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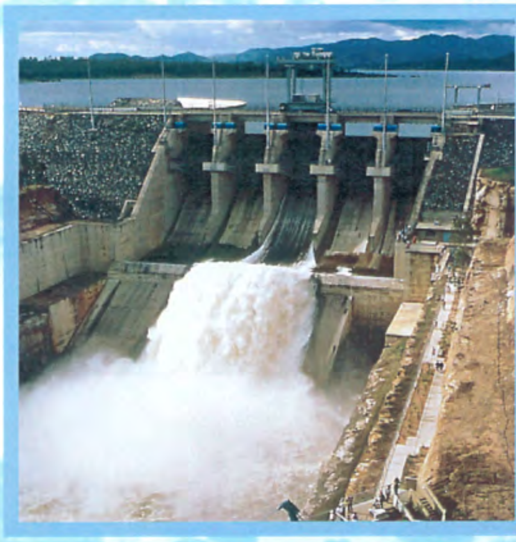
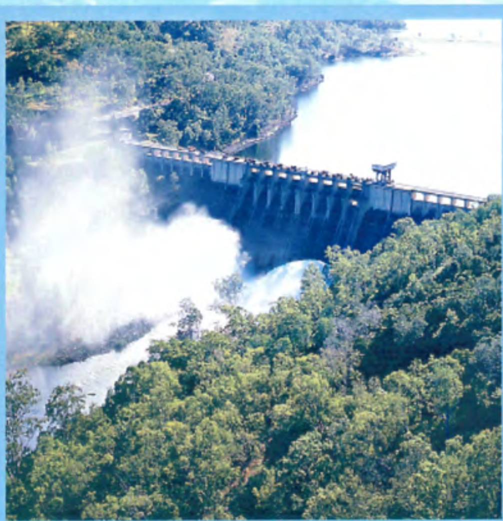


BRISBANE RIVER AND PINE RIVER FLOOD STUDY:

Report No. 8b



BRISBANE RIVER FLOOD HYDROLOGY REPORT VOLUME II

Probable Maximum Precipitation Estimates

South East Queensland WATER BOARD

NATURAL RESOURCES Queensland

BRISBANE RIVER FLOOD HYDROLOGY REPORT

REPORT ON DESIGN FLOOD ESTIMATION

VOLUME II

APPENDIX A

PROBABLE MAXIMUM PRECIPITATION STUDIES

PROBABLE MAXIMUM PRECIPITATION STUDIES

FOR THE BRISBANE RIVER CATCHMENT,

AND SUB-CATCHMENTS OF

THE BRISBANE RIVER SYSTEM

Bureau of Meteorology

Queensland Regional Office

April 1991

PMP STUDIES FOR THE BRISBANE RIVER CATCHMENT, AND SUB-CATCHMENTS OF THE BRISBANE RIVER SYSTEM

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PMP STUDIES FOR THE BRISBANE RIVER CATCHMENT, AND SUB-CATCHMENTS OF THE BRISBANE RIVER SYSTEM

1. INTRODUCTION

The Water Resources Commission, Brisbane, have requested the Bureau of Meteorology to provide estimates of probable maximum precipitation (PMP) for the catchments:

1. Somerset Dam - 1335 sq kms,
2. Upper Brisbane River - 4715 sq kms,
3. Residual between junction of Stanley River and Wivenhoe Dam - 970 sq kms,
4. Wivenhoe Dam - 7020 sq kms,
5. Brisbane River - 13560 sq kms,
6. Lockyer Creek - 2990 sq kms,
7. Bremer River - 2020 sq kms,
8. Residual between Wivenhoe Dam and the mouth - 1530 sq kms.

Estimates of PMP for durations from 6 hours to 7 days have been provided. A location map is shown at Figure 1.

2. METHODS FOR ESTIMATING PMP

The size and location of the subject catchments determines the range of methods of PMP estimation that can be utilised in this study. The Bulletin 51 Method can be applied to small areas (less than 1000 sq kms) and for durations up to 6 hours. A generalised method has been developed for durations from 6 to 96 hours for areas that may be affected by tropical storms. The Gordon Method extends the duration of the tropical storm methodology out to 7 days.

The Bulletin 51 Method is applicable to catchment No 3 only, as the others all exceed 1000 sq kms in surface area. The remaining two methods are applicable to each of the subject catchments.

3. BULLETIN 51 METHOD OF PMP ESTIMATION for durations up to 6 hours

Procedures used in this method have been published by the Bureau of Meteorology (1985) and involve the use of enveloping depth-duration-area curves. Sets of curves have been provided for two categories of topography - "smooth" and "rough", the latter being defined as areas in which elevation changes of 50 metres or more within 400 metres are common. By this standard the subject catchment is partially rough, however, "if a catchment includes a smooth or flat area of land within 20km of generally rough terrain the whole catchment should be classified as rough." (The Institution of Engineers, 1987). "Rugged terrain, as well as triggering more convective storms than flat terrain, tends to hold them in place, thus increasing rainfall over a given area." The subject catchment is overshadowed by the rugged terrain of the D'Aguilar Range, accordingly, the topography must be classified as rough.

Values applicable to the subject catchment were extracted from the curves for durations up to

6 hours. As the curves are standardised to the moisture content of a saturated atmospheric column with a surface dewpoint of 28°C and a surface pressure of 1000 hPa, adjustments were made for the highest expected moisture content over the subject catchment.

The extreme 24-hour persisting dewpoint temperature for the catchment was extracted from maps prepared by the Bureau of Meteorology, and the values derived from the depth-duration-area curves adjusted by the ratio of precipitable water at the extreme 24-hour persisting dewpoint temperature to the precipitable water at the standardised dewpoint of 28°C.

The extreme 24-hour persisting dewpoint temperature for the catchment is 25.1°C, which allows for a Moisture Adjustment Factor of 0.78.

No adjustment for elevation is considered necessary as the mean elevation of the catchment is less than 1500 metres.

The derived PMP values for durations up to 6 hours are listed in Table 3. These estimates of PMP have been based on a number of theoretical assumptions concerning the storm mechanisms. The depth-duration-area values used are those derived from major short duration, limited area rainfall events both in the United States and in Australia. In view of the assumptions made the PMP values given should be regarded as approximate upper limits until an adequate Australian data base exists.

4. GENERALISED TROPICAL STORM METHOD (GTSM) OF PMP ESTIMATION for durations of 6 to 96 hours for the ECTZ

4.1 Method

A generalised method (the Generalised Tropical Storm Method or GTSM) for estimating Probable Maximum Precipitation (PMP) has been developed for those parts of Australia affected by storms of tropical origin (Kennedy (1982) and (Kennedy and Hart, 1984)). These parts of Australia have been sub-divided into two regions, namely the "East Coast Tropical Zone" (ECTZ, formerly called the "Queensland Coastal Zone") being the area of influence of a quasistationary easterly trough adjacent to the Queensland coast which appears to enhance heavy rainfall events, and the "Remaining Tropical Zone" (RTZ). In these areas of Australia the meteorological situation most likely to produce the PMP is considered to be either the proximity of a tropical cyclone or the slow movement of a low pressure system of tropical origin, sometimes interacting with a monsoonal trough.

For the two regions of Australia where the GTSM is applicable, the 6-, 12-, 24-, 48- and 72-hour (plus the 96-hour for the ECTZ only) rainfall values associated with heavy rainfall events have been extracted. These values were adjusted to remove the differences in observed storm depths caused by differing moisture content, distance from the coast, height of any intervening barrier and topography. The highest adjusted values of each storm were then enveloped to obtain depth-duration-area (DDA) curves. These curves provide the base PMP values for durations up to 96 hours for a catchment which is flat, is at the coast and has no significant barrier between it and its moisture source. The enveloping curves are standardised to a moisture index (the precipitable water) corresponding to a dew point temperature of 28°C.

Base values obtained from the DDA curves must therefore be adjusted for the conditions applying to the subject catchments which lie within the ECTZ. Each of the adjustments is discussed in the following sections.

4.2 Adjustment for Moisture Content of the Air

The moisture content adjustment allows for the difference between the standard extreme dew point of 28° C and the extreme persisting dew point temperature for the area in question. The extreme 24 hour persisting dew point temperature is obtained from maps prepared by the Bureau of Meteorology. The moisture adjustment factor is the ratio of the precipitable water value at this dew point temperature to that at the standard dew point temperature of 28° C.

The extreme 24 hour persisting dewpoint temperature varies across the subject catchments from 24.9 to 25.3° C. The moisture adjustment factors therefore range from 0.77 to 0.79.

4.3 Adjustment for Distance from the Coast

This adjustment is made to allow for a decrease in moisture content of the air with distance from the moisture source, and is based on reduction factors obtained from a comparison of Australian rainfall data with a study of 60 United States storms (United States Weather Bureau, 1966). All plausible inflow directions are examined and from these the critical inflow path was determined by calculating the distance and barrier adjustments for each direction and choosing the direction which gives the highest combined adjustment factor. The mean distance of the catchment from the coast is measured along the critical inflow path.

The mean distance of the subject catchments from the coast, along their respective critical inflow paths varies from 35km to 90km which gives distance adjustment factors ranging from 0.99 to 1.00.

4.4 Adjustment for Height of Barrier

A significant topographical barrier between the moisture source and the catchment may also reduce the moisture content of the air which reaches the catchment. The adjustment factor is calculated as the ratio of the mixing ratios (specific humidities) of the air at the surface (assumed to be 1000 hPa) and the air at the height of the barrier.

The direction of low level inflow which would produce the heaviest rains from consideration of both synoptic influences and the height of intervening barrier is along the critical inflow path.

The critical inflow direction varies between East south east and East north east and the effective barrier heights vary between 100m and 550m. The resulting adjustment factors correspondingly vary between 0.94 and 0.99.

4.5 Adjustment for Topography

The recommended method of adjusting for the effect of topography on a broad scale is that given by the United States Weather Bureau (1965, 1966, 1969)and reproduced by WMO (1973 and 1986). Average percentage changes can be applied to whole areas of the catchment.

Application of this method to each of the subject catchments give adjustments ranging from -2% to +1%, accordingly the topographical adjustment factor varies between 0.98 and 1.01.

4.6 Summary of Catchment Adjustments

The details of the adjustments, at paragraphs 4.2 to 4.5, for each catchment are provided at Table A.

4.7 The 6 hour to 96 Hour Derived PMP Values

The products of the adjustment factors derived for each catchment above has been applied to the base PMP values obtained from the DDA curves and these derived PMP values are listed in Tables 1 to 8 inclusive.

5. GORDON METHOD OF PMP ESTIMATION
For durations of 5 to 7 days for the ECTZ

5.1 Introduction

This method was devised by Barry Gordon of the Qld Regional Office for the report:
"Probable Maximum Precipitation Study, Brisbane River
- Somerset Dam - Wivenhoe Dam Catchments, Queensland",
B. of M., Qld R.O., September 1983.

It was based on a method used in the U.S. Hydrometeorological Report No. 46, "Probable Maximum Precipitation, Mekong River Basin", (1970).

It has since been used in several reports by both Qld and NSW Regional Offices.

5.2 Situation 1

In this situation it is proposed that the extreme rainfall event affecting an area would result from two distinct storms with a short period of little or no rainfall between the major storm events. It is further proposed that one of the two storms would be the extreme [PMP] storm event. Two possibilities were considered.

(a) Two 3-day storms separated by one day of no significant rainfall; and

(b) Two 2-day storms separated by three days of little or no rainfall.

To arrive at the best estimate using this method, it is necessary to consider how soon before or after an extreme storm a second significant storm occur and how much rain could the smaller storm produce. Little data are available in Australia on the occurrence of two major storms within a 7 day period. However, in some past overseas studies (eg U.S. Weather Bureau 1970), values of the lesser storm up to 70 per cent of the major storm have been assumed, based on a limited study of storms. Additionally, a minimum period of 3 to 4 days between storms was chosen. Of the two possibilities under consideration, (a) was discarded as it was not considered meteorologically feasible and so (b) was selected to derive a 7 day PMP estimate.

The temporal pattern associated with the second storm is assumed to be the same as that for the 48 hour PMP for the relevant zone.

For the ECTZ:
From the 48 hour PMP temporal pattern the proportion of rain falling in the first day is 52%.

For the RTZ:
According to the 48 hour temporal pattern the proportion of rain that will occur on the first day is 70%.

ECTZ	RTZ
	4dPMP = 2dPMP + 2d nil rain
5dPMP = 2dPMP + 3d nil rain	5dPMP = 2dPMP + 3d nil rain
6dPMP = 2dPMP + 3d nil rain	6dPMP = 2dPMP + 3d nil rain
+ [0.52 * 0.70] * 2dPMP	+ [0.70 * 0.70} * 2dPMP
= 1.36 * 2dPMP	= 1.49 * 2dPMP
7dPMP = 2dPMP + 3d nil rain	7dPMP = 2dPMP + 3d nil rain
+ 0.70 * 2dPMP	+ 0.70 * 2dPMP
= 1.70 * 2dPMP	= 1.70 * 2dPMP

In the above table please read 4dPMP as 4-day PMP, etc.

5.3 **Situation 2**

In this method it is proposed that the 7-day extreme rainfall event would result from 7 days of general rain with the 4-day PMP storm occurring within the period. To determine the remaining 3-day "general" rainfall, the storms associated with the highest 24 hour point rainfalls to have occurred in Queensland were selected for preliminary examination. For the most significant of these storms, the highest 7- day rainfall totals were extracted. From these totals the highest 4-day totals were taken and the remaining 3-day rainfalls expressed as ratios of the 4-day rainfalls.

For the ECTZ:
Using this procedure a representative ratio of 0.08 was selected. This ratio can be applied to the 4-day PMP rainfall to derive the 3 day "general" rainfall. The two rainfall totals were then summed to give the 7-day PMP estimate. The general rain is distributed over the three days in the following ratios: 0.45, 0.33 and 0.22.

For the RTZ:
The 7-day PMP is comprised of 3-day PMP and 4 days of general rain. The ratio of the general rain to the 3-day PMP is 0.25 and this is distributed in the following proportions: 0.64, 0.16, 0.12 & 0.08.

ETCZ	RTZ
	4dPMP = 3dPMP + [0.64 * 0.25] * 3dPMP = 1.16 * 3dPMP
5dPMP = 4dPMP + [0.45 * 0.08] * 4dPMP = 1.04 * 4dPMP	5dPMP = 3dPMP + [0.80 * 0.25] * 3dPMP = 1.20 * 3dPMP
6dPMP = 4dPMP + [0.78 * 0.08] * 4dPMP = 1.0624 * 4dPMP	6dPMP = 3dPMP + [0.92 * 0.25] * 3dPMP = 1.24 * 3dPMP
7dPMP = 4dPMP + 0.08 * 4dPMP = 1.08 * 4dPMP	7dPMP = 3dPMP + 0.25 * 3dPMP = 1.25 * 3dPMP

5.4 The 5 to 7 day Derived PMP Values

Recall that the subject catchments lie within the "East Coast Tropical Zone" accordingly the ECTZ relationships above have been utilised to provide the 5 to 7 day PMP values which are listed at Tables 1, 2 and 3.

6. TEMPORAL PATTERNS

Generalised temporal patterns have been developed for all durations and are shown as Figures 2 to 6.

The temporal pattern at Figure 2 is applicable for all durations up to and including 6 hours.

Two patterns are provided for the five day storm and three for the six day storms. For their respective durations, the patterns are considered to be equally likely and the most critical should be selected for use.

Three patterns are provided at Figure 6 for the seven day storm. The "stepped" curve ie the one which includes three days of nil rainfall is the temporal pattern associated with the synoptic situation which would produce the PMP event over the catchment, ie as described in Section 5 Situation 1. For the sake of completeness two temporal patterns associated with the synoptic situation described in Section 5 Situation 2 are also shown.

7. SPATIAL DISTRIBUTION DIAGRAMS

Instructions for the use of the spatial distribution diagram for the Bulletin 51 method, the spatial distribution diagram for short duration PMP together with a worked example for the Pykes Creek Catchment have been provided, at Appendix 1, for the clients information and guidance.

Similar instructions and diagrams are provided at Appendix 2 for the Generalised Tropical Storm Method. These diagrams are suitable for application to the Gordon Method of PMP estimation and distribution.

8. RAINFALL CONCURRENT WITH GTSM PMP ESTIMATES

There is no definitive method for deriving concurrent rainfall when the PMP storm occurs over an adjacent catchment. Sensitivity testing of several methods is recommended.

With the GTSM, four methods have been widely used. These are:

1) the GTSM elliptical distribution is expanded to cover the combined catchment and a scaling used to maintain the PMP depth over the required catchment.

2) the major recorded storms in the area adjacent to the main catchment are used.

3) the areally adjusted 1:100 year IFD depth and spatial distribution is used over the adjacent area.

4) PMP is calculated for the main catchment and the combined catchment and the difference is distributed as concurrent rainfall.

Instructions for their use are attached at Appendix 3.

The joint probabilities associated with these methods vary considerably. They range from method 4 with the lowest joint probability to methods 2 and 3 which have a higher joint probability.

Sensitivity testing combined with a subjective understanding of the relative joint probabilities are needed to select the most appropriate method.

Since the Gordon Method extends the GTSM out to 7 days it is appropriate that the four methods suggested above for calculating concurrent rainfall be applied to PMP Estimates for durations out to 7 days.

Catchment No	1	2	3	4	5	6	7	8
Catchment Area (sq kms)	1335	4715	970	7020	13560	2990	2020	1530
Extreme Persisting Dewpoint Temperatures (°C)	25.3	25.0	25.1	25.1	25.0	24.9	24.9	25.1
Moisture Adjustment Factor	0.79	0.77	0.78	0.78	0.77	0.77	0.77	0.78
Effective Barrier Height (m)	200	550	550	550	400	500	300	100
Barrier Name (see legend below)	a,b	a,c,d	a	a,c,d	a,e	a,f	e,g	a,h
Barrier Adjustment Factor	0.98	0.94	0.94	0.94	0.95	0.94	0.97	0.99
Critical Inflow Direction	ESE	ESE	ESE	ESE	E	ENE	ENE	E
Mean Distance from Coast (km)	40	90	50	80	80	90	70	35
Distance Adjustment Factor	1.00	0.99	1.00	0.99	0.99	0.99	0.99	1.00
Adjustment for Topography (%)	0	+1	-2	+1	+1	+1	+1	0
Topographical Adjustment Factor	1.00	1.01	0.98	1.01	1.01	1.01	1.01	1.00

a) D'Aguilar Range
b) Glasshouse Mountains
c) Conondale Range
d) Summer and Borumba Mountains
e) Darlington Range
f) Marburg and Little Liverpool Ranges
g) Flinders Peak and Mt Goodman
h) Mt Cotton

TABLE A SUMMARY OF CATCHMENT ADJUSTMENTS FOR GTSM

TABLE 1

PMP VALUES (mm) for the SOMERSET DAM CATCHMENT
(1335 sq kms)

Request No 1

Duration	Derived Values (rounded to the nearest 10mm)					PMP Estimate
	Bulletin 51	GTSM	"Best Fit" Transition	Gordon Methods Situation 1	Situation 2	
6 hours	na	390	na	na	na	390
12 hours	na	670	na	na	na	670
24 hours	na	980	na	na	na	980
2 days	na	1420	na	na	na	1420
3 days	na	1770	na	na	na	1770
4 days	na	2090	na	na	na	2090
5 days	na	na	na	1420	2170	2170
6 days	na	na	na	1940	2220	2220
7 days	na	na	na	2410	2260	2410

Notes 1. na denotes that this method is not applicable for these durations.

2. The rainfall data sets from which the GTSM was derived is much more extensive for 24 hours than for either 6 or 12 hours duration, accordingly greater confidence can be assigned to the base PMP values for 24 hours duration than for either of the 6 and 12 hour durations.

3. The two rainfall depth-duration series, as derived from the Bulletin 51 and GTSM methods, are frequently discontinuous between 6 hours and 24 hours. When this discontinuity occurs a "best fit" curve is applied to remove the point of inflection and provide a smoothed transition between the two series. An interpolated value for 12 hours is then available from the fitted transition curve.

4. The higher derived (or interpolated) value, for each duration, is recommended as the PMP Estimate for that duration.

TABLE 2

PMP VALUES (mm) for the UPPER BRISBANE RIVER CATCHMENT
(4715 sq kms)

Request No 2

Duration	Derived Values (rounded to the nearest 10mm)					PMP Estimate
	Bulletin 51	GTSM	"Best Fit" Transition	Gordon Methods Situation 1	Situation 2	
6 hours	na	270	na	na	na	270
12 hours	na	490	na	na	na	490
24 hours	na	720	na	na	na	720
2 days	na	980	na	na	na	980
3 days	na	1200	na	na	na	1200
4 days	na	1390	na	na	na	1390
5 days	na	na	na	980	1440	1440
6 days	na	na	na	1340	1480	1480
7 days	na	na	na	1670	1500	1670

Notes 1. na denotes that this method is not applicable for these durations.

2. The rainfall data sets from which the GTSM was derived is much more extensive for 24 hours than for either 6 or 12 hours duration, accordingly greater confidence can be assigned to the base PMP values for 24 hours duration than for either of the 6 and 12 hour durations.

3. The two rainfall depth-duration series, as derived from the Bulletin 51 and GTSM methods, are frequently discontinuous between 6 hours and 24 hours. When this discontinuity occurs a "best fit" curve is applied to remove the point of inflection and provide a smoothed transition between the two series. An interpolated value for 12 hours is then available from the fitted transition curve.

4. The higher derived (or interpolated) value, for each duration, is recommended as the PMP Estimate for that duration.

TABLE 3

PMP VALUES (mm) for the RESIDUAL AREA TO WIVENHOE DAM
(970 sq kms)

Request No 3

Duration	Derived Values (rounded to the nearest 10mm)					PMP Estimate
	Bulletin 51	GTSM	"Best Fit" Transition	Gordon Methods Situation 1	Gordon Methods Situation 2	
3 hours	360	na	na	na	na	360
6 hours	460	390	na	na	na	460
12 hours	na	660	na	na	na	660
24 hours	na	940	na	na	na	940
2 days	na	1390	na	na	na	1390
3 days	na	1740	na	na	na	1740
4 days	na	2060	na	na	na	2060
5 days	na	na	na	1390	2130	2130
6 days	na	na	na	1900	2190	2190
7 days	na	na	na	2360	2220	2360

Notes 1. na denotes that this method is not applicable for these durations.

2. The rainfall data sets from which the GTSM was derived is much more extensive for 24 hours than for either 6 or 12 hours duration, accordingly greater confidence can be assigned to the base PMP values for 24 hours duration than for either of the 6 and 12 hour durations.

3. The two rainfall depth-duration series, as derived from the Bulletin 51 and GTSM methods, are frequently discontinuous between 6 hours and 24 hours. When this discontinuity occurs a "best fit" curve is applied to remove the point of inflection and provide a smoothed transition between the two series. An interpolated value for 12 hours is then available from the fitted transition curve.

4. The higher derived (or interpolated) value, for each duration, is recommended as the PMP Estimate for that duration.

TABLE 4

PMP VALUES (mm) for the WIVENHOE DAM CATCHMENT
(7020 sq kms)

Request No 4

Duration	Derived Values (rounded to the nearest 10mm)					PMP Estimate
	Bulletin 51	GTSM	"Best Fit" Transition	Gordon Methods Situation 1	Situation 2	
6 hours	na	240	na	na	na	240
12 hours	na	450	na	na	na	450
24 hours	na	670	na	na	na	670
2 days	na	870	na	na	na	870
3 days	na	1080	na	na	na	1080
4 days	na	1250	na	na	na	1250
5 days	na	na	na	870	1300	1300
6 days	na	na	na	1190	1330	1330
7 days	na	na	na	1480	1350	1480

Notes 1. na denotes that this method is not applicable for these durations.

2. The rainfall data sets from which the GTSM was derived is much more extensive for 24 hours than for either 6 or 12 hours duration, accordingly greater confidence can be assigned to the base PMP values for 24 hours duration than for either of the 6 and 12 hour durations.

3. The two rainfall depth-duration series, as derived from the Bulletin 51 and GTSM methods, are frequently discontinuous between 6 hours and 24 hours. When this discontinuity occurs a "best fit" curve is applied to remove the point of inflection and provide a smoothed transition between the two series. An interpolated value for 12 hours is then available from the fitted transition curve.

4. The higher derived (or interpolated) value, for each duration, is recommended as the PMP Estimate for that duration.

TABLE 5

PMP VALUES (mm) for the BRISBANE RIVER CATCHMENT
(13560 sq kms)

Request No 5

Duration	Derived Values (rounded to the nearest 10mm)					PMP Estimate
	Bulletin 51	GTSM	"Best Fit" Transition	Gordon Methods Situation 1	Gordon Methods Situation 2	
6 hours	na	200	na	na	na	200
12 hours	na	370	na	na	na	370
24 hours	na	530	na	na	na	530
2 days	na	680	na	na	na	680
3 days	na	830	na	na	na	830
4 days	na	1010	na	na	na	1010
5 days	na	na	na	680	1050	1050
6 days	na	na	na	930	1070	1070
7 days	na	na	na	1160	1090	1160

Notes 1. na denotes that this method is not applicable for these durations.

2. The rainfall data sets from which the GTSM was derived is much more extensive for 24 hours than for either 6 or 12 hours duration, accordingly greater confidence can be assigned to the base PMP values for 24 hours duration than for either of the 6 and 12 hour durations.

3. The two rainfall depth-duration series, as derived from the Bulletin 51 and GTSM methods, are frequently discontinuous between 6 hours and 24 hours. When this discontinuity occurs a "best fit" curve is applied to remove the point of inflection and provide a smoothed transition between the two series. An interpolated value for 12 hours is then available from the fitted transition curve.

4. The higher derived (or interpolated) value, for each duration, is recommended as the PMP Estimate for that duration.

TABLE 6

PMP VALUES (mm) for the LOCKYER CREEK CATCHMENT
(2990 sq kms)

Request No 6

Duration	Derived Values (rounded to the nearest 10mm)					PMP Estimate
	Bulletin 51	GTSM	"Best Fit" Transition	Gordon Methods Situation 1	Situation 2	
6 hours	na	300	na	na	na	300
12 hours	na	540	na	na	na	540
24 hours	na	800	na	na	na	800
2 days	na	1110	na	na	na	1110
3 days	na	1380	na	na	na	1380
4 days	na	1590	na	na	na	1590
5 days	na	na	na	1110	1650	1650
6 days	na	na	na	1510	1690	1690
7 days	na	na	na	1890	1720	1890

Notes 1. na denotes that this method is not applicable for these durations.

2. The rainfall data sets from which the GTSM was derived is much more extensive for 24 hours than for either 6 or 12 hours duration, accordingly greater confidence can be assigned to the base PMP values for 24 hours duration than for either of the 6 and 12 hour durations.

3. The two rainfall depth-duration series, as derived from the Bulletin 51 and GTSM methods, are frequently discontinuous between 6 hours and 24 hours. When this discontinuity occurs a "best fit" curve is applied to remove the point of inflection and provide a smoothed transition between the two series. An interpolated value for 12 hours is then available from the fitted transition curve.

4. The higher derived (or interpolated) value, for each duration, is recommended as the PMP Estimate for that duration.

TABLE 7

PMP VALUES (mm) for the BREMER RIVER CATCHMENT
(2020 sq kms)

Request No 7

Duration	Derived Values (rounded to the nearest 10mm)					PMP Estimate
	Bulletin 51	GTSM	"Best Fit" Transition	Gordon Methods Situation 1	Gordon Methods Situation 2	
6 hours	na	340	na	na	na	340
12 hours	na	610	na	na	na	610
24 hours	na	880	na	na	na	880
2 days	na	1260	na	na	na	1260
3 days	na	1580	na	na	na	1580
4 days	na	1830	na	na	na	1830
5 days	na	na	na	1260	1900	1900
6 days	na	na	na	1720	1940	1940
7 days	na	na	na	2140	1980	2140

Notes 1. na denotes that this method is not applicable for these durations.

2. The rainfall data sets from which the GTSM was derived is much more extensive for 24 hours than for either 6 or 12 hours duration, accordingly greater confidence can be assigned to the base PMP values for 24 hours duration than for either of the 6 and 12 hour durations.

3. The two rainfall depth-duration series, as derived from the Bulletin 51 and GTSM methods, are frequently discontinuous between 6 hours and 24 hours. When this discontinuity occurs a "best fit" curve is applied to remove the point of inflection and provide a smoothed transition between the two series. An interpolated value for 12 hours is then available from the fitted transition curve.

4. The higher derived (or interpolated) value, for each duration, is recommended as the PMP Estimate for that duration.

TABLE 8

PMP VALUES (mm) for the RESIDUAL AREA DOWNSTREAM FROM WIVENHOE DAM
(1530 sq kms)

Request No 8

Duration	Derived Values (rounded to the nearest 10mm)					PMP Estimate
	Bulletin 51	GTSM	"Best Fit" Transition	Gordon Methods Situation 1	Gordon Methods Situation 2	
6 hours	na	390	na	na	na	390
12 hours	na	660	na	na	na	660
24 hours	na	950	na	na	na	950
2 days	na	1380	na	na	na	1380
3 days	na	1730	na	na	na	1730
4 days	na	2010	na	na	na	2010
5 days	na	na	na	1380	2080	2080
6 days	na	na	na	1880	2140	2140
7 days	na	na	na	2350	2170	2350

Notes 1. na denotes that this method is not applicable for these durations.

2. The rainfall data sets from which the GTSM was derived is much more extensive for 24 hours than for either 6 or 12 hours duration, accordingly greater confidence can be assigned to the base PMP values for 24 hours duration than for either of the 6 and 12 hour durations.

3. The two rainfall depth-duration series, as derived from the Bulletin 51 and GTSM methods, are frequently discontinuous between 6 hours and 24 hours. When this discontinuity occurs a "best fit" curve is applied to remove the point of inflection and provide a smoothed transition between the two series. An interpolated value for 12 hours is then available from the fitted transition curve.

4. The higher derived (or interpolated) value, for each duration, is recommended as the PMP Estimate for that duration.

7. **REFERENCES**

BUREAU OF METEOROLOGY	1985	"The Estimation of Probable Maximum Precipitation in Australia for Short Durations and Small Areas." Bulletin 51.
INSTITUTION OF ENGINEERS, (AUSTRALIA) 1987	1987	"Australian Rainfall and Runoff. A guide to Flood Estimation."
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UNITED STATES WEATHER BUREAU	1965	"Probable Maximum and Precipitation over the Tennessee River Basin above Chattanooga" Hydrometeorological Report No 41
UNITED STATES WEATHER BUREAU	1966	"Probable Maximum Precipitation, North-west States". Hydrometeorological Report No 43.
UNITED STATES WEATHER BUREAU	1969	"Probable Maximum and TVA Precipitation for Tennessee River Basins up to 3000 sq. miles in Area and Durations to 72 Hours." Hydrometeorological Report No 45.
UNITED STATES WEATHER BUREAU	1970	"Probable Maximum Precipitation Mekong River Basin." Hydrometeorological Report No 46.

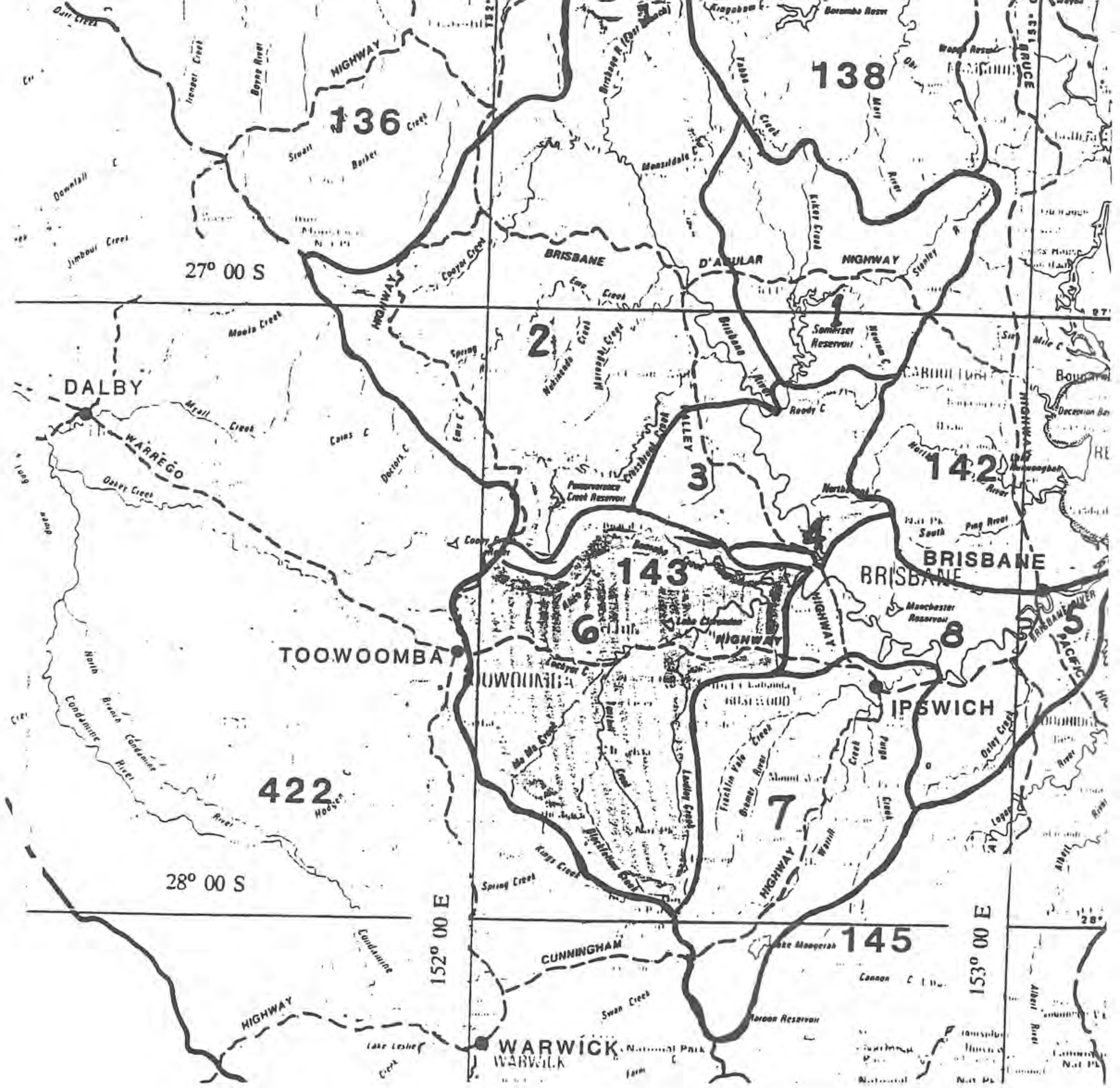


Figure 1 : CATCHMENT LOCATIONS

1.	Somerset Dam	5.	Brisbane River
2.	Upper Brisbane	6.	Lockyer Creek
3.	Residual Area above Wivenhoe	7.	Bremer River
4.	Wivenhoe Dam	8.	Residual Area below Wivenhoe

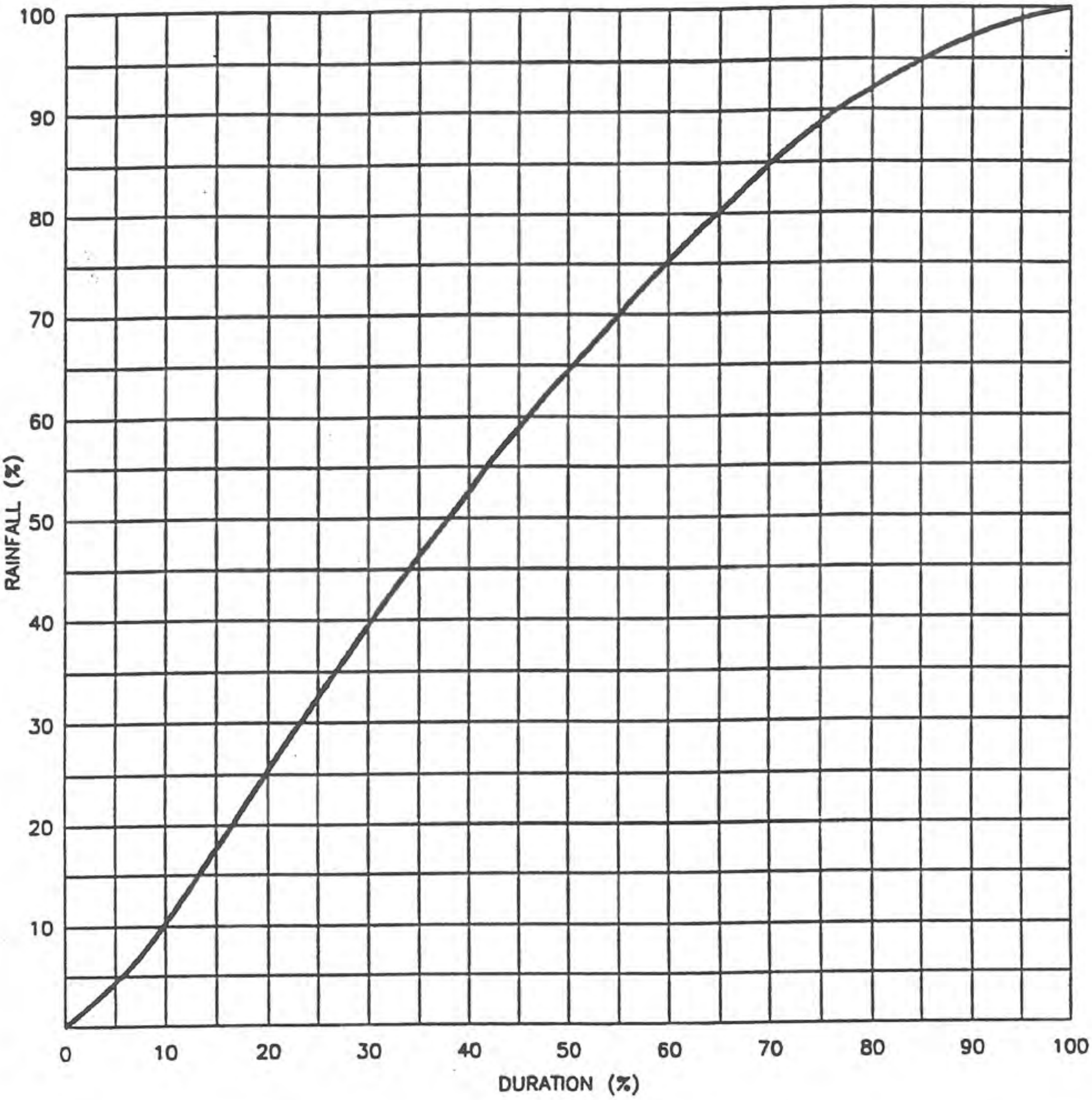


Figure 2: Design Temporal Pattern of short duration PMP

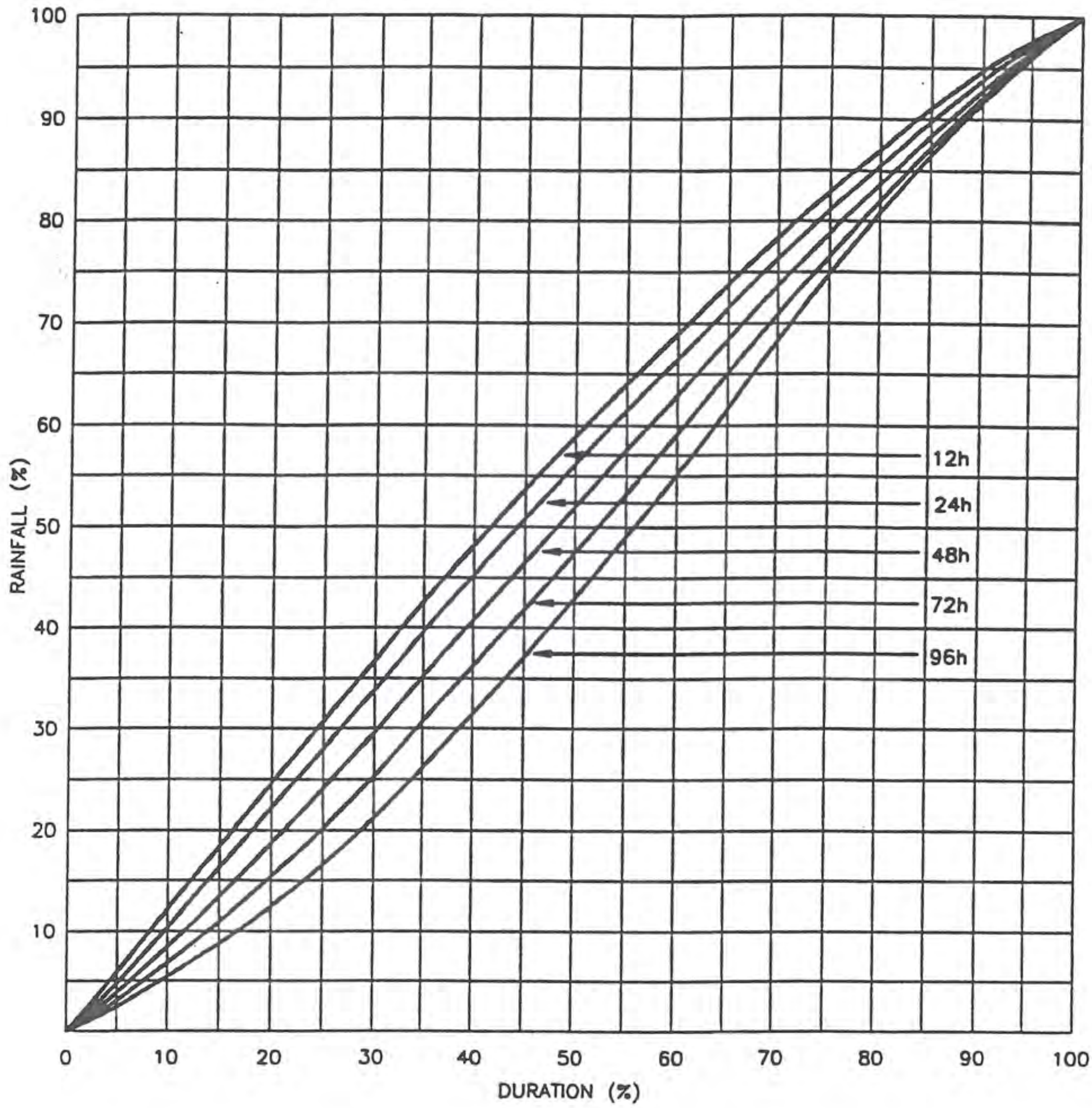


Figure 3 : Design Temporal Patterns of GTSM PMP for the "East Coast Tropical Zone" for durations of 12, 24, 48, 72 and 96 hours

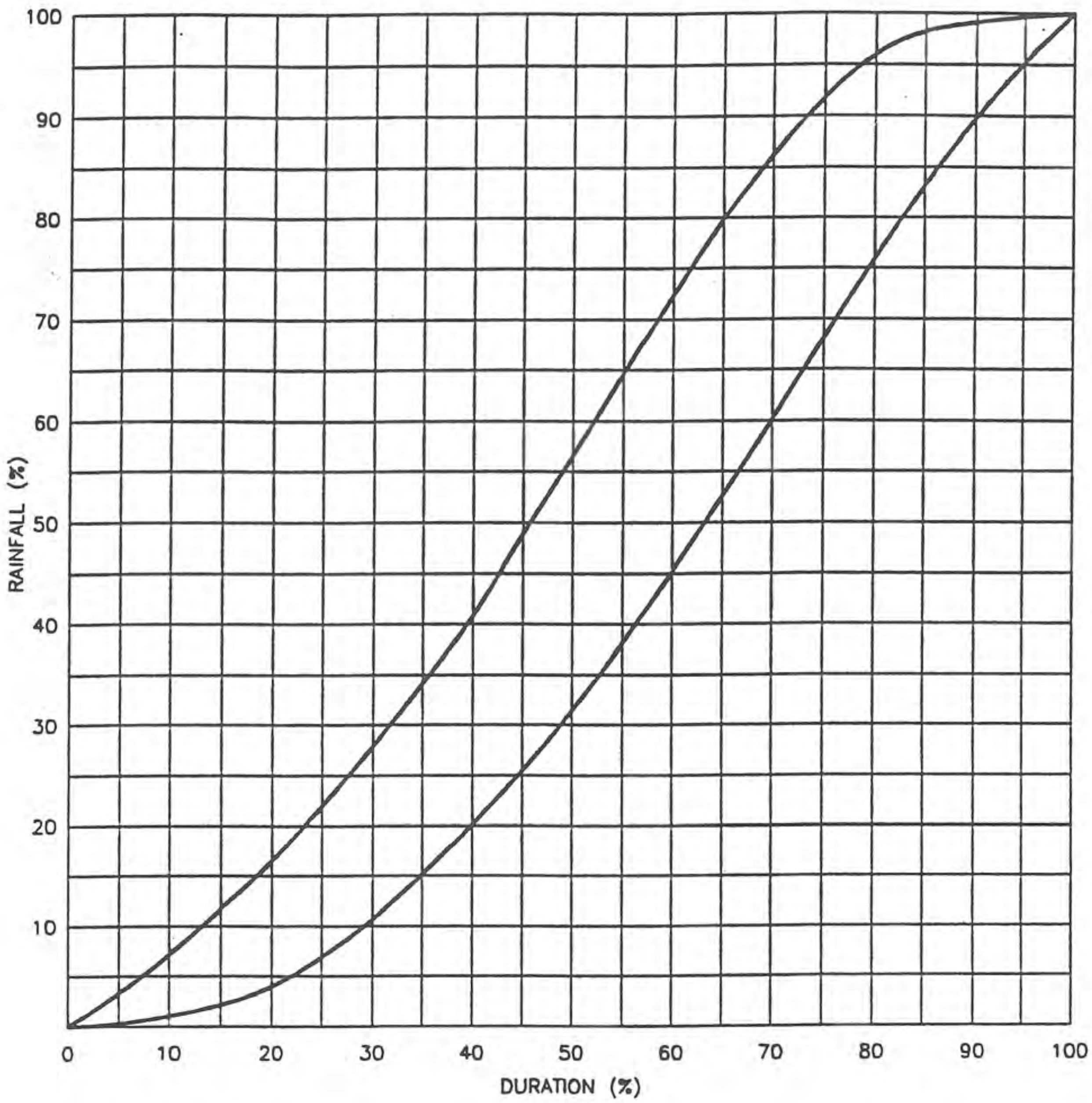


Figure 4 : Design Temporal Patterns of PMP for the "East Coast Tropical Zone" for a duration of 120 hours

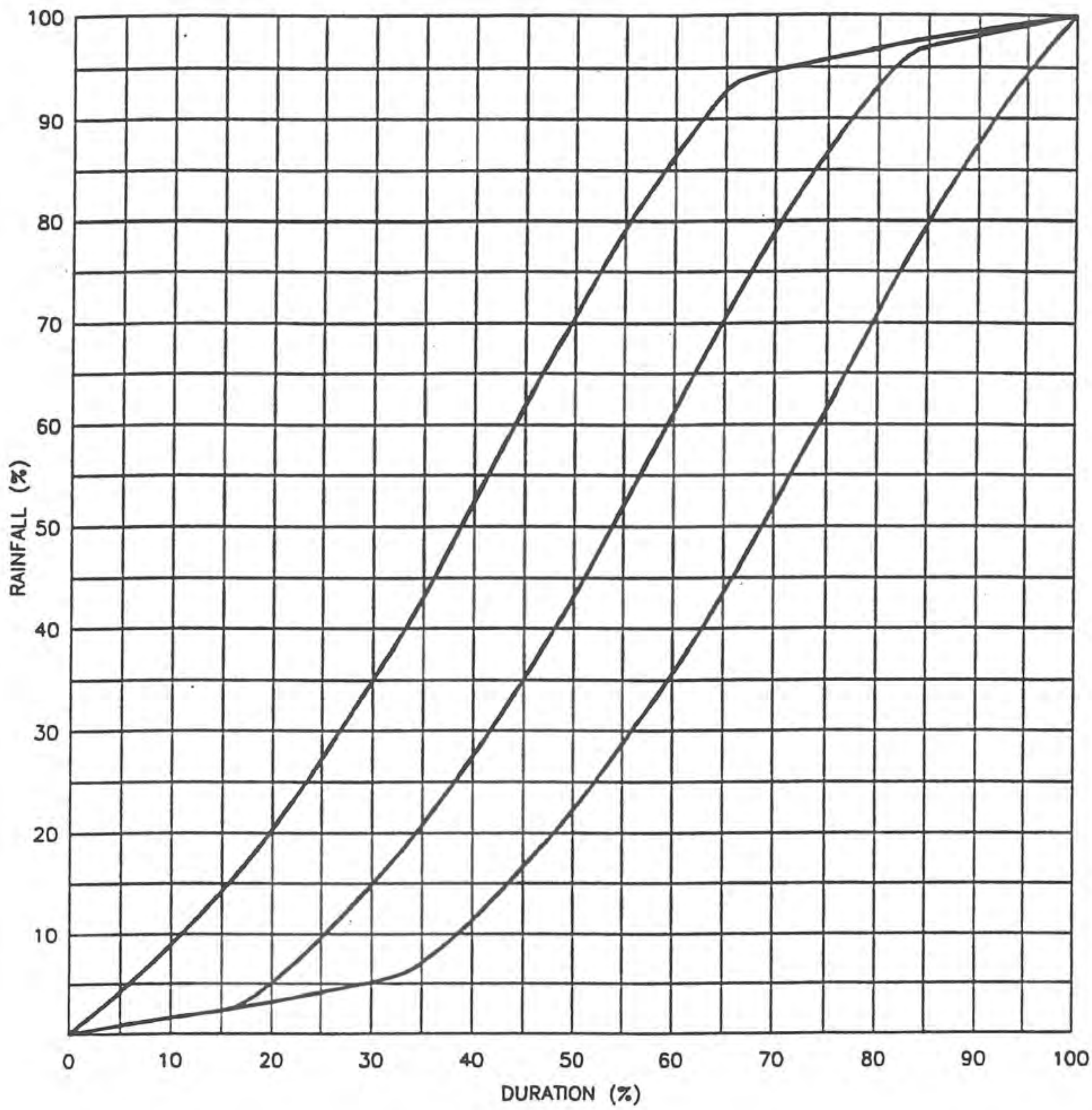


Figure 5 : Design Temporal Patterns of PMP for the "East Coast Tropical Zone" for a duration of 144 hours

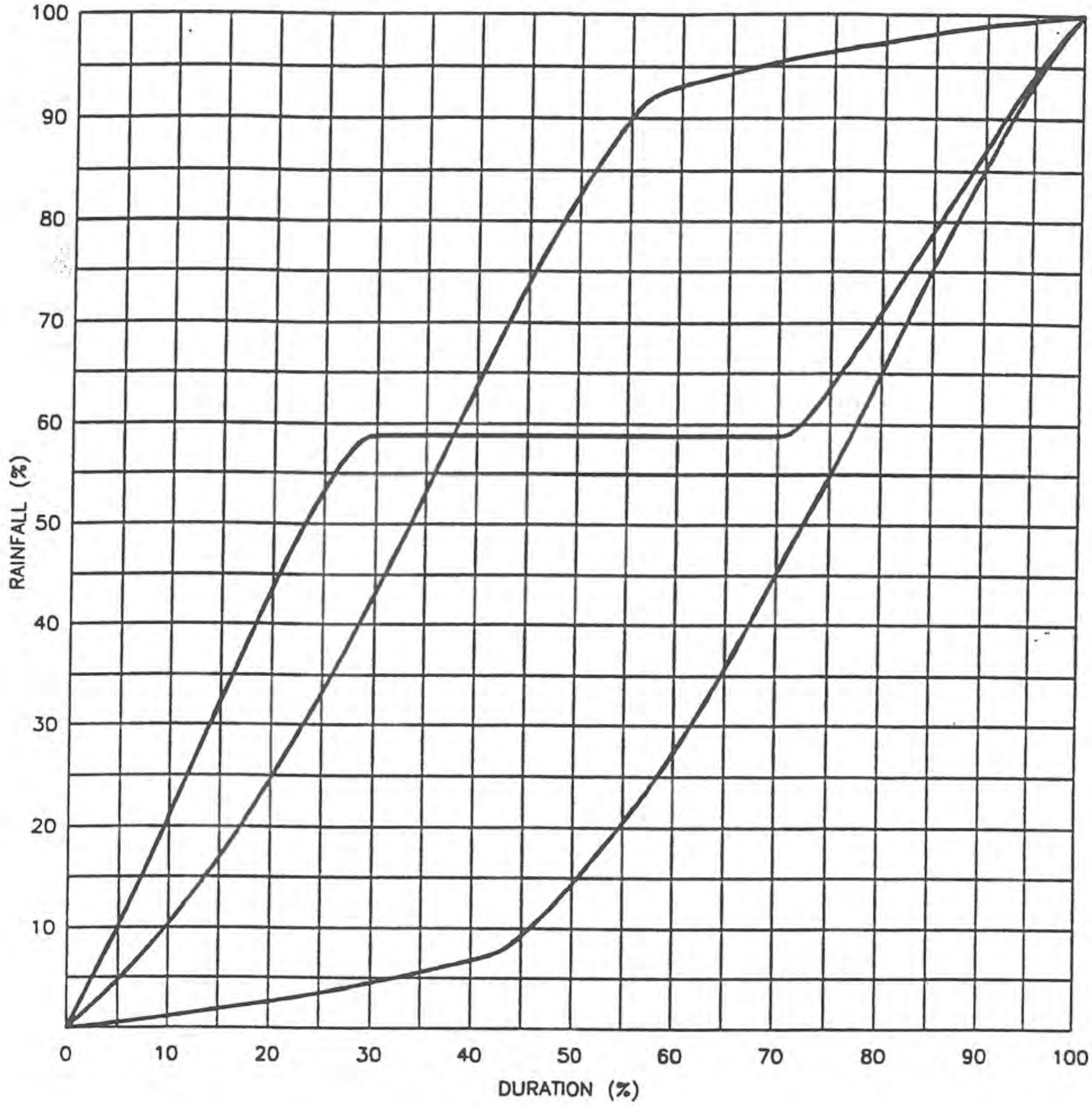


Figure 6 : Design Temporal Patterns of PMP for the "East Coast Tropical Zone" for a duration of 168 hours

INSTRUCTIONS FOR THE USE OF THE "BULLETIN 51"

PMP SPATIAL DISTRIBUTION DIAGRAM

TABLE 1

ISOHYETAL LABELS FOR SPATIAL DISTRIBUTION OF "BULLETIN 51" (AS HOURLY INCREMENTS IN PERCENT OF PMP)

Isohyet	Area Enclosed (km^2)	Hourly Increments of PMP (Percent) 1st	2nd	3rd	4th	5th	6th
A	2	100	19	10	6	5	4
B	16	76	19	10	6	5	4
C	65	54	19	10	6	5	4
D	153	40	17	9	6	5	4
E	246	32	14	8	5	4	4
F	433	21	10	7	4	3	3
G	635	14	7	5	4	3	3
H	847	8	4	4	3	3	3
I	1114	1	2	2	2	2	2
J	1396	1	3	0	0	0	0

To obtain the spatial distribution of PMP proceed as follows:

Step 1. Obtain a mean x-hour, y-km^2 PMP depth for the catchment to use as the basis for calculating the isohyetal labels. This mean depth can be any of the 1 to 6 hour PMP values for the catchment.

Step 2. Alter the scale of the spatial distribution diagram to match that of the outline of the catchment.

Step 3. Centre (approximately) and rotate the isohyetal distribution to provide the best fit between the shape of the catchment and that of the isohyets.

Step 4. Obtain labels from Table 1 for isohyets up to the minimum size to enclose the catchment completely. The labels for the isohyets are obtained by adding up the percentages given in Table 1 up to the duration required (eg for 4 hours, A = 100 + 19 + 10 + 6 = 135).

Step 5. Multiply the mean PMP value by the isohyetal percentages from Step 4 to obtain initial isohyetal labels in millimetres.

Step 6. Calculate the mean initial rainfall depth over the catchment by planimetering or other procedures. The rainfall values assigned to the area between each pair of successive ellipses should be a weighted average of the rainfall values of the two isohyets. The formula used is:

$$\textbf{Mean Initial PMP Depth} = \frac{\sum_{i=1}^{n} (\text{area}_i \ * \ \text{initial rainfall depth}_i)}{\text{Total catchment area}}$$

where n is the number of sub-areas of the catchment between successive isohyets;

area_i is the value of a sub-area of the catchment between the isohyets i and i-1;

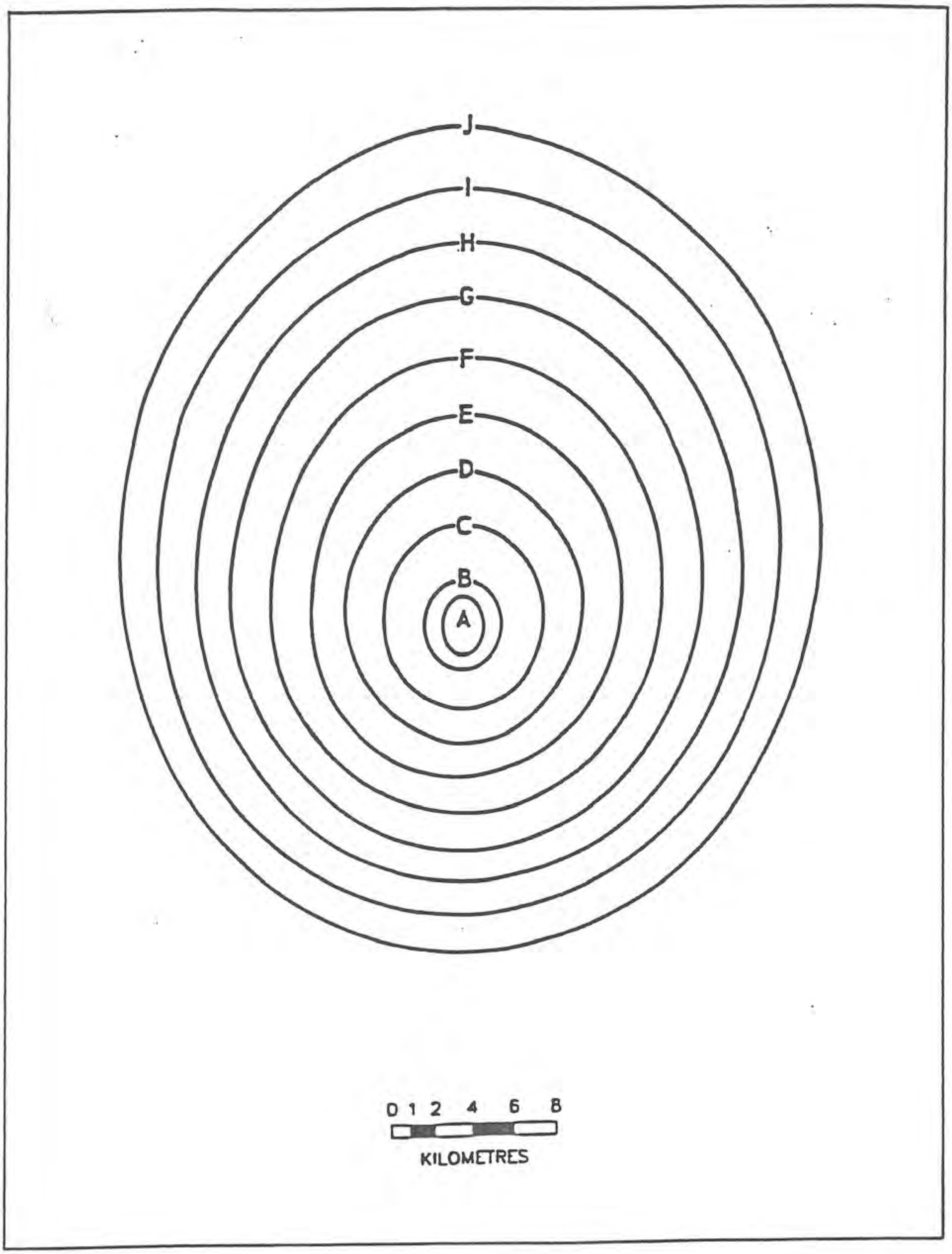
initial rainfall depth_i is the weighted average of the initial rainfall values in mm of the labels of the isohyets i and i-1;

Step 7. Scale the values for the sub-areas to obtain the correct mean PMP depth over the catchment, using the formula:

$$\textbf{Scaling Factor} = \frac{\text{Mean PMP depth from Step 1}}{\text{Mean Initial PMP Depth from Step 6}}$$

Step 8. Obtain the final isohyetal labels in millimetres by using the scaling factor of Step 7 and the values obtained in Step 5.

Step 9. Repeat the above steps for the other durations for which the PMP is required.



Bulletin 51 Spatial Distribution of Short Duration PMP.

EXAMPLE: PYKES CREEK CATCHMENT

Pykes Creek is located in southern Victoria. The area of this catchment is 120 km^2 and the maximum duration for which the Bulletin 51 method can be used here is 4 hours. The terrain in the catchment is classified as "rough". In this example only the distribution of the 4-hour PMP will be derived.

Step 1. The unadjusted 4-hour PMP is 753 mm. The moisture adjustment factor is 0.55. The 4-hour PMP is thus 753x0.55 = 410 mm (rounded to the nearest 10 mm).

Step 2. The spatial distribution diagram and the catchment outline were obtained at the same scale.

Step 3. The pattern was placed over the catchment with the isohyetal centre near the centroid of the catchment. It is necessary to use isohyets A to E to enclose the catchment.

The position of the pattern was adjusted slightly and the pattern was rotated to get the estimated optimum depth over the catchment. The position of the pattern with respect to the catchment is shown in Figure 1.

Step 4. The labels for isohyets A to E were obtained as percentages of the mean PMP by adding the incremental values up to 4 hours from Table 1. These labels are given in Table 2 as percentages of the mean PMP depth.

TABLE 2

ISOHYETAL PERCENT OF PMP LABELS FOR SPATIAL DISTRIBUTION OF 4-HOUR PMP FOR PYKES CREEK CATCHMENT

Isohyet	Area Enclosed (km^2)	4-Hour PMP Isohyet Label (Per Cent)
A	2	135
B	16	111
C	65	89
D	153	72
E	246	59

Step 5. Initial isohyetal labels in millimetres were obtained by multiplying the percentages by the mean PMP depth. These values are given in Table 3.

TABLE 3

ISOHYETAL INITIAL DEPTH LABELS FOR SPATIAL DISTRIBUTION OF 4-HOUR PMP FOR PYKES CREEK CATCHMENT

Isohyet	Area Enclosed (km^2)	Initial 4-Hour PMP Isohyet Label (mm)
A	2	554
B	16	455
C	65	365
D	153	295
E	246	242

Step 6. The magnitudes of the sub-areas of the catchment between successive pairs of isohyets were determined. The rainfall over each sub-area was obtained by taking a weighted average of the values of the two adjacent isohyets. For the central isohyet, (A), assume that the rainfall depth increases to a maximum at its central point. The mean initial PMP depth over the catchment is calculated from the sum of the products of area and rainfall as given in Table 4.

TABLE 4

CALCULATION OF MEAN AREAL RAINFALL FOR SPATIAL DISTRIBUTION OF PMP FOR PYKES CREEK CATCHMENT

Isohyet	Incremental Area (km^2)	Mean Initial Areal Rainfall Value (mm)	Area * Rainfall
A	2.0	560	1120
A to B	14.0	505	7070
B to C	49.0	410	20090
C to D	38.2	335	12797
D to E	16.8	275	4620
A to E	120.00		45697

The mean initial PMP depth (mean catchment rainfall) is the sum of the products of sub-area and rainfall divided by the total area. This is 45697/120 = 381 mm.

Step 7. The rainfall values given in Table 4 for the sub-areas are therefore scaled up by the factor 410/381 = 1.076 to give the correct mean PMP depth over the catchment. The adjusted mean rainfall values for the sub-areas are given in Table 5. This procedure distributes the mean initial PMP depth over the catchment correctly.

TABLE 5

SCALED SUB-AREA RAINFALL VALUES OF 4-HOUR PMP FOR PYKES CREEK CATCHMENT

Isohyet	Incremental Area (km^2)	Mean Areal Rainfall Value (mm)
A	2.0	603
A to B	14.0	543
B to C	49.0	441
C to D	38.2	360
D to E	16.8	296

This is the final spatial distribution of the mean PMP over the catchment.

Step 8. The final isohyetal labels in millimetres are given in Table 6. These were obtained by multiplying the values in table 3 by 1.076.

TABLE 6

FINAL ISOHYETAL LABELS FOR SPATIAL DISTRIBUTION OF 4-HOUR PMP FOR PYKES CREEK CATCHMENT

Isohyet	Area Enclosed (km^2)	Isohyetal Label (mm)
A	2	600
B	16	490
C	65	390
D	153	320
E	246	260

(Values rounded to the nearest 10 mm)

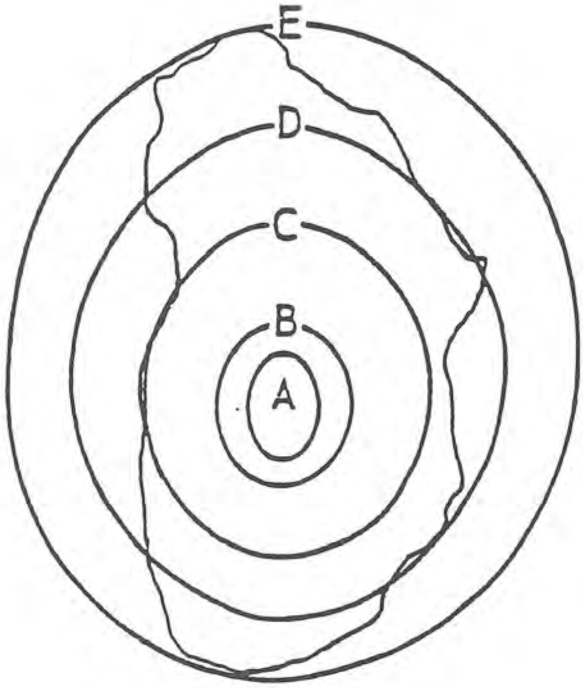


FIGURE 1. ISOHYETAL DISTRIBUTION OF PMP OVER THE PYKES CREEK CATCHMENT

INSTRUCTIONS FOR THE USE OF THE GTSM PMP SPATIAL DISTRIBUTION DIAGRAMS

1. Select the appropriate distribution diagram according to whether the area of the catchment is above or below 2000 km^2.

2. Expand or contract the scale of the isohyetal pattern until the outermost isohyet just touches the catchment. Adjust the positioning of the pattern to get an (estimated) highest PMP depth over the catchment. This depends on the shape of the catchment as well as the position of the pattern.

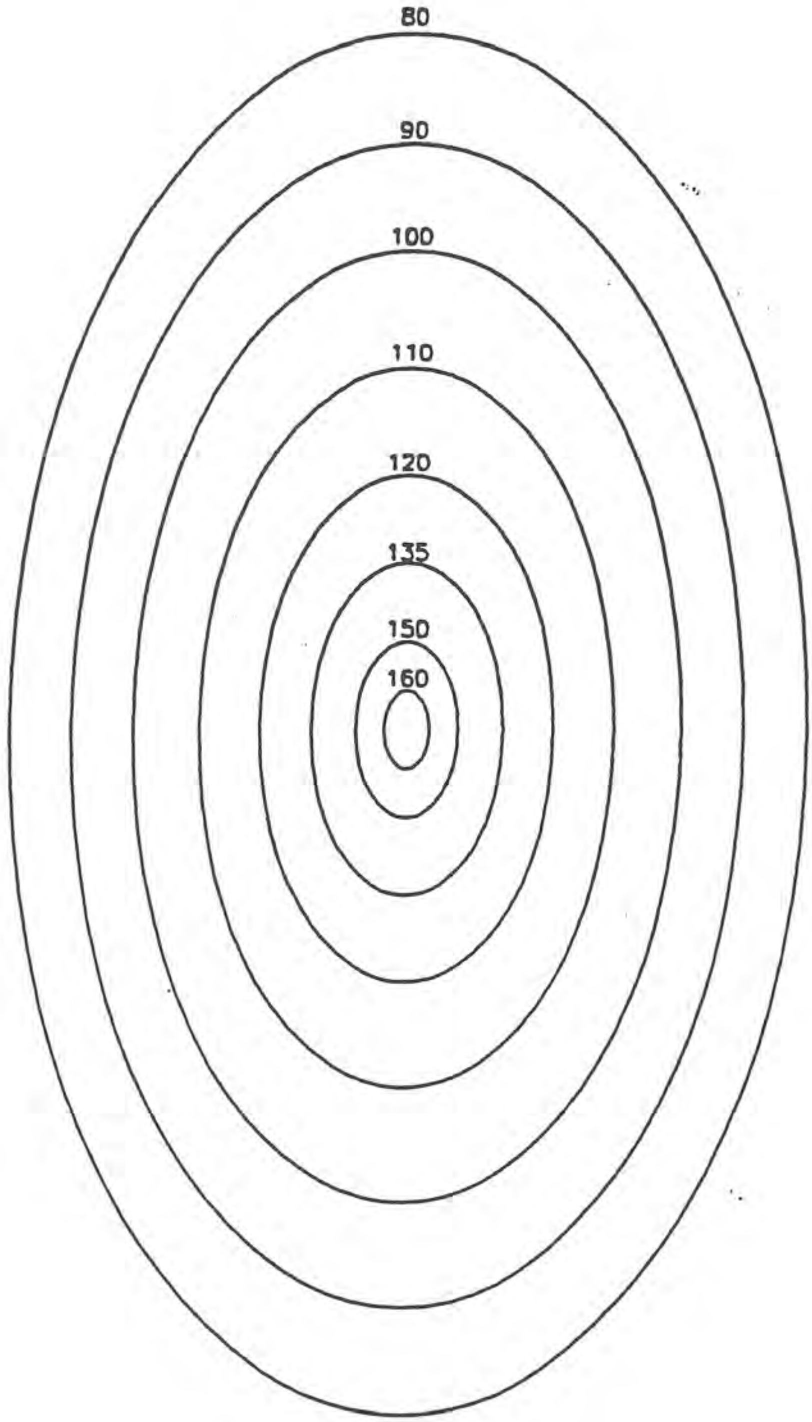
3. Calculate the area of the catchment within the central isohyet, and then between each adjacent pair of isohyets until all these areas have been calculated. A planimeter or other means are suitable methods of doing this.

4. Multiply the percentage assigned to the label on each isohyet by the mean PMP depth for that duration. This gives isohyet labels in millimeters.

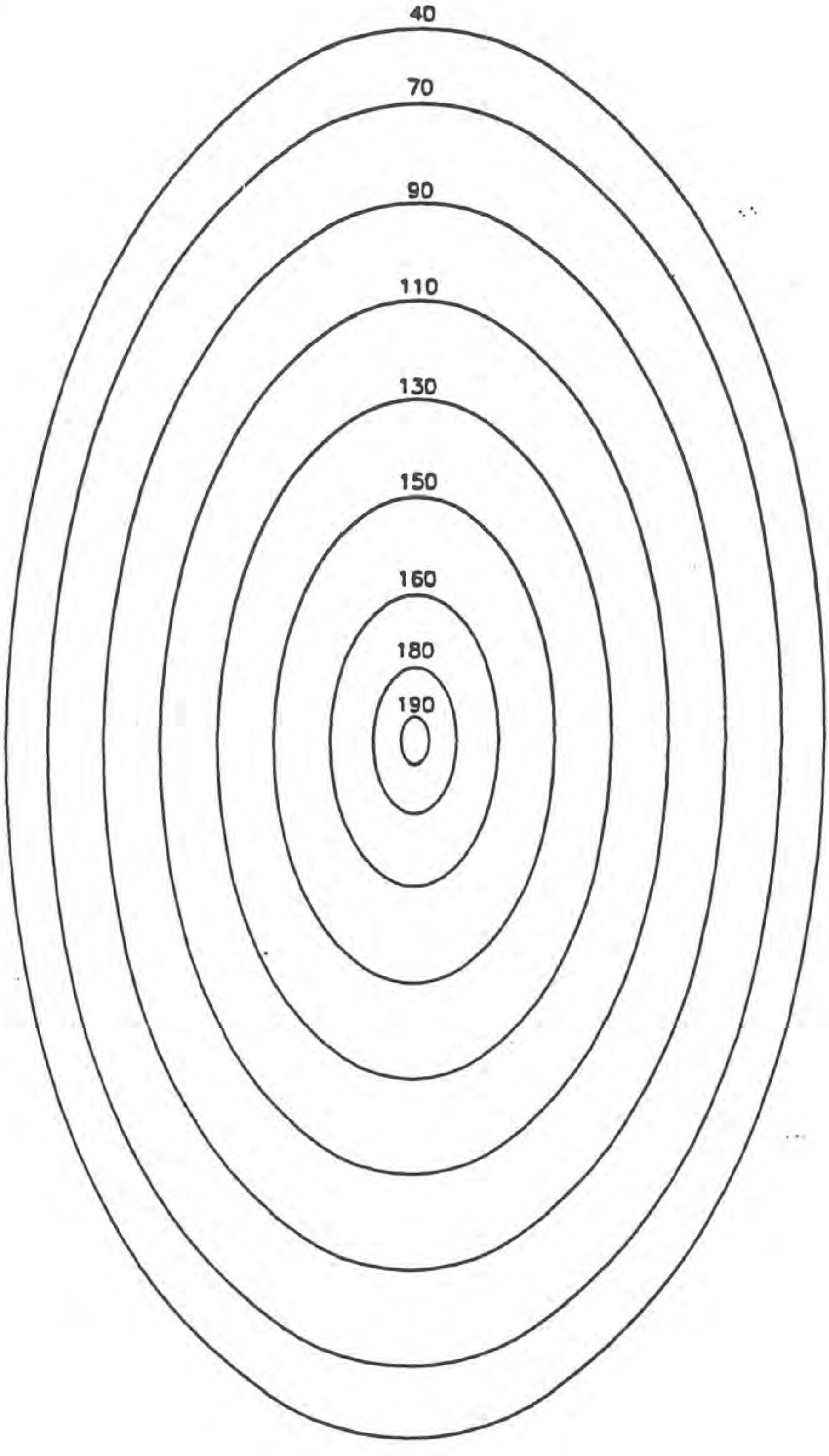
5. Multiply these areas by an estimate of the mean rainfall value over that part of the catchment contained in the annulus between each successive pair of isohyets. This will generally not be the arithmetic mean because of the usually irregular shape of the catchment boundary. For the central isohyet a mean value has to be estimated. This will not be critical.

6. The sum of all the above products is divided by the total catchment area to obtain the calculated mean catchment PMP depth. This will usually not be equal to the true PMP depth. The ratio of the actual PMP to the calculated PMP values is then calculated.

7. The values of the isohyetal labels are all multiplied by this ratio (ie a constant scaling factor) to ensure that the isohyetal pattern gives the correct mean PMP depth.



Generalised Tropical Storm Method Design Isohyetal Pattern for the Distribution of PMP over Areas <= 2000 sq km (% of mean catchment value)



Generalised Tropical Storm Method Design Isohyetal Pattern for distribution of PMP for Areas >2000 sq km.
(% of mean catchment value)

APPENDIX 3

CALCULATION OF CONCURRENT RAINFALL OVER AN AREA WHEN THE PMP STORM OCCURS OVER AN ADJACENT CATCHMENT

METHOD 1

In this method the PMP is calculated for the specified catchment using the GTSM. The design isohyetal pattern is centred over the catchment for which the PMP is required. The pattern is expanded or contracted to cover the adjacent area for which the concurrent rainfall is required. A scaling factor is calculated to give the correct mean PMP depth over the smaller catchment. It is then used to obtain the isohyetal values over the larger area.

1. Calculate the PMP using the GTSM for the smaller catchment for the range of durations required.

2. Select the design spatial distribution according to whether the area of the total or larger catchment is less than or greater than 2000 km^2.

3. Centre the isohyets over the smaller catchment for which the PMP is required and enlarge or reduce the spatial distribution until the outermost isohyet just encloses the larger catchment, as shown in Figure 1.

4. Multiply the mean PMP value for the smaller catchment by the isohyetal percentages for isohyets 1 to m, which encloses the smaller catchment, to obtain initial labels in millimetres.

5. Obtain, by planimetering or other means, the values of the sub-areas of the smaller catchment between successive isohyets and also inside the central isohyet.

6. Assign each of the areas obtained in step 5 a weighted mean rainfall value using the values for the isohyets. Estimate a rainfall value for the area enclosed by the central isohyet.

7. Calculate a mean initial PMP depth over the smaller catchment using the formula:

$$\textbf{Mean Initial PMP Depth} = \frac{\sum_{i=1}^{m} (\text{Area}_i \times \text{Initial Rainfall Depth}_i)}{\text{Catchment Area}}$$

where m is the number of sub-areas of the catchment between successive isohyets;

Area_i is the value of the sub-area of the catchment lying between the isohyets i and i-1;

$\text{Initial Rainfall Depth}_i$ is the weighted value of the labels on isohyets i and i-1.

8. Scale the weighted mean rainfall values for the sub-areas to obtain the correct mean PMP depth over the catchment using the formula:

$$\text{Scaling Factor} = \frac{\text{Mean PMP Depth from Step 1}}{\text{Mean Initial PMP Depth from Step 7}}$$

9. Obtain the final isohyetal values in millimetres for the smaller catchment by using the scaling factor obtained in Step 6 and the isohyetal values obtained in Step 4.

   To obtain the spatial distribution of the concurrent rainfall over the larger catchment when the PMP occurs over the smaller catchment, proceed as follows :

10. Obtain the ratio of the final value in mm for isohyet m to the initial percentage value of isohyet m.

11. Apply this ratio to all isohyets from m+1 to the final isohyet, which encloses the larger catchment, to obtain the spatial distribution over the larger catchment area.

12. Repeat the above procedure for other durations. This can be done by using the same scaling factors.

METHOD 2

The PMP values for the specified catchment are obtained using the GTSM. The design spatial distribution is fitted to this catchment only. The spatial distribution of rainfall accompanying the PMP storm is obtained from moisture maximised major recorded storms in the area adjacent to the main catchment.

1. Calculate the PMP using the GTSM for the smaller catchment for the range of durations required.

2. Derive the spatial distributions of these PMP depths using the appropriate design isohyetal patterns.

3. Obtain the spatial distributions of the most severe storms over the adjacent catchments.

4. Maximise these storms in situ using the ratio of the precipitable water values for the extreme and storm dew points.

5. Use the spatial distribution of the largest of these maximised storms over the adjacent areas with the PMP and design spatial distribution for the smaller catchment.

6. Derive the temporal distribution over the adjacent area of the rainfall in these storms from basic data.

METHOD 3

In this method the PMP values for the specified catchment are calculated using the GTSM. The accompanying rainfall on the adjacent areas is represented by 100-year fields of design rainfall intensity based on information given in "Australian Rainfall and Runoff" (ARR), published by the Institution of Engineers, Australia, 1987.

1. Using the GTSM, calculate the PMP for the smaller catchment for the range of durations required.

2. Obtain the spatial distribution of the point 12-hour, 50-year and 72-hour, 50-year rainfall intensities from Volume 2 of ARR.

3. The design spatial distribution of rainfall accompanying the PMP will be based on the 12-hour, 50-year field for durations of up to 36 hours and on the 72-hour, 50-year field for durations from 48 to 120 hours.

4. Estimate the position of the centroid of the area adjacent to the catchment and derive the point 50- and 100- year intensities at this point for each of the durations for which PMP is required.

5. Obtain a point-to-area reduction factor, for the adjacent area, for each duration, using the curves given in Chapter 2 or ARR. In most cases an extrapolation will have to be made. Apply these factors to both the 50-year and 100-year intensities of Step 4.

6. Calculate the ratios of the 100-year intensities for the required durations up to 36 hours to the 12-hour, 50-year value.

7. Apply these ratios to the 12-hour, 50-year field of rainfall intensities (Step 2) to obtain the 100-year field for each of the required durations up to 36 hours. Convert the intensity fields to fields of rainfall totals for each duration by multiplying by the duration (in hours).

8. Repeat Steps 6 and 7 for the durations between 48 hours and 120 hours, using the 72-hour, 50-year value.

9. Use the GTSM temporal distributions as the design temporal distributions of the rainfall over the areas adjacent to the catchment.

METHOD 4

In this method, PMP storms are assumed to occur over the smaller catchment and over the total area simultaneously. The spatial pattern is centred over the smaller catchment but expanded to encompass the larger area. The rainfall over the adjacent area is the difference between the two PMP values.

1. Calculate the PMP using the GTSM for the smaller catchment for the range of durations required.

2. Calculate the PMP using the GTSM for the larger catchment for the range of durations required.

3. Select a spatial distribution according to whether the area of the total or larger catchment is less than or greater than 2000 km^2.

4. Centre the isohyets over the smaller catchment for which the PMP is required and enlarge or reduce the spatial distribution until the outermost isohyet just encloses the larger catchment, as shown in Figure 1.

5. Multiply the mean PMP value for the smaller catchment by the isohyetal percentages for isohyets 1 to m, which encloses the smaller catchment, to obtain initial isohyetal labels in millimetres.

6. Obtain, by planimetering or other means, the values of the sub-areas of the smaller catchment between successive isohyets and also the area inside the central isohyet.

7. Assign each of the areas obtained in Step 6 a weighted mean rainfall figure using the values for the isohyets. Estimate a rainfall value for the area enclosed by the central isohyet.

8. Calculate a mean initial PMP depth over the smaller catchment using the formula:

$$\textbf{Mean Initial PMP Depth} = \frac{\sum_{i=1}^{m}(\text{Area}_i \times \text{Initial Rainfall Depth}_i)}{\text{Total Catchment Area}}$$

where m is the number of sub-areas of the catchment between successive isohyets;

$Area_i$ is the value of the sub-area of the catchment lying between the isohyets i and i-1;

Initial Rainfall $Depth_i$ is the weighted value of the labels on isohyets i and i-1.

9. Scale the weighted mean rainfall values for the sub-areas to obtain the correct mean PMP depth over the catchment using the formula:

$$\text{Scaling Factor} = \frac{\text{Mean PMP Depth from Step 1}}{\text{Mean Initial PMP Depth from Step 8}}$$

10. Obtain the final isohyetal values in millimetres for the smaller catchment by using the scaling factor obtained in Step 9 and the isohyetal values obtained in Step 5.

To obtain the spatial distribution of the concurrent rainfall over the larger catchment when PMP occurs over the smaller catchment proceed as follows:

11. Using the mean PMP depth obtained in Step 2 obtain values in millimetres for the labels of the isohyets m to the final isohyet. Use the values obtained in Step 10 for the isohyets 1 to m.

12. Repeat Steps 6 to 10 for the larger catchment but leave the values for isohyets 1 to m as calculated in Step 10.

13. If the value of the isohyet m+1 exceeds the value previously obtained for isohyet m interpolate an extra isohyet between isohyets m and m+1 with a value equal to that for isohyet m.

14. Repeat the above procedure for other durations. This can be done by just using the same scaling factors.

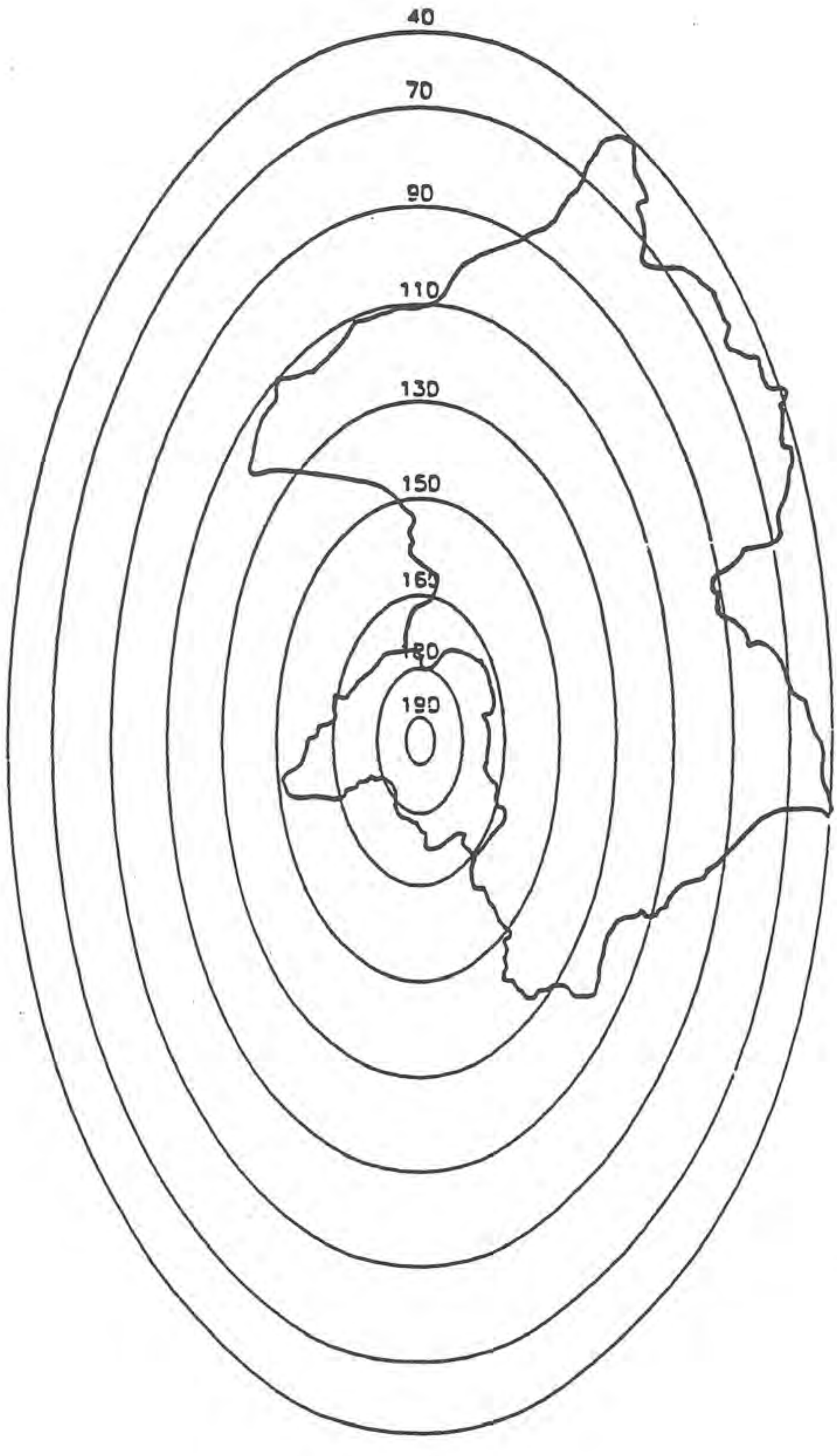
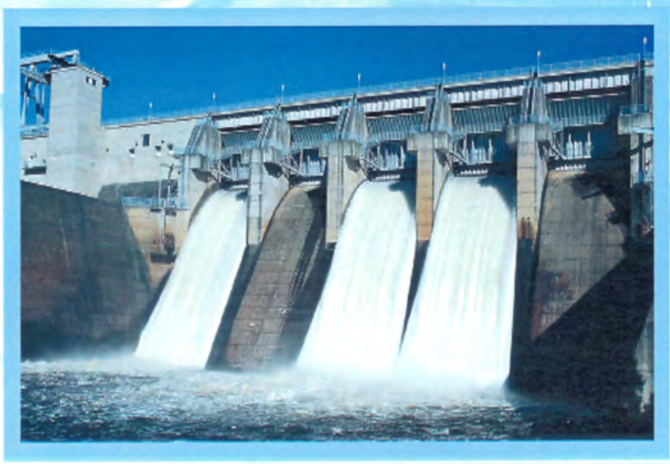


FIGURE 1 Positioning of Spatial Distribution to Obtain Rainfall over the Adjacent Area when the PMP Occurs over the Smaller Catchment

MARCH 1993

BRISBANE RIVER AND PINE RIVER FLOOD STUDY :

Report No. 8c



BRISBANE RIVER FLOOD HYDROLOGY REPORT VOLUME III

Flood Frequency Analysis Results

South East Queensland WATER BOARD

NATURAL RESOURCES Queensland

Brisbane River and Pine River Flood Studies

BRISBANE RIVER FLOOD HYDROLOGY REPORT

REPORT ON DESIGN FLOOD ESTIMATION

APPENDIX B FLOOD FREQUENCY ANALYSIS RESULTS

Volume III
March 1993

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B.1 INTRODUCTION

Flood frequency analyses have been conducted on a number of the available streamflow stations located within the Brisbane River catchment that have suitable records. Figure B.1 shows the locations of the streamgauge stations for which flood frequency analyses were conducted. Table B.1 lists the stations and the period of record available for each station.

Annual series of peak discharges were utilised in all analyses undertaken. The data was obtained from the peak series database of the HYDSYS time series data management system. More information on the HYDSYS database system can be obtained from the HYDSYS users manual, (1992). Annual series were utilised because of the emphasis of the study in regard to design flood estimation involving ARIs of greater than 10 years. This is in accordance with the recommendations of Chapter 10 of Australian Rainfall and Runoff, (1987).

A Log-Pearson Type III distribution together with 95 % confidence limits were fitted to all of the annual series data using the procedures outlined in Chapter 10 of Australian Rainfall and Runoff, (1987). Computer program WS06, (Hadgraft, 1981), was utilised to perform the fitting of the distributions. In all cases the Cunnane empirical plotting position was adopted.

The following sections present the results of the flood frequency analyses that have been undertaken. In addition to the analysis of individual station records, analyses of composite records have been performed where appropriate. Care has been taken to ensure that the annual series that have been compiled are from a reasonably homogeneous population. For example, stations located downstream of storages have had their records separated into pre-dam and post-dam series.

No attempt has been made to synthesise series of peak discharges so as to account for the existence of storages or the change of storage operation or any other major change within the catchments. The quality of the available record, the length of that record, and the number stations for which this record is available, limits the usefulness of flood frequency techniques in flood estimation for the assessment of design floods for the storages. No direct comparison between the estimates of design floods for the storages derived from the flood frequency techniques and the runoff-routing modelling can be drawn because of the differences in catchment and storage operation conditions.

However, work conducted by the BCC for the previous investigation of the flood hydrology of Somerset Dam and Wivenhoe Dam has been reviewed because it illustrates the possible impact of the operation of the storages.

Table B.1
Streamgauge Stations

STATION NUMBER	STREAM NAME	STATION NAME	PERIOD OF RECORD	YEARS OF RECORD
143001A	Brisbane R	Lowood	1909-50	41
143001B	Brisbane R	Vernor	1950-58	8
143001C	Brisbane R	Savages Crossing	1958-Date	33
143002A	Brisbane R	Plainlands	1920-32	12
143002B	Brisbane R	Fulham Vale	1931-65	34
143003A	Brisbane R	Mt Crosby Weir	1900-75	75
143005A	Brisbane R	Watts Bridge	1952-72	20
143006A	Cressbrook Ck	Tinton	1952-86	34
143007A	Brisbane R	Linville	1964-Date	27
143008A	Brisbane R	Middle Creek	1962-82	20
143009A	Brisbane R	Gregors Creek	1962-Date	29
143010A	Emu Ck	Boat Mountain	1965-76	11
143010B	Emu Ck	Boat Mountain	1976-Date	15
143011A	Emu Ck	Raeburn	1965-89	24
143013A	Cressbrook Ck	Damsite	1965-81	16
143015A	Cooyar Ck	Damsite	1968-90	22
143015B	Cooyar Ck	Damsite	1990-Date	2
143018A	Brisbane R	Avoca Vale	1970-90	20
143102A	Warrill Ck	Kalbar No 1	1912-58	46
143102B	Warrill Ck	Kalbar No 2	1958-71	13
143103A	Reynolds Ck	Moogerah	1917-54	37
143103B	Reynolds Ck	Moogerah	1954-60	6
143104A	Bremer R	Rosevale	1919-53	34
143104B	Bremer R	Rosevale	1952-73	21
143107A	Bremer R	Walloon	1961-Date	30
143108A	Warrill Ck	Amberley	1961-Date	30
143110A	Bremer R	Adams Bridge	1968-Date	23
143113A	Purga Ck	Loamside	1973-Date	18
143201A	Lockyer Ck	Tarampa	1909-26	17
143201B	Lockyer Ck	Tarampa	1925-47	22
143203A	Lockyer Ck	Helidon	1926-71	45
143203B	Lockyer Ck	Helidon No 2	1965-89	34
143203C	Lockyer Ck	Helidon	1987-Date	4
143204A	Lockyer Ck	Wilsons Weir	1953-82	29
143206A	Lockyer Ck	Brightview Weir	1953-73	20
143207A	Lockyer Ck	O'Reillys Weir	1948-Date	43
143209A	Laidley Ck	Mulgowie	1957-62	5
143209B	Laidley Ck	Mulgowie	1967-Date	24
143210A	Lockyer Ck	Lyons Bridge	1964-88	24
143210B	Lockyer Ck	Rifle Range Rd	1988-Date	3
143212A	Tenthill Ck	Tenthill Hotel	1968-Date	23
143301A	Stanley R	Hazeldean	1912-15	3
143301B	Stanley R	Donelly Dell	1915-19	4
143302A	Stanley R	Silverton	1919-68	49
143303A	Stanley R	Peachester	1927-Date	64
143305A	Stanley R	Somerset Dam	1935-59	24

B.2 FLOOD FREQUENCY ANALYSIS RESULTS

B.2.1 BRISBANE RIVER

Results of the flood frequency analysis for all of the stations located on the Brisbane River are presented in this section. Table B.2 lists the stations in order from the most upstream to the furtherest downstream. Likewise the results of the flood frequency analyses are presented in this order.

Table B.2
Brisbane River Streamgauge Station Details

STATION NUMBER	STREAM NAME	STATION NAME	AMTD (km)	CATCHMENT AREA (km^2)
143018A	Brisbane R	Avoca Vale	292.1	1 500
143007A	Brisbane R	Linville	282.4	2 005
143009A	Brisbane R	Gregors Creek	251.7	3 885
143002A	Brisbane R	Plainlands	235.9	3 965
143002B	Brisbane R	Fulham Vale	235.8	3 975
143005A	Brisbane R	Watts Bridge	231.3	4 610
143008A	Brisbane R	Middle Creek	187.2	6 710
143001A	Brisbane R	Lowood	141.1	10 060
143001B	Brisbane R	Vernor	140.0	10 060
143001C	Brisbane R	Savages Crossing	130.8	10 180
143003A	Brisbane R	Mt Crosby Weir	90.8	10 565

The station at Avoca Vale has a highest streamflow measurement of just 39 m^3/s, so the majority of recorded peak discharges in the annual series are based upon an extrapolated portion of the rating curve. The length of record and the extent of the rating curve limit the reliability of the estimates obtained from this site. The results of the flood frequency analysis for this site are presented in Table B.3 and Figure B.2.

Table B.3
Flood Frequency Estimates at 143018A
Brisbane River at Avoca Vale

AEP (%)	ARI (YEARS)	PEAK DISCHARGE (m^3/s)		
		ESTIMATE	95 % CONFIDENCE INTERVAL	
			LOWER	UPPER
10	10	1 543	609	3 909
5	20	2 528	829	7 706
2	50	4 309	1 004	18 497
1	100	6 069	1 045	35 240

Linville has a highest streamflow measurement of 1 487 m^3/s, which is about 60 % of the highest recorded flow on record. The quality of the record at this site is good. The results of the flood frequency analysis for this site are presented in Table B.4 and Figure B.3.

Table B.4
Flood Frequency Estimates at 143007A
Brisbane River at Linville

AEP (%)	ARI (YEARS)	PEAK DISCHARGE (m^3/s)		
		ESTIMATE	95 % CONFIDENCE INTERVAL	
			LOWER	UPPER
10	10	1 456	651	3 256
5	20	2 539	932	6 914
2	50	4 798	1 280	17 993
1	100	7 382	1 504	36 245

Gregors Creek also has a good quality peak discharge record, although it is rated to only 20 % of the highest recorded flow. The gauging site configuration lends itself to accurate rating curve extension, resulting in good peak discharge record. The results of the flood frequency analysis for this site are presented in Table B.5 and Figure B.4.

Table B.5
Flood Frequency Estimates at 143009A
Brisbane River at Gregors Creek

AEP (%)	ARI (YEARS)	PEAK DISCHARGE (m^3/s)		
		ESTIMATE	95 % CONFIDENCE INTERVAL	
			LOWER	UPPER
10	10	3 238	1 549	6 768
5	20	5 423	2 242	13 117
2	50	9 425	2 958	30 035
1	100	13 404	3 294	54 548

Records for stations located at Gregors Creek, Plainlands and Fulham Vale have been formed into a composite record appropriate for the site at Gregors Creek. This results in an annual series extending from 1920 to date, a sequence of some 70 complete years of record. The peak discharges recorded at Plainlands and Fulham Vale were adjusted by factoring the values by a ratio of the catchment areas raised to the power of 0.7. This adjustment is commonly used in regional flood frequency estimation techniques. The results of the flood frequency analysis for the composite record at this site are presented in Table B.6 and Figure B.5.

Table B.6
Flood Frequency Estimates at 143009A and 143002AB
Brisbane River at Gregors Creek (Composite Record)

AEP (%)	ARI (YEARS)	PEAK DISCHARGE (m^3/s)		
		ESTIMATE	95 % CONFIDENCE INTERVAL	
			LOWER	UPPER
10	10	2 712	1 741	4 223
5	20	4 401	2 586	7 492
2	50	7 323	3 609	14 861
1	100	10 073	4 245	23 901

It is interesting to note the difference in estimates obtained from the analyses of individual station series and that of the composite record series. One of the obvious reasons for the difference in results is the difference in period of record between the two series. The individual record started in 1961 and extends through to the present date, encompassing the wet periods of the 1960's, early 1970's and late 1980's. The composite record starts in 1920 and runs to the present, but apart from some large flood events in the early 1930's and mid 1950's the composite record is biased by some dry periods during the early 1920's and 1940's.

Another factor is that the quality of recording facility has changed during the corresponding period. The gauging stations at Plainlands and Fulham Vale were both manually read staff gauges, whereas the facility at Gregors Creek has always been an automatic recording facility, consisting of a gas electric vactric/transducer or a gas mechanical type transducer with either a Leupold and Stevens or Fischer and Porter chart recorder.

More importantly is that the stations at Plainlands and Fulham Vale were only rated up to 210 m^3/s and 203 m^3/s, respectively. This is in contrast to the gauging station at Gregors Creek where the highest streamflow measurement is 1 149 m^3/s. Therefore estimates of peak discharge for large floods from the station at Gregors Creek would be regarded as being more reliable than the records of the other stations.

The station at Watts Bridge has fair quality record as the highest streamflow measurement obtained at this site is 363 m^3/s. The main limitation of the flood frequency estimates at this site is the length of record. There is only 19 years of record available which does not incorporate the large flood events of the mid 1970's. The results of the flood frequency analysis for this site are presented in Table B.7 and Figure B.6.

Table B.7
Flood Frequency Estimates at 143005A
Brisbane River at Watts Bridge

AEP (%)	ARI (YEARS)	PEAK DISCHARGE (m^3/s)		
		ESTIMATE	95 % CONFIDENCE INTERVAL	
			LOWER	UPPER
10	10	3 091	1 348	7 086
5	20	4 975	1 841	13 440
2	50	8 248	2 223	30 604
1	100	11 357	2 309	55 863

Middle Creek had substantially better definition of the high flow portion of its rating curve than Watts Bridge, with the highest streamflow measurement being 2 456 m^3/s. The flood frequency estimates at this station are also limited by the total length of available record which is only 19 complete years. The station at Middle Creek was closed when construction commenced on Wivenhoe Dam. The whole of the record for this site is post-Somerset Dam. The results of the flood frequency analysis for this site are presented in Table B.8 and Figure B.7.

Table B.8
Flood Frequency Estimates at 143008A
Brisbane River at Middle Creek

AEP (%)	ARI (YEARS)	PEAK DISCHARGE (m^3/s)		
		ESTIMATE	95 % CONFIDENCE INTERVAL	
			LOWER	UPPER
10	10	3 236	1 490	7 030
5	20	5 026	1 977	12 778
2	50	7 966	2 289	27 723
1	100	10 615	2 308	48 829

The present station at Savages Crossing has been relocated a number of times, first from Lowood to Vernor and then from Vernor to its present location.

The stations at Savages Crossing and Lowood have highest streamflow measurements of 3 361 m^3/s and 2 550 m^3/s, respectively. The peak discharge estimates at these sites are therefore quite reliable. Vernor has a highest streamflow measurement of only 388 m^3/s, making the record from this station less reliable than the other stations.

The stations at Lowood, Vernor and Savages Crossing have been formed into a composite record appropriate for the site at Savages Crossing. The composite record however, has been divided into two series to account for the construction of Somerset Dam. The first series extends from 1909 to 1942, a sequence of 32 complete years, and the second from 1942 to 1978, a sequence of 35 years. Although construction started on Somerset Dam in the mid-1930's it first started storing water in 1942, thus affecting flows downstream after this time. It should be noted that Somerset Dam was not completed until the late 1950's and so the flood operation procedure varied from 1942 until 1959 when the dam was finally completed.

The results of the flood frequency analysis for the composite record at this site, for the period pre-Somerset Dam are presented in Table B.9 and Figure B.8.

Table B.9
Flood Frequency Estimates at 143001ABC
Brisbane River at Savages Crossing (Pre-Somerset Dam)

AEP (%)	ARI (YEARS)	PEAK DISCHARGE (m^3/s)		
		ESTIMATE	95 % CONFIDENCE INTERVAL	
			LOWER	UPPER
10	10	2 212	1 390	3 521
5	20	3 121	1 787	5 451
2	50	4 486	2 140	9 405
1	100	5 633	2 284	13 893

The results of the flood frequency analysis for the composite record at this site, for the period post-Somerset Dam are presented in Table B.10 and Figure B.9.

Table B.10
Flood Frequency Estimates at 143001ABC
Brisbane River at Savages Crossing (Post-Somerset Dam)

AEP (%)	ARI (YEARS)	PEAK DISCHARGE (m^3/s)		
		ESTIMATE	95 % CONFIDENCE INTERVAL	
			LOWER	UPPER
10	10	3 867	2 442	6 124
5	20	5 451	3 093	9 607
2	50	7 713	3 515	16 925
1	100	9 511	3 584	25 244

Interestingly, the results indicate larger floods for the period after construction of Somerset Dam. The reason for this is related to the different periods of record, with the pre-dam period being substantially 'drier' than the post-dam period.

The record at Mt Crosby Weir also had to be separated into two series because of the construction of Somerset Dam. The first sequence consists of 38 years extending from 1900 to 1942 and the other sequence covers 34 years from 1942 until 1975.

Mt Crosby Weir has a theoretical rating, but it has also been gauged in recent times and it has a highest streamflow measurement of 1 660 m^3/s.

The results of the flood frequency analysis for the composite record at this site, for the period pre-Somerset Dam are presented in Table B.11 and Figure B.10.

Table B.11
Flood Frequency Estimates at 143003A
Brisbane River at Mt Crosby Weir (Pre-Somerset Dam)

AEP (%)	ARI (YEARS)	PEAK DISCHARGE (m^3/s)		
		ESTIMATE	95 % CONFIDENCE INTERVAL	
			LOWER	UPPER
10	10	1 665	1 098	2 524
5	20	2 316	1 427	3 873
2	50	3 416	1 780	6 557
1	100	4 343	1 977	9 540

The results of the flood frequency analysis for the composite record at this site, for the period post-Somerset Dam are presented in Table B.12 and Figure B.11.

Table B.12
Flood Frequency Estimates at 143003A
Brisbane River at Mt Crosby Weir (Post-Somerset Dam)

AEP (%)	ARI (YEARS)	PEAK DISCHARGE (m^3/s)		
		ESTIMATE	95 % CONFIDENCE INTERVAL	
			LOWER	UPPER
10	10	3 706	2 385	5 758
5	20	4 851	2 590	9 084
2	50	6 218	2 424	15 947
1	100	7 130	2 190	23 219

The same observation can be made about the results of the flood frequency analysis of Mt Crosby Weir as was made about Savages Crossing. The post-dam period produces substantially larger estimates of flow for corresponding ARI events.

The Brisbane City Council performed a comprehensive flood frequency analysis for a number of sites on the Brisbane River below Somerset Dam, (Hegerty, 1976?). In this analysis they formed composite annual series of peak discharges for three different populations, taking into account the existence of the storages. For further discussion on these analyses refer to Section B.3.

B.2.2 COOYAR CREEK

There is only one stream gauging station on Cooyar Creek with a suitably long period of record that allows a flood frequency analysis to be performed. Details of this station are provided in Table B.13.

Table B.13
Cooyar Creek Streamgauge Station Details

STATION NUMBER	STREAM NAME	STATION NAME	AMTD (km)	CATCHMENT AREA (km^2)
143015A	Cooyar Creek	Damsite	12.2	965
143015B	Cooyar Creek	Damsite	13.3	965

The results of the flood frequency analysis performed on this site are presented in Table B.14 and Figure B.12. This particular station has a highest streamflow measurement of 208 m^3/s and a record length of only 21 years, limiting the accuracy of the flood frequency estimates.

Table B.14
Flood Frequency Estimates at 143015AB
Cooyar Creek at Damsite

AEP (%)	ARI (YEARS)	PEAK DISCHARGE (m^3/s)		
		ESTIMATE	95 % CONFIDENCE INTERVAL	
			LOWER	UPPER
10	10	717	354	1 451
5	20	1 094	469	2 550
2	50	1 705	553	5 258
1	100	2 251	569	8 905

B.2.3 EMU CREEK

There are two stream gauging stations on Emu Creek that have suitable records on which to perform flood frequency analyses.

Details of these stations are provided in Table B.15. The station located furtherest downstream at Boat Mountain is of most interest to this study.

Table B.15
Emu Creek Streamgauge Station Details

STATION NUMBER	STREAM NAME	STATION NAME	AMTD (km)	CATCHMENT AREA (km^2)
143011A	Emu Creek	Raeburn	74.0	440
143010A	Emu Creek	Boat Mountain	10.1	920

The results of the flood frequency analyses for these sites are presented in Tables B.16 and B.17 and Figures B.13 and B.14 present the results of the flood frequency analyses.

Table B.16
Flood Frequency Estimates at 143011A
Emu Creek at Raeburn

AEP (%)	ARI (YEARS)	PEAK DISCHARGE (m^3/s)		
		ESTIMATE	95 % CONFIDENCE INTERVAL	
			LOWER	UPPER
10	10	458	213	982
5	20	696	265	1 829
2	50	1 054	268	4 161
1	100	1 350	243	7 502

The station at Raeburn has a highest streamflow measurement of just 7 m^3/s, so as a consequence the peak discharge estimates at this site are not very reliable.

The record at Boat Mountain is better than at Raeburn in terms of the quality of the available rating because the highest measurement is 161 m^3/s, however overall the reliability is only fair.

Table B.17
Flood Frequency Estimates at 143010AB
Emu Creek at Boat Mountain

AEP (%)	ARI (YEARS)	PEAK DISCHARGE (m^3/s)		
		ESTIMATE	95 % CONFIDENCE INTERVAL	
			LOWER	UPPER
10	10	543	282	1 044
5	20	806	353	1 838
2	50	1 193	371	3 836
1	100	1 505	350	6 478

B.2.4 CRESSBROOK CREEK

There are two stream gauging stations on Cressbrook Creek that have suitable records on which to perform flood frequency analyses. Details of these stations are provided in Table B.18.
The station at Cressbrook Creek Damsite is of most interest to the study, although this station has since closed due to the construction of Cressbrook Creek Dam.

Table B.18
Cressbrook Creek Streamgauge Station Details

STATION NUMBER	STREAM NAME	STATION NAME	AMTD (km)	CATCHMENT AREA (km^2)
143013A	Cressbrook Ck	Damsite	58.6	325
143006A	Cressbrook Ck	Tinton	35.4	420

The station at the damsite has poor quality record due to the configuration of the gauging facility and the fact that the flow was influenced by Perseverance Dam. The highest streamflow measurement at this station was only 30 m^3/s. The results of the flood frequency analysis for this site are presented in Table B.19 and Figure B.15.

Table B.19
Flood Frequency Estimates at 143013A
Cressbrook Creek at Damsite

AEP (%)	ARI (YEARS)	PEAK DISCHARGE (m^3/s)		
		ESTIMATE	95 % CONFIDENCE INTERVAL	
			LOWER	UPPER
10	10	130	66	258
5	20	164	57	471
2	50	201	41	983
1	100	223	31	1 589

Likewise the station at Tinton has a poor quality rating with the highest streamflow measurement at this site being 21 m^3/s.

The series of annual peak discharges at Tinton should be divided into a number of pre and post Perseverance Dam and Cressbrook Creek Dam sequences. Records before 1965 would be without any dam, whilst the period between 1965 and 1981 would include Perseverance Dam, and the remainder would be with both dams. This would result in three rather short series so only the complete series was analysed.

This was considered to be appropriate because the impact of Perseverance Dam on the flows appears quite negligible. The results of the flood frequency analysis for this site are presented in Table B.20 and Figure B.16.

Table B.20
Flood Frequency Estimates at 143006A
Cressbrook Creek at Tinton

AEP (%)	ARI (YEARS)	PEAK DISCHARGE (m^3/s)		
		ESTIMATE	95 % CONFIDENCE INTERVAL	
			LOWER	UPPER
10	10	350	190	647
5	20	525	235	1 174
2	50	775	240	2 506
1	100	971	223	4 239

B.2.5 STANLEY RIVER

There are several stations on the Stanley River that have records of sufficient length to consider performing flood frequency analyses on. Details of these stations are provided in Table B.21.

Table B.21
Stanley River Streamgauge Station Details

STATION NUMBER	STREAM NAME	STATION NAME	AMTD (km)	CATCHMENT AREA (km^2)
143303A	Stanley R	Peachester	89.2	104
143301A	Stanley R	Donelly Dell	25.3	1 205
143301A	Stanley R	Hazeldean	23.7	1 230
143305A	Stanley R	Somerset Dam	7.2	1 335
143302A	Stanley R	Silverton	6.1	1 335

Peachester has a relatively long series of peak discharges of some 56 years. This station has a highest streamflow measurement of 183 m^3/s, which equates to about 35 % of the highest flow on record. The peak discharge estimates obtained from this site are regarded as being quite reliable.
The results of the flood frequency analysis for this site are presented in Table B.22 and Figure B.17.

Table B.22
Flood Frequency Estimates at 143303A
Stanley River at Peachester

AEP (%)	ARI (YEARS)	PEAK DISCHARGE (m^3/s)		
		ESTIMATE	95 % CONFIDENCE INTERVAL	
			LOWER	UPPER
10	10	435	331	574
5	20	516	335	795
2	50	597	312	1 141
1	100	643	312	1 427

The stations at Donelly Dell and Hazeldean have dubious quality record as both of these stations were manually read staff gauges and neither of them were well rated. The highest streamflow measurement at Donelly Dell was only 8 m^3/s, whilst the highest at Hazeldean was 159 m^3/s. Both of these stations were closed before or during the construction of Somerset Dam.

No frequency analysis was performed on the individual record from these stations.

The rating at Silverton is a little more reliable than the other stations, as the highest streamflow measurement at this site is 765 m^3/s. Due to the proximity of this site with respect to the junction of the Brisbane River, this station can become affected by water backing up from the Brisbane River, depending upon the relative magnitude of flow in the Stanley and Brisbane Rivers. Therefore the results of the flood frequency analyses performed with this record should be treated accordingly. The results of the flood frequency analysis for this site are presented in Table B.23 and Figure B.18.

Table B.23
Flood Frequency Estimates at 143302A
Stanley River at Silverton

AEP (%)	ARI (YEARS)	PEAK DISCHARGE (m^3/s)		
		ESTIMATE	95 % CONFIDENCE INTERVAL	
			LOWER	UPPER
10	10	1 214	754	1 954
5	20	1 595	871	2 922
2	50	2 090	881	4 954
1	100	2 450	832	7 217

Records for stations located at Donelly Dell, Hazeldean and Silverton have been formed into a composite record appropriate for the site at Silverton. This series is appropriate for the period before the construction of Somerset Dam. The results of the flood frequency analysis of the composite record for this site are presented in Table B.24 and Figure B.19.

Table B.24
Flood Frequency Estimates at 143302A
Stanley River at Silverton (Composite Record)

AEP (%)	ARI (YEARS)	PEAK DISCHARGE (m^3/s)		
		ESTIMATE	95 % CONFIDENCE INTERVAL	
			LOWER	UPPER
10	10	1 079	746	1 561
5	20	1 341	812	2 217
2	50	1 648	783	3 468
1	100	1 852	727	4 718

The introduction of the extra record reduces the magnitude of corresponding ARI events when comparing the individual record at Silverton with the composite record.

The records at Somerset Dam extend for the period of construction only. A sequence of peak discharges was formed that covers the period from 1942 until 1959.

It should be noted that the operation of the storage during this period was not consistent because of the developing structure. The peak discharge estimates cannot be considered representative of normal storage operation and would not resemble the present storage operation. The results of the flood frequency analysis for this site are presented in Table B.25 and Figure B.20.

Table B.25
Flood Frequency Estimates at 143305A
Stanley River at Somerset Dam

AEP (%)	ARI (YEARS)	PEAK DISCHARGE (m^3/s)		
		ESTIMATE	95 % CONFIDENCE INTERVAL	
			LOWER	UPPER
10	10	2 149	1 146	4 032
5	20	2 959	1 368	6 398
2	50	4 095	1 415	11 849
1	100	4 989	1 337	18 612

B.2.6 LOCKYER CREEK

There are several stations on Lockyer Creek that have records of sufficient length on which to perform a flood frequency analysis. Details of these stations are provided in Table B.26.

Table B.26
Lockyer Creek Catchment streamgauge Station Details

STATION NUMBER	STREAM NAME	STATION NAME	AMTD (km)	CATCHMENT AREA (km^2)
143203A	Lockyer Ck	Helidon	99.0	350
143203B	Lockyer Ck	Helidon # 2	96.6	375
143203C	Lockyer Ck	Helidon	99.0	350
143204A	Lockyer Ck	Wilsons Weir	61.3	1 660
143206A	Lockyer Ck	Brightview Weir	36.4	2 435
143201A	Lockyer Ck	Tarampa	29.3	2 460
143201B	Lockyer Ck	Tarampa	29.6	2 460
143210A	Lockyer Ck	Lyons Bridge	27.2	2 540
143210B	Lockyer Ck	Rifle Range Road	26.4	2 540
143207A	Lockyer Ck	O'Reillys Weir	1.4	2 980
143212A	Tenthill Ck	Tenthill	14.6	455
143209A	Laidley Ck	Mulgowie	30.7	179
143209B	Laidley Ck	Mulgowie	30.9	179

The station at Helidon has a highest streamflow measurement of 108 m^3/s, whilst at Helidon Number 2 the highest measurement is 267 m^3/s. The quality of record at these sites can only be regarded as fair because of the limited rating. Records for stations located at Helidon and Helidon Number 2 have been formed into a composite record appropriate for the site at Helidon. In addition, individual station records have been analysed for these sites.

The results of the flood frequency analysis for Helidon are presented in Table B.27 and Figure B.21.

Table B.27
Flood Frequency Estimates at 143203AC
Lockyer Creek at Helidon

AEP (%)	ARI (YEARS)	PEAK DISCHARGE (m^3/s)		
		ESTIMATE	95 % CONFIDENCE INTERVAL	
			LOWER	UPPER
10	10	338	232	493
5	20	459	279	753
2	50	616	299	1 270
1	100	731	295	1 812

The results of the flood frequency analysis for Helidon Number 2 are presented in Table B.28 and Figure B.22. The difference in estimates between the stations at Helidon are due to the different period of record and the difference in the quality of record.

Table B.28
Flood Frequency Estimates at 143203B
Lockyer Creek at Helidon #2

AEP (%)	ARI (YEARS)	PEAK DISCHARGE (m^3/s)		
		ESTIMATE	95 % CONFIDENCE INTERVAL	
			LOWER	UPPER
10	10	647	340	1 232
5	20	899	369	2 186
2	50	1 223	326	4 594
1	100	1 454	276	7 665

The results of the flood frequency analysis of the composite record for this site are presented in Table B.29 and Figure B.23.

Table B.29
Flood Frequency Estimates at 143203ABC
Lockyer Creek at Helidon (Composite Record)

AEP (%)	ARI (YEARS)	PEAK DISCHARGE (m^3/s)		
		ESTIMATE	95 % CONFIDENCE INTERVAL	
			LOWER	UPPER
10	10	418	298	586
5	20	568	360	897
2	50	760	388	1 492
1	100	897	385	2 093

At Wilsons Weir, the highest streamflow measurement is only 29 m^3/s so the reliability of the flood frequency estimates is poor. This is because large overbank flows can occur at this location which have never been measured accurately. The results of the flood frequency analysis for this site are presented in Table B.30 and Figure B.24.

Table B.30
Flood Frequency Estimates at 143204A
Lockyer Creek at Wilsons Weir

AEP (%)	ARI (YEARS)	PEAK DISCHARGE (m^3/s)		
		ESTIMATE	95 % CONFIDENCE INTERVAL	
			LOWER	UPPER
10	10	636	368	1 099
5	20	888	450	1 756
2	50	1 243	478	3 227
1	100	1 519	463	4 989

Further downstream on Lockyer Creek, there are a number of stations within close proximity that have operated at various times. These stations are located at Brightview Weir, Tarampa and at Lyons Bridge, (now Rifle Range Road). Records for the stations located at sites have been formed into a composite record appropriate for the site at Lyons Bridge. In addition, an individual station analysis of the site at Lyons Bridge has been performed. The results of the flood frequency analysis for this site are presented in Table B.31 and Figure B.25.

Table B.31
Flood Frequency Estimates at 143210AB
Lockyer Creek at Lyons Bridge

AEP (%)	ARI (YEARS)	PEAK DISCHARGE (m^3/s)		
		ESTIMATE	95 % CONFIDENCE INTERVAL	
			LOWER	UPPER
10	10	1 446	679	3 080
5	20	2 187	760	6 292
2	50	3 215	663	15 600
1	100	3 987	549	28 945

The record from each of the stations is reasonably reliable in terms of peak discharge estimation. Brightview Weir has a highest streamflow measurement of 218 m^3/s, whilst the station at Tarampa has a highest measurement of 160 m^3/s. The highest flow measurements at Lyons Bridge and Rifle Range Road are similar, being 595 m^3/s and 557 m^3/s, respectively.

All of these sites are subject to large out of bank flows so the high flow portion of the rating curves is a little suspect for each of these locations as it is not possible to accurately gauge these large flows. The results of the flood frequency analysis of the composite record for Lyons Bridge are presented in Table B.32 and Figure B.26.

Table B.32
Flood Frequency Estimates at 143210AB
Lockyer Creek at Lyons Bridge (Composite Record)

AEP (%)	ARI (YEARS)	PEAK DISCHARGE (m^3/s)		
		ESTIMATE	95 % CONFIDENCE INTERVAL	
			LOWER	UPPER
10	10	929	650	1 328
5	20	1 348	833	2 181
2	50	1 922	946	3 906
1	100	2 352	965	5 735

The remaining station on Lockyer Creek is situated at O'Reillys Weir. This station has a highest streamflow measurement of 177 m^3/s, but because of its proximity with regard to the Brisbane River it is subject to backwater effects depending upon the magnitude of the relative flows in Lockyer Creek and the Brisbane River. The results of the flood frequency analysis at this location are therefore regarded as being suspect. The results of the flood frequency analysis for this site are presented in Table B.33 and Figure B.27.

Table B.33
Flood Frequency Estimates at 143201A
Lockyer Creek at O'Reillys Weir

AEP (%)	ARI (YEARS)	PEAK DISCHARGE (m^3/s)		
		ESTIMATE	95 % CONFIDENCE INTERVAL	
			LOWER	UPPER
10	10	1 533	810	2 902
5	20	2 422	1 000	5 870
2	50	3 719	994	13 915
1	100	4 728	902	24 794

A significant change in the land use of the lower Lockyer Creek valley has occurred in the corresponding period. The impact of this change in land use has not been accounted for in the flood frequency analyses performed on any of the stations in the lower Lockyer.

There are two stations located on tributaries of Lockyer Creek that have sufficient length of record to warrant a flood frequency analysis to be performed.

The station at Tenthill on Tenthill Creek is one of these stations. The quality of the peak discharge record at this site is fair as the highest streamflow measurement is 180 m^3/s and the length of available record is 22 years. The results of the flood frequency analysis for this site are presented in Table B.34 and Figure B.28.

Table B.34
Flood Frequency Estimates at 143212A
Tenthill Creek at Tenthill

AEP (%)	ARI (YEARS)	PEAK DISCHARGE (m^3/s)		
		ESTIMATE	95 % CONFIDENCE INTERVAL	
			LOWER	UPPER
10	10	434	172	1 096
5	20	670	171	2 618
2	50	990	126	7 748
1	100	1 222	94	15 994

The other tributary station is situated at Mulgowie on Laidley Creek. The highest streamflow measurement at this station is 118 m^3/s so the reliability of the results of the flood frequency analysis is only fair. This station is effected by large out of bank flows at high stages reducing confidence in the high flow portion of the rating curve as evidenced by the plot of the annual series. The results of the flood frequency analysis for this site are presented in Table B.35 and Figure B.29.

Table B.35
Flood Frequency Estimates at 143209AB
Laidley Creek at Mulgowie

AEP (%)	ARI (YEARS)	PEAK DISCHARGE (m^3/s)		
		ESTIMATE	95 % CONFIDENCE INTERVAL	
			LOWER	UPPER
10	10	307	82	1 136
5	20	325	56	1 904
2	50	335	41	2 723
1	100	338	37	3 092

B.2.7 BREMER RIVER

Details of the stations on the Bremer River and its tributaries on which flood frequency analyses were performed are presented in Table B.36.

Table B.36
Bremer River Catchment Streamgauge Station Details

STATION NUMBER	STREAM NAME	STATION NAME	AMTD (km)	CATCHMENT AREA (km^2)
143104A	Bremer R	Rosevale	82.7	78
143104B	Bremer R	Rosevale	83.5	78
143110A	Bremer R	Adams Bridge	77.1	130
143107A	Bremer R	Walloon	37.2	620
143102A	Warrill Ck	Kalbar # 1	50.9	465
143102B	Warrill Ck	Kalbar # 2	49.7	470
143108A	Warrill Ck	Amberley	8.7	920
143113A	Purga CK	Loamside	6.8	215

The streamgauge at Rosevale has a highest measurement of 82 m^3/s, which equates to 41 % of the largest flood on record. This station also has a long record, however the high flow portion of the rating curve is not reliable because of out of bank flows and so the quality of the peak discharge record is questionable. The results of the flood frequency analysis for this site are presented in Table B.37 and Figure B.30.

Table B.37
Flood Frequency Estimates at 143104AB
Bremer River at Rosevale

AEP (%)	ARI (YEARS)	PEAK DISCHARGE (m^3/s)		
		ESTIMATE	95 % CONFIDENCE INTERVAL	
			LOWER	UPPER
10	10	274	139	541
5	20	326	112	947
2	50	368	85	1 596
1	100	387	71	2 098

The station at Adams Bridge is of somewhat better quality in terms of peak discharge estimates as it has a highest streamflow measurement of 173 m^3/s, but there is only 22 years of record at this site. The results of the flood frequency analysis for this site are presented in Table B.38 and Figure B.31.

Table B.38
Flood Frequency Estimates at 143110A
Bremer River at Adams Bridge

AEP (%)	ARI (YEARS)	PEAK DISCHARGE (m^3/s)		
		ESTIMATE	95 % CONFIDENCE INTERVAL	
			LOWER	UPPER
10	10	312	215	452
5	20	388	242	615
2	50	484	255	918
1	100	552	249	1 226

Of all of the stations on the Bremer River, Walloon has by far the best definition of its high flow portion of its rating curve. The highest streamflow measurement at this station is 406 m^3/s and the rating has been extended using a straight line extrapolation on log-log paper which has been checked by area-velocity methods. This station has almost 30 years of record, making it the most reliable station on the Bremer on which to base flood frequency estimates. The results of the flood frequency analysis for this site are presented in Table B.39 and Figure B.32.

Table B.39
Flood Frequency Estimates at 143107A
Bremer River at Walloon

AEP (%)	ARI (YEARS)	PEAK DISCHARGE (m^3/s)		
		ESTIMATE	95 % CONFIDENCE INTERVAL	
			LOWER	UPPER
10	10	779	548	1 107
5	20	952	576	1 573
2	50	1 144	537	2 436
1	100	1 266	491	3 264

The stations on Warrill Creek located at Kalbar have varying reliability of peak discharge estimates because the highest streamflow measurements at these sites are 87 m^3/s and 195 m^3/s, respectively. Two series were derived from the records of the stations located at Kalbar, to account for the construction of Moogerah Dam on Reynolds Creek. Work commenced on Moogerah Dam in 1959 and it was completed in 1961 hence, the two series extend from 1912 to 1956 and from 1959 to 1971 when the station was closed.

The results of the flood frequency analysis for Kalbar for the period pre-Moogerah Dam are presented in Table B.40 and Figure B.33.

Table B.40
Flood Frequency Estimates at 143102A
Warrill Creek at Kalbar (Pre-Moogerah Dam)

AEP (%)	ARI (YEARS)	PEAK DISCHARGE (m^3/s)		
		ESTIMATE	95 % CONFIDENCE INTERVAL	
			LOWER	UPPER
10	10	487	377	629
5	20	571	388	840
2	50	657	366	1 179
1	100	708	342	1 464

The results of the flood frequency analysis for Kalbar for the period post-Moogerah Dam are presented in Table B.41 and Figure B.34.

Table B.41
Flood Frequency Estimates at 143102BC
Warrill Creek at Kalbar (Post-Moogerah Dam)

AEP (%)	ARI (YEARS)	PEAK DISCHARGE (m^3/s)		
		ESTIMATE	95 % CONFIDENCE INTERVAL	
			LOWER	UPPER
10	10	311	197	492
5	20	347	167	723
2	50	379	128	1 123
1	100	396	106	1 475

The other station on Warrill Creek, at Amberley, is the location with the most suitable record on which to base a flood frequency analysis. This site has a highest streamflow measurement of 412 m^3/s with the rating curve extension based upon a straight line extrapolation on log-log paper which has been checked by area-velocity methods. Record at this site has been affected by the presence of Moogerah Dam for the whole period of time that data has been collected. The results of the flood frequency analysis for this site are presented in Table B.42 and Figure B.35.

Table B.42
Flood Frequency Estimates at 143108A
Warrill Creek at Amberley

AEP (%)	ARI (YEARS)	PEAK DISCHARGE (m^3/s)		
		ESTIMATE	95 % CONFIDENCE INTERVAL	
			LOWER	UPPER
10	10	745	441	1 258
5	20	1 092	568	2 100
2	50	1 694	714	4 021
1	100	2 282	806	6 466

The quality of peak discharge record at the remaining station at Loamside on Purga Creek is fair as the highest streamflow measurement at this site is 47 m^3/s. The length of record is quite short however, reducing the reliability of the flood frequency estimates obtainable from this station. The results of the flood frequency analysis for this site are presented in Table B.43 and Figure B.36.

Table B.43
Flood Frequency Estimates at 143113A
Purga Creek at Loamside

AEP (%)	ARI (YEARS)	PEAK DISCHARGE (m^3/s)		
		ESTIMATE	95 % CONFIDENCE INTERVAL	
			LOWER	UPPER
10	10	293	108	793
5	20	344	71	1 667
2	50	387	43	3 486
1	100	406	32	5 228

B.3 PREVIOUS FLOOD FREQUENCY ANALYSES

The Brisbane City Council have performed a comprehensive flood frequency analysis for a number of sites on the Brisbane River below Somerset Dam, (Hegerty, 1976?). In this analysis they formed composite annual series of peak discharges for three different populations:

(i) without any dams
(ii) with Somerset Dam
(iii) with Somerset Dam and Wivenhoe Dam

The BCC had to synthesise records from the available pre and post Somerset Dam records of each of the sites they investigated. Assumptions on how the storages operated and at what level they were prior to each flood were incorporated into these series. These assumptions were not described in detail when the WRC were provided the annual series data by the BCC.

Series of annual peak discharges were formed that extend from 1887 to 1975, a sequence of 88 years. One advantage of these series are that they incorporate the wet periods of the 1890's, which contain some of the largest floods ever witnessed in the Brisbane River.

These sequences have been analysed using computer program WS06 so that they are consistent with the results of the other analyses performed in this study. A log-Pearson Type III distribution has been fitted to each series along with 95 % confidence limits.

Locations considered in these analyses are shown in Table B.44.

Table B.44
BCC Flood Frequency Analysis Locations

STATION NUMBER	STREAM NAME	STATION NAME	AMTD (km)	CATCHMENT AREA (km^2)
143305A	Stanley R	Somerset Dam	7.2	1 335
143026A	Brisbane R	Wivenhoe Dam	150.2	7 020
143001A	Brisbane R	Savages Crossing	130.8	10 180
143003A	Brisbane R	Mt Crosby Weir	90.8	10 565
-------	Brisbane R	Moggill	64.2	12 770

By way of comparison, the results of the frequency analysis for the three cases described above for the site at Moggill are presented in Table B.45 and Figures B.37 to B.39.

The impact of the flood mitigation capability of the storages is obvious from Table B.45. The operating procedures utilised to derive the series of peak discharges have been superseded and as a consequence the series are no longer representative, except for the 'No Dams Effective' case.

The results of this analysis do provide an indication of the mitigation capability of the storages.

Table B.45
Flood Frequency Estimates at
Brisbane River at Moggill

AEP (%)	ARI (YEARS)	PEAK DISCHARGE (m^3/s)		
		ESTIMATE	95 % CONFIDENCE INTERVAL	
			LOWER	UPPER
10	10	4 978	3 921	2 830
5	20	7 936	6 059	4 627
2	50	13 149	9 677	7 757
1	100	18 195	13 059	10 719

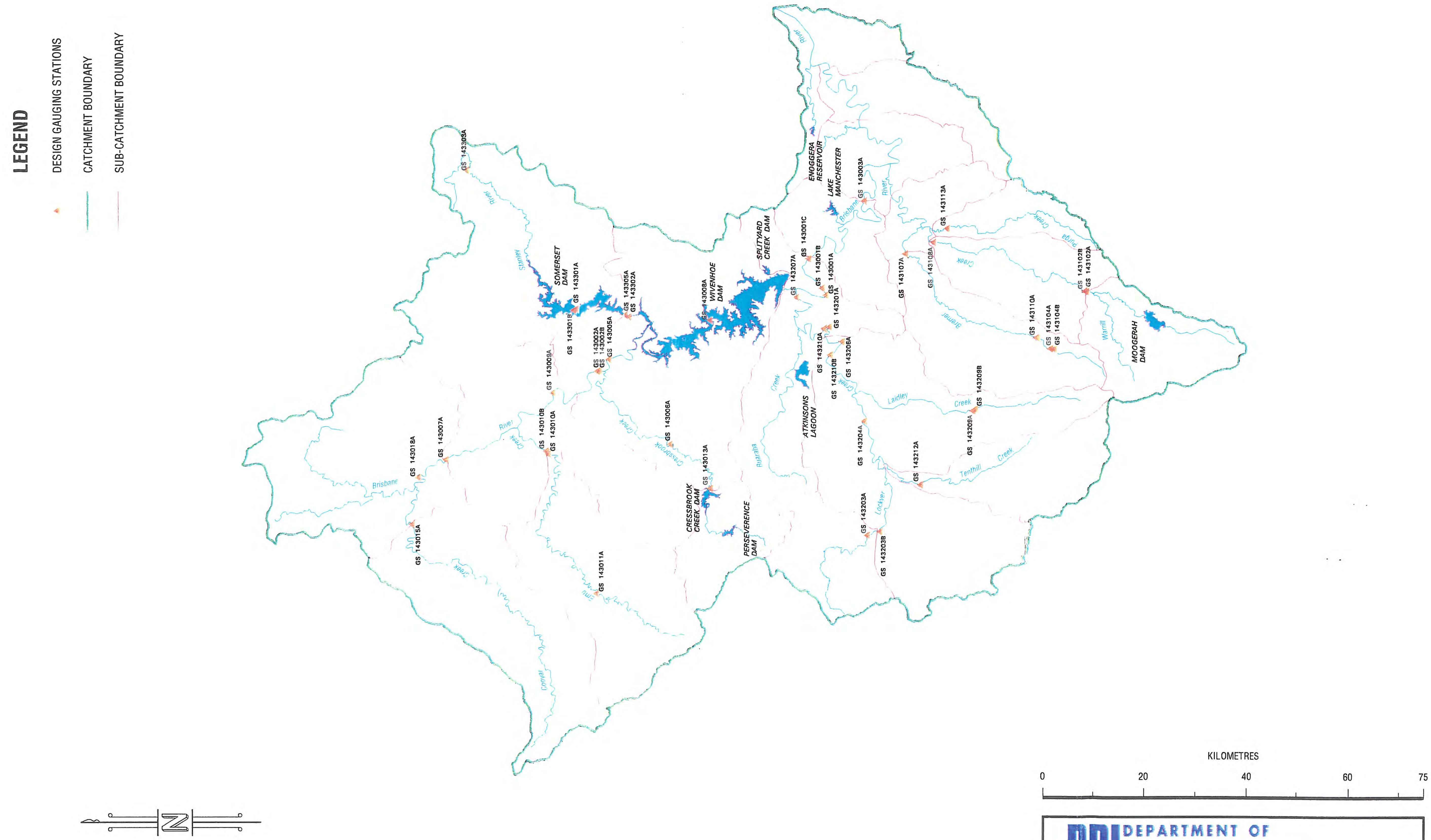
In the design flood report prepared by Weeks, (1983), the annual series of peak discharges derived by the BCC for Wivenhoe Dam was analysed as a secondary means for estimating the design floods for the dam. This series was derived assuming that Somerset Dam was effective for the entire sequence of 95 years from 1887 to 1981.
Weeks concluded that the Log-Pearson Type III distribution with parameters estimated using the maximum likelihood method agreed most closely with the results that he had obtained using runoff-routing modelling techniques. The results of the flood frequency analysis are presented in Table B.46 for comparative purposes.

Table B.46
Flood Frequency Estimates
Brisbane River at Wivenhoe Dam
(Somerset Dam Effective)
(Weeks, 1983)

AEP (%)	ARI (YEARS)	DISCHARGE (m^3/s)
1	100	7 340
0.1	1 000	12 920
0.01	10 000	18 940

It is not possible to compare these results with the results that have been obtained from the runoff-routing modelling and storage routing modelling conducted in this study directly, because the later estimates take into consideration the operation of both storages. However, an examination of the inflow estimates that have been derived for Wivenhoe Dam show that they are slightly larger than the values indicated in Table B.46. This is expected since the effect of the storage of Wivenhoe Dam has not been included in the flood frequency estimates and it is generally accepted that the inclusion of a dam will result in an apparent increase of the flow when compared to a catchment in its natural state.

FIGURE B1



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QUEENSLAND WATER RESOURCES

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Brisbane River
Gauging Stations

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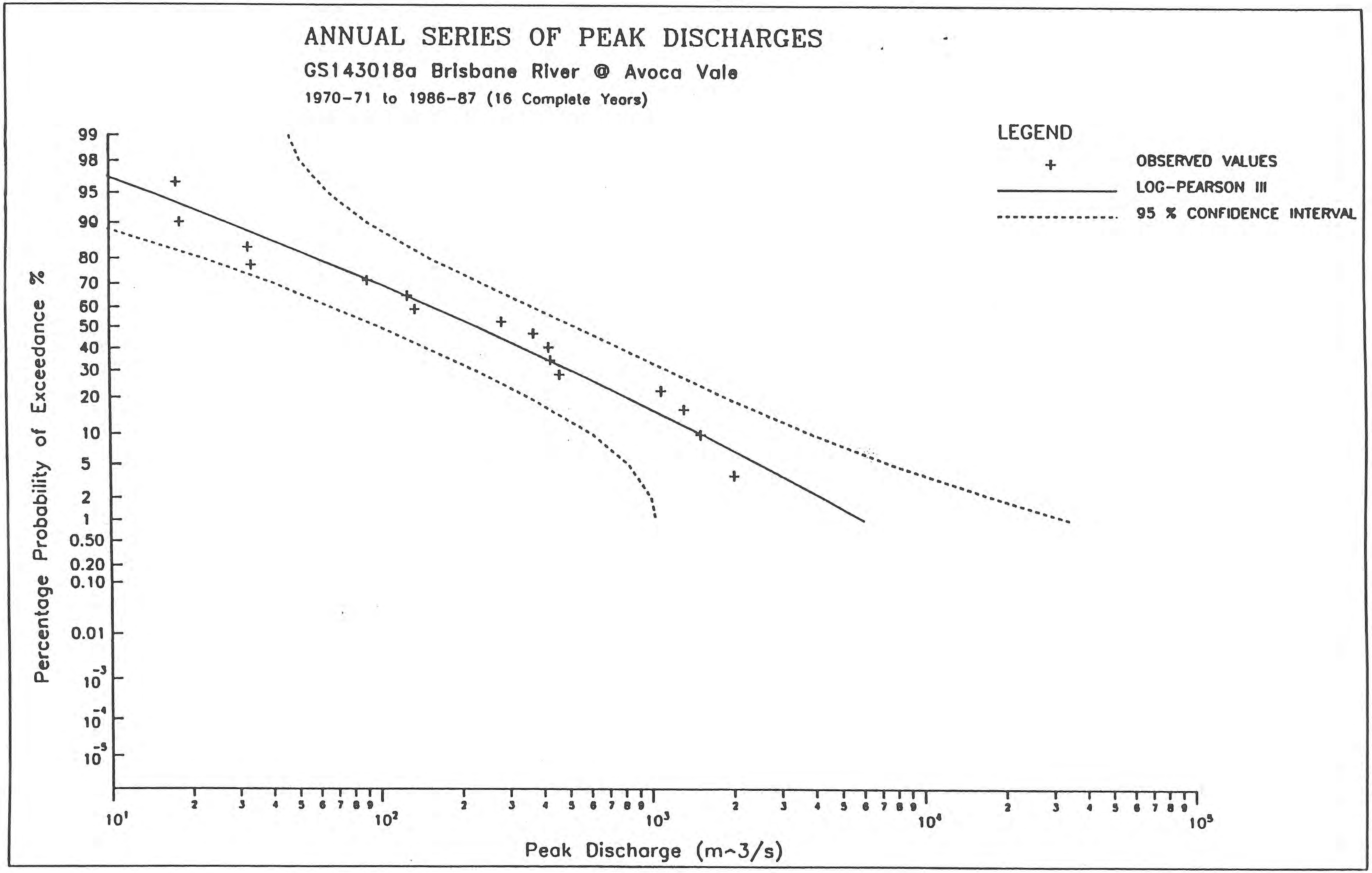

ANNUAL SERIES OF PEAK DISCHARGES
GS143018a Brisbane River @ Avoca Vale
1970-71 to 1986-87 (16 Complete Years)
LEGEND
OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
Peak Discharge (m~3/s)

FIGURE B.2

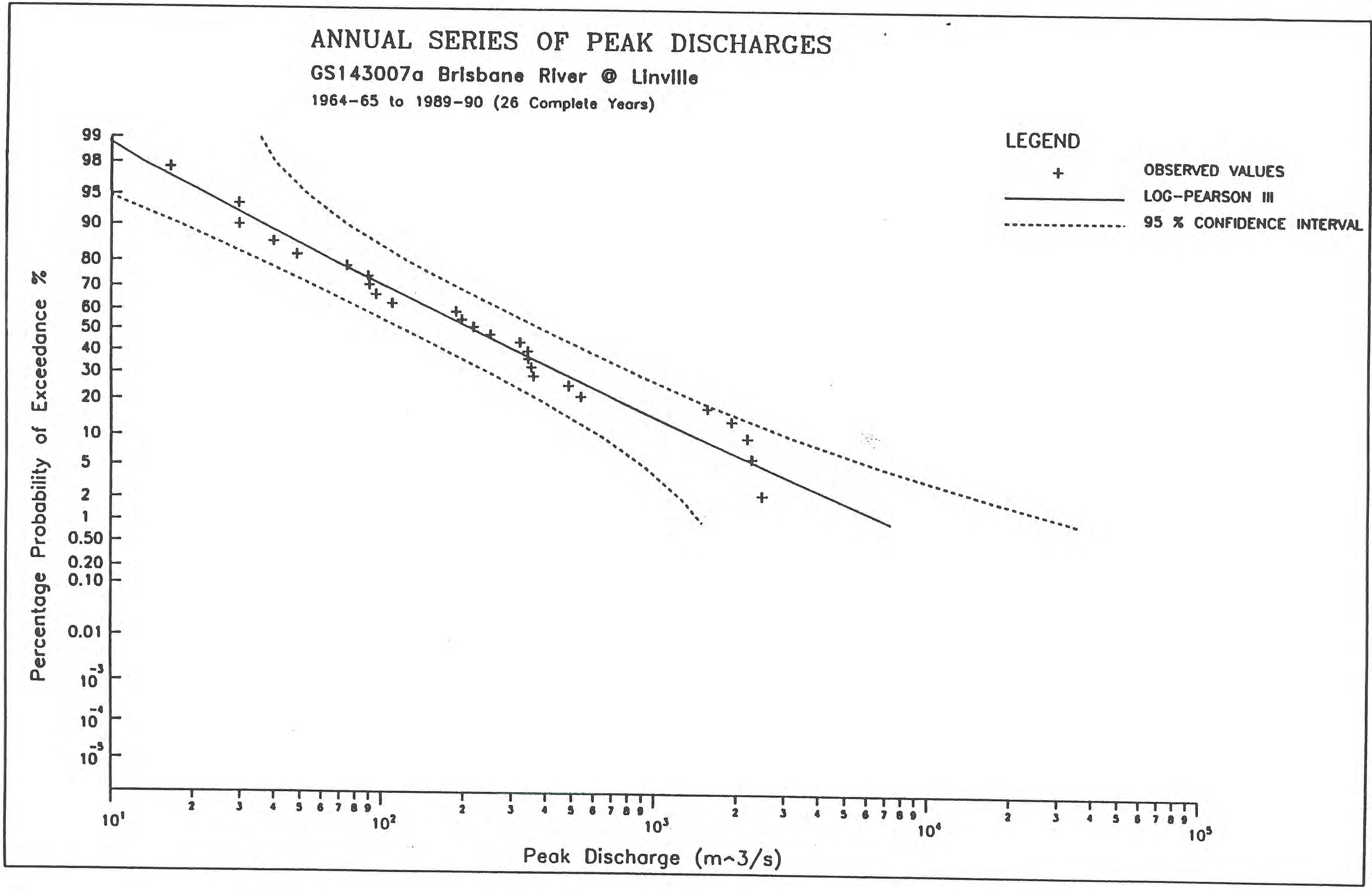

ANNUAL SERIES OF PEAK DISCHARGES
GS143007a Brisbane River @ Linville
1964-65 to 1989-90 (26 Complete Years)
LEGEND
OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.50
0.20
0.10
0.01
10^-3
10^-4
10^-5
10^1
10^2
10^3
10^4
10^5
Peak Discharge (m~3/s)

FIGURE B.3

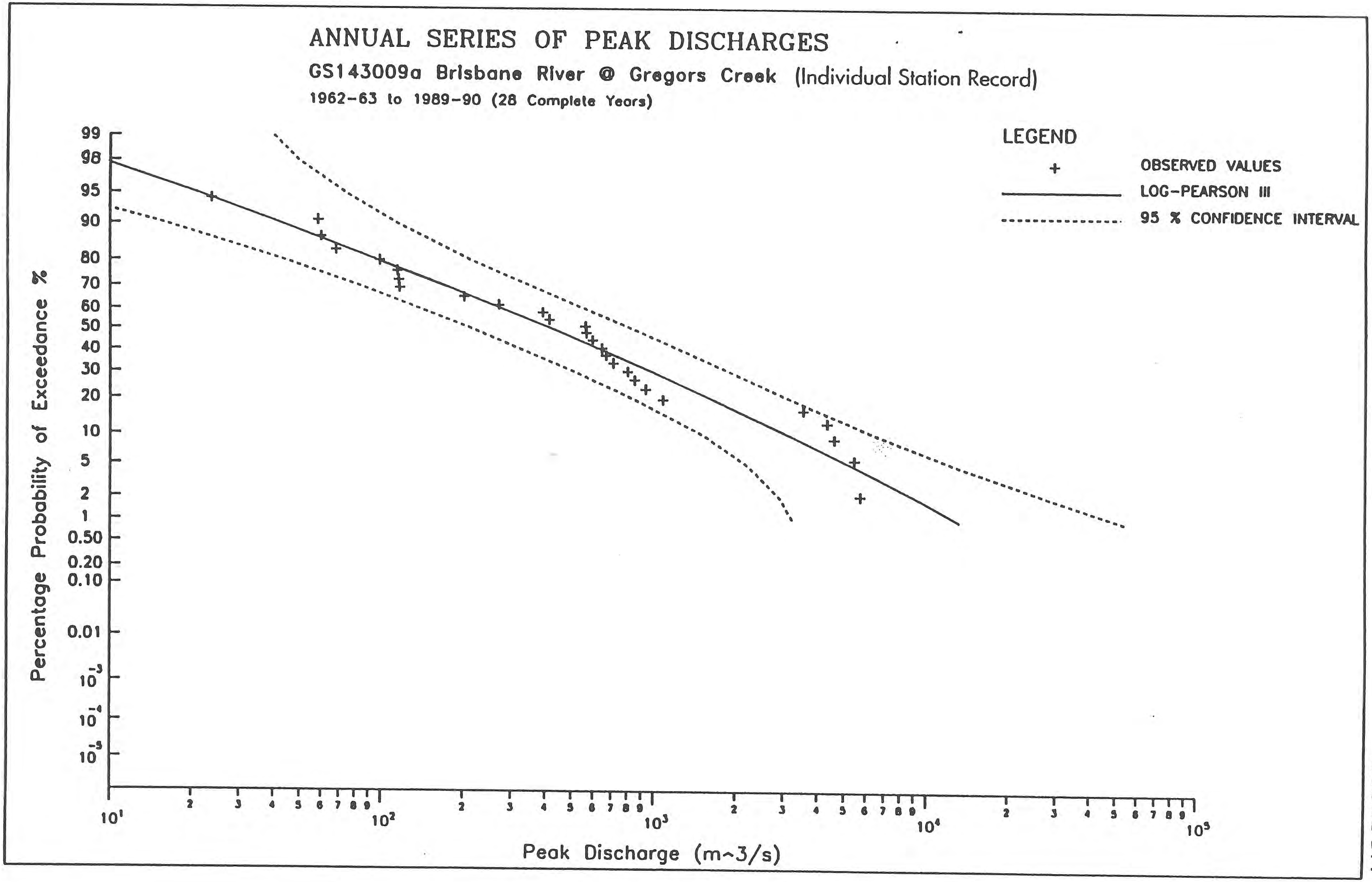

ANNUAL SERIES OF PEAK DISCHARGES
GS143009a Brisbane River @ Gregors Creek (Individual Station Record)
1962-63 to 1989-90 (28 Complete Years)
LEGEND
OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
Peak Discharge (m~3/s)

FIGURE B.4

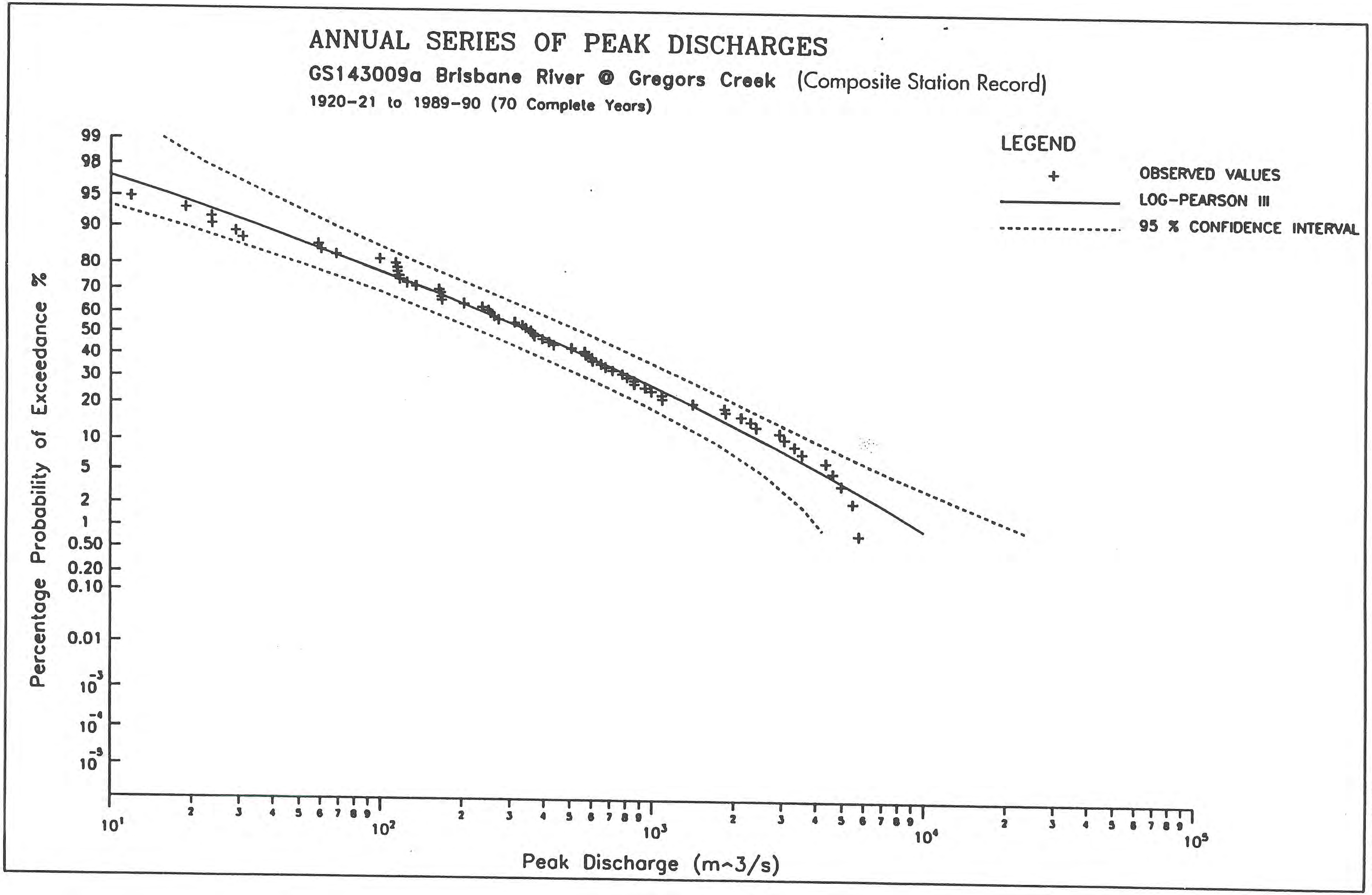

ANNUAL SERIES OF PEAK DISCHARGES
GS143009a Brisbane River @ Gregors Creek (Composite Station Record)
1920-21 to 1989-90 (70 Complete Years)
LEGEND
OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
Peak Discharge (m~3/s)

FIGURE B.5

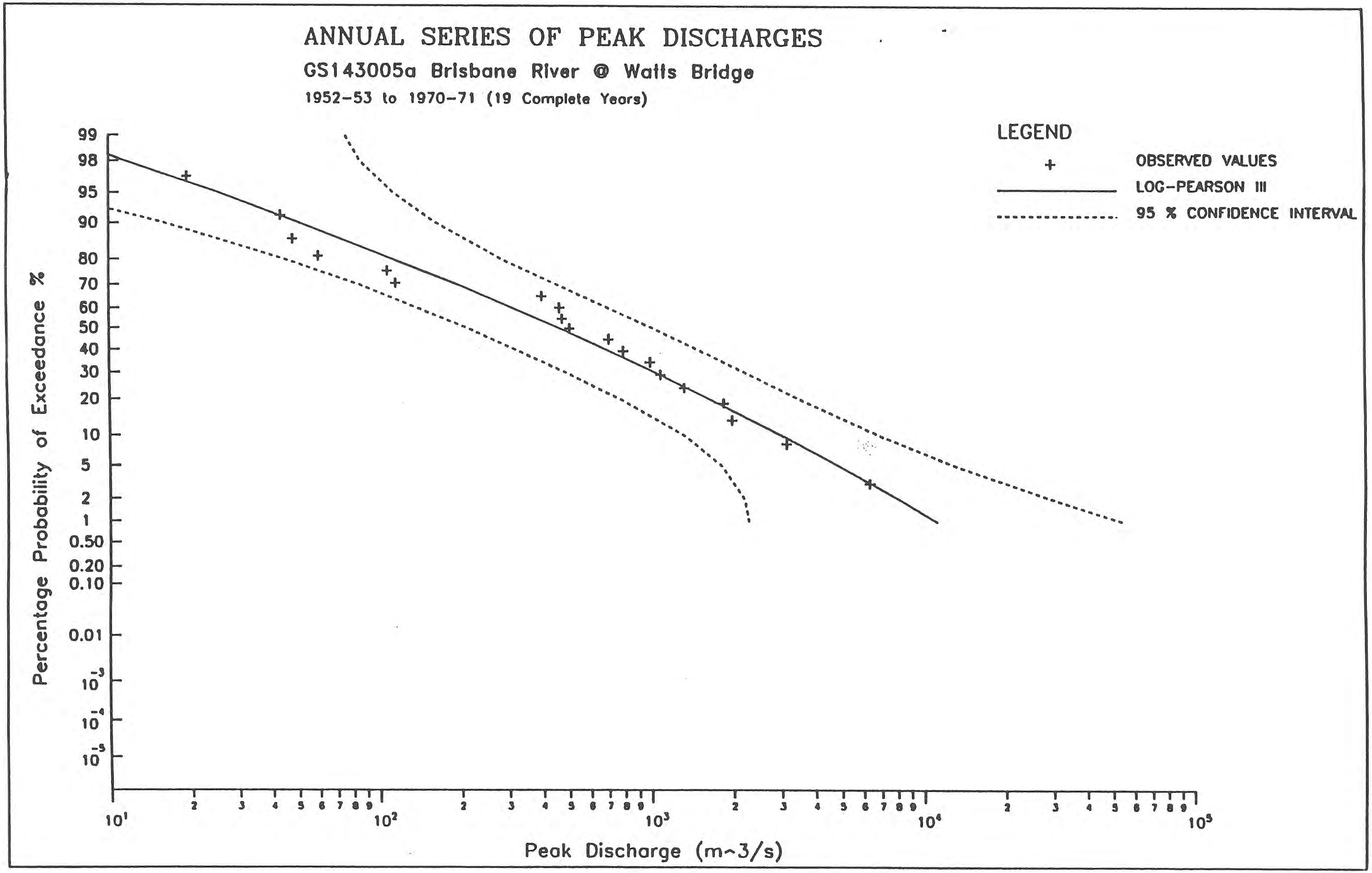

ANNUAL SERIES OF PEAK DISCHARGES
GS143005a Brisbane River @ Watts Bridge
1952-53 to 1970-71 (19 Complete Years)
LEGEND
OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.50
0.20
0.10
0.01
10^{-3}
10^{-4}
10^{-5}
10^1
10^2
10^3
10^4
10^5
Peak Discharge (m~3/s)

FIGURE B.6

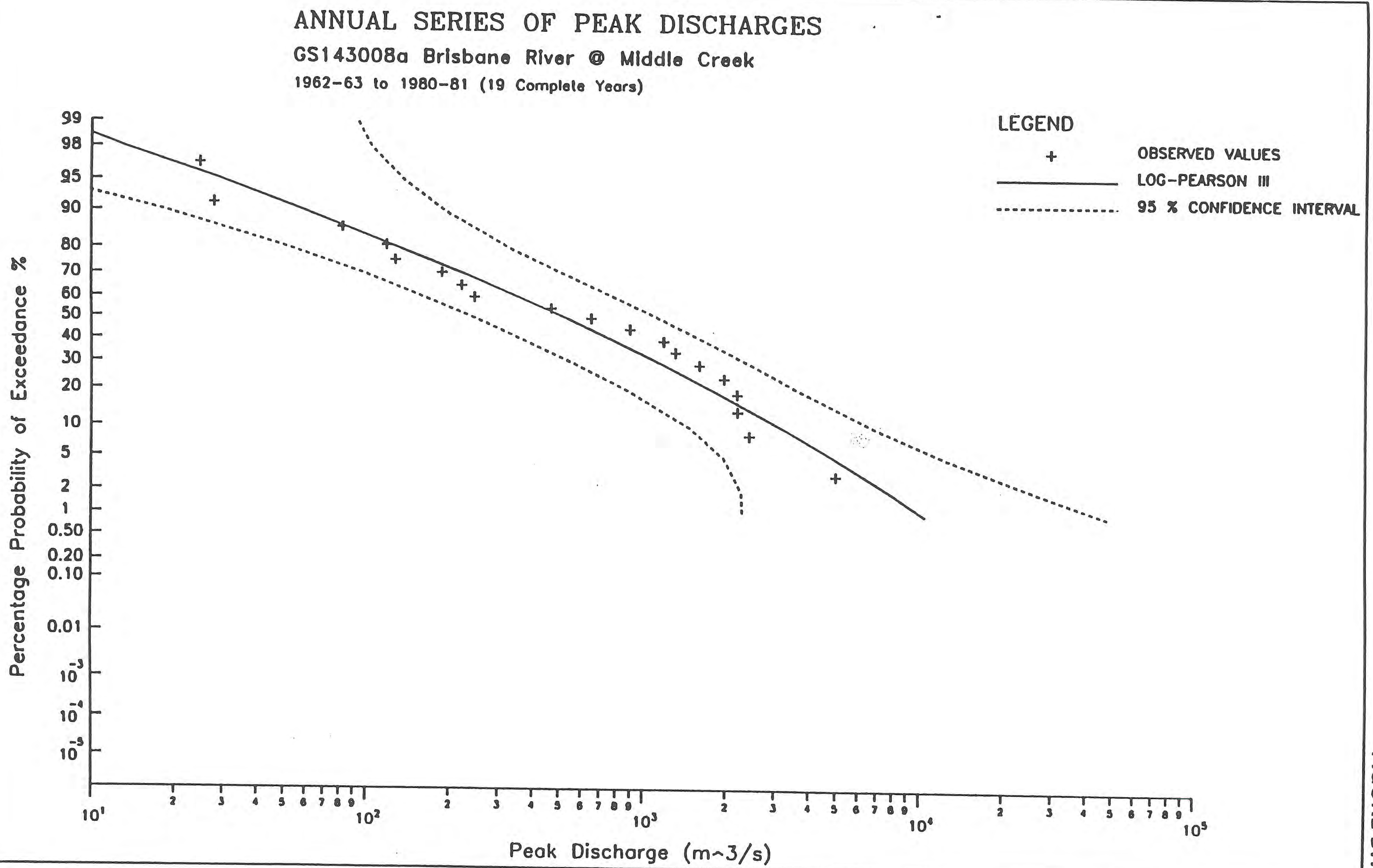
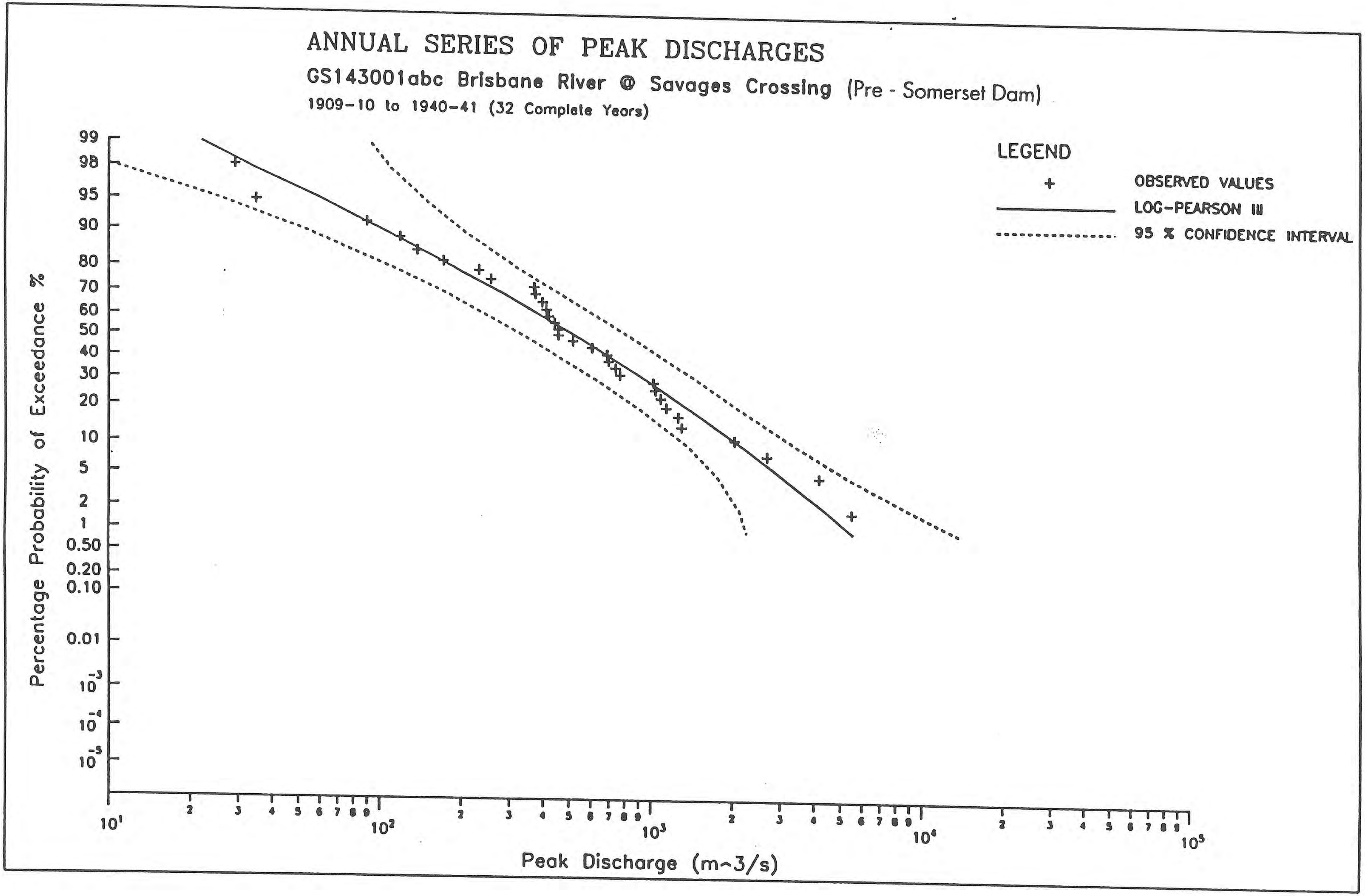
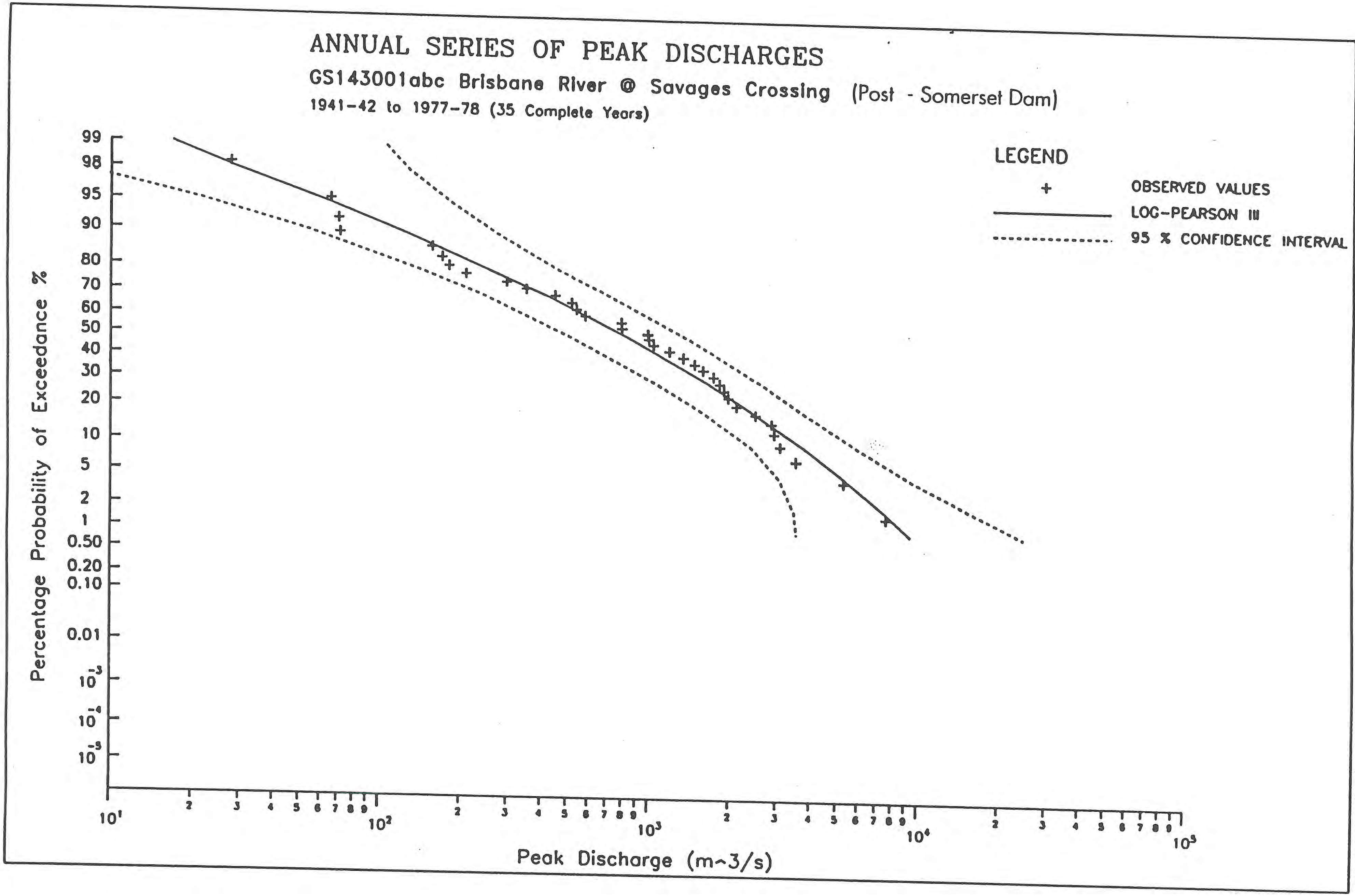

ANNUAL SERIES OF PEAK DISCHARGES
GS143008a Brisbane River @ Middle Creek
1962-63 to 1980-81 (19 Complete Years)
LEGEND
OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.50
0.20
0.10
0.01
10^-3
10^-4
10^-5
10^1
10^2
10^3
10^4
10^5
Peak Discharge (m~3/s)

FIGURE B.7



ANNUAL SERIES OF PEAK DISCHARGES
GS143001abc Brisbane River @ Savages Crossing (Pre - Somerset Dam)
1909-10 to 1940-41 (32 Complete Years)
LEGEND
OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.50
0.20
0.10
0.01
10^-3
10^-4
10^-5
10^1
10^2
10^3
10^4
10^5
Peak Discharge (m~3/s)

FIGURE B.8



ANNUAL SERIES OF PEAK DISCHARGES
GS143001abc Brisbane River @ Savages Crossing (Post - Somerset Dam)
1941-42 to 1977-78 (35 Complete Years)
LEGEND
OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
Peak Discharge (m~3/s)

FIGURE B.9

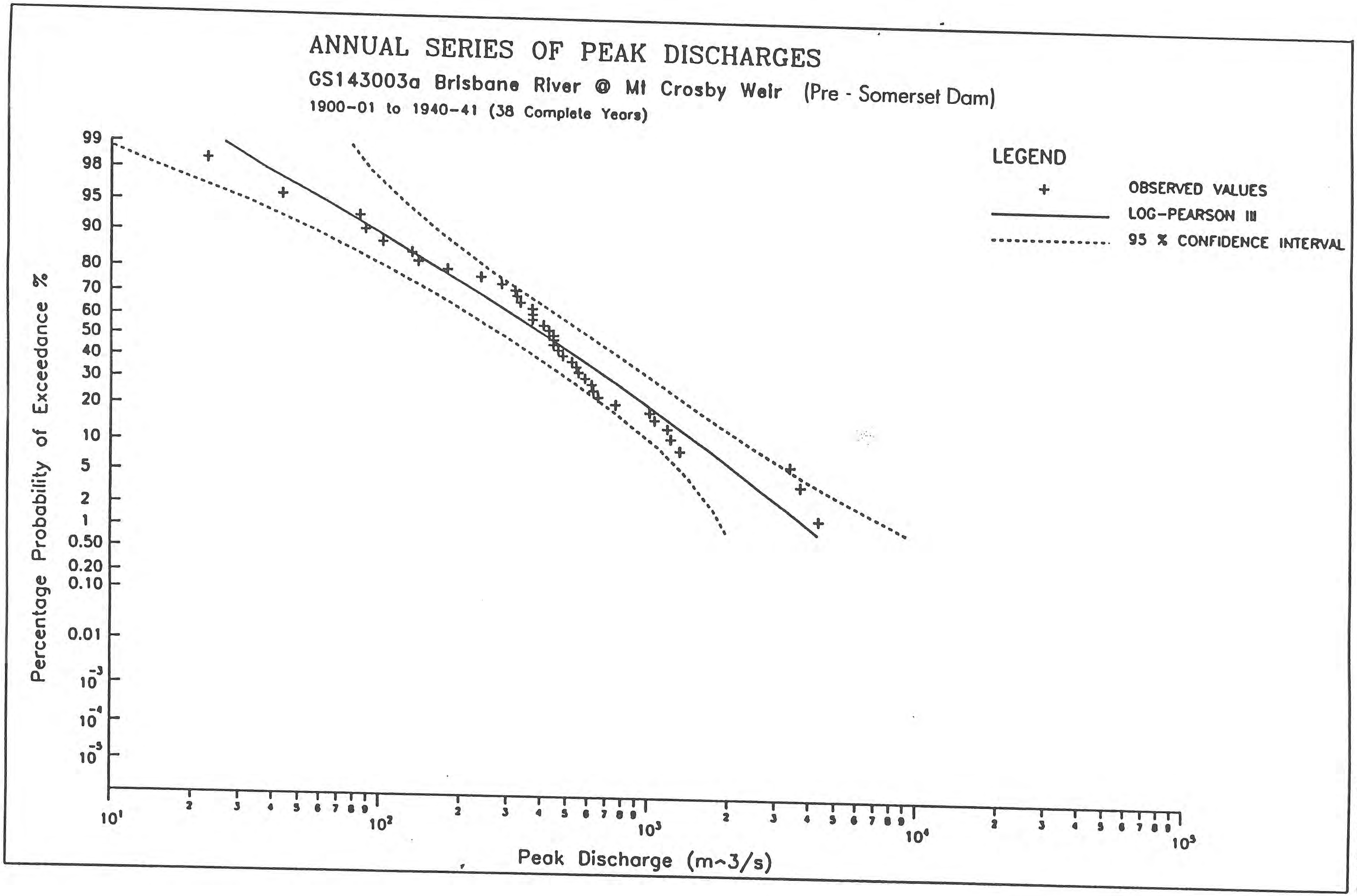

ANNUAL SERIES OF PEAK DISCHARGES
GS143003a Brisbane River @ Mt Crosby Weir (Pre - Somerset Dam)
1900-01 to 1940-41 (38 Complete Years)
LEGEND
OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
Peak Discharge (m~3/s)

FIGURE B.10

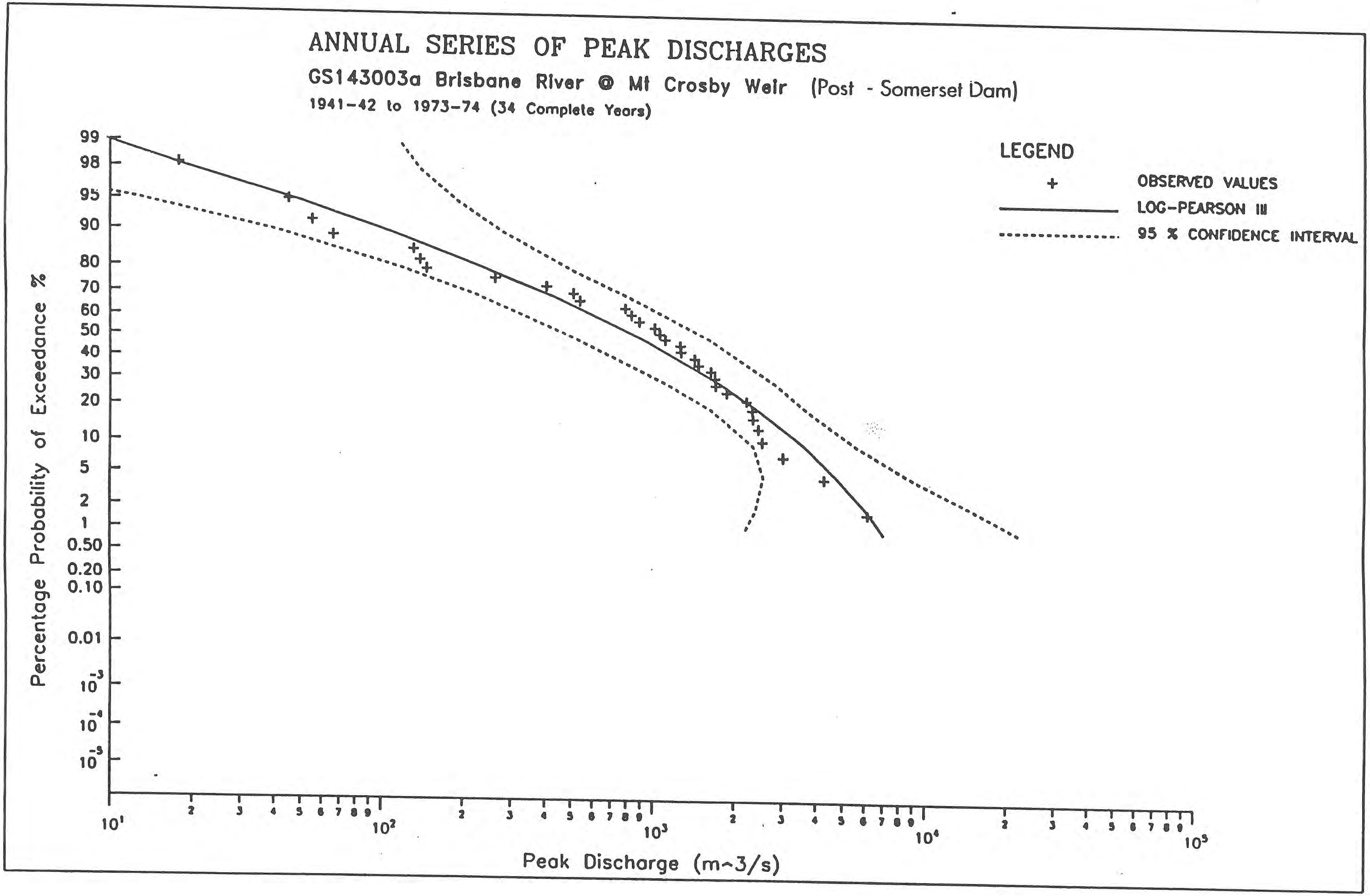

ANNUAL SERIES OF PEAK DISCHARGES
GS143003a Brisbane River @ Mt Crosby Weir (Post - Somerset Dam)
1941-42 to 1973-74 (34 Complete Years)
LEGEND
OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.50
0.20
0.10
0.01
10^{-3}
10^{-4}
10^{-5}
10^1
10^2
10^3
10^4
10^5
Peak Discharge (m~3/s)

FIGURE B.11

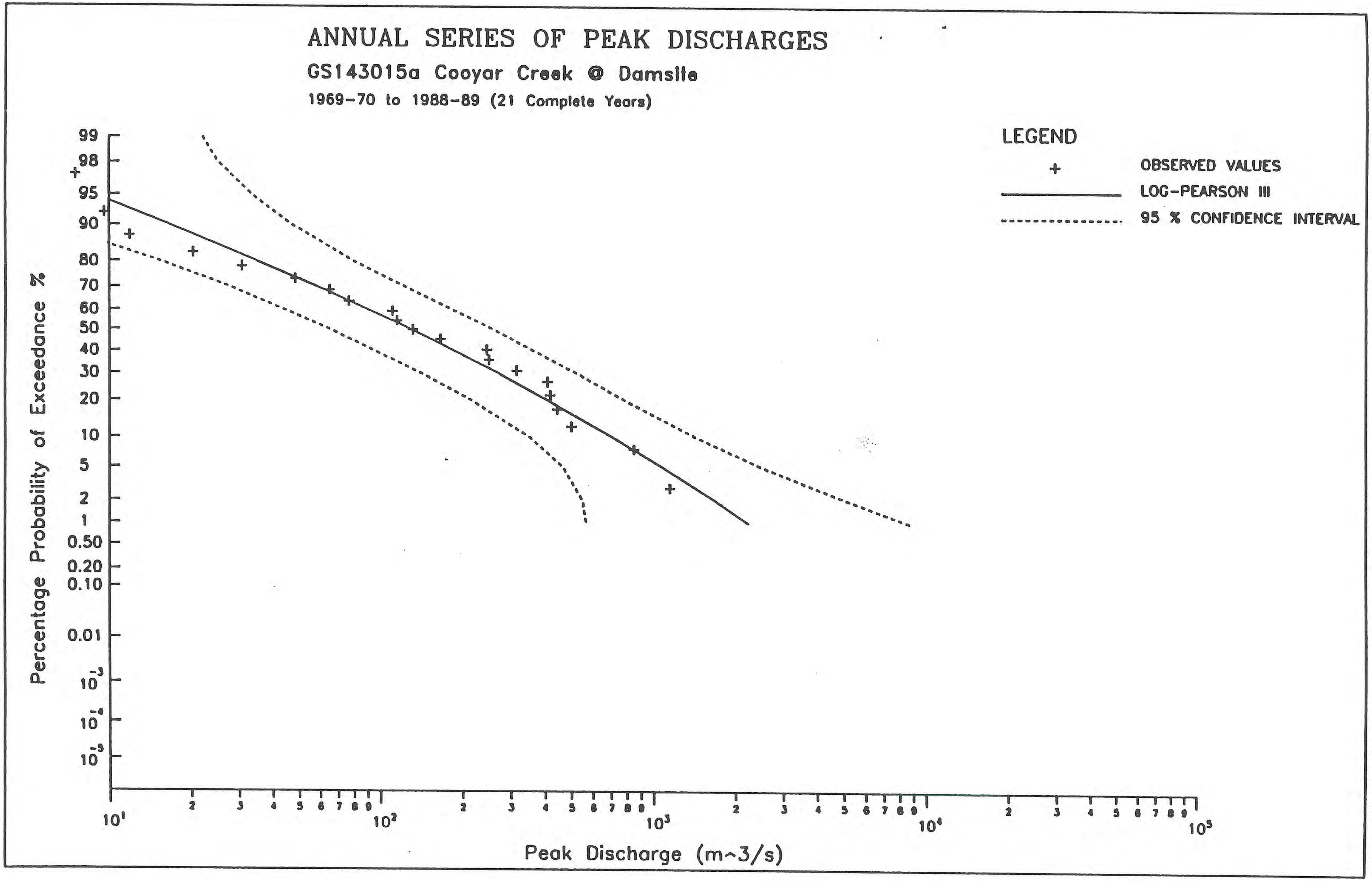
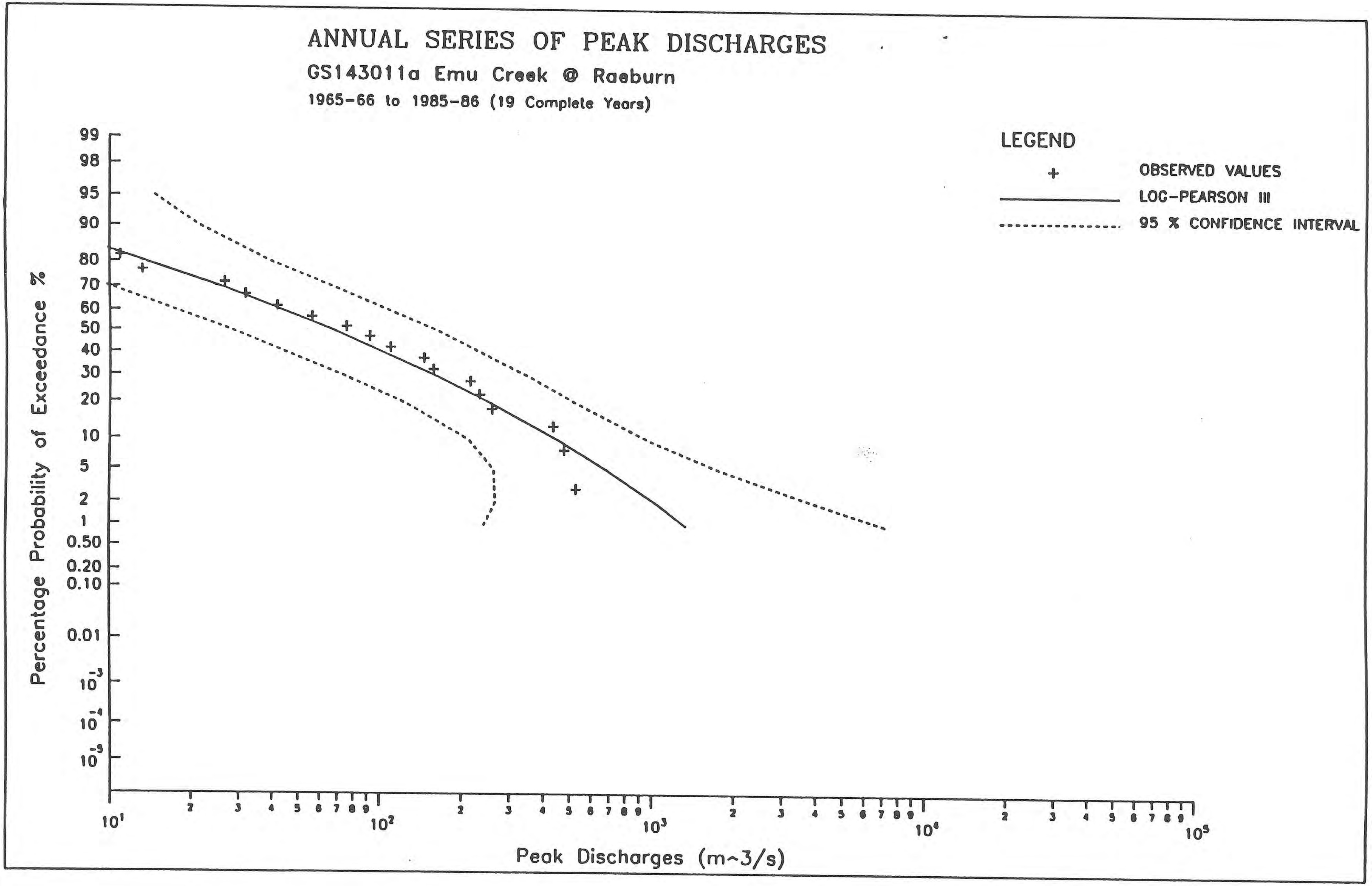

ANNUAL SERIES OF PEAK DISCHARGES
GS143015a Cooyar Creek @ Damsite
1969-70 to 1988-89 (21 Complete Years)
LEGEND
OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
Peak Discharge (m~3/s)

FIGURE B.12



ANNUAL SERIES OF PEAK DISCHARGES
GS143011a Emu Creek @ Raeburn
1965-66 to 1985-86 (19 Complete Years)
LEGEND
OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.50
0.20
0.10
0.01
10^-3
10^-4
10^-5
10^1
10^2
10^3
10^4
10^5
Peak Discharges (m~3/s)

FIGURE B.13

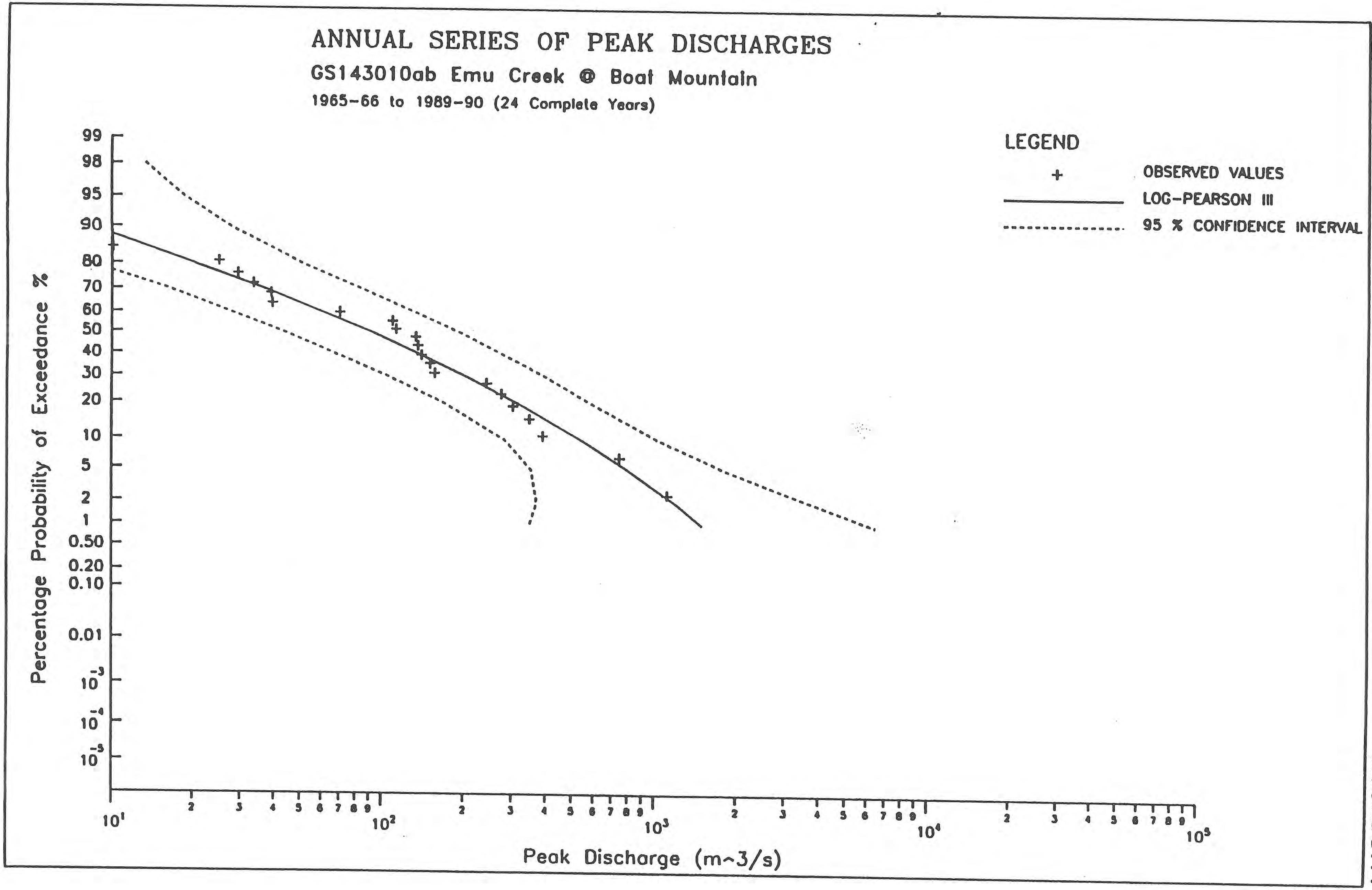
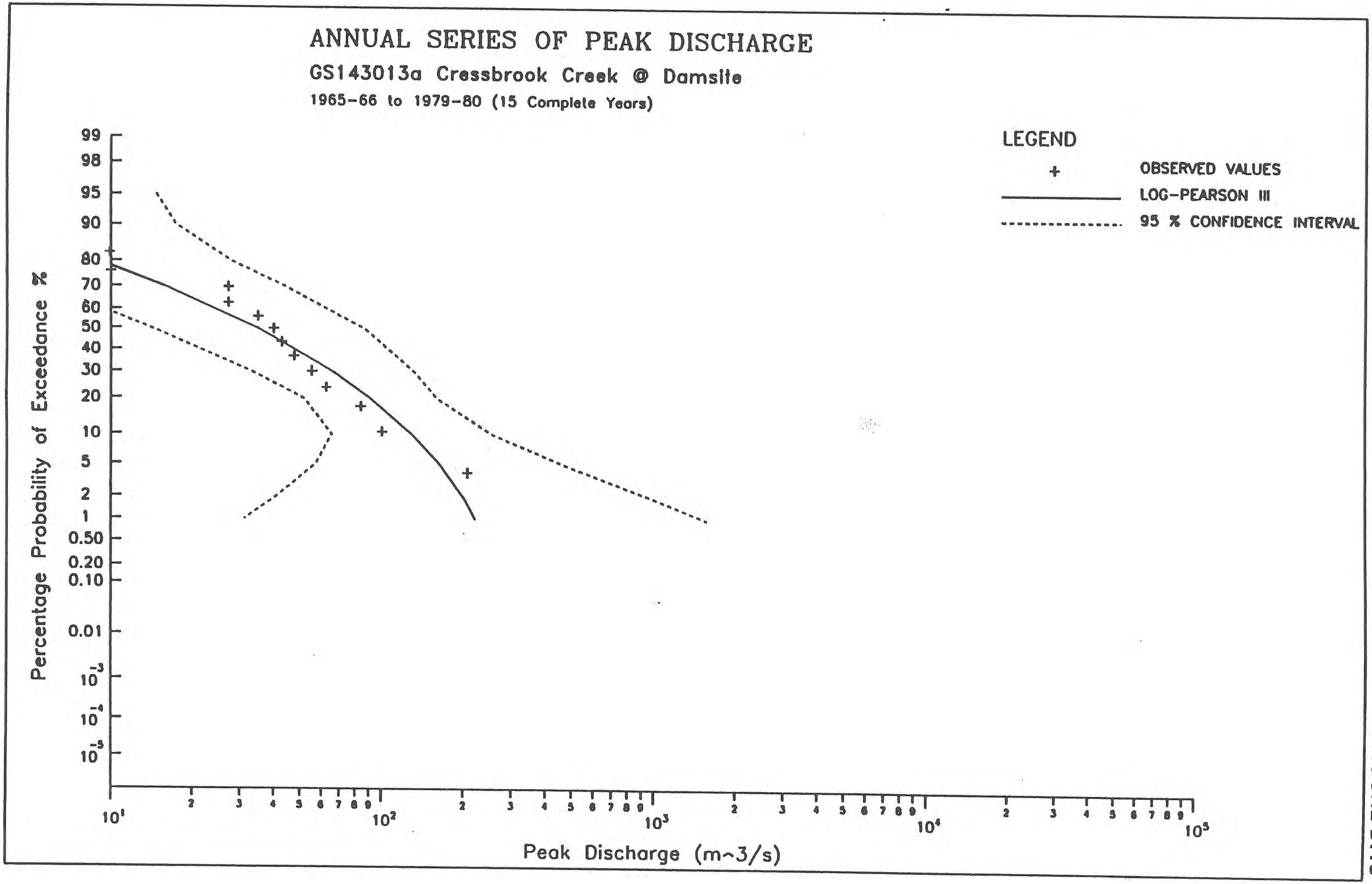

ANNUAL SERIES OF PEAK DISCHARGES
GS143010ab Emu Creek @ Boat Mountain
1965-66 to 1989-90 (24 Complete Years)
LEGEND
OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.50
0.20
0.10
0.01
10^{-3}
10^{-4}
10^{-5}
10^1
10^2
10^3
10^4
10^5
Peak Discharge (m~3/s)

FIGURE B.14



ANNUAL SERIES OF PEAK DISCHARGE
GS143013a Cressbrook Creek @ Damsite
1965-66 to 1979-80 (15 Complete Years)
LEGEND
OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
Peak Discharge (m~3/s)

FIGURE B.15

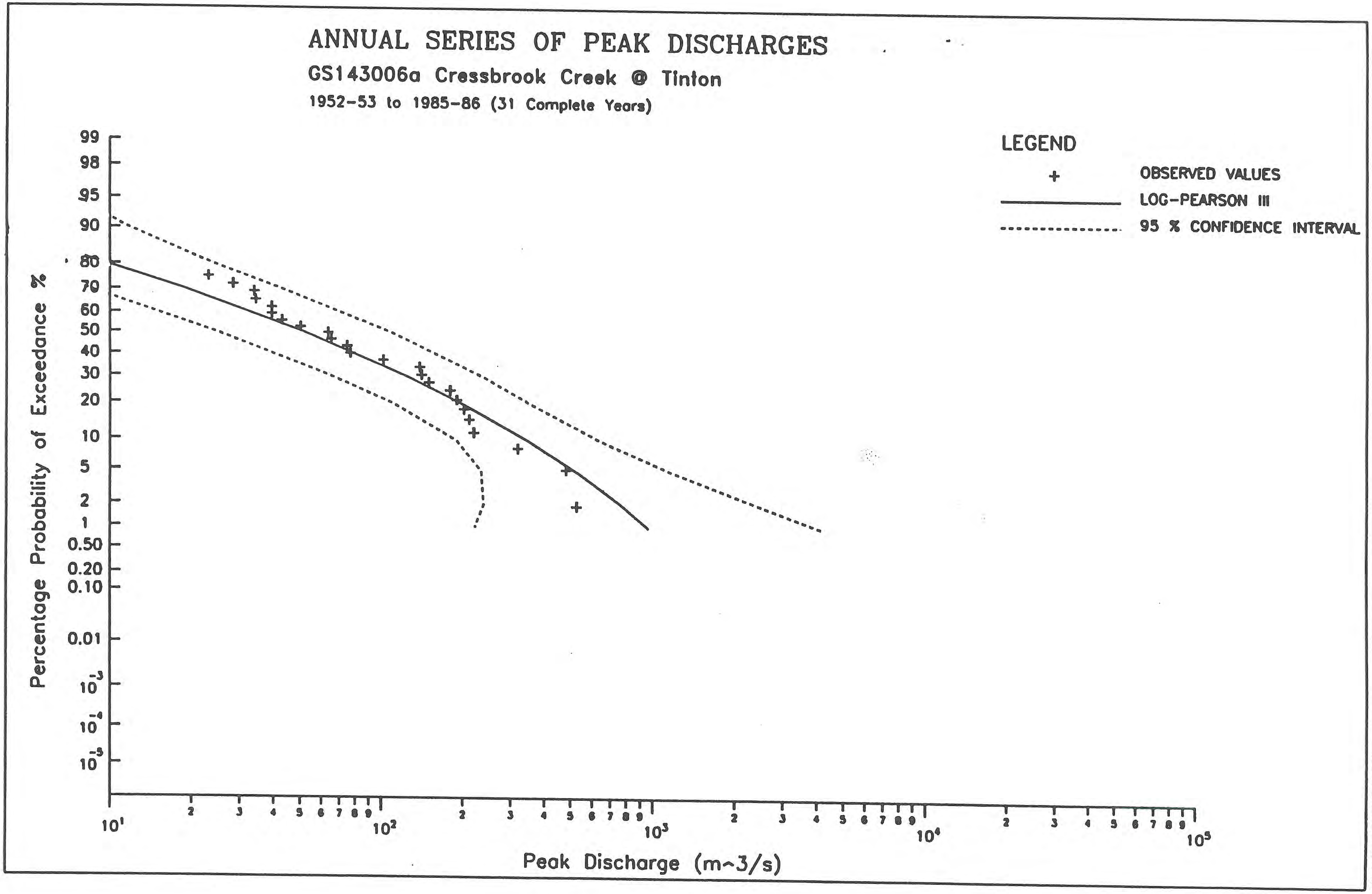

ANNUAL SERIES OF PEAK DISCHARGES
GS143006a Cressbrook Creek @ Tinton
1952-53 to 1985-86 (31 Complete Years)
LEGEND
OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
Peak Discharge (m~3/s)

FIGURE B.16

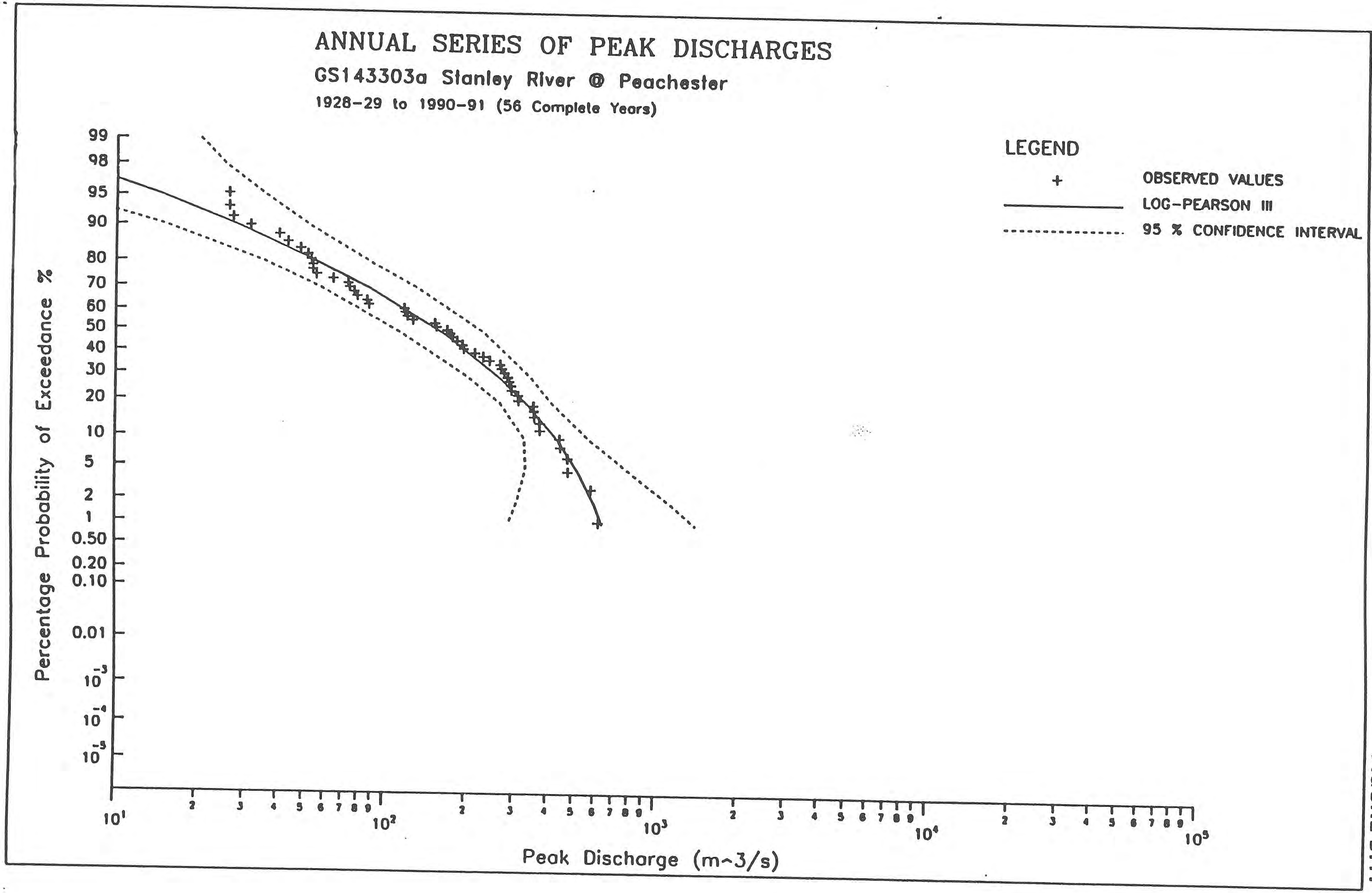
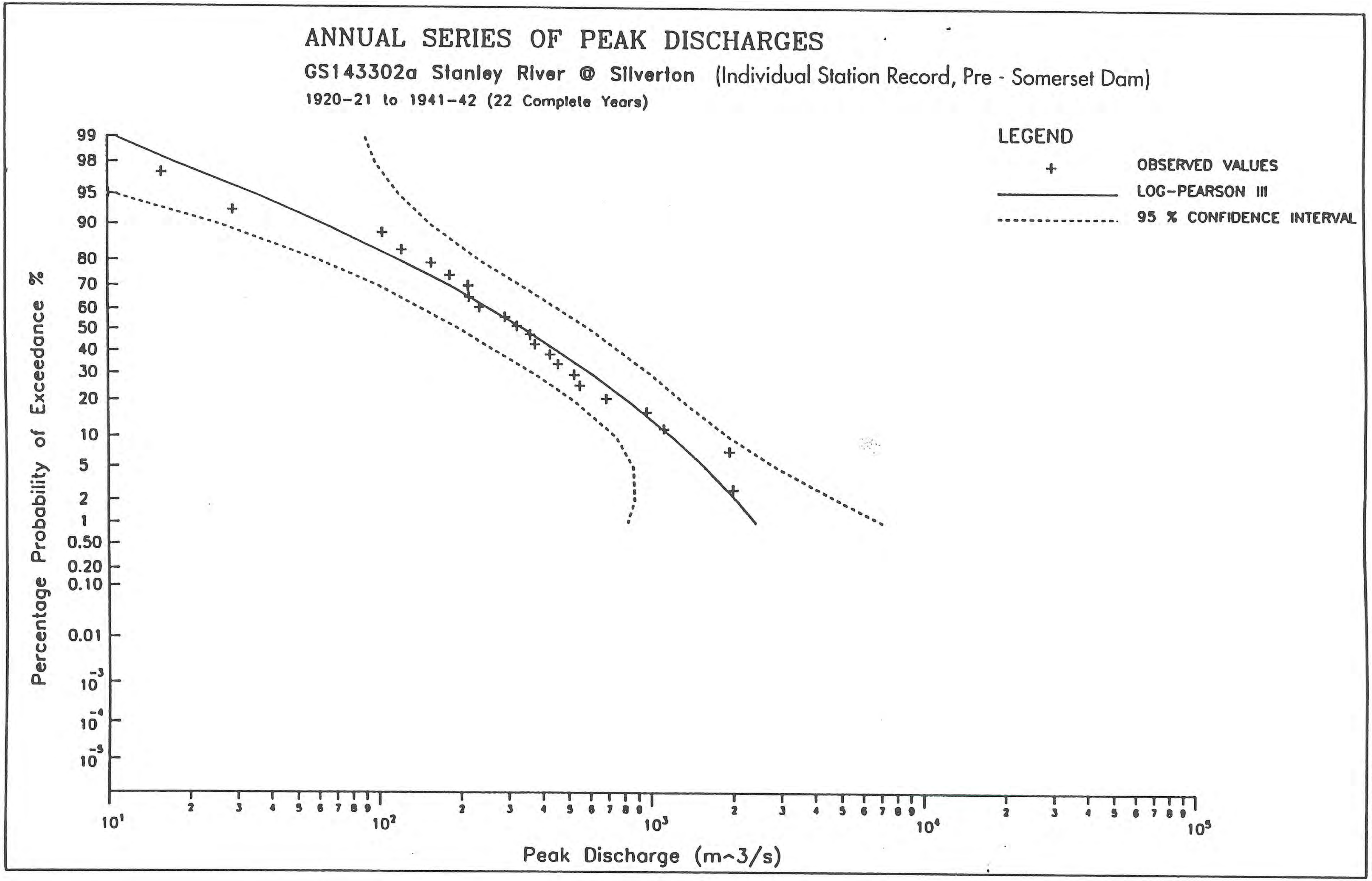
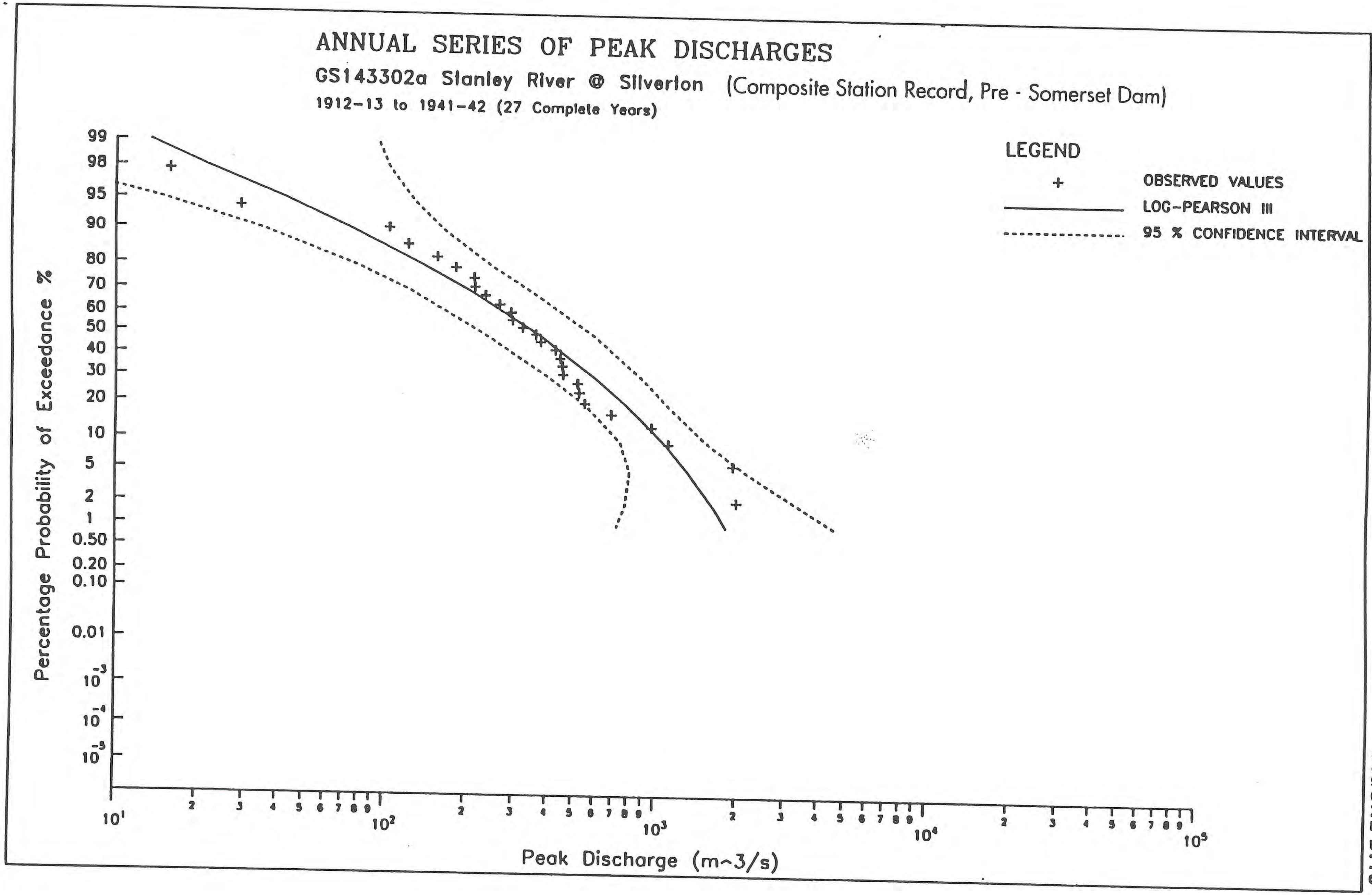

ANNUAL SERIES OF PEAK DISCHARGES
GS143303a Stanley River @ Peachester
1928-29 to 1990-91 (56 Complete Years)
LEGEND
OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
Peak Discharge (m~3/s)

FIGURE B.17



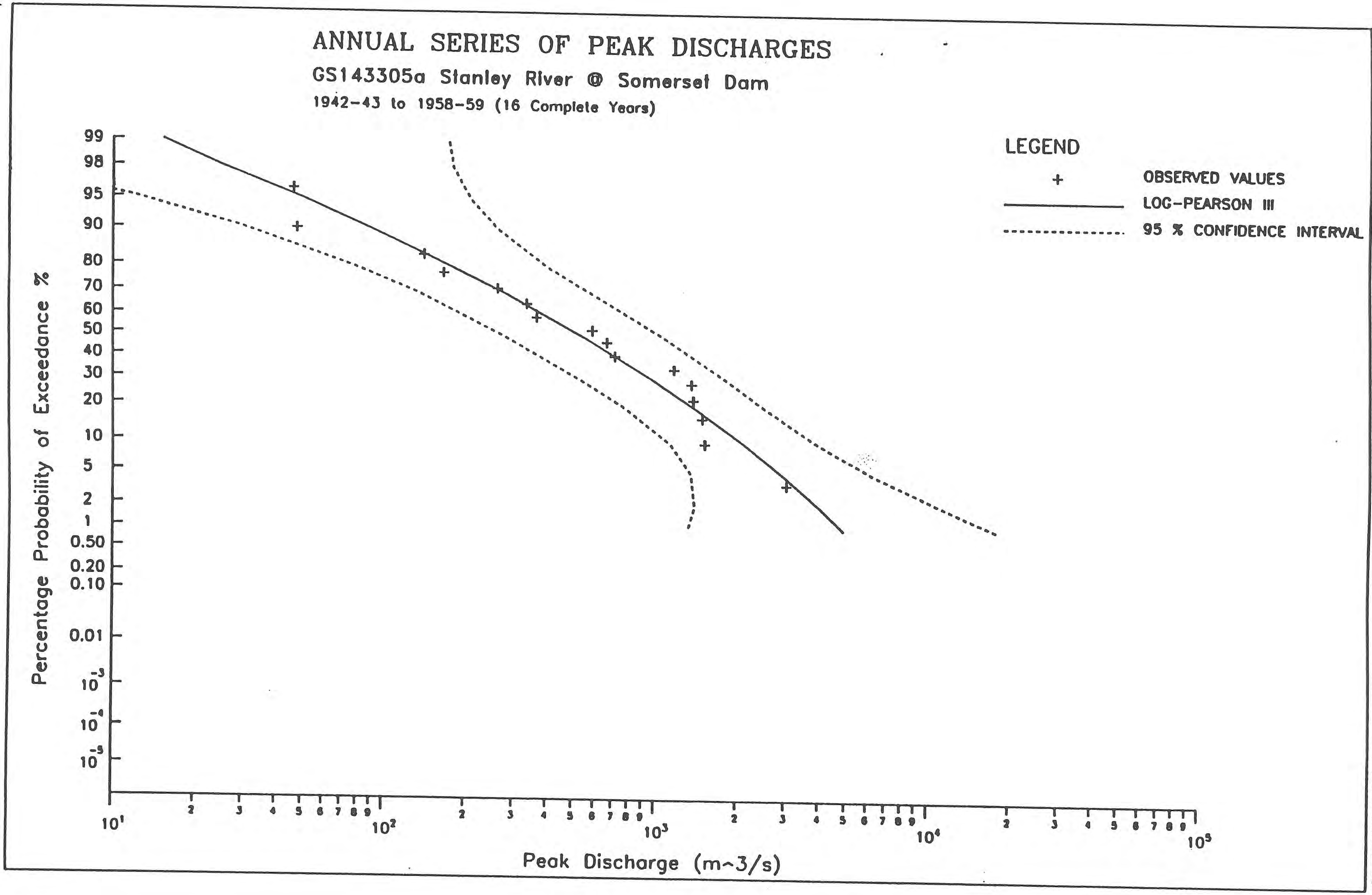
ANNUAL SERIES OF PEAK DISCHARGES
GS143302a Stanley River @ Silverton (Individual Station Record, Pre - Somerset Dam)
1920-21 to 1941-42 (22 Complete Years)
LEGEND
OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.50
0.20
0.10
0.01
10^{-3}
10^{-4}
10^{-5}
10^1
10^2
10^3
10^4
10^5
Peak Discharge (m~3/s)

FIGURE B.18



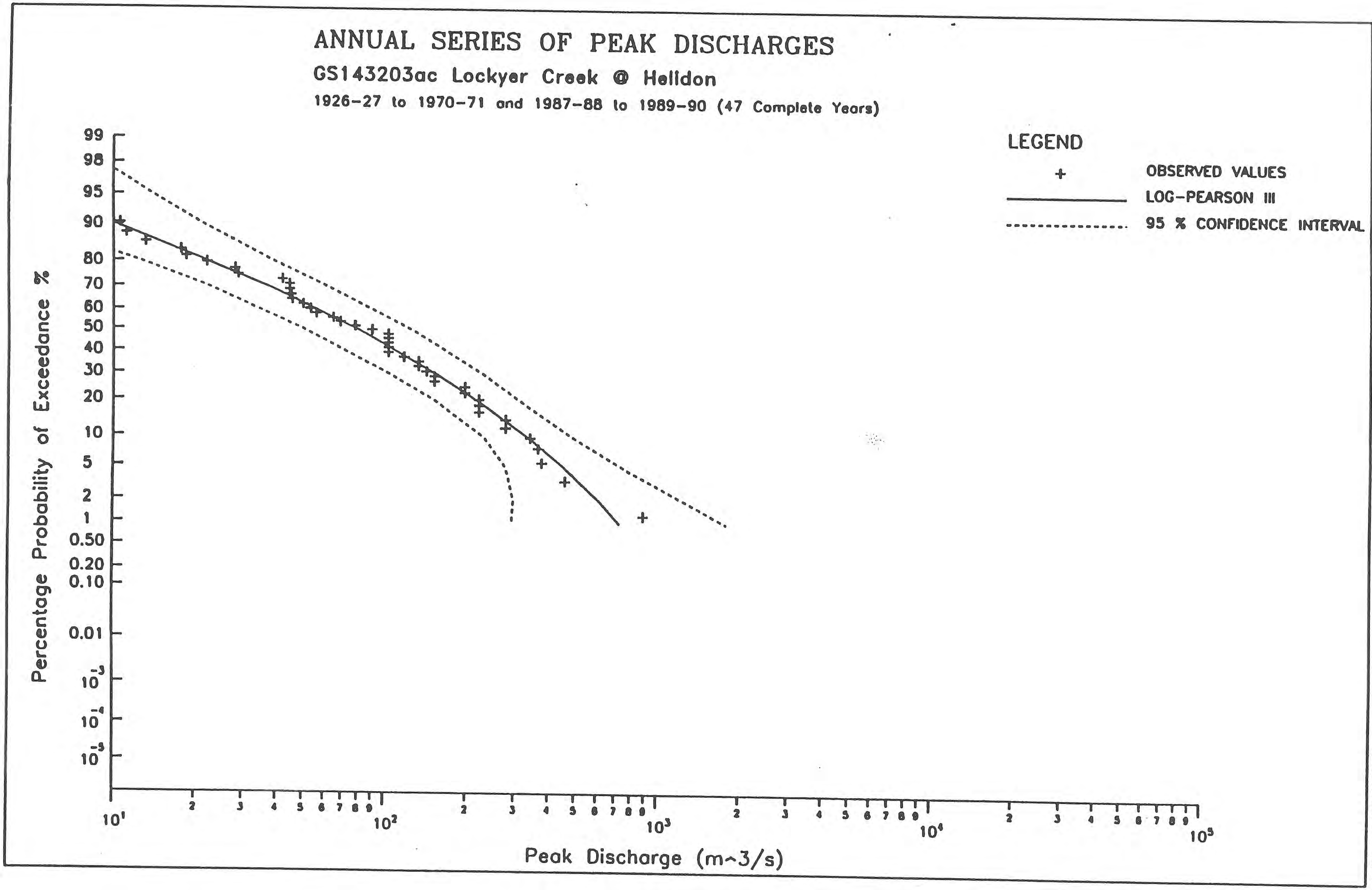
ANNUAL SERIES OF PEAK DISCHARGES
GS143302a Stanley River @ Silverton (Composite Station Record, Pre - Somerset Dam)
1912-13 to 1941-42 (27 Complete Years)
LEGEND
OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.50
0.20
0.10
0.01
10^-3
10^-4
10^-5
10^1
10^2
10^3
10^4
10^5
Peak Discharge (m~3/s)

FIGURE E.19



ANNUAL SERIES OF PEAK DISCHARGES
GS143305a Stanley River @ Somerset Dam
1942-43 to 1958-59 (16 Complete Years)
LEGEND
OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.50
0.20
0.10
0.01
10^-3
10^-4
10^-5
10^1
10^2
10^3
10^4
10^5
Peak Discharge (m~3/s)

FIGURE B.20



ANNUAL SERIES OF PEAK DISCHARGES
GS143203ac Lockyer Creek @ Helidon
1926-27 to 1970-71 and 1987-88 to 1989-90 (47 Complete Years)
LEGEND
OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.50
0.20
0.10
0.01
10^-3
10^-4
10^-5
10^1
10^2
10^3
10^4
10^5
Peak Discharge (m~3/s)

FIGURE B.21

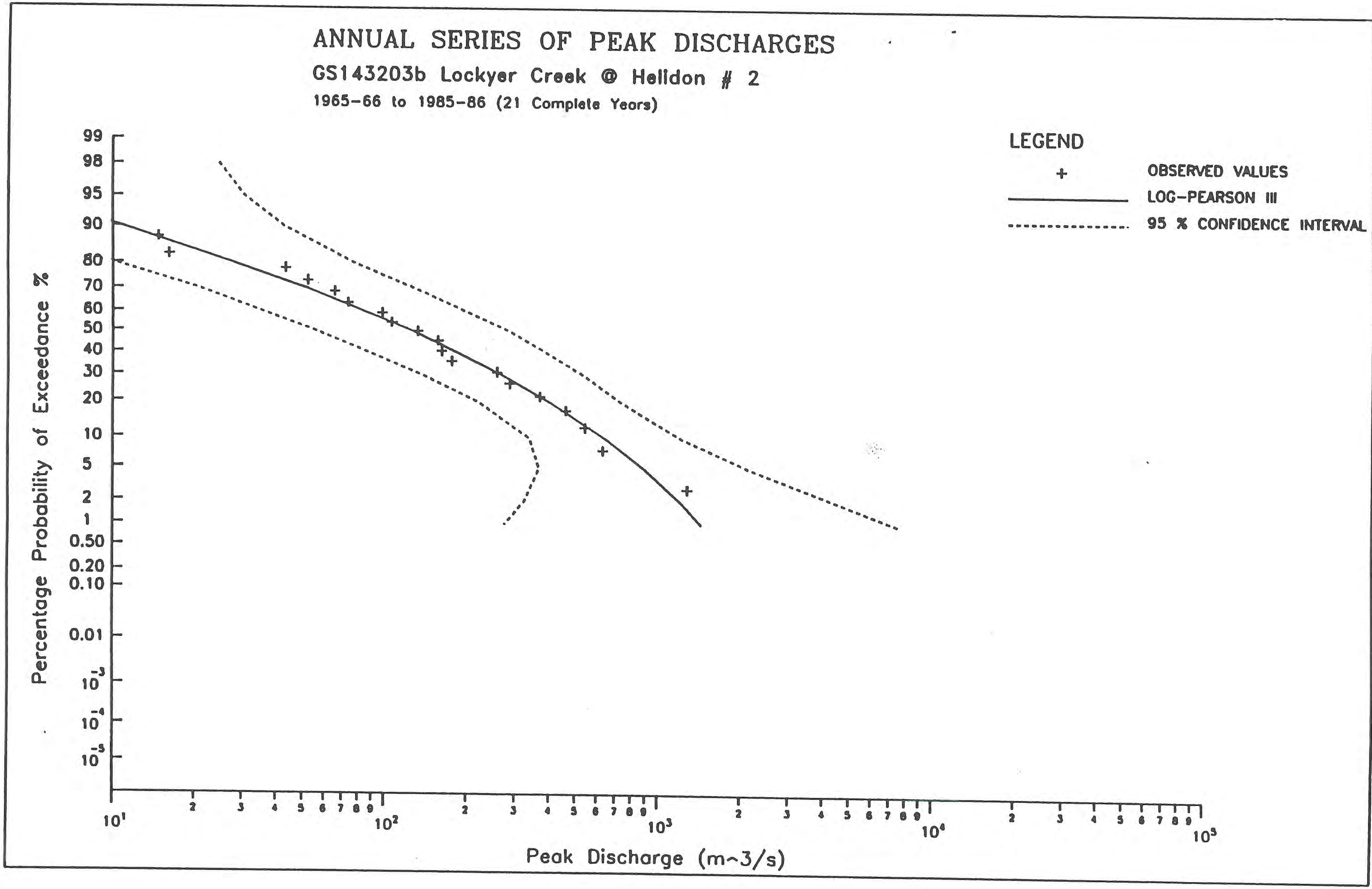

ANNUAL SERIES OF PEAK DISCHARGES
GS143203b Lockyer Creek @ Helidon # 2
1965-66 to 1985-86 (21 Complete Years)
LEGEND
OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
Peak Discharge (m~3/s)

FIGURE B.22

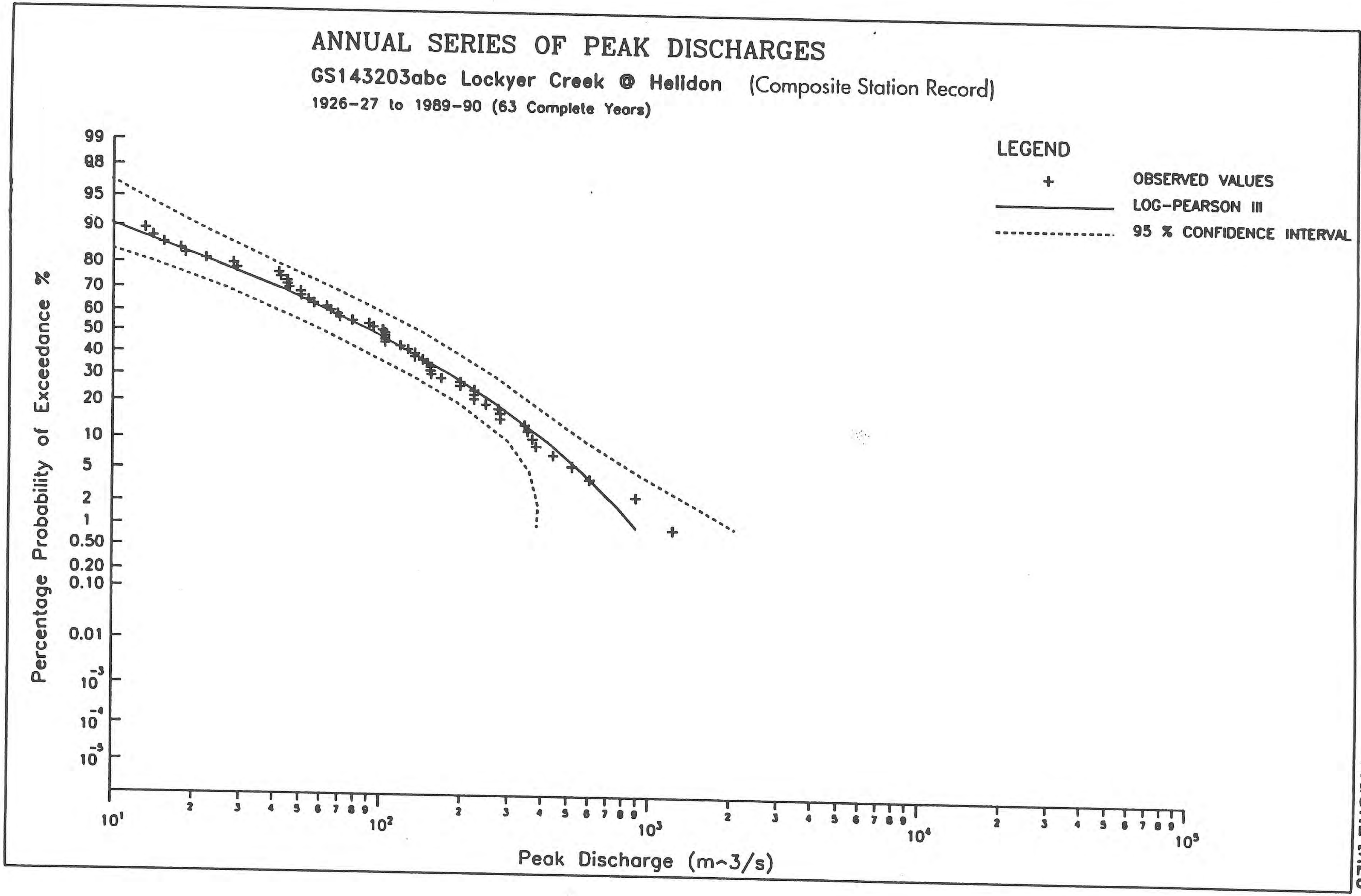
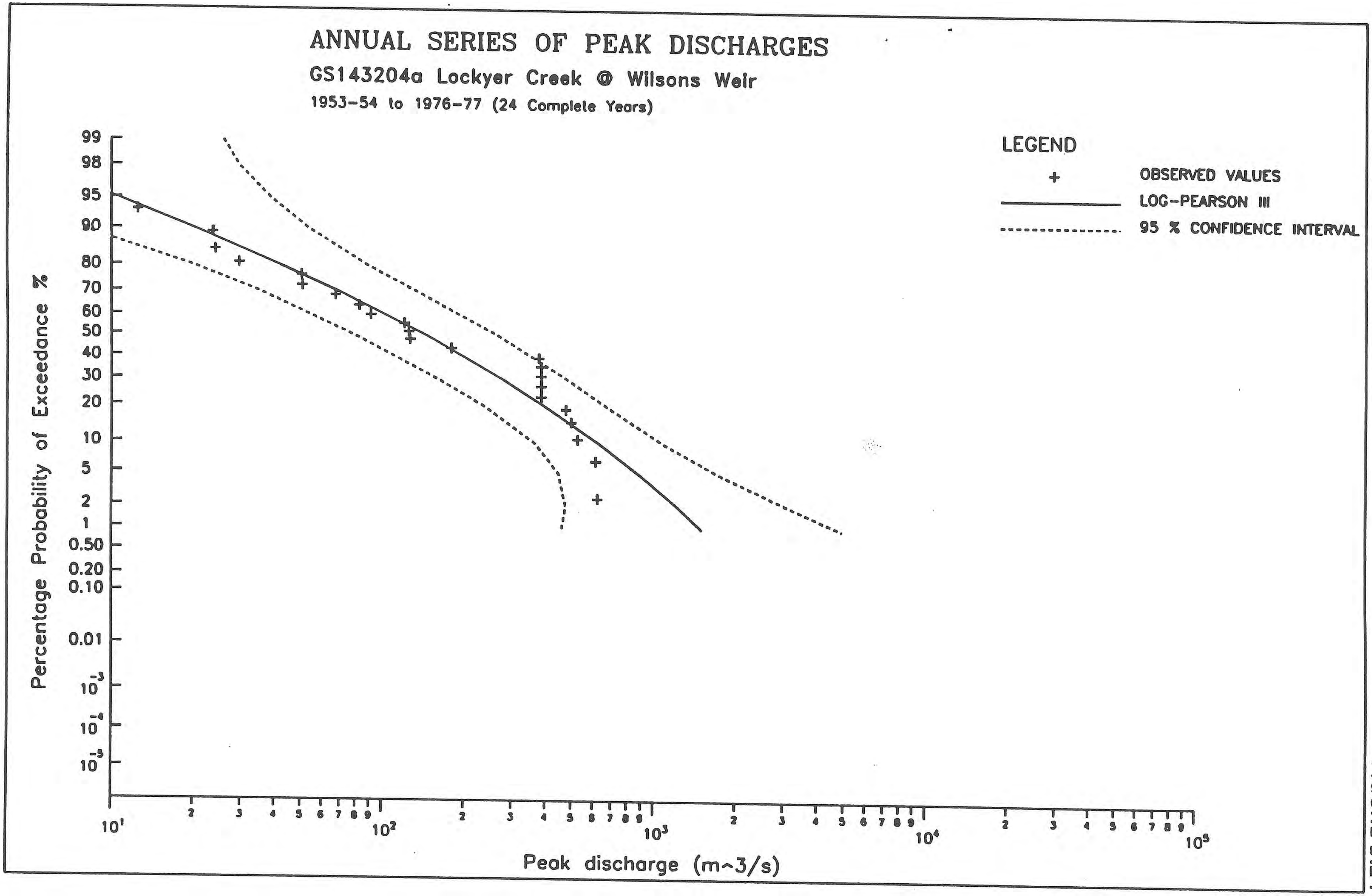
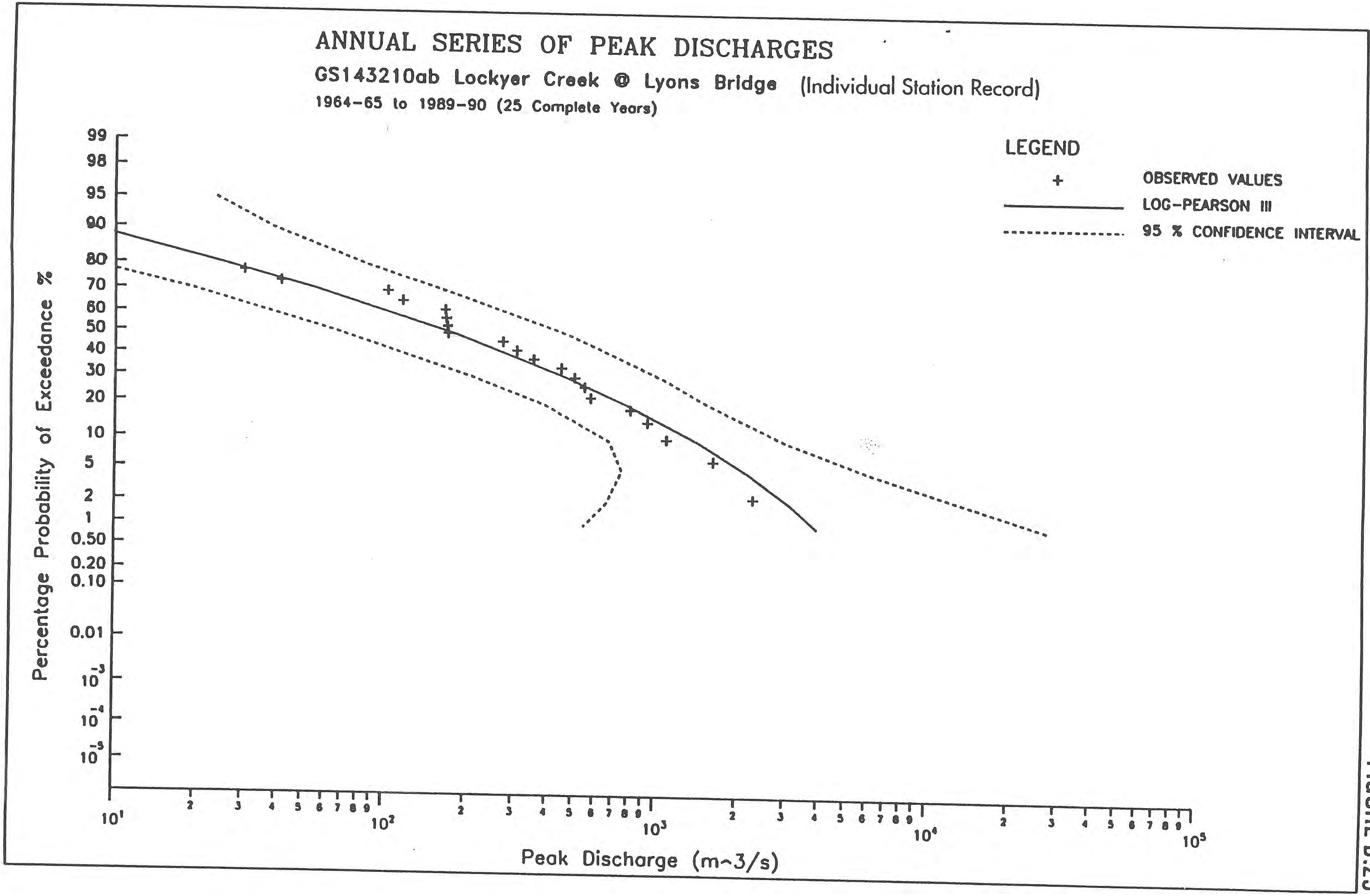

ANNUAL SERIES OF PEAK DISCHARGES
GS143203abc Lockyer Creek @ Helldon (Composite Station Record)
1926-27 to 1989-90 (63 Complete Years)
LEGEND
OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
Peak Discharge (m~3/s)

FIGURE P.23



ANNUAL SERIES OF PEAK DISCHARGES
GS143204a Lockyer Creek @ Wilsons Weir
1953-54 to 1976-77 (24 Complete Years)
LEGEND
OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
Peak discharge (m~3/s)

FIGURE B.24



ANNUAL SERIES OF PEAK DISCHARGES
GS143210ab Lockyer Creek @ Lyons Bridge (Individual Station Record)
1964-65 to 1989-90 (25 Complete Years)
LEGEND
OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.50
0.20
0.10
0.01
10^{-3}
10^{-4}
10^{-5}
10^{1}
10^{2}
10^{3}
10^{4}
10^{5}
Peak Discharge (m~3/s)

FIGURE B.25

ANNUAL SERIES OF PEAK DISCHARGES

GS143210ab Lockyer Creek @ Lyons Bridge (Composite Station Record)

1909-10 to 1989-90 (82 Complete Years)

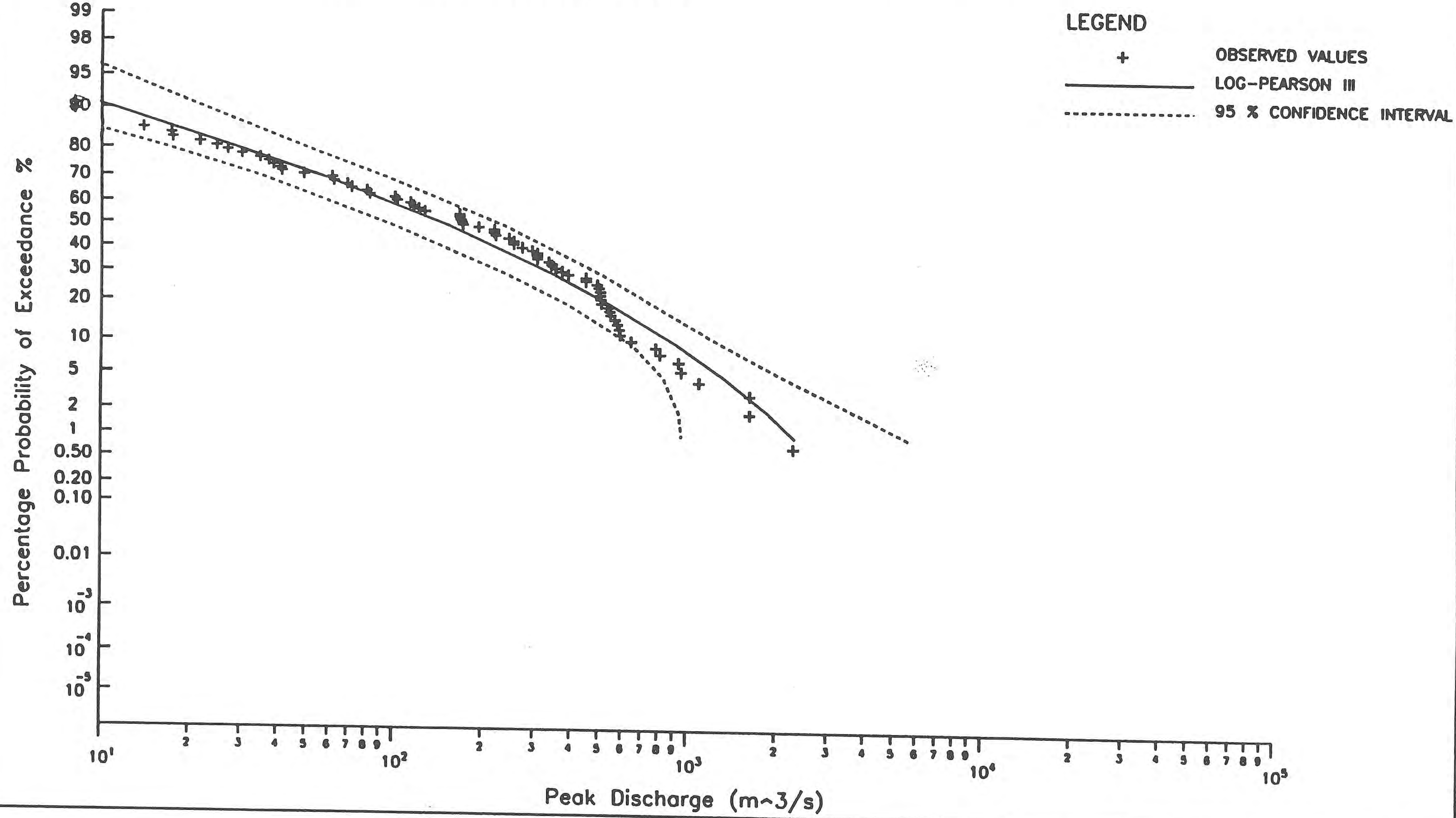
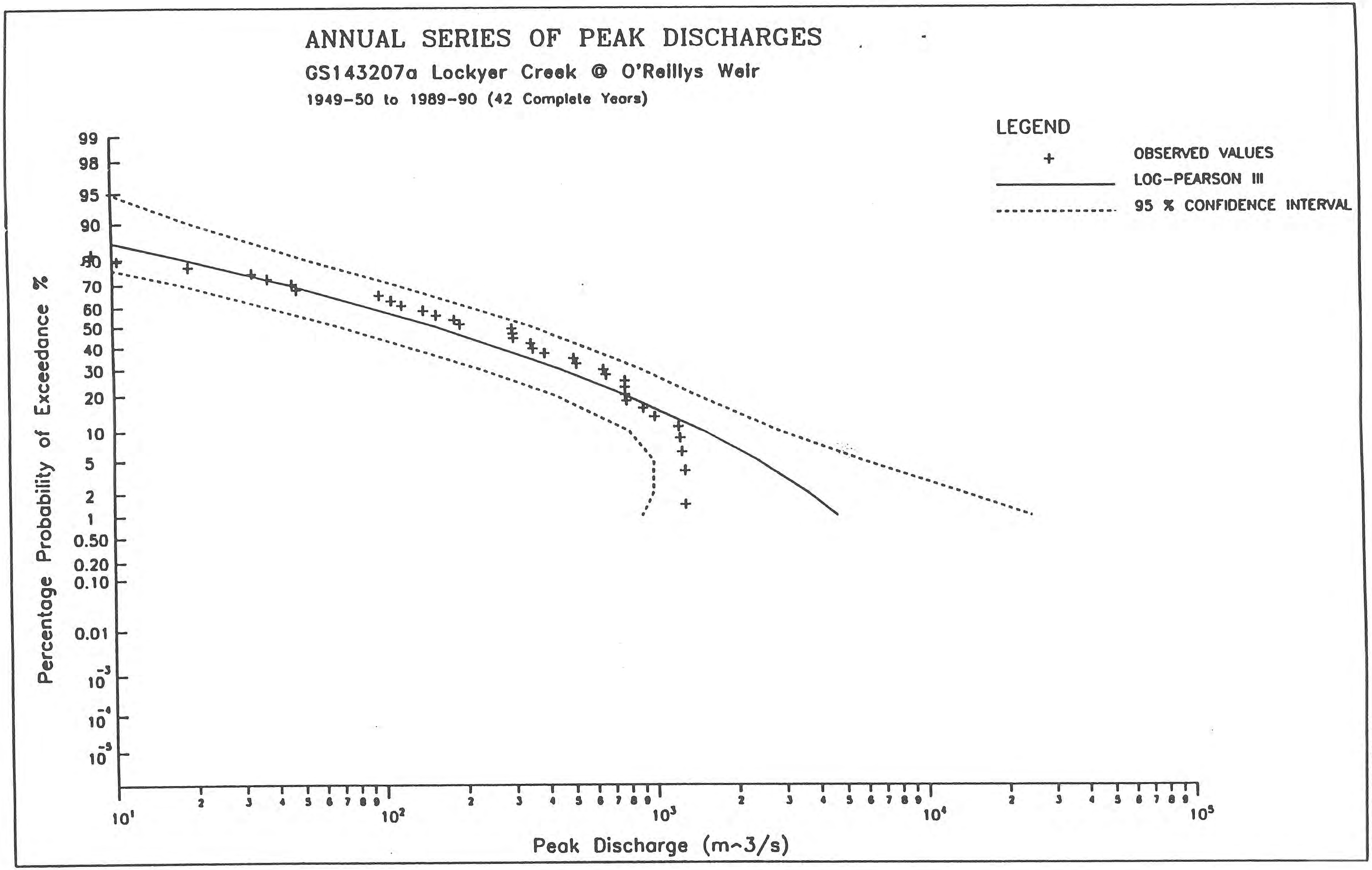


FIGURE B.26



ANNUAL SERIES OF PEAK DISCHARGES
GS143207a Lockyer Creek @ O'Reillys Weir
1949-50 to 1989-90 (42 Complete Years)
LEGEND
OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
Peak Discharge (m~3/s)

FIGURE B.27

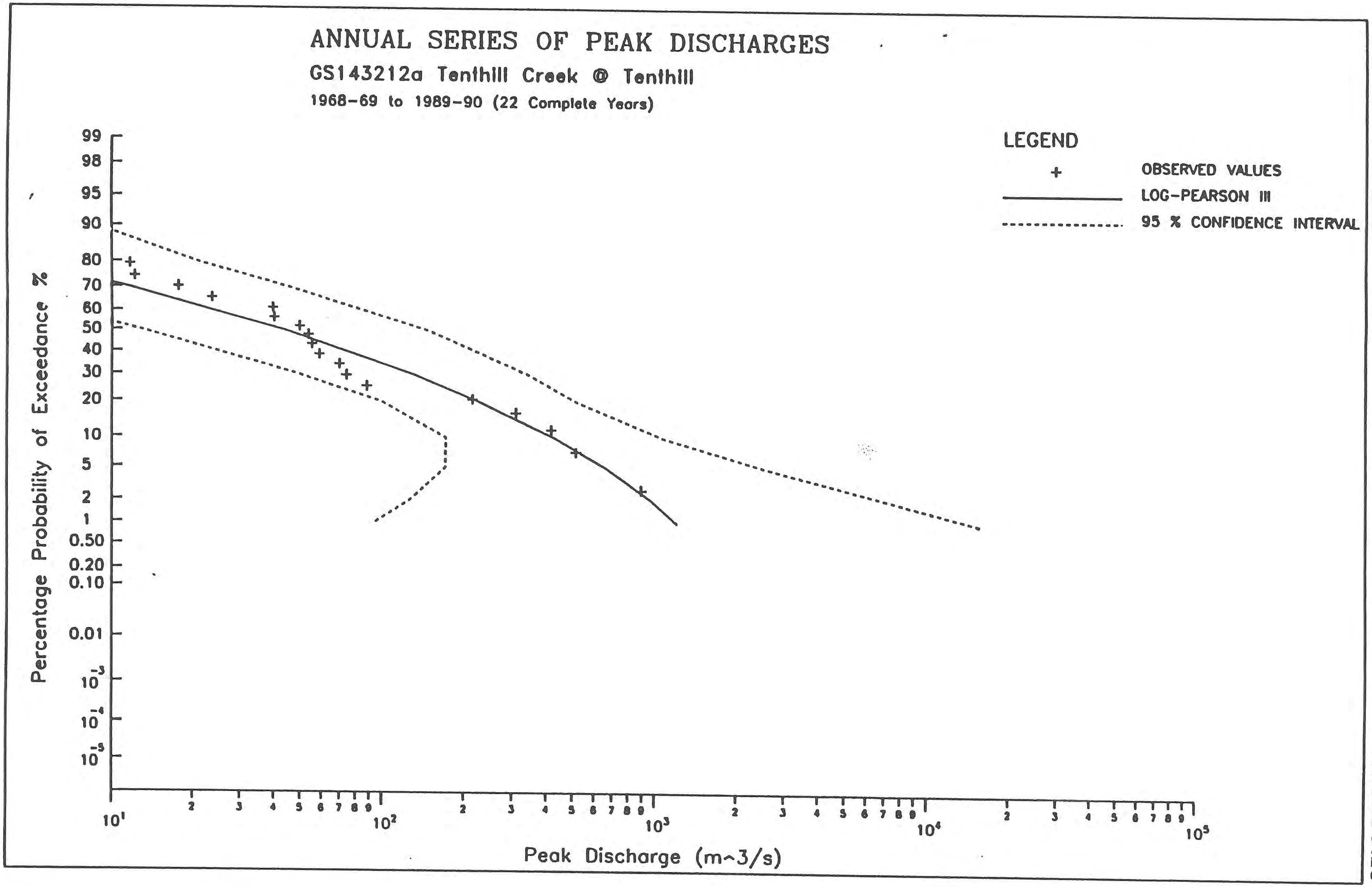

ANNUAL SERIES OF PEAK DISCHARGES
GS143212a Tenthill Creek @ Tenthill
1968-69 to 1989-90 (22 Complete Years)
LEGEND
+ OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
Peak Discharge (m~3/s)

FIGURE B.28

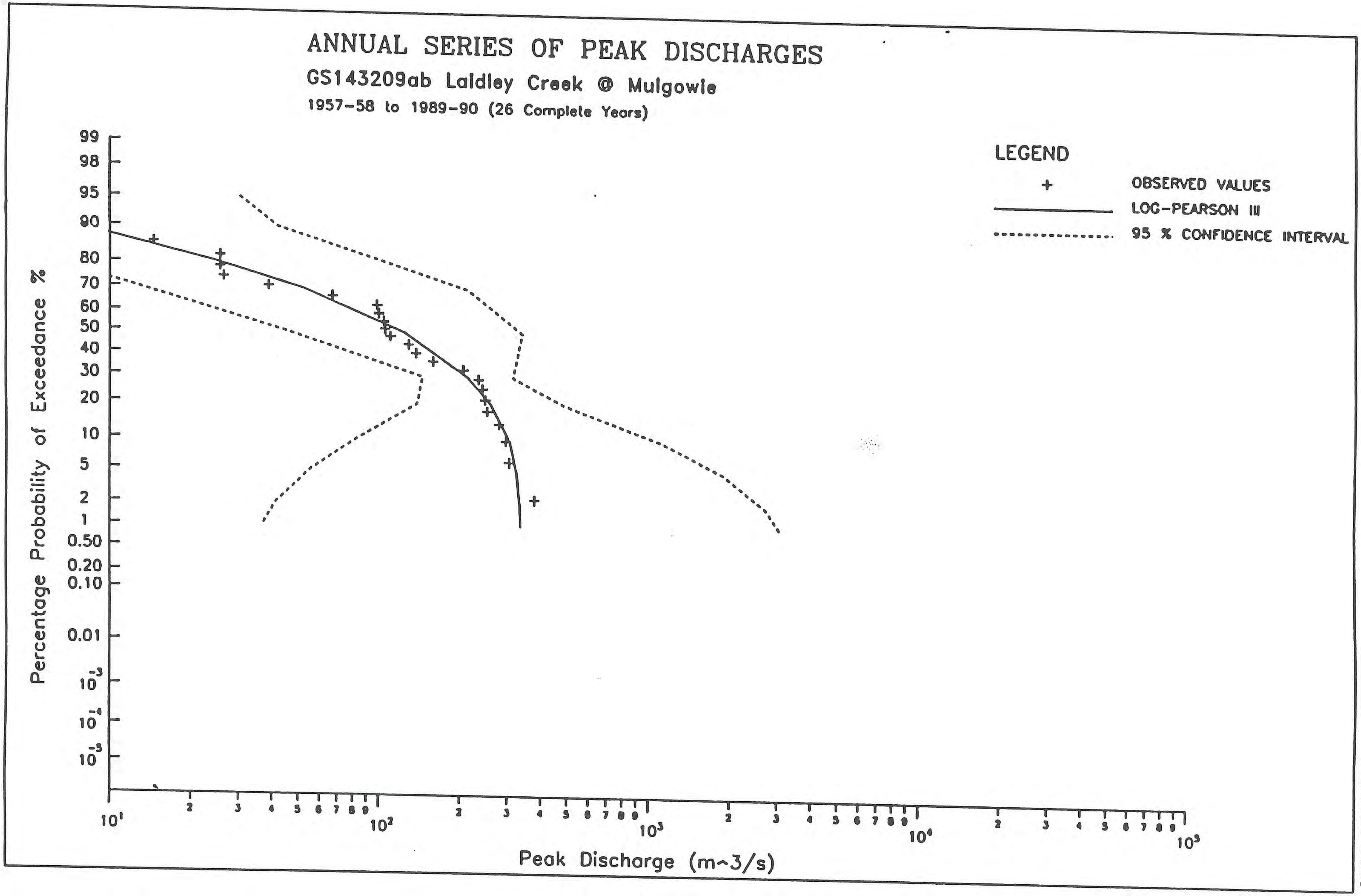

ANNUAL SERIES OF PEAK DISCHARGES
GS143209ab Laidley Creek @ Mulgowie
1957-58 to 1989-90 (26 Complete Years)
LEGEND
OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.50
0.20
0.10
0.01
10^{-3}
10^{-4}
10^{-5}
10^{1}
10^{2}
10^{3}
10^{4}
10^{5}
Peak Discharge (m~3/s)

FIGURE B.29

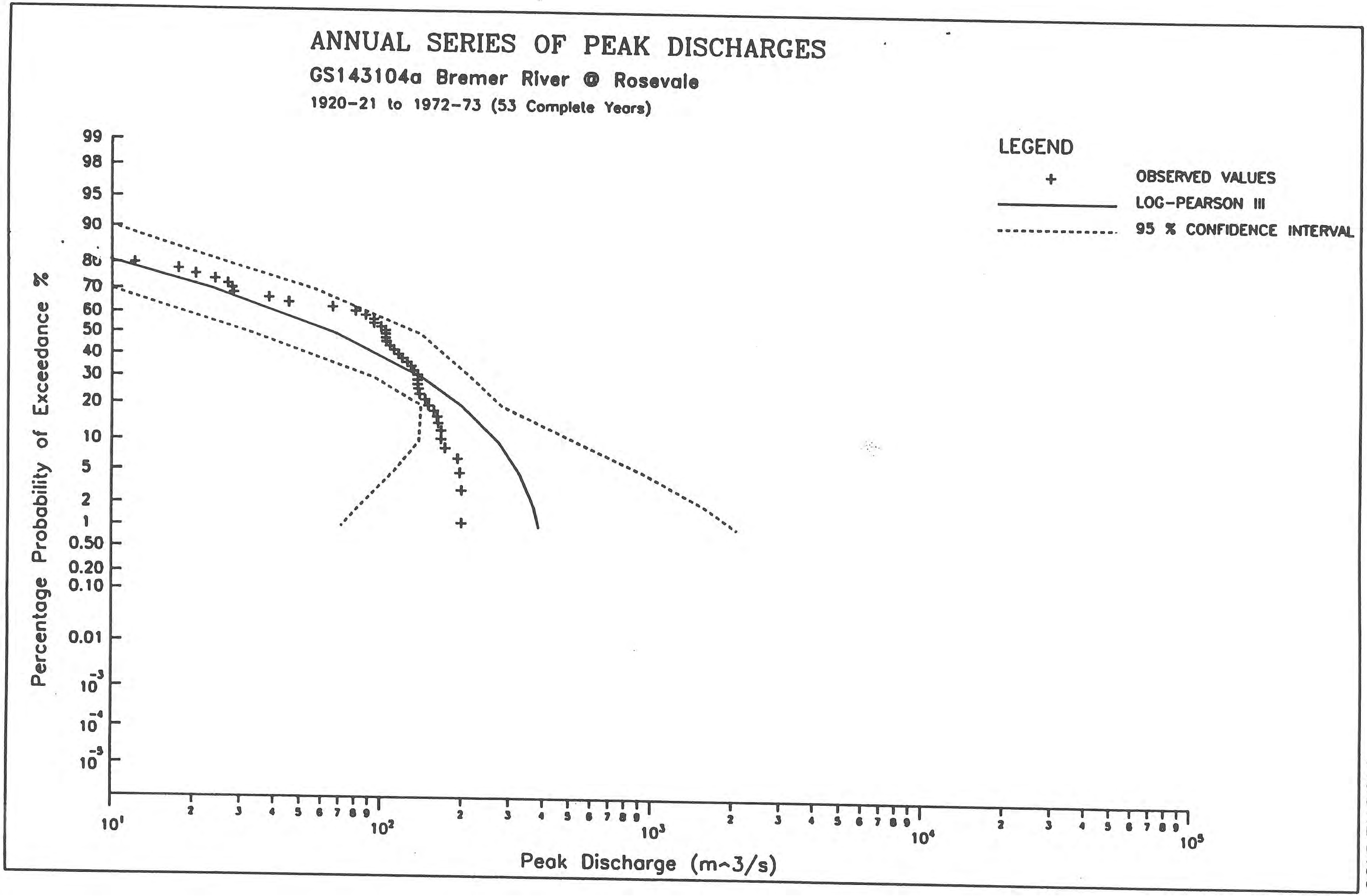

ANNUAL SERIES OF PEAK DISCHARGES
GS143104a Bremer River @ Rosevale
1920-21 to 1972-73 (53 Complete Years)
LEGEND
OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
Peak Discharge (m~3/s)

FIGURE B.30

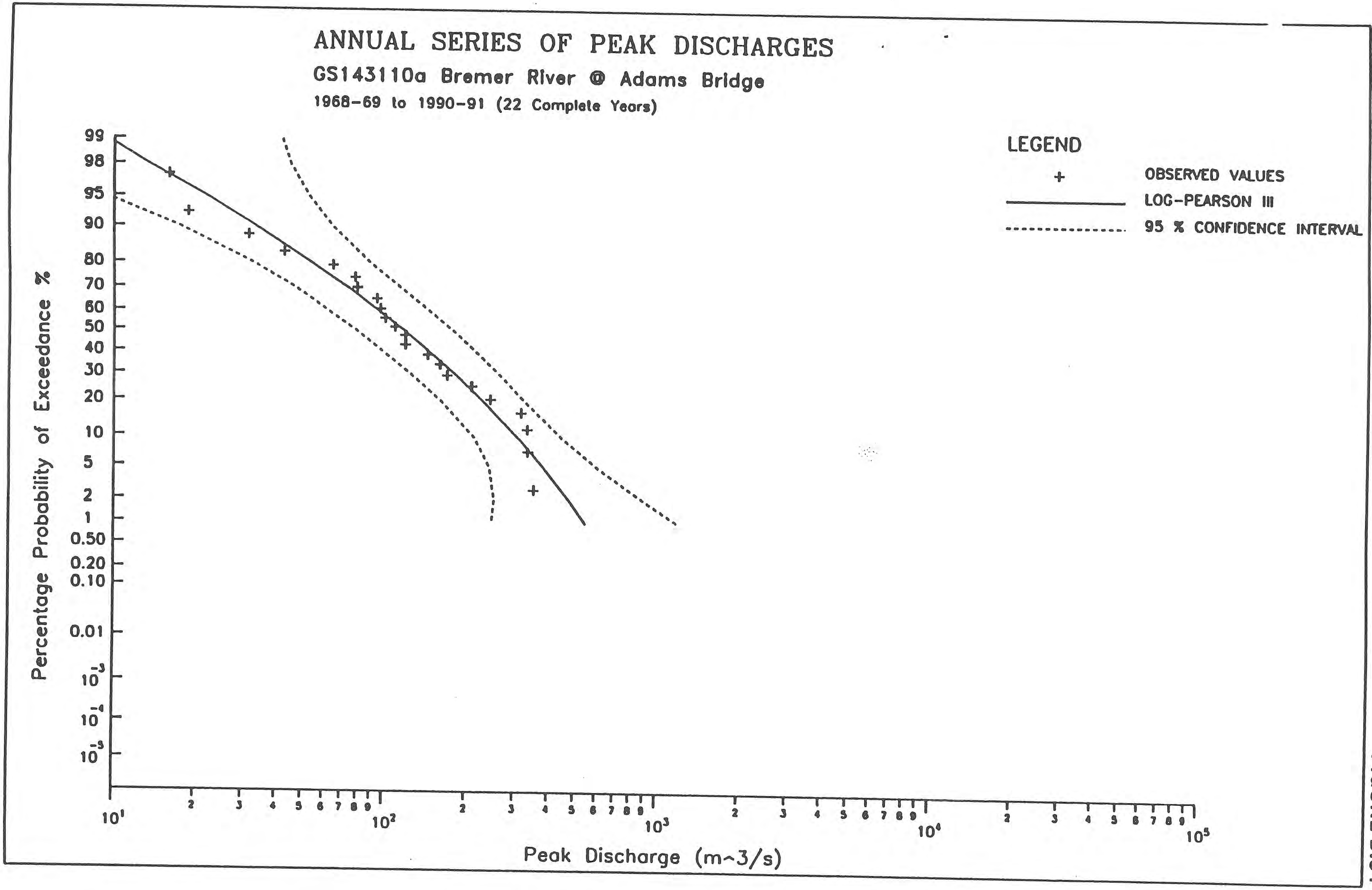

ANNUAL SERIES OF PEAK DISCHARGES
GS143110a Bremer River @ Adams Bridge
1968-69 to 1990-91 (22 Complete Years)
LEGEND
OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
Peak Discharge (m~3/s)

FIGURE B.31

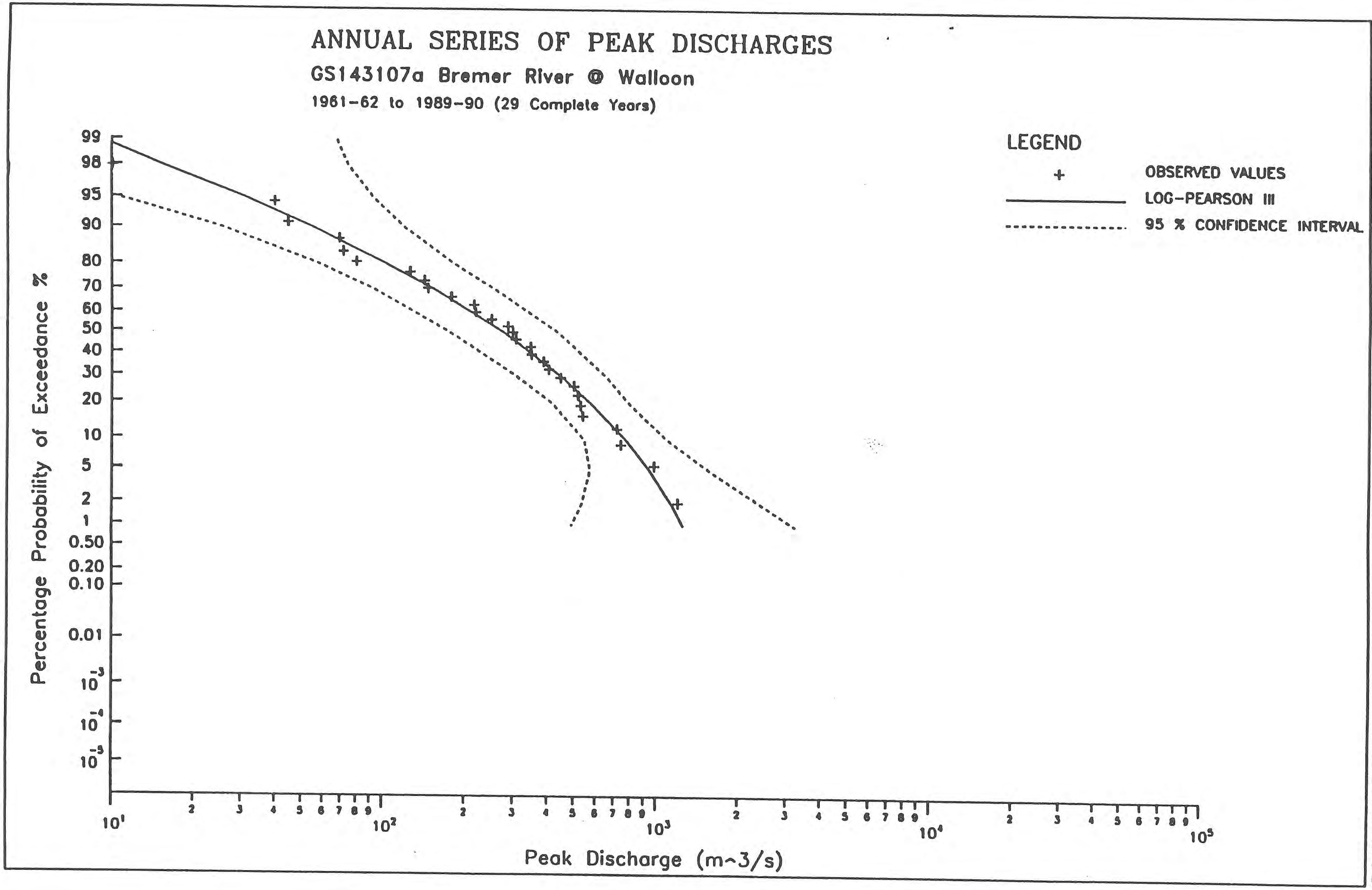
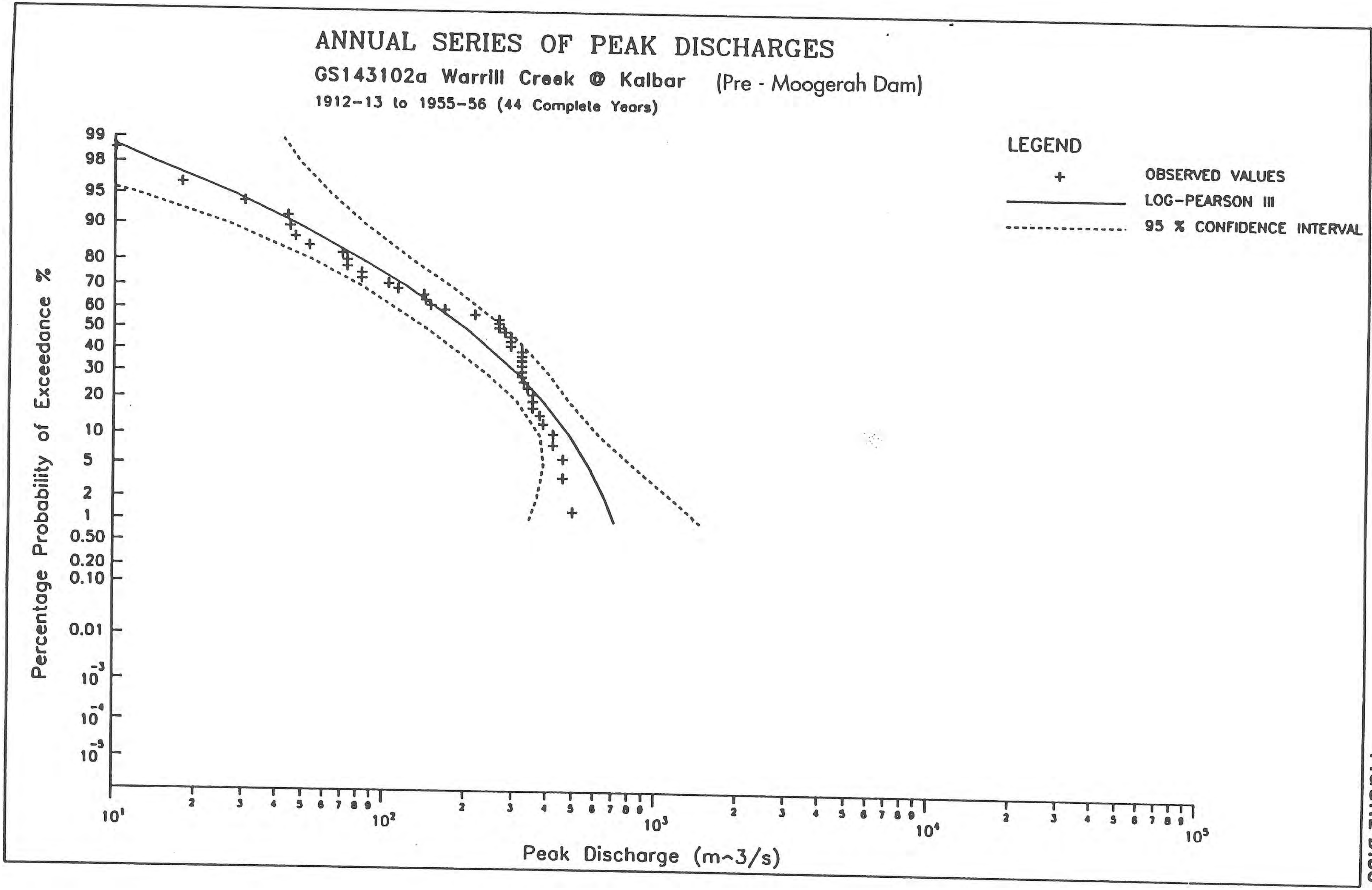

ANNUAL SERIES OF PEAK DISCHARGES
GS143107a Bremer River @ Walloon
1961-62 to 1989-90 (29 Complete Years)
LEGEND
OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
Peak Discharge (m~3/s)

FIGURE B.32



ANNUAL SERIES OF PEAK DISCHARGES
GS143102a Warrill Creek @ Kalbar (Pre - Moogerah Dam)
1912-13 to 1955-56 (44 Complete Years)
LEGEND
OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.50
0.20
0.10
0.01
10^{-3}
10^{-4}
10^{-5}
10^1
10^2
10^3
10^4
10^5
Peak Discharge (m~3/s)

FIGURE B.33

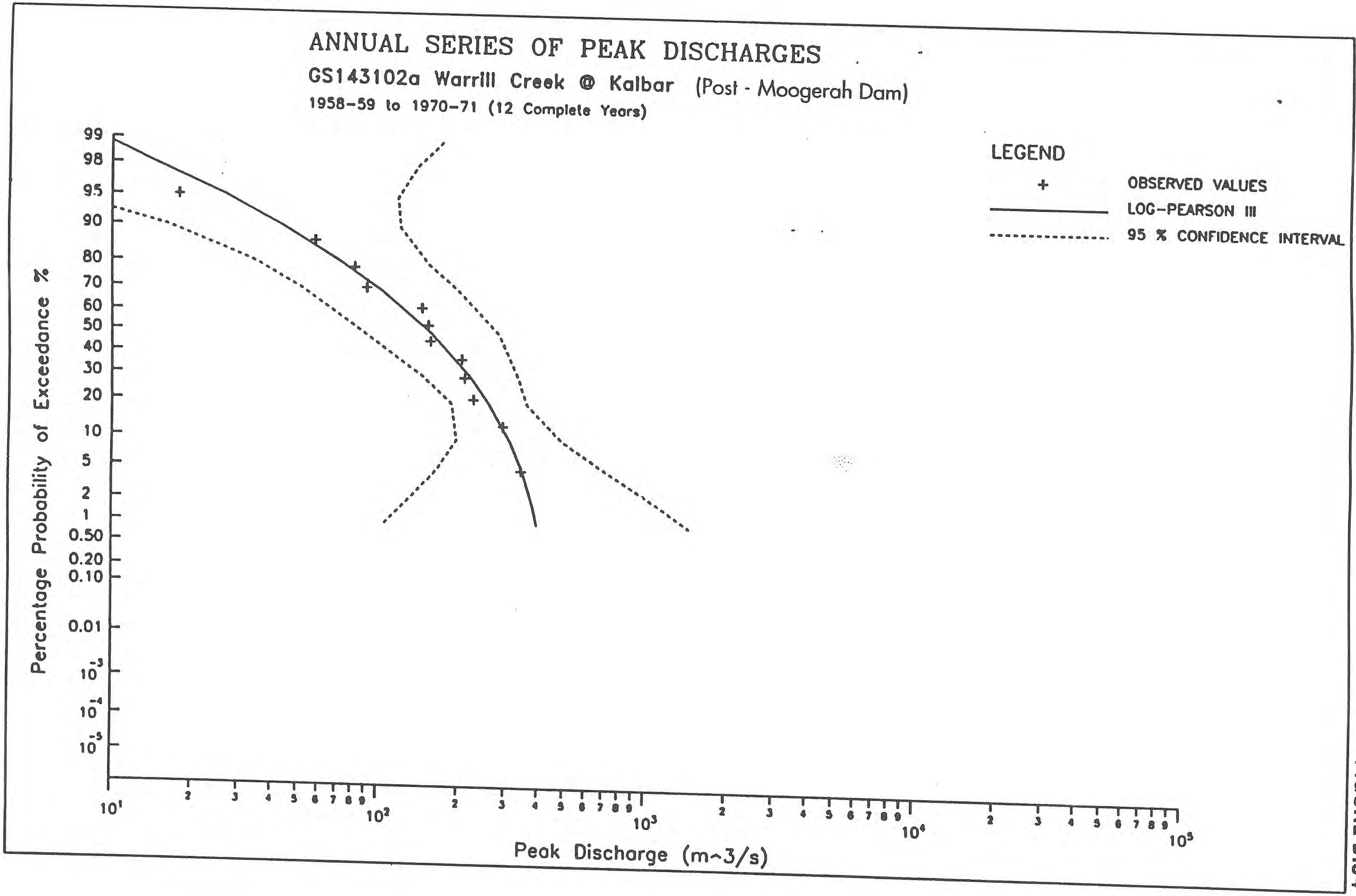
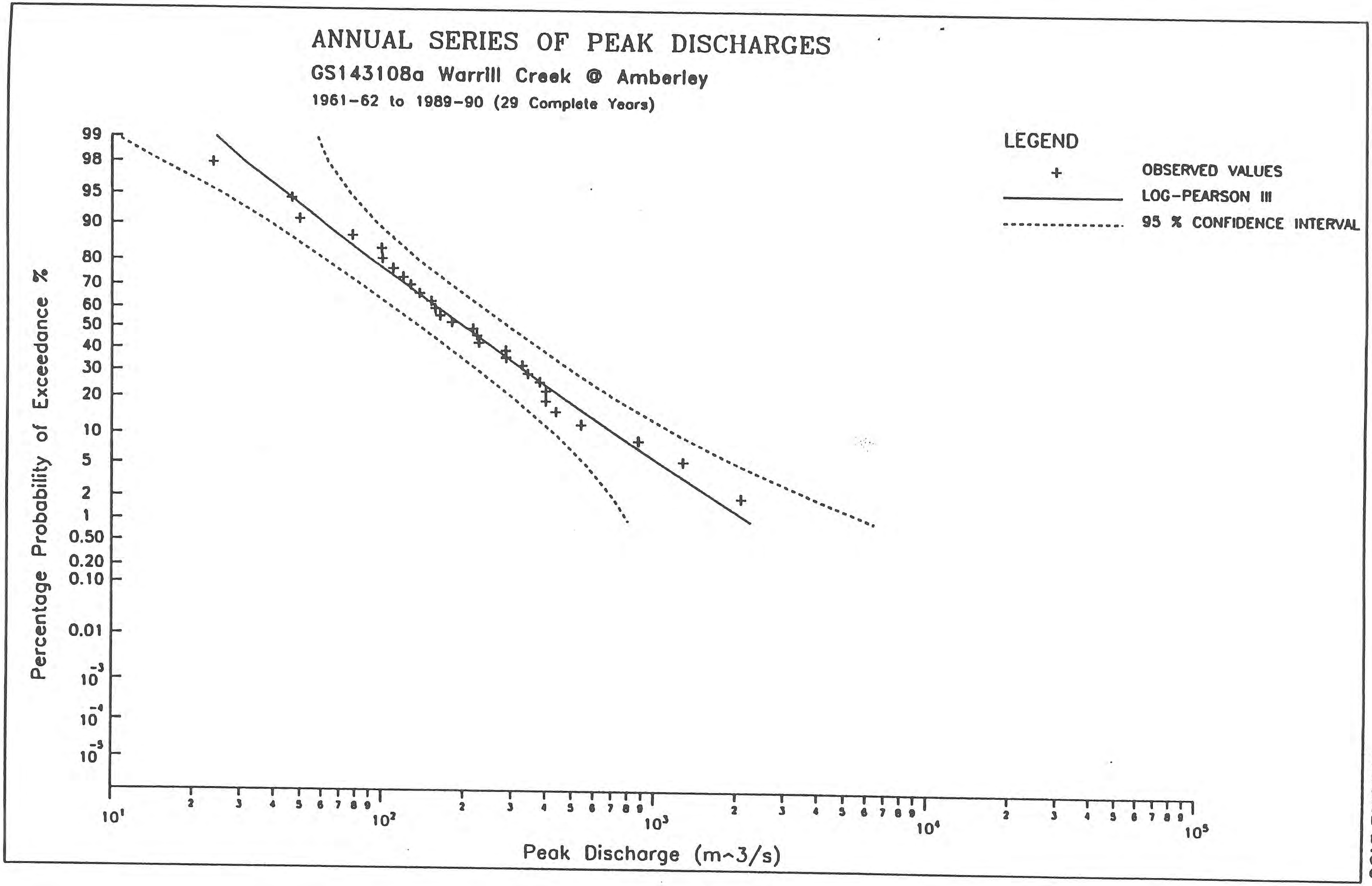

ANNUAL SERIES OF PEAK DISCHARGES
GS143102a Warrill Creek @ Kalbar (Post - Moogerah Dam)
1958-59 to 1970-71 (12 Complete Years)
LEGEND
OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
Peak Discharge (m~3/s)

FIGURE B.34



ANNUAL SERIES OF PEAK DISCHARGES
GS143108a Warrill Creek @ Amberley
1961-62 to 1989-90 (29 Complete Years)
LEGEND
OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.50
0.20
0.10
0.01
10^{-3}
10^{-4}
10^{-5}
10^1
10^2
10^3
10^4
10^5
Peak Discharge (m~3/s)

FIGURE B.35

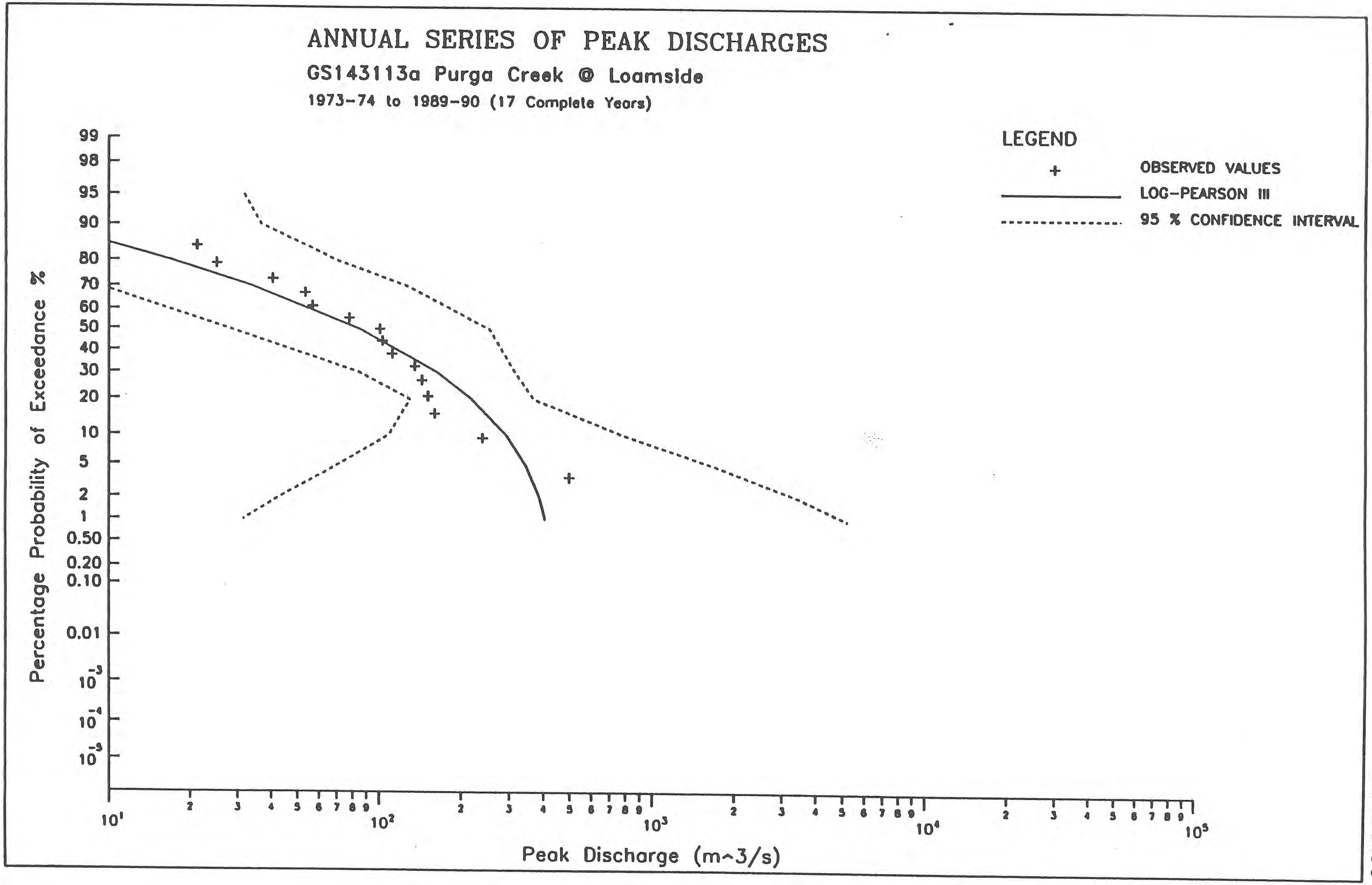

ANNUAL SERIES OF PEAK DISCHARGES
GS143113a Purga Creek @ Loamside
1973-74 to 1989-90 (17 Complete Years)
LEGEND
OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
Peak Discharge (m~3/s)

FIGURE B.36

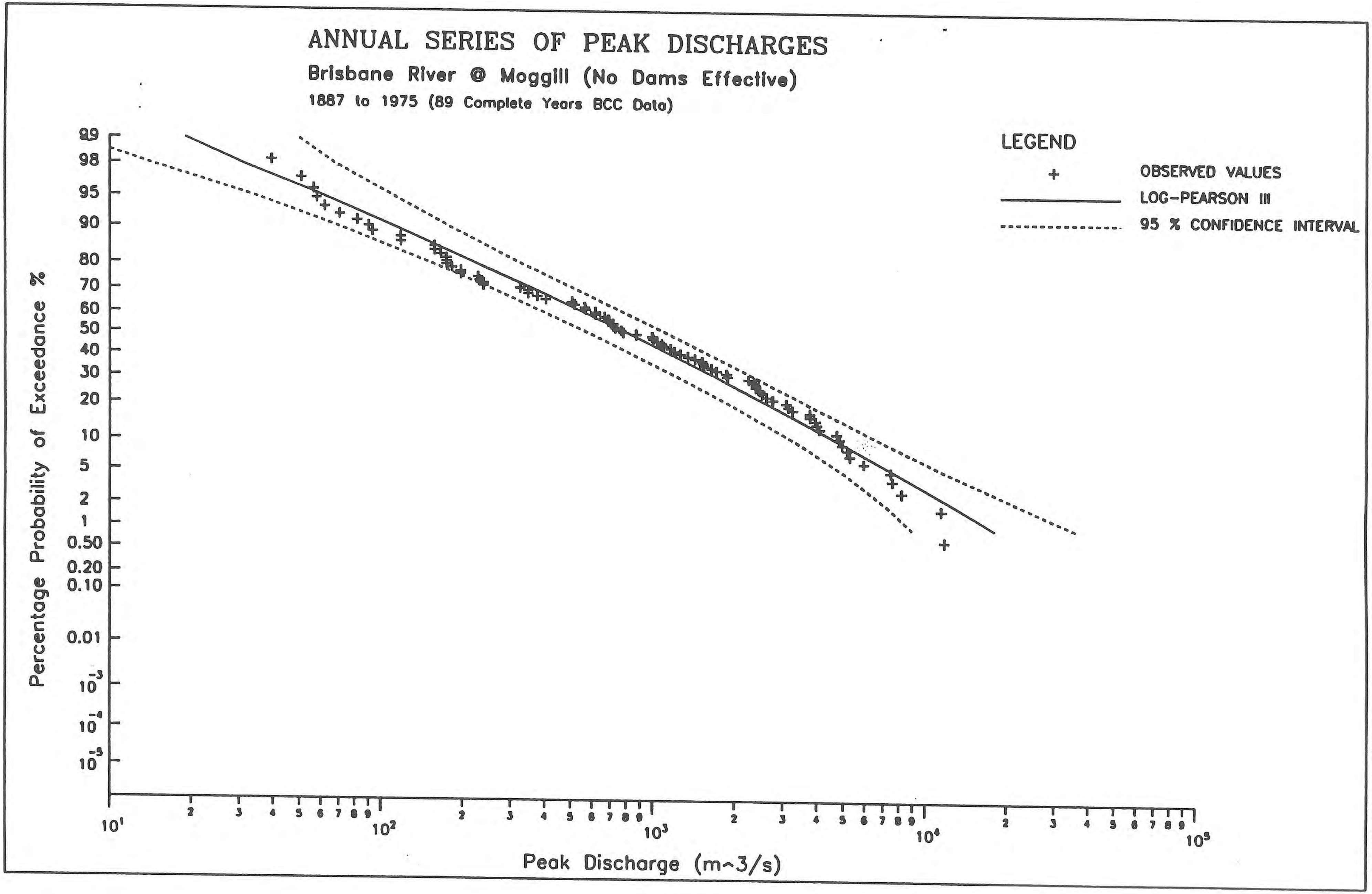

ANNUAL SERIES OF PEAK DISCHARGES
Brisbane River @ Moggill (No Dams Effective)
1887 to 1975 (89 Complete Years BCC Data)
LEGEND
OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
Peak Discharge (m~3/s)

FIGURE B.37

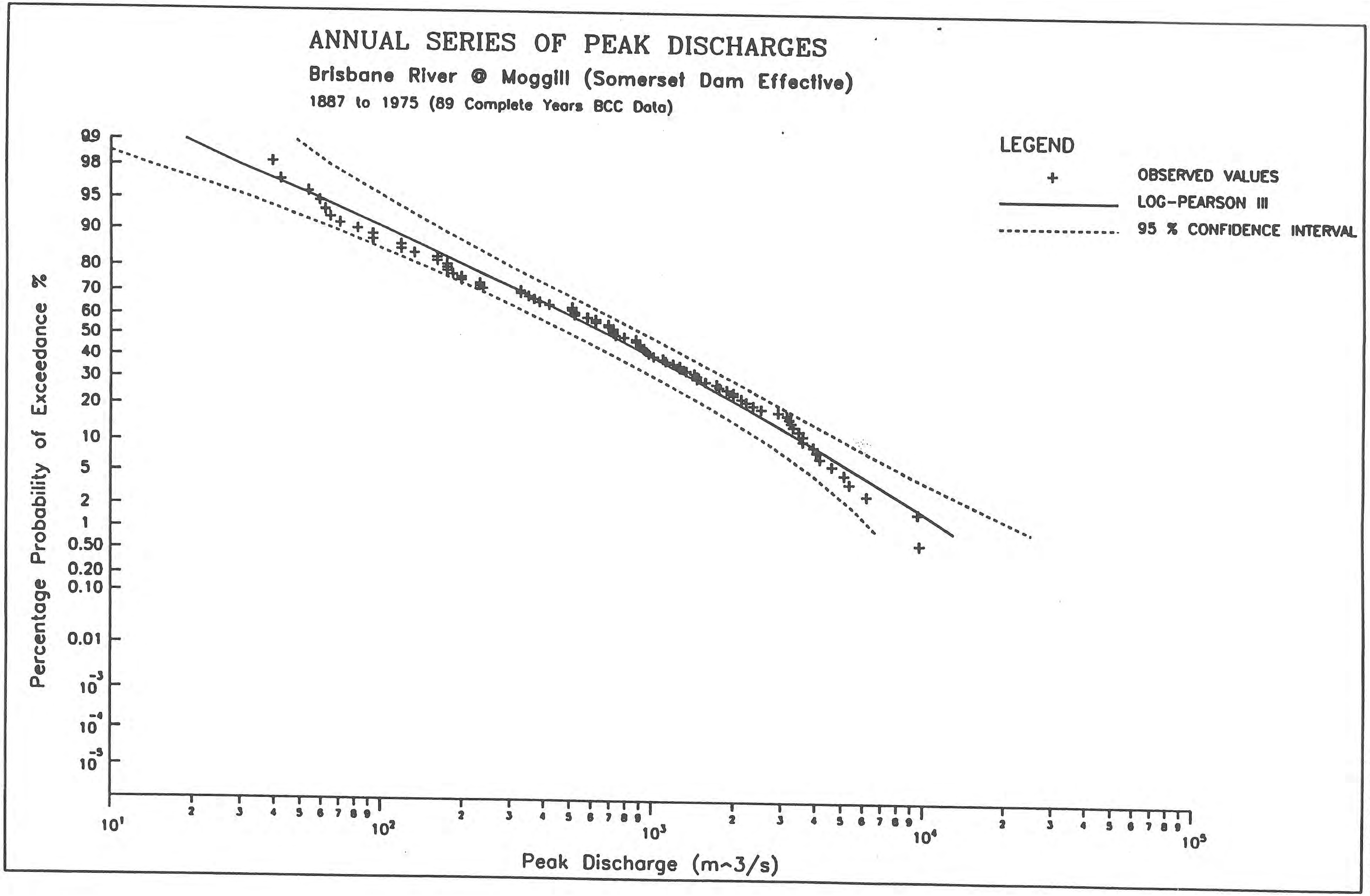
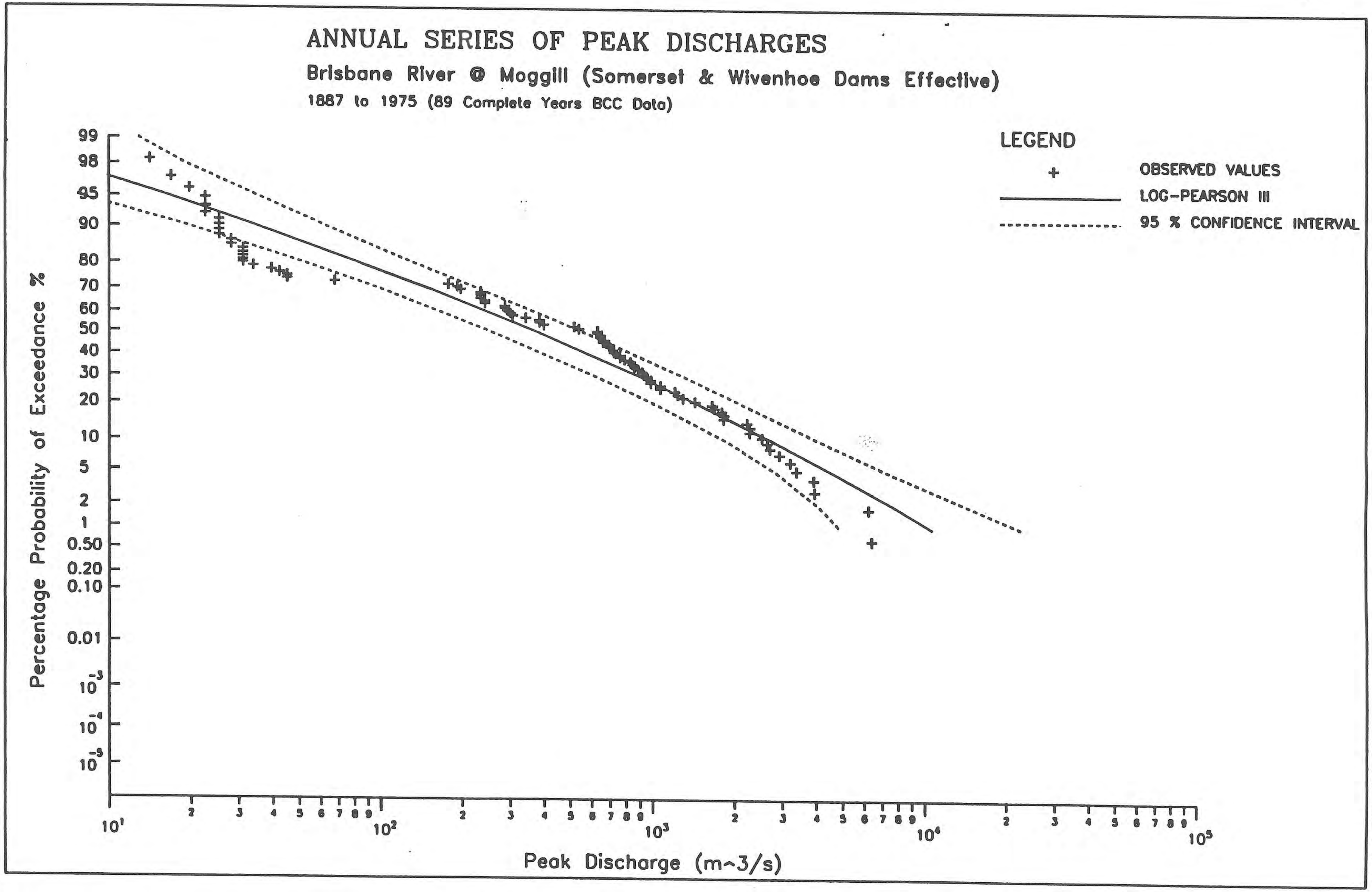

ANNUAL SERIES OF PEAK DISCHARGES
Brisbane River @ Moggill (Somerset Dam Effective)
1887 to 1975 (89 Complete Years BCC Data)
LEGEND
OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
Peak Discharge (m~3/s)

FIGURE B.38



ANNUAL SERIES OF PEAK DISCHARGES
Brisbane River @ Moggill (Somerset & Wivenhoe Dams Effective)
1887 to 1975 (89 Complete Years BCC Data)
LEGEND
OBSERVED VALUES
LOG-PEARSON III
95 % CONFIDENCE INTERVAL
Percentage Probability of Exceedance %
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.50
0.20
0.10
0.01
10^-3
10^-4
10^-5
Peak Discharge (m~3/s)
10^1
10^2
10^3
10^4
10^5

FIGURE B.39