text{ to } 1.49 \text{ m} \).

\[
\log Q = \log H \times 10.241 - 1.274 \quad \ldots \quad (5)
\]
for \( H = 1.49 \text{ m to } 1.88 \text{ m} \).
Log $Q = \log H \times 4.746 + 0.233$ ..... (6)
for $H = 1.88$ m to $3.10$ m.
Equation (6) may be used for extension up to the highest recorded gauge height of 3.50 metres.

A plot of the rating curves for both stations is given in Appendix 3.

4.4 Flood Routing

Flood routing by Muskingum method (ref. 1,2,3,6,7,8,) has been used for routing the flood wave down the stream channel. A computer program was developed to determine the parameters $X$ and $K$. This program requires an inflow and outflow hydrograph so that the storage time constant ($K$) and the weighting factor ($X$) for the river reach can be determined.

The parameters used by this program are as follow:

- $K_I$ = Storage Constant $K$ (h)
- $I_{FL}$ = Inflow at Wigley Gorge (m$^3$/s)
- $O_{FL}$ = Outflow at Wills Terrace (m$^3$/s)
- $X$ = Co-efficient $X$
- $DQ$ = Weighted Average of Discharge (m$^3$/s)
- $DT$ = Routing Period (hours)
- $NT$ = Number of Routing Period
- $C_0$ = Nash Co-efficient
- $C_1$ = Nash Co-efficient
- $C_2$ = Nash Co-efficient
- $STOR$ = Storage (m$^3$)

The following equation is used to route the flood through the river reach, once the parameters have been established.

$$O_{FL}(I) = C_0 \times I_{FL}(I) + C_1 \times I_{FL}(I-1) + C_2 \times O_{FL}(I-1)$$
Where:

\[ C_0 = \frac{(-KI)X + 0.5DT}{KI(1-X) + 0.5DT} \]

\[ C_1 = \frac{(KI)X + 0.5DT}{KI(1-X) + 0.5DT} \]

\[ C_2 = \frac{KI-(KI)X - 0.5DT}{KI(1-X) + 0.5DT} \]

Four flood events, 25/11/73, 14/3/77, 26/1/74, 16/3/83 at Wugley Gorge and Wills Terrace were selected for model calibration. The inflow and outflow data of each event were analysed by the program ROUTEMUSK to derive the \( X \) and \( K \) parameters. The results of the calibrated parameters of each event are tabulated (Table 4.4). Note that the range of annual exceedence probabilities for these events was 1 in 5 to 1 in 20.
TABLE 4.4
PARAMETERS X AND K FOR TODD RIVER BETWEEN WIGLEY GORGE AND WILLS TERRACE
(BEST FIT PARAMETERS)

<table>
<thead>
<tr>
<th>EVENT NO</th>
<th>DATE OF FLOOD EVENT</th>
<th>X</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>25 - 11 - 1973</td>
<td>0.1</td>
<td>1.54</td>
</tr>
<tr>
<td>2</td>
<td>16 - 03 - 1983</td>
<td>0.1</td>
<td>1.54</td>
</tr>
<tr>
<td>3</td>
<td>14 - 03 - 1977</td>
<td>0.1</td>
<td>1.54</td>
</tr>
<tr>
<td>4</td>
<td>26 - 01 - 1974</td>
<td>0.1</td>
<td>1.25</td>
</tr>
</tbody>
</table>

The initial operation of the flood forecasting model requires only one estimate of the parameters and therefore the "best fit" pair was selected by least squares analysis of the residuals.

The selected values of $X = 0.10$ and $K = 1.54$ were found to satisfactorily reproduce the four flood events as shown in Figures 4.4(a) to (d) and were therefore adopted for use in the flood forecasting model.

The adopted parameters were then tested using an independent event (25-1-84) and found to perform satisfactorily (Fig. 4.4(e)).
HYDROGRAPH REPRODUCTION
(NOV. 1973)

Fig. 4.4 [a]
FLOOD EVENT ON 26/1/74
START-TIME = 15:12 hrs.
X = 0.1
K = 1.54

HYDROGRAPH REPRODUCTION
(JAN. 1974)

Fig. 4.4 (b)
FLOOD EVENT ON 14/3/77
START-TIME = 23:43 hrs.
X=0.1
K=1.54

HYDROGRAPH REPRODUCTION
(MAR. 1977)

Fig. 4.4 (c)
HYDROGRAPH REPRODUCTION
(MAR. 1983)

Fig. 4.4 [d]
PARAMETER VERIFICATION
(JAN. 1984)

Fig. 4.4 (e)
4.5 Historical Rate of Rise

Three hydrograph traces at Wigley Gorge, with stage over 4.4 m, were superimposed so that their peaks occurred simultaneously (Fig. 4.5). From these, rates of water level rise and recession were determined and classified into four ranges; lower, medium, upper and recession. The results to be used for prediction, are given in Table 4.5 and have been included in the main computer program.

The rate of rise and recession which best reproduces the recorded hydrograph for the previous time increment is used to predict the future flood levels. These rate of rise and recession data are from floods with annual exceedence probabilities of between 1 in 5 and 1 in 20.
### TABLE 4.5
RATE OF RISE AT WIGLEY GORGE

<table>
<thead>
<tr>
<th>STAGE (I) (m)</th>
<th>STAGE (I+1) LOW</th>
<th>STAGE (I+1) MEDIUM</th>
<th>STAGE (I+1) HIGH</th>
<th>STAGE (I+1) RECESSION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.20</td>
<td>1.60</td>
<td>3.80</td>
<td>0.90</td>
</tr>
<tr>
<td>1.60</td>
<td>1.40</td>
<td>2.00</td>
<td>4.00</td>
<td>1.18</td>
</tr>
<tr>
<td>2.00</td>
<td>1.90</td>
<td>2.40</td>
<td>4.40</td>
<td>1.55</td>
</tr>
<tr>
<td>2.40</td>
<td>2.30</td>
<td>2.80</td>
<td>4.80</td>
<td>1.75</td>
</tr>
<tr>
<td>2.80</td>
<td>3.30</td>
<td>3.30</td>
<td>5.30</td>
<td>2.10</td>
</tr>
<tr>
<td>3.20</td>
<td>3.60</td>
<td>4.00</td>
<td>6.00</td>
<td>2.40</td>
</tr>
<tr>
<td>3.60</td>
<td>4.00</td>
<td>4.50</td>
<td>6.50</td>
<td>2.65</td>
</tr>
<tr>
<td>4.00</td>
<td>4.18</td>
<td>5.00</td>
<td>7.00</td>
<td>3.00</td>
</tr>
<tr>
<td>4.40</td>
<td>4.40</td>
<td>5.50</td>
<td>7.50</td>
<td>3.30</td>
</tr>
<tr>
<td>4.80</td>
<td>4.50</td>
<td>6.00</td>
<td>8.00</td>
<td>3.40</td>
</tr>
<tr>
<td>5.20</td>
<td>5.00</td>
<td>6.50</td>
<td>8.50</td>
<td>3.55</td>
</tr>
<tr>
<td>5.60</td>
<td>5.40</td>
<td>7.00</td>
<td>9.00</td>
<td>3.70</td>
</tr>
</tbody>
</table>

Where (I) is the time period.

Only heights of up to 6.0m have been included in this table of historical rates of rise and fall.

No information is available above this height and the rating table is only valid up to this height.

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4.6 Example of Flood Forecasting Model

Flood forecasting model operation has been presented below using the flood event of 16 March 1983 as an example. The recorded data on Wigley Gorge and Wills Terrace are provided in Table 4.6 (a) and summary results of the flood forecasting model are presented in Table 4.6 (b). The flood forecasting diagram (Fig. 4.6) shows how the model operates, and the example of computer printout is also presented.

**TABLE 4.6 (a)**

**FLOOD RECORD ON 16 MARCH 1983, START TIME 1947 HOURS**

<table>
<thead>
<tr>
<th>TIME PERIOD</th>
<th>WIGLEY GORGE (metres)</th>
<th>WILLS TERRACE (metres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.12</td>
<td>0.28</td>
</tr>
<tr>
<td>2</td>
<td>3.16</td>
<td>2.01</td>
</tr>
<tr>
<td>3</td>
<td>4.73</td>
<td>2.59</td>
</tr>
<tr>
<td>4</td>
<td>5.51</td>
<td>3.17</td>
</tr>
<tr>
<td>5</td>
<td>5.31</td>
<td>3.39</td>
</tr>
<tr>
<td>6</td>
<td>5.25</td>
<td>3.30</td>
</tr>
<tr>
<td>7</td>
<td>4.62</td>
<td>3.32</td>
</tr>
<tr>
<td>8</td>
<td>3.61</td>
<td>3.13</td>
</tr>
<tr>
<td>9</td>
<td>2.53</td>
<td>2.83</td>
</tr>
<tr>
<td>10</td>
<td>2.31</td>
<td>2.62</td>
</tr>
</tbody>
</table>
LEGEND

- M INDICATOR DETERMINED FROM COMPARISON BETWEEN THE ACTUAL DATA AND RANGE OF FORECASTING LEVELS
- RANGE OF FORECASTING LEVEL
- ○ CALCULATED LEVEL AT WILLS TCE.
- ● CALCULATED LEVEL AT WIGLEY GORGE
- ○ TELEMETERED WATER LEVEL
- USING RATE OF RISE AND RECESSION TABLE TO OBTAIN THE LEVELS AT WIGLEY GORGE FOR THE NEXT HOUR
- TRANSLATE THE FLOOD FROM WIGLEY GORGE TO WILLS TCE. USING RATING CURVES AT BOTH STATIONS
- USING MUSKINGUM ROUTING EQUATION AND RATING CURVES TO CALCULATE WATER LEVELS AT WILLS TCE.

FLOOD FORECASTING DIAGRAM

Fig. 4.6
FLOOD WARNING PROGRAM OF TODD RIVER
AT WILLS TERRACE, ALICE SPRINGS, N.T.

FOR FLOOD OF 16 March 1983
Note: The predicted water level is one hour in advance

DATE: 16 March 1983
TIME: 19:47

Input No. of routing periods? Input 2 or over
100
Time interval between routing periods?
1.0
X=0.10 & KI=1.54, would you like to change these values?
NO

Would you like to print a summary?
YES

Enter previous water level at Wigley in metre
1.12

Enter present water level at Wills Tce
2.01

Wigley at lower range = 1.32 m
Water Level = 1.32 m Discharge = 13.26 m³/s

Wigley at medium range = 2.19 m
Water level = 2.19 m Discharge = 56.41 m³/s

Wigley at upper range = 3.92 m
Water level = 3.92 m Discharge = 274.08 m³/s

Wigley at recession range = 1.07 m
Water Level = 1.07 m Discharge = 4.54 m³/s

Computed present water level at Wills Tce = 2.09
Actual present water level at Wills Tce = 2.01
Computed present discharge = 56.41

Present Water level at Wigley in metres?
2.01
Present Water Level at Wills Tce in metres?
3.16
Wills Tce at Lower range = 2.43 m
Wills Tce at Medium range = 2.52 m
Wills Tce at Upper range = 2.56 m
Wills Tce at Recession range = 2.32 m
Forecast Time:
Predicted water level (Wills Tce) = 2.52 m

20:HYDRO7
Present Water Level at Wigley in metres?
4.73

Present water level at Wills Tce in metres?
2.59

Wills Tce at lower range = 3.00 m
Wills Tce at medium range = 3.01 m
Wills Tce at upper range = 3.04 m
Wills Tce at Recession range = 2.94 m
Forecast Time:
Predicted water level (Wills Tce) = 3.04 m

*********************************************
Present Water level at Wigley in metres?
5.51

Present water level at Wills Tce in metres?
3.17

Wills Tce at lower range = 3.38 m
Wills Tce at medium range = 3.39 m
Wills Tce at upper range = 3.41 m
Wills Tce at recession = 3.34 m
Forecast Time:
Predicted water level (Wills Tce) = 3.41 m

*********************************************
Present Water level at Wigley in metres?
5.31

Present water level at Wills Tce in metres?
3.39

Wills Tce at lower range = 3.43 m
Wills Tce at medium range = 3.44 m
Wills Tce at upper range = 3.45 m
Wills Tce at recession range = 3.40 m
Forecast Time:
Predicted water level (Wills Tce) = 3.40 m

*********************************************
Present Water level at Wigley in metres?
5.25

Present water level at Wills Tce in metres?
3.30

Wills Tce at lower range = 3.38 m
Wills Tce at medium range = 3.39 m
Wills Tce at upper range = 3.39 m
Wills Tce at recession range = 3.34 m
Forecast Time:
Predicted water level (Wills Tce) = 3.34 m

*********************************************
Present Water level at Wigley in metres?
4.62

Present water level at Wills Tce in metres?
3.32

Wills Tce at lower range = 3.26 m
Wills Tce at medium range = 3.27 m
Wills Tce at upper range = 3.29 m
Wills Tce at recession range = 3.21 m
Forecast Time:
Predicted water level (Wills Tce) = 3.21 m
*********************************************

Present water level at Wigley in metres?
3.61

Present water level at Wills Tce in metres?
3.13

Wills Tce at lower range = 2.99 m
Wills Tce at medium range = 3.02 m
Wills Tce at upper range = 3.04 m
Wills Tce at recession range = 2.93 m
Forecast time:
Predicted water level (Wills Tce) = 2.93 m
*********************************************

Present water level at Wigley in metres?
2.53

Present water level at Will Tce in metres?
2.83

Wills Tce at lower range = 2.61 m
Wills Tce at medium range = 2.69 m
Wills Tce at upper range = 2.76 m
Wills Tce at recession range = 2.57 m
Forecast time:
Predicted water level (Wills Tce) = 2.57 m
*********************************************

Present water level at Wigley in metres?
2.31

Present water level at Wills Tce in metres?
2.62

Wills Tce at lower range = 2.44 m
Wills Tce at medium range = 2.53 m
Wills Tce at upper range = 2.63 m
Wills Tce at recession range = 2.40 m
Forecast time:
Predicted water level (Wills Tce) = 2.40 m

20:HYDRO7
TABLE 4.6 (b)
Summary Results of Flood Forecasting Model for March 16, 1983 Flood

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Wigley Gorge (recorded) (m)</th>
<th>Wills Terrace (recorded) (m)</th>
<th>Wills Terrace (Predicted) (m)</th>
<th>Difference (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.12</td>
<td>0.28</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>3.16</td>
<td>2.01</td>
<td>2.09</td>
<td>+0.08</td>
</tr>
<tr>
<td>3</td>
<td>4.73</td>
<td>2.59</td>
<td>2.52</td>
<td>-0.07</td>
</tr>
<tr>
<td>4</td>
<td>5.51</td>
<td>3.17</td>
<td>3.04</td>
<td>-0.13</td>
</tr>
<tr>
<td>5</td>
<td>5.31</td>
<td>3.39</td>
<td>3.41</td>
<td>+0.02</td>
</tr>
<tr>
<td>6</td>
<td>5.25</td>
<td>3.30</td>
<td>3.40</td>
<td>+0.10</td>
</tr>
<tr>
<td>7</td>
<td>4.62</td>
<td>3.32</td>
<td>3.34</td>
<td>+0.02</td>
</tr>
<tr>
<td>8</td>
<td>3.61</td>
<td>3.13</td>
<td>3.21</td>
<td>+0.08</td>
</tr>
<tr>
<td>9</td>
<td>2.53</td>
<td>2.83</td>
<td>2.93</td>
<td>+0.10</td>
</tr>
<tr>
<td>10</td>
<td>2.31</td>
<td>2.62</td>
<td>2.57</td>
<td>-0.05</td>
</tr>
</tbody>
</table>
5.0 DISCUSSION

The flood forecasting model has been tested using data from the floods of 1933 and 1984. An example of the output for the tested model is presented in Appendix 3. Further modification and refinement of the model is recommended as more data is made available.

The accuracy of the model is affected by the following:

- Parameters X and K. A revised version of the program will aim to check and refine these during each event.
- Error from the telemetered data network.
- Human error in data input e.g. wrong figure.
- Additional intense rainfall occurrence immediately after a flood forecast is issued.
- The present model does not incorporate telemetered rainfall data. This will be addressed in a model update.
- The minor Charles River contribution into the Todd River is not included into the system.
- Transmission losses and lateral inflow during transit of the flood are neglected.

Further investigations to fully establish the forecasting system are necessary. Ideally the model described here can be further tested and refined using storm events as they occur during 1986.

This model is based only on flow data and therefore a deficiency in warning time may be present. This should improve when telemetered rainfall data can be incorporated into the model. Existing liaison with the Bureau of Meteorology; particularly with use of their radar for rainfall forecasts, is to be encouraged.

Other flood routing techniques, such as the one dimensional differential equation (Saint-Venant Equation for gradually varying flow in an open channel); considered to give more accurate results, should be examined closely for inclusion into the flood forecasting model.
6.0 REFERENCES


APPENDIX 1

FLOOD FORECASTING MODEL (MUSK5)
PROGRAM MUSK5

This program is written by V. Sananikone
Water Resources Division
Department of Mines and Energy
26 November 1985

Flood prediction program
Data needed for this program are:
Water level in metres at Wigley Gorge (HT)
Water level in metres at Wills Terrace (ST)
River coefficient (XCOEF)
River constant (KI)
Routing period (NT)
Time interval (DR)

**************************************************************************************************************
* The parameters used for flood routing of a river system *
* by using Muskingum method *
**************************************************************************************************************

NAME : DESCRIPTIONS : UNIT : TYPE: I/R :

KI = Storage constant : HOURS : REAL
XIFL = Inflow : m3/s : REAL
OFL = Outflow : m3/s : REAL
XCOEF = Coefficient
DT = Routing period : HOURS : REAL
NT = Number of routing period
C0 = Nash coefficient
C1 = Nash coefficient
C2 = Nash coefficient
DR = Duration of time : HOURS : INTEGER
HT = Water level (Wigley Gorge) : METRES : REAL
ST = Water level (Wills Terrace) : METRES : REAL

**************************************************************************************************************

Character*9 DDT, DAY, R, TTT*8, P1*15
Character*1 YES, NO, ANS
Real XIFL, XCOEF, OFL, DT, HT, HT1, KI, XI, Y1, Y2, Y3, OFL1(200, 4),
ST1(200, 4), XIFL1(200, 4), TV(50), Y4(17), HY4(200)
Integer NT, DR
Dimension STOR(100), XIFL(100), DT(100), HT(50), OFL(100)
1, Y1(17), Y2(17), Y3(17), X1(17), HY1(200), HY2(200), HY
23(200), HT1(200, 4), STA(200), R(10)
YES = 'Y'
NO = 'N'
R(1) = 'LOWER'
OPEN (UNIT=2, NAME='MUSKS OUT', STATUS='NEW')

WRITE (6, *) '**********************************************************'
WRITE (6, 19) WRITE (2, 21) WRITE (6, *) '**********************************************************'
WRITE (6, *) 'NOTE: THE PREDICTED WATER LEVEL IS ONE HOUR IN ADVANCE'

CALL DATE(DDT)
CALL TIME(TTT)
WRITE(2, *) 'DATE OF EXECUTION', DDT
WRITE(6, *) 'DATE', DDT
WRITE(2, *) 'TIME', TTT
WRITE(6, *) 'TIME', TTT

WRITE(6, *) 'INPUT NO. OF ROUTING PERIOD? INPUT 10 OR MORE'
READ(5, 300, ERR=107) NT

WRITE(6, *) 'TIME INTERVAL BETWEEN ROUTING PERIOD?' READ(5, 300, ERR=108) DR

XCOEF=0.10
KI=1.54

READ (6, 300, ERR=109) ANS
IF (ANS.EQ. 'N') GOTO 555

WRITE (6, *) 'WHAT IS THE RIVER COEFFICIENT? E.G 0.1 TO 0.5'
READ (5, 300, ERR=111) XCOEF

WRITE (6, *) 'WHAT IS THE RIVER CONSTANT IN HOURS'
READ (5, 300, ERR=112) KI

WRITE(6, 56) XCOEF WRITE(2, 56) XCOEF WRITE(6, 57) KI WRITE(2, 57) KI

WRITE (6, 113) 'WOULD YOU LIKE TO PRINT A SUMMARY?' READ(5, 300, ERR=113) ANS
IF (ANS.EQ. 'Y') THEN OPEN (UNIT=3, NAME='SUMMARY.DAT', STATUS='NEW')
WRITE(3, 1) 'SUMMARY OF FORECASTING MODEL'

WRITE(3, 1) PERIOD STAGE(WIGLEY) STAGE(WILLS TCE)
1 PREDICTED(NEXT HOUR) END IF

WRITE (3, 1)
WRITE(6, *) ' ENTER PREVIOUS WATER LEVEL AT WIGLEY IN METRE'
READ(5, *) HT(1)
WRITE(6, *) ' ENTER PREVIOUS WATER LEVEL AT WILLS TCE'
READ(5, *) ST(0)
WRITE(6, *) ' ENTER PRESENT WATER LEVEL AT WILLS TCE'
READ(5, *) ST(1)
IF (HT(1).LT.1) THEN
WRITE(6, *) ' TRY HIGHER VALUE'
GOTO 556
END IF
WRITE(2, *)
WRITE(2, *)
WRITE(2, 59) HT(1)

C DATA FOR HISTORICAL RATE OF RISE
C ----------------------------------------------------
DATA X1/0. 1. 2. 1. 6. 2. 0. 12. 40. 2. 8. 3. 2. 6. 3. 8. 4. 0. 4. 20. 4. 4. 5. 6. 4. 6. 5. 8. 0. 5. 4. 5. 6. 0/ DATA Y1/1. 2. 1. 4. 1. 9. 2. 3. 12. 7. 3. 3. 6. 4. 0. 4. 19. 4. 40. 4. 50. 4. 60. 4. 70. 4. 80. 5. 10. 5. 5. 5. 7/ DATA Y2/1. 6. 2. 5. 8. 3. 10. 3. 3. 3. 7. 4. 0. 3. 14. 4. 56. 4. 60. 4. 65. 4. 70. 4. 80. 4. 90. 5. 15. 5. 7. 5. 8/ DATA Y3/3. 9. 4. 0. 4. 10. 4. 2. 14. 4. 4. 45. 4. 5. 14. 6. 4. 78. 4. 80. 4. 90. 4. 95. 5. 10. 5. 15. 5. 20. 5. 8. 6. 0/ DATA Y4/0. 90. 1. 18. 1. 55. 1. 75. 2. 10. 2. 40. 2. 65. 3 00. 3. 10 1. 3. 30. 3. 40. 3. 55. 3. 90. 4. 20. 4. 50. 5. 00. 5. 20/ WRITE(2, *) HISTORICAL RATE OF RISE AT WIGLEY WRITE(2, *) 'STAGE(T) STAGE(T+1) STAGE(T+1) STAGE(T+1) STAGE(T+1) LOW MEDIUM HIGH RECESSION '

DO 55 I=1,17
WRITE(2,1212) X1(I), Y1(I), Y2(I), Y3(I), Y4(I)
CONTINUE

NUM=0
DO 202 I=2,17
202 IF (HT(1).GT. X1(I-1).AND.HT(1).LE.X1(I)) NUM=I
IF (HT(1).LE.X1(I)) NUM=2
IF (HT(1).GT.X1(I-1)) NUM=17
HY1(I)=(Y1(NUM)-Y1(NUM-1))/(X1(NUM)-X1(NUM-1))*(HT(I)-X1(I(NUM-1))+Y1(NUM-1)
HY2(I)=(Y2(NUM)-Y2(NUM-1))/(X1(NUM)-X1(NUM-1))*(HT(I)-X1(I(NUM-1))+Y2(NUM-1)
HY3(I)=(Y3(NUM)-Y3(NUM-1))/(X1(NUM)-X1(NUM-1))*(HT(I)-X1(I(NUM-1))+Y3(NUM-1)
HY4(I)=(Y4(NUM)-Y4(NUM-1))/(X1(NUM)-X1(NUM-1))*(HT(I)-X1(I(NUM-1))+Y4(NUM-1)

HT1(1,1)=HY1(I)
HT1(1,2)=HY2(1)
HT1(1,3)=HY3(1)
HT1(1,4)=HY4(1)
WRITE(2,1001)
WRITE(2,*)' PERIOD 1'
DO 80 I=1,4
WRITE(2,1002) R(I), HT1(I,1)
WRITE(6,1002) R(I), HT1(I,1)
CONVERT THE WATER LEVEL TO DISCHARGE BY USING RATING CURVE

IF (HT1(I,1), LT. 0.75) THEN
  XIFL1(I,1)=10**(LOG10(HT1(I,1)-0.20)*2.948)+0.344
ELSE IF (HT1(I,1), LT. 1.18) THEN
  XIFL1(I,1)=10**(LOG10(HT1(I,1)-0.20)*5.547)+0.998
ELSE
  XIFL1(I,1)=10**(LOG10(HT1(I,1)-0.20)*2.523)+0.998
END IF

PRINT WATER LEVEL AND DISCHARGE AT WIGLEY G.
WRITE(6,3000) HT1(I,1), XIFL1(I,1)
WRITE(2,3000) HT1(I,1), XIFL1(I,1)
EQUATE THE DISCHARGE AT W.G. TO W.T.
OFL1(I,1)=XIFL1(I,1)
CONVERT THE ROUTED DISCHARGE BACK TO THE WATER LEVEL IN METRE BY USING RATING CURVE EQUATIONS AT WILLS TCE.

IF (OFL1(I,1), LT. 3.39) THEN
  ST1(I,1)=10**((LOG10(OFL1(I,1)))+2.050)/14.726
ELSE If (OFL1(I,1), LT. 35.97) THEN
  ST1(I,1)=10**((LOG10(OFL1(I,1)))+1.274)/10.241
ELSE
  ST1(I,1)=10**((LOG10(OFL1(I,1)))-0.233)/4.746
END IF
WRITE(2,3340) R(I), ST1(I,1)
CONTINUE

COMPARE THE CALCULATED WATER LEVELS WITH THE ACTUAL WATER LEVEL AT WILLS TCE.
D2=1000
TV(1)=ABS(ST(1)-ST1(1,1))
TV(2)=ABS(ST(1)-ST1(1,2))
TV(3)=ABS(ST(1)-ST1(1,3))
DO 60 I=1,3
IF (TV(I).LT.D2) THEN
  D2=TV(I)
  D3=I
  CONTINUE
END IF

K=1
STA(1)=ST1(1,D3)
WRITE(6,40) STA(1)
WRITE(3,430) K,HT(1),ST(0),STA(1)
WRITE(6,50) ST(1)
WRITE(2,40) STA(1)
WRITE(2,50) ST(1)

WRITE (2,420) OFL1(1,D3)
WRITE (6,420) OFL1(1,D3)

X=XCOEF
T=DR*3600
KI=KI*3600
RI=KI-KI*X+0.5*T
CO=(-KI*X+0.5*T)/RI
C1=(KI*X+0.5*T)/RI
C2=(KI-KI*X-0.5*T)/RI

WRITE(2,*) 'CO= ',CO,'C1= ',C1,'C2= ',C2

HT(K)=0.0

WRITE(2,*) '*****************************************/
WRITE(6,*)

DO 10 K=2,NT
  IF(K.EQ.2) THEN
    WRITE(6,2100)
    READ (5,*) HT(K)
    ST(K)=ST(1)
  ELSE
    WRITE (6,2100)
    READ (5,*) HT(K)
    WRITE (6,2200)
    READ (5,*) ST(K)
    WRITE (2,*)
  END IF
10 CONTINUE

2100 FORMAT(' PRESENT WATER LEVEL AT WIGLEY G. (METRE)?')
2200 FORMAT(' PRESENT WATER LEVEL AT WILLS TCE(METRE)?')
WRITE(2,58) HT(K)
WRITE(2,59) ST(K)

C ----------------------------------------------------
C INTERPOLATING THE RATE OF RISE AT WIGLEY GORGE
C -----------------------------------------------------
DO 303 I=2,17
303    IF (HT(K).GT. X1(I-1).AND.HT(K).LE. X1(I)) NUM=1
            IF (HT(K).LE. X1(I)) NUM=2
            IF (HT(K).GT. X1(I-1)) NUM=17
            HY1(K)=(Y1(NUM)-Y1(NUM-1))/(X1(NUM)-X1(NUM-1))*(HT(K)-X1
            1(NUM-1))+Y1(NUM-1)
            HY2(K)=(Y2(NUM)-Y2(NUM-1))/(X1(NUM)-X1(NUM-1))*(HT(K)-X1
            1(NUM-1))+Y2(NUM-1)
            HY3(K)=(Y3(NUM)-Y3(NUM-1))/(X1(NUM)-X1(NUM-1))*(HT(K)-X1
            1(NUM-1))+Y3(NUM-1)
            HY4(K)=(Y4(NUM)-Y4(NUM-1))/(X1(NUM)-X1(NUM-1))*(HT(K)-X1
            1(NUM-1))+Y4(NUM-1)

            HT1(K,1)=HY1(K)
            HT1(K,2)=HY2(K)
            HT1(K,3)=HY3(K)
            HT1(K,4)=HY4(K)
            WRITE(2,1001)
            WRITE(2,*1 ' PERIOD = ',K
            DO 90 I=1,4
            WRITE(2,1002) R(I),HT1(K,I)

            CONVERT THE WATER LEVEL UPSTREAM TO THE DISCHARGE
            BY USING THE RATING CURVE EQUATION AT WIGLEY G.

            IF (HT(K).LT.0.75) THEN
              XIFL(K)= 10**((LOG10(HT(K)-0.20)*2.948)+0.344)
            ELSE IF (HT(K).LT.1.18) THEN
              XIFL(K)=10**((LOG10(HT(K)-0.20)*5.547)+0.998)
            ELSE
              XIFL(K)=10**((LOG10(HT(K)-0.20)*2.523)+0.998)
            END IF

            CONVERT THE NEXT-STEP WATER LEVEL TO DISCHARGE

            IF (HT1(K,I).LT.0.75) THEN
              XIFL1(K,I)= 10**((LOG10(HT1(K,I)-0.20)*2.948)+0.344)
            ELSE IF (HT1(K,I).LT.1.18) THEN
              XIFL1(K,I)=10**((LOG10(HT1(K,I)-0.20)*5.547)+0.998)
            ELSE
              XIFL1(K,I)=10**((LOG10(HT1(K,I)-0.20)*2.523)+0.998)
            END IF

            WRITE(2,3000) HT1(K,I),XIFL1(K,I)

            CONVERT THE PRESENT WATER LEVEL TO DISCHARGE AT WILLS TCE

            IF (ST(K).LT.1.50) THEN
              OFL(K)= 10**((LOG10(ST(K))*14.726-2.050)
ELSE IF (ST(K) < 1.90) THEN
  OFL(K) = 10**(LOG10(ST(K)) + 4.746 + 0.233)
ELSE
  OFL(K) = 10**((LOG10(ST(K)) + 1.2735) * 10.241 - 2.735)
END IF

C ------------------------------
C USING MUSKINGUM EQUATION AND PRESENT WATER LEVEL
C AT WIGLEY AND WILLS TERRACE
C
C OFL1(K, I) = CO * XIFL1(K, I) + C1 * XIFL(K) + C2 * OFL(K)
WRITE(2, 3330) XIFL1(K, I), OFL1(K, I)
C
C ------------------------------
C CONVERT ROUTED DISCHARGE BACK TO WATER LEVEL IN METRE
C
C IF (OFL1(K, I) < 3.39) THEN
  ST1CK, I = 10**((LOG10(OFL1(K, I)) + 2.050)/14.726)
ELSE IF (OFL1(K, I) < 35.97) THEN
  ST1CK, I = 10**((LOG10(OFL1(K, I)) + 1.2735) / 10.241)
ELSE
  ST1CK, I = 10**((LOG10(OFL1(K, I)) - 0.233)/4.746)
END IF
WRITE(6, 3340) R(I), ST1(K, I)
WRITE(2, 3340) R(I), ST1(K, I)
C
C CONTINUE
C
C COMPARE THE CALCULATED WATER LEVELS WITH THE
C ACTUAL WATER LEVEL AT WILLS TCE.
C
C IF (HT(K) - HT(K-1)) > 226, 226, 220
D2 = 1000
TV(1) = ABS(ST(K) - ST1(K-1, I))
TV(2) = ABS(ST(K) - ST1(K-1, 2))
TV(3) = ABS(ST(K) - ST1(K-1, 3))
DO 70 I = 1, 3
  IF (TV(I).LT.D2) THEN
    D2 = TV(I)
  D3 = I
END IF
70 CONTINUE
GOTO 227
C
226 ST1(K, D3) = ST1(K, 4)
227 CALL TIME(TTT)
WRITE(2, *) 'FORECAST TIME : ', TTT
WRITE(6, *) 'FORECAST TIME : ', TTT
WRITE (2, 3350) ST1(K, D3)
WRITE (6, 3350) ST1(K, D3)
STA(K) = ST1(K, D3)
WRITE(3, 430) K, HT(K), ST(K), STA(K)
WRITE (2, 30)
WRITE(6,30)
C 10 CONTINUE
C
WRITE (6, *) ' WOULD YOU LIKE TO PLOT THE HYDROGRAPH? Y/N?
READ (5, 20) ANS
IF ( ANS .EQ. 'N') GOTO 1800
WRITE (6, *) ' NAME OF PLOTFILE?
READ (5, 1600) P
1600 FORMAT (A15)
OPEN (UNIT=7, NAME=P, STATUS='NEW')
WRITE (7, *) '#DATA'
WRITE (7, *) X(1,1)=
WRITE (7, *) (K, ', ', K=1, NT)
WRITE (7, *) Y(1,1)=
WRITE (7, *) (ST(K), ', ', K=1, NT)
WRITE (7, *) X(1,2)=
WRITE (7, *) (K, ', ', K=1, NT)
WRITE (7, *) Y(1,2)=
WRITE (7, *) (STA(K), ', ', K=1, NT)
WRITE (7, *) '#END'
WRITE (6, *) ' DATE OF FLOOD EVENT? E.G. 24-MAR-85'
READ (5, 1700) DAY
WRITE (7, *) 'FLOOD FORECASTING FOR TODD RIVER: ', DAY
1700 FORMAT (A9)
WRITE (7, *) 'TIME (HOURS)'
WRITE (7, *) 'STAGE (METERS)'
1800 WRITE (6, 400)
READ (5, 20) ANS
IF ( ANS .EQ. 'Y') GOTO 110
19 FORMAT ('FLOOD WARNING PROGRAM OF TODD RIVER: ',/,'AT WILLS TERRACE, ALICE SPRINGS, N.T.',//,///,///,///,///,///,///,///,///,///)
20 FORMAT (A1)
21 FORMAT ('FLOOD WARNING PROGRAM OF TODD RIVER: ',/,'AT WILLS TERRACE, ALICE SPRINGS, N.T.',/)
30 FORMAT ('************************************************************')
40 FORMAT (1X, 'COMPUTED PRESENT LEVEL AT WILLS TCE = ',F6.2)
50 FORMAT (1X, 'ACTUAL PRESENT WATER LEVEL AT WILLS TCE = ',F6.2)
C
56 FORMAT (1X, 'XCOEF = ',F5.2)
57 FORMAT (1X, 'K1 = ',F5.2)
58 FORMAT (1X, 'PRESENT WATER LEVEL AT WIGLEY G. = ',F6.2)
59 FORMAT (1X, 'PRESENT WATER LEVEL AT WILLS TCE = ',F6.2)
300 FORMAT (12)
400 FORMAT (' WOULD YOU LIKE TO TRY ANOTHER DATA?'
420 FORMAT (1X, 'COMPUTED PRESENT DISCHARGE= ',F6.2)
430 FORMAT (7X, 12, 9X, F6.2, 12X, F6.2, 16X, F6.2)
1001 FORMAT (' POSSIBLE WATER LEVEL AT: ',/)
1002 FORMAT (1X, 'WIGLEY AT ',A9, ' RANGE =',2X, F6.2, ' m')
1212 FORMAT (1X, F5.2, 6X, F6.2, 6X, F6.2, 6X, F6.2, 6X, F6.2)
3000 FORMAT (1X, 'WATER LEVEL=', F6.2, ' m', 2X, 'DISCHARGE= '
1, F8.2, ' m3/s')
3330 FORMAT (1X, 'INFLOW=', F10.2, ' m3/s', 3X, 'OUTFLOW=', F10.2, '
3340 FORMAT (1X, 'WILLS TCE AT ',A9, ' RANGE =', 2X, F6.2, ' m')
3350 FORMAT(1X, 'PREDICTED WATER LEVEL (WILLS TCE) = ', F6.2, ' m')
END
APPENDIX 2

EXAMPLE OUTPUT OF THE MODEL
BASED ON FLOOD (25-JAN-1984)

1. Stage Records at Wigley Gorge and Wills Tce.
2. MUSK5.OUT
3. SUMMARY.DAT
4. Plot of the model results
STAGE RECORD FOR TODD RIVER, ALICE SPRINGS
START TIME-10THS MINS 968095087
DATE-TIME 25/1/1984-1948.7
ROUTE STAGE(U/S) STAGE(D/S)

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* MODEL START HERE
NOTE THAT GAUGE HEIGHT AT WIGLEY G.
SHOULD BE GREATER THAN 1.0 METRE
EXAMPLE OF COMPUTER PRINTOUT
FILE NAME: MUSK5. OUT
FLOOD WARNING PROGRAM OF TODD RIVER
AT WILLS TERRACE, ALICE SPRINGS, N. T.
DATE OF EXECUTION: 25-JAN-84
TIME: 19:48
XCOEF = 0.10
KI = 1.54

PRESENT WATER LEVEL AT WIGLEY G. = 1.38
HISTORICAL RATE OF RISE AT WIGLEY
STAGE(T) STAGE(T+1) STAGE(T+1) STAGE(T+1) STAGE(T+1)
LOW MEDIUM HIGH RECESSION
1.00 1.20 1.60 3.80 0.90
1.20 1.40 2.58 4.00 1.18
1.40 1.70 3.10 4.10 1.55
1.60 2.00 3.30 4.20 1.75
2.00 2.40 3.70 4.40 2.10
2.40 2.80 4.00 4.60 2.40
2.80 3.20 4.30 4.90 2.65
3.20 3.60 4.60 5.10 3.00
3.60 4.00 4.90 5.30 3.10
4.00 4.40 5.20 5.50 3.30
4.40 4.80 5.50 5.70 3.40
4.80 5.20 5.80 6.00 3.55
5.20 5.60 6.00 6.20 3.70

POSSIBLE WATER LEVEL AT:

PERIOD 1
WIGLEY AT LOWER RANGE = 1.62 m
WATER LEVEL= 1.62 m DISCHARGE= 24.33 m³/s
WILLS TCE AT LOWER RANGE = 1.82 m
WATER LEVEL= 2.81 m DISCHARGE= 112.42 m³/s
WILLS TCE AT MEDIUM RANGE = 2.42 m
WATER LEVEL= 2.42 m DISCHARGE= 112.42 m³/s
WIGLEY AT MEDIUM RANGE = 2.42 m
WATER LEVEL= 2.42 m DISCHARGE= 112.42 m³/s
WIGLEY AT UPPER RANGE = 4.05 m
WATER LEVEL= 4.05 m DISCHARGE= 214.54 m³/s
WILLS TCE AT UPPER RANGE = 4.05 m
WATER LEVEL= 3.82 m DISCHARGE= 255.87 m³/s
WIGLEY AT RECESSION RANGE = 1.35 m
WATER LEVEL= 1.35 m DISCHARGE= 14.05 m³/s
WILLS TCE AT RECESSION RANGE = 1.72 m
COMPUTED PRESENT LEVEL AT WILLS TCE= 3.75
ACTUAL PRESENT WATER LEVEL AT WILLS TCE= 1.82
COMPUTED PRESENT DISCHARGE= 14.05 m³/s

CO= 0.1834570 C1= 0.3467657 C2= 0.4697773

PRESENT WATER LEVEL AT WIGLEY G. = 3.42
PRESENT WATER LEVEL AT WILLS TCE = 1.82
POSSIBLE WATER LEVEL AT:

PERIOD 2
WIGLEY AT LOWER RANGE = 3.82 m
WATER LEVEL= 3.82 m DISCHARGE= 255.87 m³/s
INFLOW= 214.54 m³/s OUTFLOW= 114.32 m³/s
WILLS TCE AT LOWER RANGE = 2.42 m
WIGLEY AT MEDIUM RANGE = 4.36 m
WATER LEVEL = 4.36 m  DISCHARGE = 362.28 m³/s
INFLOW = 362.28 m³/s  OUTFLOW = 133.84 m³/s
WILLS TCE AT MEDIUM RANGE = 2.51 m
WIGLEY AT UPPER RANGE = 4.55 m
WATER LEVEL = 4.55 m  DISCHARGE = 407.90 m³/s
INFLOW = 407.90 m³/s  OUTFLOW = 142.21 m³/s
WILLS TCE AT UPPER RANGE = 2.54 m
WIGLEY AT RECESSION RANGE = 2.84 m
WATER LEVEL = 2.84 m  DISCHARGE = 115.65 m³/s
INFLOW = 115.65 m³/s  OUTFLOW = 88.60 m³/s
WILLS TCE AT RECESSION RANGE = 2.30 m

FORECAST TIME:
PREDICTED WATER LEVEL (WILLS TCE) = 2.42 m

*******************************
PRESENT WATER LEVEL AT WIGLEY G. = 4.54
PRESENT WATER LEVEL AT WILLS TCE = 2.79

POSSIBLE WATER LEVEL AT:

PERIOD = 3
WIGLEY AT LOWER RANGE = 4.67 m
WATER LEVEL = 4.67 m  DISCHARGE = 435.63 m³/s
INFLOW = 435.63 m³/s  OUTFLOW = 324.76 m³/s
WILLS TCE AT LOWER RANGE = 3.02 m
WIGLEY AT MEDIUM RANGE = 4.77 m
WATER LEVEL = 4.77 m  DISCHARGE = 460.64 m³/s
INFLOW = 460.64 m³/s  OUTFLOW = 329.35 m³/s
WILLS TCE AT MEDIUM RANGE = 3.03 m
WIGLEY AT UPPER RANGE = 5.05 m
WATER LEVEL = 5.05 m  DISCHARGE = 536.59 m³/s
INFLOW = 536.59 m³/s  OUTFLOW = 343.28 m³/s
WILLS TCE AT UPPER RANGE = 3.06 m
WIGLEY AT RECESSION RANGE = 3.80 m
WATER LEVEL = 3.80 m  DISCHARGE = 251.44 m³/s
INFLOW = 251.44 m³/s  OUTFLOW = 290.97 m³/s
WILLS TCE AT RECESSION RANGE = 2.95 m

FORECAST TIME:
PREDICTED WATER LEVEL (WILLS TCE) = 3.06 m

*******************************
PRESENT WATER LEVEL AT WIGLEY G. = 5.00
PRESENT WATER LEVEL AT WILLS TCE = 3.10

POSSIBLE WATER LEVEL AT:

PERIOD = 4
WIGLEY AT LOWER RANGE = 5.10 m
WATER LEVEL = 5.10 m  DISCHARGE = 549.23 m³/s
INFLOW = 549.23 m³/s  OUTFLOW = 454.04 m³/s
WILLS TCE AT LOWER RANGE = 3.24 m
WIGLEY AT MEDIUM RANGE = 5.15 m
WATER LEVEL = 5.15 m  DISCHARGE = 563.48 m³/s
INFLOW = 563.48 m³/s  OUTFLOW = 456.66 m³/s
WILLS TCE AT MEDIUM RANGE = 3.25 m
WIGLEY AT UPPER RANGE = 5.20 m
WATER LEVEL = 5.20 m  DISCHARGE = 577.95 m³/s
INFLOW = 577.95 m³/s  OUTFLOW = 459.31 m³/s
WILLS TCE AT UPPER RANGE = 3.25 m
WIGLEY AT RECESSION RANGE = 4.50 m
WATER LEVEL = 4.50 m DISCHARGE = 395.03 m3/s
INFLOW = 395.03 m3/s OUTFLOW = 425.75 m3/s
WILLS TCE AT RECESSION RANGE = 3.20 m
FORECAST TIME:

PREDICTED WATER LEVEL (WILLS TCE) = 3.25 m

PRESENT WATER LEVEL AT WIGLEY Q. = 5.10
PRESENT WATER LEVEL AT WILLS TCE = 3.21
POSSIBLE WATER LEVEL AT:

PERIOD = 5
WIGLEY AT LOWER RANGE = 5.20 m
WATER LEVEL = 5.20 m DISCHARGE = 577.95 m3/s
INFLOW = 577.95 m3/s OUTFLOW = 500.00 m3/s
WILLS TCE AT LOWER RANGE = 3.31 m
WIGLEY AT MEDIUM RANGE = 5.29 m
WATER LEVEL = 5.29 m DISCHARGE = 603.80 m3/s
INFLOW = 603.80 m3/s OUTFLOW = 504.75 m3/s
WILLS TCE AT MEDIUM RANGE = 3.32 m
WIGLEY AT UPPER RANGE = 5.35 m
WATER LEVEL = 5.35 m DISCHARGE = 622.69 m3/s
INFLOW = 622.69 m3/s OUTFLOW = 508.21 m3/s
WILLS TCE AT UPPER RANGE = 3.32 m
WIGLEY AT RECESSION RANGE = 4.63 m
WATER LEVEL = 4.63 m DISCHARGE = 424.65 m3/s
INFLOW = 424.65 m3/s OUTFLOW = 471.98 m3/s
WILLS TCE AT RECESSION RANGE = 3.27 m
FORECAST TIME:

PREDICTED WATER LEVEL (WILLS TCE) = 3.31 m

PRESENT WATER LEVEL AT WIGLEY Q. = 4.56
PRESENT WATER LEVEL AT WILLS TCE = 3.04
POSSIBLE WATER LEVEL AT:

PERIOD = 6
WIGLEY AT LOWER RANGE = 4.68 m
WATER LEVEL = 4.68 m DISCHARGE = 438.09 m3/s
INFLOW = 438.09 m3/s OUTFLOW = 379.43 m3/s
WILLS TCE AT LOWER RANGE = 3.12 m
WIGLEY AT MEDIUM RANGE = 4.78 m
WATER LEVEL = 4.78 m DISCHARGE = 463.18 m3/s
INFLOW = 463.18 m3/s OUTFLOW = 384.04 m3/s
WILLS TCE AT MEDIUM RANGE = 3.13 m
WIGLEY AT UPPER RANGE = 5.07 m
WATER LEVEL = 5.07 m DISCHARGE = 540.78 m3/s
INFLOW = 540.78 m3/s OUTFLOW = 398.27 m3/s
WILLS TCE AT UPPER RANGE = 3.15 m
WIGLEY AT RECESSION RANGE = 3.83 m
WATER LEVEL = 3.83 m DISCHARGE = 257.66 m3/s
INFLOW = 257.66 m3/s OUTFLOW = 346.33 m3/s
WILLS TCE AT RECESSION RANGE = 3.06 m
FORECAST TIME:

PREDICTED WATER LEVEL (WILLS TCE) = 3.06 m

PRESENT WATER LEVEL AT WIGLEY Q. = 3.80
PRESENT WATER LEVEL AT WILLS TCE = 2.83
POSSIBLE WATER LEVEL AT:

PERIOD = 7

WIGLEY AT LOWER RANGE = 4.15 m
WATER LEVEL = 4.18 m DISCHARGE = 325.01 m³/s
INFLOW = 325.01 m³/s OUTFLOW = 259.05 m³/s
WILLS TCE AT LOWER RANGE = 2.88 m
WIGLEY AT MEDIUM RANGE = 4.58 m
WATER LEVEL = 4.58 m DISCHARGE = 413.84 m³/s
INFLOW = 413.84 m³/s OUTFLOW = 275.35 m³/s
WILLS TCE AT MEDIUM RANGE = 2.92 m
WIGLEY AT UPPER RANGE = 4.78 m
WATER LEVEL = 4.78 m DISCHARGE = 463.18 m³/s
INFLOW = 463.18 m³/s OUTFLOW = 275.35 m³/s
WILLS TCE AT UPPER RANGE = 2.94 m
WIGLEY AT RECESSION RANGE = 3.10 m
WATER LEVEL = 3.10 m DISCHARGE = 146.23 m³/s
INFLOW = 146.23 m³/s OUTFLOW = 226.25 m³/s
WILLS TCE AT RECESSION RANGE = 2.80 m

FORECAST TIME:
PREDICTED WATER LEVEL (WILLS TCE) = 2.80 m

PRESENT WATER LEVEL AT WIGLEY Q. = 3.24
PRESENT WATER LEVEL AT WILLS TCE = 2.73

POSSIBLE WATER LEVEL AT:

PERIOD = 8

WIGLEY AT LOWER RANGE = 3.64 m
WATER LEVEL = 3.64 m DISCHARGE = 224.98 m³/s
INFLOW = 224.98 m³/s OUTFLOW = 192.75 m³/s
WILLS TCE AT LOWER RANGE = 2.71 m
WIGLEY AT MEDIUM RANGE = 4.31 m
WATER LEVEL = 4.31 m DISCHARGE = 352.47 m³/s
INFLOW = 352.47 m³/s OUTFLOW = 216.14 m³/s
WILLS TCE AT MEDIUM RANGE = 2.77 m
WIGLEY AT UPPER RANGE = 4.51 m
WATER LEVEL = 4.51 m DISCHARGE = 397.35 m³/s
INFLOW = 397.35 m³/s OUTFLOW = 224.37 m³/s
WILLS TCE AT UPPER RANGE = 2.79 m
WIGLEY AT RECESSION RANGE = 2.69 m
WATER LEVEL = 2.69 m DISCHARGE = 99.04 m³/s
INFLOW = 99.04 m³/s OUTFLOW = 169.64 m³/s
WILLS TCE AT RECESSION RANGE = 2.63 m

FORECAST TIME:
PREDICTED WATER LEVEL (WILLS TCE) = 2.63 m

PRESENT WATER LEVEL AT WIGLEY Q. = 2.73
PRESENT WATER LEVEL AT WILLS TCE = 2.59

POSSIBLE WATER LEVEL AT:

PERIOD = 9

WIGLEY AT LOWER RANGE = 3.20 m
WATER LEVEL = 3.20 m DISCHARGE = 158.62 m³/s
INFLOW = 158.62 m³/s OUTFLOW = 138.54 m³/s
WILLS TCE AT LOWER RANGE = 2.92 m
WIGLEY AT MEDIUM RANGE = 3.95 m
WATER LEVEL = 3.95 m DISCHARGE = 279.22 m³/s
INFLOW = 279.22 m³/s OUTFLOW = 160.56 m³/s
WILLS TCE AT MEDIUM RANGE = 2.60 m
WIGLEY AT UPPER RANGE = 4.44 m
WATER LEVEL = 4.44 m DISCHARGE = 381.56 m³/s
INFLOW = 381.56 m³/s OUTFLOW = 179.44 m³/s
WILLS TCE AT UPPER RANGE = 2.67 m
WIGLEY AT RECESSION RANGE = 2.35 m
WATER LEVEL = 2.35 m DISCHARGE = 68.53 m³/s
INFLOW = 68.53 m³/s OUTFLOW = 122.01 m³/s
WILLS TCE AT RECESSION RANGE = 2.46 m

FORECAST TIME :
PREDICTED WATER LEVEL (WILLS TCE) = 2.45 m

PRESENT WATER LEVEL AT WIGLEY G. = 2.48
PRESENT WATER LEVEL AT WILLS TCE = 2.45
POSSIBLE WATER LEVEL AT:
PERIOD = 10
WIGLEY AT LOWER RANGE = 2.82 m
WATER LEVEL = 2.82 m DISCHARGE = 113.18 m³/s
INFLOW = 113.18 m³/s OUTFLOW = 104.87 m³/s
WILLS TCE AT LOWER RANGE = 2.38 m
WIGLEY AT MEDIUM RANGE = 3.76 m
WATER LEVEL = 3.76 m DISCHARGE = 245.31 m³/s
INFLOW = 245.31 m³/s OUTFLOW = 127.11 m³/s
WILLS TCE AT MEDIUM RANGE = 2.49 m
WIGLEY AT UPPER RANGE = 4.41 m
WATER LEVEL = 4.41 m DISCHARGE = 374.50 m³/s
INFLOW = 374.50 m³/s OUTFLOW = 152.81 m³/s
WILLS TCE AT UPPER RANGE = 2.58 m
WIGLEY AT RECESSION RANGE = 2.16 m
WATER LEVEL = 2.16 m DISCHARGE = 54.42 m³/s
INFLOW = 54.42 m³/s OUTFLOW = 79.62 m³/s
WILLS TCE AT RECESSION RANGE = 2.33 m

FORECAST TIME :
PREDICTED WATER LEVEL (WILLS TCE) = 2.33 m

PRESENT WATER LEVEL AT WIGLEY G. = 2.27
PRESENT WATER LEVEL AT WILLS TCE = 2.30
POSSIBLE WATER LEVEL AT:
PERIOD = 11
WIGLEY AT LOWER RANGE = 2.57 m
WATER LEVEL = 2.57 m DISCHARGE = 87.88 m³/s
INFLOW = 87.88 m³/s OUTFLOW = 79.62 m³/s
WILLS TCE AT LOWER RANGE = 2.25 m
WIGLEY AT MEDIUM RANGE = 3.57 m
WATER LEVEL = 3.57 m DISCHARGE = 213.61 m³/s
INFLOW = 213.61 m³/s OUTFLOW = 102.68 m³/s
WILLS TCE AT MEDIUM RANGE = 2.37 m
WIGLEY AT UPPER RANGE = 4.34 m
WATER LEVEL = 4.34 m DISCHARGE = 357.90 m³/s
INFLOW = 357.90 m³/s OUTFLOW = 129.16 m³/s
WILLS TCE AT UPPER RANGE = 2.49 m
WIGLEY AT RECESSION RANGE = 1.99 m
WATER LEVEL = 1.99 m DISCHARGE = 43.06 m³/s
INFLOW = 43.06 m³/s OUTFLOW = 71.40 m³/s
WILLS TCE AT RECESSION RANGE = 2.20 m
FORECAST TIME:
PREDICTED WATER LEVEL (WILLS TCE) = 2.20 m

PRESENT WATER LEVEL AT WIGLEY G. = 1.91
PRESENT WATER LEVEL AT WILLS TCE = 2.19
POSSIBLE WATER LEVEL AT:

PERIOD = 12
WIGLEY AT LOWER RANGE = 2.21 m
WATER LEVEL = 2.21 m DISCHARGE = 57.99 m³/s
INFLOW = 57.99 m³/s OUTFLOW = 57.17 m³/s
WILLS TCE AT LOWER RANGE = 2.09 m
WIGLEY AT MEDIUM RANGE = 3.25 m
WATER LEVEL = 3.25 m DISCHARGE = 166.76 m³/s
INFLOW = 166.76 m³/s OUTFLOW = 77.12 m³/s
WILLS TCE AT MEDIUM RANGE = 2.23 m
WIGLEY AT UPPER RANGE = 4.18 m
WATER LEVEL = 4.18 m DISCHARGE = 324.50 m³/s
INFLOW = 324.50 m³/s OUTFLOW = 166.76 m³/s
WILLS TCE AT LOWER RANGE = 1.92 m
WIGLEY AT MEDIUM RANGE = 3.13 m
WATER LEVEL = 3.13 m DISCHARGE = 149.43 m³/s
INFLOW = 149.43 m³/s OUTFLOW = 77.12 m³/s
WILLS TCE AT MEDIUM RANGE = 2.10 m
WIGLEY AT UPPER RANGE = 4.11 m
WATER LEVEL = 4.11 m DISCHARGE = 87.49 m³/s
INFLOW = 87.49 m³/s OUTFLOW = 324.50 m³/s
WILLS TCE AT UPPER RANGE = 2.29 m
WIGLEY AT RECESSION RANGE = 1.57 m
WATER LEVEL = 1.57 m DISCHARGE = 22.25 m³/s
INFLOW = 22.25 m³/s OUTFLOW = 324.50 m³/s
WILLS TCE AT RECESSION RANGE = 1.00 m

FORECAST TIME:
PREDICTED WATER LEVEL (WILLS TCE) = 2.05 m

PRESENT WATER LEVEL AT WIGLEY G. = 1.95
PRESENT WATER LEVEL AT WILLS TCE = 2.00
POSSIBLE WATER LEVEL AT:

PERIOD = 13
WIGLEY AT LOWER RANGE = 1.95 m
WATER LEVEL = 1.95 m DISCHARGE = 40.89 m³/s
INFLOW = 40.89 m³/s OUTFLOW = 37.88 m³/s
WILLS TCE AT LOWER RANGE = 1.92 m
WIGLEY AT MEDIUM RANGE = 3.13 m
WATER LEVEL = 3.13 m DISCHARGE = 149.43 m³/s
INFLOW = 149.43 m³/s OUTFLOW = 77.12 m³/s
WILLS TCE AT MEDIUM RANGE = 2.10 m
WIGLEY AT UPPER RANGE = 4.11 m
WATER LEVEL = 4.11 m DISCHARGE = 87.49 m³/s
INFLOW = 87.49 m³/s OUTFLOW = 324.50 m³/s
WILLS TCE AT UPPER RANGE = 2.29 m
WIGLEY AT RECESSION RANGE = 1.57 m
WATER LEVEL = 1.57 m DISCHARGE = 22.25 m³/s
INFLOW = 22.25 m³/s OUTFLOW = 34.46 m³/s
WILLS TCE AT RECESSION RANGE = 1.00 m

FORECAST TIME:
PREDICTED WATER LEVEL (WILLS TCE) = 1.88 m

PRESENT WATER LEVEL AT WIGLEY G. = 1.50
PRESENT WATER LEVEL AT WILLS TCE = 1.97
POSSIBLE WATER LEVEL AT:

PERIOD = 14
WIGLEY AT LOWER RANGE = 1.77 m
WATER LEVEL = 1.77 m DISCHARGE = 31.35 m³/s
INFLOW = 31.35 m³/s  OUTFLOW = 27.66 m³/s
WILLS TCE AT LOWER RANGE = 1.84 m
WIGLEY AT MEDIUM RANGE = 2.97 m
WATER LEVEL = 2.97 m  DISCHARGE = 130.25 m³/s
INFLOW = 130.25 m³/s  OUTFLOW = 45.81 m³/s
WILLS TCE AT MEDIUM RANGE = 2.00 m
WIGLEY AT UPPER RANGE = 4.07 m
WATER LEVEL = 4.07 m  DISCHARGE = 303.81 m³/s
INFLOW = 303.81 m³/s  OUTFLOW = 77.65 m³/s
WILLS TCE AT UPPER RANGE = 2.00
WIGLEY AT RECESSION RANGE = 1.46 m
WATER LEVEL = 1.46 m  DISCHARGE = 17.76 m³/s
INFLOW = 17.76 m³/s  OUTFLOW = 25.17 m³/s
WILLS TCE AT RECESSION RANGE = 1.82 m
FORECAST TIME:
PREDICTED WATER LEVEL (WILLS TCE) = 1.92 m

Forearm Water Level at Wills TCE = 1.78
Possible Water Level at:

Period = 15
WIGLEY AT LOWER RANGE = 1.62 m
WATER LEVEL = 1.62 m  DISCHARGE = 24.35 m³/s
INFLOW = 24.35 m³/s  OUTFLOW = 18.89 m³/s
WILLS TCE AT LOWER RANGE = 1.77 m
WIGLEY AT MEDIUM RANGE = 2.81 m
WATER LEVEL = 2.81 m  DISCHARGE = 112.53 m³/s
INFLOW = 112.53 m³/s  OUTFLOW = 35.07 m³/s
WILLS TCE AT MEDIUM RANGE = 1.88 m
WIGLEY AT UPPER RANGE = 4.05 m
WATER LEVEL = 4.05 m  DISCHARGE = 297.91 m³/s
INFLOW = 297.91 m³/s  OUTFLOW = 69.09 m³/s
WILLS TCE AT UPPER RANGE = 2.18 m
WIGLEY AT RECESSION RANGE = 1.35 m
WATER LEVEL = 1.35 m  DISCHARGE = 14.07 m³/s
INFLOW = 14.07 m³/s  OUTFLOW = 17.01 m³/s
WILLS TCE AT RECESSION RANGE = 1.76 m
FORECAST TIME:
PREDICTED WATER LEVEL (WILLS TCE) = 1.76 m

Forearm Water Level at Wills TCE = 1.76
Possible Water Level at:

Period = 16
WIGLEY AT LOWER RANGE = 1.51 m
WATER LEVEL = 1.51 m  DISCHARGE = 19.79 m³/s
INFLOW = 19.79 m³/s  OUTFLOW = 14.01 m³/s
WILLS TCE AT LOWER RANGE = 1.72 m
WIGLEY AT MEDIUM RANGE = 2.70 m
WATER LEVEL = 2.70 m  DISCHARGE = 100.25 m³/s
INFLOW = 100.25 m³/s  OUTFLOW = 28.77 m³/s
WILLS TCE AT MEDIUM RANGE = 1.95 m
WIGLEY AT UPPER RANGE = 4.02 m
WATER LEVEL = 4.02 m  DISCHARGE = 293.53 m³/s
INFLOW = 293.53 m³/s  OUTFLOW = 64.23 m³/s
WILLS TCE AT UPPER RANGE = 2.15 m
WIGLEY AT RECESSION RANGE = 1.26 m
WATER LEVEL = 1.26 m DISCHARGE = 11.63 m$^3$/s
INFLOW = 11.63 m$^3$/s OUTFLOW = 12.52 m$^3$/s
WILLS TCE AT RECESSION RANGE = 1.70 m
FORECAST TIME:
PREDICTED WATER LEVEL (WILLS TCE) = 1.70 m
*************************************************************
PREDICTED WATER LEVEL (WILLS TCE) = 1.64 m
PRESENT WATER LEVEL AT WIGLEY G. = 1.21
PRESENT WATER LEVEL AT WILLS TCE = 1.64
POSSIBLE WATER LEVEL AT:
PERIOD = 17
WIGLEY AT LOWER RANGE = 1.41 m
WATER LEVEL = 1.41 m DISCHARGE = 16.20 m$^3$/s
INFLOW = 16.20 m$^3$/s OUTFLOW = 10.48 m$^3$/s
WILLS TCE AT LOWER RANGE = 1.67 m
WIGLEY AT MEDIUM RANGE = 2.59 m
WATER LEVEL = 2.59 m DISCHARGE = 90.05 m$^3$/s
INFLOW = 90.05 m$^3$/s OUTFLOW = 24.03 m$^3$/s
WILLS TCE AT MEDIUM RANGE = 1.82 m
WIGLEY AT UPPER RANGE = 4.00 m
WATER LEVEL = 4.00 m DISCHARGE = 289.68 m$^3$/s
INFLOW = 289.68 m$^3$/s OUTFLOW = 60.65 m$^3$/s
WILLS TCE AT UPPER RANGE = 2.12 m
WIGLEY AT RECESSION RANGE = 1.19 m
WATER LEVEL = 1.19 m DISCHARGE = 9.70 m$^3$/s
INFLOW = 9.70 m$^3$/s OUTFLOW = 9.29 m$^3$/s
WILLS TCE AT RECESSION RANGE = 1.66 m
FORECAST TIME:
PREDICTED WATER LEVEL (WILLS TCE) = 1.66 m
*************************************************************
PREDICTED WATER LEVEL (WILLS TCE) = 1.59 m
PRESENT WATER LEVEL AT WIGLEY G. = 1.15
PRESENT WATER LEVEL AT WILLS TCE = 1.59
POSSIBLE WATER LEVEL AT:
PERIOD = 18
WIGLEY AT LOWER RANGE = 1.35 m
WATER LEVEL = 1.35 m DISCHARGE = 14.18 m$^3$/s
INFLOW = 14.18 m$^3$/s OUTFLOW = 8.09 m$^3$/s
WILLS TCE AT LOWER RANGE = 1.63 m
WIGLEY AT MEDIUM RANGE = 2.33 m
WATER LEVEL = 2.33 m DISCHARGE = 67.53 m$^3$/s
INFLOW = 67.53 m$^3$/s OUTFLOW = 17.98 m$^3$/s
WILLS TCE AT MEDIUM RANGE = 1.76 m
WIGLEY AT UPPER RANGE = 3.95 m
WATER LEVEL = 3.95 m DISCHARGE = 279.69 m$^3$/s
INFLOW = 279.69 m$^3$/s OUTFLOW = 56.80 m$^3$/s
WILLS TCE AT UPPER RANGE = 2.09 m
WIGLEY AT RECESSION RANGE = 1.11 m
WATER LEVEL = 1.11 m DISCHARGE = 5.91 m$^3$/s
INFLOW = 5.91 m$^3$/s OUTFLOW = 6.57 m$^3$/s
WILLS TCE AT RECESSION RANGE = 1.60 m
FORECAST TIME:
PREDICTED WATER LEVEL (WILLS TCE) = 1.60 m
*************************************************************
PREDICTED WATER LEVEL (WILLS TCE) = 1.10 m
PRESENT WATER LEVEL AT WIGLEY G. = 1.10
PRESENT WATER LEVEL AT WILLS TCE = 1.55
POSSIBLE WATER LEVEL AT:

PERIOD = 19
WIGLEY AT LOWER RANGE = 1.30 m
WATER LEVEL= 1.30 m DISCHARGE= 12.67 m3/s
INFLOW= 12.67 m3/s OUTFLOW= 6.48 m3/s
WILLS TCE AT LOWER RANGE = 1.60 m
WIGLEY AT MEDIUM RANGE = 2.09 m
WATER LEVEL= 2.09 m DISCHARGE= 49.65 m3/s
INFLOW= 49.65 m3/s OUTFLOW= 13.26 m3/s
WILLS TCE AT MEDIUM RANGE = 1.71 m
WIGLEY AT UPPER RANGE = 3.90 m
WATER LEVEL= 3.90 m DISCHARGE= 270.38 m3/s
INFLOW= 270.38 m3/s OUTFLOW= 53.75 m3/s
WILLS TCE AT UPPER RANGE = 2.07 m
WIGLEY AT RECESSION RANGE = 0.98 m
WATER LEVEL= 0.98 m DISCHARGE= 2.58 m3/s
INFLOW= 2.58 m3/s OUTFLOW= 2.58 m3/s
WILLS TCE AT RECESSION RANGE = 1.52 m
FORECAST TIME :
PREDICTED WATER LEVEL(WILLS TCE)= 1.52 m

******************************
PRESENT WATER LEVEL AT WIGLEY G. = 1.06
PRESENT WATER LEVEL AT WILLS TCE = 1.53
POSSIBLE WATER LEVEL AT:

PERIOD = 20
WIGLEY AT LOWER RANGE = 1.26 m
WATER LEVEL= 1.26 m DISCHARGE= 11.54 m3/s
INFLOW= 11.54 m3/s OUTFLOW= 5.56 m3/s
WILLS TCE AT LOWER RANGE = 1.57 m
WIGLEY AT MEDIUM RANGE = 1.89 m
WATER LEVEL= 1.89 m DISCHARGE= 37.67 m3/s
INFLOW= 37.67 m3/s OUTFLOW= 10.36 m3/s
WILLS TCE AT MEDIUM RANGE = 1.67 m
WIGLEY AT UPPER RANGE = 3.86 m
WATER LEVEL= 3.86 m DISCHARGE= 263.06 m3/s
INFLOW= 263.06 m3/s OUTFLOW= 51.71 m3/s
WILLS TCE AT UPPER RANGE = 2.05 m
WIGLEY AT RECESSION RANGE = 0.98 m
WATER LEVEL= 0.98 m DISCHARGE= 2.58 m3/s
INFLOW= 2.58 m3/s OUTFLOW= 3.92 m3/s
WILLS TCE AT RECESSION RANGE = 1.52 m
FORECAST TIME :
PREDICTED WATER LEVEL(WILLS TCE)= 1.52 m

******************************
PRESENT WATER LEVEL AT WIGLEY G. = 1.03
PRESENT WATER LEVEL AT WILLS TCE = 1.49
POSSIBLE WATER LEVEL AT:

PERIOD = 21
WIGLEY AT LOWER RANGE = 1.23 m
WATER LEVEL= 1.23 m DISCHARGE= 10.74 m3/s
INFLOW= 10.74 m3/s OUTFLOW= 4.68 m3/s
WILLS TCE AT LOWER RANGE = 1.55 m
WIGLEY AT MEDIUM RANGE = 1.75 m
WATER LEVEL= 1.75 m DISCHARGE= 29.96 m3/s

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**Forecast Time:**

**Predicted Water Level (WIGLEY):** 1.49 m

**Predicted Water Level (WILLS TCE):** 1.47 m

**Present Water Level at WIGLEY:** 0.98 m

**Possible Water Level:**

- Period = 22
- WIGLEY Lower Range = 1.20 m
- Water Level = 1.20 m
- Discharge = 9.96 m3/s
- INFLOW = 9.96 m3/s
- OUTFLOW = 4.05 m3/s

- Period = 23
- WIGLEY Lower Range = 1.18 m
- Water Level = 1.18 m
- Discharge = 9.47 m3/s
- INFLOW = 9.47 m3/s
- OUTFLOW = 3.60 m3/s
WILLS TCE AT RECESSION RANGE = 1.45 m
FORECAST TIME:
PREDICTED WATER LEVEL (WILLS TCE) = 1.45 m
****************************************************
PRESENT WATER LEVEL AT WIGLEY G. = 0.96
PRESENT WATER LEVEL AT WILLS TCE = 1.43
POSSIBLE WATER LEVEL AT:
PERIOD = 24
WIGLEY AT LOWER RANGE = 1.16 m
WATER LEVEL = 1.16 m DISCHARGE = 7.95 m3/s
INFLOW = 7.95 m3/s OUTFLOW = 0.49 m3/s
WILLS TCE AT LOWER RANGE = 1.49 m
WIGLEY AT MEDIUM RANGE = 1.40 m
WATER LEVEL = 1.40 m DISCHARGE = 15.92 m3/s
INFLOW = 15.92 m3/s OUTFLOW = 4.49 m3/s
WILLS TCE AT MEDIUM RANGE = 1.54 m
WIGLEY AT UPPER RANGE = 3.76 m
WATER LEVEL = 3.76 m DISCHARGE = 245.31 m3/s
INFLOW = 245.31 m3/s OUTFLOW = 146.57 m3/s
WILLS TCE AT UPPER RANGE = 2.01 m
WIGLEY AT RECESSION RANGE = 0.84 m
WATER LEVEL = 0.84 m DISCHARGE = 0.97 m3/s
INFLOW = 0.87 m3/s OUTFLOW = 1.72 m3/s
WILLS TCE AT RECESSION RANGE = 1.43 m
FORECAST TIME:
PREDICTED WATER LEVEL (WILLS TCE) = 1.43 m
****************************************************
PRESENT WATER LEVEL AT WIGLEY G. = 0.94
PRESENT WATER LEVEL AT WILLS TCE = 1.41
POSSIBLE WATER LEVEL AT:
PERIOD = 25
WIGLEY AT LOWER RANGE = 1.14 m
WATER LEVEL = 1.14 m DISCHARGE = 7.07 m3/s
INFLOW = 7.07 m3/s OUTFLOW = 2.61 m3/s
WILLS TCE AT LOWER RANGE = 1.47 m
WIGLEY AT MEDIUM RANGE = 1.31 m
WATER LEVEL = 1.31 m DISCHARGE = 12.85 m3/s
INFLOW = 12.85 m3/s OUTFLOW = 3.67 m3/s
WILLS TCE AT MEDIUM RANGE = 1.51 m
WIGLEY AT UPPER RANGE = 3.74 m
WATER LEVEL = 3.74 m DISCHARGE = 241.84 m3/s
INFLOW = 241.84 m3/s OUTFLOW = 45.68 m3/s
WILLS TCE AT UPPER RANGE = 2.00 m
WIGLEY AT RECESSION RANGE = 0.82 m
WATER LEVEL = 0.82 m DISCHARGE = 0.68 m3/s
INFLOW = 0.68 m3/s OUTFLOW = 1.43 m3/s
WILLS TCE AT RECESSION RANGE = 1.43 m
FORECAST TIME:
PREDICTED WATER LEVEL (WILLS TCE) = 1.41 m
****************************************************
PRESENT WATER LEVEL AT WIGLEY G. = 0.92
PRESENT WATER LEVEL AT WILLS TCE = 1.40
POSSIBLE WATER LEVEL AT:
PERIOD = 26
WIGLEY AT(lower RANGE = 1.12 m
WATER LEVEL = 1.12 m DISCHARGE = 6.27 m³/s
INFLOW = 6.27 m³/s OUTFLOW = 2.30 m³/s
WILLS TCE AT LOWER RANGE = 1.46 m
WIGLEY AT MEDIUM RANGE = 1.21 m
WATER LEVEL = 1.21 m DISCHARGE = 10.17 m³/s
INFLOW = 10.17 m³/s OUTFLOW = 3.02 m³/s
WILLS TCE AT MEDIUM RANGE = 1.49 m
WIGLEY AT UPPER RANGE = 3.72 m
WATER LEVEL = 3.72 m DISCHARGE = 238.41 m³/s
INFLOW = 238.41 m³/s OUTFLOW = 44.89 m³/s
WILLS TCE AT UPPER RANGE = 1.99 m
WIGLEY AT RECESSION RANGE = 0.79 m
WATER LEVEL = 0.79 m DISCHARGE = 0.52 m³/s
INFLOW = 0.52 m³/s OUTFLOW = 1.25 m³/s
WILLS TCE AT RECESSION RANGE = 1.40 m
FORECAST TIME:
PREDICTED WATER LEVEL (WILLS TCE) = 1.40 m

PRESENT WATER LEVEL AT WIGLEY G. = 0.90
PRESENT WATER LEVEL AT WILLS TCE = 1.39
POSSIBLE WATER LEVEL AT:
PERIOD = 27
WIGLEY AT LOWER RANGE = 1.10 m
WATER LEVEL = 1.10 m DISCHARGE = 5.55 m³/s
INFLOW = 5.55 m³/s OUTFLOW = 2.03 m³/s
WILLS TCE AT LOWER RANGE = 1.45 m
WIGLEY AT MEDIUM RANGE = 1.11 m
WATER LEVEL = 1.11 m DISCHARGE = 5.91 m³/s
INFLOW = 5.91 m³/s OUTFLOW = 2.10 m³/s
WILLS TCE AT MEDIUM RANGE = 1.45 m
WIGLEY AT UPPER RANGE = 3.70 m
WATER LEVEL = 3.70 m DISCHARGE = 235.01 m³/s
INFLOW = 235.01 m³/s OUTFLOW = 44.13 m³/s
WILLS TCE AT UPPER RANGE = 1.98 m
WIGLEY AT RECESSION RANGE = 0.76 m
WATER LEVEL = 0.76 m DISCHARGE = 0.40 m³/s
INFLOW = 0.40 m³/s OUTFLOW = 1.09 m³/s
WILLS TCE AT RECESSION RANGE = 1.39 m
FORECAST TIME:
PREDICTED WATER LEVEL (WILLS TCE) = 1.39 m

PRESENT WATER LEVEL AT WIGLEY G. = 0.89
PRESENT WATER LEVEL AT WILLS TCE = 1.38
POSSIBLE WATER LEVEL AT:
PERIOD = 28
WIGLEY AT LOWER RANGE = 1.09 m
WATER LEVEL = 1.09 m DISCHARGE = 5.22 m³/s
INFLOW = 5.22 m³/s OUTFLOW = 1.88 m³/s
WILLS TCE AT LOWER RANGE = 1.44 m
WIGLEY AT MEDIUM RANGE = 1.06 m
WATER LEVEL = 1.06 m DISCHARGE = 4.34 m³/s
INFLOW = 4.34 m³/s OUTFLOW = 1.72 m³/s
WILLS TCE AT MEDIUM RANGE = 1.43 m
WIGLEY AT UPPER RANGE = 3.69 m
WATER LEVEL = 3.69 m DISCHARGE = 233.32 m³/s

FORECAST TIME:
PREDICTED WATER LEVEL (WILLS TCE) = 1.39 m

PRESENT WATER LEVEL AT WIGLEY G. = 0.89
PRESENT WATER LEVEL AT WILLS TCE = 1.38
POSSIBLE WATER LEVEL AT:
PERIOD = 28
WIGLEY AT LOWER RANGE = 1.09 m
WATER LEVEL = 1.09 m DISCHARGE = 5.22 m³/s
INFLOW = 5.22 m³/s OUTFLOW = 1.88 m³/s
WILLS TCE AT LOWER RANGE = 1.44 m
WIGLEY AT MEDIUM RANGE = 1.06 m
WATER LEVEL = 1.06 m DISCHARGE = 4.34 m³/s
INFLOW = 4.34 m³/s OUTFLOW = 1.72 m³/s
WILLS TCE AT MEDIUM RANGE = 1.43 m
WIGLEY AT UPPER RANGE = 3.69 m
WATER LEVEL = 3.69 m DISCHARGE = 233.32 m³/s
INFLOW = 233.32 m³/s
OUTFLOW = 43.73 m³/s

WILLS TCE AT UPPER RANGE = 1.98 m
WIGLEY AT RECESSION RANGE = 0.75 m
WATER LEVEL = 0.79 m DISCHARGE = 0.37 m³/s
INFLOW = 0.37 m³/s OUTFLOW = 0.99 m³/s
WILLS TCE AT RECESSION RANGE = 1.38 m

FORECAST TIME:
PREDICTED WATER LEVEL (WILLS TCE) = 1.38 m

PRESENT WATER LEVEL AT WIGLEY G. = 0.87
PRESENT WATER LEVEL AT WILLS TCE = 1.37
POSSIBLE WATER LEVEL AT:
PERIOD = 29
WIGLEY AT LOWER RANGE = 1.07 m
WATER LEVEL = 1.07 m DISCHARGE = 4.60 m³/s
INFLOW = 4.60 m³/s OUTFLOW = 1.65 m³/s
WILLS TCE AT LOWER RANGE = 1.43 m
WIGLEY AT MEDIUM RANGE = 0.96 m
WATER LEVEL = 0.96 m DISCHARGE = 2.22 m³/s
INFLOW = 2.22 m³/s OUTFLOW = 1.21 m³/s
WILLS TCE AT MEDIUM RANGE = 1.40 m
WIGLEY AT UPPER RANGE = 3.67 m
WATER LEVEL = 3.67 m DISCHARGE = 229.96 m³/s
INFLOW = 229.96 m³/s OUTFLOW = 42.99 m³/s
WILLS TCE AT UPPER RANGE = 1.97 m
WIGLEY AT RECESSION RANGE = 0.72 m
WATER LEVEL = 0.72 m DISCHARGE = 0.32 m³/s
INFLOW = 0.32 m³/s OUTFLOW = 0.36 m³/s
WILLS TCE AT RECESSION RANGE = 1.36 m

FORECAST TIME:
PREDICTED WATER LEVEL (WILLS TCE) = 1.36 m

PRESENT WATER LEVEL AT WIGLEY G. = 0.86
PRESENT WATER LEVEL AT WILLS TCE = 1.36
POSSIBLE WATER LEVEL AT:
PERIOD = 30
WIGLEY AT LOWER RANGE = 1.06 m
WATER LEVEL = 1.06 m DISCHARGE = 4.32 m³/s
INFLOW = 4.32 m³/s OUTFLOW = 1.52 m³/s
WILLS TCE AT LOWER RANGE = 1.42 m
WIGLEY AT MEDIUM RANGE = 0.91 m
WATER LEVEL = 0.91 m DISCHARGE = 1.54 m³/s
INFLOW = 1.54 m³/s OUTFLOW = 1.01 m³/s
WILLS TCE AT MEDIUM RANGE = 1.38 m
WIGLEY AT UPPER RANGE = 3.66 m
WATER LEVEL = 3.66 m DISCHARGE = 228.29 m³/s
INFLOW = 228.29 m³/s OUTFLOW = 42.61 m³/s
WILLS TCE AT UPPER RANGE = 1.97 m
WIGLEY AT RECESSION RANGE = 0.70 m
WATER LEVEL = 0.70 m DISCHARGE = 0.29 m³/s
INFLOW = 0.29 m³/s OUTFLOW = 0.79 m³/s
WILLS TCE AT RECESSION RANGE = 1.36 m

FORECAST TIME:
PREDICTED WATER LEVEL (WILLS TCE) = 1.36 m

*******************************************
PRESENT WATER LEVEL AT WIGLEY G. = 0.84
PRESENT WATER LEVEL AT WILLS TCE = 1.35
POSSIBLE WATER LEVEL AT:
  PERIOD = 31
  WIGLEY AT LOWER RANGE = 1.04 m
  WATER LEVEL = 1.04 m DISCHARGE = 3.79 m³/s
  INFLOW = 3.79 m³/s OUTFLOW = 1.33 m³/s
  WILLS TCE AT LOWER RANGE = 1.41 m
  WIGLEY AT MEDIUM RANGE = 0.82 m
  WATER LEVEL = 0.82 m DISCHARGE = 0.68 m³/s
  INFLOW = 0.68 m³/s OUTFLOW = 0.76 m³/s
  WILLS TCE AT MEDIUM RANGE = 1.35 m
  WIGLEY AT UPPER RANGE = 3.64 m
  WATER LEVEL = 3.64 m DISCHARGE = 224.98 m³/s
  INFLOW = 224.98 m³/s OUTFLOW = 41.91 m³/s
  WILLS TCE AT UPPER RANGE = 1.96 m
  WIGLEY AT RECESSION RANGE = 0.68 m
  WATER LEVEL = 0.68 m DISCHARGE = 0.25 m³/s
  INFLOW = 0.25 m³/s OUTFLOW = 0.68 m³/s
  WILLS TCE AT RECESSION RANGE = 1.34 m
FORECAST TIME:
PREPARED WATER LEVEL (WILLS TCE) = 1.34 m

**************************************************
### SUMMARY OF FORECASTING MODEL
**FOR FLOOD EVENT 25 JAN 1984, START-TIME 20:48 HRS**

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FLOOD FORECASTING MODEL FOR TODD RIVER (25-JAN-84)
APPENDIX 3

STAGE-DISCHARGE RELATIONSHIPS OF TODD RIVER AT WIGLEY GORGE AND WILLS TCE.
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STAGE-DISCHARGE RELATIONSHIPS FOR WIGLEY GORGE AND WILLS TCE

Wigley Gorge

Wills Tce

STAGE (METRES)

DISCHARGE (CU.M/SEC)

0 100 200 300 400 500 600 700 800 900 1000 1100

0 1 2 3 4 5 6 7
TABLE OF CONTENTS

1.0 INTRODUCTION
2.0 PROGRAM ABSTRACT
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4.0 PROGRAM EXECUTION
5.0 PROGRAM OUTPUT

1: HYDRO8
1.0 INTRODUCTION

This manual outlines the procedure developed for forecasting flood level in the Todd River at Wills Terrace. The catchment of Todd River at Alice Springs and the location of the automatic telemetry system network are shown in Figure 2.0 (main text).

Data requirements, execution of the program and output from the program are the principle components of this manual.

This manual is produced with the following objective: given the required input data, the user should be able to execute the program and provide level forecasts on an hourly basis for Wills Terrace for any flood event.

Full details of the methodology are contained in the main text of this report.
2.0 PROGRAM ABSTRACT

PROGRAM NAME : MUSK5
TITLE : FLOOD FORECASTING - ALICE SPRINGS
MAINTENANCE : SURFACE WATER SECTION; ASSESSMENT BRANCH, WATER RESOURCES DIVISION
ACCESSIBILITY : VAX-11/750 - FORTRAN
CAPABILITY AND LIMITATIONS : MUSK5 is used to provide a prediction on an hourly basis of the flood level at the Wills Terrace Gauging Station, given the present water level at Wigley Gorge and at Wills Terrace. The program estimates the range of possible water levels and given the previous rate of rise predicts the most likely flood level. It reviews this prediction after each time step (one hour). Flood levels must be greater than 1 metre (gauge height) at Wigley Gorge.

INPUT : Input consist of the following:
- Muskingum Routing Parameters
- Previous - hour water levels at both stations
- Present water levels at both stations

OUTPUT : Output is in two forms:
- Interactive presentation of possible flood level at Wigley Gorge at different ranges and predicted water level at Wills Terrace based on Wigley Gorge data.
- Summary listing of recorded levels at Wigley Gorge and Wills Terrace including the forecasting level at Wills Terrace.

LANGUAGE : FORTRAN
AUTHOR : V Sananikone

1:HYDRO8
DOCUMENTATION : Manual Available
KEYWORDS : Flood Forecasting, Flood routing
PREPARED BY : V Sananikone
CONTACT : V. Sananikone, Surface Water Section, Tel. 897373.

1:HYDRO8
3.0 INPUT REQUIREMENTS

Before executing the program, you require the present and previous hour water levels for the Wills Terrace and Wigley Gorge gauge stations. The flood routing interval is one hour. This routing interval can be changed to any time interval as long as you are consistent with the routing time period used from the start until you stop the program. Adopted parameters X and K for Todd River between Wigley Gorge and Wills Terrace are 0.1 and 1.54 respectively. These parameters should be checked from time to time as required. The program is being updated to check the parameters X and K (based on the flood being analysed) and modify them if requested.

The rainfall from the Telemetry system will be incorporated into the system in the future. At present the rainfall is not included in the model due to a lack of rainfall data at the telemetric installation site. When rainfall data becomes available and incorporated into the system, the forecast time extended depending on the time-lag of the rainfall-runoff response.

The stage-discharge curves for both stations are included in the model, these rating curves should be checked and updated as required. The stage-discharge curves are given in Appendix 3.
4.0 PROGRAM EXECUTION

To execute the program: type in after $

RUN MUSK5

It will respond with:

FLOOD WARNING PROGRAM OF TODD RIVER AT WILLS TERRACE, ALICE SPRINGS, N.T.

NOTE: THE PREDICTED WATER LEVEL IS ONE HOUR ADVANCE

DATE: 26 NOVEMBER 1985
TIME: 09:18:21
INPUT NO. OF ROUTING PERIOD. INPUT 10 OR MORE.

1. A one hour time interval and 24 routing periods is equivalent to 24 hours operating time. If you choose a 30 minute time interval and 24 routing periods, analysis will be over a 12 hour operating time. To prevent premature termination of the program, 10 or more routing periods are suggested. It must be an integer value. After typing in the value press return.

2. TIME INTERVAL BETWEEN ROUTING PERIOD? Suggested one hour, press return.

1.0

3. X = 0.1 & K = 1.54 WOULD YOU LIKE TO CHANGE THESE VALUES? Answer yes or no, if answer is no it will accept the value X = 0.1 and K = 1.54. If the answer is yes, new values of X and K can be entered.

4. WOULD YOU LIKE TO PRINT SUMMARY OUTPUT? Answer yes or no, then press return.

5. ENTER PREVIOUS WATER LEVEL AT WIGLEY IN METRES.

2.0

Input water level at Wigley Gorge for time (t-1) in metres (gauge height). Press return.

6. ENTER PRESENT WATER LEVEL AT WIGLEY GORGE.

2.5

Input water level at Wigley Gorge for time (t) in metres (gauge height). Press return.

7. ENTER PRESENT WATER LEVEL AT WILLS TERRACE.

3.0

Input water level at Wills Terrace for time (t) in metres (gauge height). Press return.

1:HYDRO8
8. The predicted water level at Wills Terrace is calculated and printed on the screen, including different ranges of water levels at Wills Terrace (upper, medium, lower and recession). Steps 6 to 7 are then repeated.
5.0 PROGRAM OUTPUT

The computer output file is known as "MUSK5.OUT". To obtain an output file type after $ sign "PRINT MUSK5.OUT".

The summary output can be obtained by typing the following "PRINT SUMMARY.DAT". The outputs of MUSK5.OUT and SUMMARY.DAT are included as Appendix 2.

An example of the tested model for flood of 25 Jan 1984 is plotted and presented in Appendix 2.