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PHOSPHORUS TRANSPORT IN THE BERG RIVER, WESTERN CAPE

A. J. Bath

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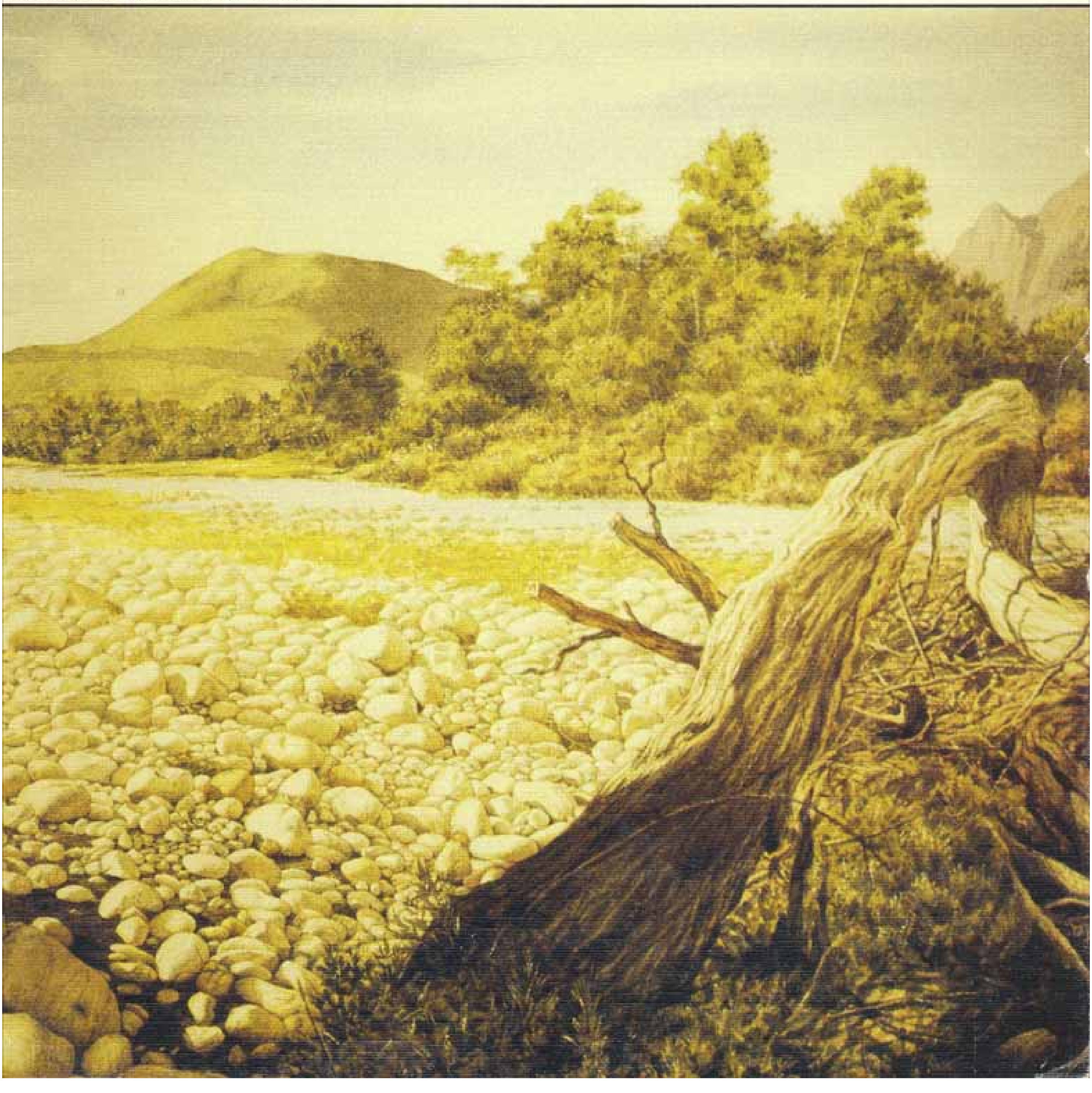

TR 143

PHOSPHORUS TRANSPORT IN THE BERG RIVER, WESTERN CAPE.

BY

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ABSTRACT

The objective of this investigation was to develop a dynamic phosphorus export model that describes the transportation of phosphorus through the Berg River drainage basin. Such a model had to consider (1) export of phosphorus from nonpoint sources via surface and subsurface drainage, and from point sources such as wastewater treatment discharges, (2) transportation of phosphorus in the water column along the river channel, taking account of removal and remobilization of phosphorus from and to the water column, and transportation of phosphorus in the bed load.

A phosphorus transport model based on the mass continuity equation was developed, calibrated and verified using discharge and phosphorus concentration data collected from the Berg River. River and effluent discharges were measured using continuous flow recording facilities. Phosphorus concentration measurements were obtained using a flow-proportional sampling strategy.

To predict the temporal and spatial variation in the discharge in the main river channel a hydrodynamic flow model was developed. Input to the model includes the measured upstream and lateral inflow hydrographs as well as estimated ungauged lateral inflow and outflow.

To predict the flux of phosphorus entering the main river channel from agricultural and urban areas a nonpoint source model was developed. A looped phosphorus discharge rating approach was adopted to account for the transients in phosphorus concentration associated with flood events. Further development of the model resulted in the formulation of a semi-mechanistic nonpoint source model accounting for phosphorus export from surface and subsurface drainage.

The phosphorus transport model uses data from the hydrodynamic flow model, nonpoint source model, and measured flux of phosphorus from point sources to predict the phosphorus chemograph at discrete points along the main river channel. The mass transfer of phosphorus between sediments and water column is found to be dependent on the river discharge rate.

The model has found useful application in (1) quantifying the mass of phosphorus exported from point and nonpoint sources, (2) identifying the processes influencing phosphorus transport, (3) designing water quality monitoring networks, and (4) planning future water resource development of the river basin.

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SYNOPSIS

The objective of this investigation was to develop a dynamic phosphorus export model that describes the transportation of phosphorus through the Berg River drainage basin. Such a model had to consider (1) export of phosphorus from nonpoint (diffuse) sources via surface and subsurface drainage, and from point sources such as wastewater treatment discharges, (2) transportation of phosphorus in the water prism along the river channel, taking account of removal and remobilization of phosphorus from and to the water column, and transportation of phosphorus in the bed load.

In seeking a structure within which a solution could be developed, one proviso constantly was kept in mind: the model must be practical, in the sense that information to calibrate and run the model must be readily obtainable.

Many processes are involved in the generation and transportation of phosphorus. Although research had been reported on some of the important processes, a mechanistic modelling approach was not feasible for reason that the mathematical descriptions of the processes either were not available, or were inadequate - an empirical or semi-empirical lumped parameter approach appeared to be the only practical one; this approach dominated the development of the different models.

Nonpoint Source Phosphorus Export Model:

In the lumped parameter approach the objective is to seek a parameter, or parameters, in terms of which some or all of the required components can be modelled. In developing the nonpoint source model for phosphorus export, two parameters were identified as potentially useful model parameters, the discharge and the rate-of-change of discharge. From observation on nonpoint sources, characteristically the phosphorus concentration exhibits a behavioural pattern apparently related to discharge. In any river or catchment monitoring system, discharge would be the parameter most commonly measured. For this reason alone selection of discharge as an independent parameter, in terms of which to model the phosphorus component, would not be an unreasonable choice. During flood events, for the same discharge, the total phosphorus concentration is higher during the rising limb of a flood hydrograph than during the falling limb. Incorporating the rate-of-change of discharge, as an independent parameter, empirically provides a mathematical structure that allows separating out the phosphorus concentrations in the rising and falling limbs of the nonpoint source hydrograph.

Using the lumped parameters, discharge and rate-of-change of discharge, it was found possible to give an adequate description of the phosphorus chemographs associated with the hydrographs from nonpoint sources — called the looped phosphorus discharge rating method. This description also was consistent in that the calibration constants in the looped discharge equation (for subcatchments in the Berg River basin) were found to be related functionally to the magnitude of the total subcatchment discharge; this allowed the phosphorus export to be estimated for subcatchments in which no phosphorus measurements were collected.

The looped rating method was applied also to subcatchments which were ungauged: in the Berg River basin only about 40 percent of the catchment area between Paarl and Drie Heuwels Weir is gauged. However, for ungauged subcatchments between gauged subcatchments, it was found, by interpolation procedures, that the discharge hydrograph for the ungauged subcatchment could be synthesized with reasonable accuracy from the hydrographs of the gauged subcatchments on either side of the ungauged subcatchment. Once the hydrograph for such a subcatchment was available, the chemograph was synthesized by applying the looped rating method using the functionally related constants, as described above.

To calibrate the looped phosphorus-discharge rating model it was essential to monitor the phosphorus concentrations on the rising and falling limbs of flood flows at intervals as short as 4 to 6 hours; monitoring of phosphorus at regular time intervals, daily or weekly, provided completely inadequate information both for calibration of the model and for estimation of the mass of phosphorus exported from a nonpoint source. Flood waves on average lasted only a few days, yet within this period massive changes in phosphorus concentration and discharge (and hence phosphorus load) were observed. Almost 80 percent of the phosphorus exported from the basin took place during flood events even though the total time of such events constituted less than 3 percent of the total time period monitored. In the Southern African region, where sharp transient flood flows are common, associated extreme transient phosphorus concentrations are to be expected – data acquisition strategies always would need to take this behaviour into account.

<u>Phosphorus channel transport model</u>:

Advective transport of phosphorus along a river channel implicitly requires solution of the time varying discharge at any point in the length of the channel. During flood events there is a time varying discharge to the channel at different points along the channel. The velocity of flow in the channel at any point will depend on a number of parameters such as the bed slope, discharge, bed friction forces, channel cross section and others.

Theoretically the flow could be modelled using the momentum and continuity equations of St. Venant. However, the amount of information required to describe the boundary conditions for such a solution makes these equations quite unsuitable for flow routing. As a consequence the literature records various simplifications to the momentum equation, e.g. neglecting some terms in the momentum equation or replacing this equation completely by an empirical one that indirectly includes the energy effects. With the simplified models the boundary effects can be accommodated to a greater or lesser degree, by calibration. Amongst the number of simplified models studied that of Li proved to be the most practical. Li accepts the discharge as the independent parameter in terms of which he formulates the energy/velocity effects. This approach is used in other models but the formulation in the model of Li is such that calibration is readily achievable by measurements in the field. The field measurements include discharge, depth of flow, and cross section at a number of points along the flow path.

To solve the hydrodynamic model the mass continuity and simplified energy equation are rewritten into finite difference form and applied sequentially to a set of contiguous subreaches along the main river channel.

Discharge is determined in each sub-reach as follows: as input are the calculated or measured discharge hydrographs at the upstream end of a sub-reach and, hydrographs of the lateral gauged and ungauged tributaries in the sub-reach (the ungauged tributary hydrographs are synthesized by appropriate interpolation of the hydrographs from gauged tributaries to either side of the ungauged tributary). The discharge at the downstream end of the sub-reach is calculated by solving the finite difference mass continuity and simplified energy equation. Minor factors, incorporated empirically, are seepage losses and abstractions. The model was calibrated using data over one hydrologic year.

The performance of the hydrodynamic model was assessed by comparing the measured channel hydrograph at the downstream boundary of the catchment (100 km below the upstream boundary), with the simulated hydrograph calculated from the measured upstream hydrograph and the lateral input hydrographs in the sub-reaches between the upper and lower main channel boundaries. Over three years of hydrograph data the simulated and observed hydrographs compare remarkably well.

In developing a model for phosphorus transport along the river channel cognisance had to be taken of the removal of phosphorus from the water column by settlement, biotic assimilation and others; and remobilization of phosphorus into the water column from the riverbed.

To develop a model for removal/remobilization, the phosphorus behaviour along the channel was monitored under steady flow conditions, at different discharges. These showed that the removal conformed to an exponential type formulation with respect to channel distance, but that the exponential "*constant*" was a *function* of discharge. From a number of phosphorus concentration profile plots at different discharges an empirical relationship between the constant and discharge was established. This showed that in the Berg River the rate of removal of phosphorus from the water column increased as the discharge dropped below 17 cumecs, and remobilization of phosphorus took place as the flow increased above 17 cumecs.

The phosphorus transport model operates as follows: over a sub-reach the input of phosphorus and discharge is known at the upstream boundary. Along the sub-reach the input of phosphorus and discharge are available from the tributary hydrographs and their associated chemographs developed from the nonpoint source model. The discharge in the sub-reach is determined from the hydrodynamic model. Knowing the discharge, the removal/-remobilization of phosphorus from/to the water column in the sub-reach is calculated. In this fashion the discharge and phosphorus concentration at the downstream end of the sub-reach is determined.

As with the hydrodynamic flow model, the performance of the transport model was assessed by comparing the simulated phosphorus chemograph at the downstream boundary of the channel with the measured chemograph — the correspondence was good. The performance of the phosphorus transport model was all the more acceptable when one considers that there was virtually no calibration leeway available. If the correlation had been poor it would have required a review of the nonpoint phosphorus export and the *removal/remobilization models. The* good correspondence indicated that the structure of the model and the calibration procedures were acceptable.

The modelling approach adopted above, for the removal or remobilization of phosphorus, in effect left out consideration of the mass of phosphorus stored on the riverbed. Initially it was attempted to model the storage of phosphorus on the bed of the river in order to trace the mass movement in and out of the bed due to removal and remobilization. This attempt was unsuccessful; the model proved to be elaborate and presented difficulties in accommodating the mass of phosphorus stored on the bed and the removal and accretion effects over sequential flood events. Also, experimentally no meaningful field data on the phosphorus stored on the bed could be obtained. As it was felt that the bed load problem could not be abandoned, an attempt was made to model the bed load transport quite independently of the interaction with the water column above. A bed load transport model that had been proposed in the literature was applied except that the bed load contains a proportion of phosphorus material. This model indicated that very little phosphorus would be exported with the bed load. Interpretation of the findings of the bed model is not yet clear.

Model Implications:

The calibrated model provided information of significant importance as to the behaviour characteristics of phosphorus in the catchment and the implications of various operational and management strategies.

(1) Of the phosphorus exported at Drie Heuwels, almost 80 percent is derived from nonpoint sources, the remaining 20 percent from point sources (the municipal effluents from Paarl and Wellington). This finding provides information, for the first time in South Africa, that nonpoint phosphorus sources may be of much greater importance than realized previously.

(2) Phosphorus transportation from a nonpoint source is strongly linked to surface runoff during storm events. The present indications are that the mass exported is principally a function of the discharge under the rising limb of the hydrograph. The chemograph does not appear to be significantly affected by sequential storm events; this would indicate that the phosphorus source is infinite, a conclusion probably specific to the Berg River basin. A large proportion of the basin is under wheat production and for the soils in this basin phosphorus supplementation needs to be higher than normal.

(3) The major mass of phosphorus exported from nonpoint sources takes place during storm events. In the Berg River 80 percent of the phosphorus exported during storm events takes place in less than 3 percent of the yearly hydrologic cycle.

(4) In the main river channel, although removal of phosphorus from the water column takes place under low flow conditions and remobilization of phosphorus into the water column under high flows, the indications are that in the long term there is no, or only very little, net removal of phosphorus in the channel. Thus, all phosphorus that discharges to the main river channel eventually will be exported at the lower catchment boundary — phosphorus storage in the channel is of a temporary nature only.

(5) The indications are that with the present inter-catchment water transfer facilities, to export water out of the Upper Berg River catchment is feasible but only during the high flow periods, and then only with stringent operational control. Abstraction under low and medium flow conditions will lead to a significant increase in the phosphorus concentration in the lower Berg River which may in turn, affect adversely the water treatment facility at the Withoogte Works.

(6) Augmentation of Voëlvlei Dam from the Berg River, by abstraction at Hermon, may be implemented but only during high flow periods, specifically not during storm events. Even during high flow periods (outside storm events) the phosphorus concentration in the river still may be 3 to 7 times that in the Twenty Four and Klein Berg Rivers, presently the source of water for Voëlvlei. During a storm event, the phosphorus concentration could rise to 700 μg/ℓ, up to 14 times or more than that in the Twenty Four and Klein Berg Rivers.

(7) Should an impoundment be constructed at Misverstand the water quality will be dominated by nonpoint source drainage. Implementation of the 1 mg/ℓ effluent standard at Paarl and Wellington will reduce the total phosphorus load at the dam by only 10 percent. Construction of retention weirs on the tributaries in the reach from Paarl to Drie Heuwels Weir, should these be 50 percent effective in retaining phosphorus, would reduce the total phosphorus by about 20 percent only. If however retention weirs should be constructed also on the tributaries upstream of Paarl, a preliminary estimate (insufficient data on the upper Berg River system is available) indicates that the total phosphorus load will be reduced by about 50 percent at Misverstand. However, at present there are no definitive performance data available to verify whether these retention weirs in fact will function effectively.

(8) The high fraction of the phosphorus load delivered from nonpoint sources points to enquiry into methods to reduce phosphorus export from agricultural areas inter alia by improved agricultural practices.

<u>Conclusions</u>:

(1) The hydrodynamic phosphorus transportation model, developed in this investigation, provides a reasonably reliable description of the phosphorus generation and phosphorus transportation in the aqueous phase of the Berg River catchment within the Paarl — Misverstand reach.

(2) The model is largely empirical, but in describing the various phosphorus behavioural patterns it indirectly addresses the mechanisms and processes effecting the behaviour; this may provide material for future research.

(3) The model serves as a powerful instrument in assessing the implications of a variety of proposed operational and phosphorus management strategies.

(4) The model provides reliable temporal information on the phosphorus input to any proposed impoundment in the Berg River in the Paarl — Misverstand reach. In this respect the information probably is more extensive and more complete than for any other catchment in South Africa. Evaluation of the trophic status of such an impoundment no longer will be limited by inadequate phosphorus input information, rather by deficiencies in the existing models for assessing the trophic status of an impoundment. It is to be hoped that the availability of a reliable model, to describe the phosphorus mass-time input behaviour to the impoundment, may stimulate development of a dynamic eutrophic impoundment model.

(5) The model in its present form, although site specific is very flexible. With the exception of data from 2 or 3 accurate discharge monitoring stations, other information for calibrating the model can be obtained by field measurements. The model should be applied in other catchments, under different hydrologic regimes, topography, catchment size and configuration, in order to improve or modify it for general application.

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

CHAPTER 1

INTRODUCTION

Enrichment of waterbodies with plant nutrients, a process referred to as eutrophication, has developed into a serious water quality problem throughout the world. In South Africa, because of the paucity of the water resource and the relatively high demand on it, eutrophication and its consequences have manifested themselves to a higher degree than in any other industrialized country. Quantification of eutrophication and its effects, and procedures to manage it have, in consequence, become matters of high priority.

It is universally accepted today that the principal nutrient controlling the degree of eutrophication is phosphorus. Efforts at describing and quantifying the effects of eutrophication in waterbodies have led to the development of eutrophication models. One such model, developed by the Overseas Economic Community Development (OECD) has found useful application in South Africa, in quantifying the eutrophic state of impoundments and testing the effects of proposed management strategies.

One of the basic requirements in applying the OECD model (and others) is the magnitude of the phosphorus load on the waterbody. In this respect, however, it has been found that at best phosphorus load calculations are characterized by errors of circa 35 percent. This poor accuracy/precision in load estimation, is regarded as the major source of scatter in the OECD evaluation of the intensity of eutrophication in various waterbodies. Precise and accurate estimates of the phosphorus loads are, in consequence, matters of vital concern in quantifying eutrophication and devising management strategies and implementing them.

At present all the important eutrophication models are based on the annual input of phosphorus load to the waterbody. It is very likely, and indeed inevitable, that these models will be refined and extended to produce a dynamic response. Such a model will require, inter alia, temporal changes in discharge, and phosphorus load associated with the discharge to the waterbody.

Quantification of the temporal changes in discharge and phosphorus export load require study of the catchment discharging to the waterbody. Numerous studies have been undertaken to quantify the discharge and phosphorus export from a catchment. However no practical dynamic model has emerged that satisfactorily resolves both discharge and phosphorus export simultaneously.

The problems to be resolved in such a joint model are considerable. With regard to the water movement through the system, the model is required to produce an acceptably accurate description of the discharge hydrograph from each subcatchment, and the discharge hydrograph at any selected point along the main river channel.

With regard to the phosphorus load, there are two aspects to be considered, (1) the "generation" of the phosphorus load, and (2) the transport of the phosphorus along the main channel.

(1) Phosphorus is generated from two sources: firstly, point sources such as wastewater treatment discharges in which the phosphorus concentration and flow (and hence the phosphorus load) are, or can be, readily quantified by appropriate monitoring. Secondly, diffuse sources - called nonpoint sources - in which the phosphorus load is generated by surface and subsurface drainage. Nonpoint phosphorus generation is not so readily quantified; it is a complex phenomenon, inter alia a function of the runoff discharge.

(2) With regard to phosphorus transport, once the subcatchment flow with its associated phosphorus load is discharged to the main river channel, the phosphorus in the water prism (the wash load) can decline in concentration due to removal of phosphorus to the riverbed principally by settlement and biotic uptake, or can increase due to remobilization of the phosphorus from the bed to the water column during flood flows.

A number of models describing nonpoint source load-discharge behaviour in subcatchments, and transport of phosphorus along the river channel have been presented in the literature.

In this investigation a dynamic model is developed that deals with all the aspects mentioned above, viz. point, nonpoint, and channel hydrograph formation; point and nonpoint dynamic phosphorus generation; and phosphorus removal and remobilization in the main channel river flow. The principal output is a discharge hydrograph and its associated phosphorus chemograph, at any selected point(s) along the main river channel.

In structuring the model it was soon evident that the model could not be built up quantitatively, as yet, on the basic processes that govern the generation and transportation of phosphorus in a drainage basin. Most of the processes (if not all) have been identified conceptually but many cannot be formulated quantitatively in mathematical form or where such mathematical formations are available, require such elaborate calibration inputs that application becomes impracticable. It seems that for the immediate future an empirical or semi-empirical lumped parameter approach is the only feasible one to obtain approximate but practical solutions. In such a model it is attempted to formulate the process components (e.g. phosphorus) in terms of variables that can be measured practically (e.g. discharge) where such relationships appear to have a description potential. Following this approach, the model presented here contains a fair amount of empirical formulation relating one component with another. In particular, discharge is extensively used in the formulation of the response of other model components and their rates of formation. A prime endeavour kept in mind, was that the model must not require extensive input of data to calibrate it, and this input must be of a nature that can be obtained with a relatively small resource allocation.

To develop the model data needed to be available from a suitable river catchment. A number of river systems were investigated and the Berg River, in the Western Cape Province of South Africa, was selected as the most suitable area for the following reasons:

- The river is within 45 to 150 km from Cape Town, enabling rapid and easy access.

- The catchment has a diverse land-use comprising urban, agricultural, industrial and forestry areas.

- The catchment has a seasonal rainfall that varies in intensity over the catchment area from 400 to 3 000 mm per year. During the rainy season (winter) the rainfall pattern is periodic, giving rise to a number of flood events with peak river discharges >200 cumecs. During the dry season (summer) the minimum discharge can reduce to as low as 0.5 cumecs. The flow regime therefore provides an extensive range of flow conditions for modelling purposes.

- There are 16 flow-gauging structures located in the catchment as follows: two on the main river channel 100 km apart, 12 on the subcatchments (not all the subcatchments), and 2 on the discharge lines of the treated municipal effluents.

- The river has been surveyed and sampled over a period of up to 10 years, providing a useful base line of hydrologic and water quality information.

A further reason for selecting the Berg River catchment was that the Water Act (Act 56 of 1958) (Government Gazette, 1984) was amended on 1 August 1980 to include the control of soluble ortho-phosphate in effluent discharges to rivers located in seven "sensitive" catchment areas; the list of river catchments includes the Berg River, declared a "sensitive" catchment because of the proposed construction of an impoundment in the lower reaches. In the Berg River basin are located two of the three impoundments (Wemmershoek and Voëlvlei Dam) supplying water to Cape Town and various satellite municipalities. This river constitutes an important water resource in the Western Cape which must be protected for future utilization.

In this report the developments up to and including the dynamic hydro-phosphorus transport model are set out as follows:

Chapter 2 introduces the causes and consequences of eutrophication, with emphasis on the role played by phosphorus, its behaviour in aquatic systems and methods of quantifying and controlling the transport of phosphorus along river channels.

Chapter 3	gives a description of the Berg River catchment in terms of its physical location, topography, climate, geology, soils, agricultural development, hydrology, water quality, demography and water resource development.
Chapter 4	describes the procedures to collect discharge and water quality data from the Berg River system. An interactive monitoring network approach is developed comprising two components, a preliminary survey and main river survey. The preliminary survey is used to identify the principle sources and sinks of phosphorus in the drainage basin, and the main river survey to obtain detailed data for the development and calibration of a phosphorus transport model.
Chapter 5	presents and analyses the water quality and river flow data collected over the monitoring period to show the temporal and spatial variations in flow and quality.
Chapter 6	proposes the conceptual framework for modelling phosphorus transport in drainage basins; two submodels are identified, a hydrodynamic flow model and a phosphorus transport model. It then describes the development, calibration and verification of the hydrodynamic flow model based on the kinematic wave equation, suitably modified to accommodate ungauged lateral runoff as well as ungauged losses from the main river channel. The model is calibrated against one year's flow data and tested against the flow data over two further years of data.

Chapter 7 describes the development and calibration of a phosphorus transport model. The model is made-up of three submodels: a phosphorus nonpoint source model, a phosphorus transport model and a phosphorus bed load model.

Chapter 8 deals with the use of the hydrodynamic and phosphorus transport models to evaluate the implications of various management options on the phosphorus budget of the Berg River system. These options include: imposition of the phosphorus standard on treated wastewater discharges at Paarl and Wellington; nonpoint source control; pre-impoundments; inter-catchment transfer; diversion scheme to fill Voëlvlei Dam; and the construction of an impoundment at Misverstand.

Chapter 9 comprises the conclusions and recommendations from this investigation. It assesses model performance and lists recommendations for further research and application.

CHAPTER 2

LITERATURE SURVEY

1 CONCEPT OF EUTROPHICATION

1.1 Causes and consequences

Eutrophication is a problem facing many aquatic systems throughout the world (Jones and Lee, 1982). The term eutrophic (eutrophos literally means "well nourished") was originally applied to shallow European lakes, characterized by high concentrations of dissolved solids, high productivity, a deoxygenated hypolimnion, extensive weeds and planktonic algae as well as the presence of non-Salmonid fish. The term was developed to contrast waterbodies that are oligotrophic (oligotrophos meaning "providing little nourishment") typically, upland lakes with deep basins, low dissolved solids, low productivity, an oxygenated hypolimnion, few plant species and Salmonid fish (Moss, 1980). However, it should be emphasized that most lakes will not fall within this neat classification; a spectrum of conditions exists between these two extremes.

The first trophic classification of South African impoundments was undertaken by Toerien, Hyman, and Bruwer (1975). They ranked ninety-eight South African impoundments and found 11 percent highly eutrophic, 50 percent oligotrophic and the rest intermediate. Taylor et al. (1984) and Wiechers et al. (1984) demonstrated a high correlation between the trophic status and the input loading of phosphorus, see Table 2.1.

Table 2.1 Selection of South African impoundments ranked according to their phosphorus input loadings, with an indication of their trophic status (from Taylor *et al*., 1984).

Impoundment:	Annual phosphorus load: (g $P/m^2/y$)	Trophic status:
Hartbeespoort	23.20	Hypertrophic
Rietvlei	15.82	Hypertrophic
Laing	13.82	Eutrophic
Roodeplaat	11.08	Hypertrophic
Bridle Drift	2.43	Eutrophic
Rust de Winter	0.40	Mesotrophic
Albert Falls	0.02	Oligotrophic

Grobler and Silberbauer (1984) enquired into the effect an imposition of a phosphorus standard (for effluents) would have on the trophic status of 19 South African impoundments. They concluded that the trophic status of impoundments in which the phosphorus originated principally from point sources, would derive the greatest benefit.

The prolific growth of both planktonic algae and macrophytes associated with eutrophication causes a variety of water quality problems:

(1) Trihalomethanes (THM) are produced when water abstracted from eutrophic impoundments is chlorinated, even after conventional treatment for potable use. THM's are chloroform-related compounds, which if ingested in sufficient quantity, may cause

certain types of liver damage and cancer (Marx, 1974; Lahl et al., 1981; Williamson, 1981). Recent research (Codd and Bell, 1985; Scott, van Steenderen and Welch, 1985) indicates a positive relationship between the level of eutrophication and the concentration of THM's.

(2) Livestock and fish deaths may be associated with blooms of toxic algae (e.g. certain species of cyanophycae) (Bruwer, 1979; Codd and Bell, 1985). Their influence on humans is not well documented but Scott et al. (1985) state that certain instances of gastro-enteritis have been caused by consumption of impounded water containing Microcystis spp.

(3) Recreation is influenced adversely by eutrophication. Water Hyacinth (Eichhornia crassipes (Martius) Solms-Laubach), Salvinia molesta and other floating macrophytes can make waterbodies unusable for sailing; unpleasant odours and algal-scums can make the water offensive to bathers and have health implications (e.g. allergenic response) as well as reduce property values sited on, or near, the shoreline of the waterbody (Walmsley and Butty, 1980).

(4) Release of water from the hypolimnion of an eutrophic impoundment gives rise to odour problems in the downstream watercourse as well as impairing its ecology and fishing potential (Krenkel, Lee and Jones, 1979). For municipal water supplies, water drawn from the hypolimnion may contain high concentrations of iron and manganese which must be removed, and hence add to the cost of water treatment.

(5) Eutrophic conditions can cause a considerable increase in the cost of treating water for domestic and industrial purposes. Algae not only present problems in flocculation, sedimentation and filtration but also excrete extra-cellular products which can impart unpleasant odours and tastes to the water (Viljoen, 1984), see Table 2.2. To remove tastes and odours it may be necessary to incorporate activated-carbon columns in the water treatment system, a relatively costly unit process. Biological growth favoured by nutrient enrichment may cause biological fouling in pipes and industrial equipment.

(6) Abundant growth of macrophytes, also associated with eutrophic conditions, may give rise to navigation and nuisance problems in waterways and irrigation canals. By virtue of article one of the Act on Weeds (South African Act no. 42, 1937) Myriophyllum aquaticum, Lemna minor and Eichhornia grassipes are proclaimed weeds; the Rand Water Board employs a full-time work force to remove these plants from the Vaal Barrage at an annual cost of around R45 000 (Viljoen, 1984).

Table 2.2 Algae which cause problems in South African impoundments and in water treatment (based on: Walmsley and Butty, 1980).

Algae:	Problem:
Melosira	filter blockage
Microcystis	filter blockage, taste and odours, toxicity, scums
Oscillatoria	filter blockage, taste, odour, scums
Anabaena	filter blockage, toxicity, scums
Euglena	filter blockage, taste
Chlamydamonas	filter blockage and penetration
Dinobryon	taste, odour
Prymnesium	toxicity to fish

In contrast to the negative aspects discussed above, Walmsley and Butty (1980) state that eutrophication can have some beneficial effects. Moderate eutrophication may increase the productivity of an impoundment; by harvesting species of economic or recreational interest, for example fish, it should be possible to take advantage of this condition. However, impoundments that become eutrophic may experience a shift in fish species, resulting in the dominance of unpalatable varieties, in which event less favourable angling prospects are to be expected. Irrigation water is improved as a result of a higher nutrient concentration, but again this advantage can be diminished by the fouling of irrigation canals. Except in isolated cases, the disadvantages of eutrophication outweigh the advantages.

1.2 Economics of eutrophication

Bruwer (1979) and Viljoen (1984) have attempted to estimate the cost to the community of the eutrophication of waterbodies in terms of the loss of recreational value and increased water purification costs, but found it virtually impossible to allocate a monetary value. However, in the provision of potable water one may assess the cost of eutrophication by estimating treatment costs associated with the level of eutrophication, in this fashion assist in the choice of sources of raw water at the planning stage of urban developments (Herold and Pitman, 1987).

1.3 Autotrophic nutrient requirements: role played by phosphorus

In addition to sunlight, algae and other aquatic plants need a variety of chemical constituents (nutrients) for growth, principally carbon, nitrogen, phosphorus, oxygen, hydrogen and silicon plus a host of trace nutrients. An important concept which governs the growth of algae is the principle of the limiting nutrient. Briefly, this principle is based on the concept that the mass of algae that can grow is restricted by the mass of that essential element which becomes exhausted first.

Carbon:

In terms of stoichiometry, algae typically need 106 carbon atoms and 16 nitrogen atoms for each phosphorus atom, for growth and reproduction. The relatively large demand for carbon, as compared to phosphorus, could lead one to speculate that carbon very likely may be the limiting element. This however is rarely the case. Effectively, there is an infinite source of carbon dioxide in the air - the limiting factor with carbon is not in the mass to be supplied but in the rate of supply. Limitation in the rate of carbon supply may arise from high rates of photosynthesis in the upper layers of highly eutrophic waterbodies when the carbonate and bicarbonate species are depleted, indicated by a shift in the pH to values of around 9.5 or higher (NIWR, 1985). For most waterbodies however, carbon is rarely a limiting factor in the rate of biomass generation or the total biomass generated in a waterbody.

Nitrogen:

This element has been cited as being an algal growth limiting nutrient in certain waterbodies. This however is rare; nitrogen is available for growth in the nitrate and ammonia forms, if these are deficient, certain groups of organisms, the nitrogen fixers, convert nitrogen gas into organic nitrogen compounds, in this fashion increasing the supply of usable nitrogen. For this reason few impoundments are nitrogen limited.

Phosphorus:

In the large proportion of impoundments phosphorus is the limiting nutrient - algal assay techniques have shown that most fresh water lakes and impoundments are phosphorus limited. A reduction in the phosphorus loading to the waterbody usually will result in an associated reduction in the algal biomass (Rast and Lee, 1983).

Trace elements:

Micro-nutrients (e.g. iron and silicon) or growth factors (e.g. vitamin B12) may be limiting (Lee, Rast and Jones, 1978; Round, 1977) but such situations are rare.

We have mentioned above that when the load of the limiting nutrient is decreased in a waterbody it should result in an associated decrease in the algal biomass. This implies that in the majority of instances by controlling the phosphorus load to a waterbody it should be possible to exercise some control on the autotrophic biomass (Toerien, 1977; Jones and Lee, 1982; Wiechers and Heynike, 1986). However, Sonzogni, Chapra, Armstrong and Logan (1982) state that some forms of phosphorus entering lakes have a limited effect on lake productivity: land runoff, often containing a high proportion of particulate phosphorus may be un-utilized by planktonic algae. These authors found, based on studies carried-out on the Great Lakes, that of the total phosphorus load carried by the rivers to the Great Lakes only 60 percent was potentially bio-available. They concluded that the mass of bio-available phosphorus corresponds to the dissolved reactive portion plus that fraction of the particulate inorganic phosphorus that can be extracted with 0.1 N NaOH. It is possible that the remaining portion of "unavailable" phosphorus may become bio-available, but the quantity and process are not well understood. In contrast, Huettl, Wendt and Corey (1979) estimate the proportion of available phosphorus entering the system at 90 percent of the total mass input. Evidently it is not possible to make generalised statements regarding the bio-availability of phosphorus in surface waters.

2 SOURCES OF PHOSPHORUS

The catchment area surrounding an impoundment has an important influence on the quality of that waterbody - runoff derived from within this area eventually will enter the impoundment; any anthropogenic or natural activity within the catchment, which influences the drainage process, concurrently will influence the quality of the impounded water.

Phosphorus entering the aquatic system is derived principally from two sources: point and nonpoint. Point sources are defined as discharges of industrial and municipal effluents (treated and untreated). Nonpoint sources are defined as drainage from agricultural and urban areas to the main river channel itself or tributaries feeding the main river channel.

2.1 Point sources

In South Africa, municipal and industrial effluent discharges have been identified as a major contributor to the phosphorus load entering the aquatic system (Taylor et al., 1984). This is illustrated in Tables 2.3 and 2.4; these give respectively typical phosphorus concentrations in municipal wastewaters before treatment, and the annual tonnages of total phosphorus discharged in the effluents after treatment in wastewater plants located in sensitive catchments.

The major sources of phosphorus in domestic wastewater are human excreta and detergents. In a survey conducted by Wiechers and Heynike (1986) between 50 and 60 percent of the phosphorus load received at a wastewater treatment plant originates from human excreta, the remaining fraction mainly from detergents. In combined domestic and industrial waste flows the phosphorus load from industry may cause a significant shift in these percentages.

Phosphorus content of human excreta is related to the dietary habits, but an average daily quantity of phosphorus in excreta is estimated at 1.3 g P per capita. The average daily mass contribution of phosphorus from detergents is estimated at 1.0 g P per capita (Wiechers and Heynike, 1986).

Contributions of phosphorus from industrial effluents are more difficult to estimate because some industries discharge little phosphorus, others, such as fertilizer production, feedlots, milk and meat processing, discharge highly concentrated phosphorus effluents (Wiechers and Heynike, 1986).

Phosphorus in untreated waste flows can be categorized as organically bound or inorganic, each present in different forms, particulate, colloidal or dissolved. One of the soluble forms, ortho-phosphate, makes up 40 to 75 percent of the total load of phosphorus in the untreated waste flow. During treatment a high percentage of the other forms usually are converted to ortho-phosphate; the net effect is that the proportion of phosphorus in the ortho-phosphate form can increase to 90 percent or more as the waste flow passes through the plant.

Table 2.3 Typical phosphorus concentrations in municipal wastewaters (mg/ℓ as P) (from: Wiechers, 1985).

City and works:	ortho-phosphate:	total phosphorus:
Pretoria, Daspoort	7.5	10.5
Boksburg, Vlakplaats	6.5	15.3
Cape Town, Cape Flats	-	14.2
Pinetown, Umlaas	7.0	12.2

Table 2.4 Annual tonnage of total phosphorus discharged from wastewater plants to rivers in the critical catchments.

Catchment:	1981	1985	1995	2000
Vaal River	1093	331	504	634
Crocodile River	929	165	254	322
Umgeni River	330	49	73	108
Berg River	48	9	13	17
Buffalo River	29	6	9	11
Olifants River	20	22	18	22

(From: Davidson and Howarth, see Grobler and Silberbauer, 1984).

2.2 Nonpoint sources

Nonpoint sources of phosphorus include: atmospheric precipitation, urban runoff, and drainage from agricultural lands.

Atmospheric precipitation: Atmospheric wet precipitation and dry fall-out generally are low, Sonzogni and Lee (1974) for example report 0.02 and 0.08 g $P/m^2/y$ for these two sources, in the USA. These figures are not dissimilar from observations in South Africa: Simpson and Kemp (1982) report atmospheric deposition of 0.06 g $P/m^2/y$ for an urban area (Pinetown,South Africa) and Bosman and Kempster (1985) 0.06 g $P/m^2/y$ for a mixed catchment (Roodeplaat Dam catchment, South Africa). Higher values are to be expected in the proximity of industrial areas, and lower ones in undisturbed catchments.

Urban and agricultural runoff: Weibel, Weidner, Cohen and Christianson (1966) investigated the contributions of nutrients from rainfall and runoff. For urban runoff from a 27 acre residential and light commercial area in Cincinnati, USA, the phosphorus concentration ranged from 0.02-7.3 mg P/ℓ, with an average value of 1.1 mg P/ℓ. For agricultural runoff they investigated the phosphorus contribution from an experimental farm catchment - the concentration ranged from 0.25-3.3 with an average of 1.7 mg P/ℓ. During storm events the phosphorus concentration increased greatly yielding 5 g $P/m^2/y$ in the runoff. Weibel, Anderson and Woodward (1964) report an average yearly export figure for phosphorus of 0.3 g $P/m^2/y$. In urban runoff Uttormark et al. (1974) give total phosphorus export rates of 0.11 to 0.31 g $P/m^2/y$. They also supply values for total phosphorus export from croplands, see Table 2.5.

Table 2.5 Total phosphorus export from cropland by surface runoff (after Uttormark et al., 1974).

Crop:	Total phosphorus ($g/m^2/y$):
Maize	0.19-1.00
Cotton	0.017
Wheat	0.04-0.13
Lucerne	0.02
Mixed vegetables	1.80-3.00

A survey carried-out by Hemens, Simpson and Warwick (1977) in the Umgeni catchment in Natal (South Africa), indicate that about 2 percent of the phosphorus applied to the catchment area is exported via river flow.

2.3 Point and nonpoint sources compared

The following conclusions, as regards point and nonpoint sources of phosphorus, are indicated:

(1) A considerable mass of phosphorus is exported from nonpoint sources during storm events; when investigating phosphorus export it is most likely that during storm events a large proportion of the nonpoint annual export load of phosphorus takes place. The effect of storms probably is accentuated in South Africa because storms are of high intensity in certain areas, and the rainfall is seasonal with average rainfall exceeding average evaporation giving rise to

depletion of vegetation cover during the dry season. These factors combined can result in substantial soil erosion during a storm event; with erosion, the nutrient load carried by a river will be increased, depending on the fertility of the soil eroded.

(2) Agricultural and urban areas are more important as sources of phosphorus than atmospheric deposition; phosphorus control strategies for surface runoff, therefore, are more likely to result in the reduction in the phosphorus load to the water system.

(3) It is not unlikely that in many situations nonpoint sources will yield a substantial fraction of the total phosphorus load carried by the river.

3 SINKS OF PHOSPHORUS

3.1 Wetlands as phosphorus sinks

Research carried-out in the United States and Canada indicate that effluents passing through wetlands and marshes are depleted of nitrogen and phosphorus (Nichols, 1983). Wetlands, or reed bed systems, as a form of tertiary wastewater treatment is receiving increasing interest, but the nutrient dynamics of these systems are still poorly understood (Kadlec, 1986). For example, the mechanisms whereby a wetland removes nutrients (adsorption, absorption and precipitation), must have finite capacities. Also, because the adsorption reaction will be partially reversible, under low effluent concentrations adsorbed nutrients may be released back into solution (Logan, 1982). The seasonal growth pattern also will influence uptake of nutrients (Nichols, 1983). During winter, plant die-down may result in nutrient release from cell lysis. Finally, storm events may cause scouring of the wetland causing the remobilization of stored nutrients. Wetlands therefore present a temporary sink for nutrients. Over an extended time scale each catchment will provide different nutrient retention and release characteristics depending on the catchment hydrology (Rast and Lee, 1983; Nichols, 1983; Bath, 1983). Viljoen (1984) is of the opinion that wetlands should not be used as a permanent method of removal of point source phosphorus, rather they should serve to accommodate point source mishaps and peaks of nonpoint source inputs to the river system.

3.2 Rivers as phosphorus sinks

Assimilation of nutrients in rivers is one area that has received little attention. The work of Keup (1968) serves as an illustration of the propensity of riverine processes to remove phosphorus from the overlying water column. Keup reported that the phosphorus concentration in the South Platte River, Colorado, USA, decreased below the treated effluent outfall as a function of river distance (see Fig 2.1). He ascribes the removal to biotic activity and formulated a simple empirical relationship to describe the phosphorus concentration profile in the river. However, he also reports that during high flow, phosphorus accumulated along the channel is remobilized and transported downstream. The flow regime therefore is a major factor in the mobility, availability and spatial distribution of phosphorus within a river. Other riverine processes that abstract or return phosphorus to the river water are:

(1) Adsorption and desorption processes; through these river sediments can act as both a sink and source of phosphorus (Green, Logan and Smech, 1978; Cooke, 1988). Sediments act as scavengers of phosphorus, limited only by the maximum sediment adsorption capacity. Desorption of phosphorus usually is associated with changes in the pH, causing a destabilization of the sediment-phosphorus complex (McCallister and Logan, 1978; Logan, 1982).

(2) The role played by the river biota is described by Simons and Cheng (1985); two pathways are discernible: firstly, absorption of soluble phosphorus by algae; and secondly, sedimentation of particulate phosphorus material. Keup (1968) and Logan (1982) report that under appropriate flow conditions the biota may remove large portions of the discharged phosphorus (up to 90 percent) which is then remobilized under high flow conditions.

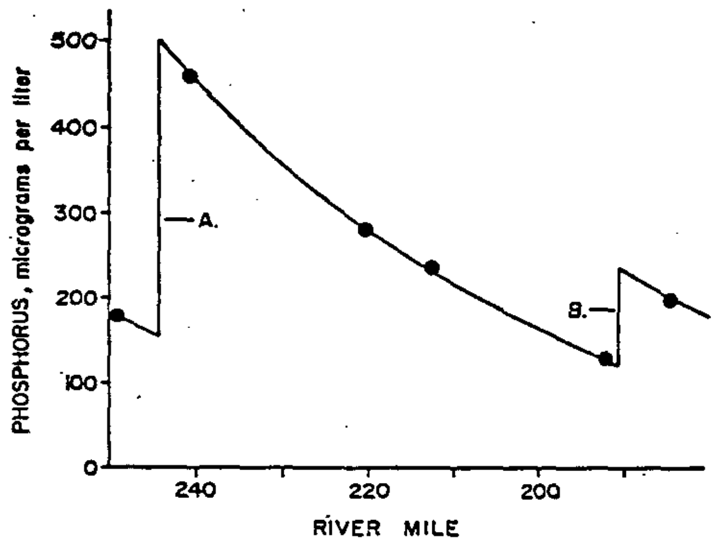

Fig 2.1 Phosphorus in the South Platte River, Colorado. Points A and B are respective projected municipal waste loads from cities with 26 000 and 8 000 sewered populations (from Keup, 1968).

3.3 Impoundments as phosphorus sinks

Sedimentation of phosphorus in an impoundment makes the nutrient unavailable for plant growth. Lee et al. (1978) are of the opinion that impoundments with hydraulic residence times of greater than a few months tend to be effective phosphorus sinks with retention of between 80 and 90 percent of the input loading. However, the bottom sediments also can be a significant source of phosphorus, particularly in shallow waterbodies where wind-induced currents can cause considerable mixing, resulting in resuspension of bottom sediments to the upper layers of the water column (Grobler, 1985). Studies of the bottom sediments from Hartbeespoort Dam (Transvaal, South Africa) have identified and quantified some of the factors controlling the flux of phosphorus to or from the sediments (NIWR, 1985). These include: the presence or absence of oxygen, phosphorus concentration, temperature and pH of the water, as well as the history of the sediments (episodes of dehydration and rewetting). Quantification and modelling of sediment resuspension in an impoundment is complex because of the number and interaction of the processes. Nonetheless, the net flux of phosphorus, either to or from suspended sediments, can be estimated by phosphorus mass balances for an impoundment. Initial indications are that these fluxes are considerable and may become significant when external loads are reduced to a level where the phosphorus concentration of the water is less than the equilibrium concentration of the sediments.

4 MODELLING PHOSPHORUS BEHAVIOUR

To describe the behaviour of phosphorus in a drainage basin three aspects need to be given attention, (1) temporal load (i.e. flow and concentration) of phosphorus entering the river above a given point in the flow path, (2) transport of the phosphorus down the river channel under a variable flow regime, and (3) behaviour of the phosphorus in waterbodies.

4.1 Phosphorus nonpoint source models

Phosphorus is delivered to the river via point and nonpoint sources. Usually, point sources can be quantified quite readily over a daily cycle and seasonally. However, with contributions from nonpoint sources, quantification is not a simple matter and a number of approaches, or models, have been proposed to deal with this problem. These models fall into three basic categories, namely:

(1) Export coefficient models.

(2) Phosphorus-discharge rating curve models.

(3) Mechanistic models.

In the following section the models in each category will be introduced with regard to: structure and objectives, assumptions, data requirements, and limitations.

(1) Export coefficient models:

Export coefficient model have been developed to determine the total annual mass of phosphorus exported from ungauged and unmonitored catchments. These models assume that a given land-use will yield a characteristic (annual) quantity of phosphorus per unit area. These export coefficients are determined for a selection of well monitored catchments, under various land-use practises. The coefficients are then applied in unmonitored catchments to predict the total annual phosphorus export loads.

Rast and Lee (1983), after examining the export coefficients developed by previous authors, produced "generalized" values applicable to the USA, given in Table 2.6. To test the reliability of these coefficients, they estimated the phosphorus load from 38 drainage basins in the USA and compared these with the measured export loads. They concluded that reasonable agreement exists between the observed and predicted results. Export coefficient models thus can provide a first approximate estimate of phosphorus loads in drainage basins where no measured data are available. Export coefficients also can be used to provide information for designing monitoring programs by focusing on the major sources of phosphorus contributing to river systems (Rast and Lee, 1977 and 1983).

Considerable criticism has been directed against the export coefficient models. Kröger (1981), Thornton and Walmsley (1982), Grobler and Silberbauer (1985a), and Prairie and Kalff (1986) state that a large degree of uncertainty is associated with phosphorus loads estimated by means of export coefficients. Grobler and Silberbauer (1985a) concur in this; from data collected from 7 South African catchments over a period of 3-5 years they concluded that two important factors had been ignored in developing the export coefficients: the geology of the catchment and the contribution from point sources. By grouping catchments according to geology and whether the catchment contained mainly point or nonpoint sources, 74 to 99 percent of the deviations can be explained, see Fig 2.2. It is reasonable to conclude that if each drainage basin is considered in the same detail, as done by these authors, the export coefficient approach could be reliable.

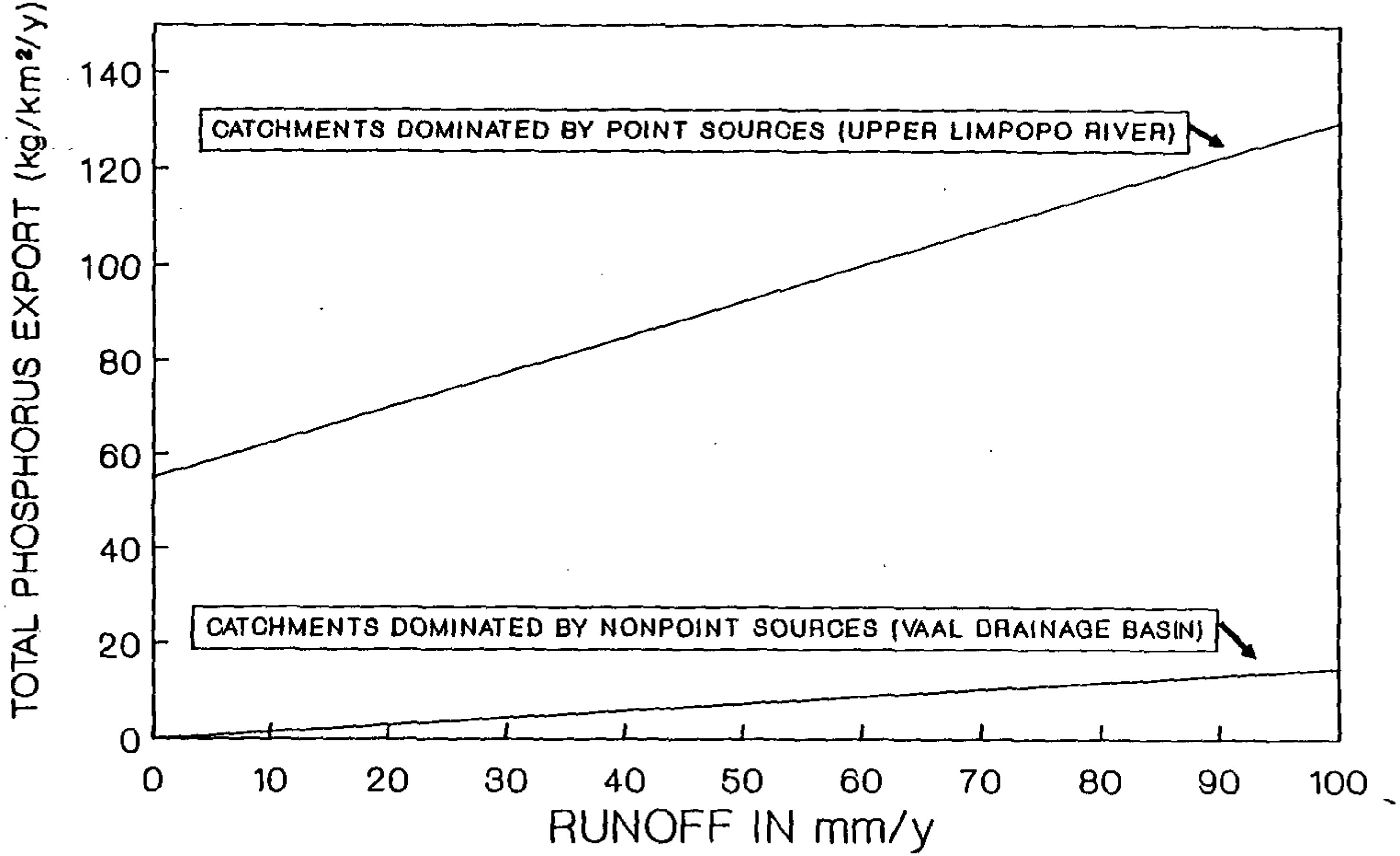

Fig 2.2. Lines of best fit for total phosphorus export versus runoff for catchments in which phosphorus export is dominated by point sources (in the Upper Limpopo River drainage basin) and for catchments dominated by nonpoint sources (Vaal drainage basin). Based on Grobler and Silberbauer (1985).

Table 2.6 Catchment nutrient export coefficients (after Rast and Lee, 1983) expressed as total phosphorus g P/m^2/y.

Land-use:	Export coefficient:
urban	0.1
rural	0.05
forest	0.005-0.01
atmosphere	0.025

(2) Phosphorus-discharge rating curve models:

The second category of nonpoint source model is based on the concept that, for a given river station, a correlation exists between the magnitude of the river discharge and the load of phosphorus exported by the river at the specified station. Unlike the export coefficient approach which attempts to quantify the total annual load based only on catchment characteristics, the phosphorus-discharge rating curve model requires a time series of paired discharge and phosphorus concentration data. From these, regression relationships are derived for the discharge - phosphorus concentration. Knowing the discharge hydrograph, the chemograph or loadograph can be derived and the total load determined over any selected interval. Rating curve models require a greater input of data than the export coefficient models, but have the potential to yield better predictions in the quantification of phosphorus loads.

Several mathematical relationships have been proposed to describe the regression relationship between nutrient concentration and river discharge. Prominent regression relationships are: the hyperbolic equation of Durum (1953); the exponential of Ledbetter and Gloyna (1964); and linear of Wang and Evans (1970). Attempts to improve the predictive power of these methods include: the mass balance approach of Cahill, Imperato and Verhoff (1973); incorporation of a flow rate-of-change term in the model proposed by Johnson, Bouldin, Goyette and Hedges (1976); and the use of a load-discharge relationship (instead of a concentration-discharge approach) proposed by Houston and Brooker (1981), Brooker and Johnson (1984) and Grobler, Rossouw, van Eeden and Oliviera (1987).

Conceptually, the work of Johnson et al. (1976) holds significant promise. From an examination of the water quality data associated with the rising and falling limb of the hydrograph for successive flood events they found that, on the rising limb, the ortho-phosphate concentration generally was higher than for the same discharge on the falling limb. This phenomenon they assumed was due to the scouring of river sediments during the beginning of the flood event. Johnson and East (1982) hypothesized that a cyclical (hysteresis) relationship always exists between discharge and concentration under flood conditions, that a particular idealized cycle always resulted from the occurrence of defined extremes of antecedent discharge, rainfall and recession conditions, reflecting the hydro-geological characteristics of a catchment area. They hypothesized that the chemical concentration can be derived from a mass balance approach in a three component algorithm, governed by the surface, interflow and groundwater discharge; they verified the hypothesis of a looped response using data for a stream draining a small moorland catchment.

Phosphorus-discharge rating curve models have been applied to numerous rivers throughout the world to quantify phosphorus from nonpoint sources, with varying degrees of success. Limitations of the model are the uncertainty due to the scatter of data when the river phosphorus concentrations are plotted as a function of discharge. However, the general consensus is that chemical-discharge rating curves have potential to predict the phosphorus load accurately over a given period of time, provided that:

(i) Accurate time series of river discharge (hydrograph) data are available.

(ii) Sufficient water quality data are available for model calibration.

(iii) The scatter of data can be minimized by using the looped rating (hysteresis) curve.

(3) Mechanistic nonpoint source models:

This category of model attempts to identify the processes that act on the phosphorus. Numerous mechanistic models have been developed with the objective of predicting soluble and particulate phosphorus fractions in runoff from nonpoint sources. These models incorporate processes such as: phosphorus adsorption isotherm (Wendt and Alberts, 1984); adsorption processes combined with bio-assimilation and convection processes (Novotny, Tran, Simisman and Chesters, 1978); and a unit-mass response function (Zingales, Marani, Rinaldo and Bendoricchio, 1984). In each model, the phosphorus behaviour is governed principally by the adsorption and convection processes.

These models are quite complex and necessitate a considerable input of data for both calibration and verification. For example, the model proposed by Novotny et al. (1978) requires a time series of: soil moisture content, soil moisture movement, soil erosion and excess rain. Such input requirements would put a substantial demand on most data bases, this tends to limit their application to research catchments where the necessary data input requirements can be satisfied. Where this has been done this category of models have shown good predictive qualities.

Conclusion:

By categorizing the nonpoint source models into the three classes it is possible to distinguish a spectrum of methods, ranging from the simplest (export coefficients) to the most complex (mechanistic). Between these extremes lie the rating curve models, a category of model that does not appear to have been investigated as fully as its potential suggests.

4.2 Phosphorus transport models

The objective of a phosphorus transport model is the prediction of the movement of phosphorus down the river. The description is a complex one as it must take cognizance of the phosphorus and flow input to the river, the hydrodynamic behaviour of the water mass in the river as well as the physical, chemical and biological processes that act on the phosphorus transported along the river channel (Bedford et al., 1983).

The input to the river has been reviewed in the previous section (Section 4.1). The hydrodynamic behaviour depends upon the river discharge, cross sectional area of flow, the morphology and slope of the riverbed and lateral inputs. The physical processes include sedimentation, remobilization, adsorption, desorption, diffusion and mixing; the biological processes are primarily biotic assimilation of phosphorus as well as the phosphorus release associated with cell lysis and excretion; the chemical processes are inorganic precipitation, dissolution and absorption.

Models of different levels of complexity have been developed to describe the movement of phosphorus along the river channel. The more elementary models essentially disregard the hydrodynamic aspects, lump two or more processes together and formulate these lump parameters in terms of distance of travel, that is, a lumped steady-state approach is taken. The more advanced models attempt to describe the temporal and spatial variation along the length of the river channel, that is, a dynamic approach is taken.

(1) Steady-state approach to modelling phosphorus transport:

Keup (1968) investigated the change of phosphorus concentration as a function of distance in a number of North American rivers. The discharge of treated sewage effluent causes an abrupt increase in the phosphorus concentration of the river at the point of discharge. Downstream of this point, the phosphorus concentration rapidly diminishes, apparently as a function of river distance. Keup hypothesized that the phosphorus depletion from the water column is caused by biotic assimilation, the solid biotic material settles to the riverbed to increase the phosphorus content of the sediments. During flood events, the phosphorus stored in the sediment is remobilized and transported further downstream. Keup concluded that the transport of phosphorus down the river can be visualized as a series of jumps, in which phosphorus is effectively transported as bed load only during flood events when the river sediments are scoured. Ultimately, the phosphorus will arrive at the estuary, or flood plain, where it becomes permanently stored.

Simons and Cheng (1985) investigated the removal of phosphorus in the Nepean River, New South Wales, Australia, through an extensive series of small impoundments in the river channel. They report that phosphorus added to the river via treated sewage effluents is removed by biotic processes, described as the sum of two exponentials:

$$Ct\ Qt = a\ Co\ Qo\ EXP\ (-K1\ t) + (1-a)\ Co\ Qo\ EXP\ (-K2\ t) \quad \ldots\ldots \quad (2.1)$$

where

Ct	=	phosphorus concentration at time t,
Qt	=	discharge at time t,
Co	=	initial phosphorus concentration,
Qo	=	initial discharge,
K1	=	first order rate constant,
K2	=	first order rate constant, and
a	=	constant.

This formulation implies two processes are active: a rapid and a slow one (represented by the coefficients K1 and K2 in Eq (2.1) and illustrated in Fig 2.3). The rapid process is attributed to the assimilation of soluble phosphorus by particles (assumed to be phytoplankton) and takes place over about 11 days. The slower process is one of sedimentation of nutrient laden particles taking place over 70 days. They also observe a shift in the phosphorus speciation from soluble to particulate, brought about by biotic uptake of soluble phosphorus.

Logan (1982) and Taylor and Kunishi (1971) ascribe phosphorus depletion to sediment/water interaction; the sediments act as scavengers for phosphorus, causing a rapid depletion of the water column until some minimum steady-state is attained. Consequently, the transport of phosphorus along river channels is governed by both biotic and abiotic processes influencing the sedimentation and remobilization of phosphorus.

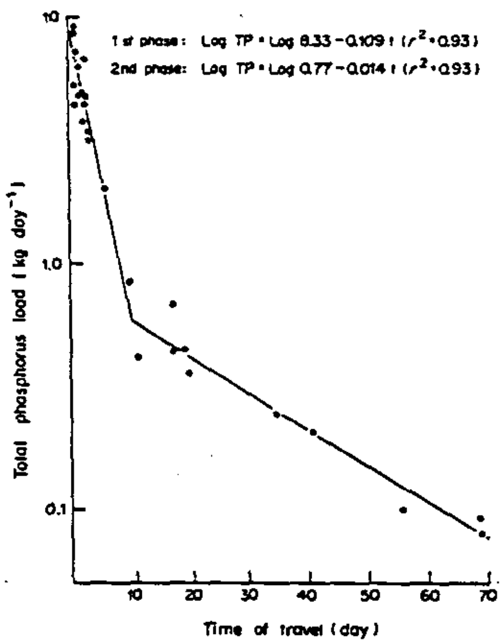

Fig 2.3 Relationship between total phosphorus load and time of travel to stations in the Nepean River between 1.2 and 3.2 km downstream of the Camden sewage treatment works outfall. (From Simons and Cheng, 1985).

(2) Dynamic approach to phosphorus transport:

The objective of a dynamic river channel model is to describe the temporal and spatial variation of phosphorus along the length of the river channel. This type of predictive capability would be of particular importance in river quality modelling in dry and arid climates, like South Africa, where storm events exhibit a combination of low frequency, short duration, and high intensity, inducing abrupt changes in river quality over short intervals of time and distance along the river channel. A large fraction of the total mass of phosphorus transported down the river takes place during the storm induced flood waves.

The movement of phosphorus along a river during a storm is complex, it requires resolution of inputs to the river, transport along the river, while physical, chemical and biological processes act on the phosphorus during transport. A number of attempts to model the transport of phosphorus along river channels use coupled nonlinear equations (Chen, 1970; Chen and Wells, 1976; Verhoff and Melfi, 1978; Bedford, Sykes and Libicki, 1983). These models however are complex and have achieved varying degrees of success in modelling the transport phenomena.

A review of existing coupled dynamic water quality models yields a sparse literature. Bedford, Sykes and Libicki (1983) present a dynamic water quality model for storm induced flows. The model incorporates a variety of subcomponents to accommodate for the influence of plankton bio-degradation, sedimentation and diffusion. The water quality component is formulated to predict the soluble ortho-phosphate concentration, in addition to seven other chemical species. Calibration is likely to be complex.

Also, the model does not take into account either phosphorus remobilization, bed load transport, or the phosphorus speciation shift caused by the adsorption processes. Nonpoint source inputs to the main river channel are only given a sketchy treatment.

Another multi-parameter dynamic water quality model is that proposed by Chen and Wells (1976) based on an ecological structure to provide chemical and biological information on the Boise River, Idaho (USA). The river is divided into a number of reaches and mass balance equations developed for each one using: the law of conservation of mass and the kinetic principle (stating the rate of change is equal to the product of a coefficient and one or more constituent concentrations that interact to cause the change). The mass balances are then calculated for the biotic and abiotic components. The final result is a model specific to the river in question, requiring a large data set in which to calibrate the model. The main point of interest to be derived from this model, is the manner in which (i) the river is subdivided into sub-reaches and (ii) the various chemical components are calculated using mass balances and (iii) the kinetic principle. However, the lateral input to the river channel and remobilization of phosphorus are not incorporated.

Verhoff and Melfi (1978) attempt to account for the remobilization and sedimentation of phosphorus using a derivation of the mass continuity equation given below

$$A\ \partial c/\partial t + Q\ \partial c/\partial x + qc = qc'' + a\ \partial u/\partial t\ c \qquad \text{..... (2.2)}$$

where

A	=	flow cross sectional area,
Q	=	river discharge of main river channel,
q	=	discharge of lateral inflow per unit length of channel,
c	=	phosphorus concentration in main river channel,
c"	=	phosphorus concentration in lateral inflow,
u	=	flow velocity of main river channel,
x,t	=	increments of time and river distance,
a	=	constant.

In Eq (2.2), the remobilization of phosphorus is assumed to be proportional to the rate-of-change of discharge, whereby the rising flow causes remobilization of phosphorus, while the decreasing flow causes sedimentation. Although empirical, application of the model for rivers in Western Ohio, USA, would indicate that the model is capable of predicting the transport of phosphorus under flood conditions. Unfortunately, little information is provided by Verhoff and Melfi.

4.3 Nutrient load/eutrophication response relationships

A method that has a demonstrated capability to predict the changes in eutrophication related water quality characteristics from changes in phosphorus load, is the Overseas Economic Community Development (OECD) eutrophication modelling approach. This approach was developed from an intensive study of 200 waterbodies to quantify nutrient load/eutrophication response relationships for surface waters (OECD, 1982). Through this study empirical relationships were developed between the phosphorus loading of a waterbody (normalised by mean depth, hydraulic residence time and surface area) and the eutrophication related water quality characteristics of the waterbody such as mean summer chlorophyll, mean summer secchi depth and the rate of oxygen depletion in the hypolimnion of the waterbody (Rast and Lee, 1977; Lee et al., 1978).

Rast et al. (1983) and Jones and Lee (1982) developed the OECD approach further - they determined the change in position of a waterbody's load/response (i.e. mean summer chlorophyll, secchi depth and oxygen depletion rate) that occurred after its phosphorus load had been altered. They found that a waterbody would track parallel to the line of best fit for each of the quality parameters when the phosphorus loading was changed. For example, by knowing an initial phosphorus load/response, the change in chlorophyll could be estimated for a given change in phosphorus load. Consequently, it was possible to predict the improvement in the trophic status of an impoundment based on a reduction in the phosphorus load.

The OECD modelling approach has found useful application in the management of eutrophication related problems in many South African impoundments (Jones and Lee, 1984). However, the following points have been made in regard to this approach:

(1) The OECD approach is formulated on an average input estimated over say a year. Grobler and Silberbauer (1984) state the highly variable nature of South African hydrology and associated nutrient inputs may influence the predictive capabilities of the approach.

(2) Errors in the phosphorus load calculations are regarded as the major source of data scatter in the load/response relationships (OECD, 1982).

Basically, for any waterbody, the predictive capability of any load/response model, for water quality management, will be limited by (1) inadequacies in quantification of the phosphorus loads entering the waterbody and (2) the time serial manner of entry of such loads.

Up to now only "steady-state" impoundment modelling has been attempted. A predictive hydro-nutrient model for impoundments would be a valuable aid in (1) describing spatial and temporal distribution of algal biomass, and nutrient concentration in waterbodies, (2) the location of dam abstraction points and (3) the operational use of the impoundment. Such a model however can be expected to be of great complexity. It will need to take account of the influent river chemograph, hydrograph, temperature of the river water and its density; radiation input, air temperature, turbidity of the water; wind effects on the mixing and stratification. Compounded with this will be movement of phosphorus in the impoundment, algal growth, settlement of phosphorus, remobilization and so on.

5 CONTROL OF PHOSPHORUS IN THE ENVIRONMENT

To develop a river management strategy for the maintenance of satisfactory water quality, we require a quantitative description of the yearly hydro-chemical cycle. As yet this ideal situation has not been realised. The more usual situation is that management has operated on individual aspects - no practical integrated model of behaviour has been available. Although numerous models describing nonpoint sources and river transportation have been proposed they have not been integrated to provide a practical solution to the problem of quantifying the phosphorus transport along river channels.

In this section we shall review control procedures based on ad hoc assessment of nutrient input, then review briefly operational procedures to minimise the adverse effects of eutrophication on impoundments.

5.1 Point source control

There are two methods available for the control (removal) of phosphorus from point sources, viz. chemical precipitation of phosphorus (WRC, 1985) and biological excess phosphorus removal (WRC, 1984).

Chemical precipitation is based on the precipitation of the ortho-phosphate by the addition of iron or aluminum salts. Precipitation removal is highly effective and can be readily implemented on existing plants (activated sludge or trickling filter). However, this method has two main disadvantages:

(1) Costs associated with phosphorus removal are high so that small municipalities require allocation of relatively large treatment costs from small budgets. For example, Bath (1985) determined the costs for the Municipality of Paarl to remove phosphorus from their final effluent as: capital outlay of about R100 000, annual running cost for chemicals about R270 000 (volumetric flow of: 16 500 m^3/d and average effluent total phosphorus concentration of 3.4 mg/ℓ), giving an increased treatment cost of approximately 4 cents per cubic metre of effluent.

(2) Addition of the salts raises the salinity of the effluent which in some instance may reduce the re-use value of the water downstream.

Biological removal of phosphorus is obtained in specially designed wastewater treatment systems e.g. Modified Bardenpho, UCT, and other systems, WRC (1984). As the removal is biologically mediated, no salt addition is necessary so that the salinity of the effluent is not increased. Generally, the total cost of removal per unit volume of effluent is significantly lower than with chemical precipitation. The disadvantages of the system are:

(1) The system is relatively complex and requires a relatively high technical component for operation. The system is subject to process upsets so that the removal achievable can not be guaranteed on a continuous basis.

(2) The concentration of phosphorus that can be removed is dependent on certain wastewater characteristics. Consequently, it may not be possible to remove all the phosphorus. To ensure that the specified maximum effluent phosphorus concentration is not exceeded, supplementary, or back-up chemical precipitation is necessary, to be used as the occasion demands or to supplement the removal continuously.

In an endeavour to control the phosphorus loads entering impoundments, regulations have been gazetted by the South African government to limit the concentration of soluble ortho-phosphate to 1 mg/ℓ (expressed as P) in domestic and industrial effluents discharging to "sensitive catchments" (Government Gazette, 1984). A "sensitive catchment" is defined as one containing an impoundment whose utility is impaired by eutrophication (Walmsley and Butty, 1980). The 1 mg/ℓ standard for sensitive areas was selected after an assessment of the technical and economic feasibility of phosphorus removal technology at the time the standard was promulgated.

Although the 1 mg/ℓ effluent standard is uniform for sensitive catchment areas, there is flexibility in implementing it - the standard can be set at higher concentrations for certain effluents by granting of permits (exemptions) where it can be shown that the impact of these effluents on the trophic status of the receiving water will be negligible (Grobler and Silberbauer, 1984). However, for certain areas, consideration also is being given to the introduction of an even stricter phosphorus effluent standard (Best, 1986).

The phosphorus standard has received criticism on the grounds that differences in the phosphorus receiving capacity of impoundments has been ignored (Pretorius, 1983). Also, in some catchments it is suspected that the contribution of phosphorus from nonpoint sources (agricultural and urban runoff) may exceed the contribution from point sources (effluents). In such an event the enforcement of the effluent phosphorus standard would not result in the expected reduction in phosphorus loading of the particular impoundment.

Other methods of reducing the phosphorus load from treated sewage effluent include mass reduction of the phosphorus component in commercial detergents. In South Africa, detergents contain on average 70 g P/kg detergent and with the higher capita use of detergents could comprise a major fraction of phosphorus discharge to the aquatic environment. As detergents are man-made products their manufacture and composition can be controlled. A number of countries, for example the United States, Canada, the Netherlands, Switzerland and Japan have implemented bans, or reductions, of phosphorus in detergents, as part of their strategy to control phosphorus to the environment. In South Africa, the authorities have opted for a policy of controlling phosphorus by means of an effluent standard, but additional strategies, such as a ban on phosphorus detergents, are also being evaluated.

The contribution of detergent phosphorus to the total phosphorus load on sewage works in South Africa varies between 35 to 50 percent (Wiechers et al., 1984; Wiechers, 1985; Wiechers and Heynike, 1986). From these figures it is clear that a detergent phosphorus ban could significantly reduce the phosphorus load on a sewage works, but this in itself may not be sufficient to reduce the level required to protect the aquatic environment from eutrophication-related problems. From limnological investigations, Maki, Porcella and Wendt (1984) reported that reduction of phosphorus in wastewaters had not reduced the trophic status of certain American impoundments. They concluded that the reduction of phosphorus in detergents will not result in a significant reduction in the phosphorus-loading to dams. However, Pallesen, Berthouex and Booman (1985) state that from intervention analysis, the implementation of the detergent phosphorus-ban has caused a 25.5 percent reduction in the phosphorus load from a Wisconsin water treatment plant. They do not assess the effect this reduction would have on the aquatic environment. Hartig and Horvath (1982) report that the application of the phosphorus-detergent ban has caused a 23 percent decrease in phosphorus loadings from Michigan's Municipal sewage outfalls into the Great Lakes. Etzel et al. (1975) however concluded from algal assay and river sampling techniques, that the P-detergent ban would not have a significant effect on river and dam systems.

Introduction of a phosphorus detergent ban in South Africa does not appear to be vital at present. Wiechers and Heynike (1986) have undertaken a cost benefit analysis, analyzing the effect of a detergent phosphorus ban or conventional phosphorus removal from treated effluents.

Table 2.7 Cost benefit estimates (1983) for banning of detergent phosphorus versus removal of phosphorus at wastewater treatment works (from: Wiechers and Heynike, 1986).

Item:	Annual cost cost:	(R million/y) benefit:
Additional cost items:		
10% increase in detergent cost	22.7	
5% decrease in life-cycle of:		
- washing machines	3.8	
- washable fabrics	62.5	
Perceived benefits:		
reduced cost for chemical P removal:		4.7
reduced cost for biological P removal:		1.2
reduced salt load (saving to produce effluent with equivalent TDS):		22.5
cost benefit without desalination (15:1):	89.0	5.9
cost benefit with desalination (3:1):	89.0	28.4

Table 2.7 lists the results of the cost benefit analysis for banning phosphorus from detergents. If the removal of salts added to precipitate the phosphorus at the sewage works is ignored, the cost-benefit ratio for banning phosphorus in detergents is about 15:1. If salt removal is included, then the ratio is 3:1, still indicating that a detergent-ban will not be economically feasible (Wiechers and Heynike, 1986).

Since the time the phosphorus standard has been promulgated, industries and municipalities have invested considerable funds on capital equipment to remove phosphorus from their effluents. The question remains whether it is necessary to impose a ban on phosphorus based detergents: Wiechers and Heynike (1986) state that any reduction in the phosphorus load to biological excess phosphorus removal works will assist in achieving the phosphorus standard without chemical addition. On works using chemical phosphorus removal, reduced phosphorus loads will reduce the chemical requirements and mass of sludge produced, thereby reducing overall costs. However, detergent manufacturers state that a phosphorus-free detergent will ultimately cost the consumer more because of increased wear on clothes and increased corrosion of washing machines (De Jong, 1985).

5.2 <u>Nonpoint source control</u>

The Overseas Economic Community Development (OECD) study (OECD-Paris 1982) states that control of nonpoint phosphorus sources is difficult. However, from these studies the opinion is expressed that the upgrading and improvement of all aspects of agricultural practises which may contribute nutrients and sediments to waterbodies, should be encouraged, particularly:

(1) Control of waste from intensive animal husbandry.

(2) Control of the dose, period and method of fertilizer application to achieve minimum nutrient loss and optimum uptake by the crop.

(3) Control of erosion and runoff from tillage land and from forestry operations (Logan, 1982) as well as control of over-irrigation.

In South Africa the control of nonpoint sources is vested in the Conservation of Agricultural Resources Act (Act 43 of 1983) and the Water Act (Act 54 of 1956). However, effective control of nonpoint sources is hampered by our limited understanding, and ability to quantify the mass of nutrients exported via nonpoint sources.

5.3 Management of impoundments

In many impoundments throughout the world it has not been possible to control the input of nutrients, either because the nonpoint source is large and difficult to control, or the point source is uncontrolled. In some impoundments, recycling of the internal nutrient load is sufficient to maintain the nutrient concentration in the water column, at eutrophic levels even in the external nutrient load is significantly reduced (Lennox, 1984). Various attempts have been made to minimise the adverse effects of eutrophication by management of the impoundment:

- Physical manipulation e.g. by destratification, hypolimnetic aeration, withdrawal of hypolimnetic water, draw-down and alteration of flushing regime (Oglesby, 1969; Jacoby, Lynch, Welch and Perkins, 1982).

- Chemical and sediment manipulation e.g. by nutrient precipitation inside the waterbody as well as the inactivation and removal of sediments (Hayes, Clarke, Stent and Redshaw, 1984); also the discharge of nutrient laden hypolimnetic water during periods of impoundment stratification (Walmsley and Butty, 1980).

- Biological manipulation e.g. by mechanical harvesting of the biomass (macrophytes, algae, and fish), application of toxic substances (herbicides, algicides, and pesticides) and the direct manipulation of the food chain (Henrikson, Nyman, Oscarson and Stenson, 1980; Clarke, Jarvis, Ashton and Zohary, 1987).

These impoundment management techniques have achieved varying degrees of success. Positive results have been reported using one or more of these management techniques (Oglesby, 1969; Henrikson et al., 1980; Hayes et al., 1984).

Application of impoundment management techniques necessitates a detailed understanding of the biological, chemical and hydrodynamics of these systems. Without such information, the control of eutrophication using impoundment management could be ineffective (Taylor et al., 1984). In South Africa, the National Institute of Water Research followed this approach; they conducted an intensive study on phosphorus cycling in Hartbeespoort Dam, a hypertrophic impoundment and developed a model (TROFIC) to simulate the impoundment response. Different management strategies tested on the model, to reduce the size of the phytoplankton standing crop and modify the species composition from predominantly blue-green to green algae. The model predicts that the only biological method likely to control eutrophication in the impoundment is through an algal-species shift, to make the algae more palatable to zooplankton. This, the model predicts, can be brought about by: aeration-destratification; increase in the N:P ratio; or decrease in the pH of the impoundment. The model further predicts that a reduction of the external phosphorus loading to the impoundment may have a minimal effect because the internal nutrient loading will remain the principle source of nutrient;

it will necessitate the application of chemical precipitation in the lake to reduce the nutrient source (Clarke et al., 1987). These techniques have not yet been tested in the impoundment, so the predictive capabilities of the model are still unknown.

6 CONCLUSION

In so far as it concerns modelling of phosphorus transportation through a basin the literature points to the following conclusions:

(1) Eutrophication of impoundments affects many potential uses of the impounded waters, for public supply, water transportation in pipelines, fishing, swimming, etc. The financial implication of eutrophication has not been resolved in South Africa but the cost is expected to be high.

(2) The nutrient identified as a key to the control of eutrophication is phosphorus; by controlling phosphorus discharges it is possible, in many instances, to limit the trophic status of receiving waterbodies. Description of the eutrophication state is still of a macroscopic "static" nature. No practical dynamic model is available. When such a model is developed, two of the inputs would be the flow hydrograph and associated phosphorus chemograph.

(3) The principal sources of phosphorus generation in a basin are point and nonpoint (or diffuse) sources. Much controversy still exists concerning the relative importance of these two sources. Up to the present, in South Africa point sources appear to have attained greater recognition than nonpoint sources, but no comparative studies are available.

(4) Quantification of nonpoint source generation is still in the embryonic stage. Mechanistic models of some specific processes have been developed but are, for a number of reasons, not practical. Empirical approaches, in particular the looped phosphorus discharge rating method, appear to have potential. This approach empirically links the nonpoint phosphorus concentration (or load) to the discharge hydrograph; this implies that quantification of the discharge hydrograph is essential in applying this method.

(5) When phosphorus in the water column is transported along the river channel, under low flow, it is subject to removal by settlement, biotic extraction both in the channel and in wet lands; under high flows and flood events phosphorus is remobilized into the water column. The net removal of phosphorus achieved over a number of seasons, however, is not known with any certainty. Modelling of the removal and remobilization of phosphorus in the channel is poorly developed.

(6) The empiric link between flow and phosphorus removal and remobilization implies that description of phosphorus transportation along a river channel requires an adequate description of the flow hydrograph at every point in the channel, under low and high flow, and floods.

(7) There are numerous models describing flow routing in a channel. All models essentially are based on the continuity and momentum equations of Saint-Venant, but with the momentum equation simplified in various degrees in the respective models. The problem is to find a model that gives an adequate description of the flow hydrograph without making excessive demands on data for calibration.

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CHAPTER 3

DESCRIPTION OF BERG RIVER BASIN

Based on the information given in Chapter 1, the Berg River was selected as a suitable catchment in which to study phosphorus transport. A general description of the Berg River catchment will be given in terms of: geographical location, topography, climate, geology, hydrology, water quality, soils, demography and water resource development.

1 CATCHMENT DESCRIPTION

1.1 Location

The Berg River is situated in the Western Cape Province of the Republic of South Africa and rises in the Jonkershoek and Franschhoek mountains from where it flows in a north-westerly direction to discharge into the sea at St. Helena Bay. Its major tributaries are the Franschhoek, Wemmer, Dwars, Krom, Kompagnies, Klein Berg, Twenty-Four, Matjies, Platkloof, Boesmans and Sout Rivers (see Fig 3.1).

The river valley is approximately 160 km long (from headwaters to the sea) while its width varies from 1 to 5 km near its headwaters to between 30 to 45 km at the coast. The length of the river is approximately 270 km, and the catchment covers an area of about 6 415 km^2.

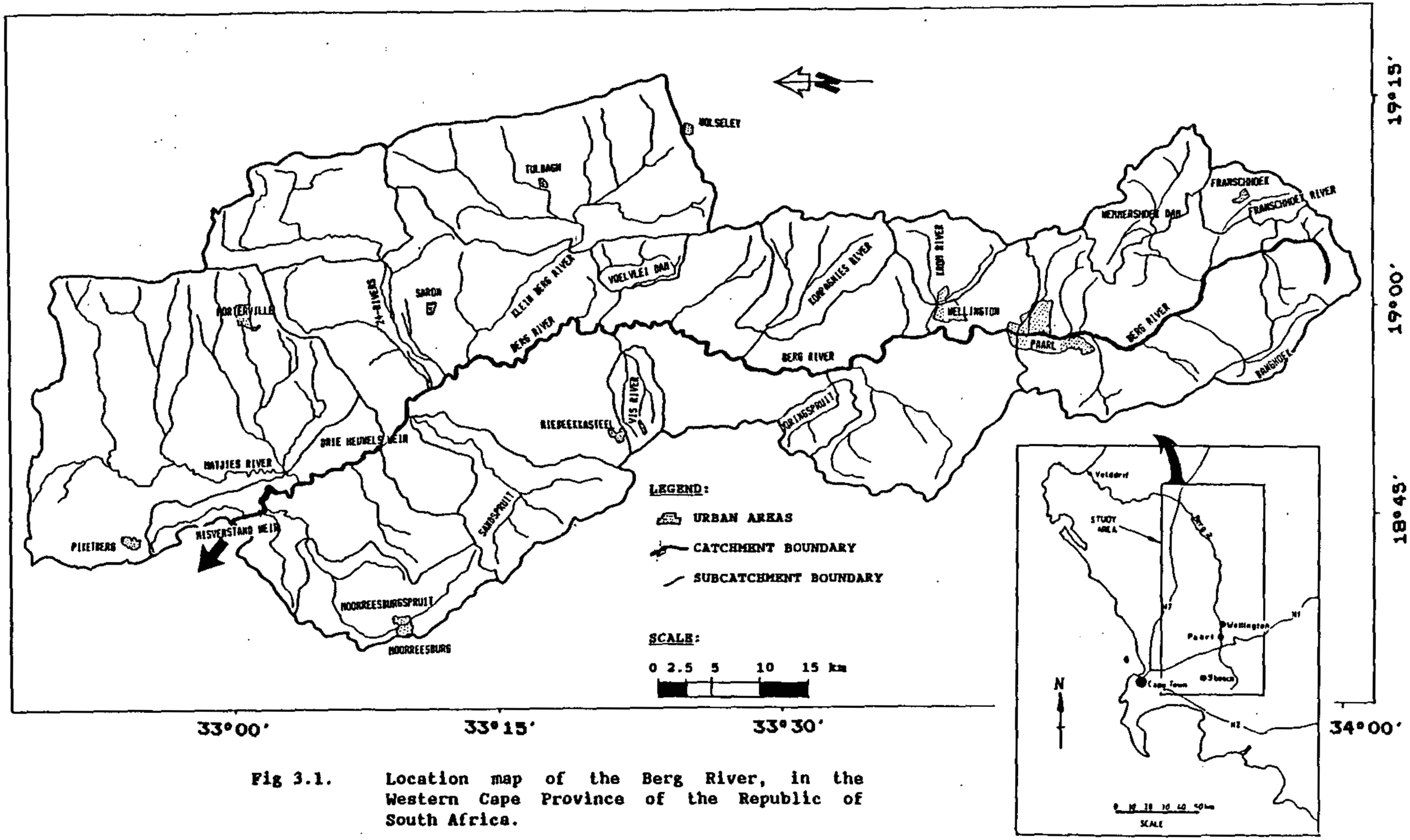

Fig 3.1. Location map of the Berg River, in the Western Cape Province of the Republic of South Africa.

1.2 Topography

The river profile falls about 900 metres after only one eighth of its course. From Paarl, the river profile flattens, falling from only 100 m above sea level to sea level at its mouth, over a distance of 220 km. The lower reach is extremely flat so that sea water intrusion pushes up nearly 100 km from the river mouth under high tide conditions (Kersandt and Marais, 1973).

The Berg River catchment is surrounded in the south by the Franschhoek and Jonkershoek mountains (see Fig 3.2). In the east, going in a south to north direction the basin is bounded by the Wemmershoek, Limiet, Elandskloof mountains, as well as the Witzenberg, Twenty-Four and Olifants River mountains. In the north the divide swings west to the Ketberg, Gryskop and along the Piquetberg to the Platteberg. From the Platteberg the divide swings to a south-westerly direction to meet the sea approximately at Rooibaai, just north of Veldrif. The western divide runs north from the Jonkershoek mountain along the Simonsberg and Paarl mountain. From the Paarl mountain, the divide proceeds slightly westerly along the Perdeberg and then northwards again to the Kasteel mountain, just west of Riebeck-Kasteel. From the Kasteel mountain the divide runs west to Kanonkop and south to the Dassenberg. After the Dassenberg, the divide swings west to the Kattenberg and then north-west to the Contreberg, passing just north of Darling, from where it swings north again to meet the coast just south of Veldrif.

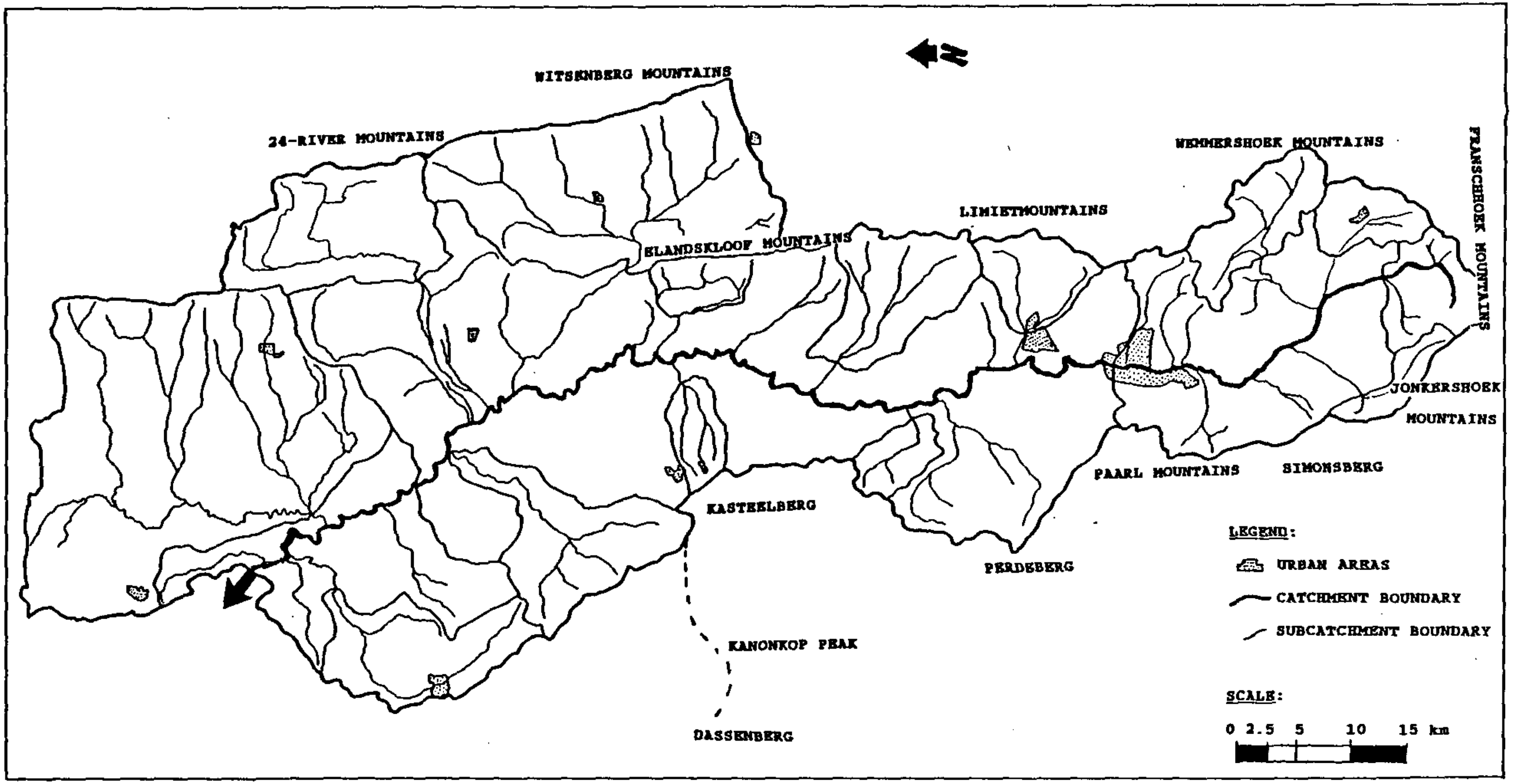

Fig 3.2. Topography of the Berg River catchment.

3.4

1.3 Climate

The Berg River has a Mediterranean climate and falls within the winter rainfall region of the Western Cape. The rainfall is mainly of a cyclonic nature caused by atmospheric turbulences drawing in air masses from various regions: warm air is drawn-in from regions over the Atlantic Ocean from the west between the 12th and 13th parallel, colder air from the sea south of the mainland and relatively dry air from the southern parts of the country (Kersandt and Marais, 1973).

Frontal rains are caused by air masses with differing moisture contents, temperatures and densities. The mountain ranges cause the air to be forced upward resulting in a reliable mountain rainfall compared with the frontal plains.

The rainfall in the mountains is high, up to 3 000 mm per year. The melting snow that falls on the peaks and upper slopes of the mountains during intermittent cold spells in winter also contributes to the river flow. In the adjoining valleys, rainfall varies from 900 mm to 1 200 mm annually, but drops to between 400 and 500 mm in the hilly plain which the river travels for most of its length (Fourie and Görgens, 1977). The distribution in mean annual precipitation for the Berg River catchment is shown in Fig 3.3 (from Forster and van der Berg, 1985).

In the annual distribution of rainfall, some 80 percent falls during the six winter months, April to September. Due to the influence of the mountain ranges, there is a distinct spatial and temporal component in rainfall pattern. June is the wettest month for all but the Vredenburg region, near the mouth, where July is the wettest. January generally is the driest month but February is the driest in the Piketberg region.

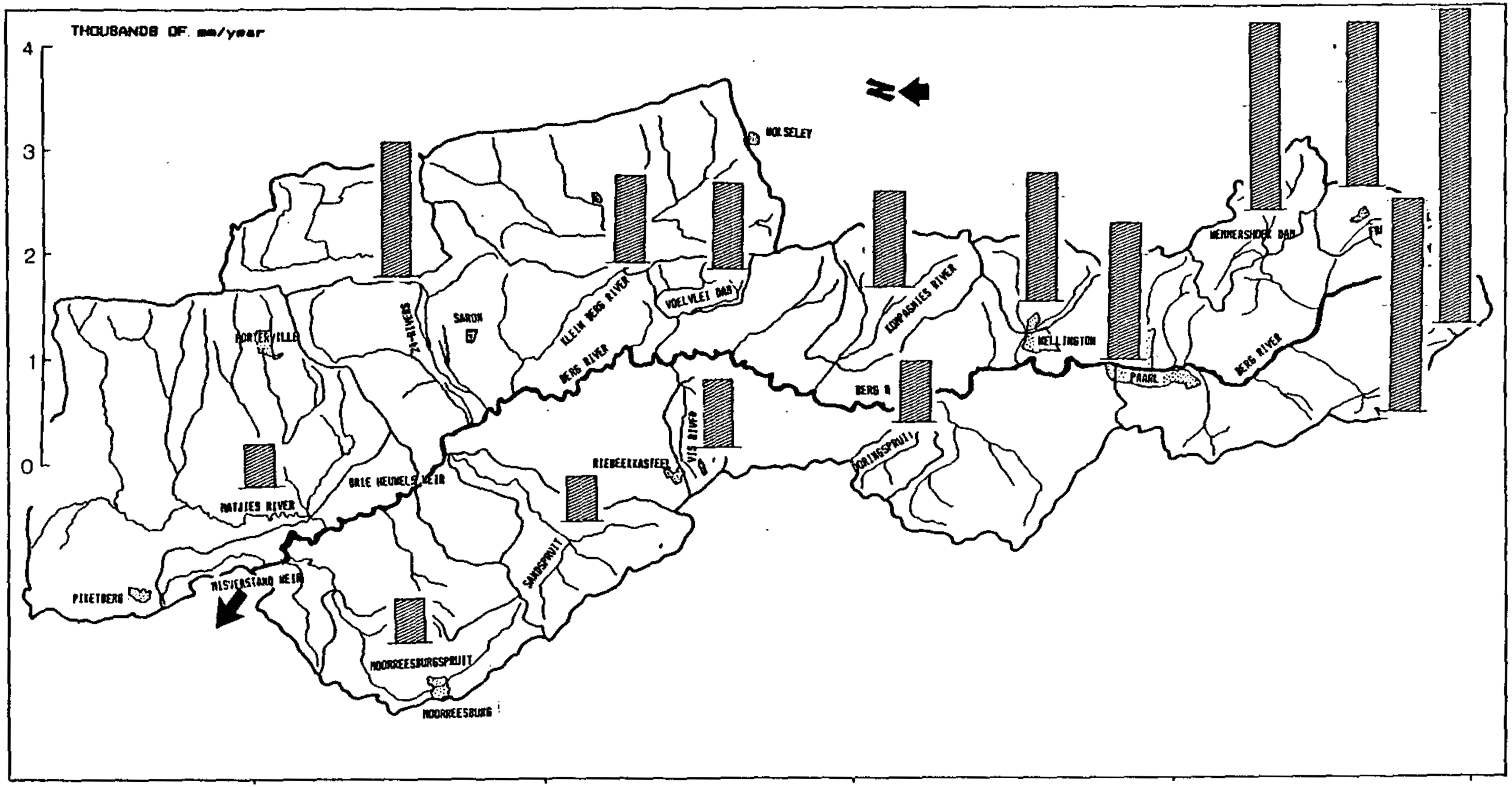

Fig 3.3. **Distribution in mean annual precipitation in the Berg River basin (from Forster and van der Berg, 1985).**

January and February are the hottest months of the year in the Berg River catchment. In February mean daily maximum temperatures vary from 24°C along the coast, to 32°C in the north-east, and inland temperatures of over 40°C are recorded.

The predominant wind direction in the summer months is the "South-Easter" which in exposed areas such as Voëlvlei Dam causes a 25 percent increase in evaporation rate compared with Wellington. Kersandt and Marais (1973) report annual evaporation figures for Voëlvlei Dam of 2 711 mm and Wellington 2 220 mm. During the winter months the dominant wind is the "North-Wester" bringing rain to the region.

1.4 Geology

The geology of the Berg River basin is shown in Fig 3.4. The catchment consists of semi-perennial streams arising in the mountains composed of Table Mountain Sandstone (TMS). Further north, in the Paarl area, several tributaries arise in granite hills and flow through clay soils derived from weathered granite.

Below Paarl the overlying TMS has been progressively eroded exposing bedrock of Malmesbury shale. Malmesbury shale remains the main underlying rock formation down to the mouth of the river. In the middle reaches of the Berg River, the Klein Berg and Twenty-Four rivers are semi-perennial tributaries rising from areas dominated by TMS.

The Berg River is geologically an old river; this is born out by (1) the very rapid fall in profile from headwaters to a point at Paarl and the gentle slope thereafter down to the mouth of the river, (2) the degree of meandering of the main

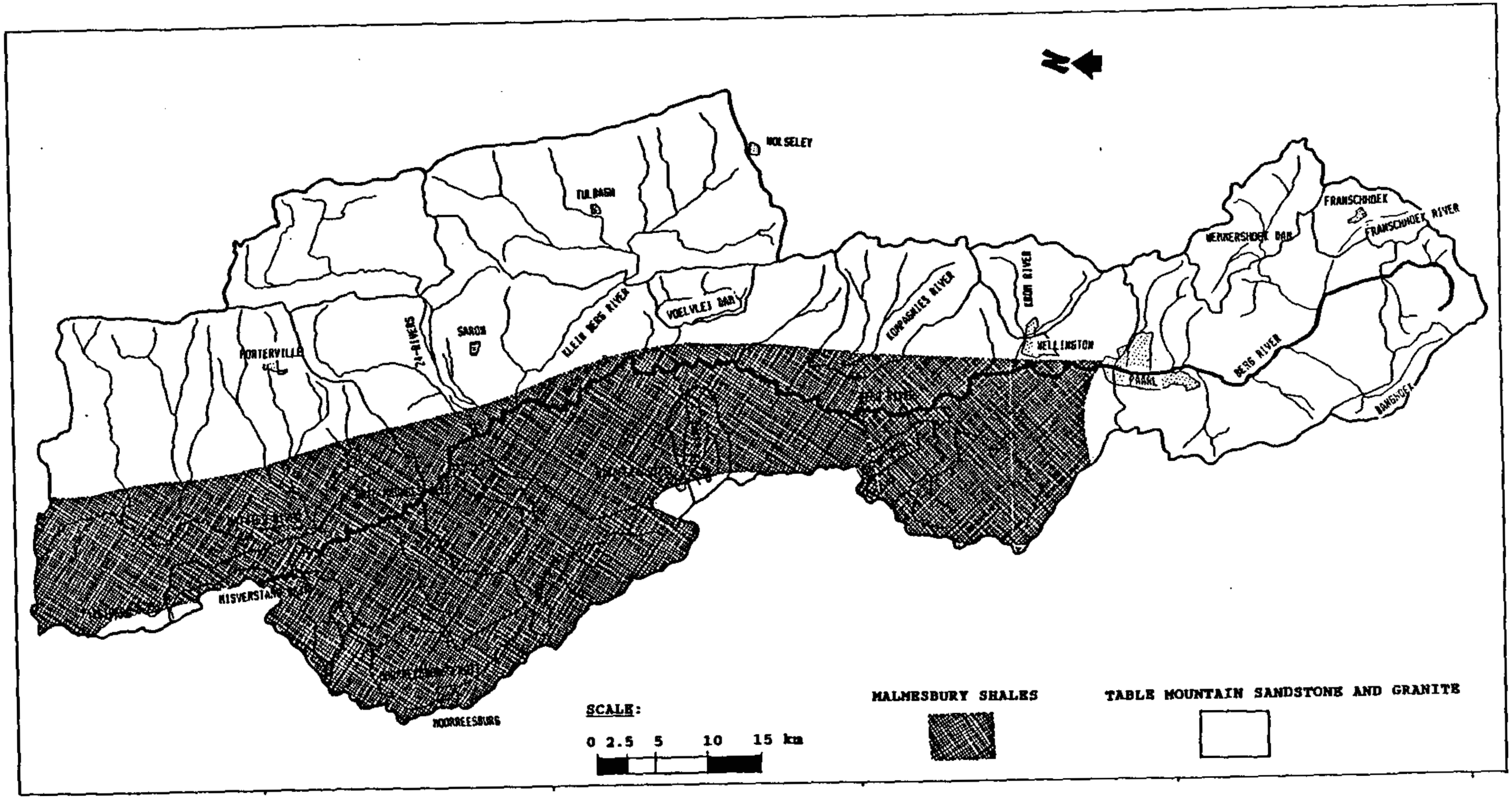

Fig 3.4. Geology of the Berg River catchment.

river channel, (3) the existence of multiple channels separated by low lying islands in the lower reaches and (4) the great width of the river valley. Fourie and Steer (1971) state that the profile is also influenced by the change in bedrock formation from Table Mountain Sandstone (TMS) in the upper reaches to Malmesbury shales in the lower reaches.

Ploughing of the relatively shallow soils has in several areas resulted in fragments of shale being brought to the surface. This in turn has facilitated the process of mineral decomposition, increasing the concentration of soluble salts in drainage waters.

1.5 Soils

The distribution of soil types in the river catchment are shown in Fig 3.5. The undisturbed soils, exposed on cuttings, consist of two horizons:

(1) Top soil containing an abundance of fine clay and silt particles mixed with organic matter (A horizon);

(2) subsoil of disintegrating rock partially devoid of organic matter (B horizon).

Under these horizons lie the parent rock. The top soil has been formed by the action of chemical, biological and physical processes on the parent bedrock. These changes are brought about by the combined action of weather, plants and soil organisms. The soils in the Berg River catchment are chiefly derived from Malmesbury shales and TMS.

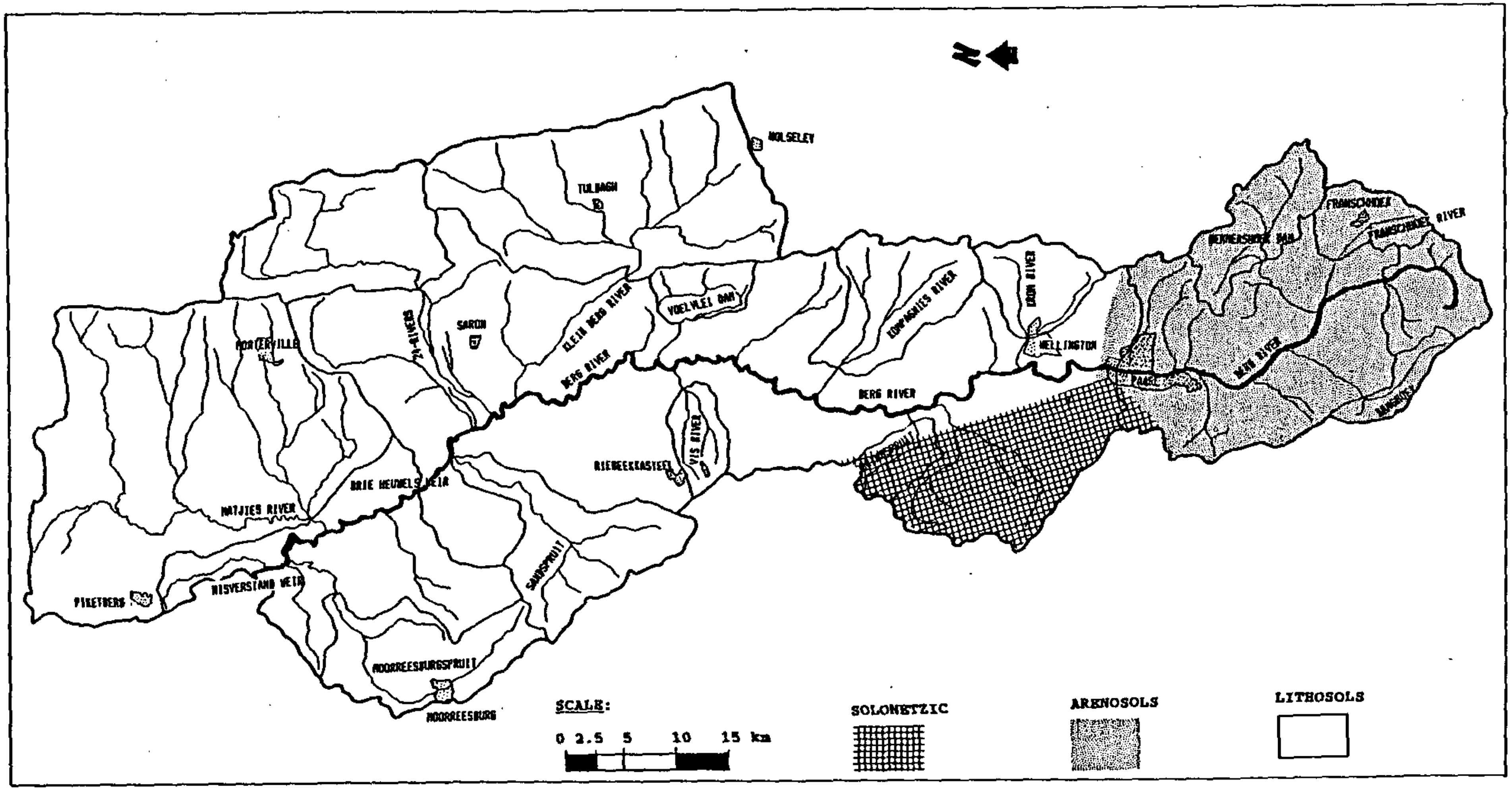

Fig 3.5. Distribution of soil types in the Berg River catchment.

Soils derived from Malmesbury shales are brown, sandy, and gravely loams, usually of shallow depth. Narrow horizons of small ferruginuous concretions (hardpan) and rock fragments often are found at depths varying from 100 to 450 mm below the surface. Theses horizons overlie a clay layer which varies from 20 to 450 mm in thickness and is impervious and plastic when wet. The clay layer is underlain by the parent material, the Malmesbury shales.

When the top soil (A horizon) is shallow, ploughing breaks the hardpan and mixes it with the underlying subsoil producing a sandy loam with concretionary characteristics. From an agricultural aspect these soils are generally poor in phosphates and nitrogen, fairly acid and tend to cake after rain. This type of soil tends to produce "alkaline" soils where drainage is poor as the salts are drawn upwards from the bedrock by capillary action. These soils are suitable for grain production.

Soils derived from TMS decompose gradually to arenaceous acid soils, usually in thin horizons on the mountain slopes, containing an abundance of unweathered sandstone particles (see Fig 3.5). The top soil (A horizon) usually is a dark brown sand containing organics, and averages about 150 mm in depth. The subsoil (B horizon) consists of a thin band of white sand strata overlying the bedrock. On more gentle slopes the A horizon deepens to 450 mm or more in depth and the B horizon may be a yellow-brown sandy loam or sandy clay.

At the foot of the mountains, the surface layer may be underlain by 300 to 600 mm of whitish sand and the lower B horizon may be reddish-brown or yellow-brown with hardpan characteristics. The B horizon may consist of iron oxide concretions which may change to a heavily illuviated sandy clay which is more or less impervious.

All TMS derived soils are poor in plant nutrients but support a remarkable variety of indigenous fynbos and proteas. The deeper soils are suitable for the cultivation of vines and fruit trees, but only with copious amounts of fertiliser and manure (Kersandt and Marais, 1973).

1.6 Agricultural development

The distribution of agricultural activity in the Berg River catchment is governed by rainfall, soil type, climate as well as the availability and quality of water used for irrigation.

The slopes of the valleys along the upper reaches of the Berg River from Franschhoek to Wellington are suitable for the cultivation of vines, fruit trees and commercial forestry, because of the deep soil and dependable rainfall (see Fig 3.6).

Up to the Second World War (1945) limited irrigation from the river was practised. Because of the decrease in rainfall in the catchment area to the north of Wellington, grain farming used to be generally practised, but the onset of irrigation resulted in a rapid increase in the number of fruit orchards and vineyards, replacing grainlands. The main areas for irrigation in the catchment lie between the Franschhoek and Banghoek valleys, and the areas around Paarl and Wellington. Considerable irrigation development has also taken place in the vicinity of Tulbagh. Vines are the predominant crop in both these areas which are characterised by good quality drainage waters during the irrigation season. A limited amount of irrigation has taken place along the banks of the Berg River as far as Misverstand Weir (see Fig 3.6). In the remaining areas dryland farming is practised interspersed with pastoral, cattle and pig farming.

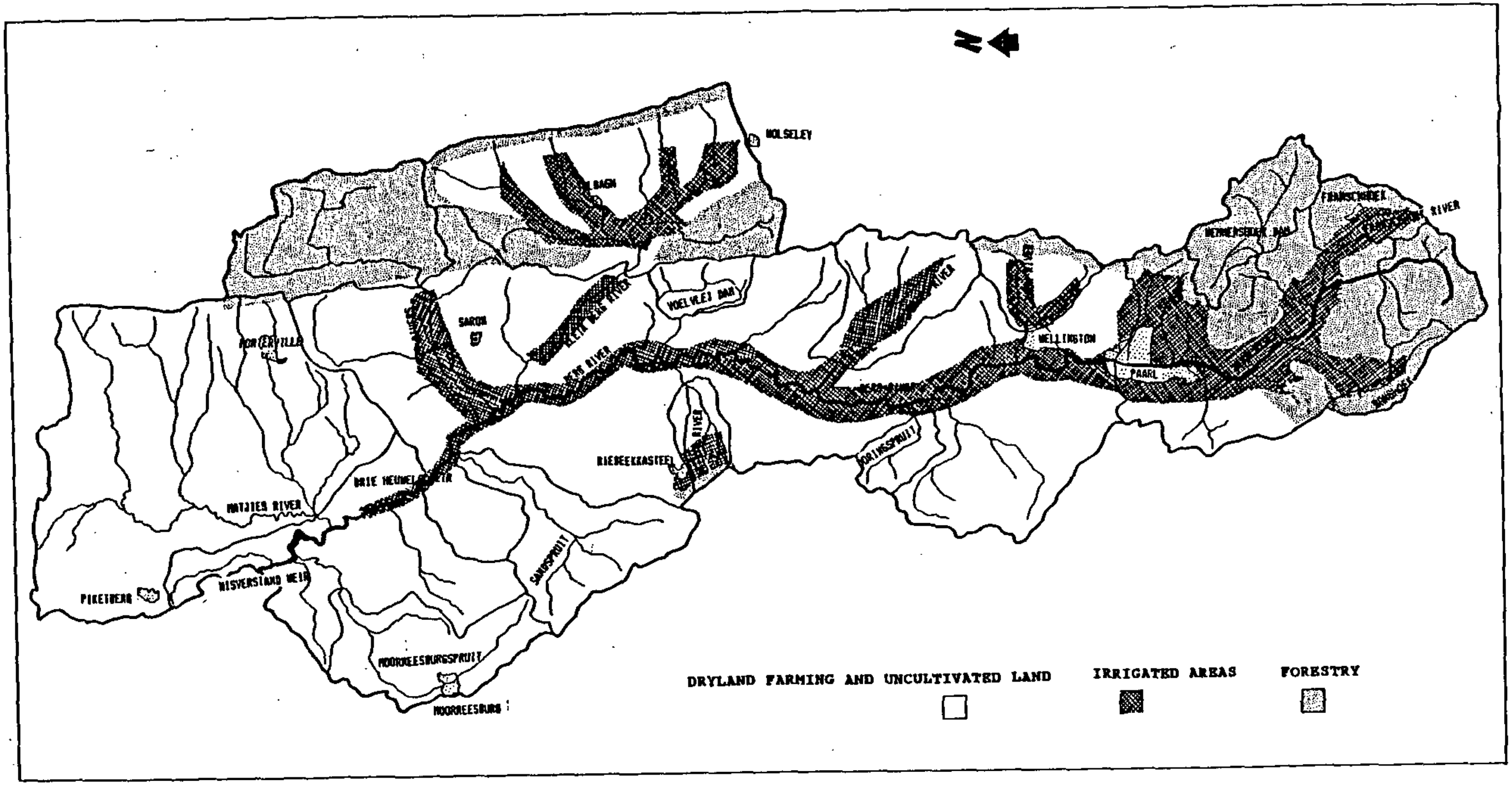

Fig 3.6. Distribution of irrigated areas, dry land farming and forestry in the Berg River catchment.

1.7 Hydrology and water quality

The water quality of the Berg River is a product of two geological regions. The first is the good water quality draining from the Table Mountain Sandstone outcrops of the Jonkershoek and Franschhoek Mountains. The steep slopes and shallow soils of the area produce a rapid response runoff which can be as much as 66 percent of the rainfall (Fig 3.7). The median total dissolved solids (TDS) concentration of this runoff is between 15 and 60 mg/ℓ with a median phosphorus concentration of between 10 and 50 µg/ℓ.

The second geological region is the more saline water quality from the low lying Malmesbury Shale north of Paarl. The runoff from these areas averages about 20 percent of the rainfall (Fig 3.7) with streams exhibiting a median TDS concentration of between 1 000 and 7 000 mg/ℓ and a median phosphorus concentration of between 50 and 300 µg/ℓ. Fortunately, the high concentrations of salt and phosphorus are associated with tributaries with low runoff which are diluted by the runoff from the upper catchment.

In Fig 3.8 the simulated annual mass export of TDS is shown for the main subcatchments in the river basin. With a few exceptions, the tributaries on the west bank of the main river channel downstream of Wellington run dry during the summer months. This is fortunate because these drain extensive areas of Malmesbury shale which produces flows with high salt concentrations. The tributaries on the east bank drain TMS and contribute a lower salt load compared with the west bank tributaries.

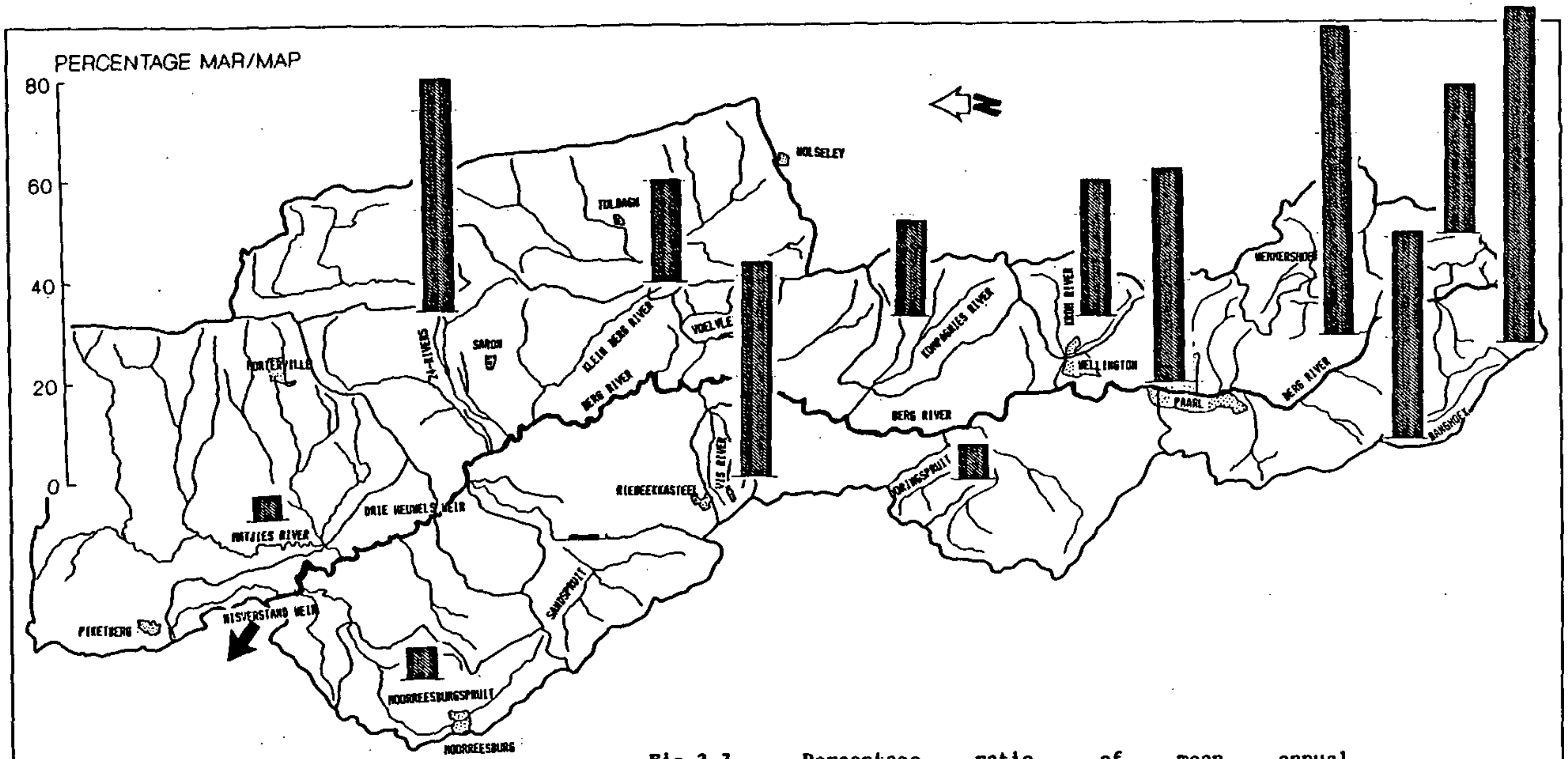

Fig 3.7. Percentage ratio of mean annual precipitation (MAP) to mean annual runoff (MAR) for major subcatchments in the Berg River basin.

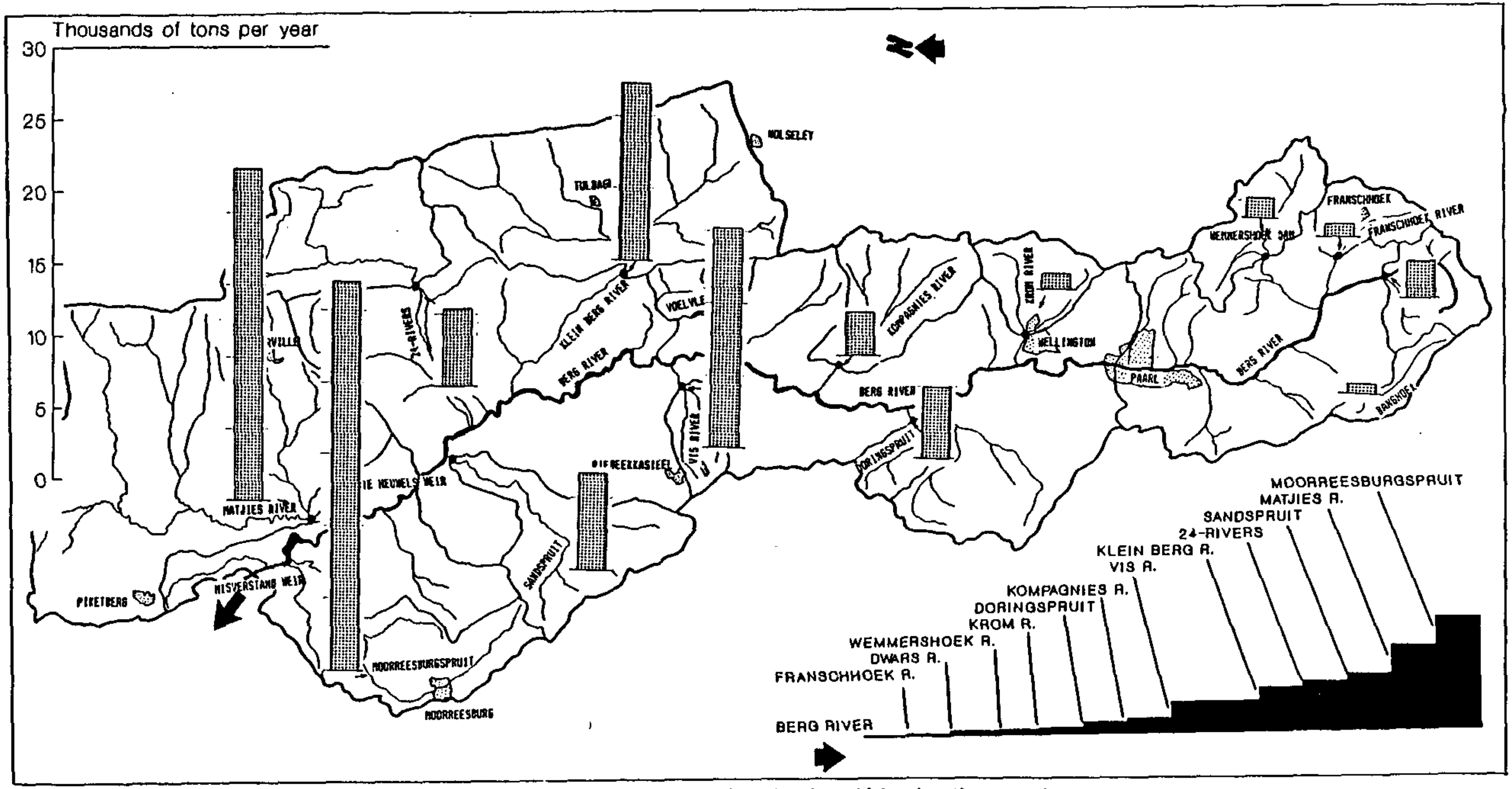

Fig 3.8. Simulated total dissolved solids (TDS) export from major subcatchments in the Berg River basin (from Forster and van der Berg, 1985). The inset shows the cumulative input of TDS to the main river channel of the Berg River.

Return of irrigation water to the main river channel in the form of seepage is increasing the salinity of the river. The seepage water is mineralised due to evapotranspiration and leaching of ground salts, causing an increase in the salinity down the length of the river (Fourie and Steer, 1971; Kersandt and Marais, 1973; Fourie 1976).

The combined effect of high salt and low nutrient content of the soils in the lower catchment requires the addition of copious amounts of fertiliser and manure (Kersandt and Marais, 1973). A proportion of these nutrients are exported from the land during surface runoff or as leachate, and discharges to the main river channel. There is little information available on the mass export of phosphorus from the agricultural areas but it is expected to be high because of the sheet erosion of top soil and the intensive fertilising of the soil.

1.8 Demography

Apart from the small village of Franschhoek along the headwaters of the river and some villages along the lower reaches, Piketberg, Vredenburg, Veldrif, Laaiplek, Saldanha Bay and Langebaan, there are only two sizeable towns in the catchment, Paarl and Wellington. The population distribution of the catchment, for both urban and agricultural areas, is shown in Fig 3.9.

Paarl:

Extending along the banks of the Berg River for a distance of about 10 km Paarl has a total population of about 63 000 (Central Statistical Service, 1987). Water is drawn from reservoirs on Paarl mountain which are partially filled by pumping approximately 0.9 million cubic metres from the Berg

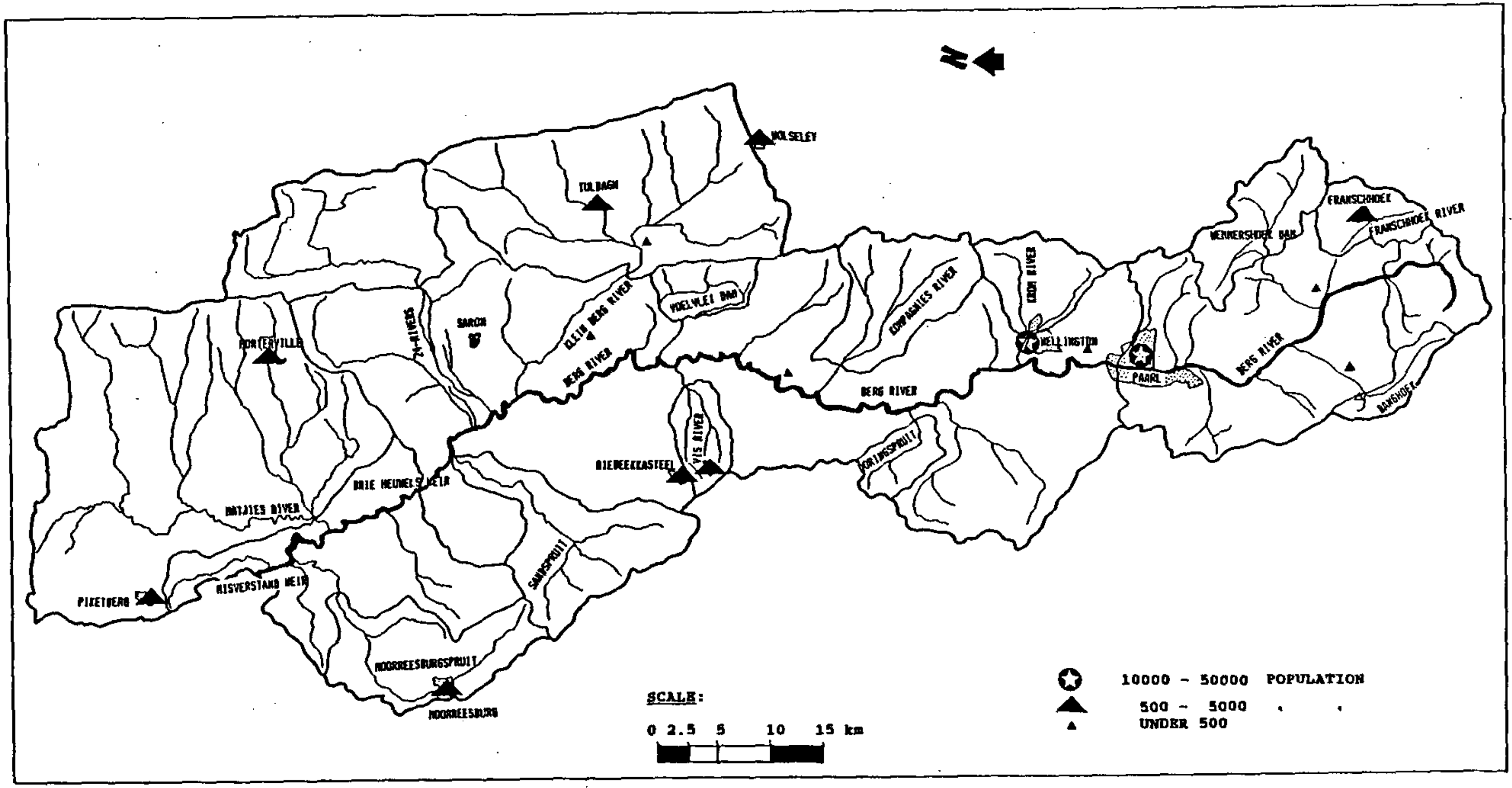

Fig 3.9. **Demography of the Berg River catchment.**

River every year. This water is filtered and chlorinated before entering the mains supply. The supply is augmented from Wemmershoek Dam; the water is used for agricultural, industrial, and domestic purposes.

In Paarl, vineyards are interdispersed with residential and industrial areas, giving a runoff which is a combination of urban, industrial and agricultural sources. The principle industries are wine and spirit production, food processing and canning, textiles, and manufacture of cigarettes.

The first wastewater treatment works at Paarl was constructed in the 1930's and consisted of a conventional biological filtration works for the domestic sewage and a series of evaporation ponds for the industrial wastewaters. In the early 1950's, as a result of serious contamination of the Berg River by seepage from the industrial ponds (Fourie and Steer, 1971), an extensive monitoring investigation was undertaken. The domestic, distillery and industrial effluents were separated and by 1957 the first extensions to the works were completed, comprising extensions to the bio-filters and to the industrial ponds. In 1960 an extensive maturation pond system was constructed, for tertiary treatment of effluent prior to disposal in the Berg River. Due to the increase in hydraulic load to the works, an aerated lagoon system was constructed plus the addition of maturation ponds (Pers. Comm. Reid, 1987).

Wellington:

Wellington is situated 10 km downstream from Paarl with a population of about 32 500 (Central Statistical Service, 1987). Water is obtained from the Wemmershoek Dam for both industrial and domestic purposes. Industrial development is similar to that of Paarl, i.e. production of wines and spirits, canning and processing of fruit, and textile manufacture. A tannery on the boundary of the municipality treats its own effluent by means of evaporation ponds.

A sewerage system and a treatment works were installed in 1950, for domestic sewage only. The treatment consists of a series of bio-filters, discharging into maturation ponds and chlorination, prior to release into the Berg River.

The industrial effluents are separate from the domestic effluents. The industrial effluents pass to a series of evaporation/oxidation ponds. Fourie and Steer (1971) report considerable infiltration to the groundwater from these ponds. To minimize seepage to the river, ponds have been lined and located as far from the river as possible.

1.9 Water resource development

The Berg River catchment is one of the main sources of water for household and industrial purposes in the Western Cape. Cape Town receives the bulk of its water requirements from the Wemmershoek and Voëlvlei Dams in the Berg River catchment (see Fig 3.10). The water supply of a number of smaller towns in the vicinity are supplied also from these dams. The Berg River pump station, located about 60 km from the mouth of the river, supplies water to the Saldanha, Vredenburg and Veldrif areas, since 1942. The plant is dependent on the flow in the river to minimise seawater intrusion (Fourie and Steer, 1971) but the water abstracted often is very saline, with TDS of around 2 000 mg/ℓ (Fourie and Steer, 1971).

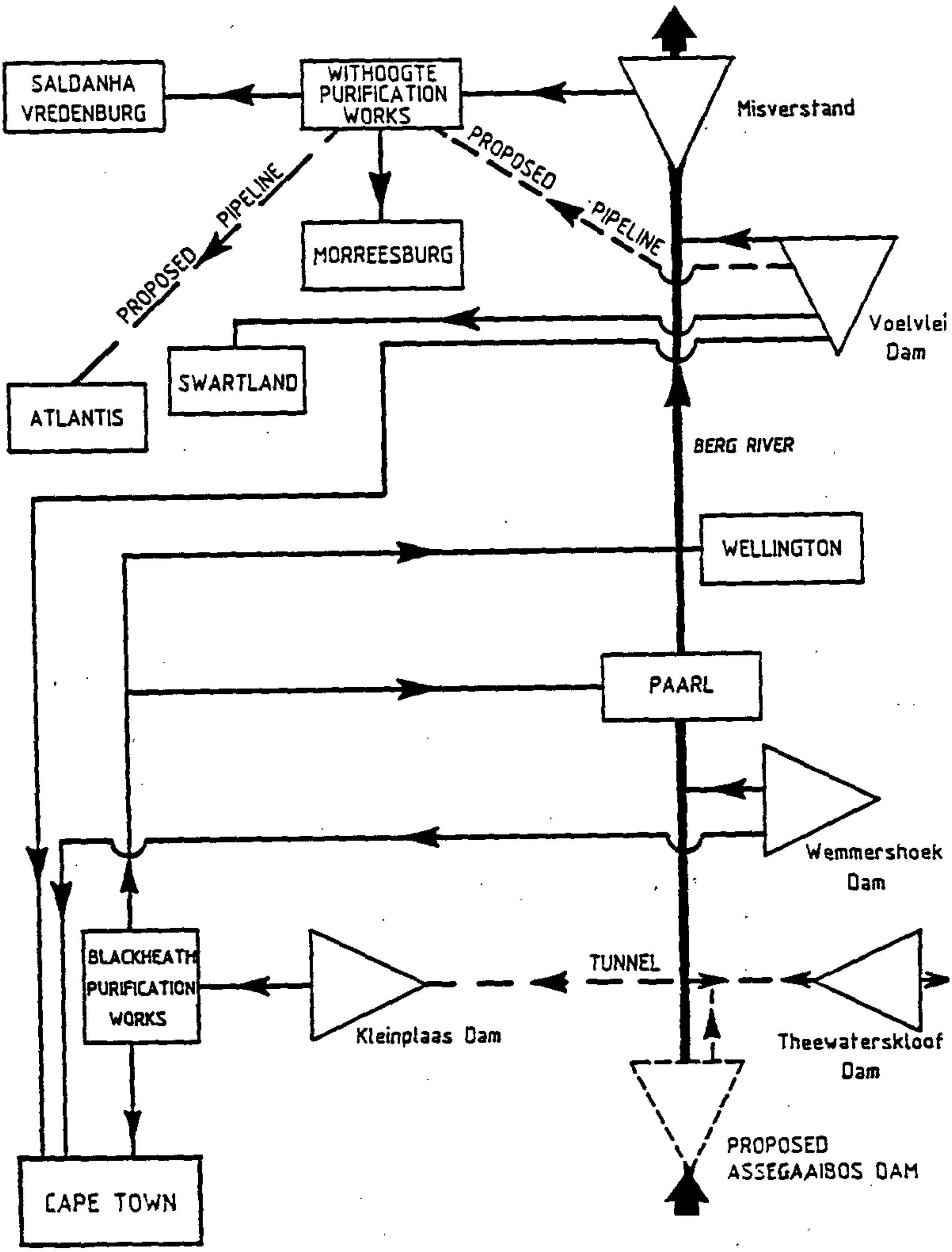

Fig 3.10. Role of the Berg River in the water supply network of the Western Cape Province of South Africa (from Forster, 1985).

The first Voëlvlei scheme was completed in 1953; it consisted of a weir across the Klein Berg River to divert a maximum flow of 1.3 million cubic metres per day of water into a canal leading to Voëlvlei, an impounded natural lake at that time with a capacity of 50 million cubic metres.

In 1969, the dam wall of Voëlvlei was raised to increase capacity to 170 million cubic metres, and the maximum flow from the Klein Berg River into Voëlvlei Dam was increased to 1.7 million cubic metres per day. A diversion canal from the Twenty Four rivers was completed in 1972 to carry an additional 2.9 million cubic metres per day to Voëlvlei Dam (White Paper, 1968).

In the upper reaches of the Berg River catchment, the Wemmers River was impounded in 1961 to produce a storage facility of capacity of 59 million cubic metres, known as the Wemmershoek Dam. During low flow in the Berg River, this dam releases compensation discharges down the Wemmers and Berg Rivers to maintain channel flow as far as the Voëlvlei Canal. More recently, the Theewaterskloof Dam (capacity of 484 million cubic metres) was constructed on the Sonderend River which has the provision for releasing water through a tunnel into the Berg River at Robertsvlei (see Fig 3.10). The dam releases are also used for flow compensation in the Berg River to provide the farmers and irrigation boards with water during the summer months. There is a proposal to build a dam in the upper catchment of the Berg River at Assegaaibos to divert 100 million cubic metres per year to the Theewaterskloof Dam via the Theewaterskloof Tunnel.

In the lower reaches, a weir has been built across the Berg River at Misverstand to enable water to be abstracted and pumped to a holding reservoir at Withoogte. The water is treated at Withoogte to supply the Saldanha region via an extensive pipeline system. The reservoir at Withoogte is sufficiently large to bridge periods when pumping from Misverstand Weir must be suspended temporarily because of highly saline, or turbid water (White Paper, 1976).

The minimum guaranteed winter flow at Misverstand, with the present and proposed upper catchment diversions, is estimated at 200 million cubic metres (Fourie and Steer, 1971). The site of the weir at Misverstand is suitable for the construction of a large dam in which most of the winter runoff could be stored. This dam is likely to be built around the year 2000 because of the lower than expected increase in water demand in the Atlantis-Saldanha region. However, the highly variable salinity and turbidity in the lower Berg River reduces the attractiveness of the Misverstand site for an impoundment, also very little information is available on the eutrophication potential of the proposed impoundment.

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CHAPTER 4

MONITORING STRATEGY AND DATA CAPTURE

1 MONITORING STRATEGY

The development of a phosphorus transport model requires a quantitative description of the processes governing the transport phenomena. To acquire this information, water quality and flow data have to be collected from the catchment using a water quality monitoring network. The design of a monitoring network requires a systematic approach otherwise vast quantities of data may be collected yielding little information - the "data-rich but information poor" syndrome (Ward, Loftis and McBride, 1986).

The problem in design of a monitoring network, i.e. a network that would supply the appropriate information at the required density, is that initially one does not know where and when the critical situation may develop that requires a greater frequency of sampling. This point is also made by Moss (1980) where he states:

> "It is a paradox of network design that the statistical parameters controlling the optimality of a network are frequently the unknowns that the network is being designed to estimate".

Establishment of an optimal monitoring network is unlikely to be achieved on the first attempt. As needs develop, or as new ones are identified, the monitoring network must be adjusted accordingly. Thus, the optimal network design is developed by a process of iteration. This approach was followed to develop an optimum monitoring network for water quality in the Berg River system.

2 PRELIMINARY SURVEY

The primary objective of the investigation was to describe the movement of phosphorus through the Berg River system. We have seen that such a description requires both phosphorus concentration and discharge in order to determine the phosphorus loads.

When the investigation was inaugurated there were virtually no data on phosphorus, but flow data were available for a number of gauging weirs. The only extensive measurements on phosphorus concentration and associated discharge were from the effluent wastewater treatment works of Paarl and Wellington. However, only irregular measurements of phosphorus concentration had been taken of the river upstream and downstream of the Paarl and Wellington works so that information on phosphorus load in the main river channel was rudimentary. Furthermore, measurements were of little value as the measurement technique for the determination of phosphorus at low concentration was suspect. No measurements of phosphorus had been taken down the river, or on the tributaries.

With regard to the measurement of flow, continuous data were available at 3 points on the main river channel (weirs: G1M04, G1M20 and G1M13) and on 12 lateral inflows (two on the sewage works effluent line weirs: G1Q01 and G1Q02), one on the water release from Voëlvlei Dam (weir: G1R01), and nine on the tributaries. The locations of the gauging weirs are shown in Fig 4.1; main channel gauging stations are identified by the letter "M", weirs on effluent lines by "E", and weirs on tributaries by "T".

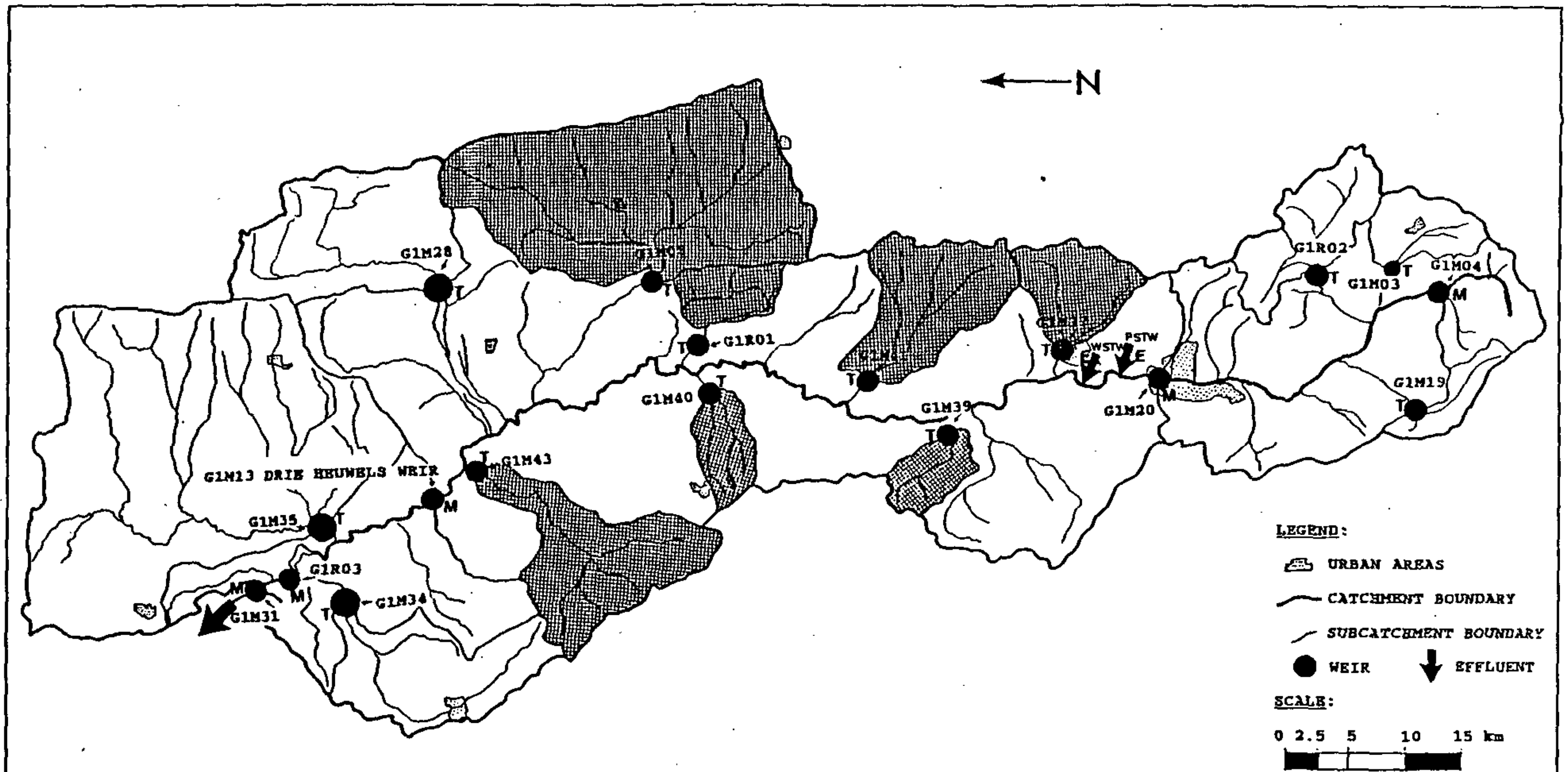

Fig 4.1. Location of gauging weirs in the Berg River basin. Weirs on the main river channel are denoted by "M", weirs on the effluent lines are denoted by "E", and weirs on tributaries to the main river channel by "T".

2.1 Selection of sampling station location

In the preliminary survey the objective was to form an approximate assessment of the variation of phosphorus concentration and load along the main river channel. With this information it would be possible to identify regions that were important contributors and require more intensive sampling.

A number of sampling stations were sited on the main river channel below reaches that receive substantial lateral flows, some of which were suspected to be contributors of phosphorus. These stations were all near existing gauging weirs so that the phosphorus loads at the stations could be calculated as accurately as possible. These stations were located above and below.

(1) Tunnel discharge from the Theewaterskloof Dam outlet (Stations 1A and 1B),

(2) urban runoff canals for Paarl (Stations 7A and 9A),

(3) treated effluent discharge at Paarl and Wellington (Stations 9A and 13B),

(4) point of water release from Voëlvlei Dam (Stations 21A and 22A).

These seven stations are shown on Fig 4.2.

To obtain an estimate of the nonpoint phosphorus loads exported from the tributaries and diffuse surface discharges to the main river channel, eight "secondary" stations were selected down the river between Wellington and Drie Heuwels Weir. These stations were selected on the basis of: (1) easy access, (2) good mixing in the river, and (3) where there was

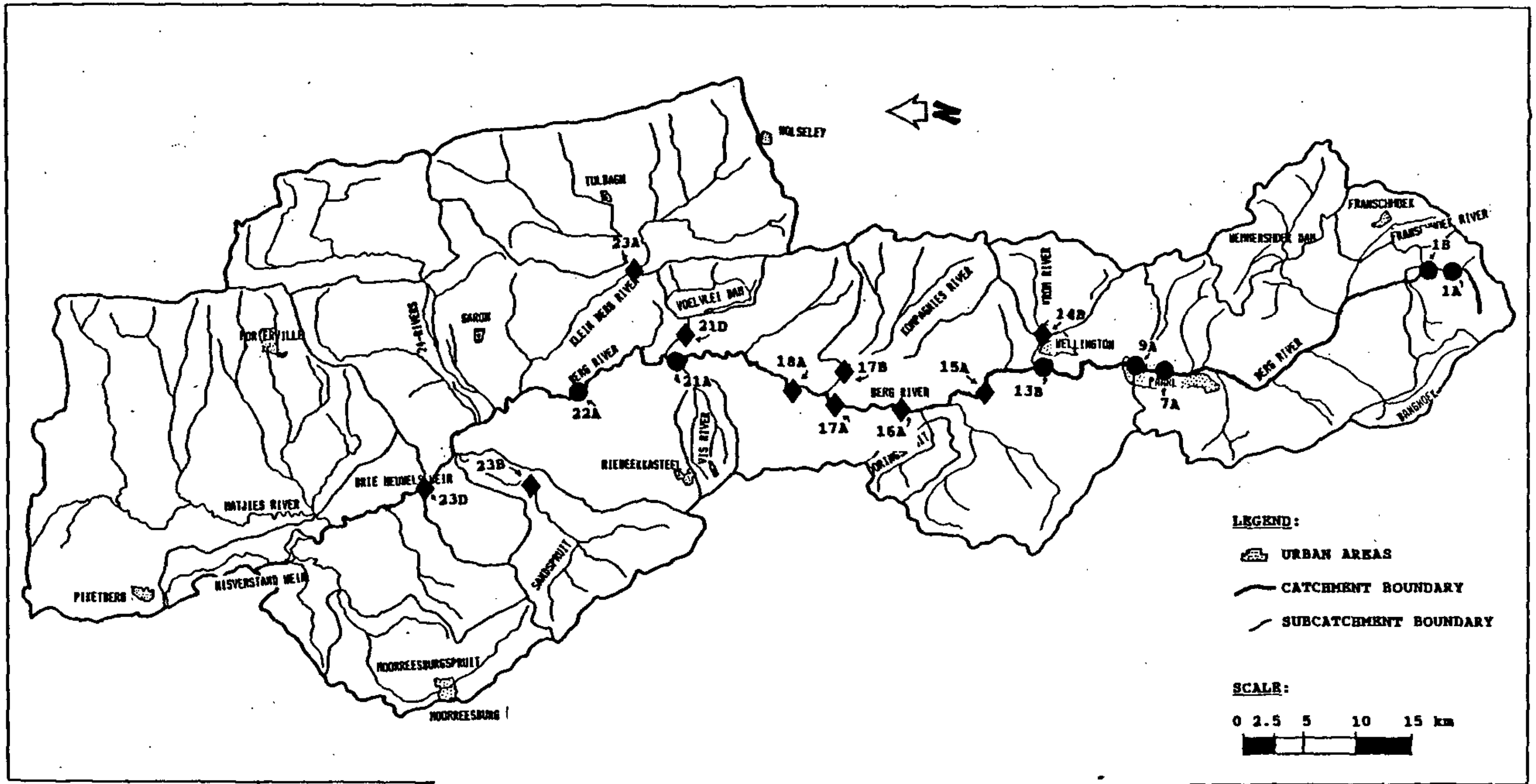

Fig 4.2. Layout of sampling stations in the Berg River basin for the Preliminary survey. Primary stations are denoted by circles, and secondary stations by a diamond, see text for details.

no gauging weir, a river reach with stable cross sectional profile in order to estimate river discharge using a field method (see Section 3.4 Field Methods). These "secondary" stations are shown in Fig 4.2 (Stations: 14B, 15A, 16A, 17A, 17B, 18A, 21D, 23A, 23B and 23D).

Each sampling station was identified by an alpha-numeric. The numeral increases at consecutive stations down the length of the river, e.g. at the headwaters the station is labelled 1A and at the downstream of the river, at Misverstand Weir, labelled 25A. The alpha symbol is incorporated in the station-code so that in any reach of the river should a new station be added between two existing stations, the new station could be coded to indicate its approximate location. For example a new station located between existing stations 1A and 2A would be coded 1B.

2.2 Selection of sampling frequency

Samples were collected at each sampling station at a frequency of between once and three times a month, for a period of one year, to span the hydrologic year. At each station, water samples were collected for analysis and at the same time river discharge calculated either from the gauging weir or by using the manual field method (see Section 3.4).

2.3 Data storage, processing and presentation

The water quality and flow data were stored on a computerized data base to enable rapid processing and presentation of data. Information on the design of the data base is given in Appendix 1. A number of computer programs were produced for the processing and presentation of water quality data; documentation and listings of these programs are given in Appendix 2.

2.4 Results of preliminary survey

The objective of the preliminary survey was to obtain information for implementation of the monitoring program for the main river survey. There is little merit in presenting a detailed analysis of the data obtained in the preliminary survey - only such data will be presented that shows the need for the modifications in the monitoring program for the main river survey.

In Fig 4.3 the discharge hydrograph and phosphorus concentration measurements are shown for Station 9A from 24/11/1983 to 18/11/1984, the period over which the preliminary survey approximately extended. Station 9A monitors the drainage from an area in which phosphorus is principally derived from nonpoint sources. It is immediately apparent that the discharge ranged from 0.5 to as high as 200 cumecs, that the flood flows were peaky and extended over relatively short periods of time. Under this flow regime the phosphorus measurements, at intervals of one or two weeks, did not provide any information on the phosphorus behaviour during floods, except one data point which indicated that the phosphorus concentration was very high. Plotting the phosphorus concentration versus discharge (Fig 4.4) indicated that (1) the concentration increases with discharge, (2) there is scatter in the plotted points, and (3) no information is available as to the behaviour of phosphorus during flood events.

Along the river channel, on a selected day during a flood event abrupt changes in the phosphorus concentration were measured (Fig 4.5), that is, high transient effects are apparent, induced by flood waves entering the main river channel at different points along the channel.

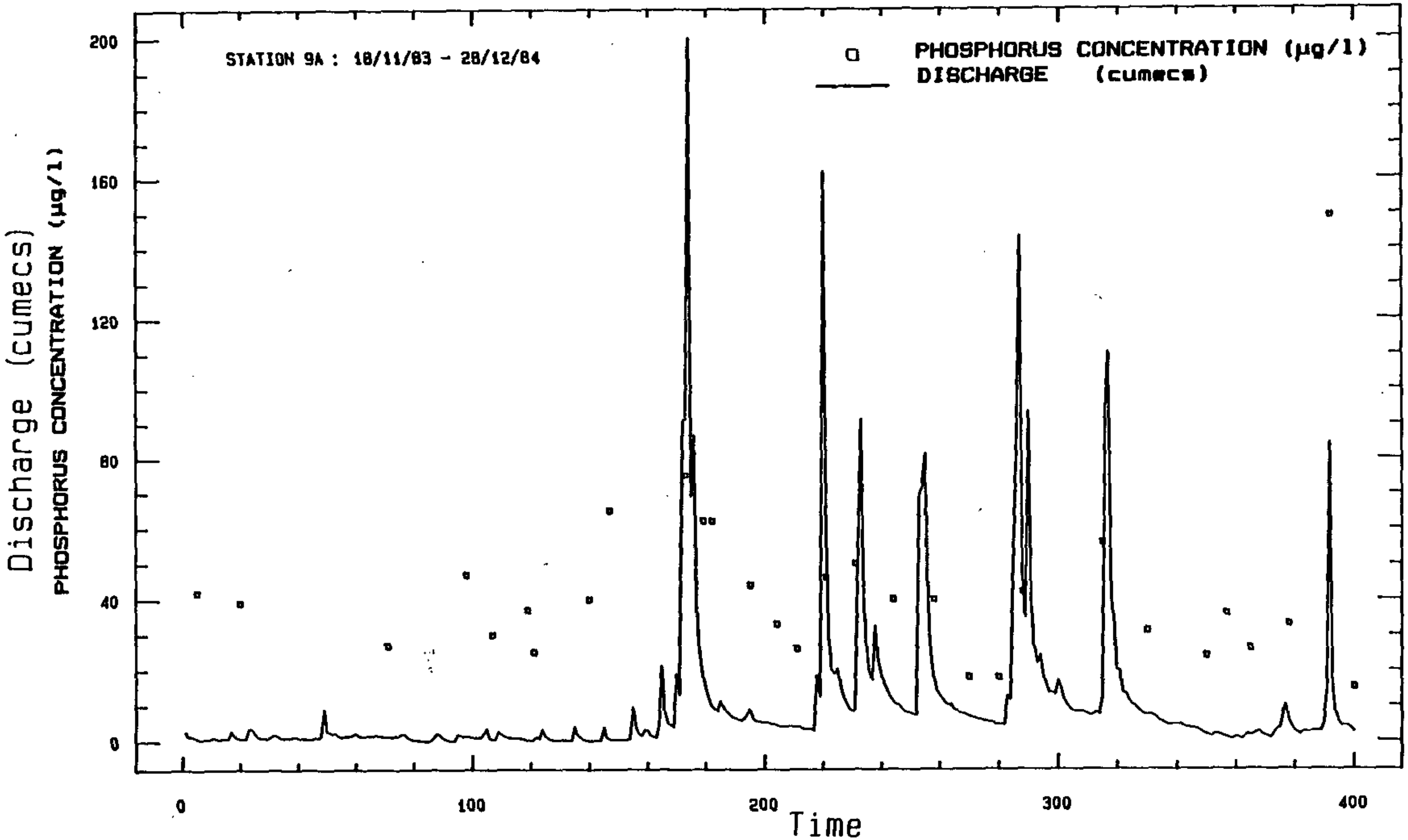

Fig 4.3. **Discharge hydrograph and associated phosphorus concentration measurements for Station 9A for the period 18/11/1983 to 28/12/1984.**

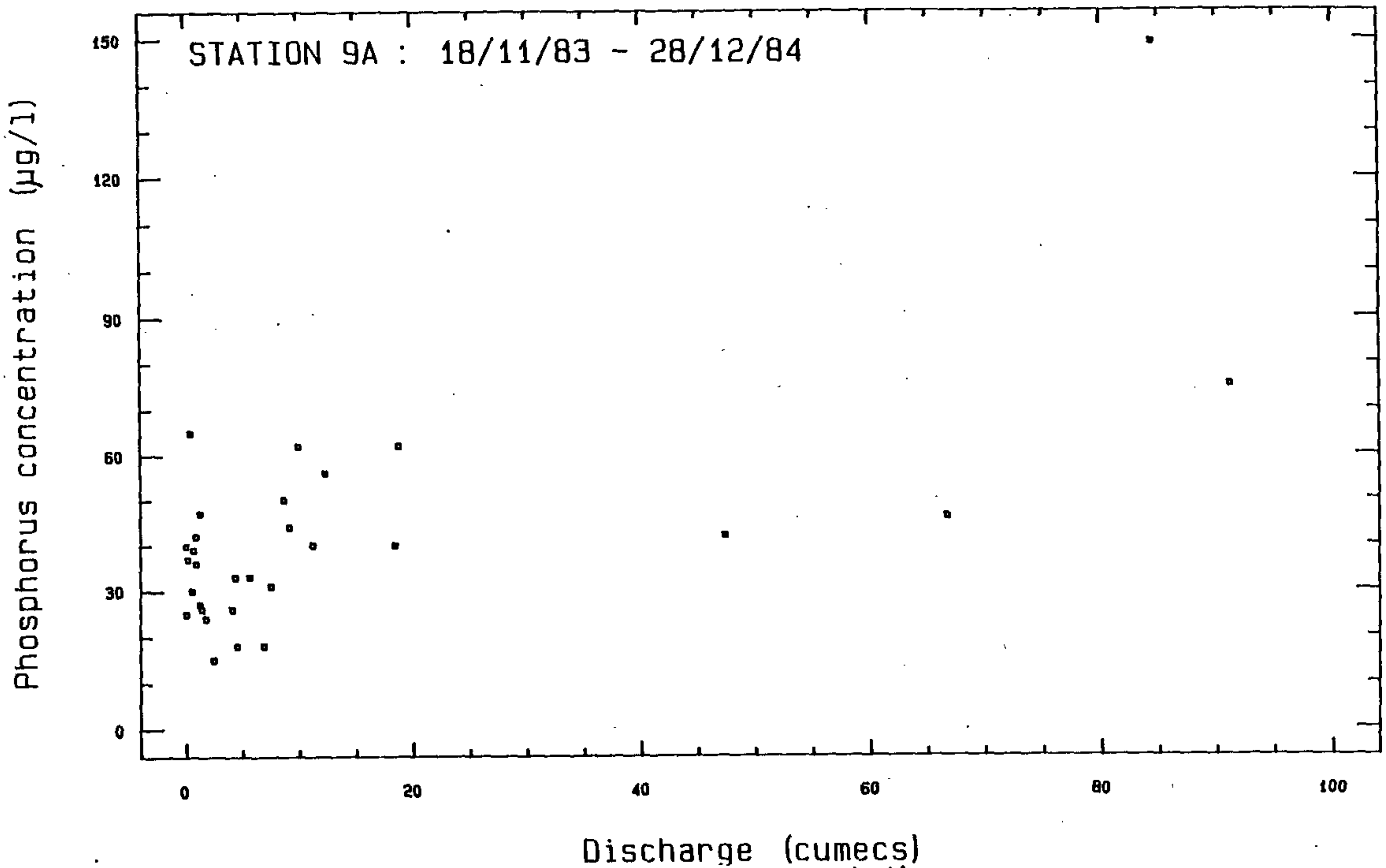

Fig 4.4. Plot of the phosphorus concentration versus discharge for Station 9A. Data collected during the period 18/11/83 to 28/12/1984.

4.9

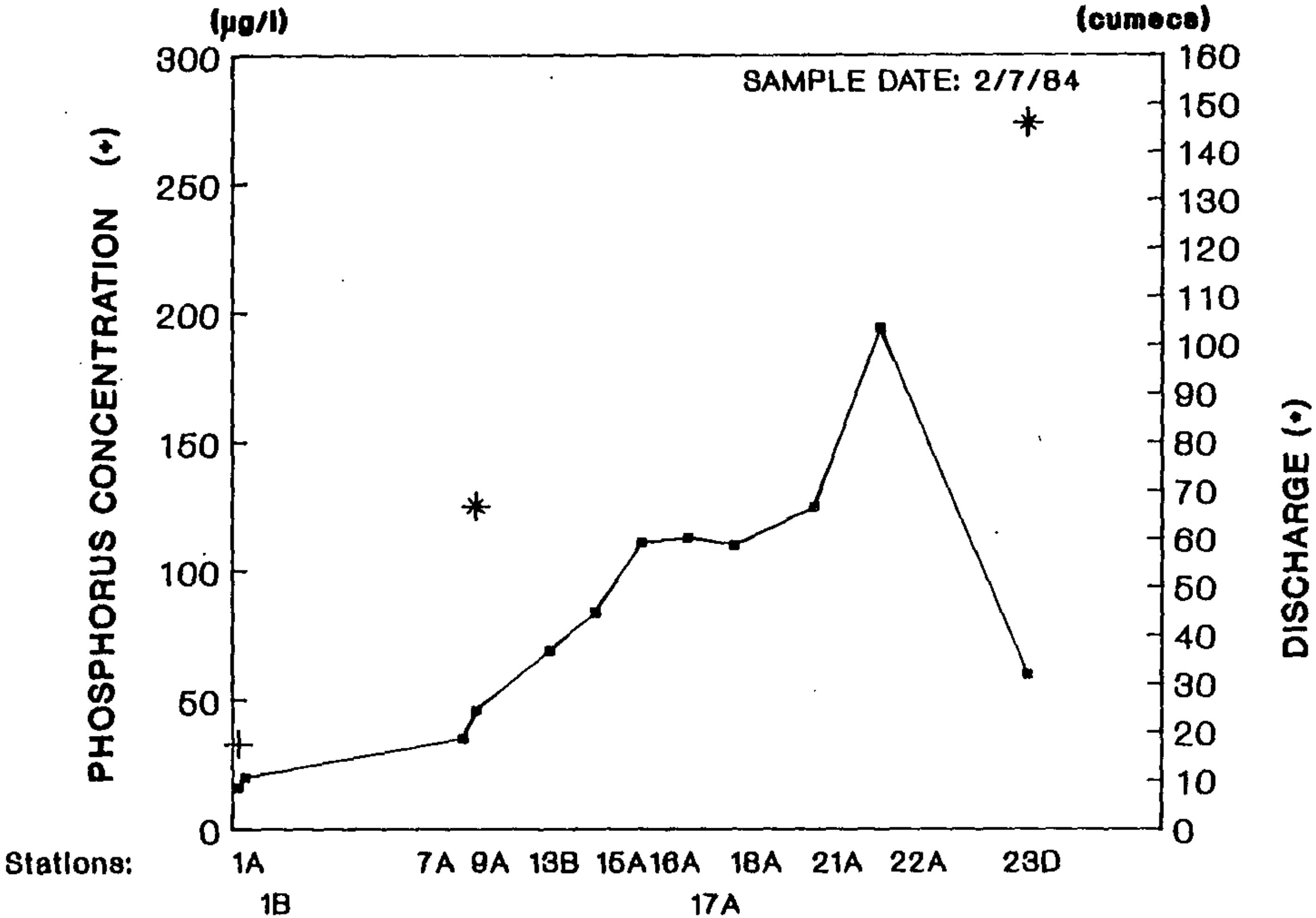

Fig 4.5. Phosphorus concentration profile for sampling stations located along the main river channel. Samples collected on 2/7/1984 during flood flow conditions.

In the main channel clearly the behaviour of phosphorus during flood events demand closer scrutiny; this implies that during flood events the frequency of sampling of phosphorus should be increased to such a level that a time series of phosphorus concentration (chemograph) could be distinguished. This chemograph, in association with the discharge hydrograph should provide information as to the phosphorus load exported.

The transient behaviour along the main river channel makes it virtually impossible to estimate the nonpoint source contributions by doing mass balances. Contributions of phosphorus from tributaries draining nonpoint sources therefore need to be assessed individually. Again, this implies high frequency sampling during flood events.

Adequate monitoring of nonpoint source subcatchments is particularly important because the chemograph in association with the discharge hydrograph provides information to develop a relationship between the discharge and phosphorus concentration for incorporation in a model.

By plotting the phosphorus concentration down the length of the main river channel from headwaters to Drie Heuwels Weir, under steady state high and low flow conditions respectively (see Figs 4.6 and 4.7) it became apparent that the stations upstream of Paarl on the main river channel (1A, 1B and 4A) may be omitted from the monitoring network because there appear to be no major inputs of phosphorus in this stretch of the river. Sampling station 16A also could be omitted; under both high and low flow conditions the remaining stations provided sufficient information for the description of the phosphorus profile (see Figs 4.6 and 4.7).

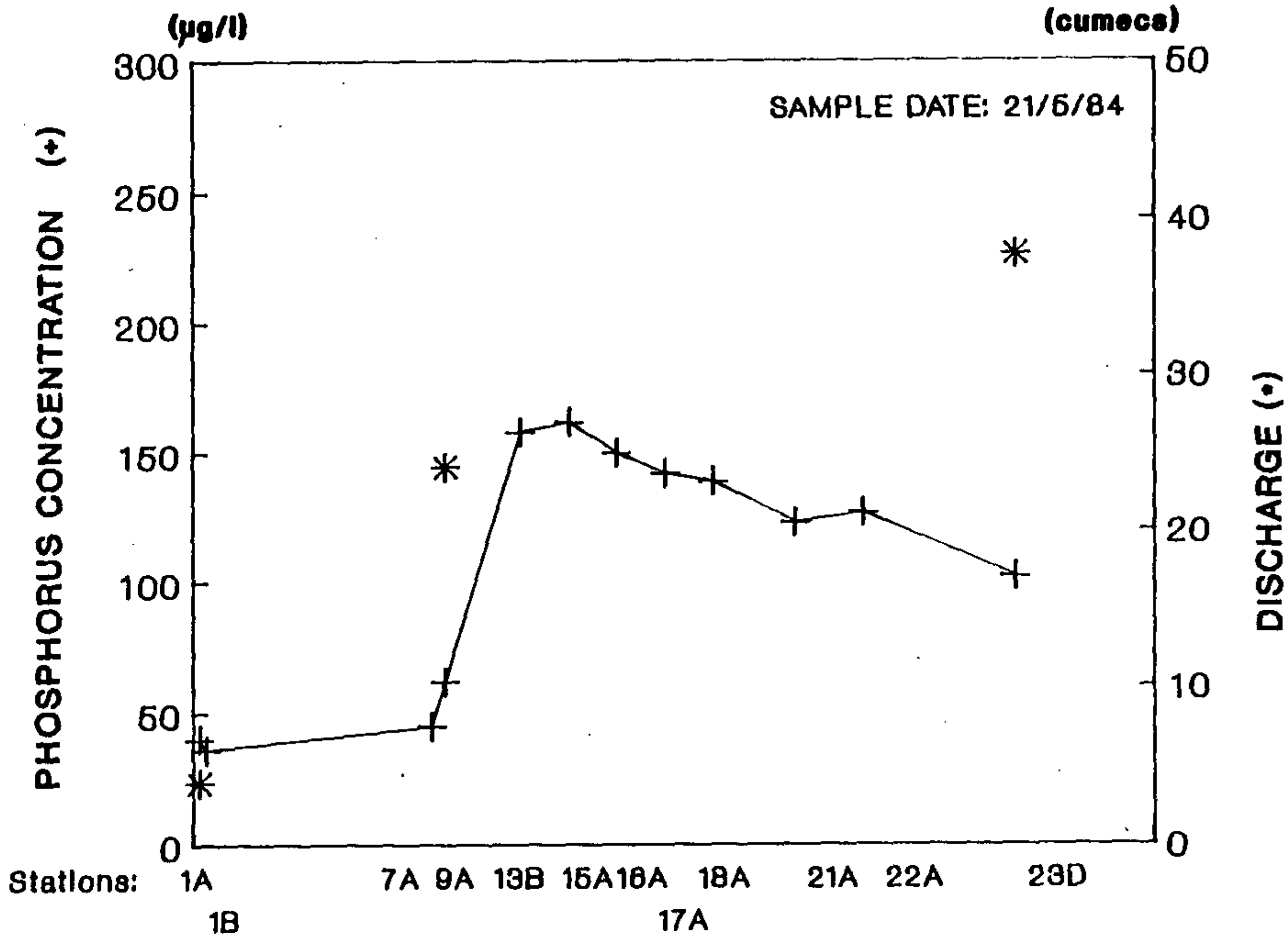

Fig 4.6. Phosphorus concentration profile for sampling stations located along the main river channel. Samples collected on 21/5/1984 during high flow conditions.

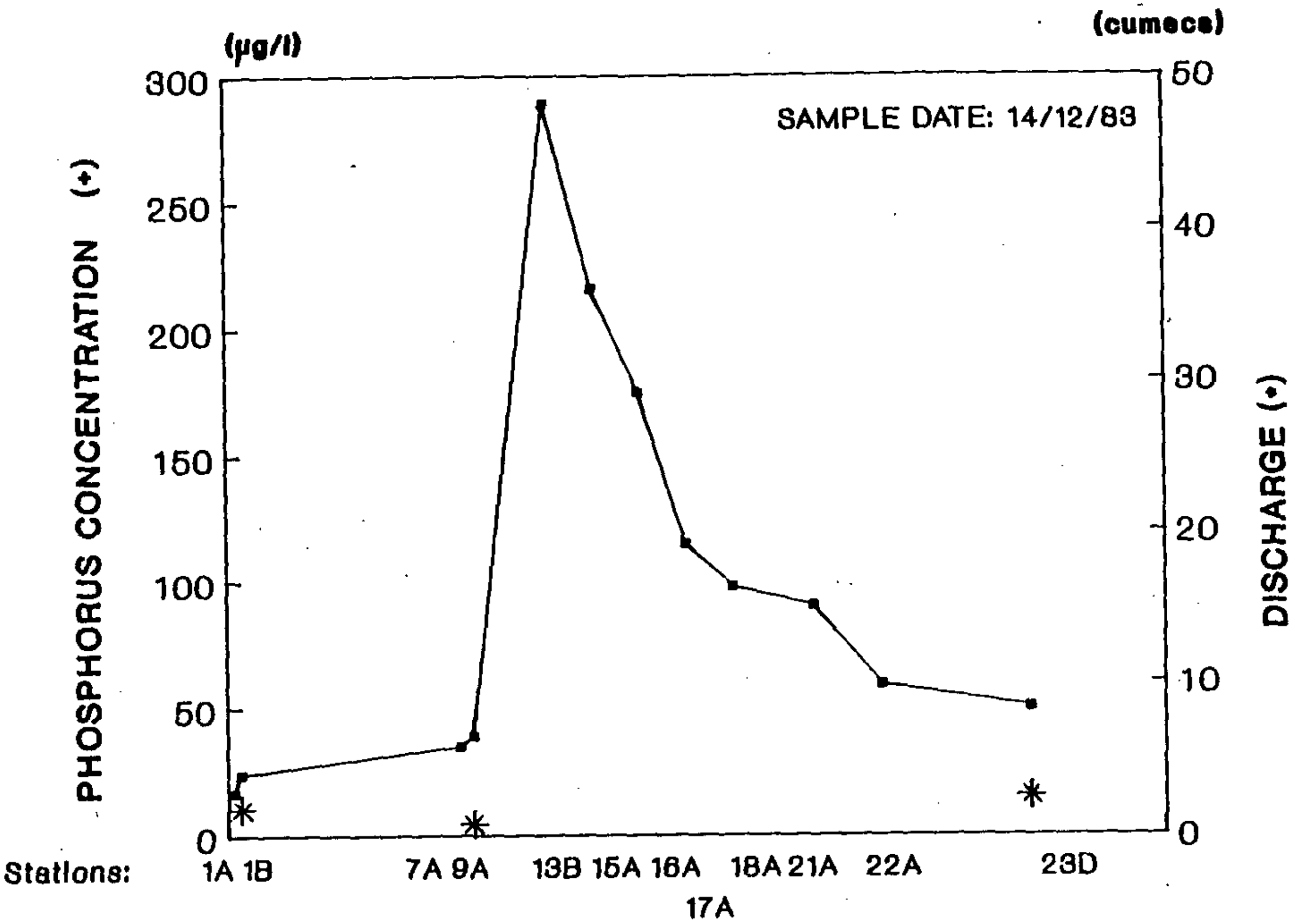

Fig 4.7. Phosphorus concentration profile for sampling stations located along the main river channel. Samples collected on 14/12/1983 during low flow conditions.

3 MAIN SURVEY

The information derived from the preliminary survey indicated that a greater emphasis should be placed on obtaining water quality data for: (1) lateral inflows to the main river channel, particularly phosphorus contributed from nonpoint sources, and (2) obtaining information on the transient behaviour of phosphorus during flood events.

3.1 Sampling location : Main Survey

Taking account of the observations mentioned above, the following sampling stations were selected. On the main river channel, eight sampling stations were located, as shown in Fig 4.8.

(1) Stations 9A and 13B were selected to measure water quality upstream and downstream of the municipal wastewater discharges from Paarl and Wellington as in the preliminary survey.

(2) At Station 23D the downstream water quality was measured.

(3) Five sampling stations were located between these to provide water quality information on the spatial variation along the main river channel (Stations: 15A, 17A, 18A, 21A and 22A).

To monitor the contribution of phosphorus from lateral sources six sampling stations were located on tributaries selected considering their location on the east and west banks, their spacing in the drainage basin, and had continuous flow gauging:

(1)	Krom River	(Station 14B)
(2)	Doringspruit	(Station 15D)
(3)	Kompagnies River	(Station 17B)
(4)	Canal from Voëlvlei Dam	(Station 21D)
(5)	Klein Berg River	(Station 23A)
(6)	Sandspruit	(Station 23B)

In addition, the two stations were located on the discharge lines of the Paarl and Wellington wastewater treatment works to monitor the phosphorus loading from these sources (Stations PSTW and WSTW). The location of the sampling stations is shown in Fig 4.8.

3.2 <u>Sampling frequency: Main survey</u>

The sampling frequency on the main river channel and tributaries was selected from the following considerations. From the preliminary survey it was evident that during the dry period i.e. low flow periods, the phosphorus concentration at selected points along the river, and from the tributaries tended to be fairly stable. Consequently, the frequency of sampling was instituted at between 10 to 14 days.

One of the most important pieces of information derived from the preliminary survey was that the peak phosphorus concentration is associated with peak river discharge. Consequently, a manual sampling frequency approximately proportional to flow, was proposed. High flow periods could be predicted fairly well from weather forecasts. When the forecast indicated a rainy period the proportional sampling procedure was implemented. The highest frequency of sampling was approximately once every hour in order to obtain precise information of the phosphorus movement under flood conditions. During off peak periods the frequency of sampling was reduced; under sustained high flow conditions the sampling was reduced to once a day.

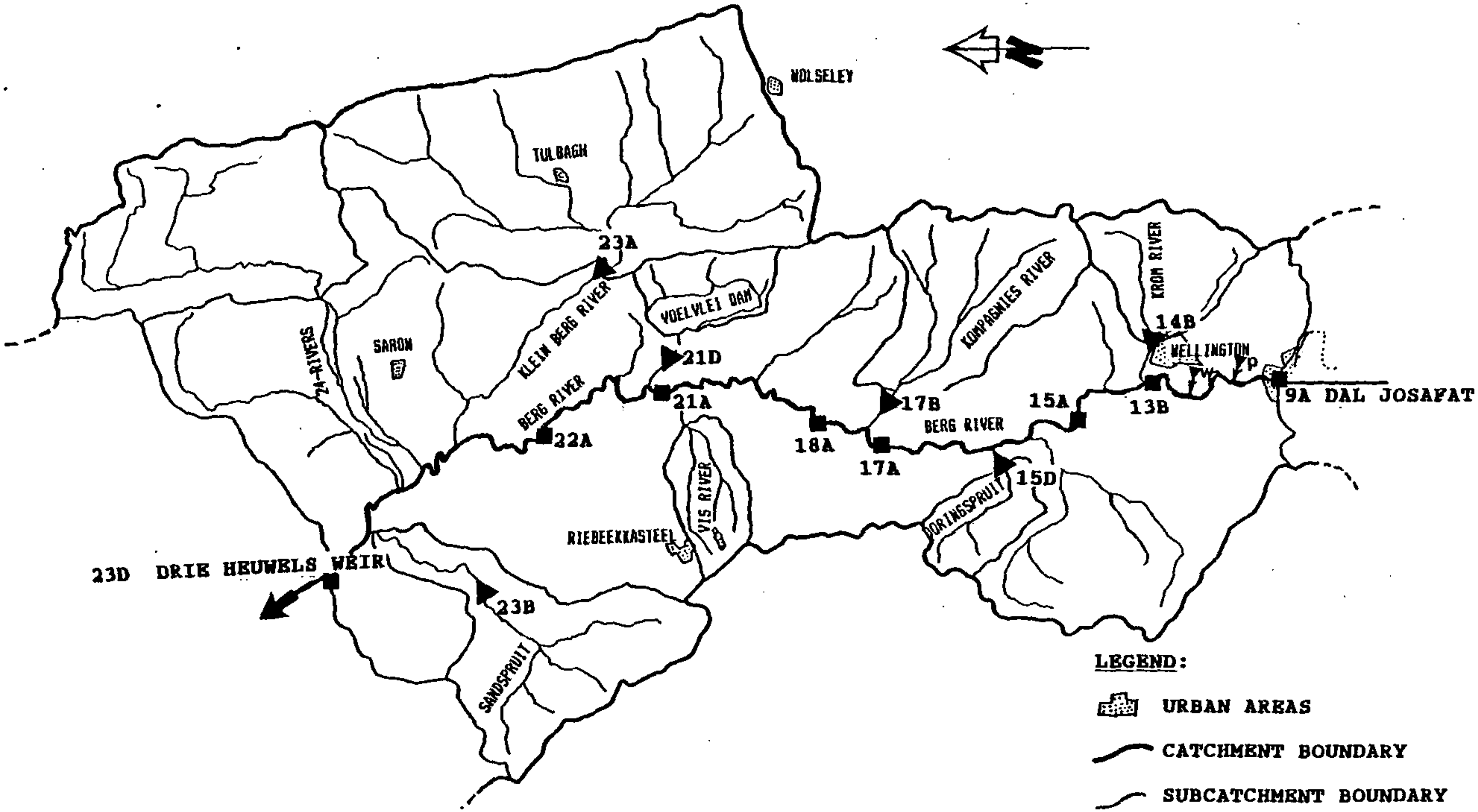

Fig 4.8. Sampling station location - main river survey. Sampling stations located on the main river channel are shown by a square, stations located on tributaries by a triangle.

At Drie Heuwels Weir (Station 230), the phosphorus chemographs associated with flood events were found to be attenuated and samples were collected every 19 hours using an automatic sampling device; the method is described in Section 3.4.

3.3 Sampling periods

The monitoring network was operated from November 1983 until October 1986, a total period of three years which was subdivided into six consecutive 180-day periods.

These periods are numbered sequentially and approximately coincide with the dry and wet seasons of the Western Cape. Further information is given on each period in Table 4.1.

Table 4.1 Description of data periods.

Period No:	Start date:	End Date:	Season:	Runoff:
1	24/11/83	22/05/84	summer	low
2	23/05/84	18/11/84	winter	high
3	19/11/84	17/05/85	summer	low
4	18/05/85	05/11/85	winter	high
5	06/11/85	04/05/86	summer	low
6	05/05/86	31/11/86	winter	high

3.4 Field methods

At each sampling station indicated in Figs 4.2 and 4.8, the following field methods were used:

(1) Two water samples were collected: one sample (one litre volume) for total suspended solids analysis and one sample (335 mℓ volume) for nutrient analysis (total phosphorus and soluble ortho-phosphate). The sample bottles were made of high density polyethylene with a high density water tight lid. The bottles were thoroughly rinsed in river water prior to collection of the sample, which was taken from a mid-depth level, at least 2 m from the river bank to avoid disturbance of river sediments. The nutrient sample was preserved with 20 mg/ℓ mercury (II) chloride, stored at approximately 10°C in an insulated container, prior to analysis. Analytical methods are described by van Vliet, Sartory, Schoonraad, Kempster and Gerber (1988).

(2) At gauging weirs, the river discharge was determined by reading the stage height and converting this reading into river discharge using the discharge rating-curve table for the specific weir. The rating curve tables were developed by the Department of Water Affairs (Directorate of Hydrology). At sampling stations along the main river channel without gauging facilities (i.e. Stations 13B, 17A, 18A, 21A, 22A) a manual flow determination method was used, based on the method developed by Robins and Crawford (1954):

- The width of the river (W) is measured using a thirty-metre measuring tape stretched across the river from bank to bank, secured at either end by metal pegs;

- the profile of the river is determined by dividing the total river width into six (j) sub-widths of length, L_i. The river depth (d_i) was measured at each sub-width using a levelling staff;

- the mean flow velocity (V_i) within each sub-width is determined using a portable Ott Flow Meter.

In Fig 4.9 a sketch of the river cross section shows the dimensions and terms described above. The total river discharge (Q_t) is calculated as the sum of the discharges for each of the sub-widths, calculated from

$$Q_t = \sum_{i=1}^{j}((d_i \quad L_i) \quad V_i) \qquad \ldots\ldots \qquad (4.1)$$

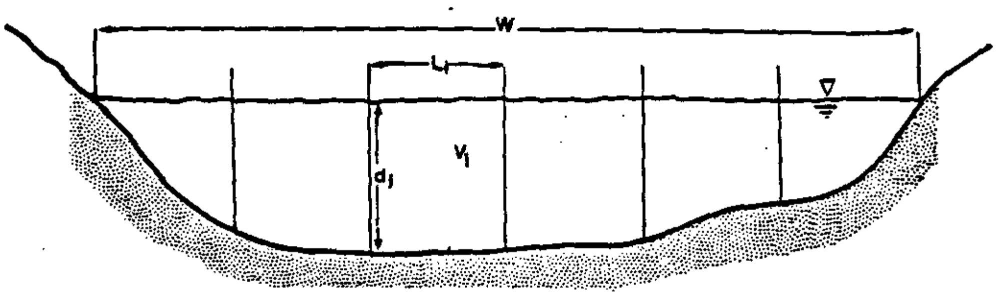

Fig 4.9 Schematic diagram of cross section of river showing terms used in Eq (4.1).

(3) During Periods 4 and 6 an automatic sampler was installed at Drie Heuwels Weir (Station 23D). This was done to obtain as accurate a description of the phosphorus chemograph as possible. This station is located at the bottom of the study area being investigated and consequently the data could serve both for calibration and verification of the proposed hydrodynamic phosphorus transport model. The data from Period 6 were used for model calibration (measured phosphorus values were obtained at most of the flood hydrographs) and the data for Period 4 used for model verification.

(4) Riverbed sediments were collected during low river flow in Period 5 and during high flow in Period 6, at Stations 9A, 13B, 18A and 21A. At each station, two 500 mℓ wide necked bottles were filled with the riverbed sediment removed from an area of approximately 150 mm by 150 mm to a depth of approximately 20 mm. One sample preserved with 20 mg/ℓ mercury (II) chloride was dispatched for total phosphorus analysis, while the other was used for granulometric analysis. To determine the median sieve size of the riverbed sediments granulometric methods were used which are reported in the standard test methods (van Vliet _et al_., 1988).

3.5 Compilation of flow data

The gauging weirs located in the Berg River are operated and maintained by the Directorate of Hydrology, Department of Water Affairs, at Sandhills near Worcester. The recorded data for the gauging weirs shown on Fig 4.1, for the survey period (November 1983 - October 1986) were processed as follows:

(1) The hydrograph recorded at the weir is in analog format (of stage readings) and digitized at 12-hourly intervals at: 12h00 (noon) and 00h00 (midnight).

(2) The stage values for each time interval are converted to the discharge value using the stage/discharge table for the specific gauging weir.

(3) The data are saved on floppy disk (using the program DISKIO, see Appendix 2).

Due to the consistent maintenance and inspection of the gauging weirs in the Berg River catchment by the Department of Water Affairs a complete record of flow was available for the upstream station at Paarl (Station 9A). At other gauging weirs malfunctioning of the recorder equipment occurred very infrequently. To patch the missing flow data records, linear interpolation was used to generate the flow values over the period of missing data. Fortunately, the gauging chart sheets were changed once a week so that loss of data would extend a maximum of seven days. Over the sampling period of three years flow data were patched for 5 weirs, on 11 occasions.

4 SUMMARY

(1) The iterative approach to monitoring network design allowed evolution of an efficient scheme for collecting water quality data. In particular, development of a variable interval sampling frequency was of crucial importance in obtaining optimal information from the monitoring effort - fixed-interval sampling frequency would have given greatly reduced information for the same effort.

(2) Application of flow-proportional sampling frequency provided detailed information on the temporal variation exhibited in the phosphorus concentration of lateral inflows and along the main river channel. This had particular importance during flood events and periods of high flow when abrupt spatial and temporal gradients in the phosphorus concentration were observed.

(3) Use of an automatic sampler at Drie Heuwels Weir, during Periods 4 and 6, provided a water quality data set containing phosphorus measurements taken every 19 hours. These data were important in defining the downstream boundary conditions accurately, for subsequent use in model calibration.

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CHAPTER 5

DATA PRESENTATION AND ANALYSIS

The objective of this chapter is to: (1) present water quality and river flow data collected during the preliminary and main river surveys; (2) process the data to show the temporal and spatial variation in quality and flow; and (3) examine the interdependence between variables.

To simplify analysis, the data set will be divided into two groups: (1) data associated with sampling stations located on the main river channel; and (2) data associated with the lateral inflows to the main river channel.

1 ANALYSIS OF FLOW DATA

1.1 Main river channel

Within the study area, the main river channel is gauged at North Paarl (Station 9A) and Drie Heuwels Weir (Station 23D). In Fig 5.1 the hydrographs for the gauging weir at North Paarl (Station 9A) are shown for Periods 1 to 6. During low flow (summer periods) the river discharge ranges from between 0.2 to 2 cumecs; during high flow (winter periods) the discharge may exceed 200 cumecs. After a single flood event the recession limb of the hydrograph may extend for a period of up to 70 days before the base flow condition is re-established. During successive flood events, the frequency of storm events may prevent the river discharge from returning to a baseflow condition. This is illustrated in Fig 5.2, during the winter flow Period 6 (of 180-days) there were 10 storm events over a

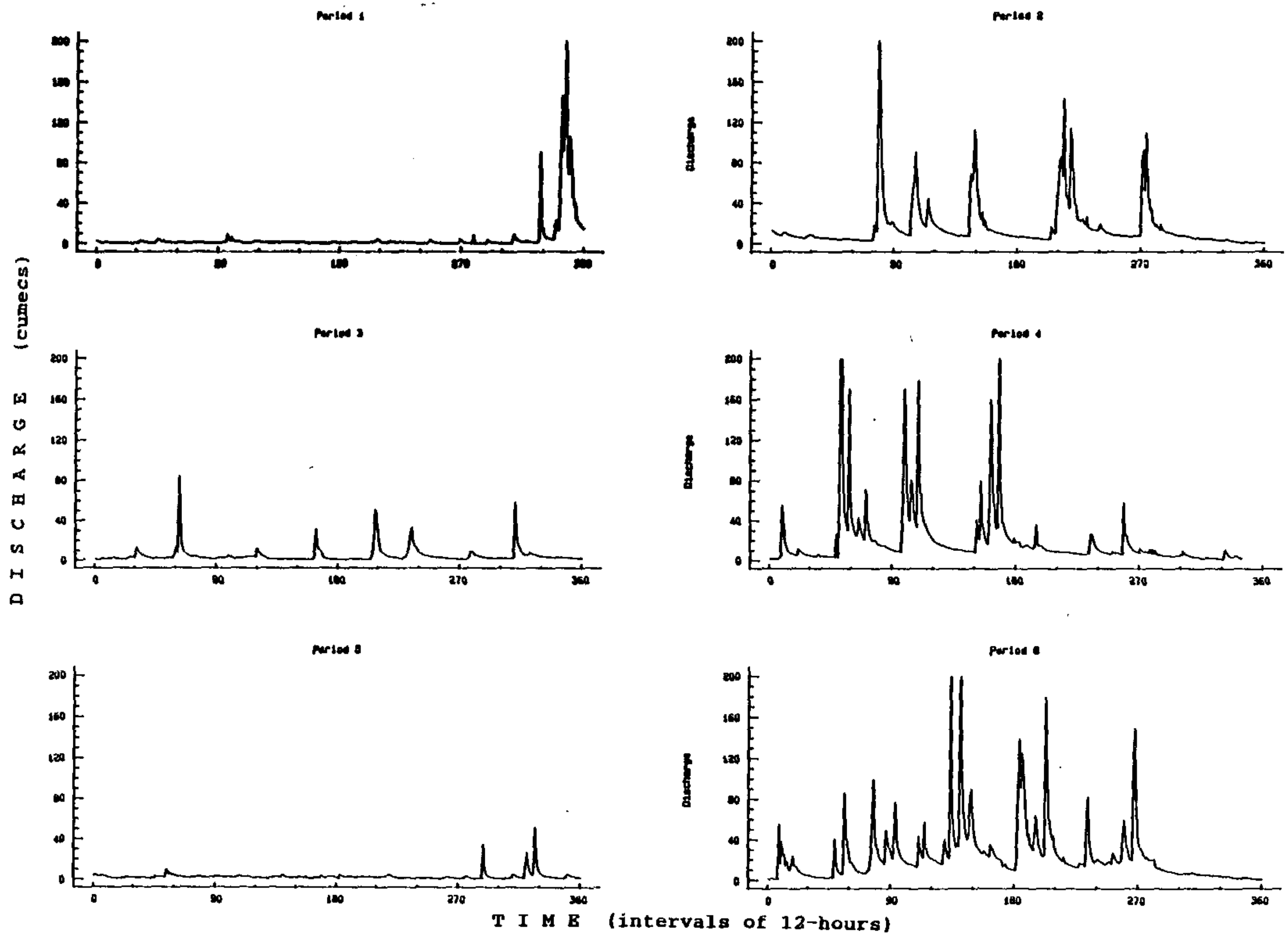


Fig 5.1. Hydrographs for Station 9A at North Paarl, Periods 1 to 6.

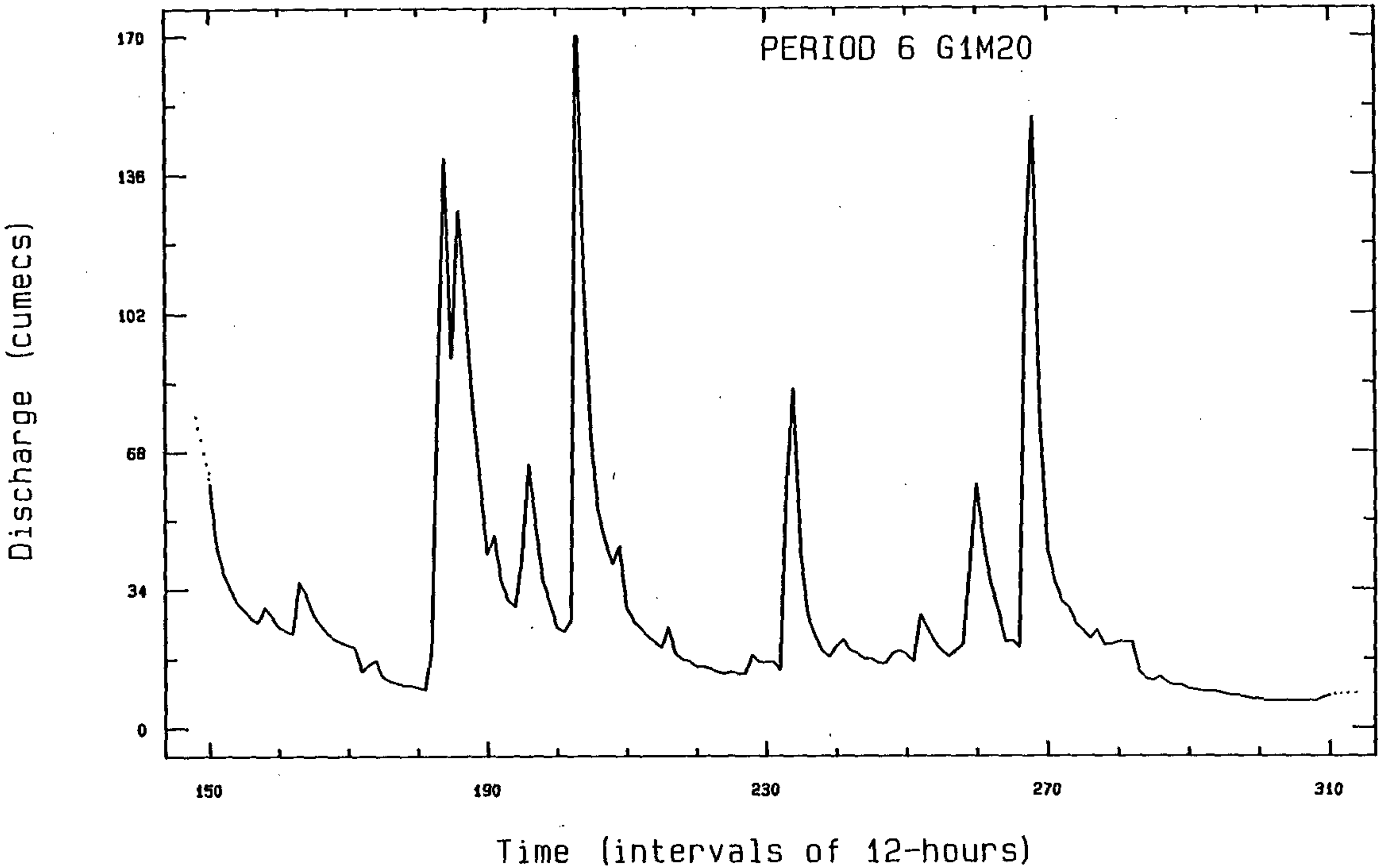


Fig 5.2. **Section of the hydrograph measured at Station 9A (Period 6) showing a number of flood hydrographs and associated recession curves.**

period of 100 days, in which time the recession limbs of the hydrograph were truncated, lasting only a few days before the next storm.

At Paarl during the summer, Periods 1, 3 and 5, (each a period of 180 days) the total runoff ranged from 2.0 to 17.2 million cubic metres. During the winter, Periods 2, 4 and 6, the total runoff per 180-days ranged between 34.7 and 57.8 million cubic metres.

At Drie Heuwels Weir, 90 km downstream of Paarl, the flood hydrographs have characteristics similar to the upstream hydrographs, except that at Drie Heuwels the peaks are higher, there is a time shift of peaks with respect to the peaks at Paarl and the peaks are more attenuated (Fig 5.3).

To calculate the total river discharge for each Period, the hydrographs for Station 9A and 23D during Periods 1 to 6 were integrated and the total discharge volumes per period are shown in Fig 5.4. During Periods 3 and 5 (low flow conditions) the total runoff at Paarl and at Drie Heuwels Weir are approximately equal, provisionally indicating that lateral inflows and abstraction and infiltration between Paarl and Drie Heuwels Weir tended to compensate each other. However, during Periods 2, 4 and 6 (high flow conditions) the differences in the total runoff between these two stations are pronounced, brought about by the substantial inflow from lateral sources over the 90 km reach.

All the gauged tributaries discharging between Station 9A and 23D were added to the discharge at Station 9A to give a calculated estimate of the discharge at 23D, for each period. In Fig 5.5 the calculated and measured discharges at Drie Heuwels Weir are shown. During the high flow periods, the calculated discharges are significantly less than the measured flow for reason of the substantial inflow from ungauged areas.

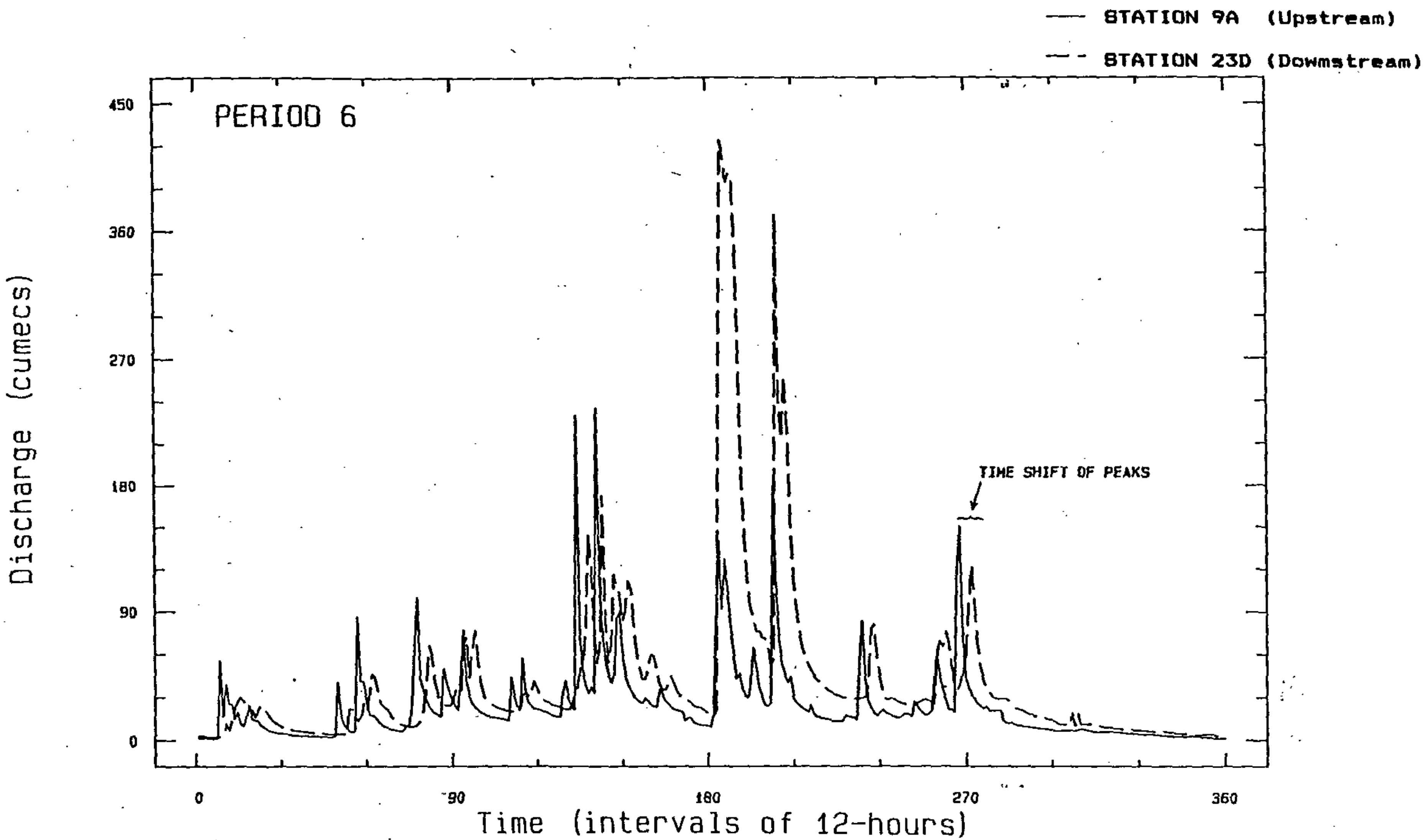


Fig 5.3. **Hydrograph for Station 9A (upstream) and 23D (downstream) showing flood wave attenuation and the time shift of peak flows - Period 6.**

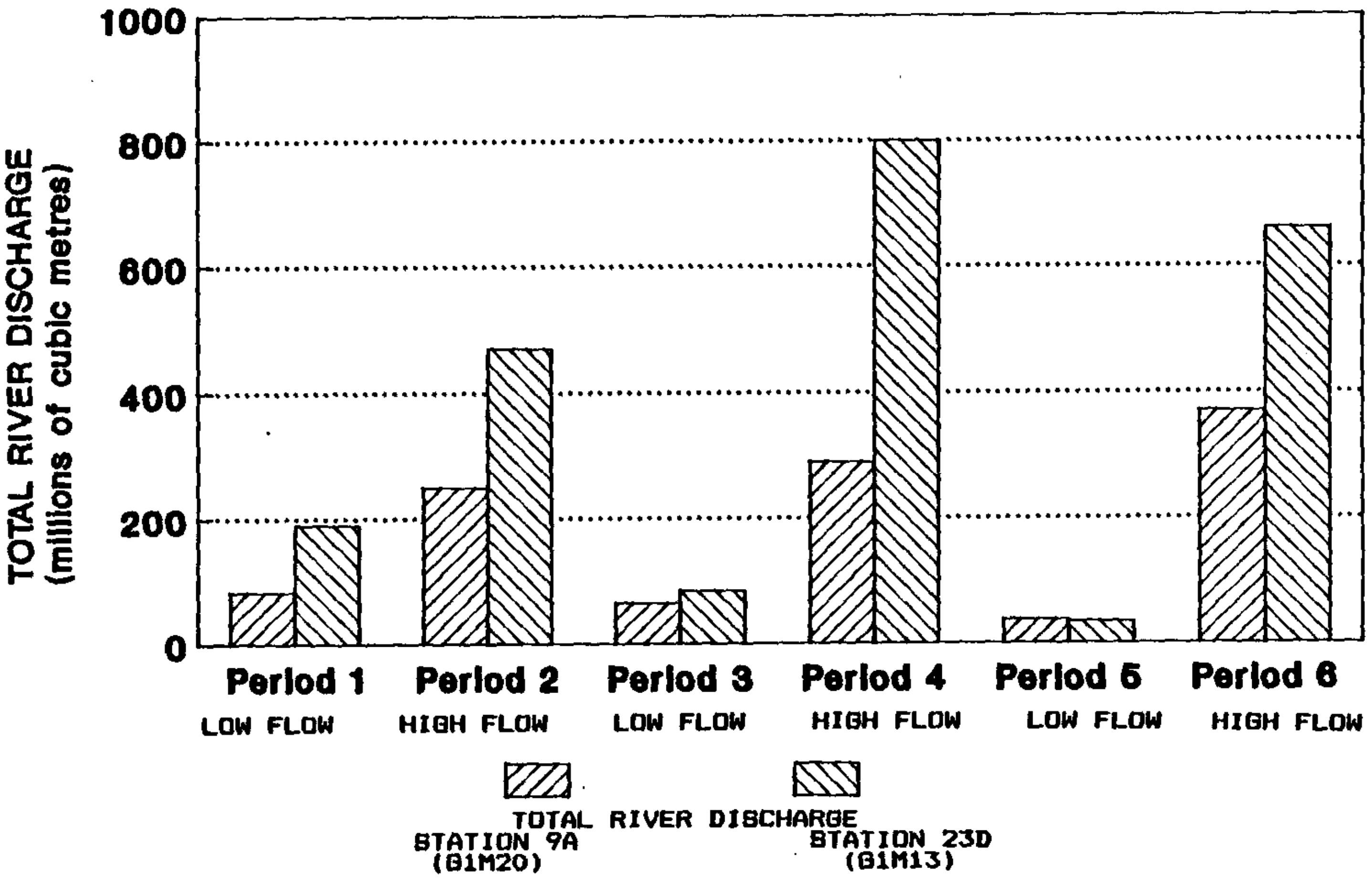


Fig 5.4. Total measured discharge for Stations 9A and 23D for Periods 1 to 6.

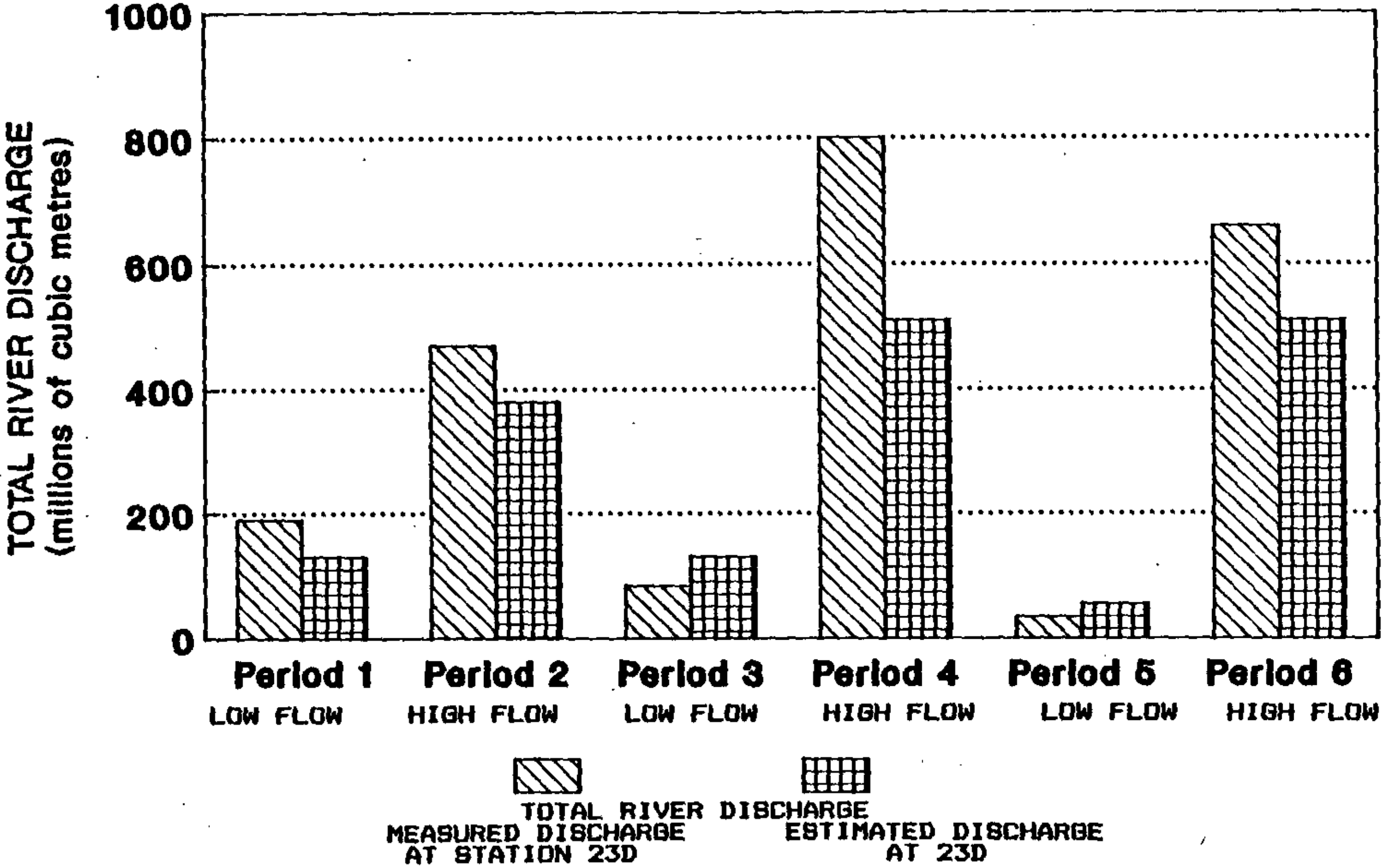


Fig 5.5. Measured and estimated discharge at Station 23D (Drie Heuwels Weir). The estimated discharge is the sum of all gauged lateral inflows between the upstream hydrograph (Station 9A) and Drie Heuwels Weir plus the discharge at Station 9A.

During the low flow period, the calculated discharge tends to be more than the measured; the most likely reasons are abstraction by riparian users along the river channel, and seepage losses from the river channel to the ground water (effects which are not accounted for in the calculated flow).

1.2 Point sources

Hydrographs of the effluent discharges from the wastewater treatment works at Paarl and Wellington are shown in Fig 5.6 for Period 6. Influx of stormwater to the sewerage system gives rise to a pattern of rising and falling discharge at the beginning and towards the end of the wet period, falling to as low as 50 percent of the peak discharges. Also during the summer months a small proportion of the effluent from the Wellington works is used to irrigate the local golf course resulting, on occasion, in an effluent discharge of as low as 0.01 cumec.

1.3 Tributaries

The mean annual runoff from gauged tributaries to the main river channel between Paarl and Drie Heuwels Weir are shown volumetrically (millions of cubic metres per year) in Fig 5.7, and as yield (mm of runoff per year) in Fig 5.8. Tributaries on the west bank of the main river channel have a relatively low yield compared with tributaries on the east bank which arises from differences in the rainfall and runoff characteristics of the two groups of subcatchments. This is illustrated by the discharge hydrographs from two drainage areas (the Kompagnies River and Sandspruit), of approximately the same size, located respectively in the east and west of the drainage basin, see

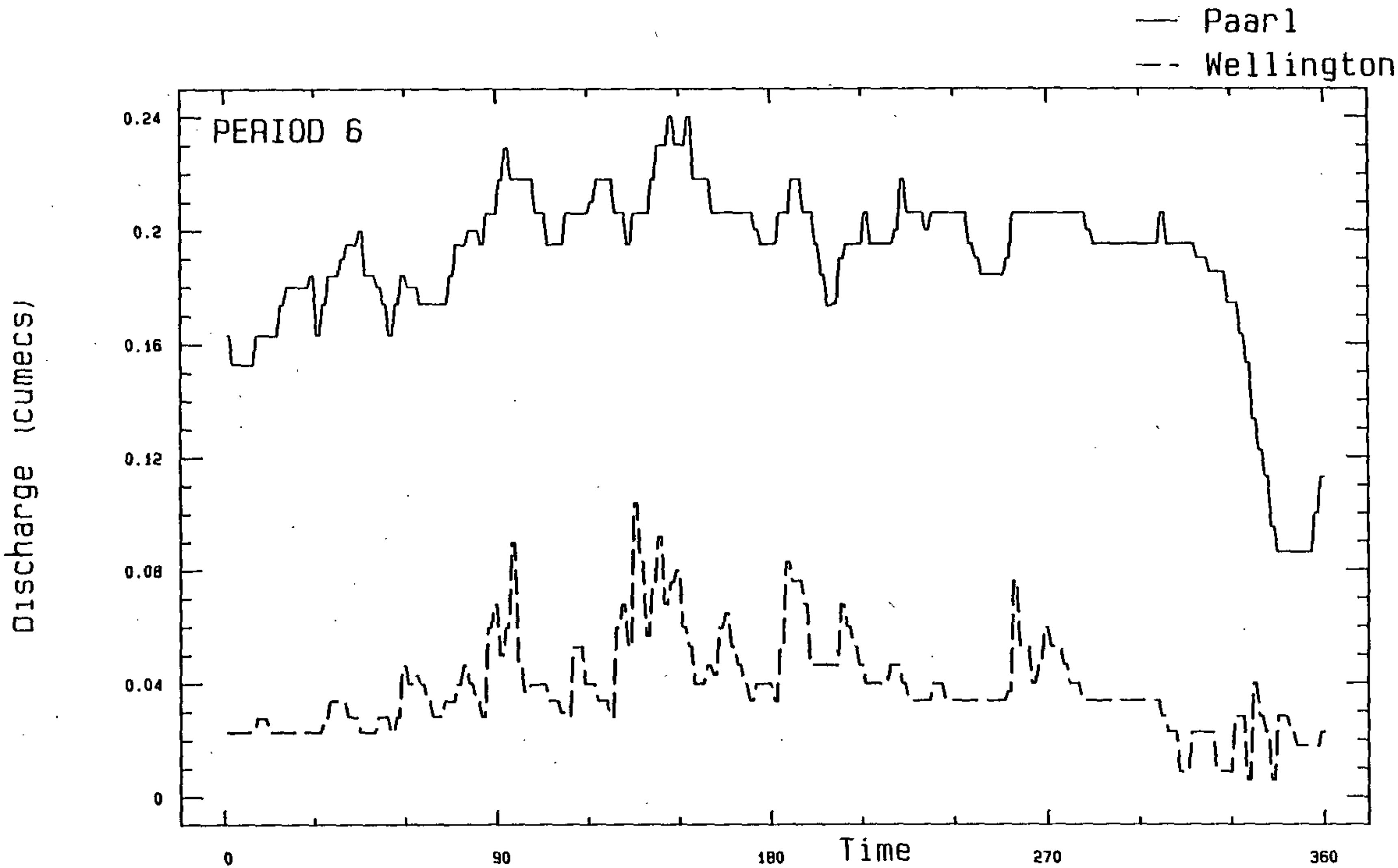


Fig 5.6. **Hydrographs for Paarl and Wellington treated effluent discharge to the main river channel of the Berg River - Period 6 (High flow period).**

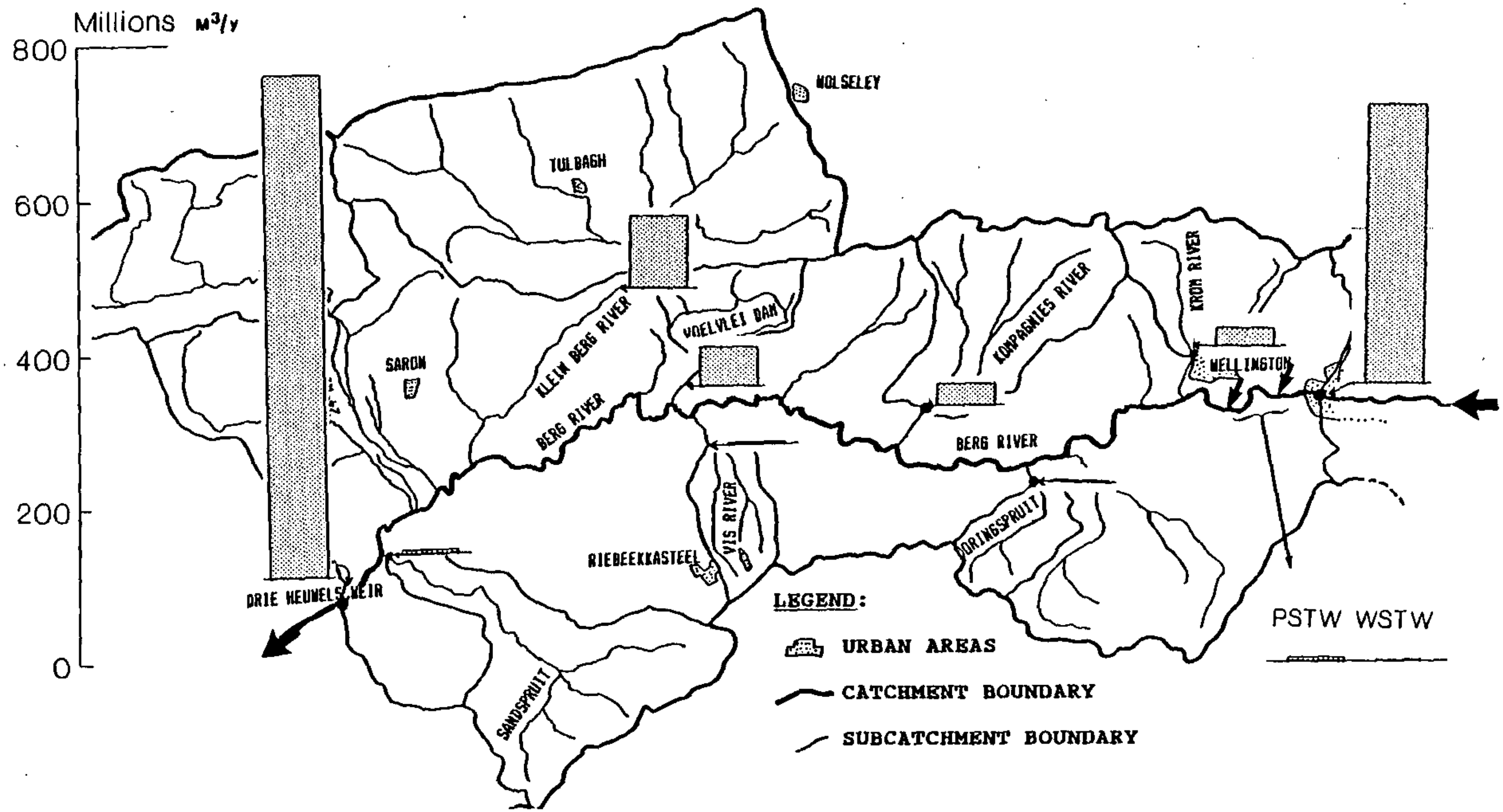


Fig 5.7. Mean annual runoff for gauged tributaries - runoff expressed in million cubic metres per year (from Forster and van der Berg, 1985). Paarl and Wellington wastewater discharges are shown in the inset, denoted by PSTW and WSTW respectively.

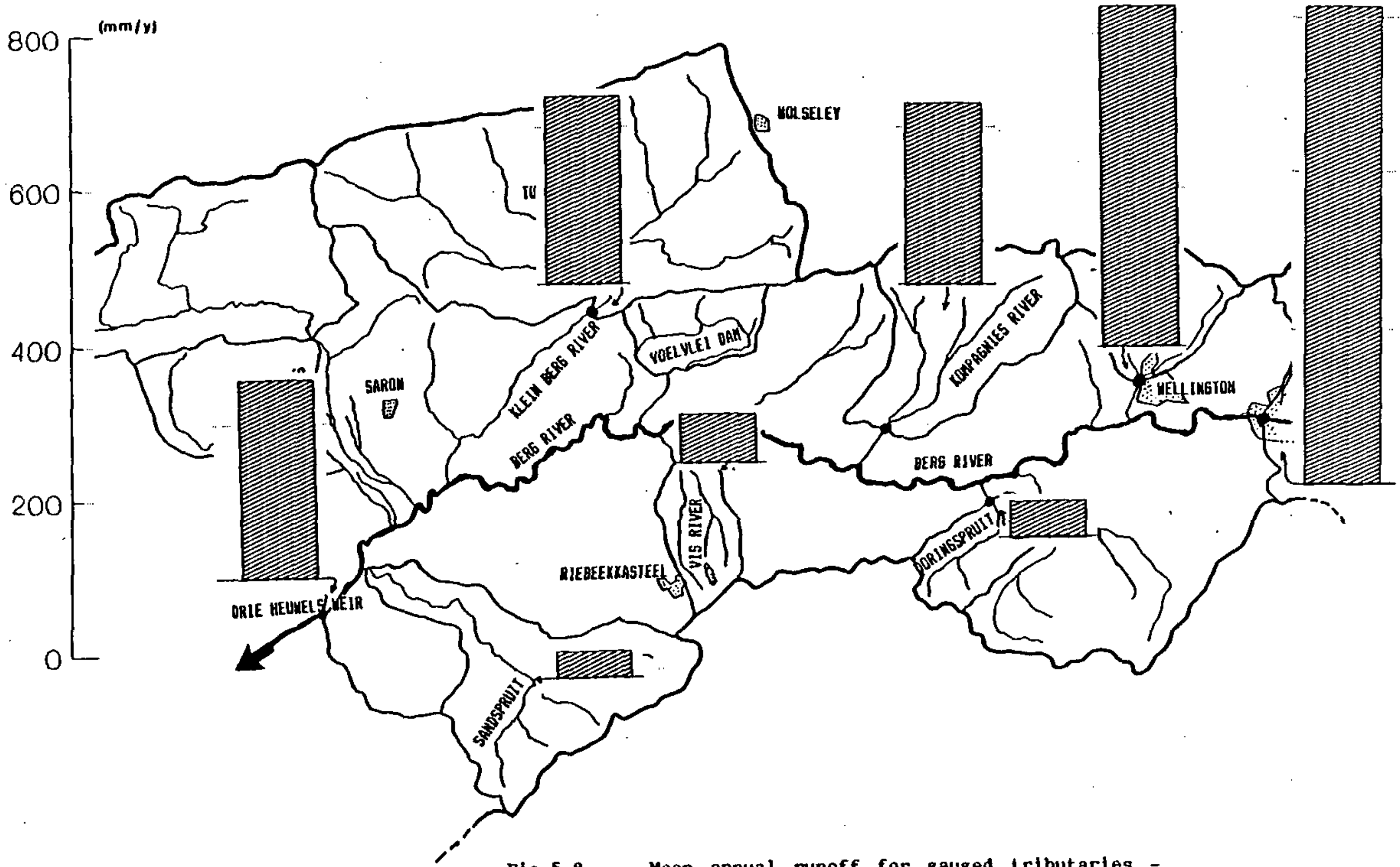


Fig 5.8. Mean annual runoff for gauged tributaries - runoff expressed in mm/y (from Forster and van der Berg, 1985).

Fig 5.9. The Kompagnies River is located in mid-catchment on the east bank of the main river channel and has a total surface area of 120.9 km^2 (see Fig 5.7). The Sandspruit is located in the lower section of the catchment on the west bank of the main river channel and has a total area of 150.3 km^2. Both subcatchments have dryland farming, but the Kompagnies also has a small percentage of the drainage area under irrigation.

Comparison of the hydrographs shows that these tributaries not only have different yields (mm per year) but also have different runoff responses. During winter high flow period the Sandspruit shows a rapid hydrograph response with a peak discharge of 9 cumecs and a recession hydrograph limb lasting for a maximum of 6 days; baseflow during the dry spells ranges from 0 to 0.02 cumec. In contrast, the Kompagnies River has a peak discharge in excess of 25 cumecs and hydrograph recession curve lasting up to 15 days; baseflow ranges around 0.05 cumec (Fig 5.9). Other tributaries in the Berg River basin have hydrograph responses similar to the ones presented above but with some variation in runoff response caused by differences in the geology, land use, soil type, topography, climate and size of the subcatchments.

To supply irrigation water during the dry summer periods, compensation water is released from Voëlvlei Dam into the Berg River. Summer releases range from 0.2 to 1.0 cumecs. During the wet winter period water is released from Voëlvlei Dam to maintain the water level in the impoundment at an acceptable operational level. Typical hydrographs for summer and winter periods are shown in Fig 5.10.

Based on the information given above, the flow regime of the river channel between Paarl and Drie Heuwels Weir is governed by:

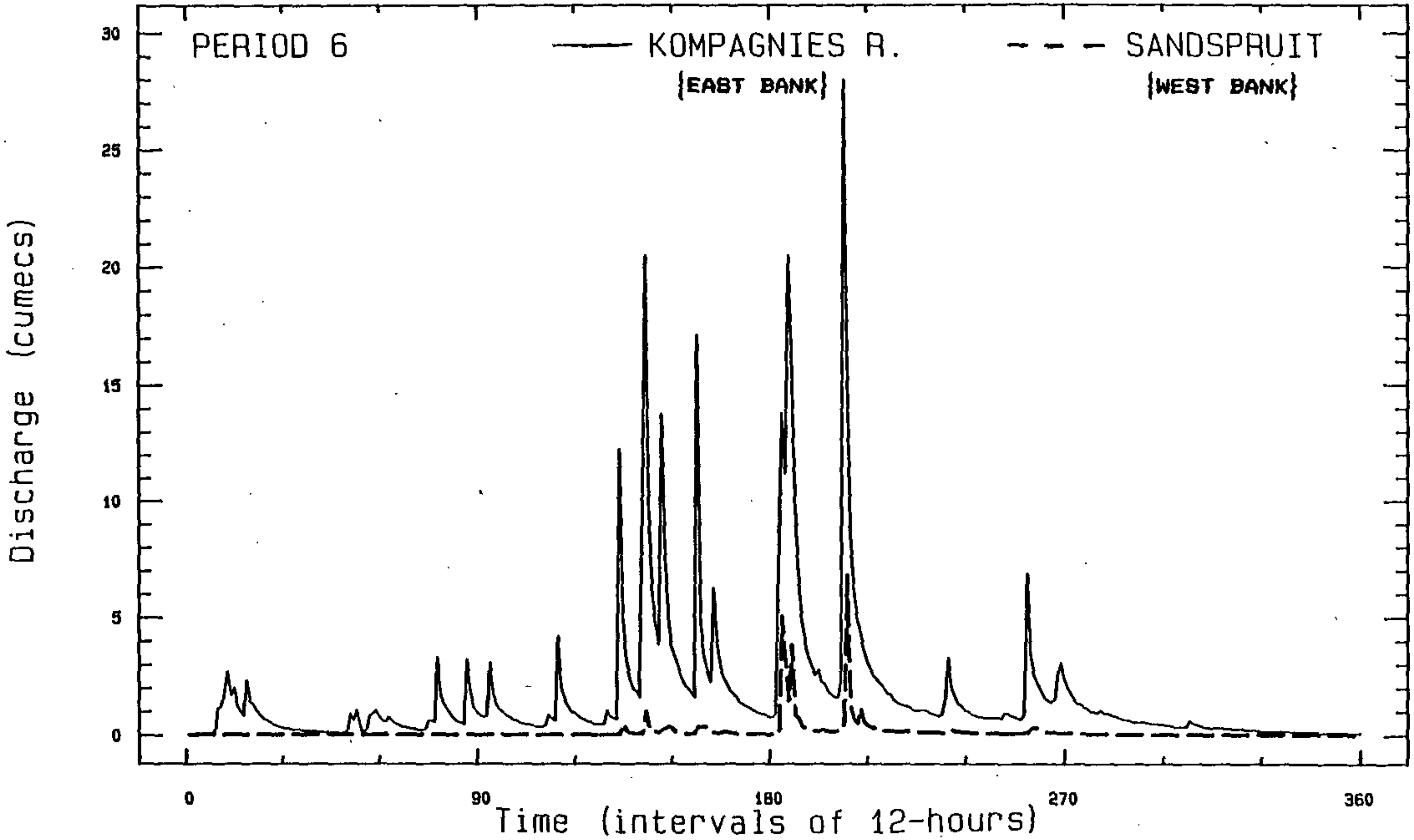


Fig 5.9. **Winter hydrographs for the Kompagnies River (Station 17B) and Sandspruit (Station 23B) for Period 6.**

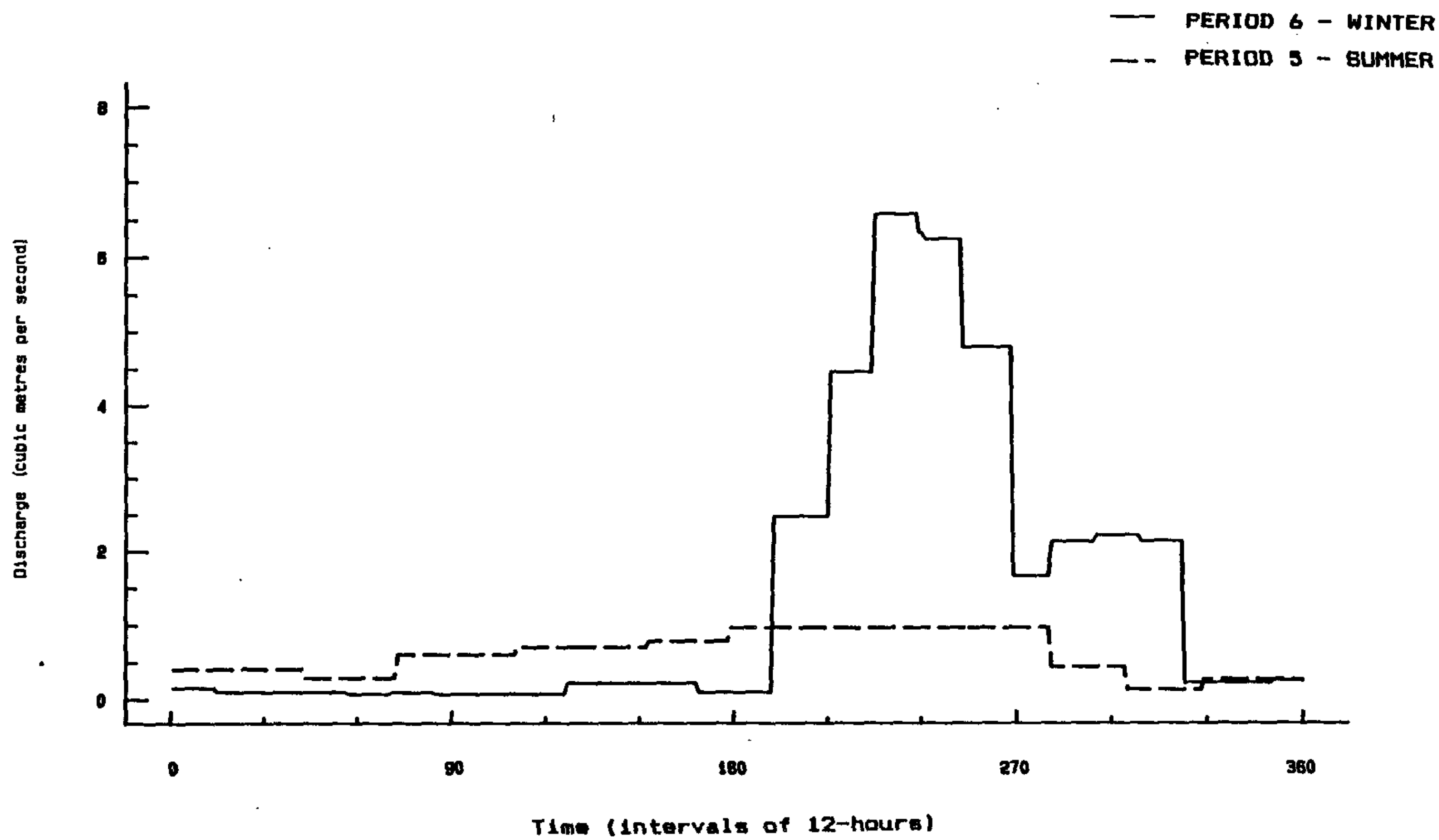


Fig 5.10. Summer and winter hydrographs for the outlet canal from Voëlvlei Dam - Period 5 (summer) and Period 6 (winter).

(1) The upstream hydrograph at Paarl.

(2) The gauged flow inputs for point sources (municipal discharges and Voëlvlei Dam) and tributaries.

(3) The ungauged flow inputs from tributaries and direct surface runoff.

(4) In-channel losses.

(5) Riparian abstraction.

The summation of these runoff components gives rise to steady flow conditions during the summer dry period and rapid temporal and spatial variations during the winter rainy season.

2 ANALYSIS OF PHOSPHORUS DATA

The phosphorus concentration data collected during the sampling program are presented under two headings; the phosphorus regime in the main river channel and the phosphorus regime of the lateral inputs comprising point sources (municipal and Voëlvlei Dam) and nonpoint sources (tributaries and direct runoff).

2.1 Main river channel

In Fig 5.11 the phosphorus concentration data and associated hydrograph are shown for the gauging station at North Paarl (Station 9A), for Period 6. During low river flows (when the flow is less than 10 cumecs) the phosphorus concentration ranges from 10 to 35 µg/ℓ, during high flows

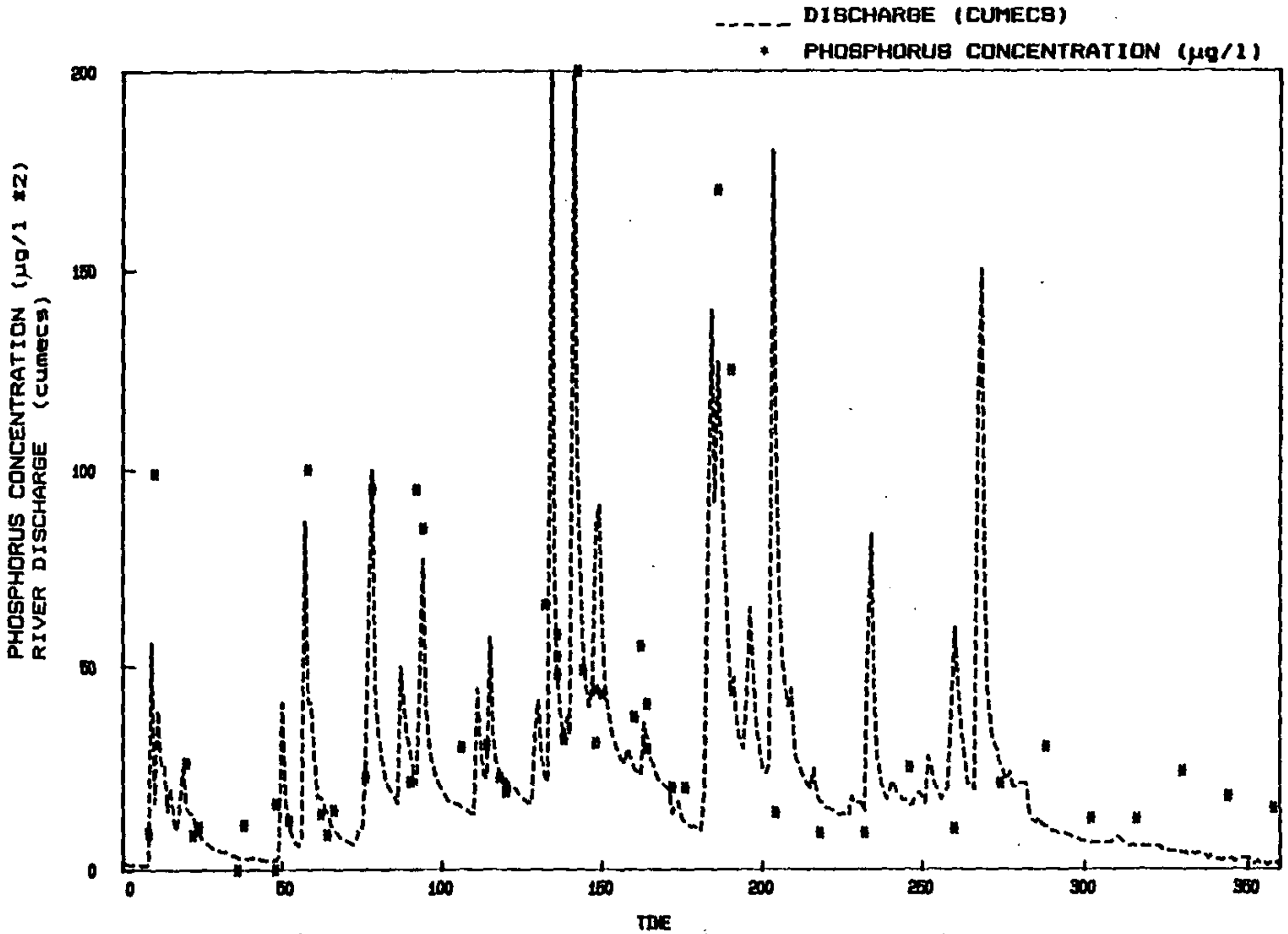


Fig 5.11. Phosphorus concentration data and associated hydrograph for Station 9A at North Paarl - Period 6 (winter).

peaks of up to 700 μg/ℓ can be measured. The data in Fig 5.11 do not give a clear picture of the inter-relationships between the hydrograph and chemograph response during a flood event. To obtain this data two flood events were monitored with the resultant hydrograph and chemograph shown in Fig 5.12. During the rising limb of a hydrograph the phosphorus concentration increases dramatically. However, after peak flow there is a rapid reduction in the phosphorus concentration. In Fig 5.13 the phosphorus concentration data are plotted as a function of the river discharge (measured at the time of sampling). As the river discharge increases so does the phosphorus concentration, but the relationship is associated with a large amount of scattering of the data points. By plotting the phosphorus concentration data for the rising and falling limbs of the flood hydrograph it is apparent that during the rising limb of the flood hydrograph the phosphorus concentration is very much higher compared with the same discharge on the falling limb (see Fig 5.13) - a hysteresis or looped effect appears to be associated with the phosphorus transport from nonpoint sources. This phenomenon was also observed by Cahill et al. (1974), Johnson et al. (1976) and Zingales et al. (1984).

The measured phosphorus data collected at Paarl (Station 9A) immediately upstream of the wastewater discharges and at Lady Loch Bridge 7 km downstream (Station 13B) are shown in Fig 5.14. Comparing the individual phosphorus concentrations at Paarl with the values measured at Lady Loch Bridge (Fig 5.14) it is apparent that the effluent discharges cause an increase in the phosphorus concentration. During low flow conditions the phosphorus concentration at Lady Loch Bridge may be increased by a factor of up to 7 times the phosphorus concentration measured at Paarl. During high flow conditions (with discharges exceeding 12 cumecs) the phosphorus concentration is only

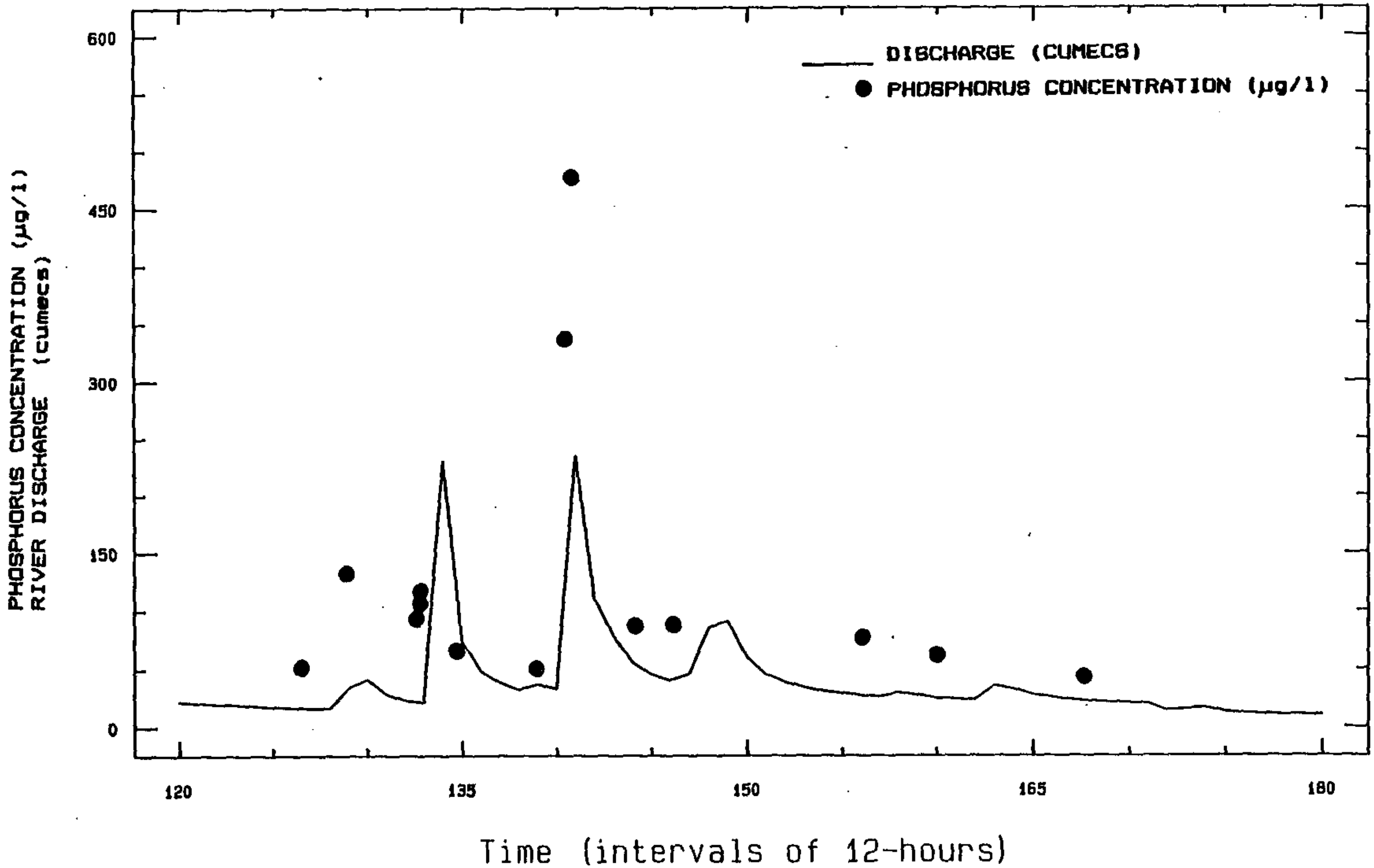


Fig 5.12. **Phosphorus concentration data and associated hydrograph for two flood events at Station 9A during Period 6 (winter period).**

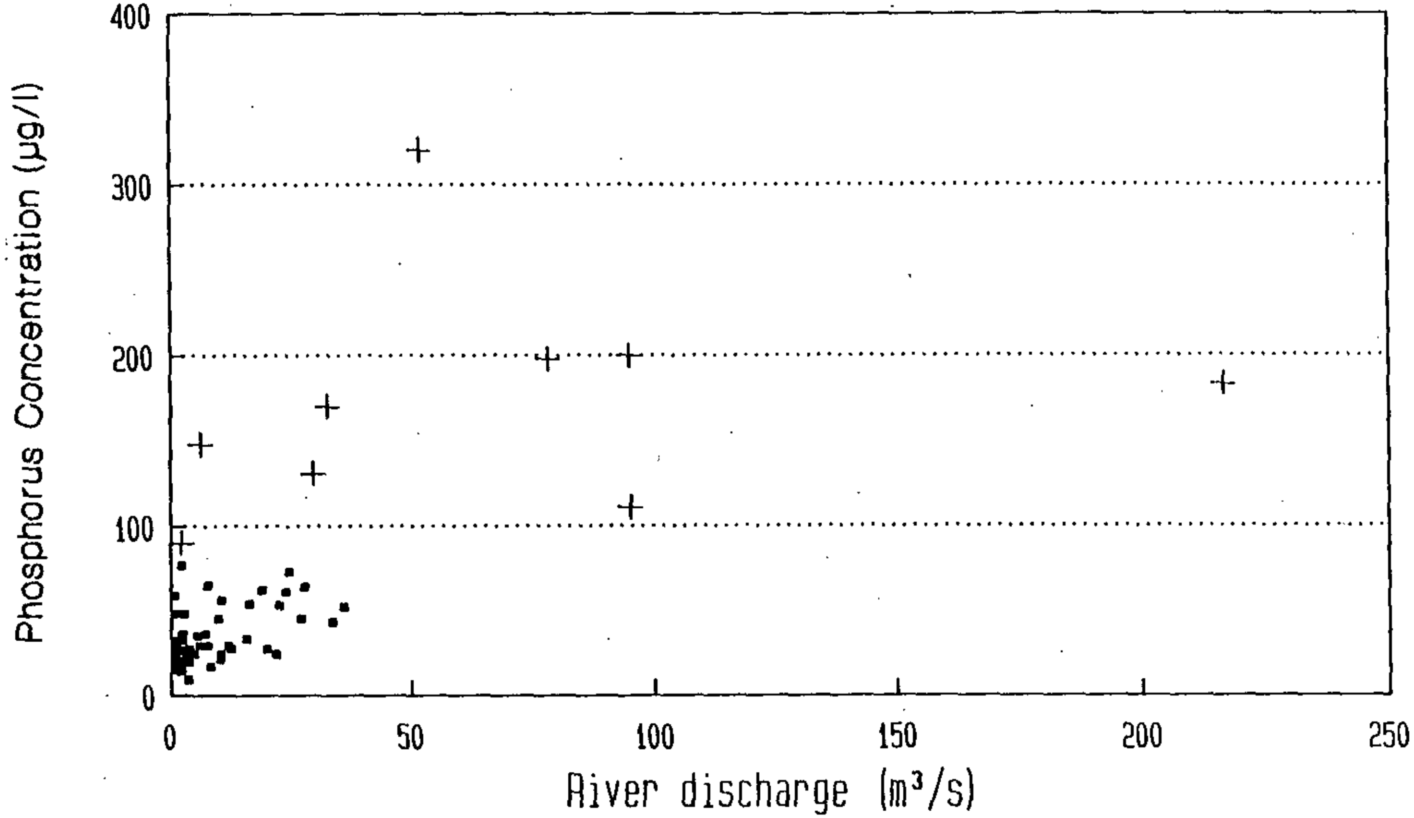


Fig 5.13. Phosphorus concentration measurements plotted versus discharge for Station 9A. Data on the rising limb of the flood hydrograph are shown by a cross and data on the falling limb by a square.

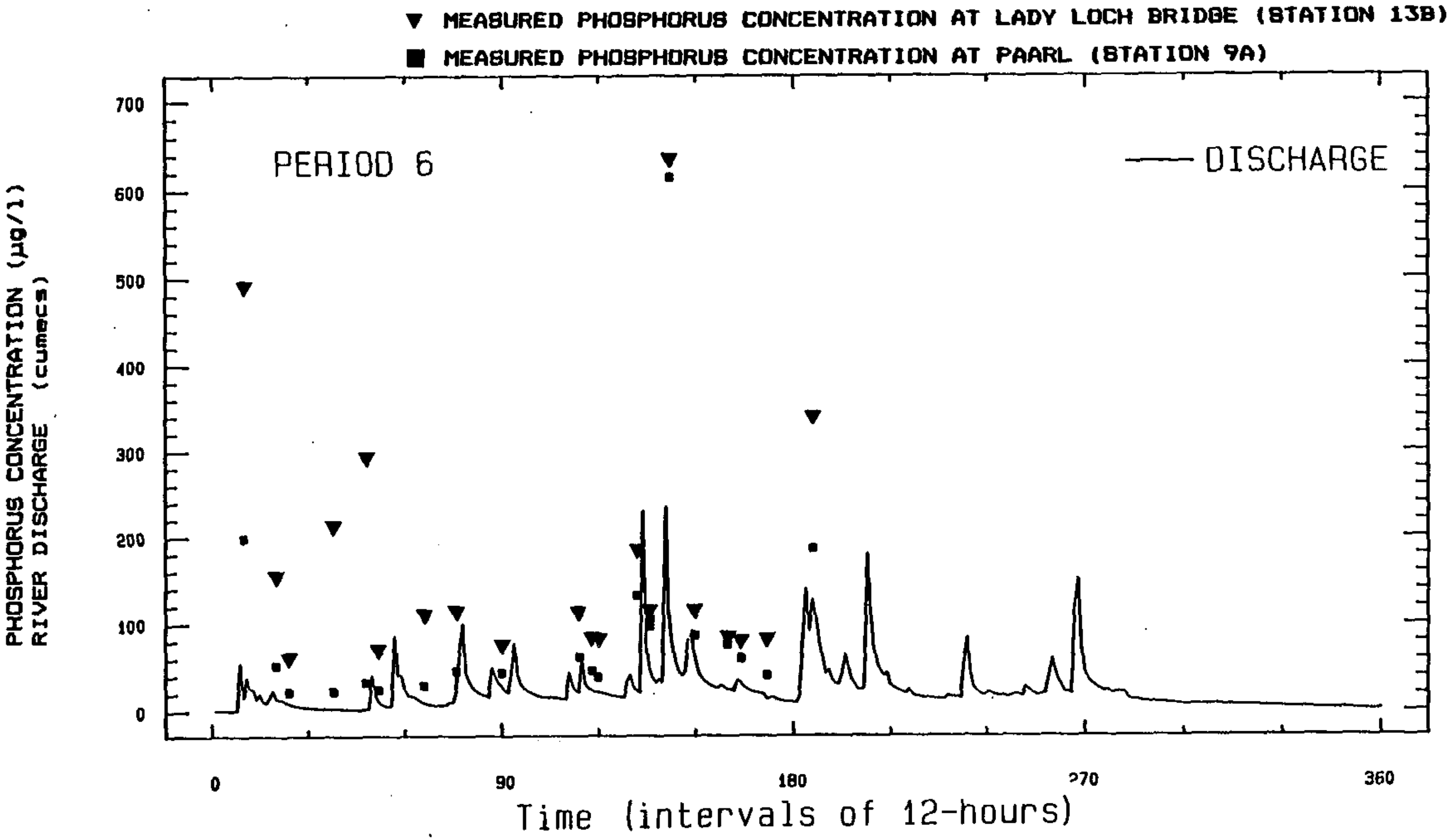


Fig 5.14. Phosphorus concentration data for Station 9A (North Paarl) and 13B (Lady Loch Bridge) during Period 6 (winter). Data for Station 9A are shown by a square and data for 13B are shown by a triangle. The associated discharge hydrograph is also shown.

marginally increased at Lady Loch Bridge, by a factor of about 1.5 times. Consequently, the phosphorus concentrations at Lady Loch Bridge are directly influenced by the magnitude of the river flow and the wastewater discharges from Paarl and Wellington treatment works. However, the situation is not straightforward: forming a mass balance on the phosphorus between Paarl and Lady Loch Bridge, during low flow up to 70 percent of the phosphorus discharged from the treatment works at Paarl and Wellington did not reach Lady Loch Bridge. Also, the rate of disappearance of phosphorus appears to be higher between Paarl and Wellington than that downstream of Lady Loch Bridge (see Fig 5.15).

Between Lady Loch Bridge (Station 13B) and Drie Heuwels Weir (Station 23D) the phosphorus concentration profile is markedly affected by the flow conditions, for example:

(1) During low flow conditions there is a marked reduction in the phosphorus concentration along the main river channel (Fig 5.16).

(2) During steady high flow conditions the phosphorus concentration is steady throughout the length of the main river channel as far as Drie Heuwels Weir (Fig 5.17).

(3) During flood events at any specific time, there are abrupt changes in phosphorus concentration along the river channel (Fig 5.18). These are due to lateral inflows and the transient state in phosphorus concentration during the rising and falling limb of the flood hydrograph. Consequently, the phosphorus profile at any specific time will change significantly with the passage of time.

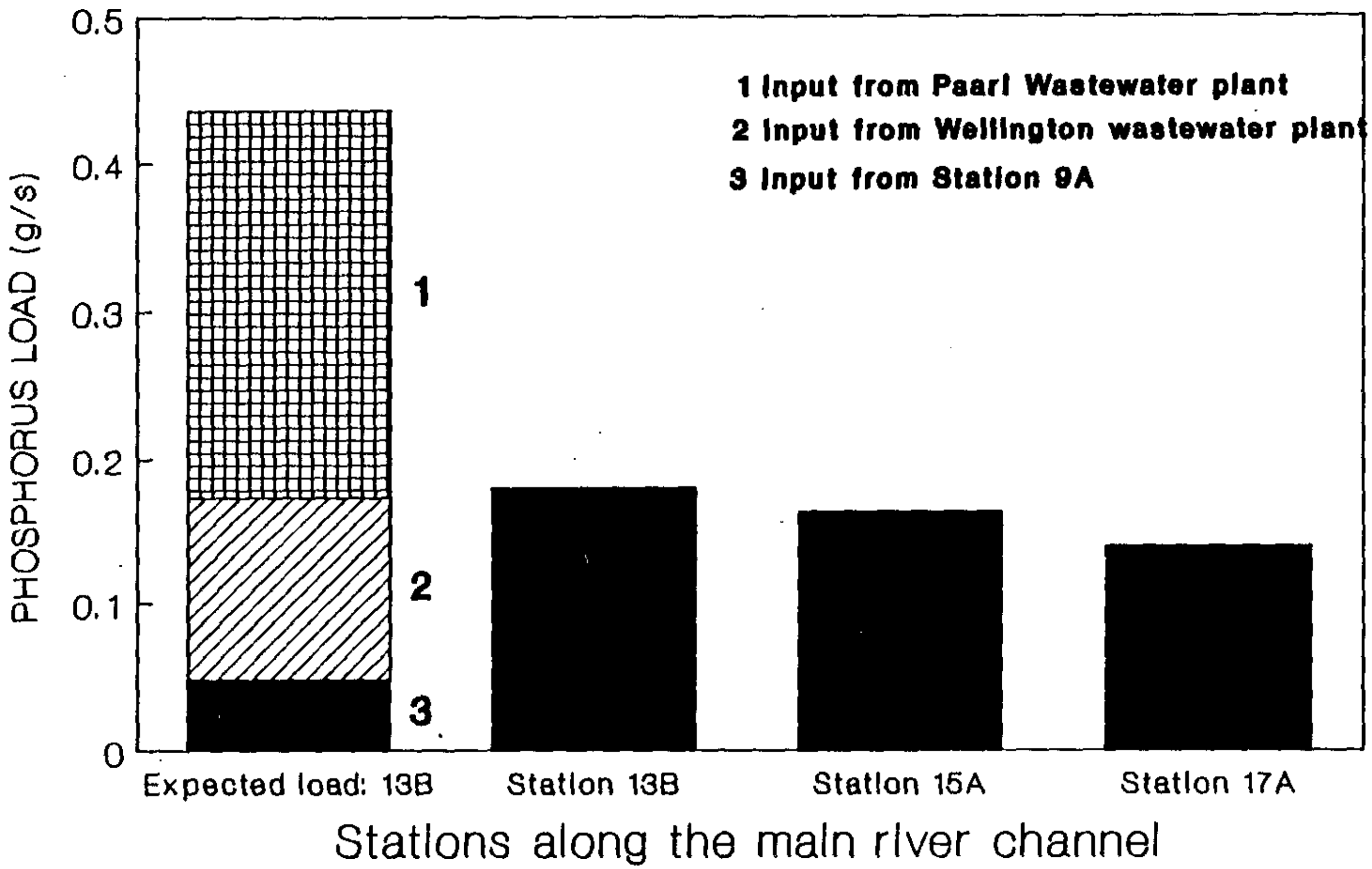


Fig 5.15. Phosphorus load calculations for Station 9A, 13B, 15A and 17A as well as the input loads from Paarl and Wellington wastewater treatment works. Samples collected on 27/2/1986 during low flow conditions.

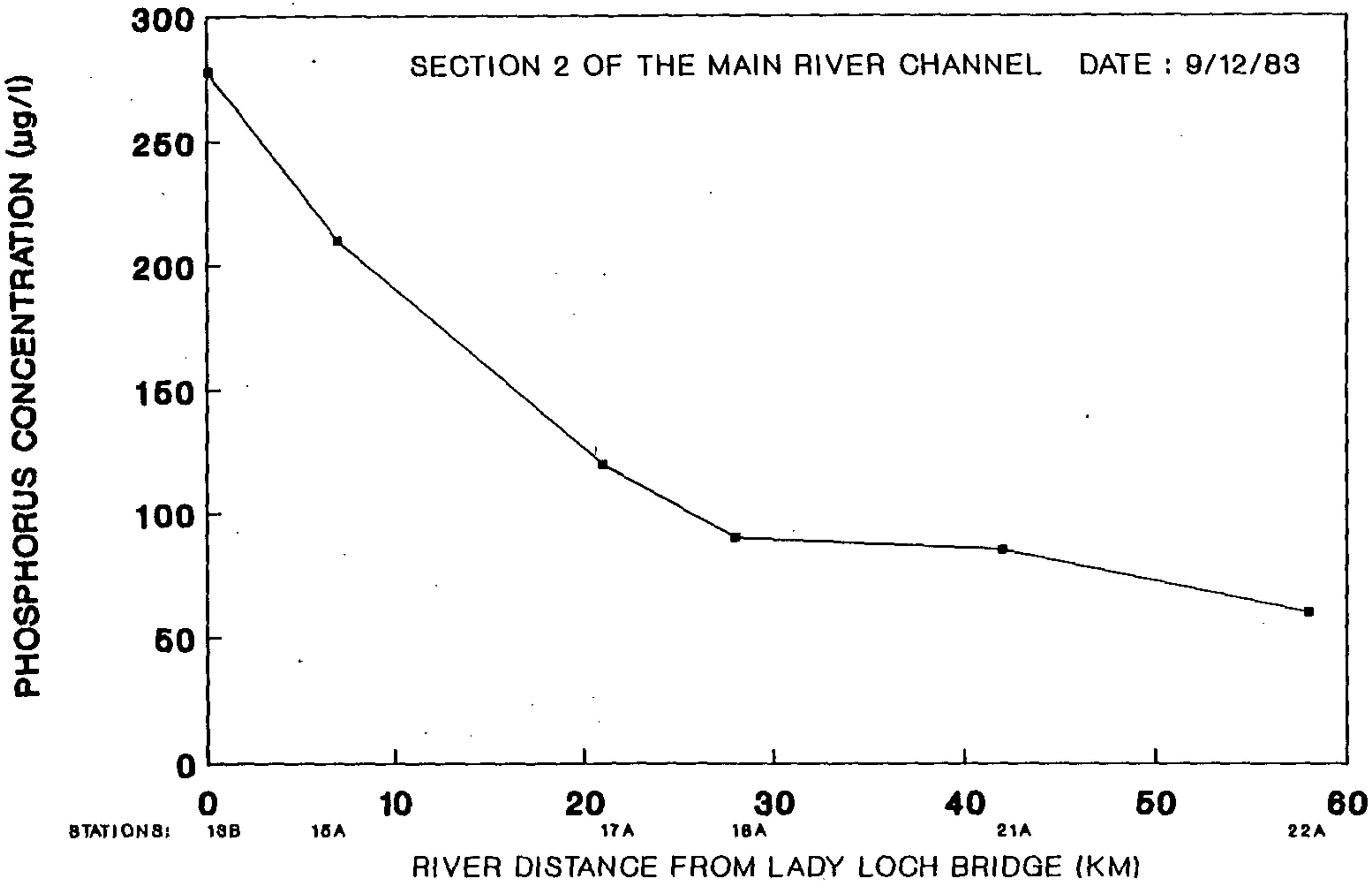


Fig 5.16. Phosphorus concentration profile for stations located on the main river channel between Lady Loch Bridge and Drie Heuwels Weir during low flow conditions. Samples collected on 9/12/1983.

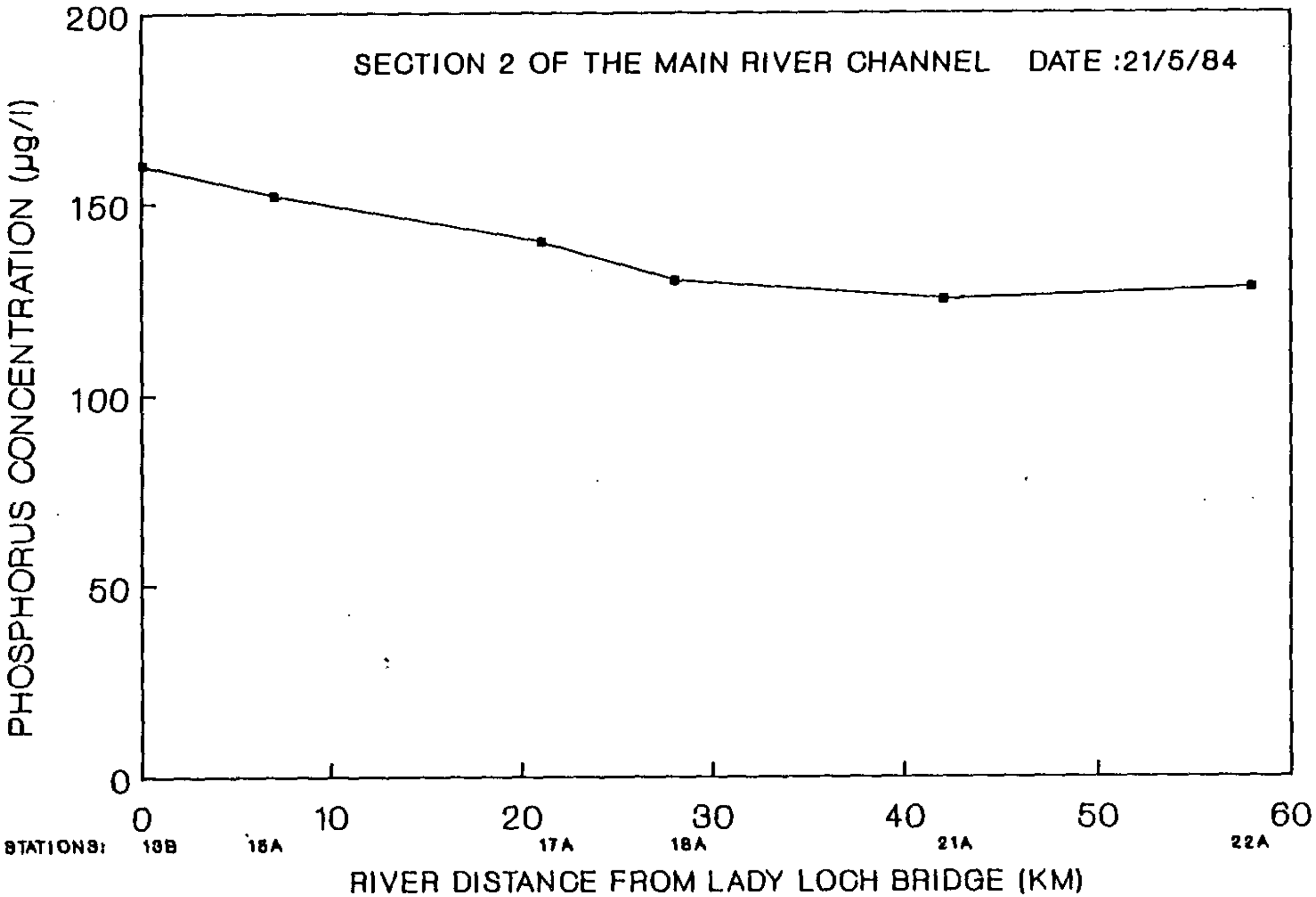


Fig 5.17. Phosphorus concentration profile for stations located on the main river channel between Lady Loch Bridge and Drie Heuwels Weir during high flow conditions. Samples collected on 21/5/1984.

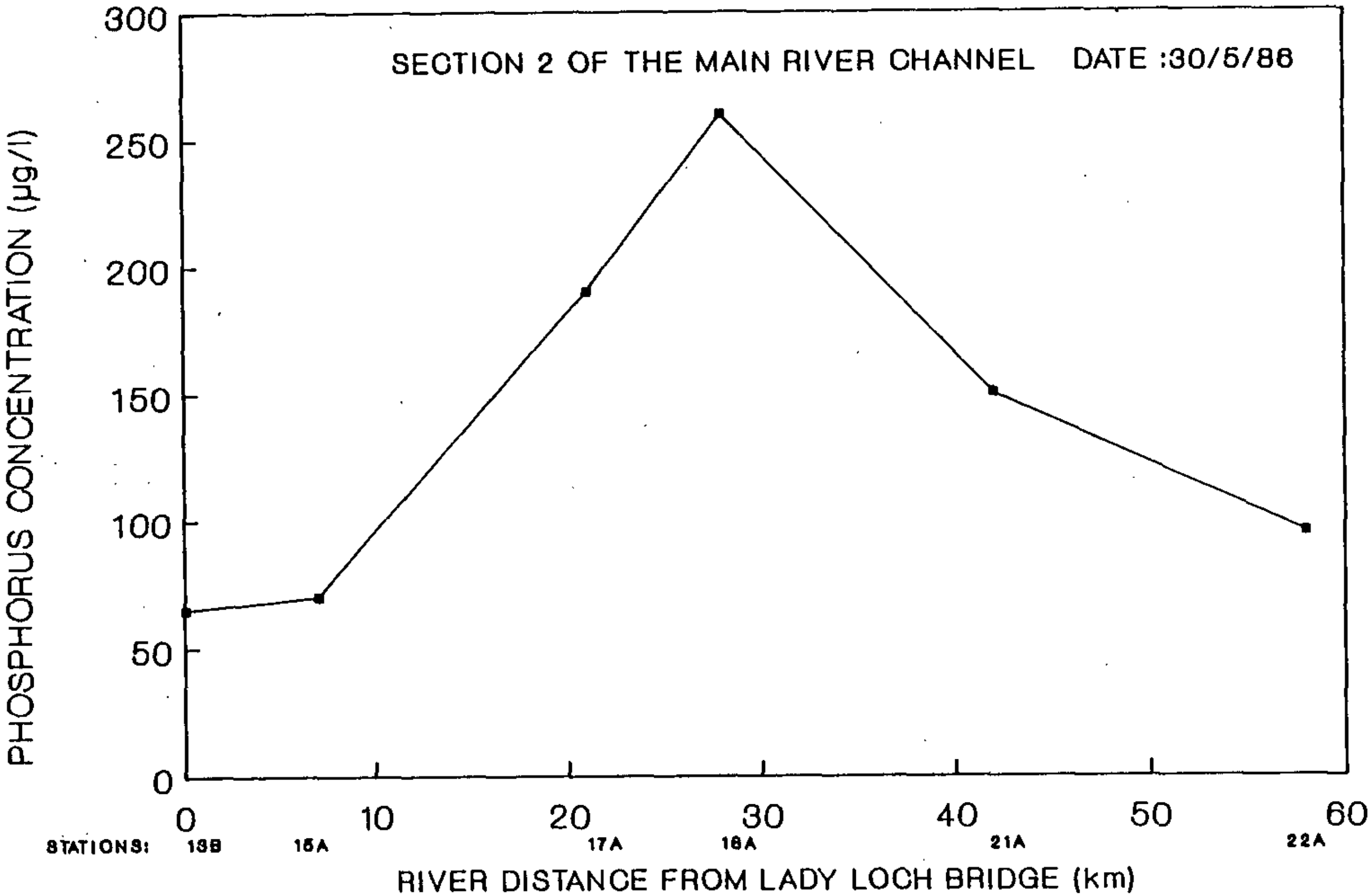


Fig 5.18. Phosphorus concentration profile for stations located on the main river channel between Lady Loch Bridge and Drie Heuwels Weir during flood flow conditions. Samples collected on 30/5/1986.

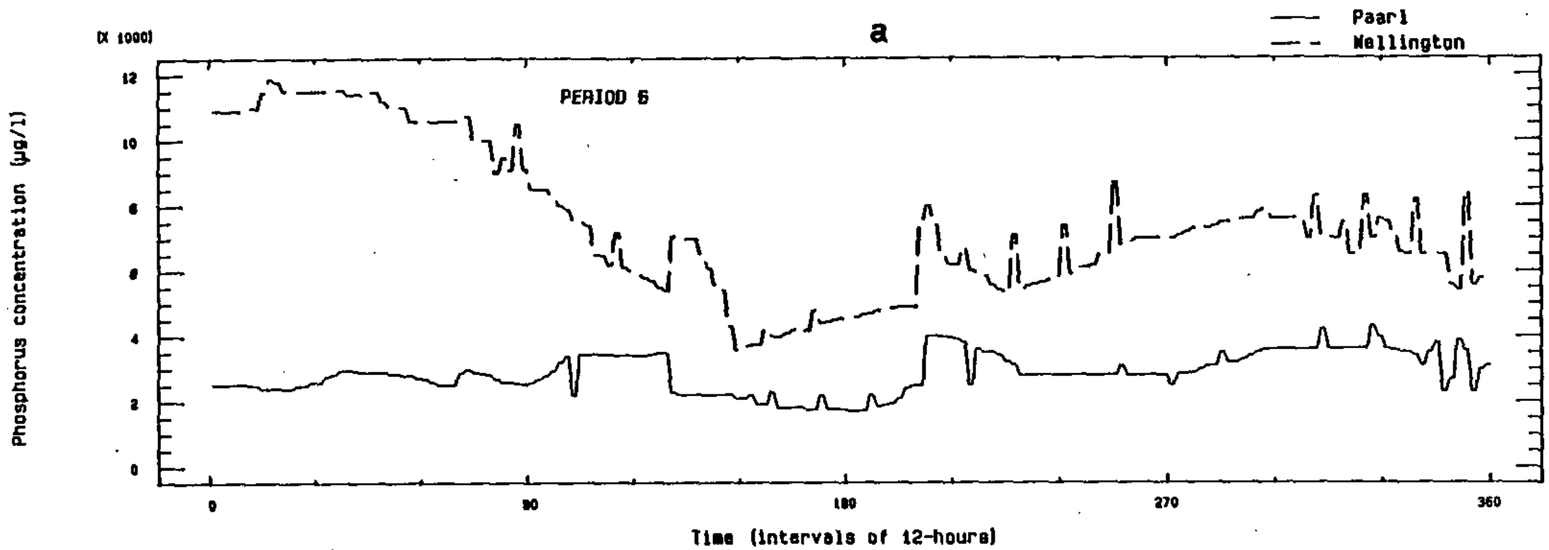
2.2 Point sources

In Fig 5.6 the hydrographs and in Fig 5.19 (a) the associated phosphorus chemographs for Paarl and Wellington wastewater treatment works effluents are shown for Period 6. The phosphorus concentration from the Paarl works ranges from 1 900 to 4 500 µg/ℓ and from the Wellington works from 3 900 to 12 000 µg/ℓ. Concentration decline with flow increase indicates that the mass loading per day is approximately constant so that with increased flow there is some dilution effect. However there is some additional phosphorus discharge during the high flow periods. This is indicated by plotting the mass of phosphorus discharged against time, see Fig 5.19 (b).

In Fig 5.20 the mass phosphorus discharged for both the Paarl and Wellington works are shown for Periods 1 to 6. The total loads over the six periods ranged from 4.2 to 11.9 tons for Paarl, and from 1.1 to 3.9 tons for Wellington. Again, during the dry periods the phosphorus loads are lower than loads discharged during the wet winter periods.

2.3 Tributaries

The phosphorus concentration data collected at discrete intervals for Stations on the Krom River (Station 14B), Kompagnies River (Station 17B), Klein Berg River (Station 23A), and Sandspruit (Station 23B) are plotted in Figs 5.21 to 5.24 respectively, together with the associated hydrograph. During conditions of baseflow, measured phosphorus concentrations ranged from 10 to 50 µg/ℓ. In flood events, during the rising limb of the flood hydrograph the phosphorus concentrations increased and reached peaks exceeding 700 µg/ℓ; during the recession limb the concentration



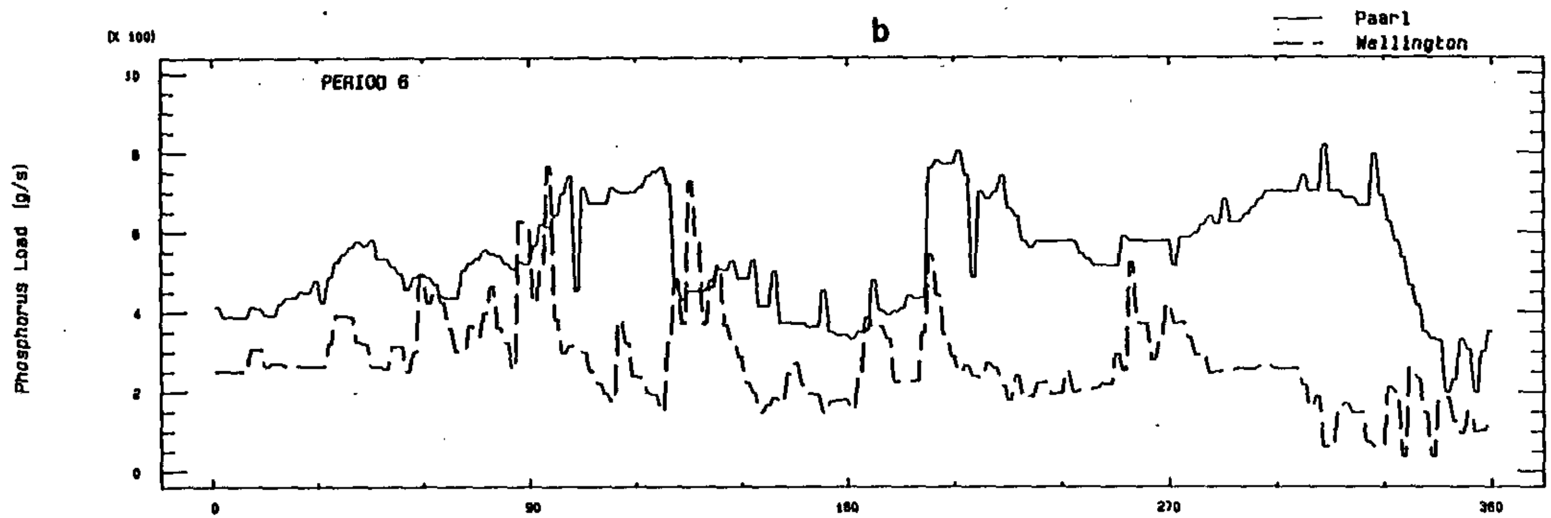


Fig 5.19. Phosphorus chemograph (a) and loadograph (b) for Paarl and Wellington wastewater effluent discharges - Period 6 (winter).

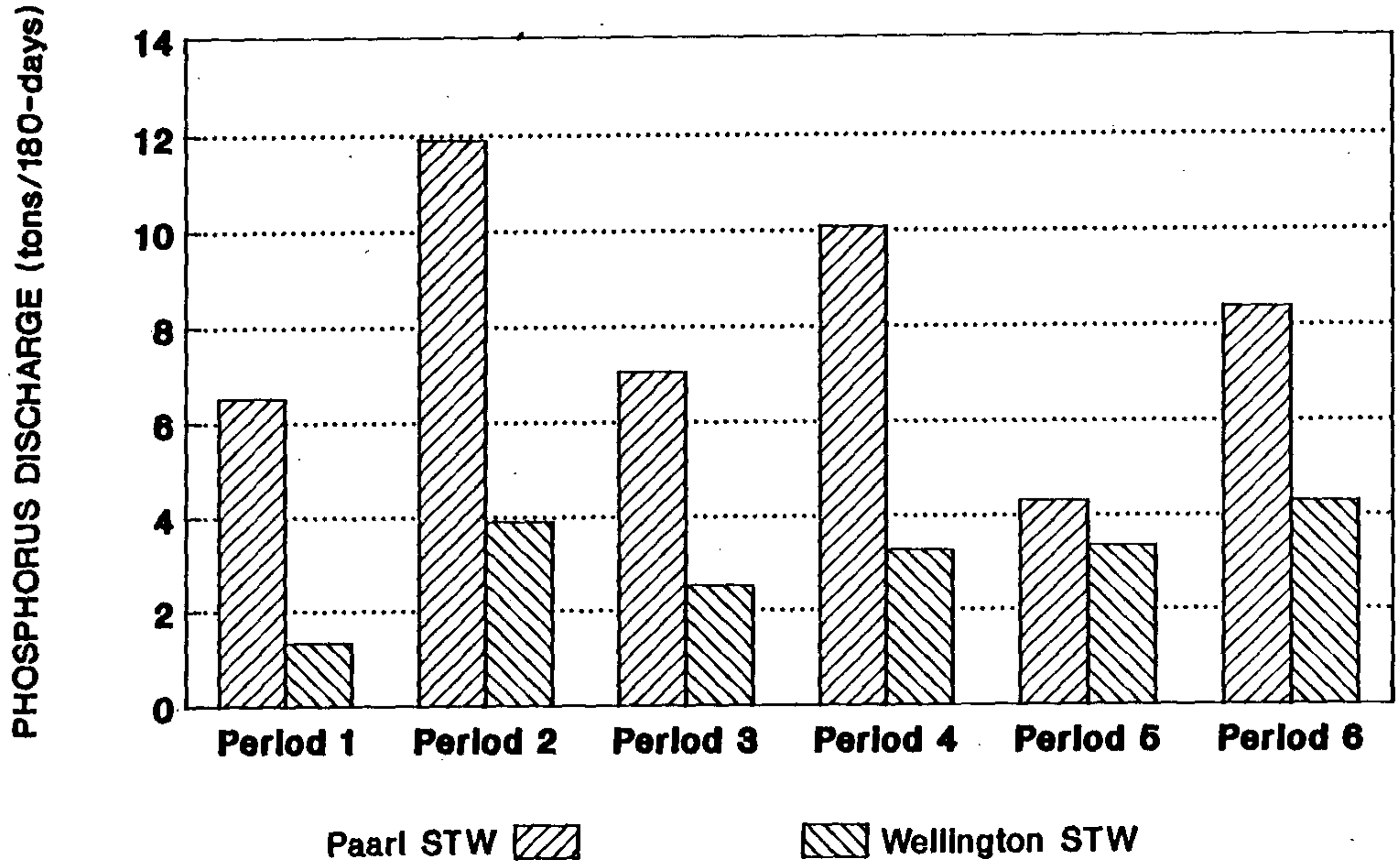


Fig 5.20. Phosphorus loadings for Paarl and Wellington wastewater effluent discharges - Periods 1 to 6. Loads expressed in tons per period of 180 days.

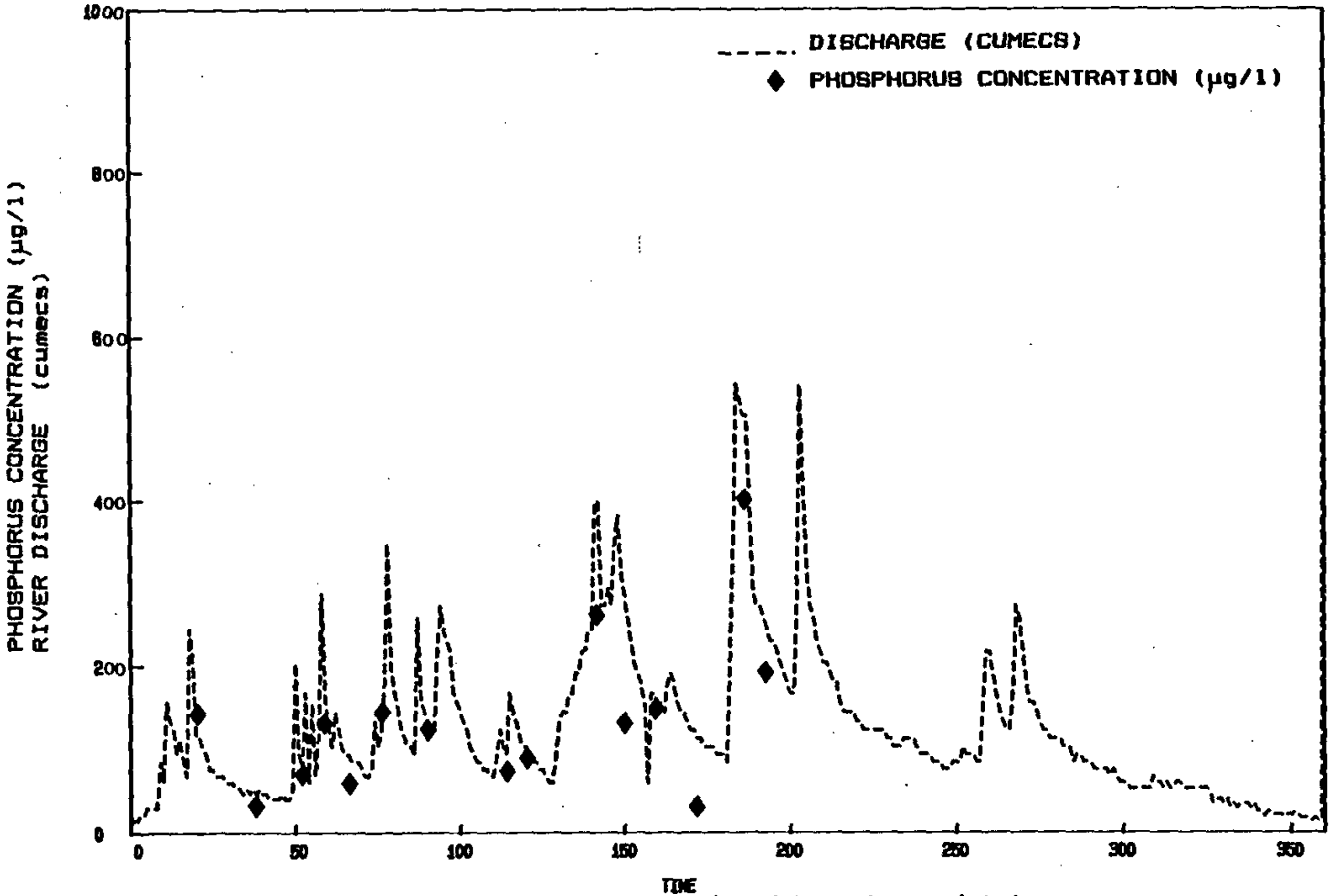


Fig 5.21. Phosphorus concentration data and associated hydrograph for Station 14B at the Krom River - Period 6.

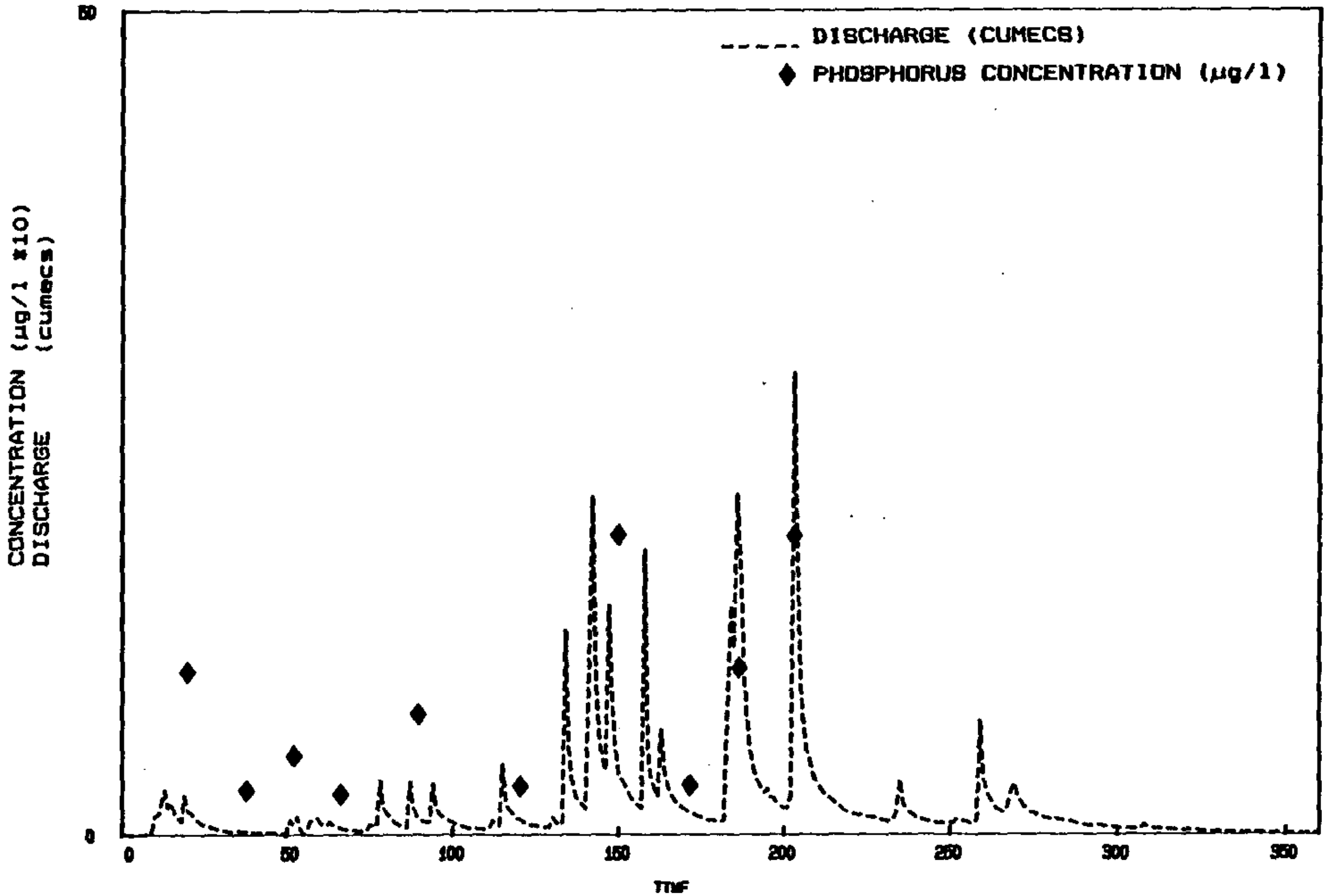


Fig 5.22. Phosphorus concentration data and associated hydrograph for Station 17B at the Kompagnies River - Period 6.

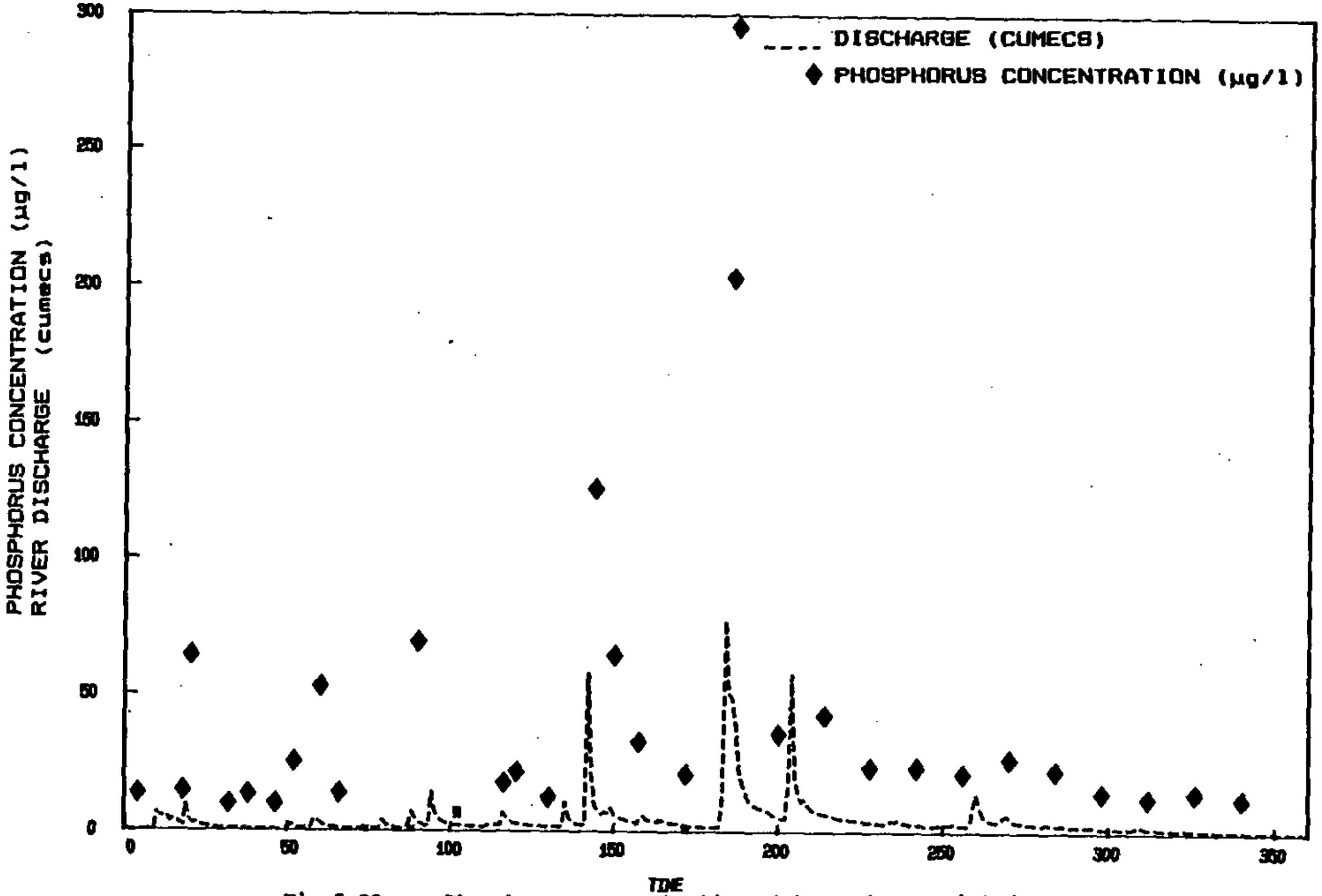


Fig 5.23. Phosphorus concentration data and associated hydrograph for Station 23A at the Klein Berg River - Period 6.

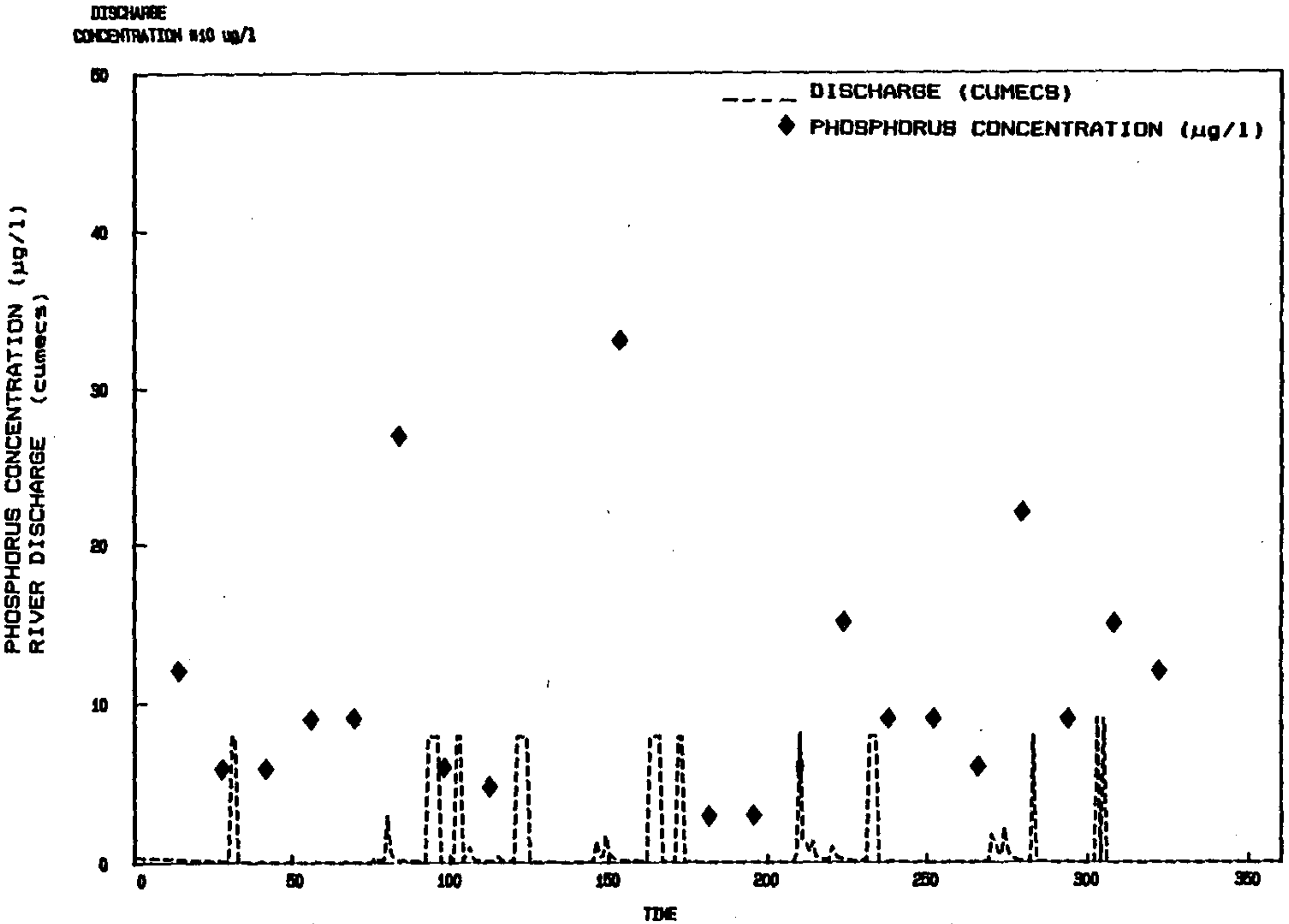


Fig 5.24. Phosphorus concentration data and associated hydrograph for Station 23B at the Sandspruit – Period 2.

exhibited a rapid decline. These responses were clearly similar to those of stations located on the main river channel (c.f. Station 9A at Paarl, Fig 5.12). The similarity in response between the tributaries (which receive only nonpoint inputs) and that at Station 9A would indicate that the sources of phosphorus at the latter is also derived mainly from nonpoint sources.

The phosphorus measurements (shown in Figs 5.11 to 5.14 and 5.21 to 5.24) are adequate to show the behaviour of phosphorus transport but inadequate to calculate accurately the mass transport of phosphorus over a given time interval, particularly during flood events. Further processing of the phosphorus data will require the development of mathematical techniques to assist in the integration of these discrete data values in order to calculate the total phosphorus load over an extended time base, see Chapter 7.

In Fig 5.25 the instantaneous phosphorus loads are calculated for one set of sampling data (collected during high river flow on 11/7/1985). The contribution of phosphorus from gauged point and nonpoint sources make up about 74 percent of the phosphorus load measured at Drie Heuwels Weir, the remaining 26 percent of the measured load contributed by ungauged inputs and scouring of the riverbed material. Consequently, the modelling of phosphorus transport behaviour in the Berg River must take particular account of the influx from point and nonpoint sources as well as phosphorus remobilization from bottom sediments.

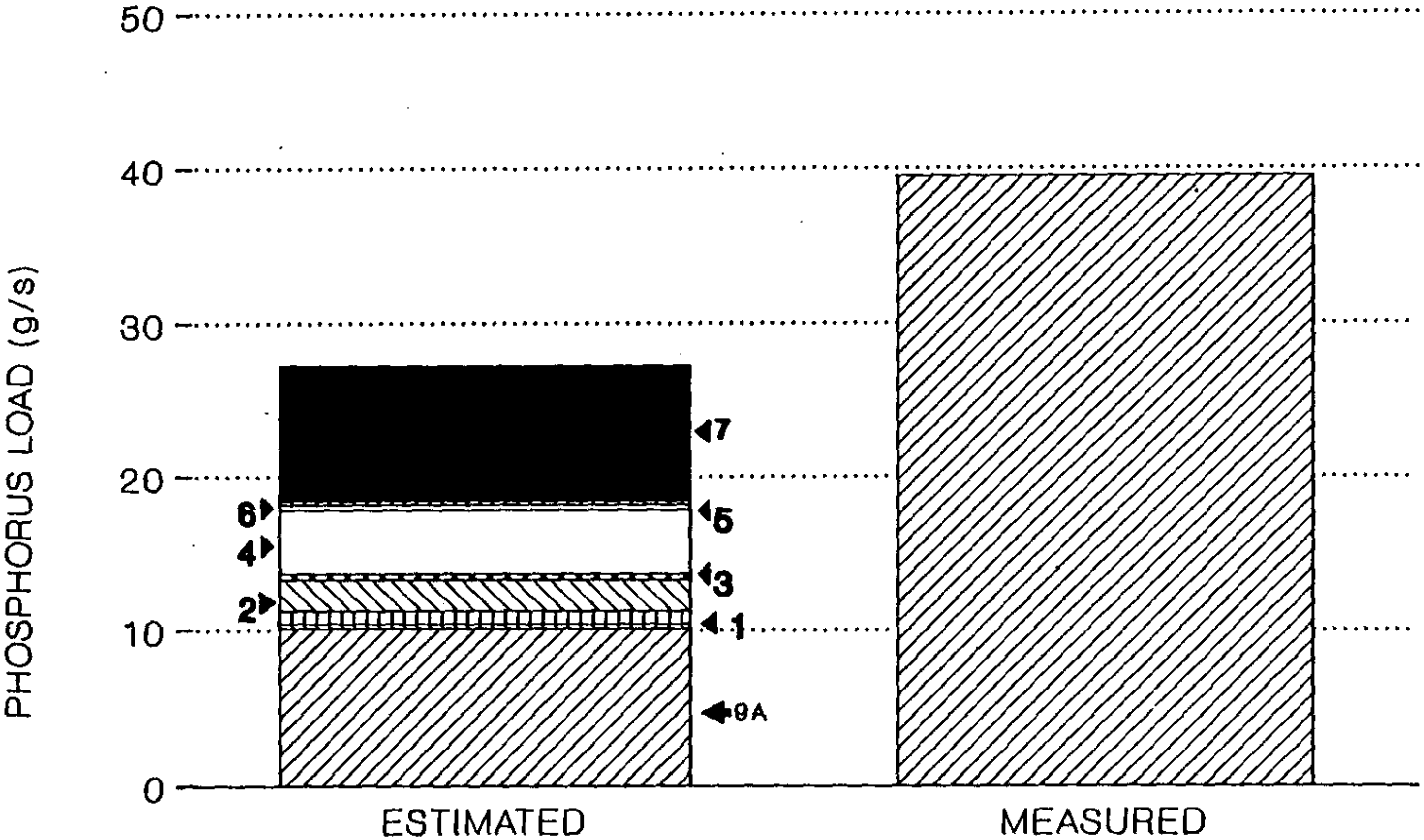


Fig 5.25. Measured and estimated phosphorus load at Drie Heuwels Weir (Station 23D) during high flow conditions. The estimated phosphorus load is calculated as the summation of inputs from Station 9A, wastewater treatment works (1), Krom River (2), Doringspruit (3), Kompagnies River (4), Vis River (5), outlet from Voëlvlei Dam (6), and the Klein Berg River (7). Samples collected on 11/7/1985.

2.4 River sediment samples

Phosphorus bed load estimation requires the collection of sediment samples from the riverbed for the determination of: the median particle size and the phosphorus content. Four sampling stations were chosen along the main river channel: Station 9A (the upstream point), Station 13B (point immediately downstream of the effluent discharges), Station 21A and Station 22A (the downstream point).

Two batches of samples were collected: one batch collected during the summer low flow period (Period 5), and the second batch collected during the winter high flow period (middle of Period 6). The median particle size and phosphorus content for these samples are shown in Fig 5.26. The median particle size decreases down the length of the river corresponding to the changing morphology of the riverbed substrate, from coarse material at Paarl, to fine silt material at Station 22A (70 km downstream). This corresponds to the decrease in median particle size from 0.6 mm at Paarl, to 0.35 mm at Station 22A.

The phosphorus content of the sediment samples (expressed as mg P/g of sediment) are shown in Fig 5.26, reflecting a constant value for the phosphorus concentration between individual stations and for the summer and winter periods. This information indicates that the sedimentation of phosphorus in proximity to the wastewater works and the scour of bed material during the winter storms have a minimal influence on the phosphorus content of the riverbed sediments.

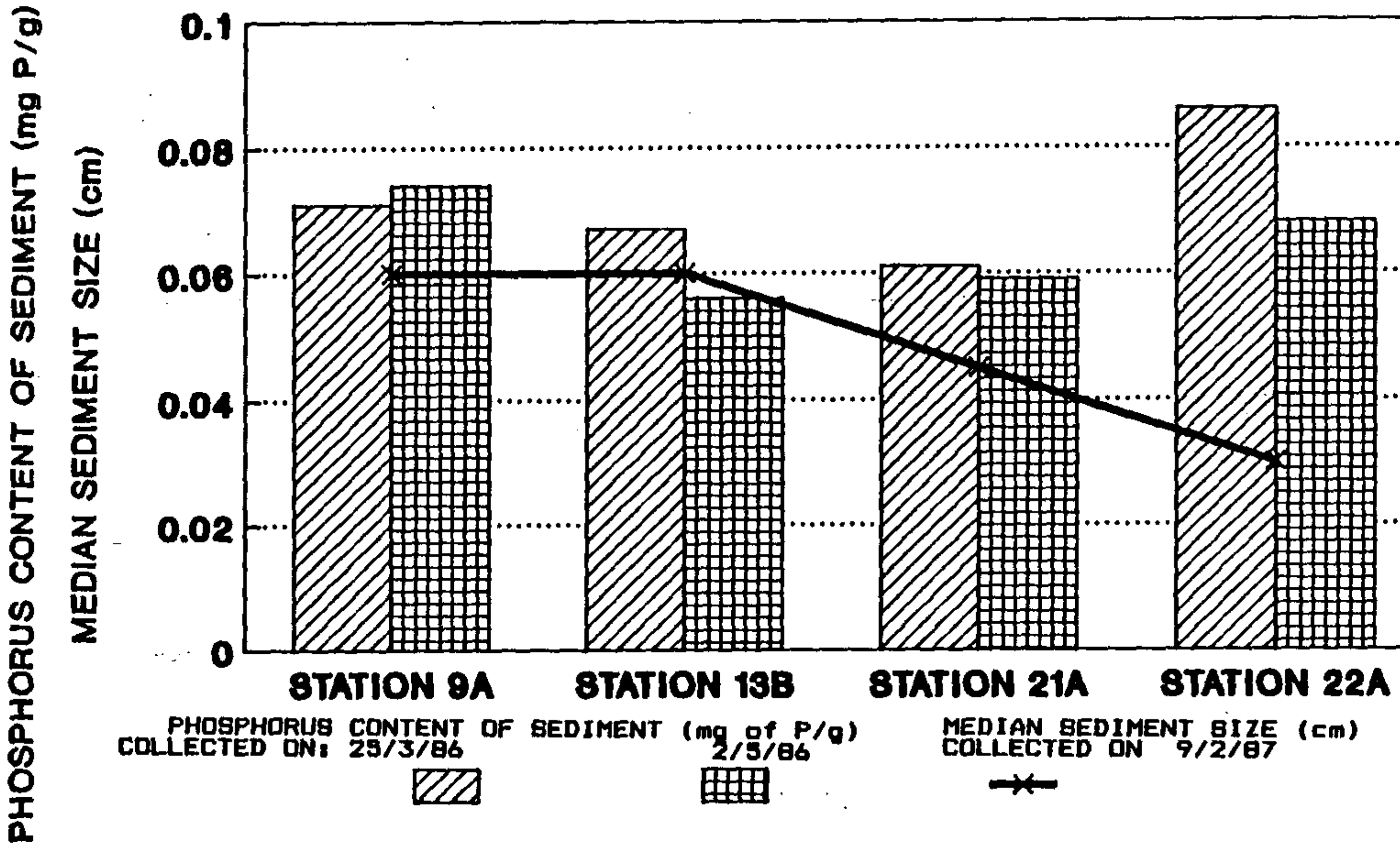


Fig 5.26. Median particle size and phosphorus concentration of river bed sediments collected at sampling stations located along the main river channel of the Berg River.

Total suspended solids data:

Water samples were collected for total suspended solids analysis at Stations 9A, 14B, and 23D to provide some information on the relationship between the mass transport of phosphorus and wash load. In Fig 5.27 the total suspended solids (TSS) concentration data for Station 9A are shown. The peak in the TSS concentration is associated with the peak river discharge, with the concentration reducing abruptly after peak flow (Cooke, 1988; Irvine and Drake, 1987). During peak flow the maximum recorded TSS concentration is 1 700 mg/ℓ and during low flow the value ranges between less than 1 to 19 mg/ℓ. In Fig 5.28 the total suspended solids concentration is plotted versus flow showing that the concentration of total suspended solids increases with flow but a wide scatter of data points is associated with the relationship. Further processing of the data shown in Fig 5.28 indicates that the suspended solids concentration is higher on the rising limb of the flood hydrograph compared with the same discharge on the falling limb (Irvine and Drake, 1987). Based on this information it is apparent that processes influencing the export of phosphorus and TSS during flood events are closely related.

3 SUMMARY

Analysis of the water quality and associated flow data provide the following information about the behaviour of phosphorus in drainage basins:

(1) In a storm event, the export of phosphorus from nonpoint sources gives rise to a higher phosphorus concentration during the rising limb of the flood hydrograph than during the recession limb; exhibiting

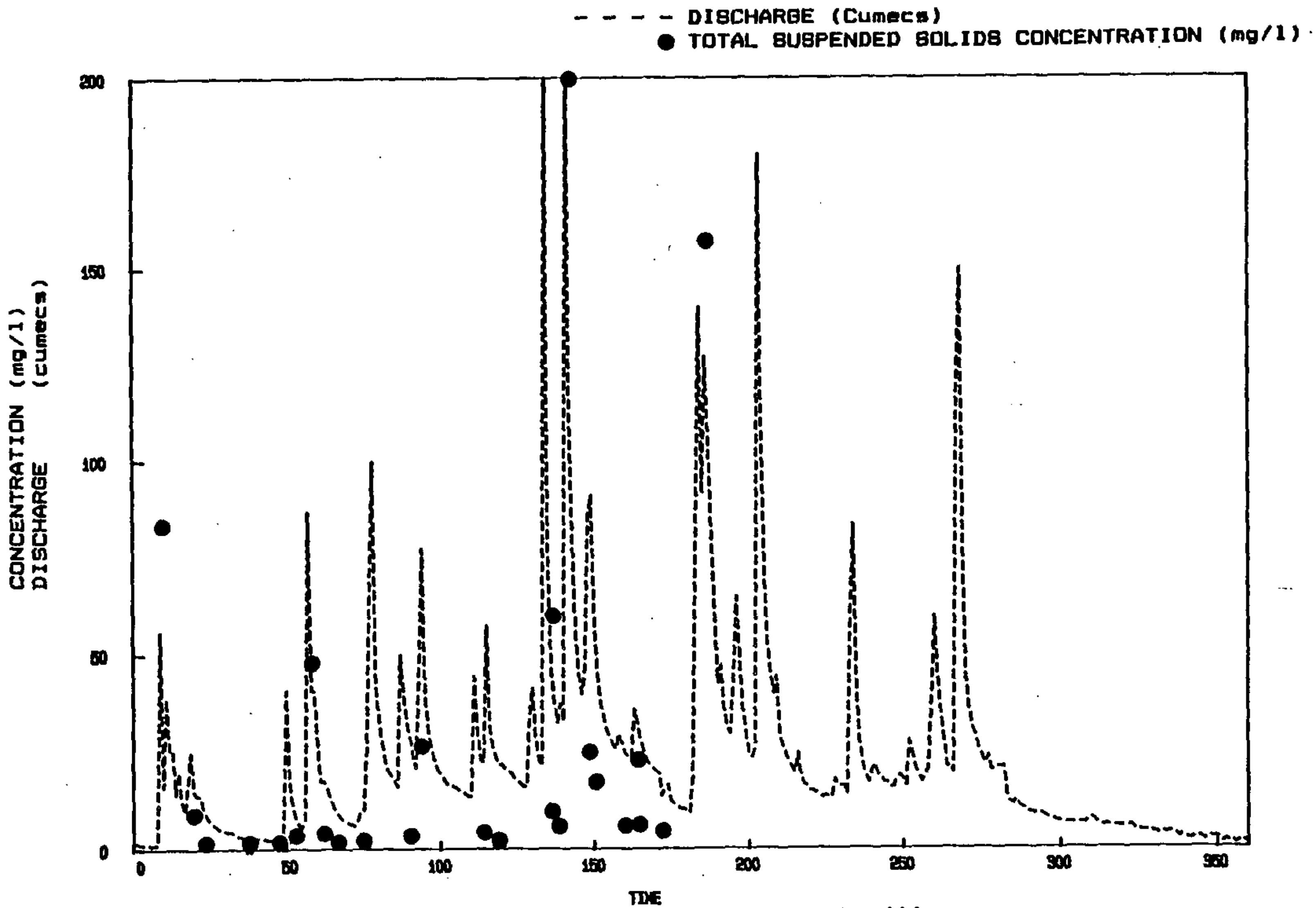


Fig 5.27. Time sequence plot of total suspended solids data and associated hydrograph for Station 9A (North Paarl), Period 6 (winter).

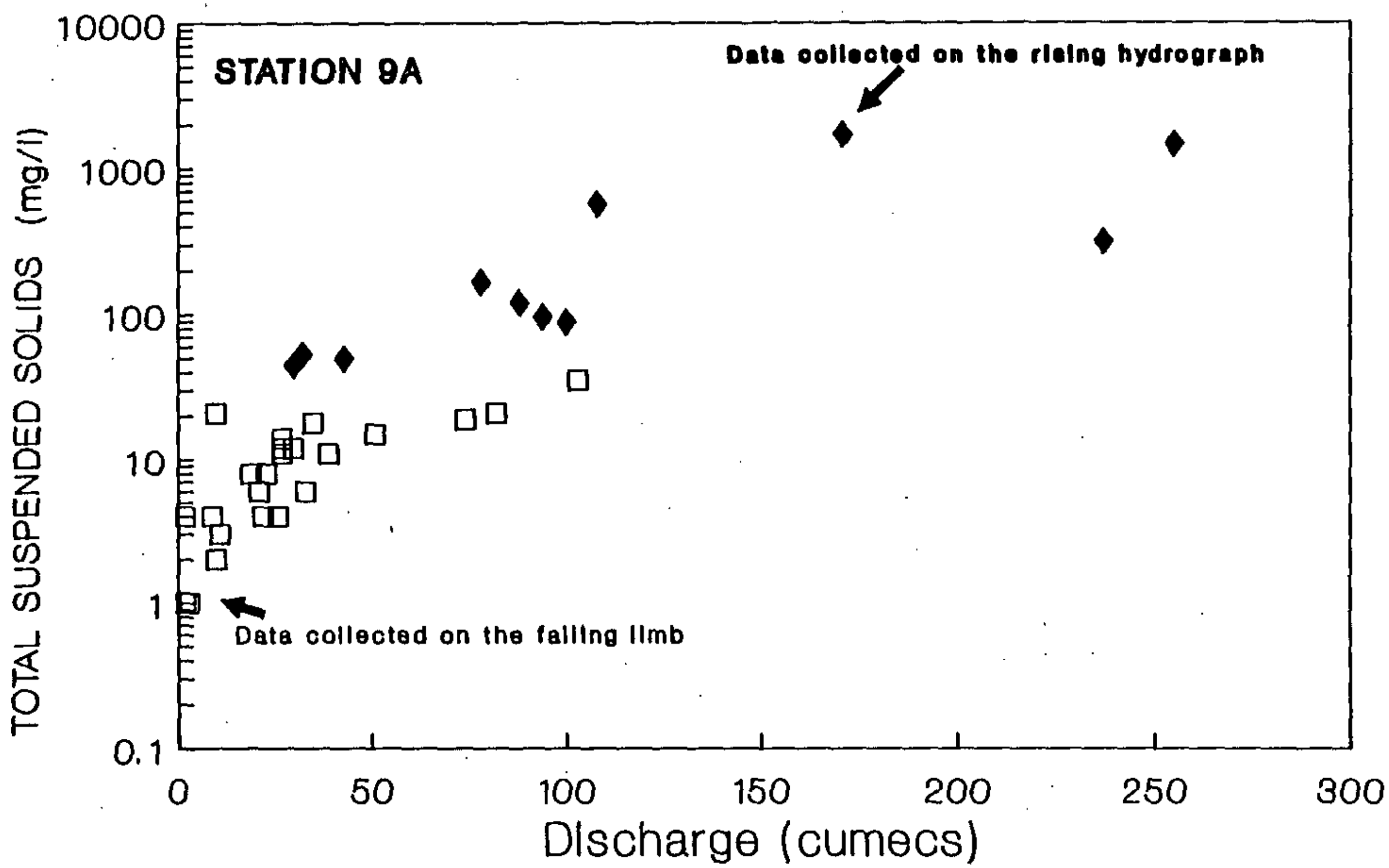


Fig 5.28. Total suspended solids concentration plotted on a log scale versus discharge for samples collected at Station 9A during Period 6. Samples collected on the rising limb of a flood hydrograph are shown as diamonds. Samples collected on the recession limb of a flood hydrograph are shown as squares.

the so called hysteresis effect. This behaviour applies to both the tributaries and the main river channel discharges. The discharge and concentration characteristics of the lateral flows therefore appear to have a significant effect on the main channel characteristics. This implies that for a reliable chemo-hydrodynamic description of the main channel discharge the lateral nonpoint hydrographs and associated phosphorus concentrations form essential inputs.

(2) The transport of phosphorus along the main river channel is influenced by two discharge-dependent processes: removal of phosphorus from the water column and remobilization of phosphorus into the water column. During low flow, physical, chemical and biological removal of phosphorus from the water column of the river to sediments has a pronounced effect on the phosphorus concentration along the main river channel. During high flow, phosphorus is remobilized from river sediments to the water column of the river.

(3) During low flow, the phosphorus contribution from point sources plays an important role in the phosphorus budget of the river channel; under high flow conditions the nonpoint sources dominate the phosphorus budget of the river.

(4) In a river in which the flow pattern is dominated by flood events, because of the high phosphorus concentration transients associated with flood waves, weekly and daily sampling are inadequate to allow reliable estimates to be made on the mass of phosphorus transported. It would seem that procedures

need to be developed whereby, from continuous flow hydrograph and discrete phosphorus measurements, a continuous time series of phosphorus values can be generated, from which the phosphorus load can be estimated.

(5) For an adequate description of the phosphorus transport along the main river channel it is essential to have a hydrodynamic description of the river flow along the main river channel. Such a hydrodynamic flow model must take into account the ungauged lateral runoff as well as the influences of in-channel losses and abstractions.

In Chapters 6 and 7 the conclusions given above will be implemented to develop a hydro-phosphorus transport model.

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CHAPTER 6

DEVELOPMENT OF HYDRODYNAMIC FLOW MODEL

1 INTRODUCTION

In Chapter 5, amongst the number of conclusions, there are two important ones in regard to, phosphorus export to the river channel, and phosphorus transport along the river channel; viz.

(1) Export of phosphorus from nonpoint sources gives rise to higher phosphorus concentrations during the rising limb than during the falling limb of the nonpoint source hydrograph, exhibiting a hysteresis effect - the phosphorus export to the river channel is significantly affected by the magnitude of the flow from the nonpoint sources.

(2) Transport of phosphorus along the river channel is influenced by removal from the water column to the channel bed and remobilization from the bed to the water column. Both processes are dependent on the magnitude of the river discharge.

The two conclusions above are sufficient to establish that the hydrodynamic flow regime in the river tributaries and the river channel are inextricably linked to the export of phosphorus to the river channel and along the channel. Conceptually the interaction of the flow on the phosphorus export and transport can be depicted as in Fig 6.1. The hydrodynamic behaviour is completely independent of the phosphorus transport whereas the phosphorus transport is heavily dependent on the hydrodynamic behaviour.

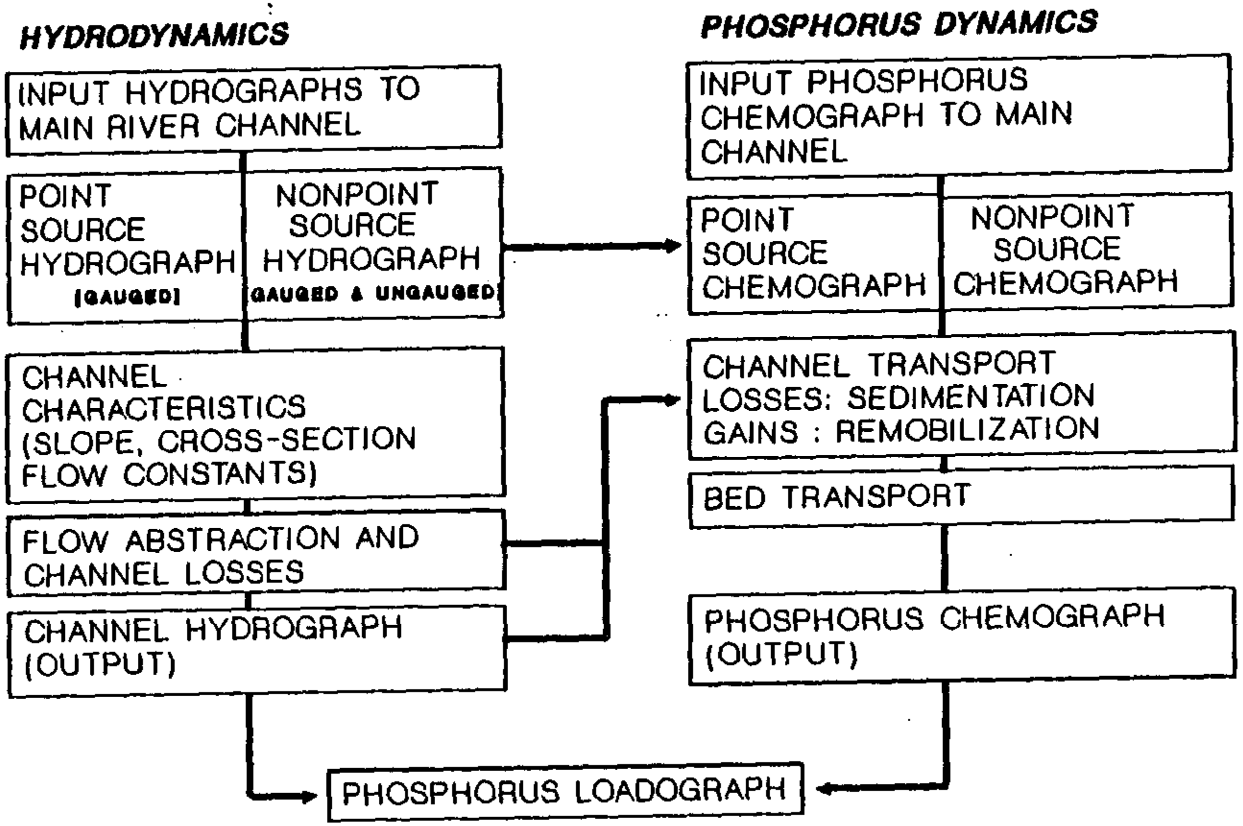


Fig 6.1. Framework showing the major processes associated with the transport of phosphorus along river channels.

In this chapter attention will be focused on the hydrodynamic description; in Chapter 7 the phosphorus transport aspect will be addressed.

2 MODEL SELECTION

The basic mathematical model describing the flow in open channels is that due to Saint-Venant, in which he derived two equations, the continuity and momentum equations, to describe the movement of water along a channel. The continuity equation is

$$\partial Q/\partial x + \partial A/\partial t = q \qquad \ldots\ldots \quad (6.1)$$

where

A = flow cross sectional area (m^2),
Q = discharge (cumecs),
q = lateral discharge per unit length of channel (cumecs/m),
t = time (s), and
x = distance (m).

Equation (6.1) has two unknowns A and Q and hence a second independent equation is required to obtain a solution. This equation is derived considering the energy relationships in a small segment of the channel length, dx, and leads to the momentum equation, Eq (6.2).

$$So - Se = v/g\ \partial v/\partial x + 1/g\ \partial v/\partial t + \partial y/\partial x \quad \text{..... (6.2)}$$

where

So = bed slope,
Se = energy slope,
v = flow velocity (m/s),
g = acceleration due to gravity (m/s^2),
y = depth of flow (m).

The terms in the left hand side of Eq (6.2) represent the bed and energy slopes, and those on the right-hand side the convective and local accelerations and pressure head, respectively.

As yet the model proposed by Saint-Venant per se has found little practical application because of the difficulties in describing the boundary conditions. As a consequence various simplifications have been proposed to the momentum equation, by neglecting certain terms, or indeed, replacing the momentum equation by another that indirectly includes the energy effects. These simplified models have the advantages that the boundary effects can be accounted for by calibration (to a greater or lesser degree) and the solution procedures are easier. The simplified models of course have the disadvantages that the simulation can reproduce the observed behaviour only approximately depending on the simplification, and with each set of simplifications the range of problems that can be resolved is restricted.

A number of simplified models have been published in the literature to suit specific classes of problems, see Table 6.1. These models often are accompanied by suggested numerical techniques to obtain solutions. In selecting a model it is essential to take cognizance of (1) the model requirements viz. boundary conditions, channel description and (2) the desired outputs. *Considering* (2) the output should be a reasonable description of the channel hydrograph at any selected point along the main river channel; this is necessary because we shall show in Chapter 7 that the phosphorus chemograph is implicitly linked to the flow hydrograph. With regard to (1) from practical limitations, channel description is possible only in the crudest terms - the momentum equation needs to be replaced by a velocity or discharge equation of the simplest form in which the "constants" defining the velocity or discharge can be readily estimated in the field.

Table 6.1 List of hydrodynamic models investigated.

Model:	Author:	Year:
Implicit dynamic routing	Fread	(1973)
Kinematic wave approximation	Li, Simons and Stevens	(1975)
Kinematic wave approximation	Li	(1979)
Diffusion and kinematic wave	Weinmann and Laurenson	(1979)
Linear reservoirs	Ponce	(1980)
Convection-diffusion	Koussis	(1980)
Diffusion-wave	Akan and Yen	(1981)
Advection-dispersion	Koussis, Saenz and Tollis	(1983)
Nonlinear Routing	Bates and Pilgrim	(1985)

In selecting a model the complexity of the model must be balanced by the required output and the input data that are available; these were the considerations that entered in the selection of the model proposed by Li _et al_. (1975), from the number of models examined (shown in Table 6.1) Li _et al_. (1975) replace the momentum equation by

$$A = \alpha Q^{\beta} \qquad \text{..... (6.3)}$$

where α and β are constants.

Some of the other models also may have served our purpose, but the practicality with which this model could be calibrated from available data and its ability to give reasonable simulation of the observed behaviour, justified its selection.

3 NUMERICAL SOLUTION

The model proposed by Li _et al_. (1975) uses a four-point implicit solution scheme with a rectangular x-t grid using the discharge values of three points (Q1, Q2 and Q3) to determine the fourth unknown discharge (Q4). In Fig 6.2 the rectangular x-t grid is shown. For convenience, the increment of time, Δt, is usually taken as constant, however, the river distance, Δx, may vary between grid points. Equation (6.1) is written in finite difference form to give

$$[(Q4-Q3)/\Delta x(1-a) + (Q2-Q1)/\Delta x(a)] +$$
$$[(A4-A2)/\Delta t(1-b) + (A3-A1)/\Delta t(b)] =$$
$$0{,}5[(1-b)q4 + b\ q3 + (1-b)q2 + b\ q1] \qquad \text{..... (6.4)}$$

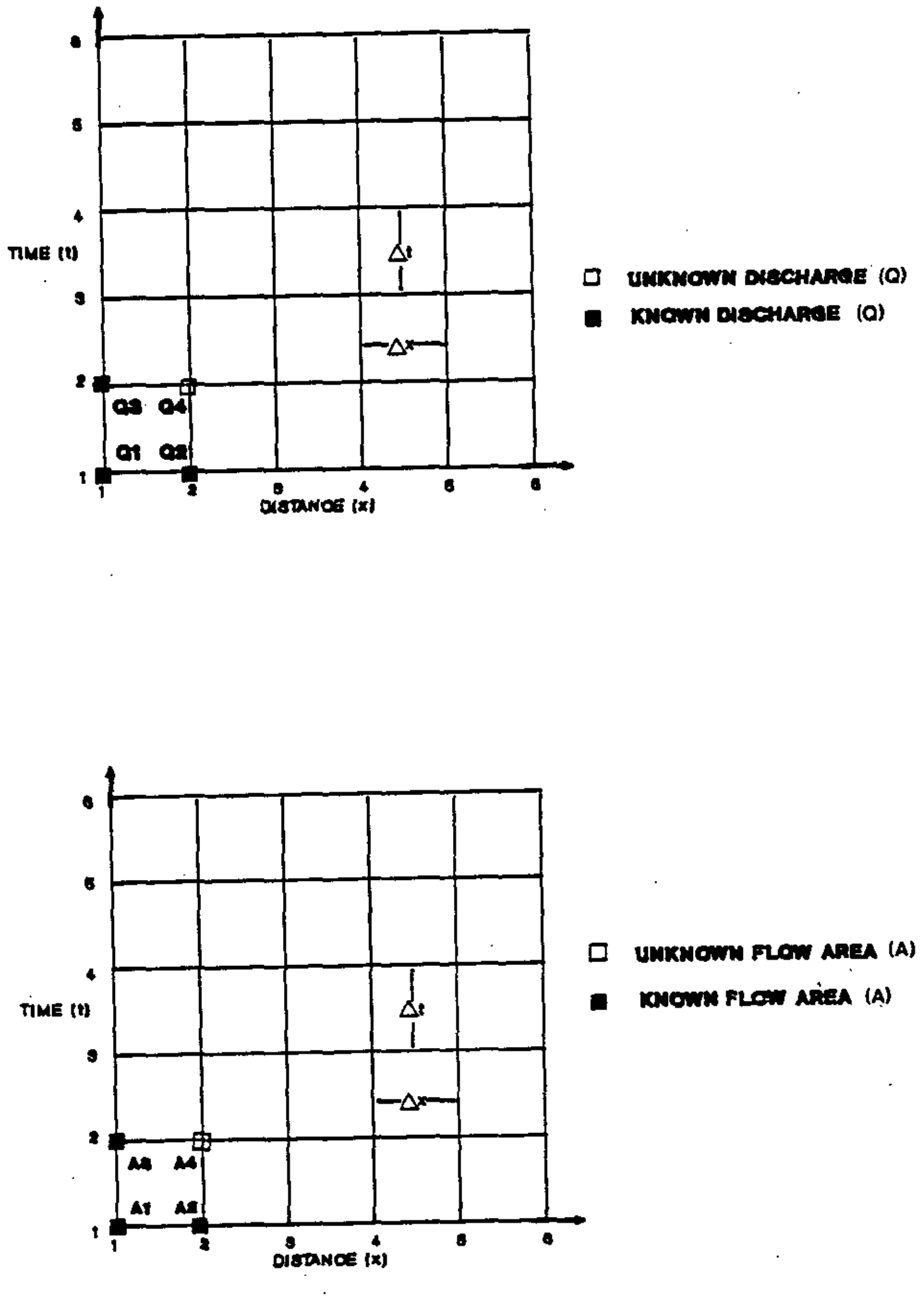


Fig 6.2. Rectangular x-t grid showing spatial and temporal discharge and flow cross-sectional area relations.

where

a = the time-weighting factor, and
b = the space weighting factor.

Converting the discharge, Q, to cross sectional area, A, using Eq (6.3) we obtain

$$\Delta t/\Delta x\ Q4(1-a) + \alpha Q4^{\beta}(1-b) =$$
$$\Delta t/\Delta x\ [Q3(1-a) - (Q2-Q1)(a)] +$$
$$[\alpha Q2^{\beta}(1-b) - (\alpha Q3^{\beta} - \alpha Q1^{\beta})(b)] +$$
$$[\Delta t/2[(1-b)q4 + b\ q3 + (1-b)q2 + b\ q1] \quad \ldots\ldots \quad (6.5)$$

The right-hand side of Eq (6.5) contains only known quantities, which for convenience are represented by Ω.

where

$$\Omega = \Delta t/\Delta x[Q3(1-a) - (Q2-Q1)(a)] +$$
$$[\alpha Q2^{\beta}(1-b) - (\alpha Q3^{\beta} - \alpha Q1^{\beta})(b)] +$$
$$[0.5\ \Delta t[(1-b)q4 + b\ q3 + (1-b)\ q2 + bq1] \quad \ldots\ldots \quad (6.6)$$

let $\theta = \Delta t/\Delta x$ and $\tau = Q4$.

then the left-hand side of Eq (6.5) can be written as

$$f(\tau) = \theta(1-a)\tau + \alpha(1-b)\tau^{\beta} \quad \ldots\ldots \quad (6.7)$$

The solution to Eq (6.5) is the solution, τ^*, which satisfies the condition

$$f(\tau^*) = \theta(1-a)\tau^* + \alpha(1-b)\tau^{*\beta} = \Omega \qquad \text{..... (6.8)}$$

Equation (6.8) is nonlinear in τ^* and is solved using an iterative technique. Let τ^κ be the value of τ at the κ^{th} iteration. The Taylor series expansion of the function $f(\tau)$ around τ^κ is

$$f(\tau)=f(\tau^\kappa)+(\tau-\tau^\kappa)f'(\tau^\kappa)+{}^1/_2(\tau-\tau^\kappa)^2f''(\tau^\kappa)$$
$$+{}^1/_6(\tau-\tau^\kappa)^3f'''(\tau^\kappa)+ ----. \qquad \text{...... (6.9)}$$

in which $f'(\tau^\kappa)$, $f''(\tau^\kappa)$ and $f'''(\tau^\kappa)$ are the first, second and third derivatives of the function at τ^κ. Dropping terms higher than third order one obtains

$$f(\tau)\simeq f(\tau^\kappa) + (\tau-\tau^\kappa)f'(\tau^\kappa) +$$
$${}^1/_2(\tau-\tau^\kappa)^2 f''(\tau^\kappa) \qquad \text{..... (6.10)}$$

Iteration forces $f(\tau^{\kappa+1})$ to approach the value

$$\Omega = f(\tau^\kappa) + (\tau^{\kappa+1} - \tau^\kappa)f'(\tau^\kappa) +$$
$$0.5(\tau^{\kappa+1} - \tau^\kappa)^2 f''(\tau^\kappa) \qquad \text{...... (6.11)}$$

The solution of Eq (6.11) is

$$\tau^{\kappa+1} = \tau^{\kappa} - \frac{f'(\tau^{\kappa})}{f''(\tau^{\kappa})} \pm \left[\left\{\frac{f'(\tau^{\kappa})}{f''(\tau^{\kappa})}\right\}^2 - \frac{2[f(\tau^{\kappa})-\Omega]}{f''(\tau^{\kappa})}\right]^{\frac{1}{2}} \quad \ldots (6.12)$$

where

$$f(\tau^{\kappa}) = \theta(1-a)\tau^{\kappa} + \alpha(1-b)(\tau^{\kappa})^{\beta} \quad \ldots\ldots (6.13)$$

$$f'(\tau^{\kappa}) = \theta(1-a) + \alpha\beta(1-b)(\tau^{\kappa})^{\beta-1} \quad \ldots\ldots (6.14)$$

$$f''(\tau^{\kappa}) = \alpha\beta(\beta-1)(1-b)(\tau^{\kappa})^{\beta-2} \quad \ldots\ldots (6.15)$$

The iteration is stopped when the difference between the left-hand side and right-hand side is less than a selected tolerance e.g. $\epsilon<0.01\Omega$ when

$$|f(\tau^{\kappa+1}) - \Omega| \leq \epsilon \quad \ldots\ldots (6.16)$$

3.1 Solution initiation

The key to rapid convergence is the choice of the initial value for Q4. This is best achieved using a linear scheme to obtain the first approximation.

In the mass continuity equation, Eq (6.1), write

$$\partial A/\partial t = (\partial A/\partial Q)(\partial Q/\partial t) \quad \ldots\ldots \quad (6.17)$$

From Eq (6.3) we get

$$\partial A/\partial Q = \alpha\beta Q^{\beta-1} \quad \ldots\ldots \quad (6.18)$$

Substitution of Eqs (6.17 and 6.18) into Eq (6.1) yields

$$q = \partial Q/\partial x + \alpha\beta Q^{\beta-1}\partial Q/\partial t \quad \ldots\ldots \quad (6.19)$$

The finite difference form of Eq (6.19) is as follows

$$(Q4-Q3)/\Delta x(1-a) + (Q2-Q1)/\Delta x(a) +$$
$$\alpha\beta[(Q3 + Q2)/2]^{\beta-1} [(Q4-Q2)/\Delta t(1-b) + (Q3-Q1)/\Delta t(b)]$$
$$= {}^{1}/_{2}[(1-b)q4 + b\ q3 + (1-b)q2 + b\ q1]$$
$$\ldots\ldots \quad (6.20)$$

where $\tau o = Q4$ and solving for τo gives

$$\tau o = \left[(1-a)/\Delta x + \alpha\beta\ \frac{(Q3+Q2)}{2}^{\beta-1}(1-b)/\Delta t\right]^{-1}$$
$$Q3/\Delta x(1-a) - (Q2-Q1)/\Delta x(a) - \alpha\beta[(Q3+Q2)/2]^{\beta-1}$$
$$[Q2/\Delta t(1-b) + (Q3-Q1)/\Delta t(b)] +$$
$${}^{1}/2[(1-b)q4 + b\ q3 + (1-b)\ q2 + b\ q1]$$
$$\ldots\ldots \quad (6.21)$$

This solution is employed in the computer program, QMODEL, which simulates the flow hydrographs at discrete points along the main river channel of the Berg River, see Appendix 2.

4 MODEL CALIBRATION

4.1 Calibration strategy

The following is an outline of the scheme to calibrate the model. The sequence below should, in the main, serve for calibration of the model for other river channels.

(1) Calibration period:

The calibration period should span an annual cycle of flow for which the maximum amount of information has been obtained.

(2) Upstream and downstream hydrographs:

Of the greatest importance is the availability of accurate upstream and downstream hydrographs taken over the same period. This requirement is definitive, without it no reliable calibration is possible. It is essential therefore that the gauging weirs at these two locations are accurate over the full range of flows to be simulated.

(3) Division of the main river channel into sub-reaches:

Although the sub-reaches may be equal in length, it is more likely that each reach will have a different length. This is because the points of division are usually determined by the location of water quality sampling stations.

(4) Lateral inflow hydrographs observed over the same period as in (2) above and their location along the main river channel:

It is unlikely that a complete set of such measurements will be available i.e. the availability may range from nothing to near 100 percent. The more complete the information on lateral inflow data the more reliable the simulation. Even if no lateral inflow data are available, providing the upstream and downstream hydrographs are accurate, it is possible to make an estimation of a "lumped" lateral discharge hydrograph by repeated trials using the upstream hydrograph with trial lateral discharge hydrographs until the observed downstream hydrograph is simulated correctly.

Where there are gauged tributaries more or less evenly spaced along the channel with at least one gauging weir in each sub-reach, it may be possible to estimate the ungauged hydrograph for each sub-reach by multiplying the gauged hydrograph by the ratio of the ungauged runoff area to the gauged area for the respective sub-reaches, see Section 4.2.

(5) Estimation of the coefficients α and β in Eqs (6.4 to 6.8, 6.20 and 6.21) for each sub-reach:

These values are determined from field measurements of the flow cross sectional area (A) at the corresponding flow (Q) over a range of discharges (see Section 4.2). If a sub-reach is ungauged, Q will have to be estimated by manual methods (see Chapter 4, Section 3.4).

(6) Estimation of the weighting factors a and b, in Eqs (6.4 to 6.8, 6.20 and 6.21):

These factors are components of the numerical scheme itself. Li (1979) states that these must have numerical values between 0 and 0.5, to ensure stability in the numerical scheme. From trial simulations it would appear that the influence of these weighting factors on the simulated channel hydrograph are not marked and values of a=0.4 and b=0.3, seem adequate (see Section 4.2).

(7) Lateral outflows:

Data on channel seepage losses are, as a result of their insidious nature, not directly measurable. Data on abstractions are seldom reliable. Usually lateral outflow data are either unreliable or not available. However, lateral losses are significant only during low flow periods. These are also the times when the magnitude of the lateral losses can be assessed most readily, providing the upstream and downstream hydrographs and estimates of the lateral inflows during these periods, are available. By performing repeated simulations for the low flow periods and by incorporating different outflow rates per sub-reach, the rate that allows the closest correspondence between the observed and simulated downstream hydrograph, forms an estimate of the seepage loss/abstraction rates (see Section 4.2).

4.2 Calibration of the Berg River hydrodynamic model

In this section the calibration of the hydrodynamic model for the Berg River will be set out in detail, following the calibration strategy outlined above.

(1) Calibration period:

Two consecutive 180-day periods were used to calibrate the model: Period 5 (November 1985 to 1986) and Period 6 (May 1986 to November 1986). These two periods span the third hydrologic year in this investigation. Due to the experience gained in collecting data during the previous two cycles, the data in the third year are the most comprehensive.

(2) Upper and lower channel hydrographs:

The upper and lower hydrographs, forming the boundary hydrographs for the channel length being modelled, are located at gauging weirs G1M20 and G1M13 (see Fig 6.3). It was mentioned in Section 4.1 that a prime requirement for calibration of the model is that the gauging weirs at the upper and lower ends are accurate. At the time this investigation was commenced (November 1983) the accuracies of these weirs were estimated to be + 5 percent at low flow and + 10 percent at high flow (Pers. Comm. van Wyk, 1988). However, these estimates refer to the time before Misverstand Diversion Weir was constructed in 1977. The gauging weir at Drie Heuwels, a sharp crested weir, lies about 17 km upstream of Misverstand Weir. The height of the weir wall above bed level is 5 m. The mean bed slope between Misverstand and Drie Heuwels is about 1:3000, thus the sharp crest level of the gauging weir is about 1.50 m above the flood crest level of the Misverstand Weir, see Fig 6.4.

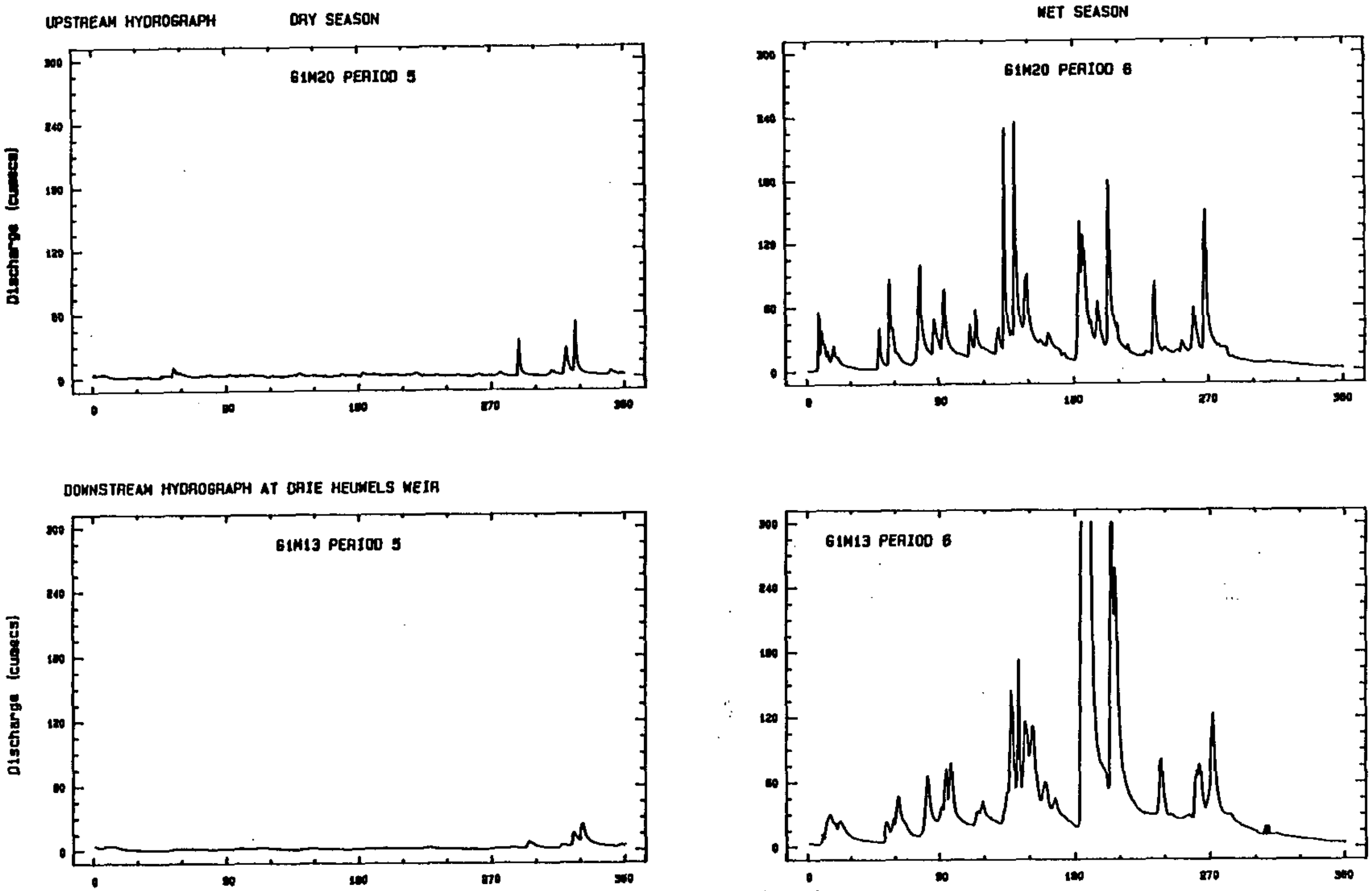


Fig 6.3. Measured hydrographs at G1M20 (Station 9A - North Paarl) and G1M13 (Station 23D - Drie Heuwels Weir) for Periods 5 (summer) and 6 (winter).

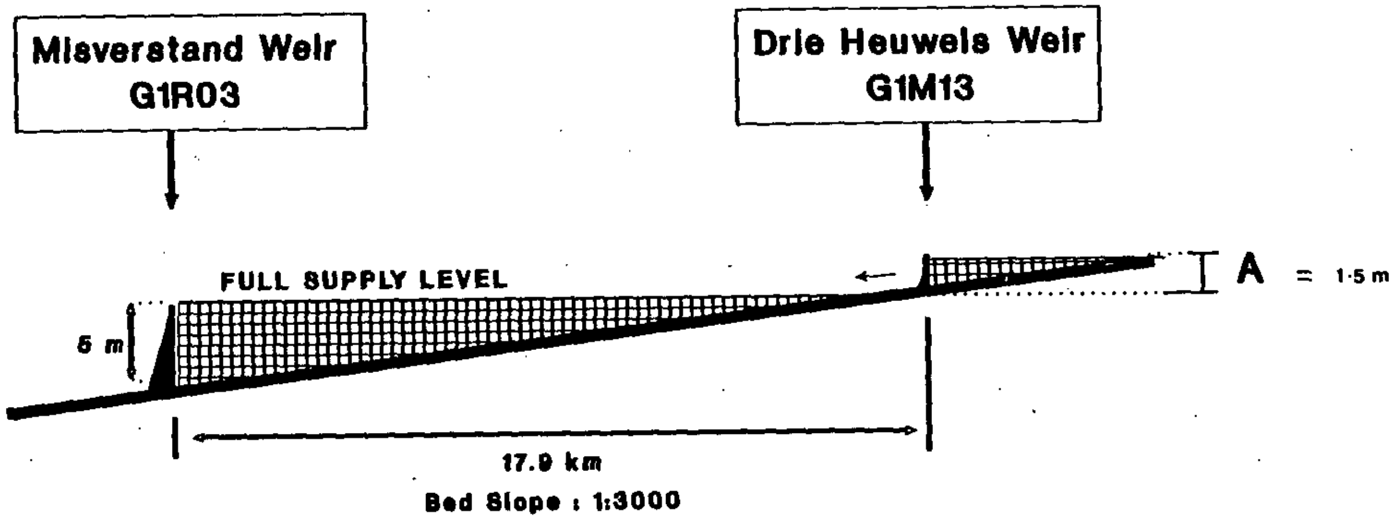


Fig 6.4. Schematic diagram of the relationship between full supply level of the impounded water at Misverstand Weir (G1R03) and the gauging weir at Drie Heuwels (G1M13). The term "A" represents the difference in level between full supply at Misverstand and the gauging weir crest at Drie Heuwels.

Calculation of the backwater curves from Misverstand, at different flow rates in the river, indicate that above flows of about 120 to 150 cumecs the back-water curve is likely to interfere with the calibration of Drie Heuwels Weir, see Fig 6.4 (Pers. Comm. Rowlston, 1988). The interference effect will be even greater should (i) a flood discharge occur in the Matjies River (6 km downstream of Drie Heuwels Weir) at the same time as a flood in the main river channel and (ii) over-bank flow occur in the main river channel downstream of the weir during high flows. These effects will result in the backwater curve rising even higher. In Figs 6.5 and 6.6 the Drie Heuwels Weir is shown under low and high flows respectively. The drowned state of the gauging weir is readily apparent in Fig 6.6, at the rated discharge of 200 cumecs (stage head of 2.5 m); there is no free fall or indeed, any indication of the weir itself, apart from the stilling-well and gauging hut! Thus, the rating curve for Drie Heuwels Weir is likely to be unreliable for rated discharges in excess of about 120 cumecs.

The hydrographs over the calibration period for the gauging weir, G1M20, and Drie Heuwels Weir, G1M13, are shown in Fig 6.3. The discharge at Drie Heuwels Weir include the unreliable discharges greater than 120 cumecs.

(3) Sub-reach divisions:

The intention was to have water quality stations every ten to fifteen kilometres; within this range the exact locations of the sampling stations were fixed virtually totally by ease of access. The location of these stations define the divisions between the sub-reaches, as shown in Fig 6.7.

Fig. 6.5 Drie Heuwels Weir during summer low flow.

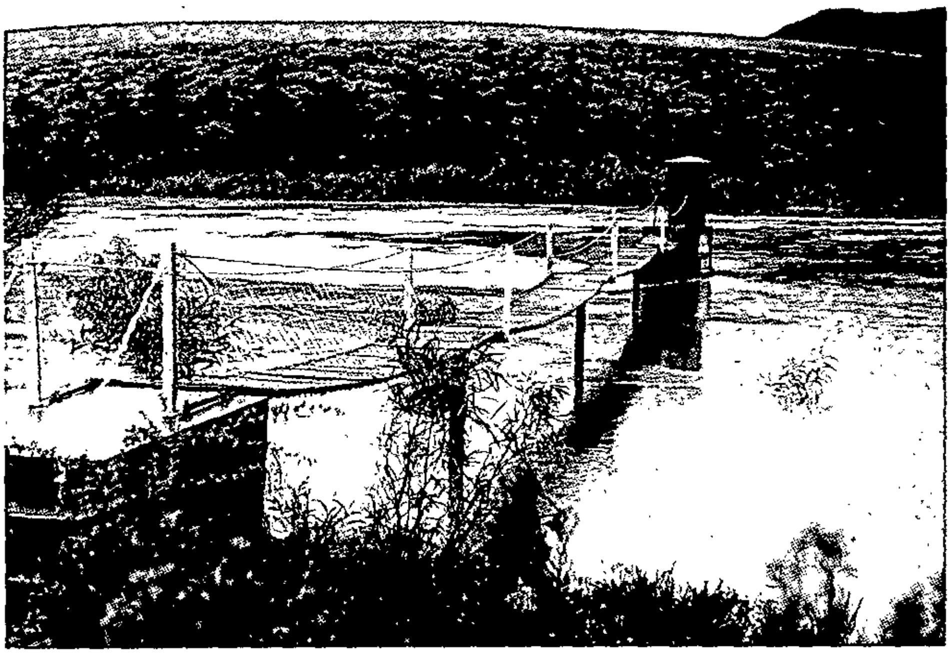


Fig. 6.6 Drie Heuwels Weir during Winter flood flow, note total submergence of weir.

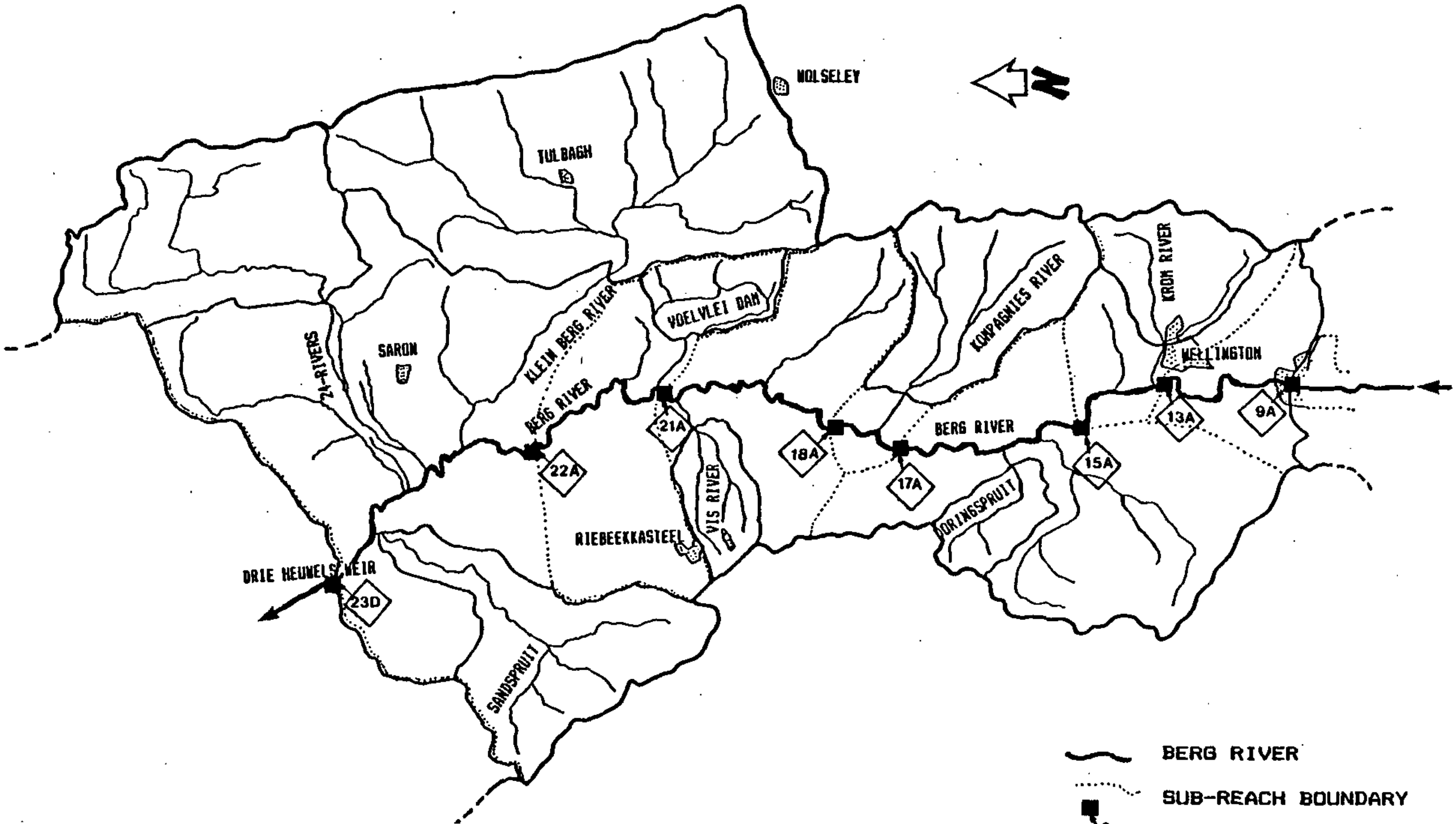


Fig 6.7. Location of sampling stations and sub-reach boundaries.

(4) Lateral inflows to the main river channel:

Gauged lateral hydrographs are available at six gauging stations on tributaries in the catchment (Stations G1M37, G1M39, G1M41, G1M40, G1M08, G1M43); two gauging weirs record effluent outfall hydrographs from the Paarl and Wellington sewage treatment works, respectively (Stations PSTW and WSTW); a gauging weir measures the dam release from Voëlvlei (Station G1R01C). The location of gauging weirs are shown in Fig 6.8. The hydrographs for each gauged tributary, effluent discharges from Paarl and from Wellington and release from Voëlvlei Dam are shown in Figs 6.9 and 6.10.

With regard to ungauged lateral inflows, these were estimated as follows: The gauged tributaries and their associated drainage areas are shown in Fig 6.11. Approximately 60 percent of the total drainage area between Paarl (gauging Station G1M20) and Drie Heuwels Weir (Station G1M13) is ungauged. However, the gauged drainage areas are relatively evenly spaced down the east and west banks of the river. Hence, the simplest method to obtain estimates of the ungauged hydrographs for each sub-reach was adopted. This method is described as follows:

(i) On a topographical map, mark-out the drainage areas of each sub-reach on the east and west banks of the main river channel.

(ii) For each sub-reach on the east and west banks respectively, determine the gauged drainage area and the ungauged area (see Table 6.2). The discharge from the ungauged areas is given by the hydrograph for the gauged area times the ungauged area divided by the gauged area (see Table 6.3). Calculations shown in Table 6.3 are performed using the program LATERL12, see Appendix 2.

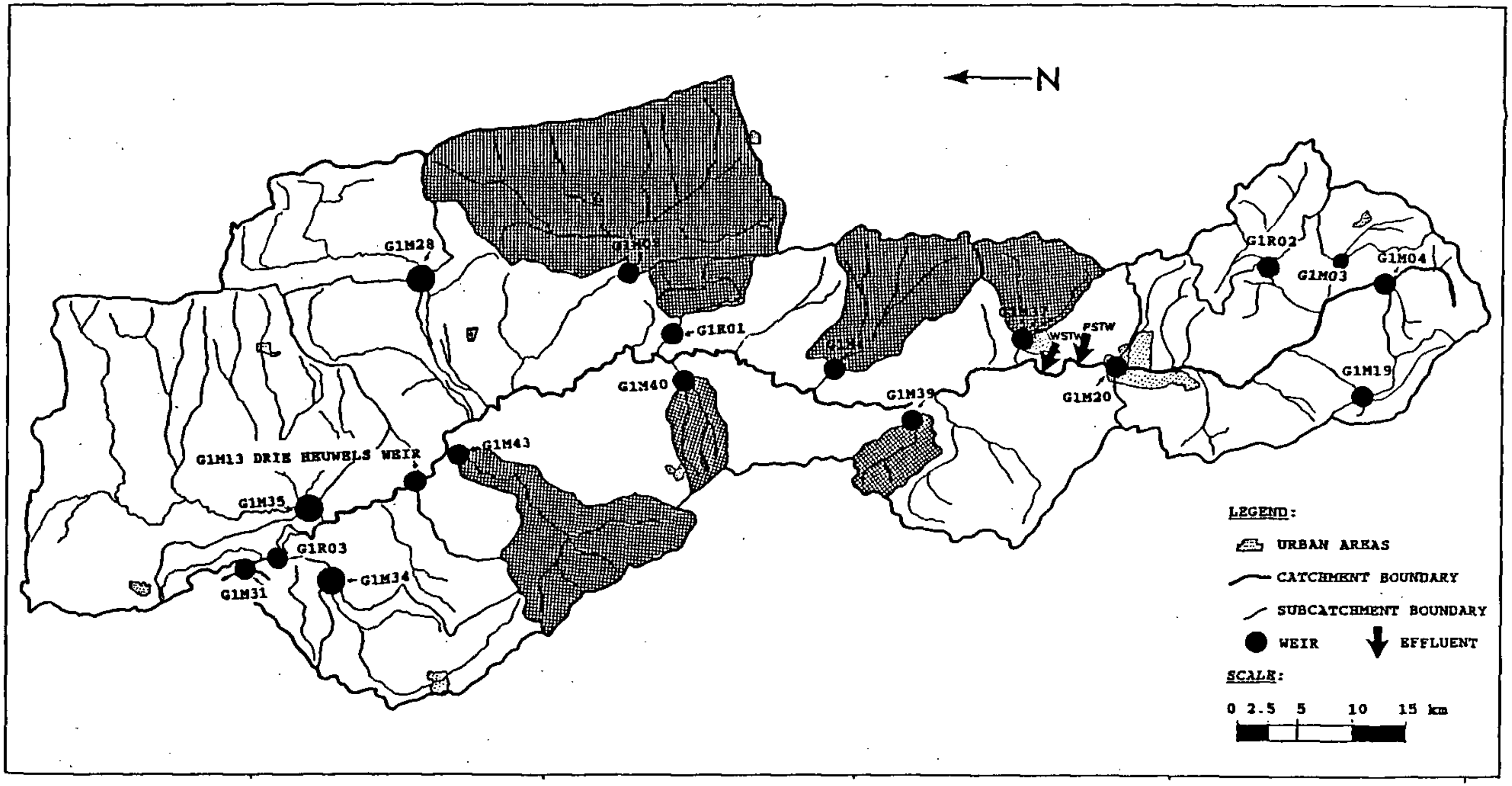


Fig 6.8. Location of flow gauging weirs.

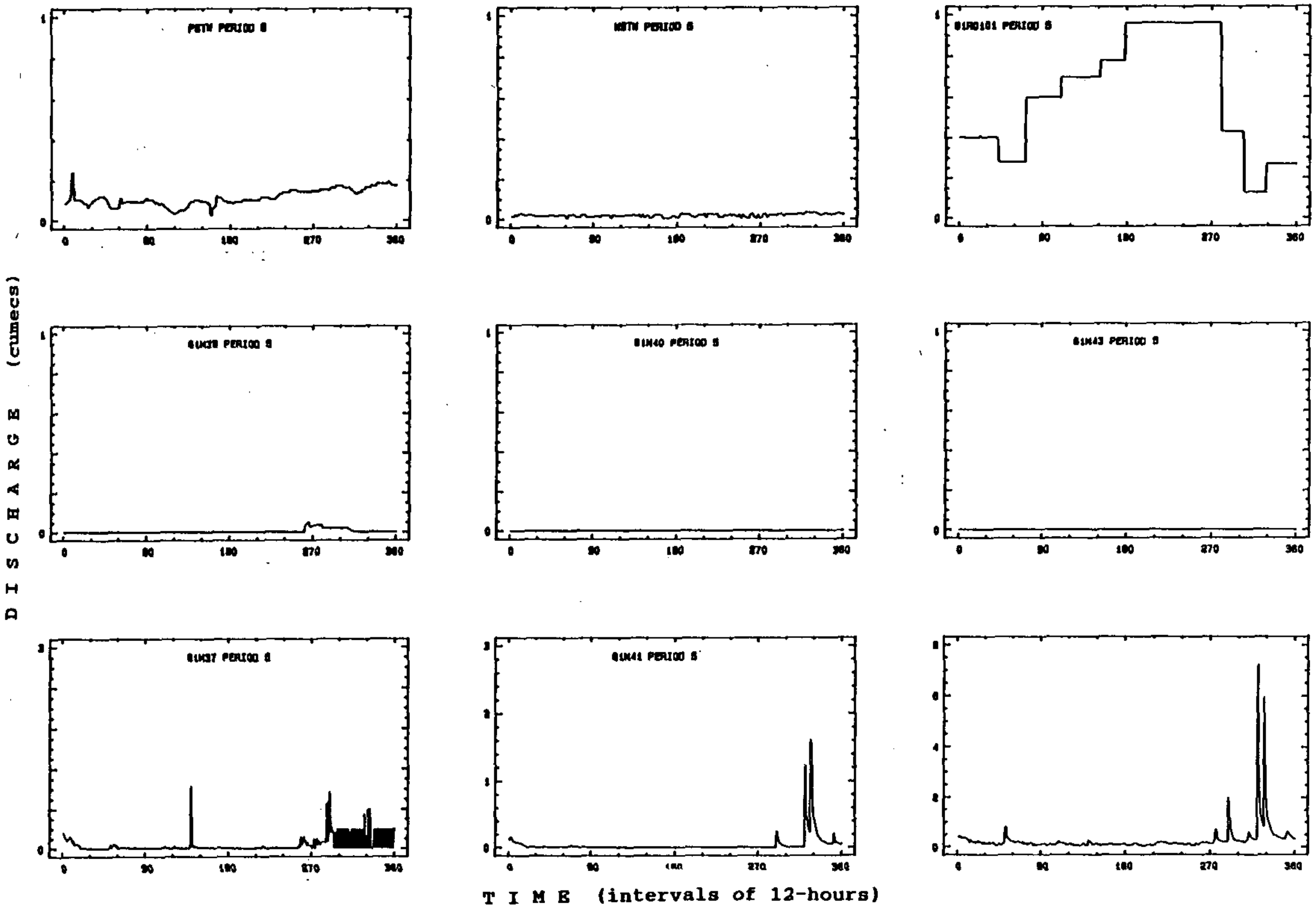


Fig 6.9. Measured lateral inflow hydrographs to the main river channel - Period 5 (summer).

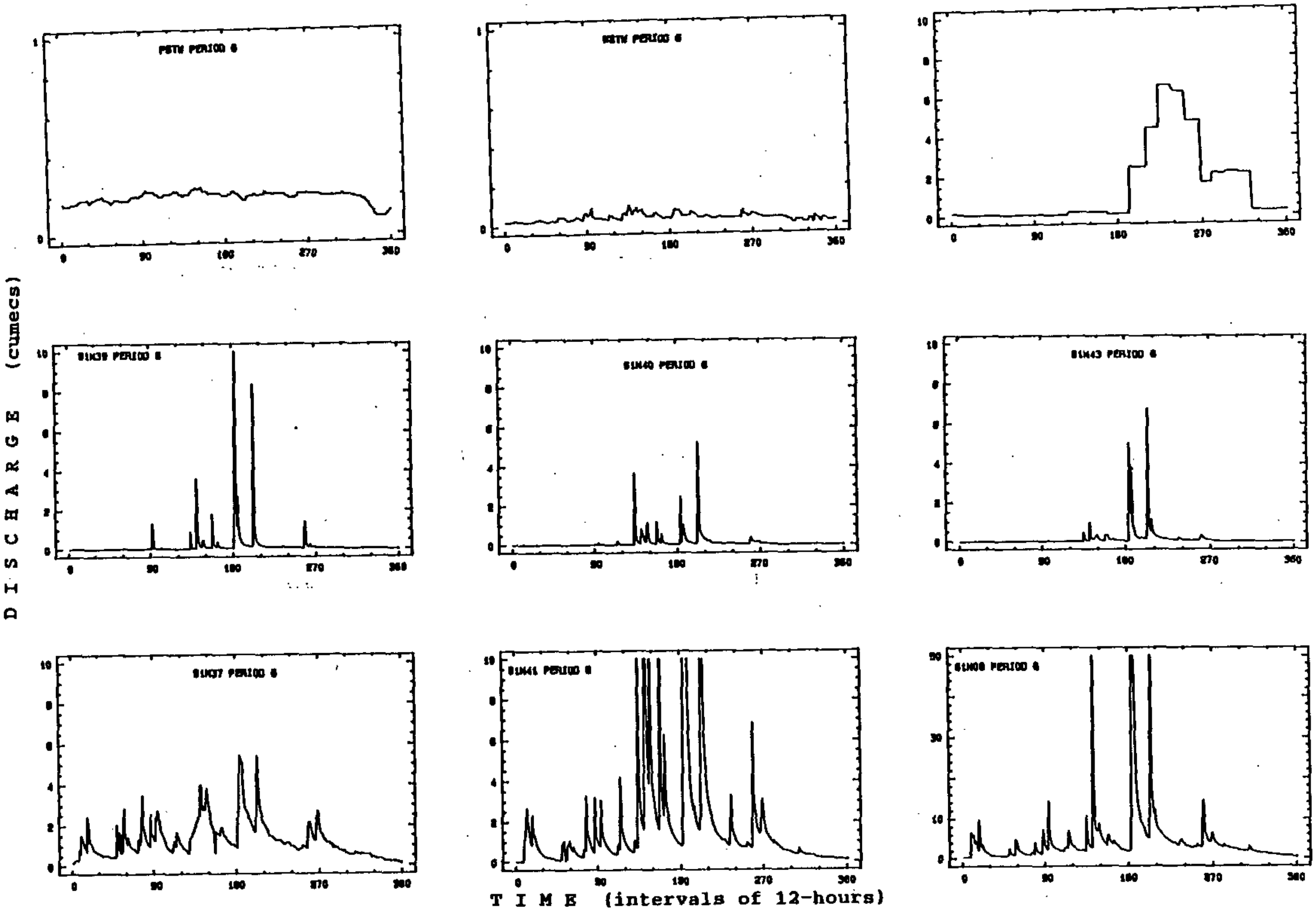


Fig 6.10. Measured lateral inflow hydrographs to the main river channel - Period 6 (winter).

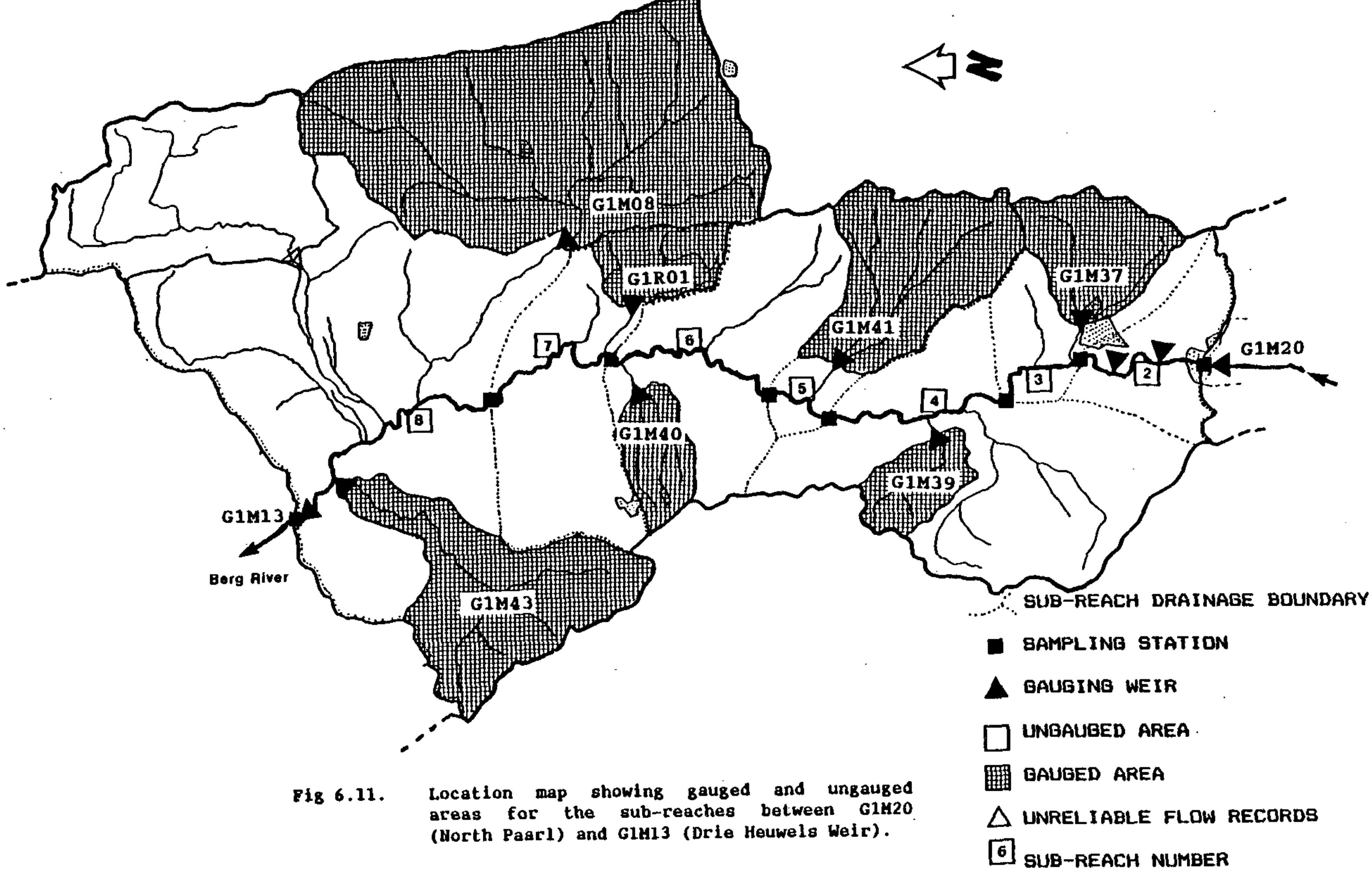


Fig 6.11. Location map showing gauged and ungauged areas for the sub-reaches between G1M20 (North Paarl) and G1M13 (Drie Heuwels Weir).

Table 6.2 Area of gauged and ungauged catchment within each sub-reach drainage area, given in km^2, see Fig 6.7.

Bank: Sub-reach:	Gauged: West:	Gauged: East:	Ungauged: West:	Ungauged: East:
2	-	-		59
3	-	52	-	96
4	37	-	225	40
5	-	120		28
6	39	-	72	92
7	-	25	168	
8	147	389	145	314

Table 6.3 Determination of lateral inflow to each sub-reach of the main river channel between Paarl and Drie Heuwels Weir. The lateral inflow is calculated as the sum of: (i) the gauged drainage i.e. G1M37, and (ii) ungauged drainage i.e. G1M37*96/52, calculated from the gauged hydrograph, G1M37, times the ungauged area (96 km^2) divided by the gauged area (52 km^2).

Bank: Sub-reach:	West:	East:
2	-	PSTW+WSTW+(G1M37*59/52)
3	-	G1M37+(G1M37*96/52)
4	G1M39+(G1M39*225/37)	(G1M41*40/120)
5	-	G1M41*(G1M41*28/120)
6	G1M40+(G1M40*72/39)	(G1M41*92/120)
7	(G1M43*168/147)	G1R01
8	G1M43+(G1M43*145/147)	G1M08+(G1M08*314/389)

(5) Estimation of the coefficients α and β in Eqs (6.4 to 6.8, 6.20 and 6.21) for each sub-reach:

The relationship suggested between the flow cross sectional area and discharge proposed by the Li, (1979) model is given by Eq (6.3) i.e.

$$A = \alpha Q^{\beta} \qquad \ldots\ldots \quad (6.22)$$

For each sub-reach α and β will differ. These were determined at each sampling station. The approach suggested by Dingman (1984) was followed to determine these constants: The flow cross sectional area is taken as a rectangle with y equal to the depth, w equal to the width, v equal to the average flow velocity and A equal to the flow cross sectional area. The discharge, Q, is given by

$$Q = A\,v = w\,y\,v \qquad \ldots\ldots \quad (6.23)$$

The flow cross sectional area, A, is determined by the procedure described in Chapter 4, Section 3.4.

The flow velocity, v, is determined either from the gauged discharge, Q, from

$$v = Q/A \qquad \ldots\ldots \quad (6.24)$$

or, if no gauging weir is located nearby, v, is determined manually as set out in Chapter 4, Section 3.4. and the discharge, Q, is determined from

$$Q = v\,A \qquad \ldots\ldots \quad (6.25)$$

Most river cross sections can be approximated by a rectangle (Dingman, 1984); in the Berg River the measurements indeed indicate a cross section approximately of this form, see Fig 6.11(a). For a series of discharges, Q, and measuring the corresponding water surface width, w, the depth, y, is determined from

$$y = A / w \qquad \ldots\ldots \quad (6.26)$$

Dingman (1984) relates w, y, and v to the river discharge, Q, using coefficients c, d, e, f, g and h

$$w = c\,Q^{d} \qquad \ldots\ldots \quad (6.27)$$

$$y = e\,Q^{f} \qquad \ldots\ldots \quad (6.28)$$

$$v = g\,Q^{h} \qquad \ldots\ldots \quad (6.29)$$

then manipulates the coefficients in Eqs (6.27 to 6.29) to determine α and β, using the following method:

The formulations, Eqs (6.27 to 6.29), imply

$$ceg = 1$$

and

$$d+f+h = 1$$

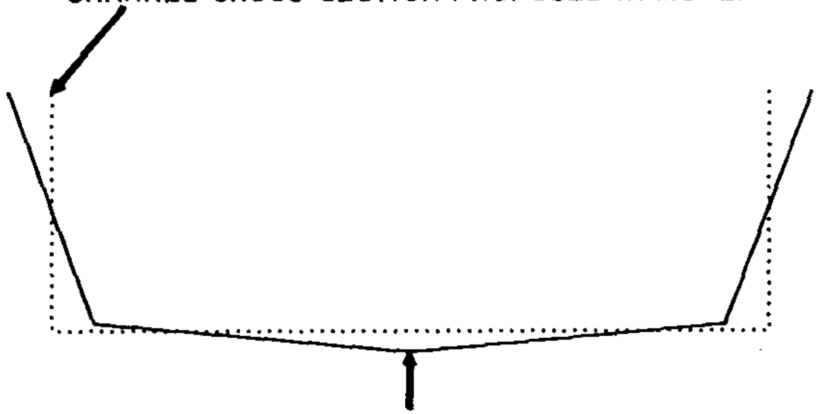
now, if we put

$$wy = Q/v = Q(Q^{-h})/g \qquad \ldots\ldots \quad (6.30)$$

then

$$ce = 1/g \qquad \ldots\ldots \quad (6.31)$$

CHANNEL CROSS-SECTION PROPOSED IN MODEL



TYPICAL CHANNEL CROSS-SECTION FOUND IN SOUTH AFRICAN RIVERS

Fig 6.11(a). Schematic diagram showing the typical channel cross-section found in South African rivers, and the cross-section used in the hydrodynamic flow model.

and

$$d+f = 1-h \qquad \ldots\ldots \quad (6.32)$$

this leads to

$$\alpha = 1/g \qquad \ldots\ldots \quad (6.33)$$

$$\beta = 1-h \qquad \ldots\ldots \quad (6.34)$$

The values for w, y and v for each station on the main channel were determined as described above. After plotting y, w and v separately against discharge Q (see Fig 6.12), a curvilinear least squares regression for each was used to determine the coefficients c, d, e, f, g and h (program REGRESS, see Appendix 2). The final coefficients α and β were then computed using Eqs (6.33 and 6.34). The computed values for α and β for each station along the main river channel are shown in Table 6.4 and illustrated in Fig 6.13, showing plots of log A versus log Q. It is evident that the values do not differ greatly.

Table 6.4 Channel geometry coefficients α and β.

station:	α:	β:
13B	1.80	0.85
15A	1.85	0.87
17A	1.65	0.95
18A	1.75	0.86
21A	1.85	0.85
22A	2.47	0.95
23D	2.20	0.99
Mean:	1.92	0.90

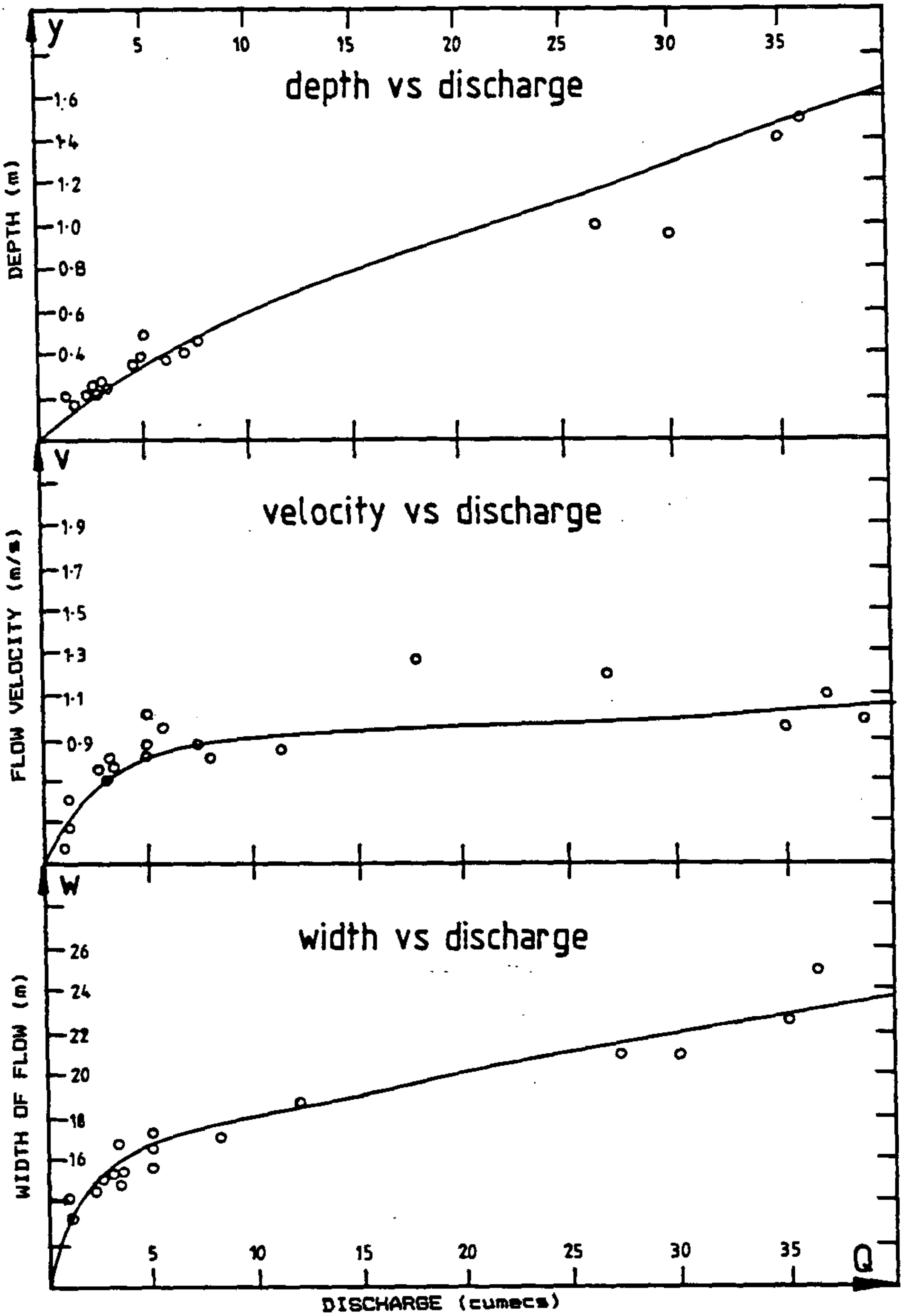


Fig 6.12. River channel depth (y), flow velocity (v) and flow width (w) plotted as a function of discharge (Q) at Station 13B (Lady Loch Bridge).

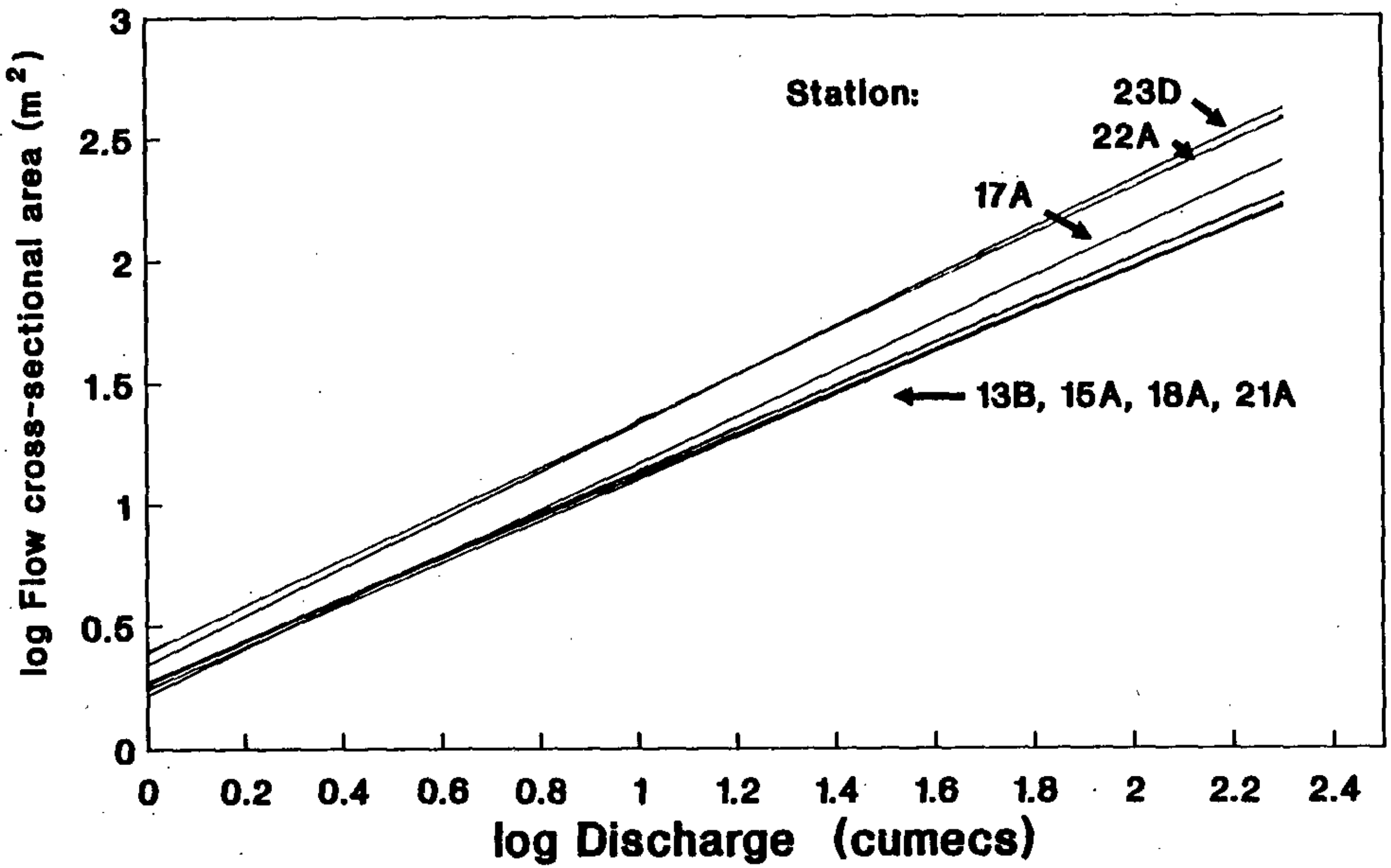


Fig 6.13. Plot of log river discharge versus log flow cross-sectional area for stations located along the main river channel.

Leliavsky (1959) discusses this formulation and concludes that it tends to constant values for special situations. He gives the "Indian" values for α and β which we can convert to the metric equivalents, α=2.23 and β=0.83. These values caused the rising and falling limbs of the simulated hydrograph to precede the measured ones. Good fits were obtained with the values for α and β shown in Table 6.4. It would appear that in the event of no data being available for α and β, good fits can be obtained by trial simulations for a set of paired values in the neighbourhood of α=2.00 and β=0.90.

(6) Time and space weighting factors in Eqs (6.4 to 6.8, 6.20 and 6.21):

The weighting factors a and b in the implicit numerical solution method are not directly influenced by physical conditions in the catchment. Rather, they are pertinent only to the mathematics of the numerical solution technique and the time and space steps used in the input data. This suggests the use of a trial-and-error approach when investigating their effect on model output (Keefer, 1976).

Two guidelines are available: firstly, the values must lie between zero and 0.5 otherwise the solution becomes unstable if values outside these limits are used, and secondly, setting both values to zero, the scheme becomes explicit (Richtmyer and Morton, 1957). An explicit scheme solves the unknown discharge directly in terms of the known ones. The implicit method does not predict the discharge directly from the equation but determines the discharge by iteration; it is more accurate then the explicit method, is more stable and during peak flow conditions and gives predictions that can be significantly higher than the explicit method.

The most appropriate values for a and b were found only after the model was in operation. Initially arbitrary values for a and b equal to 0.3 were used in the model calibration and afterwards a range of values were tested to determine the influence of a and b on the simulations (see Figs 6.14 to 6.17). The value 0.4 for the time-weighting factor a, and 0.3 for the space-weighting factor b, appeared to provide the most favourable results.

(7) Main channel losses:

Having dealt with ungauged inflow it is now appropriate to examine the influence of ungauged channel losses. This was done as follows: The winter period calibration was done against the data set for the wet period not taking lateral outflows into account - it was assumed that during the wet periods the channel losses due to seepage and abstraction would be only an insignificant fraction of the channel flow. Applying the model thus calibrated the model consistently over-estimates the channel flow at Drie Heuwels Weir during dry periods. To accommodate channel losses, a constant term for flow losses per sub-reach length was incorporated. The "best" value was estimated by trial simulations of the model with different abstraction rates until such time as the difference between the simulated and measured hydrographs at Drie Heuwels Weir was minimised. An in-channel loss of 0.05 cumecs per sub-reach gave best overall improvement to the hydrograph at Drie Heuwels Weir during the low flow periods (Fig 6.18), this rate had virtually no effect on the high flow predictions.

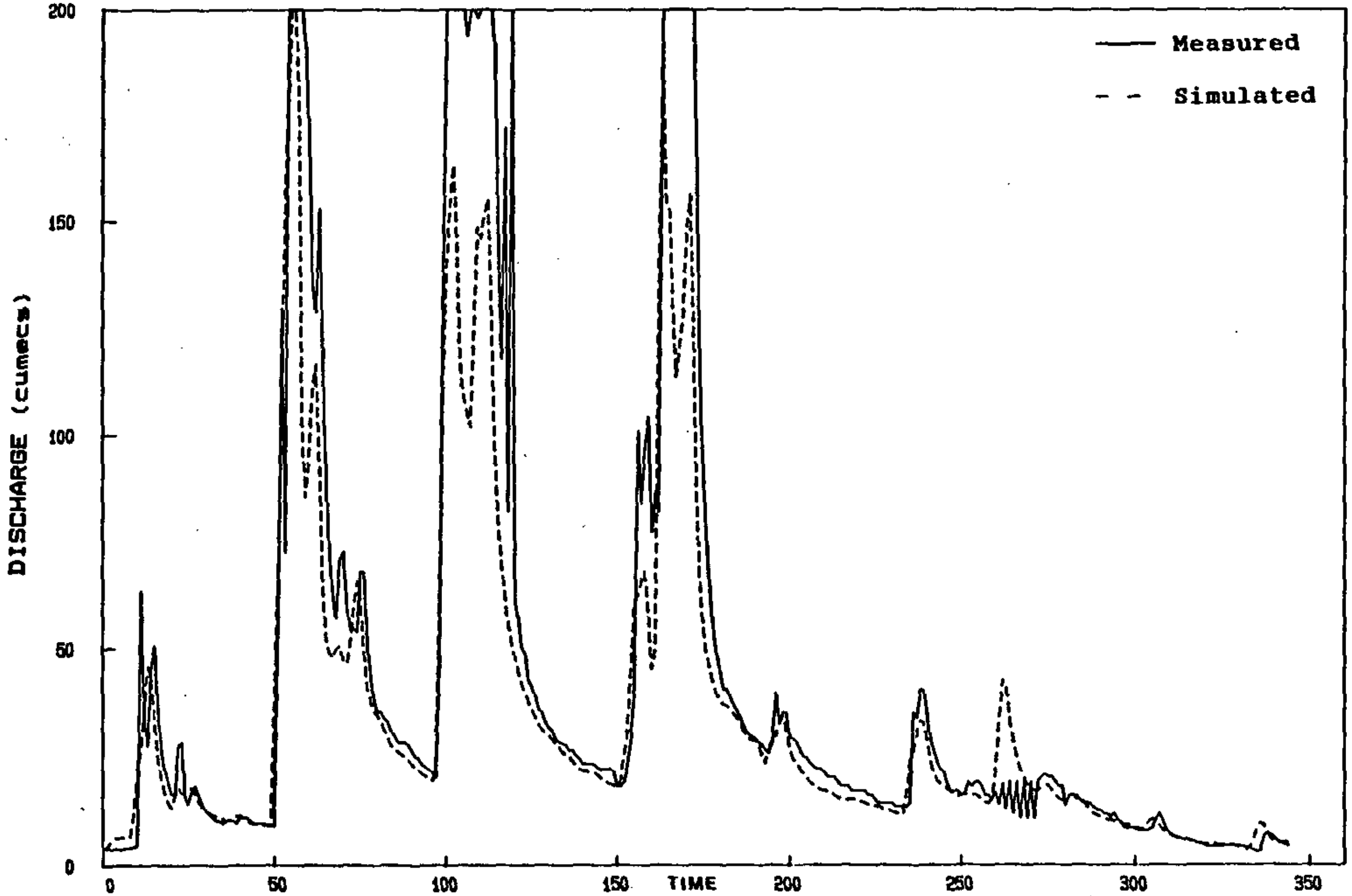


Fig 6.14. Measured and simulated hydrographs for Drie Heuwels Weir using weighting coefficients of value a=0 and b=0 for Period 4.

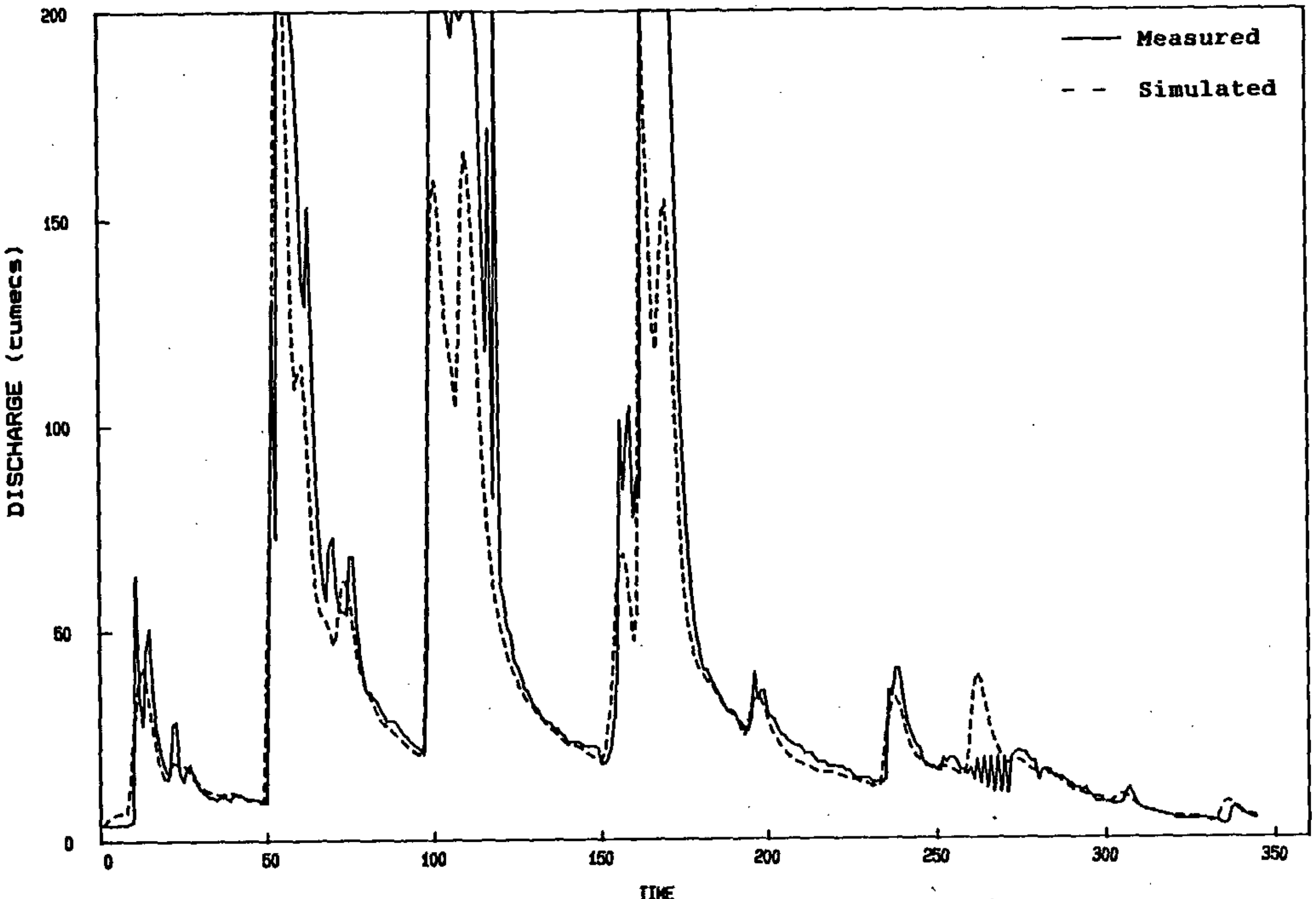


Fig 6.15. Measured and simulated hydrographs for Drie Heuwels Weir using weighting coefficients of value a=0.2 and b=0.2 for Period 4.

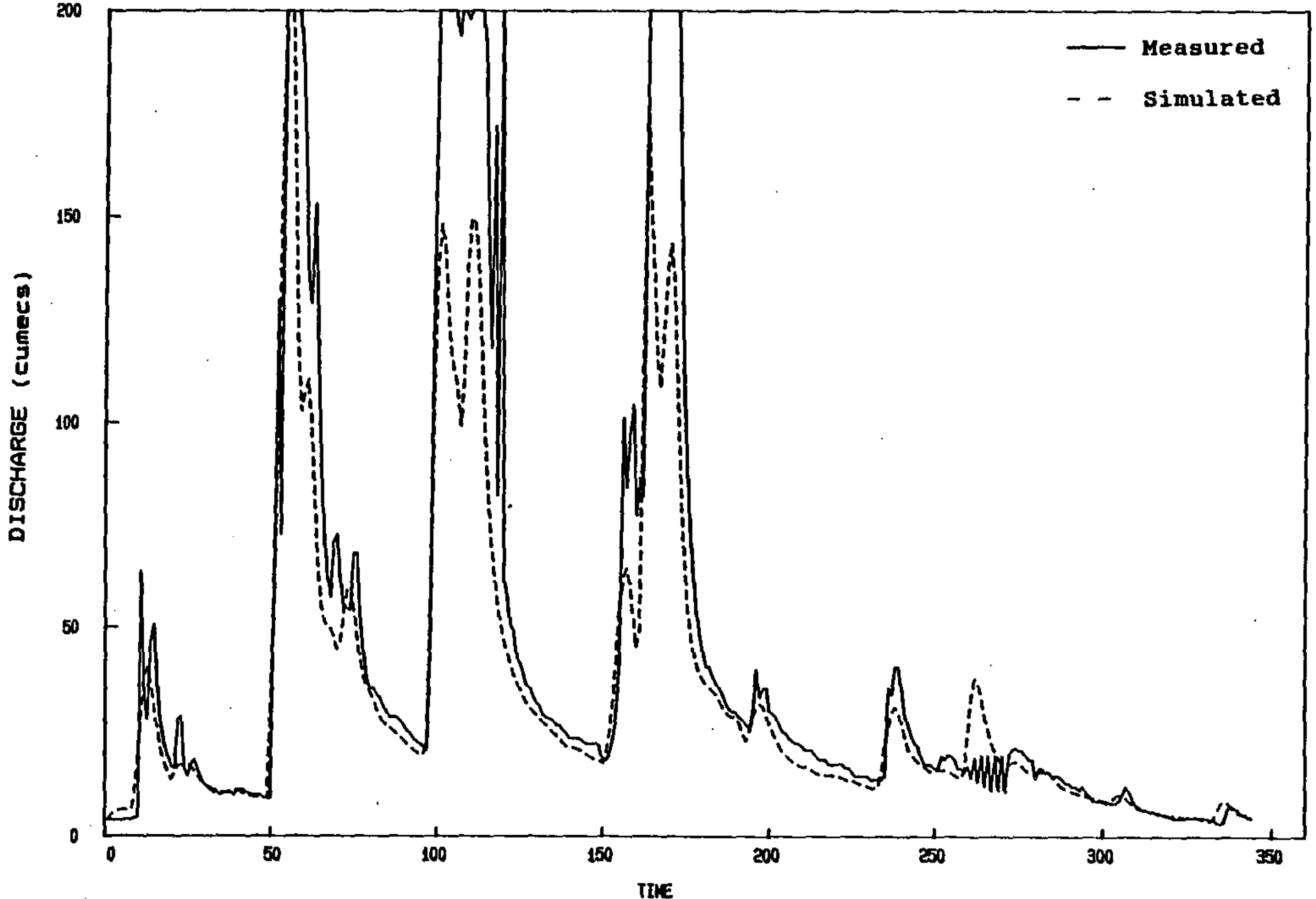


Fig 6.16. Measured and simulated hydrographs for Drie Heuwels Weir using weighting coefficients of value a=0.1 and b=0.4 for Period 4.

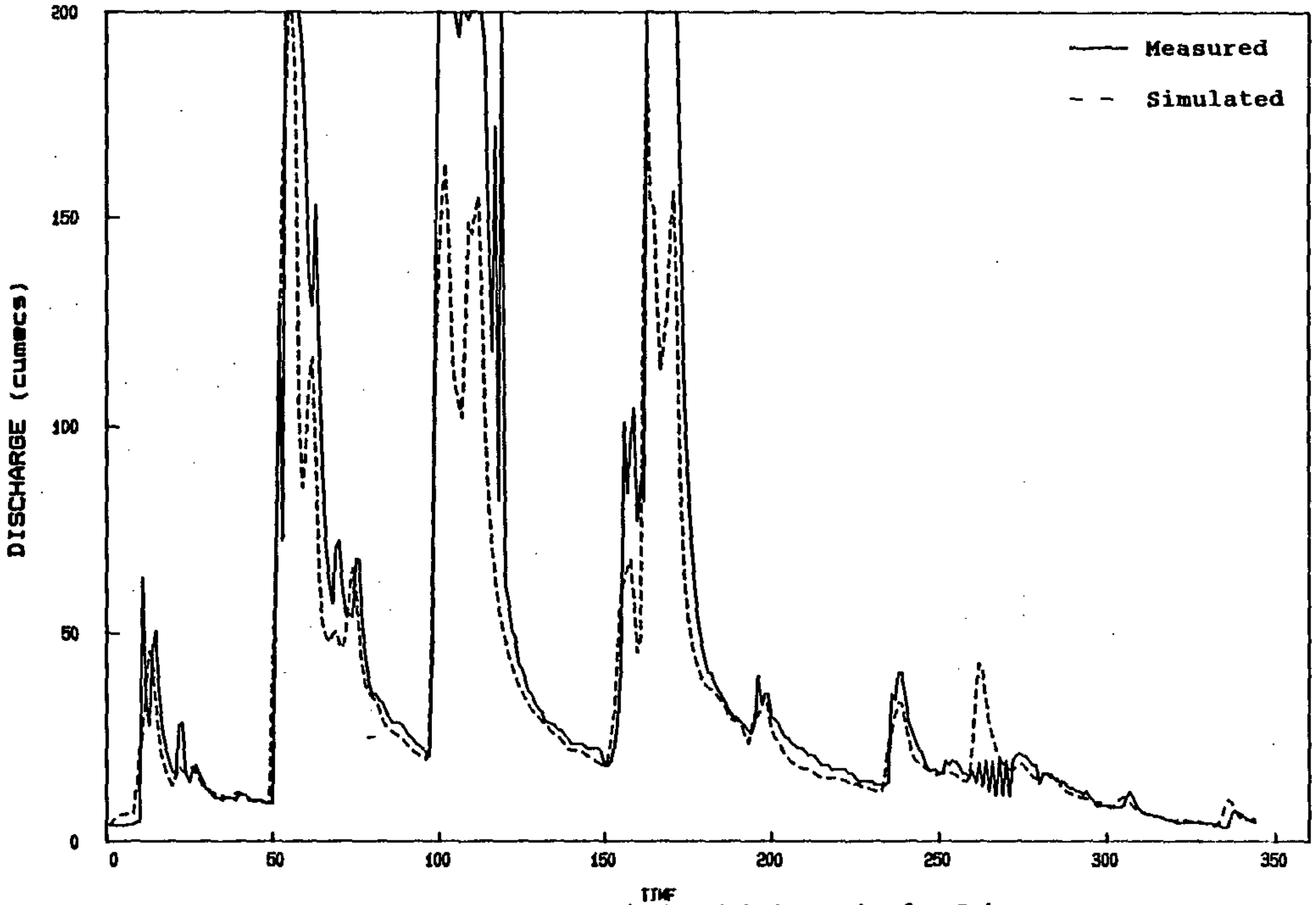


Fig 6.17. Measured and simulated hydrographs for Drie Heuwels Weir using weighting coefficients of value a=0.4 and b=0.3 for Period 4.

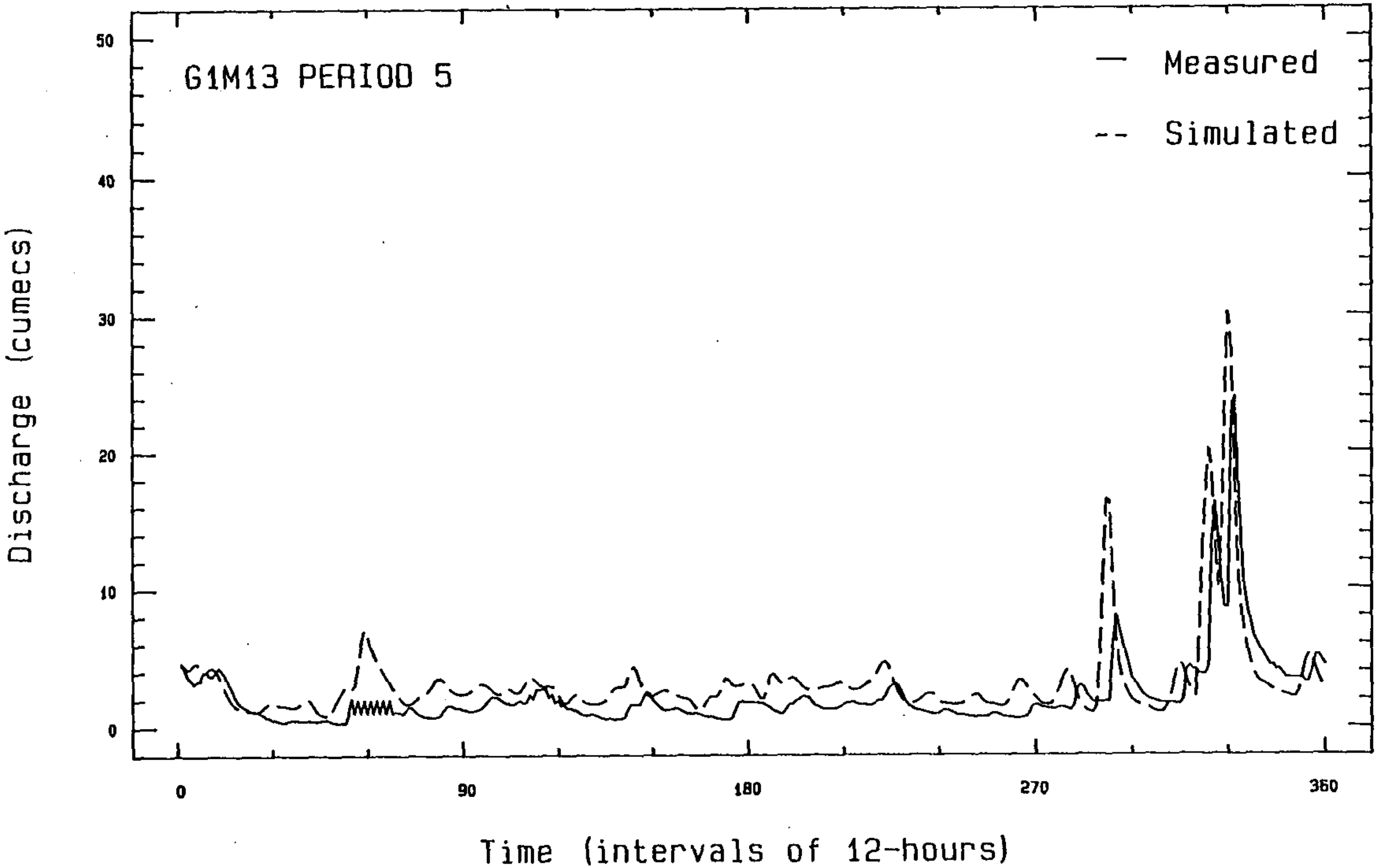


Fig 6.18. Simulated and measured hydrograph for Drie Heuwels Weir - Period 5.

4.3 Calibration trials

(1) Continuity and the numerical technique:

It is necessary to check in what measure the implicit and explicit numerical techniques conserve the continuity condition implied by the continuity (wave) equation, Eq (6.1). To do this, at the top gauging station G1M20, an idealized hydrograph input was made: comprising an event period of 10 days, a continuous input of 10 cumecs and a superimposed equilateral triangular flood wave of 4 days duration, rising to 100 cumecs, to give a peak total flow of 110 cumecs, Fig 6.19. Allow no lateral inflows and outflows, and select 12 hours as the time element.

The hydrograph generated at Drie Heuwels Weir, Station G1M13, also is shown in Fig 6.19. The following can be noted

(i) There is a time shift of approximately 24-hours, the estimated time of travel down the 90 km long channel.

(ii) There is virtually no or only slight attenuation of the flood wave. Theoretically with the kinematic wave approximation there should be no attenuation but Li (1979) intimates that the numerical technique gives rise to a slight pseudo-attenuation effect.

(iii) The implicit and explicit solution are virtually identical; differences only become apparent when a multiple peak input hydrograph is used. In "real life" simulations on the Berg River, observable differences were found between the two methods, so that the implicit method, which theoretically should be more accurate, was used in preference to the explicit method.

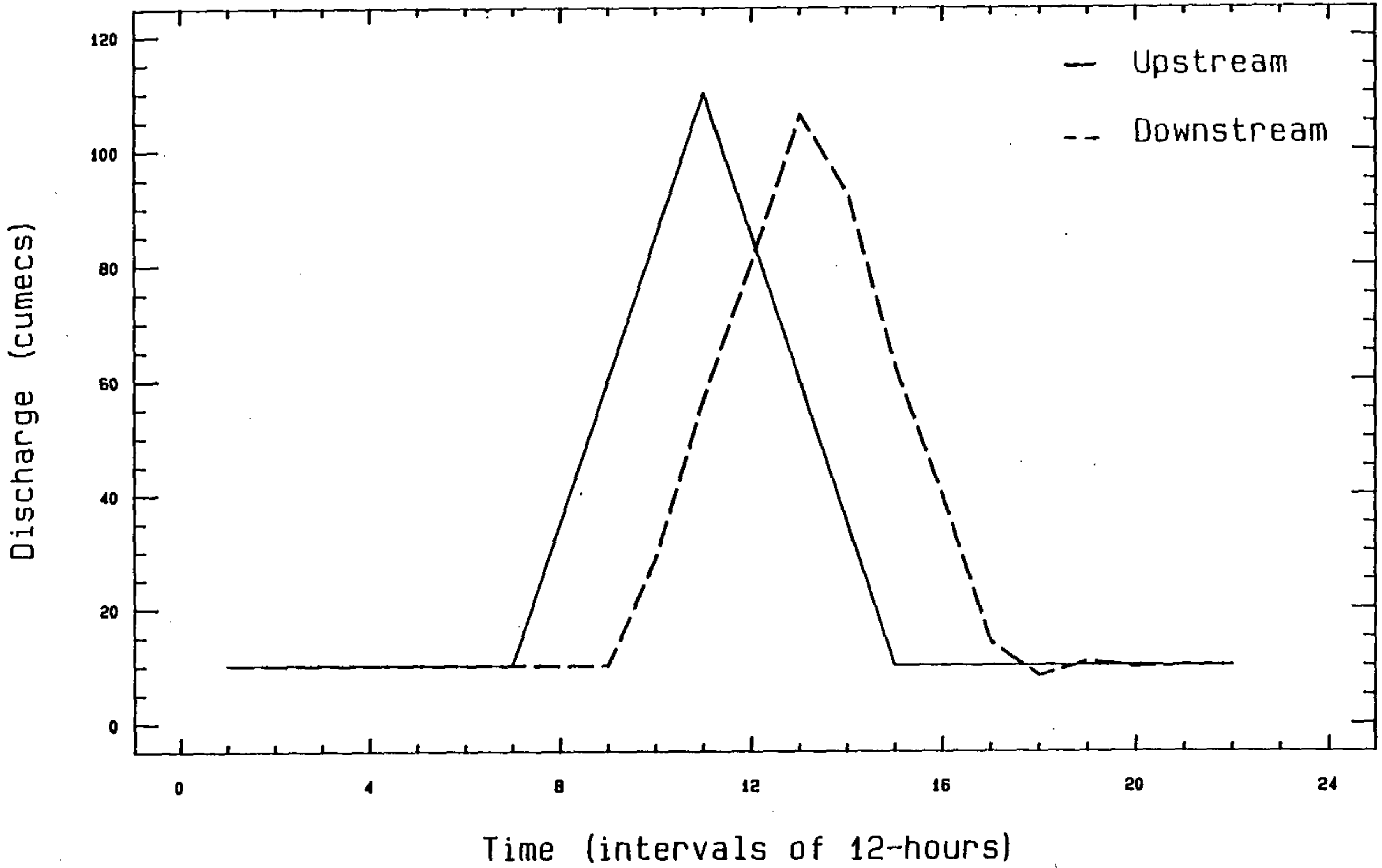


Fig 6.19. Upstream "test" hydrograph and simulated downstream hydrograph. The downstream hydrograph shows some attenuation and is shifted in time by 24-hours.

(iv) From a print-out of the generated hydrograph, the total discharge at Drie Heuwels Weir was calculated over the 10 day interval and compared with the total upstream input at Paarl.

Input mass flow	=	25.920 million cubic metres
Output mass flow	=	25.894 million cubic metres
Error	=	-0.0259 million cubic metres
	=	-0.01 percent

For all practical purposes the numerical technique satisfies continuity.

(2) *Model calibration* - Wet season:

The input data for Period 6, a wet period (May 1986 to November 1986) are shown in Fig 6.3 for the upper channel hydrograph and the lateral input hydrographs in Fig 6.10. Accepting: (i) the flow constants α and β shown in Table 6.4; (ii) the time and spatial weighting coefficients a=0.4 and b=0.3 in the numerical solution procedure; (iii) the method of estimating the ungauged runoff hydrograph (explained earlier) and (iv) the implicit numerical technique; a trial simulation was run over the time period of 180-days to determine the hydrograph at Drie Heuwels gauging weir. In Fig 6.20 the measured and simulated hydrographs are shown.

It is at once apparent that the simulated and observed hydrographs are in reasonable accord provided the flood flows do not exceed about 120 to 150 cumecs. With higher flows the differences become gross. At high flows the predicted results provide support for the earlier observations that the discharge calibration at Drie Heuwels

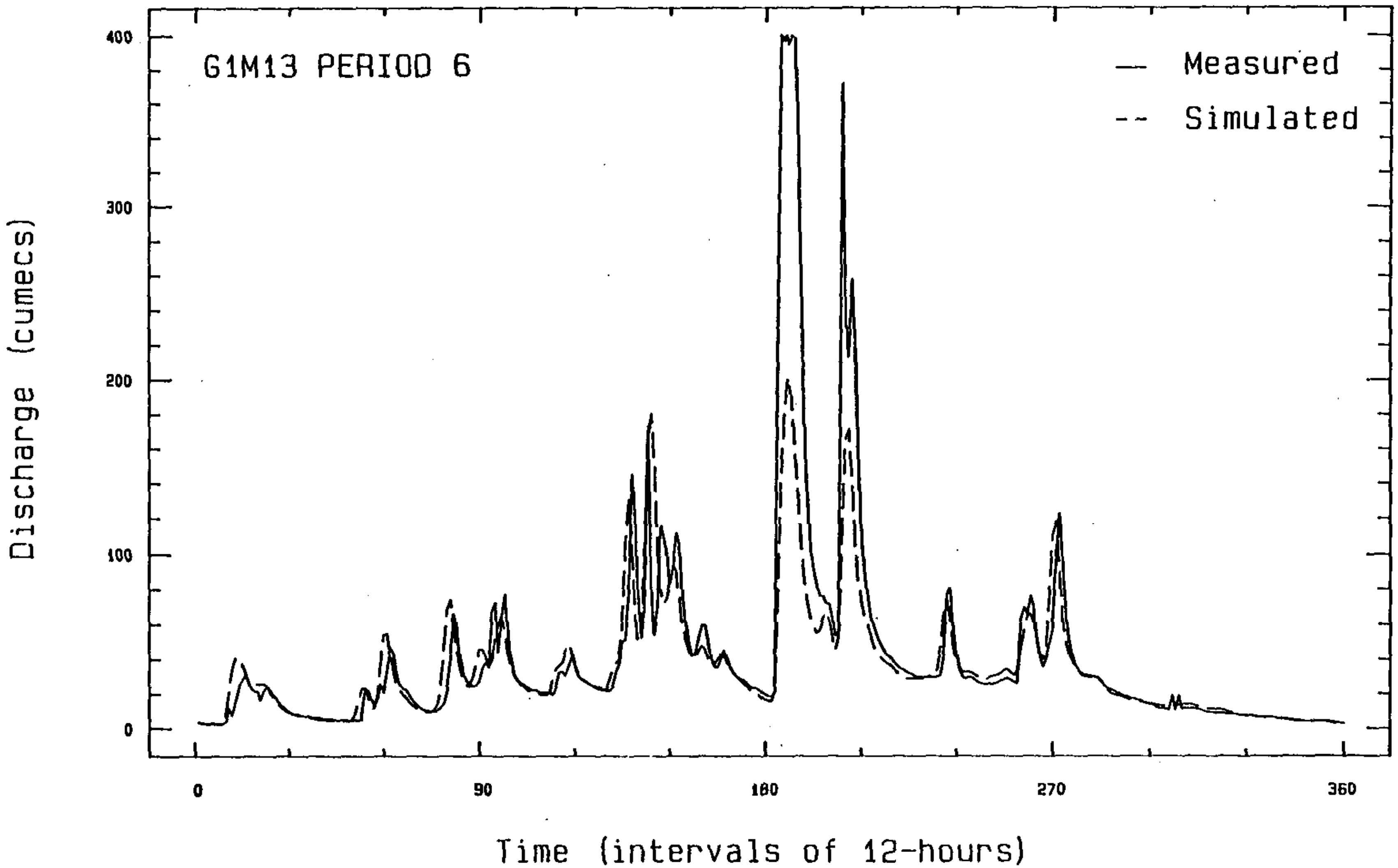


Fig 6.20. **Simulated and measured hydrograph for Drie Heuwels Weir - Period 6.**

Weir becomes grossly in error at discharge values in excess of about 120 cumecs. There is sufficient evidence to accept that observed discharges greater than about 120 cumecs should not be admitted in the river analysis.

(3) Model Calibration - Dry season:

The model was applied without modification to simulate the dry season Period 5 (November 1985 to May 1986). The input hydrograph at Paarl is shown in Fig 6.3 and the lateral flow hydrographs in Fig 6.9.

The predicted and observed hydrographs at Drie Heuwels Weir are shown in Fig 6.18 (to a larger scale for clarity). It is clear that the model consistently over-estimates the flow at Drie Heuwels Weir, probably due to seepage and due to abstraction for irrigation by farms along the banks of the main river channel. To accommodate these it was found by trial that a loss rate of 0.1 cumec per sub-reach brought the low flow hydrograph pattern into line with the observed. This implies an outflow of about 0.7 cumecs over the seven sub-reaches, spanning a 89 km length of river. Period 5 (1985-1986) was an exceptionally hot and dry summer season and this is a likely cause for the high outflow rate. Considering the dry Periods 1 and 3, these required much lower outflow rates, of 0.05 cumecs per sub-reach to give a good fit to the respective low flow hydrographs.

5 MODEL VERIFICATION - MONITORING PERIOD

To verify the calibration of the model given above, the model is used to simulate the hydrographs at Drie Heuwels Weir for Periods 1 to 4 using:

(i) the measured channel hydrograph at Paarl (G1M20), Fig 6.21,

(ii) lateral inflow hydrographs, see Fig 6.21(a),

(iii) main channel outflow rate of 0.05 cumecs per sub-reach,

(iv) channel geometry coefficients in Table 6.4,

(v) time and space weighting factors of a=0.4 and b=0.3.

The measured and simulated hydrographs at Drie Heuwels, are shown in Figs 6.22 to 6.27 all plotted to the same scale. Observed flows in excess of 120 cumecs are not plotted because these are shown to be unreliable. In Figs 6.28 to 6.30, observed and simulated flows during the dry periods 1, 3 and 5 are shown plotted to a discharge scale eight times larger than that in Figs 6.22 to 6.27.

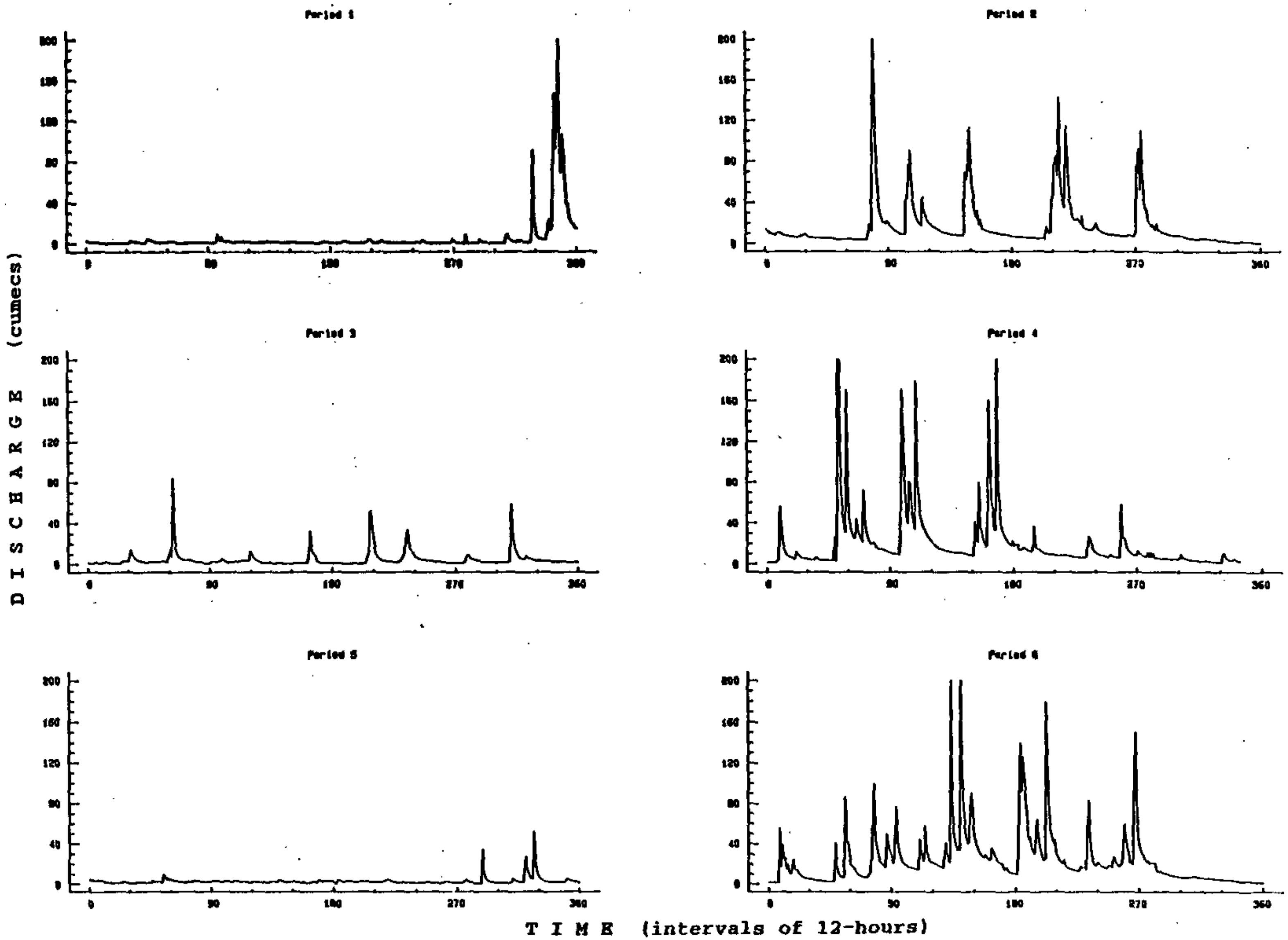


Fig 6.21. Measured hydrographs at G1H20 (North Paarl) for Periods 1 to 6.

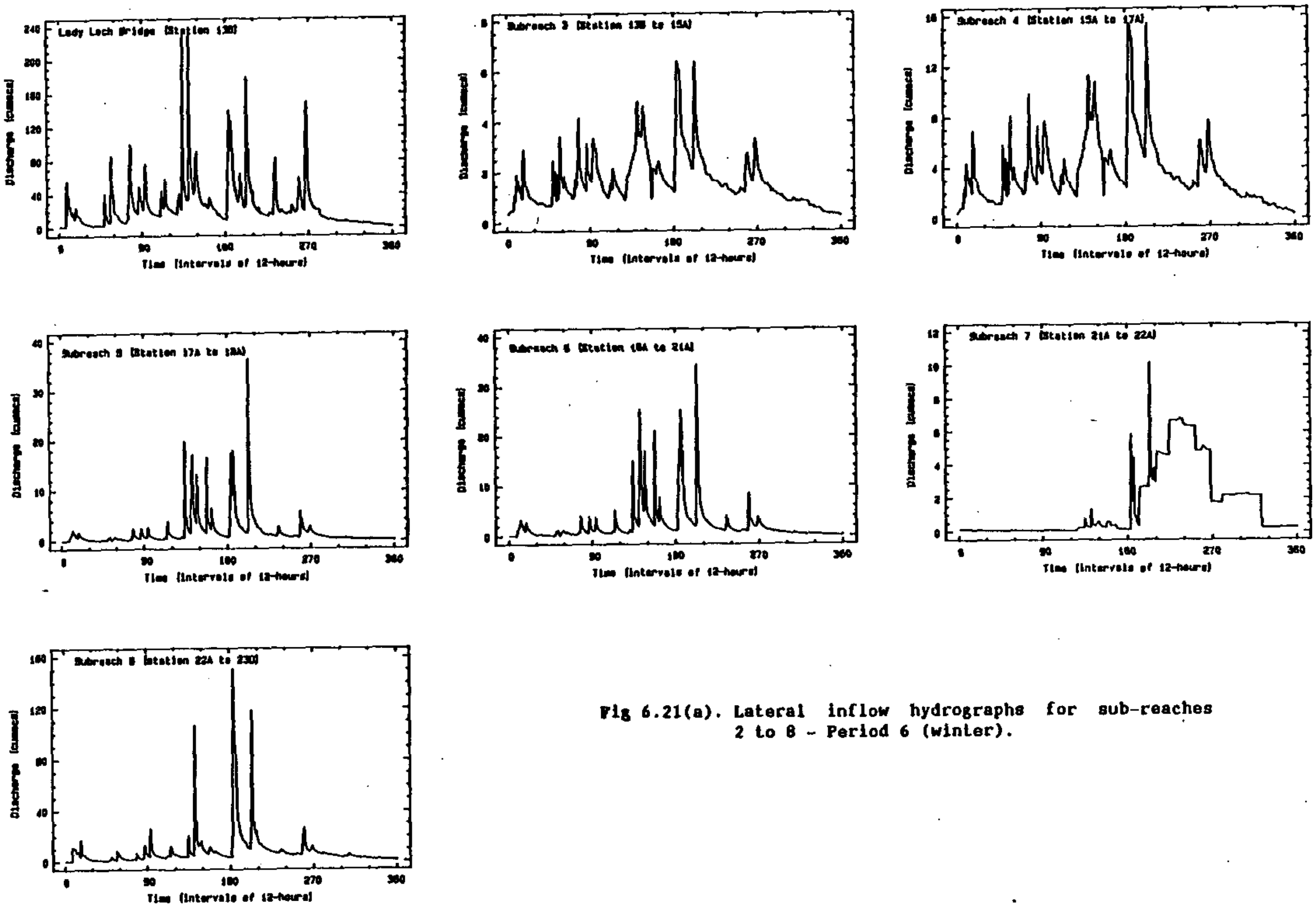


Fig 6.21(a). Lateral inflow hydrographs for sub-reaches 2 to 8 - Period 6 (winter).

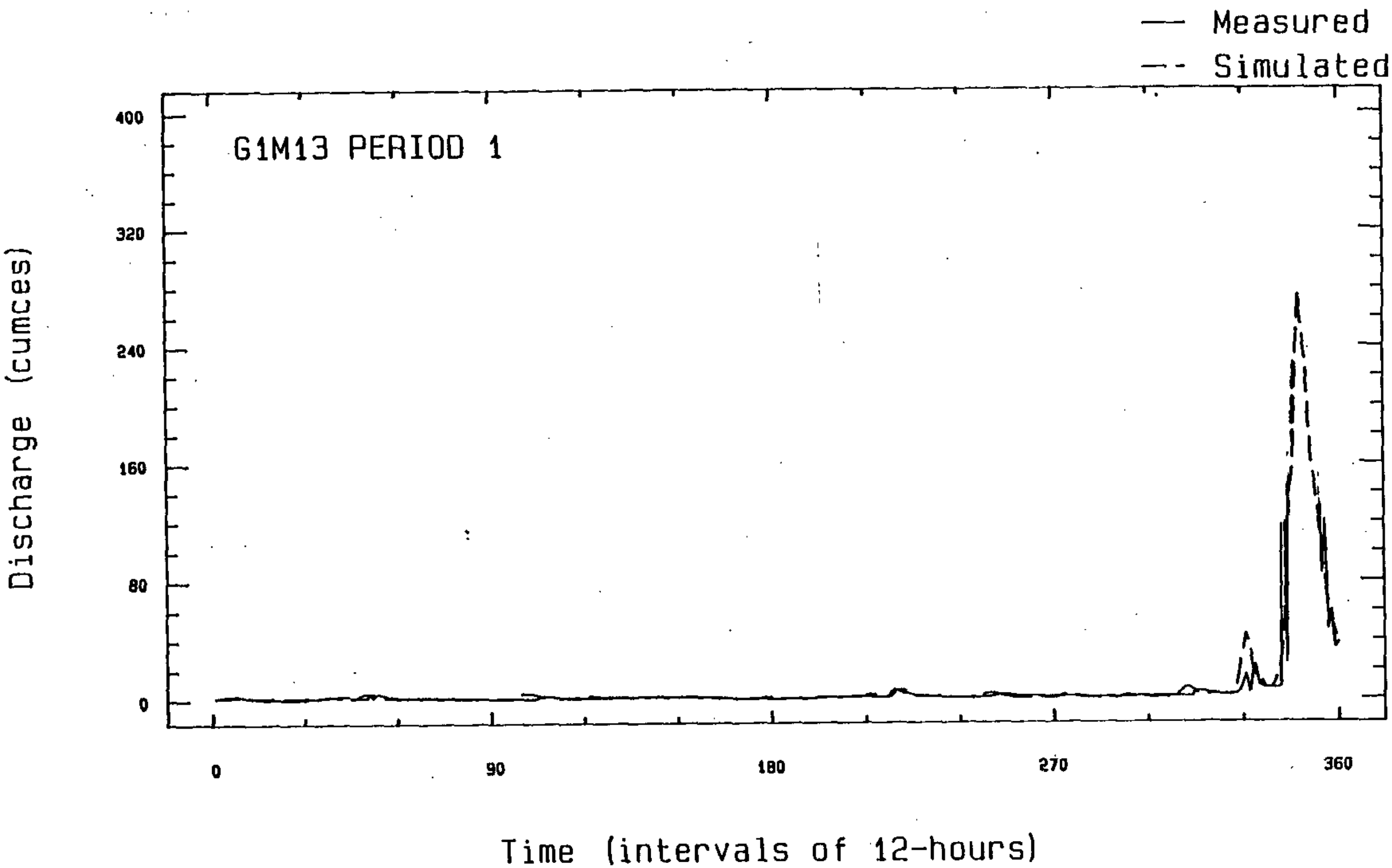


Fig 6.22. **Simulated and measured hydrograph for Drie Heuwels Weir (G1M13) - Period 1. All measured discharges in excess of 120 cumecs are not plotted.**

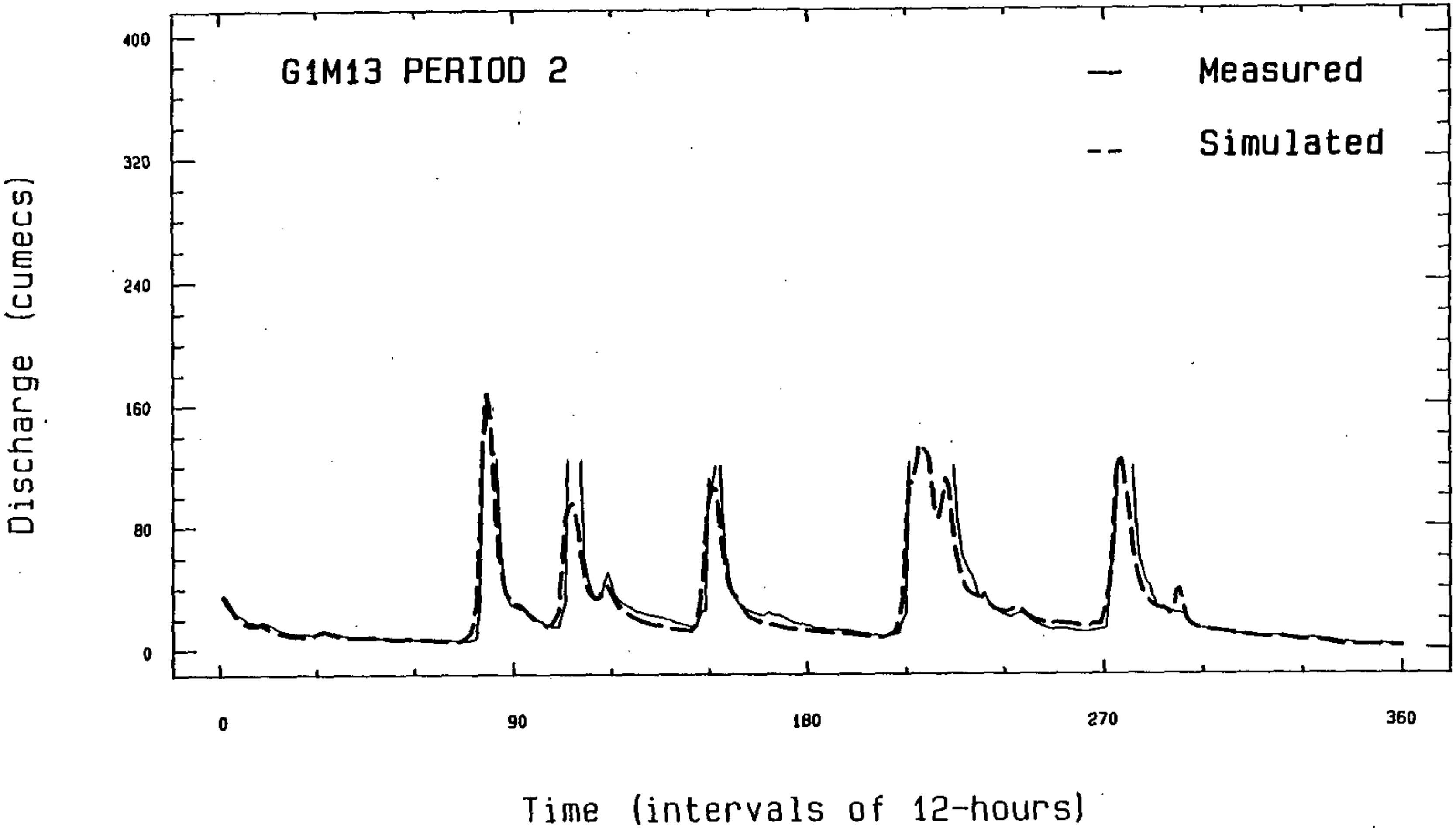


Fig 6.23. Simulated and measured hydrograph for Drie Heuwels Weir (G1M13) - Period 2. All measured discharges in excess of 120 cumecs are not plotted.

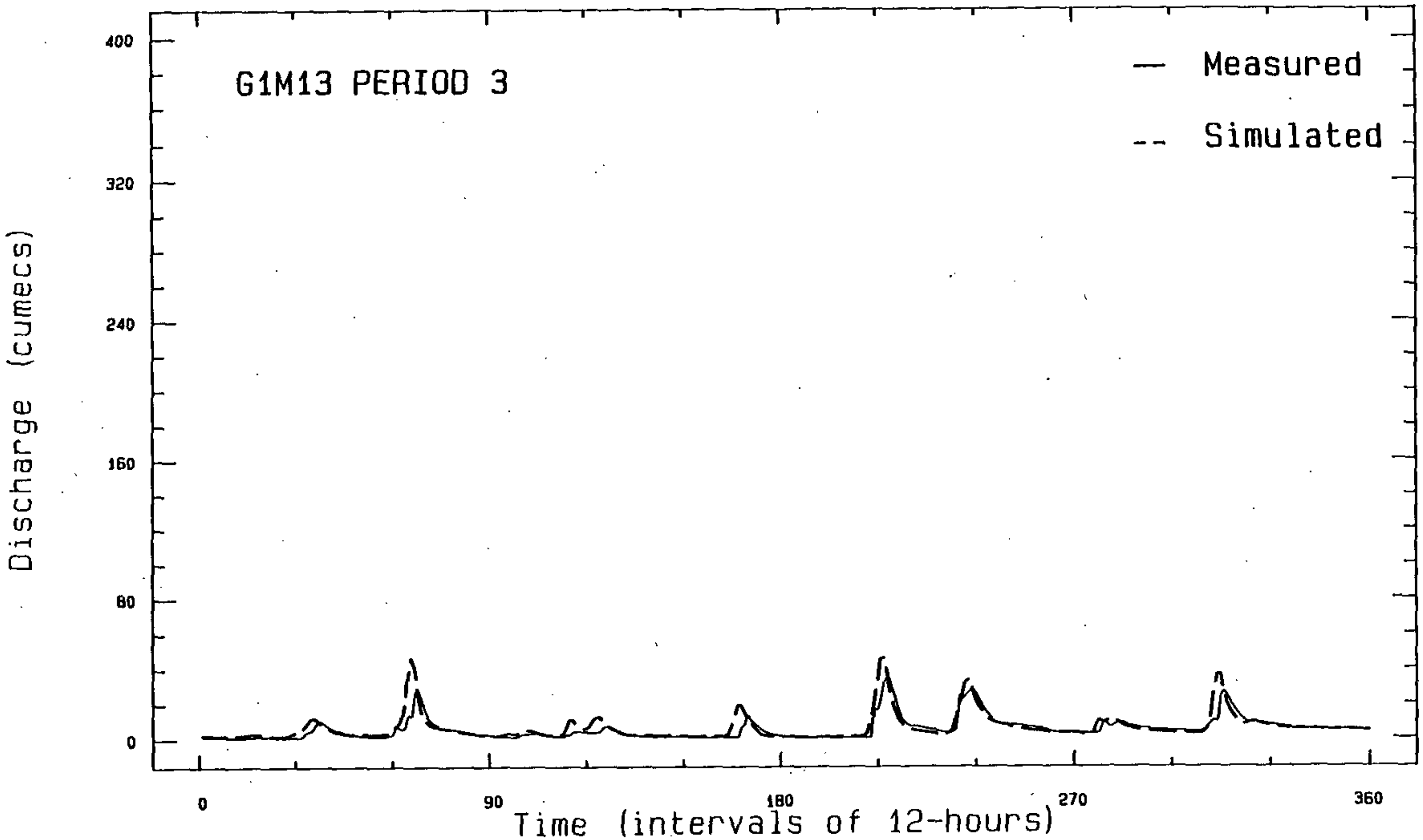


Fig 6.24. **Simulated and measured hydrograph for Drie Heuwels Weir (G1M13) - Period 3. All measured discharges in excess of 120 cumecs are not plotted.**

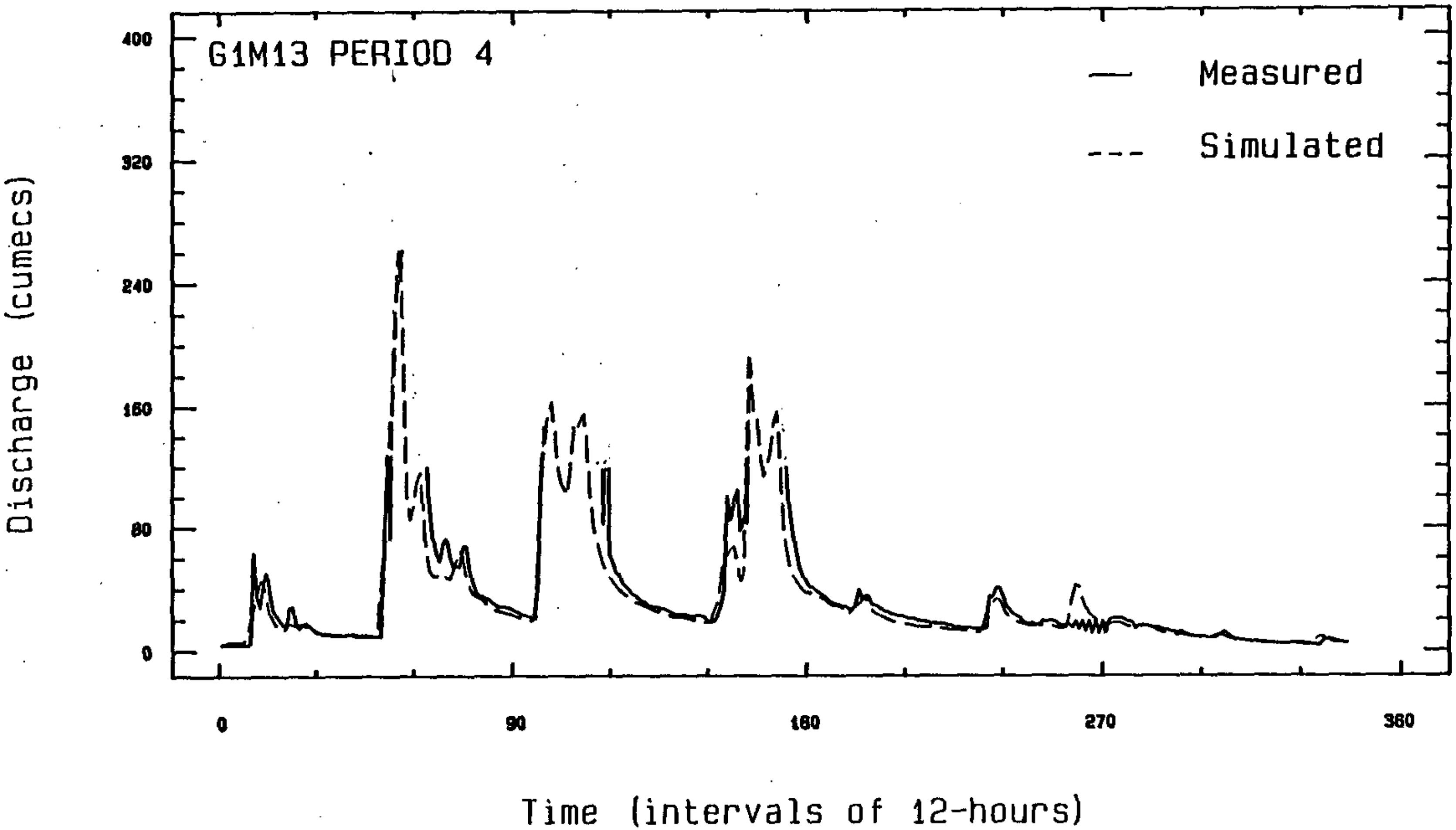


Fig 6.25. **Simulated and measured hydrograph for Drie Heuwels Weir (G1M13) - Period 4. All measured discharges in excess of 120 cumecs are not plotted.**

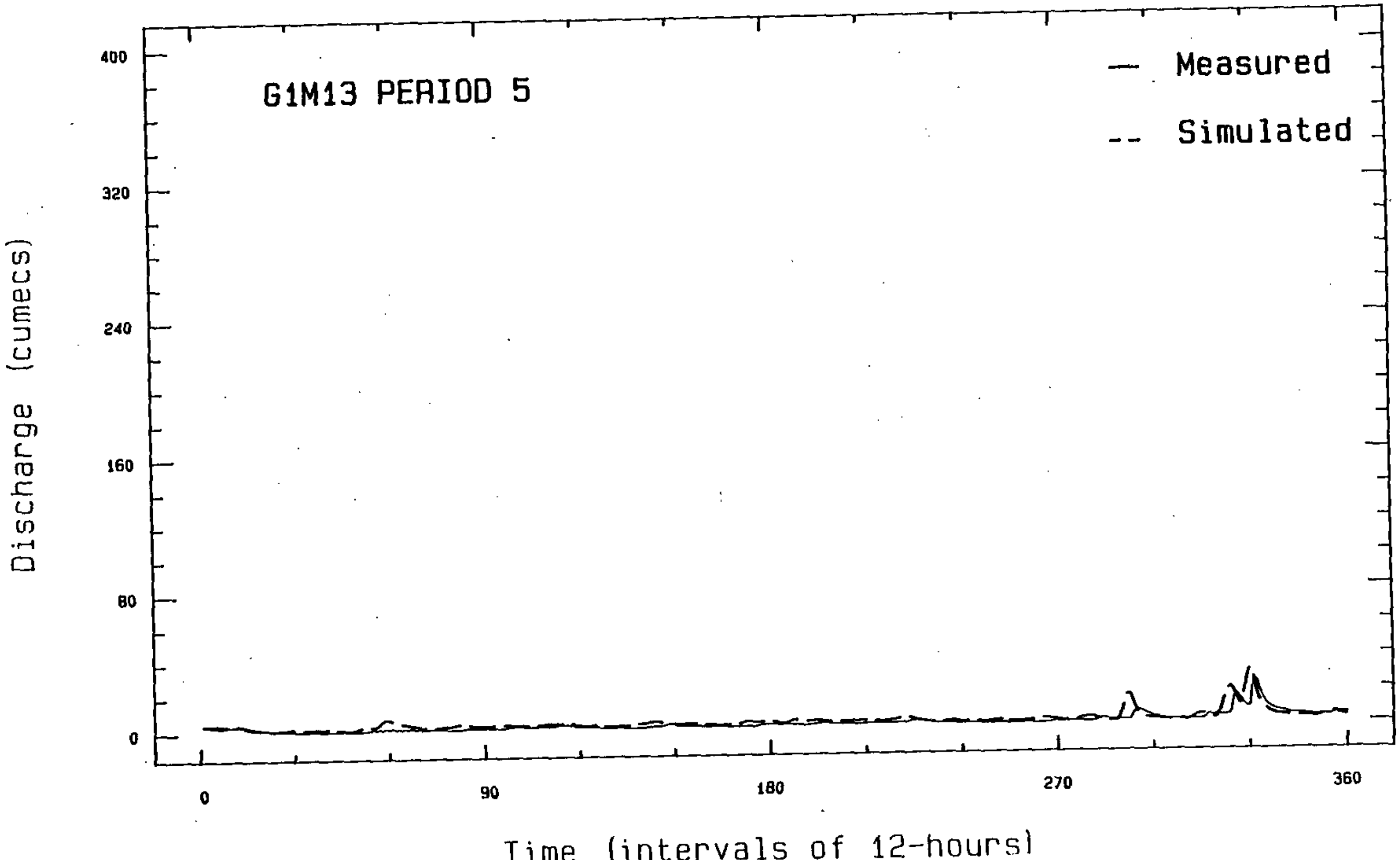


Fig 6.26. **Simulated and measured hydrograph for Drie Heuwels Weir (G1M13) - Period 5. All measured discharges in excess of 120 cumecs are not plotted.**

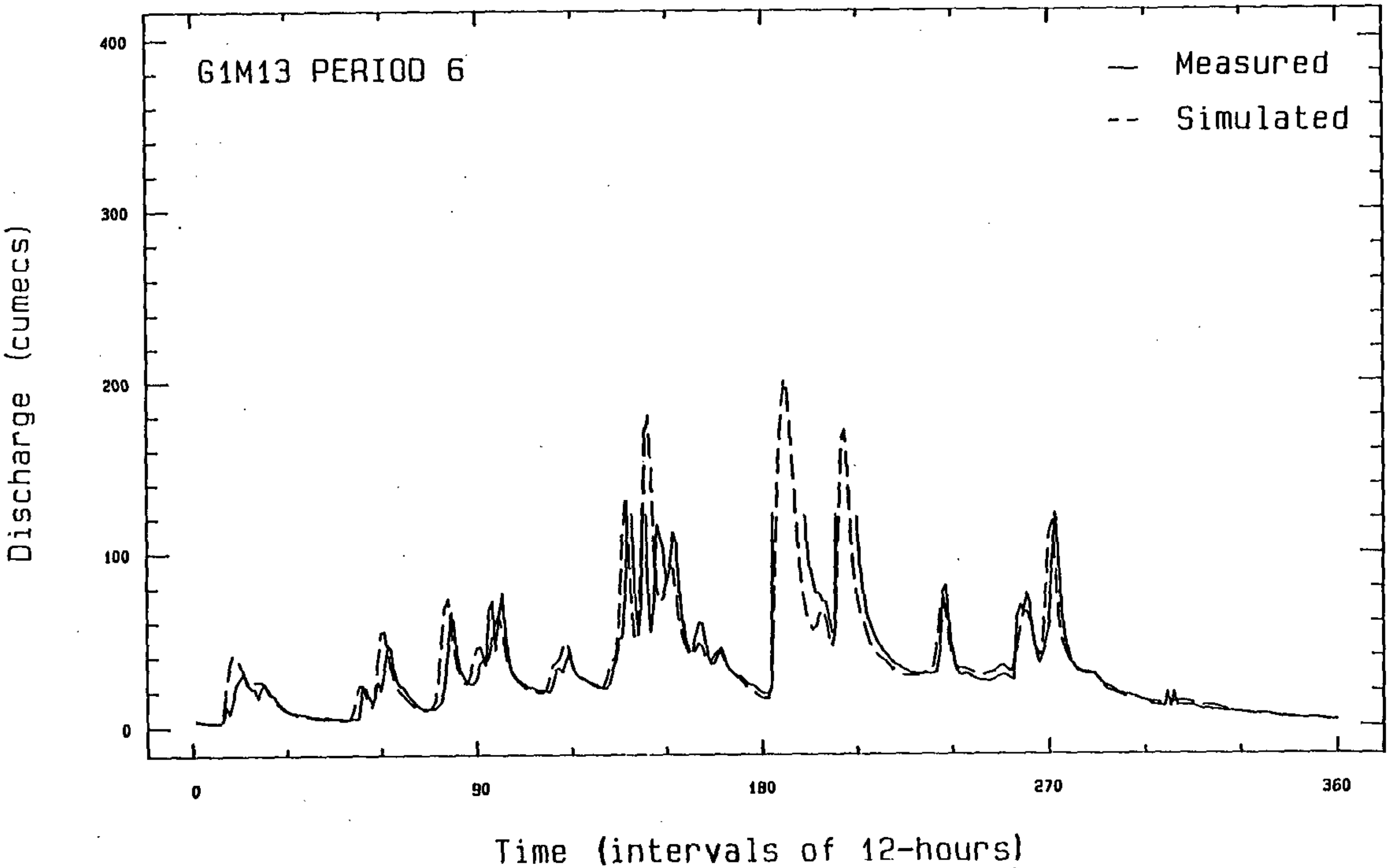


Fig 6.27. **Simulated and measured hydrograph for Drie Heuwels Weir (G1M13) - Period 6. All measured discharges in excess of 120 cumecs are not plotted.**

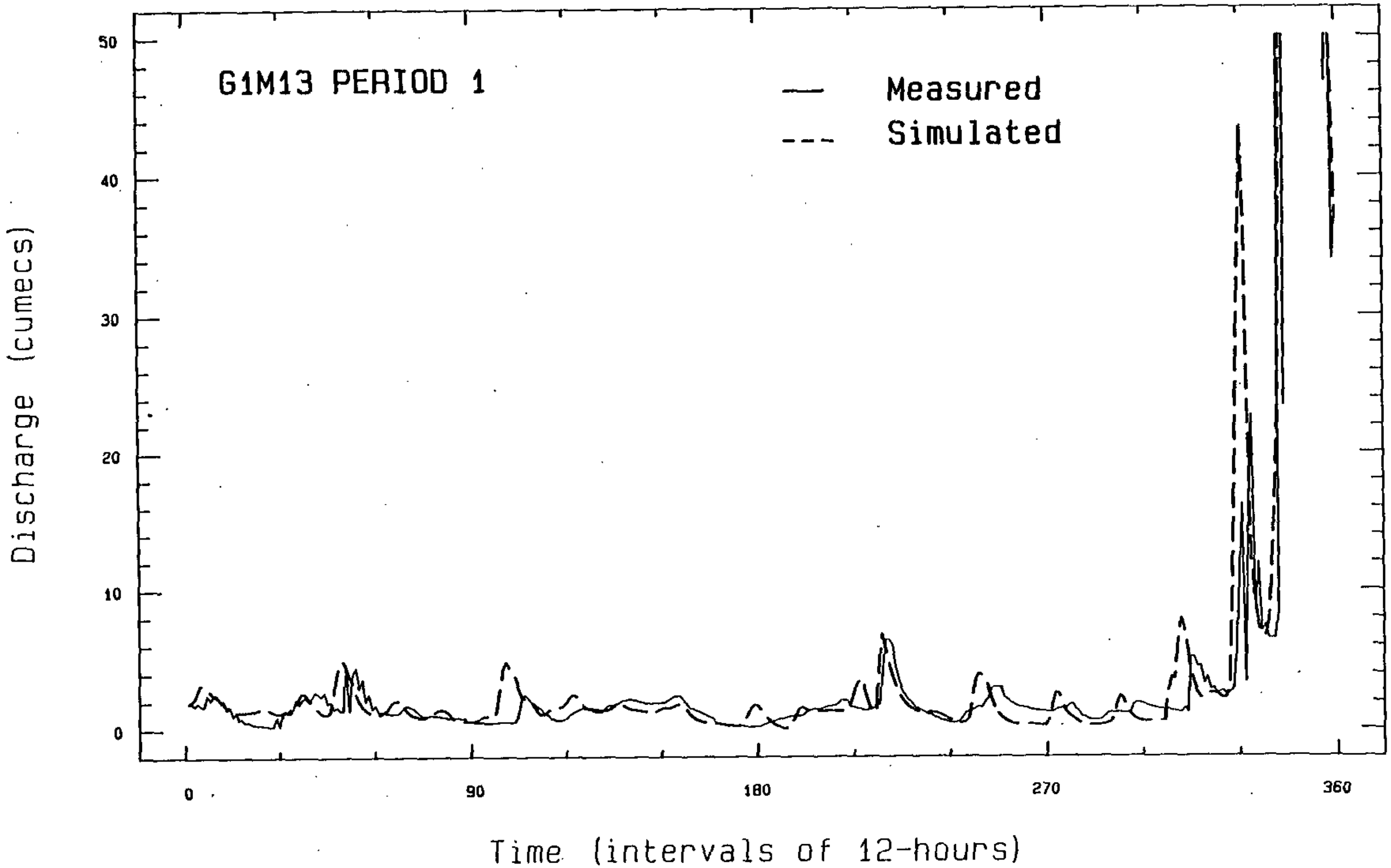


Fig 6.28. **Simulated and measured hydrograph at Drie Heuwels Weir during the dry Period 1, plotted with an extended discharge scale.**

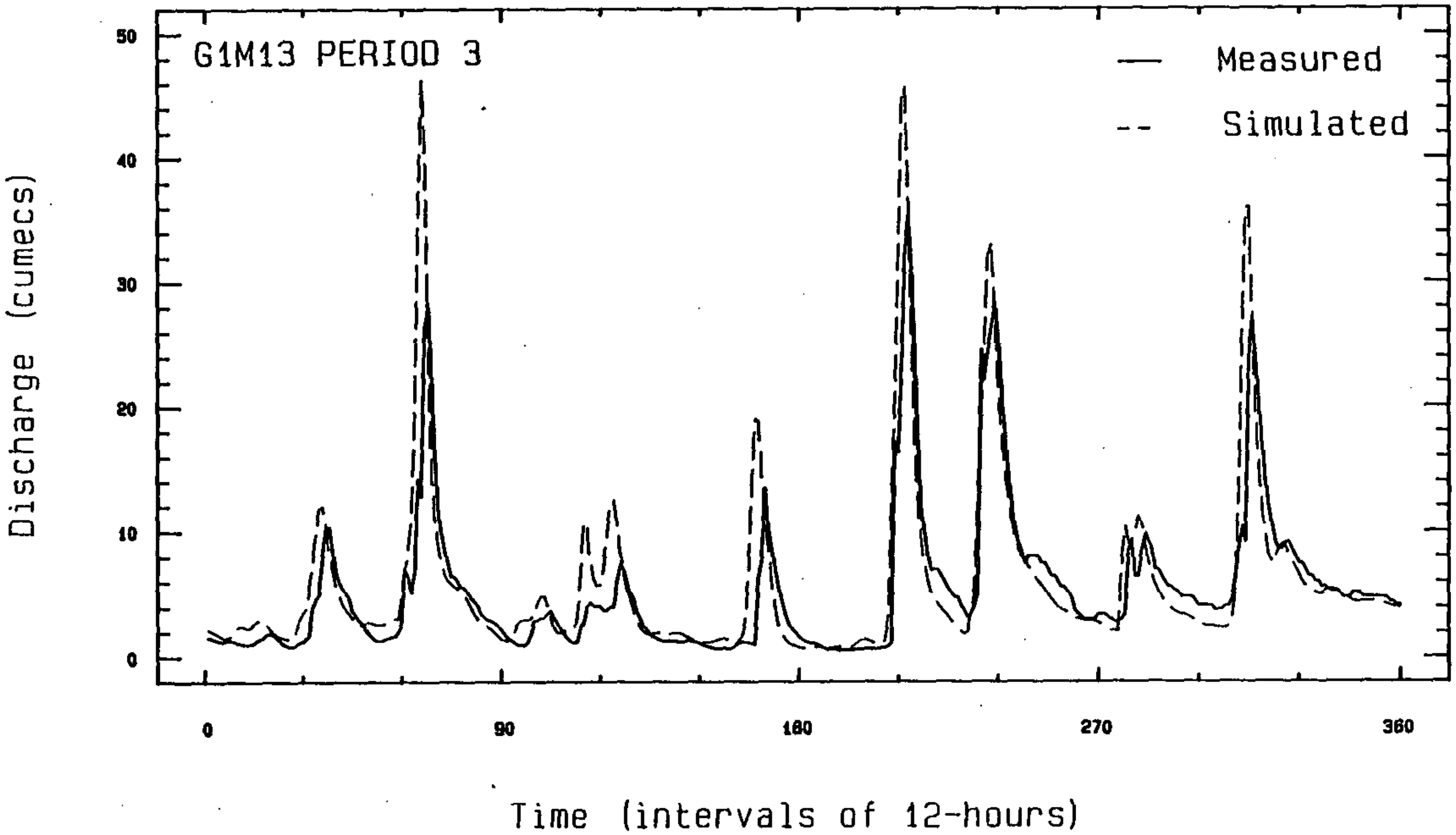


Fig 6.29. Simulated and measured hydrograph at Drie Heuwels Weir during the dry Period 3, plotted with an extended discharge scale.

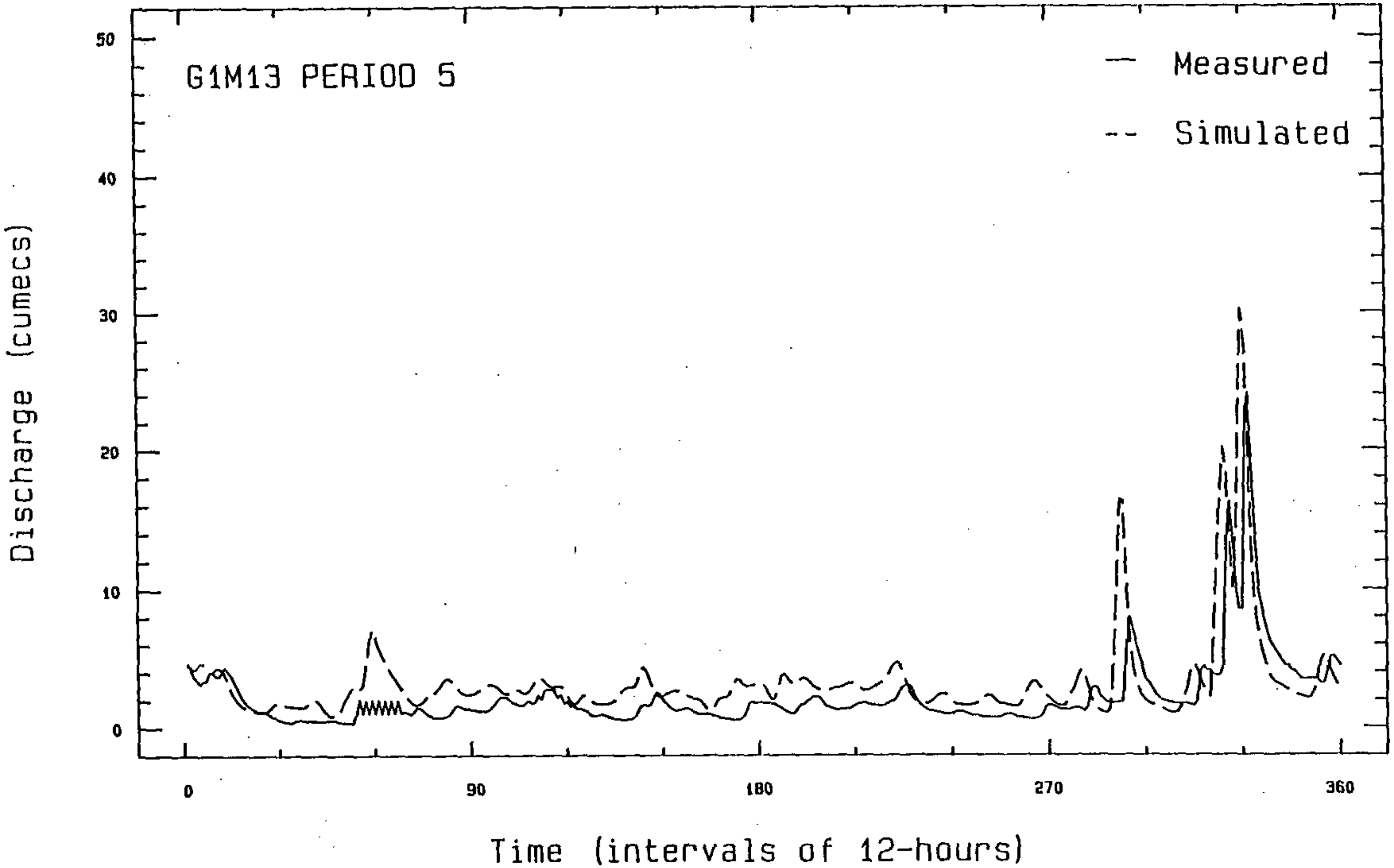


Fig 6.30. Simulated and measured hydrograph at Drie Heuwels Weir during the dry Period 5, plotted with an extended discharge scale.

6 MODEL EVALUATION

(1) Model performance:

Taking a general overview on the predicted and observed hydrograph at Drie Heuwels, these compare remarkably well over the range of flows 2 to 120 cumecs. It is most unfortunate that the measured discharges greater than 120 cumecs are completely unreliable, due to the backwater effects from the Misverstand diversion weir. Consequently, it is not possible to assess the performance of the model for river flows in excess of 120 cumecs. Based on the Berg River experience with this model, there is good reason to expect that it could also be useful in this kind of flow modelling of other rivers.

(2) Approximation of Li's model:

The model proposed by Li (1979) fall under the category of kinematic flow models. Basically (i) over every element of the flow path it preserves continuity, that is, it calculates a mass balance over the element and (ii) at any point along the channel reach it makes provision for estimating discharge or velocity of flow. This provision, a postulation, based on experience, is stated by Eq (6.3) i.e.

$$A = \alpha Q^{\beta} \qquad \text{.....} \qquad (6.35)$$

On this formulation hinges the prediction of the movement of the flow along the channel. If the structure of the formulation is inadequate then inevitably the predictions must suffer accordingly. The good general fit between the observed and predicted hydrograph gives support to the assumption that Eq (6.35) is of an acceptable form. Even if the flood predictions are correct, out of phase time shifts of the rising and falling limbs of the predicted wave can be expected if the values of α and β are in error. Clearly the values of α and β will be influenced by the slope, bed friction and other factors. These values should be determined at a number of points along the reach; the seven pairs of values for α and β determined along the 90 km reach i.e. one pair every 11 km approximately appear to have been adequate to accommodate for the change in channel geometry over this total reach. Furthermore, the rather crude field procedures for determining α and β which could be applied only during low flows nevertheless appear to be adequate and give values that are successful, an aspect that would commend the model to those wishing to construct dynamic transport models of nutrients.

(3) Out-of-phase peaks:

Comparing the flood hydrographs during the dry periods (Figs 6.28 and 6.30) the predicted flood waves are slightly before the observed flood waves. This also occurs during the wet season but only marginally so. In the Berg River there are numerous low concrete dams in the main channel. These structures are erected by farmers to hold water in the summer low flow period. The effect of these dams is to delay a flood wave, by backing-up a volume of water behind the dam. The model, relying on data from off-channel sources, does not allow for obstructions in the main channel.

In wet periods, discharges are high enough to reduce or eliminate the out-of-phase behaviour due to obstructions. The slight out of phase behaviour still apparent probably arises from the small errors in the estimation of channel coefficients α and β.

(4) "Mystery" peaks:

In Periods 4 and 5 two "mystery" peaks were observed in the simulated hydrograph, but not in the observed data, see Figs 6.18 and 6.31. The reason for the non appearance of the peak in the measured hydrograph at Drie Heuwels is that for those few days, no stage height recordings were made at Drie Heuwels Weir, due to a malfunction of the equipment. The data were originally "patched" by extrapolating from the pre-malfunction and post-malfunction data. The model however utilizes the upstream information, which manifests the flood peak, and reproduces the peak. The existence of this peak at Drie Heuwels Weir was verified from field observations.

7 CONCLUSIONS

The objective in this chapter was to develop a flow model capable of predicting the hydrograph at any point in the main river channel. The model devised by Li (1979), suitably modified for application for the Berg River, appears to be adequate in achieving this objective, successfully simulating the measured hydrographs at the downstream end of the main river channel.

An interesting feature of this model is that it provides both the necessary output and information about the discharge characteristics of the entire catchment.

To attain the maximum model accuracy, the ungauged lateral runoff is estimated using an areal-weighted coefficient. The channel geometry is characterised by the model using two coefficients α and β. These coefficients are assumed to represent the average conditions in the river sub-reach which in terms of model output seems acceptable.

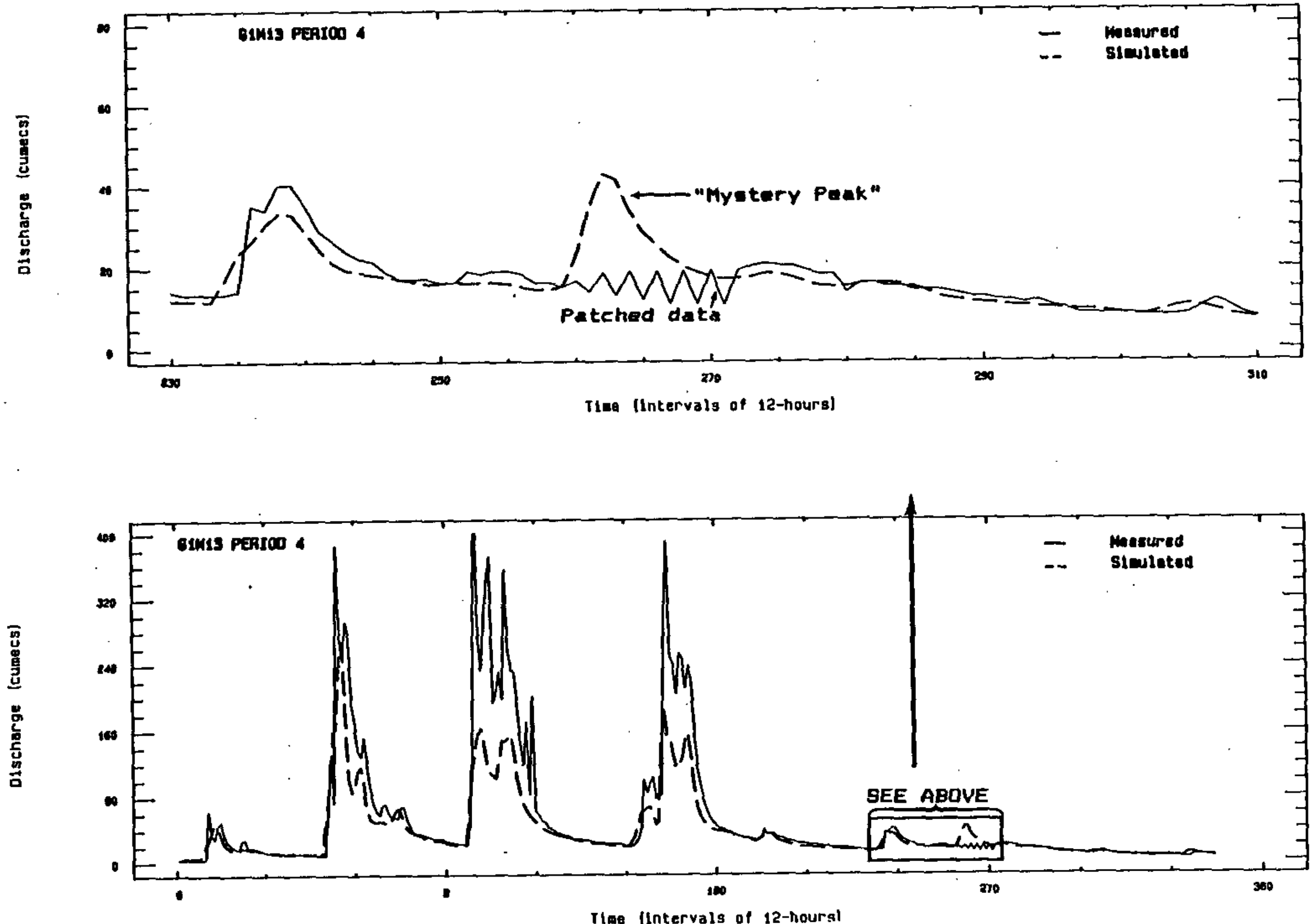


Fig 6.31. Simulated and measured hydrograph at Drie Heuwels Weir, Period 4, showing the presence of the "Mystery Peak".

It can therefore be concluded that the model has the ability to predict, with sufficient accuracy, the hydrograph at a downstream station. The model is also capable of patching the flow records when the original data are missing. This hydrodynamic-flow model is now in a suitable form for use in conjunction with the other sub-components of the model to predict the transport of phosphorus along the main river channel.

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9 NOTATION USED IN CHAPTER 6

A,A1,A2,A3,A4	=	flow cross sectional area (m^2)
t	=	time (s)
Q,Q1,Q2,Q3,Q4	=	River discharge (cumecs)
x	=	river distance (m)
q,q1,q2,q3,q4	=	lateral discharge (cumecs)
So	=	bed slope
Se	=	energy slope
v	=	flow velocity (m/s)
g	=	acceleration due to gravity (m/s^2)
y	=	depth of flow (m)
α,β	=	channel geometry coefficients
a,b	=	time and space weighting factors
θ	=	quotient of time and distance increments
τ	=	predicted discharge (Q4) (cumecs)
τ^*	=	discharge term in Eq (6.8) (cumecs)
Δt	=	increment of time (s)
Δx	=	increment of distance (m)
$\tau 0$	=	discharge using linear scheme (cumecs)
Ω	=	right-hand side of Eq (6.5)
c,d,e,f,g,h	=	channel geometry regression coefficients

CHAPTER 7

DEVELOPMENT OF A PHOSPHORUS TRANSPORT MODEL

In Chapter 6 the development and calibration of the hydrodynamic flow model was presented. That model constituted the first stage in the development of a phosphorus transport model. In this chapter the next stage in the development of the phosphorus transport model is presented, consisting of three sub-models: (1) phosphorus nonpoint source model; (2) phosphorus transport model and (3) a phosphorus bed load model.

1 PHOSPHORUS NONPOINT SOURCE (NPS) MODEL

1.1 NPS model selection

The objective of this sub-model is to quantify the mass of phosphorus exported from nonpoint sources into the main river channel. Such a model is complex due to the interaction of a large number of processes associated with the mobilization of phosphorus in the nonpoint source area (Novotny et al., 1978). Conceptually the model must take account of the processes shown in Fig 7.1.

To quantify the phosphorus export from a nonpoint source we can use one of two approaches:

- Develop a mechanistic model incorporating each of the processes shown in Fig 7.1.

- Develop a lumped parameter model.

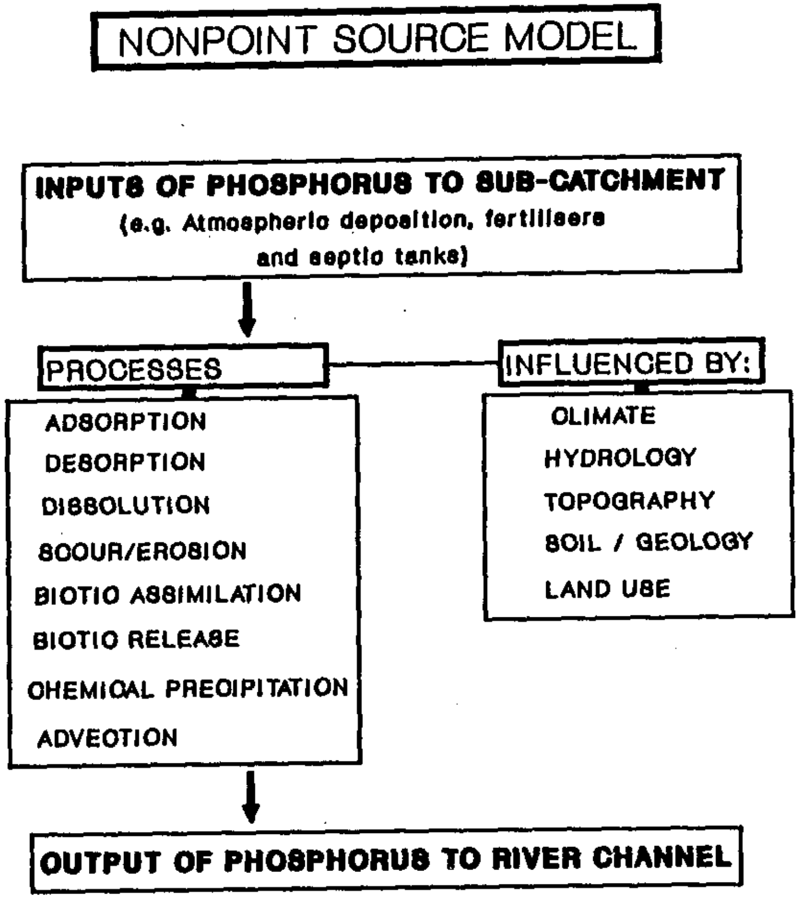


Fig 7.1. Conceptual framework showing the processes associated with the release of phosphorus from nonpoint sources.

The first approach, although the ideal, presents severe practical difficulties in isolating each process and tracing their dynamic behaviour (Wang and Evans, 1970; Betson and McMaster, 1975). The literature reports a number of models formulated to quantify one or more of the processes (Taylor and Kunishi, 1971; McCallister and Logan, 1978; Novotny et al., 1978; Logan, 1982; Casey and Farr, 1982; Wendt and Alberts, 1984; Zingales et al., 1984). However, such models have been applied only in defined research catchments which have been designed specifically to isolate and measure the processes being investigated.

Lack of available information forced the conclusion that for the Berg River basin the only feasible approach to nonpoint source phosphorus modeling is the lumped parameter approach. A difficulty with this approach is to identify the lumped parameter in terms of which an adequate description of the nonpoint phosphorus export can be formulated and is practical. Johnson et al. (1976) selected the nonpoint discharge as the lumped parameter and linked the phosphorus export to it. They found that a plot of phosphorus concentration versus discharge showed significant scatter. They speculated that the scatter was due, in part, to a different relationship between phosphorus concentration and the discharge on the rising and the falling limbs of the discharge hydrograph respectively. On separating out the phosphorus data on the rising and on the falling limbs they found that for a given discharge the phosphorus concentration was higher on the rising then on the falling limb, giving rise to a looped or hysteresis effect. They hypothesized that the cause for the higher phosphorus concentration on the rising limb is the mobilization of phosphorus from riverbeds and surface drainage during the beginning of the flood event.

To formulate the phosphorus concentration over a flood event they accepted a basic linear relationship between the phosphorus concentration, P, and the discharge, Q; the hysteresis effect they accommodated by hypothesizing that the phosphorus concentration is proportional to the rate-of-change of discharge, $\Delta Q/\Delta t$, i.e.

$$P = A0 + A1\,Q + A2\,(\Delta Q/\Delta t) \qquad \ldots\ldots \quad (7.1)$$

where

P	=	ortho-phosphate concentration,
Q	=	instantaneous river discharge,
$\Delta Q/\Delta t$	=	rate-of-change of discharge,
A0,A1,A2	=	regression coefficients.

The value of $\Delta Q/\Delta t$ is positive on the rising limb and negative on the falling limb of the hydrograph; by a suitable choice of the proportionality constant the looped or hysteresis effect observed experimentally, can be accommodated to a degree.

It is not difficult to find objections against the formulation for the hysteresis effect, because there appears to be no rational physical basis for it. However, if by its use a mathematical structure can be established which allows the phosphorus concentration to be simulated approximately correctly and consistently over a number of flood events then it has value as an interim parameter until a better one is discovered or, perhaps, a mechanistic explanation for it comes to light.

7.2 NPS model development

Hysteresis manifestation on the Berg River:

It was stated above that the looped phosphorus-discharge approach could be an acceptable practical predictive method if over a number of flood hydrographs it provides consistently good estimates of the measured phosphorus concentration. Accordingly, an inquiry was initiated into the feasibility and consistency of the looped phosphorus-discharge rating approach.

To check if the looped phosphorus discharge (hysteresis) effect is present in the phosphorus chemograph on the Berg River, data, collected over one flood event at Station 9A on the main river channel, were analysed. In Fig 7.2 a flood hydrograph with associated phosphorus concentration data are shown, and in Fig 7.3 a plot of phosphorus concentration versus discharge. Clearly for any selected discharge, the phosphorus concentration on the rising limb of the flood hydrograph is higher than on the falling limb. Furthermore, the phosphorus concentration shows a rapid reduction after the peak flow has passed, that is, a marked hysteresis effect is exhibited. It seemed therefore that the formulation of Johnson et al. (1976), Eq (7.1) has merit. It remained to determine whether the formulation is consistent in that it applies over a series of flood events.

Equation (7.1) can be presented graphically in a three dimensional plot as follows: choose the discharge, Q, and the rate-of-change of discharge, $\Delta Q/\Delta t$, as the two axis in the XY plane, and the total phosphorus concentration, TP, on the Z axis, see Fig 7.4(a). Define $\Delta Q/\Delta t$ as the present discharge minus the previous discharge divided by the time intervals between the two discharges; then on the rising limb of the

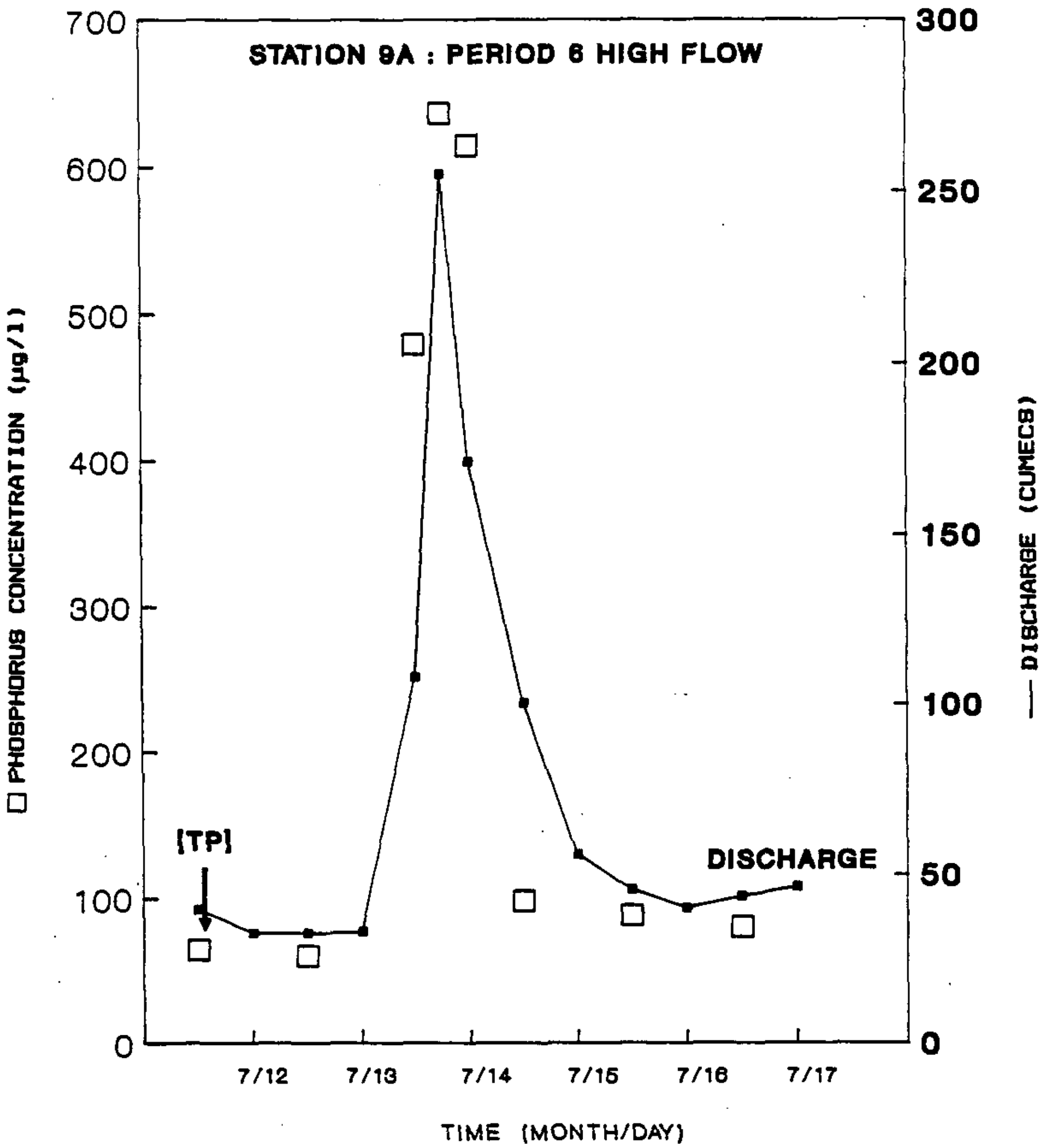


Fig 7.2. Phosphorus concentration data and associated hydrograph for one flood event at Station 9A (North Paarl) during Period 6.

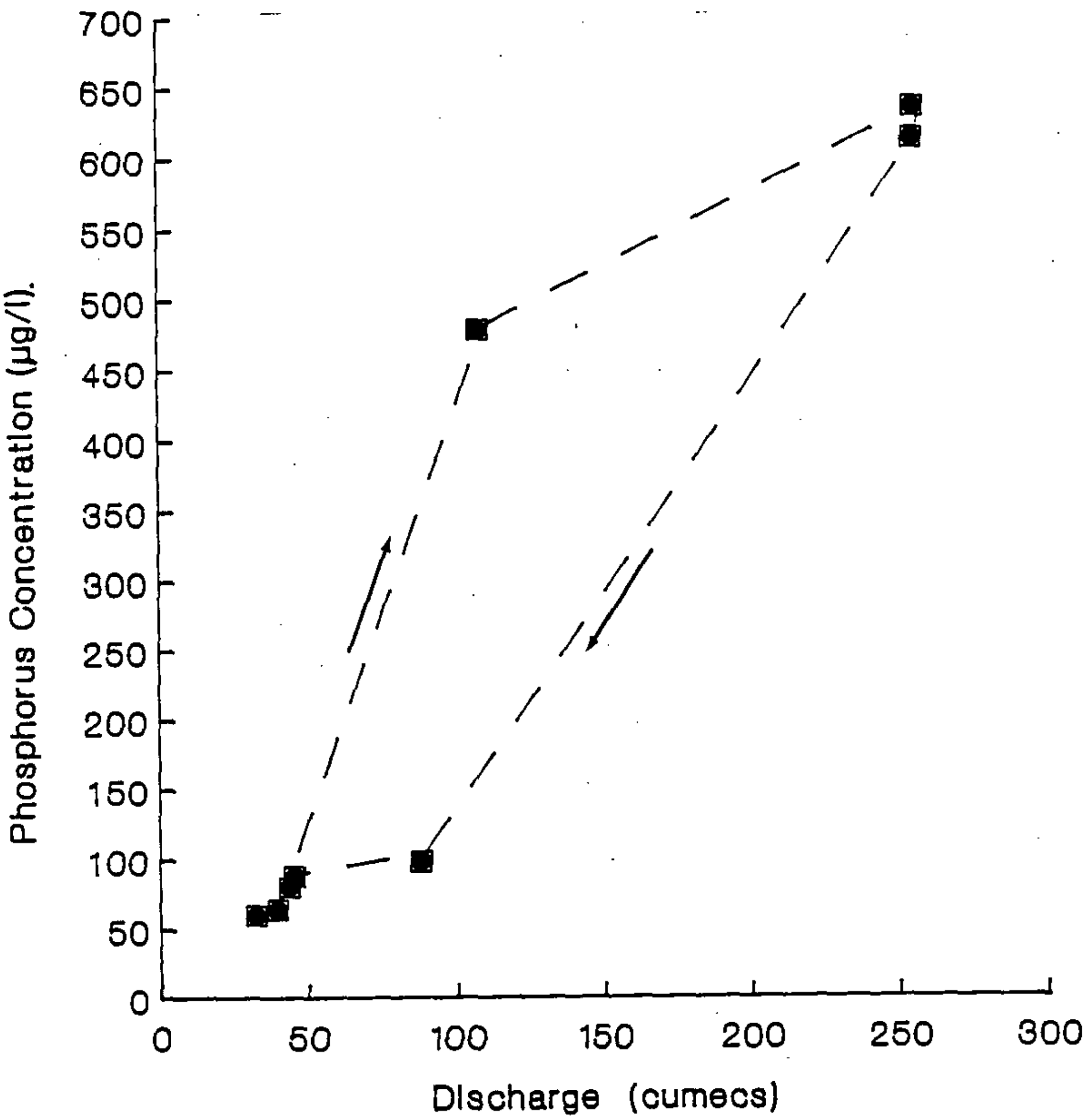


Fig 7.3. Plot of the phosphorus concentration *versus* discharge for Station 9A (North Paarl) on the main river channel.

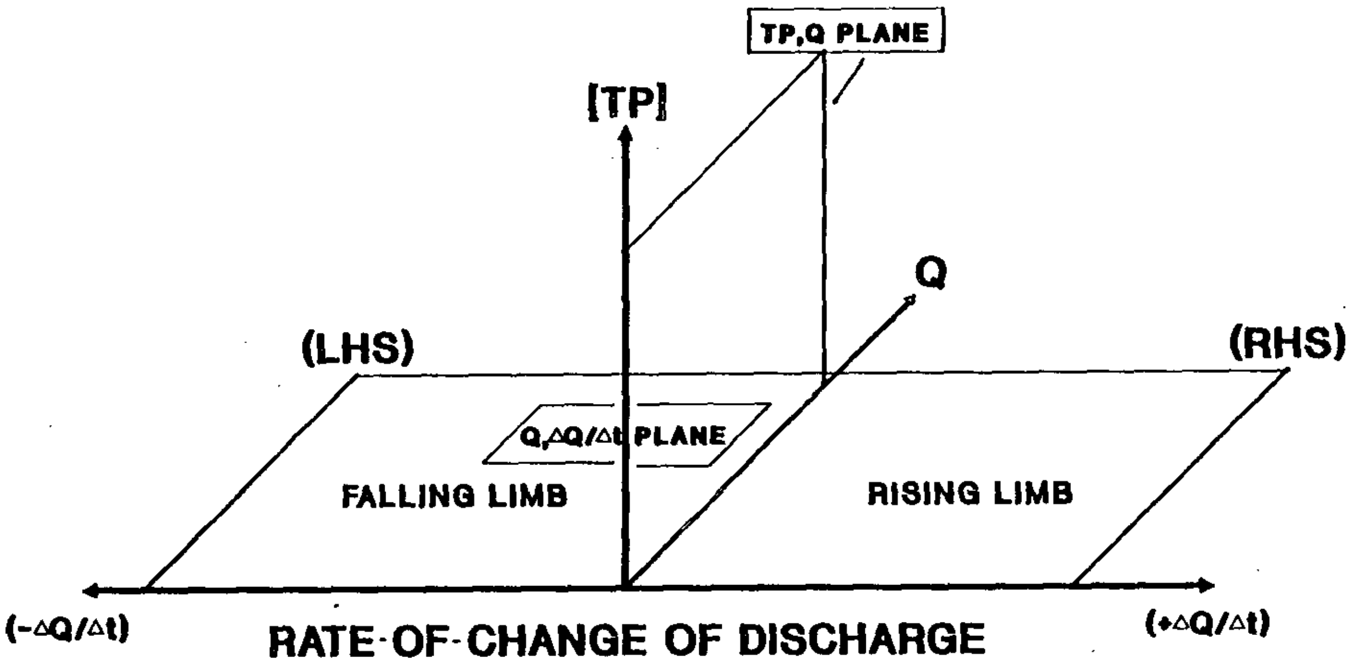


Fig 7.4(a). Three dimensional grid used for empirical nonpoint source model.

hydrograph $\Delta Q/\Delta t$ is positive and on the falling limb, negative. If the phosphorus concentration, TP, is a function of the discharge, Q, and rate-of-change, $\Delta Q/\Delta t$ then

$$TP = f(Q, \Delta Q/\Delta t) \qquad \ldots\ldots \quad (7.2)$$

then the phosphorus concentration, TP, plots as a surface over the (Q, $\Delta Q/\Delta t$) plane see Fig 7.4(b). If the phosphorus concentration is a linear function of Q and $\Delta Q/\Delta t$ as proposed in Eq (7.1), then the TP surface is a plane lying at a slope A1 to Q axis and a slope A2 to the $\Delta Q/\Delta t$ axis, intersecting the TP axis at A0; where A0, A1 and A2 are positive constants, see Fig 7.4(c).

Selection of NPS drainage area:

To develop the looped phosphorus discharge approach it is important to select a drainage basin for which accurate hydrograph and associated water quality data are available; without accurate data no reliable mathematical descriptive formulation can be achieved. Once the mathematical structure is developed then subsequently, for other drainage basins in the same hydrological region, less information will be needed to calibrate the model constants.

The nonpoint source drainage area selected for developing the mathematical structure of the model was that draining via gauging station G1M20 (Station 9A) on the Berg River at Paarl. Accurate total phosphorus concentrations, TP, at reasonably close intervals and continuous flow records were available over the entire period of the three year investigation.

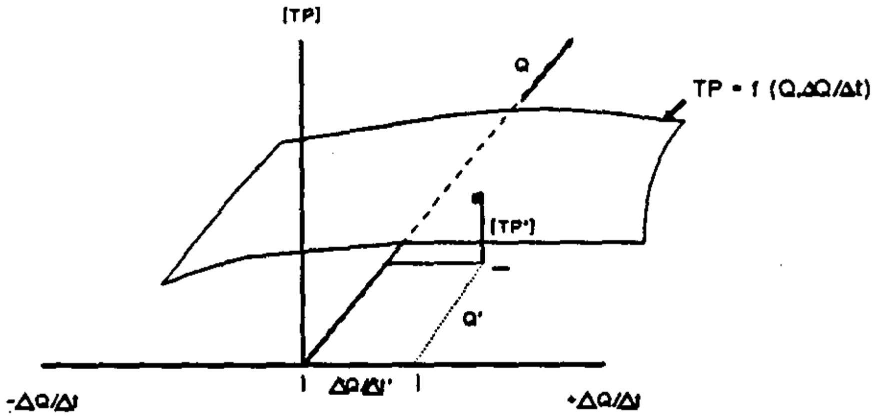


Fig 7.4(b). Three dimensional plot of the phosphorus surface over the Q-$\Delta Q/\Delta t$ plane.

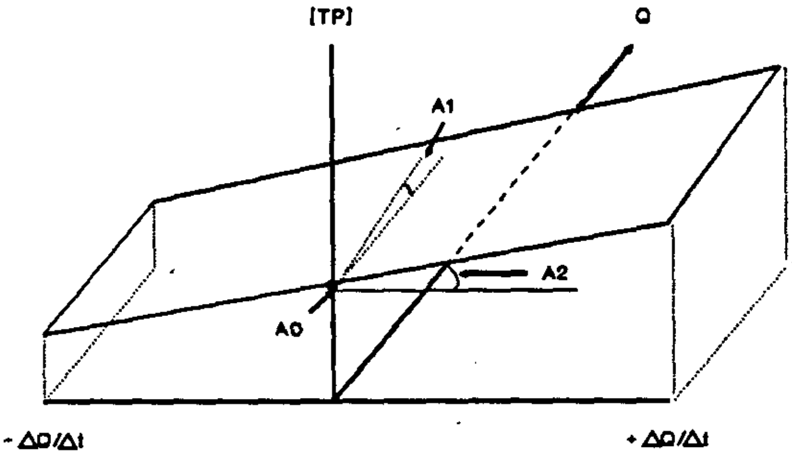


Fig 7.4(c). Three dimensional plot of the phosphorus plane lying at a slope A1 to the Q axis, and at a slope A2 to the $\Delta Q/\Delta t$ axis, intersecting the TP axis at A0; where A0, A1 and A2 are positive constants.

For every phosphorus measurement the time of sampling was noted and from the discharge hydrograph, the term $\Delta Q/\Delta t$ was determined using

$$\Delta Q/\Delta t = \frac{Q_{to} - Q_{t-1}}{to - (t-1)} \qquad \ldots\ldots \quad (7.2a)$$

where

Q_{to} = the discharge at time of sampling,

Q_{t-1} = discharge 12-hours previously,

to = time of sampling,

t-1 = time 12-hours previously.

From the matrix of triple data - phosphorus concentration, discharge and the rate-of-change of discharge - the data were sorted into two matrices, those with a positive rate-of-change of discharge ($+\Delta Q/\Delta t$) and those with a negative rate ($-\Delta Q/\Delta t$). The matrix with the negative rate-of-change of discharge data correspond to the recession limb conditions and those with a positive rate of change to the rising limb conditions.

To make a preliminary assessment whether the phosphorus concentration is influenced by the magnitude of the rate-of-change of discharge, plots were made of the phosphorus concentration (TP) versus discharge (Q) for both the recession and rising limbs. These plots will now be analysed to formulate the relationship between the phosphorus concentration, TP, and the discharge, Q, and the rate-of-change of discharge, $\Delta Q/\Delta t$.

Recession limb:

A plot of TP versus Q for data taken during the recession limbs of the hydrographs is shown in Fig 7.5. All the data plot in a fairly narrow band increasing linearly at a low rate as the discharge increases. The narrow band of dispersion indicates that on the recession limbs the rate-of-change of discharge has negligible effect on the phosphorus concentration, and the low slope indicates that the flow has a relatively minor positive effect on TP. Thus in so far as the recession limbs of the hydrographs are concerned, it appears adequate to formulate the phosphorus concentration, TP, in Eq (7.1) as follows:

$$TP = A0 + A1\ Q \qquad \ldots\ldots \quad (7.3)$$

Writing Eq (7.3) in terms of the recession flow

$$TPr = a1 + b1\ Qr \qquad \ldots\ldots \quad (7.4)$$

where

Qr = river discharge (recession flow) in cumecs,

TPr = phosphorus concentration (recession flow) in mg/ℓ,

a1 = intercept (at Q=0 on Fig 7.4),

b1 = slope constant.

In the (Q, $\Delta Q/\Delta t$, TP) diagram, Eq (7.4) (i.e. TP independent of $\Delta Q/\Delta t$ and linearly dependent on Q) defines a TP plane surface parallel to the $\Delta Q/\Delta t$ axis, at a slope b1 to the Q axis. The plane is defined only for $\Delta Q/\Delta t$ less than zero, see Fig 7.5(a).

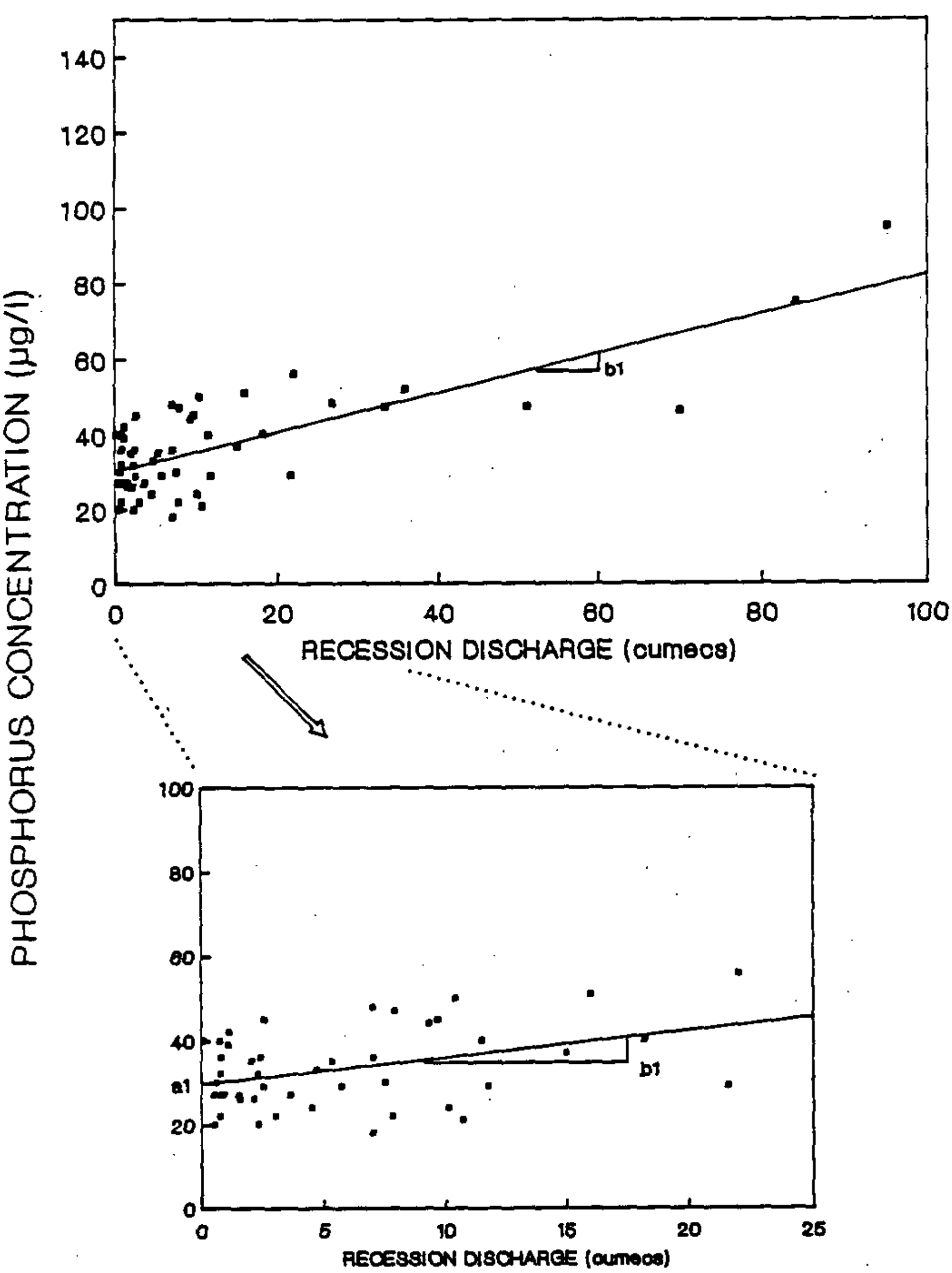


Fig 7.5. Plot of the phosphorus concentration versus discharge for recession flow conditions at Station 9A. The intercept and slope of the regression line, a1 and b1 are shown.

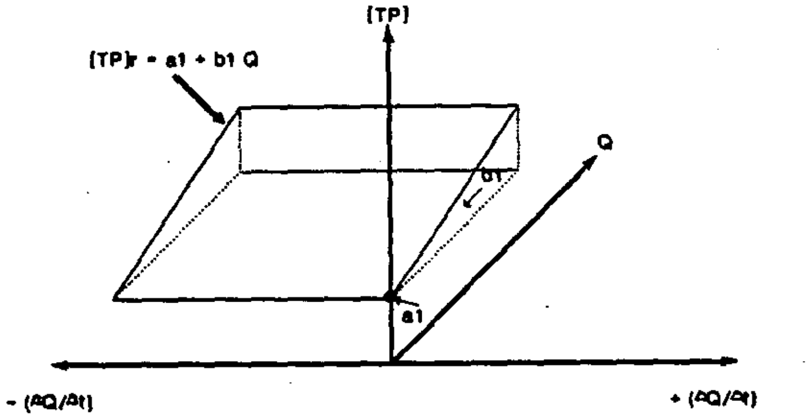


Fig 7.5(a) **Phosphorus concentration plane for recession flow independent of ΔQ/Δt but linearly dependent on Q, i.e. at a slope of b1 on the Q axis and parallel to the ΔQ/Δt axis. The plane is only defined for ΔQ/Δt less than zero.**

Terms a1 and b1 were determined using the phosphorus data in the recession limb of the hydrograph, and under steady flow, using linear least squares regression (Program REGRESS - see Appendix 2). The analysis gave a1=0.027 and b1=0.0053; these values formed initial numerical estimates of the constants.

Rising limb:

A plot of TP versus discharge for data taken during the rising limb of the hydrographs is shown in Fig 7.6. The TP values plot in a broad band indicating that either the TP values have a dispersed random content or the rate-of-change of discharge values have an effect on the TP values.

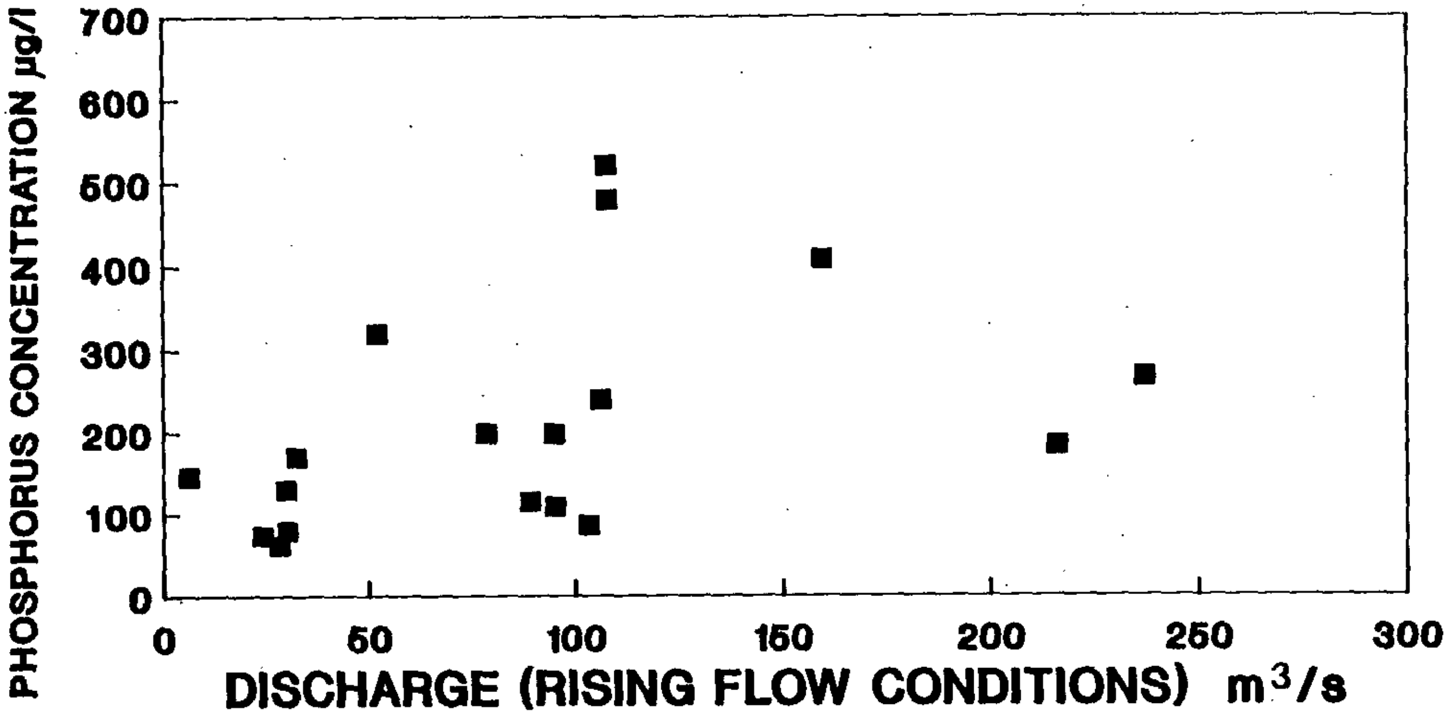


Fig 7.6. Phosphorus concentration data plotted versus discharge during rising flow conditions.

To determine if there is any connection between the phosphorus concentration, the rate-of-change of discharge, and discharge, the discharge data were sorted into class intervals from: 20 to 40, 41 to 79, 80 to 110, and 111 to 170 cumecs. For each class, a plot, phosphorus concentration versus the rate-of-change of discharge, was made, shown in Fig 7.7. Clearly not only does TP depend on the $\Delta Q/\Delta t$ (indicated by the slopes) but TP also depends on the instantaneous discharge, Q (indicated by the shift in the Q-plots). At high discharge the effects of $\Delta Q/\Delta t$ on TP is relatively small and at low discharge the effect is large.

To formulate the relationship between TP and Q and $\Delta Q/\Delta t$ for the rising limb it is apparent that when $\Delta Q/\Delta t = 0$ then

$$TPs = TPr \qquad ..... \quad (7.5)$$

where

TPs = phosphorus concentration for rising flow limb (mg/ℓ).

For $\Delta Q/\Delta t$ greater than zero, from the plots in Fig 7.7, it is apparent that not only is TPs a function of $\Delta Q/\Delta t$ but also of Q. We could write

$$TPs = TPr + b2\,(\Delta Q/\Delta t) \qquad ..... \quad (7.5a)$$

where b2 is a function of discharge, Q.

A number of formulations for b2 were attempted. Initially a linear relationship with Q was suggested i.e.

$$b2 = a3 + b3\,Q \qquad ..... \quad (7.6)$$

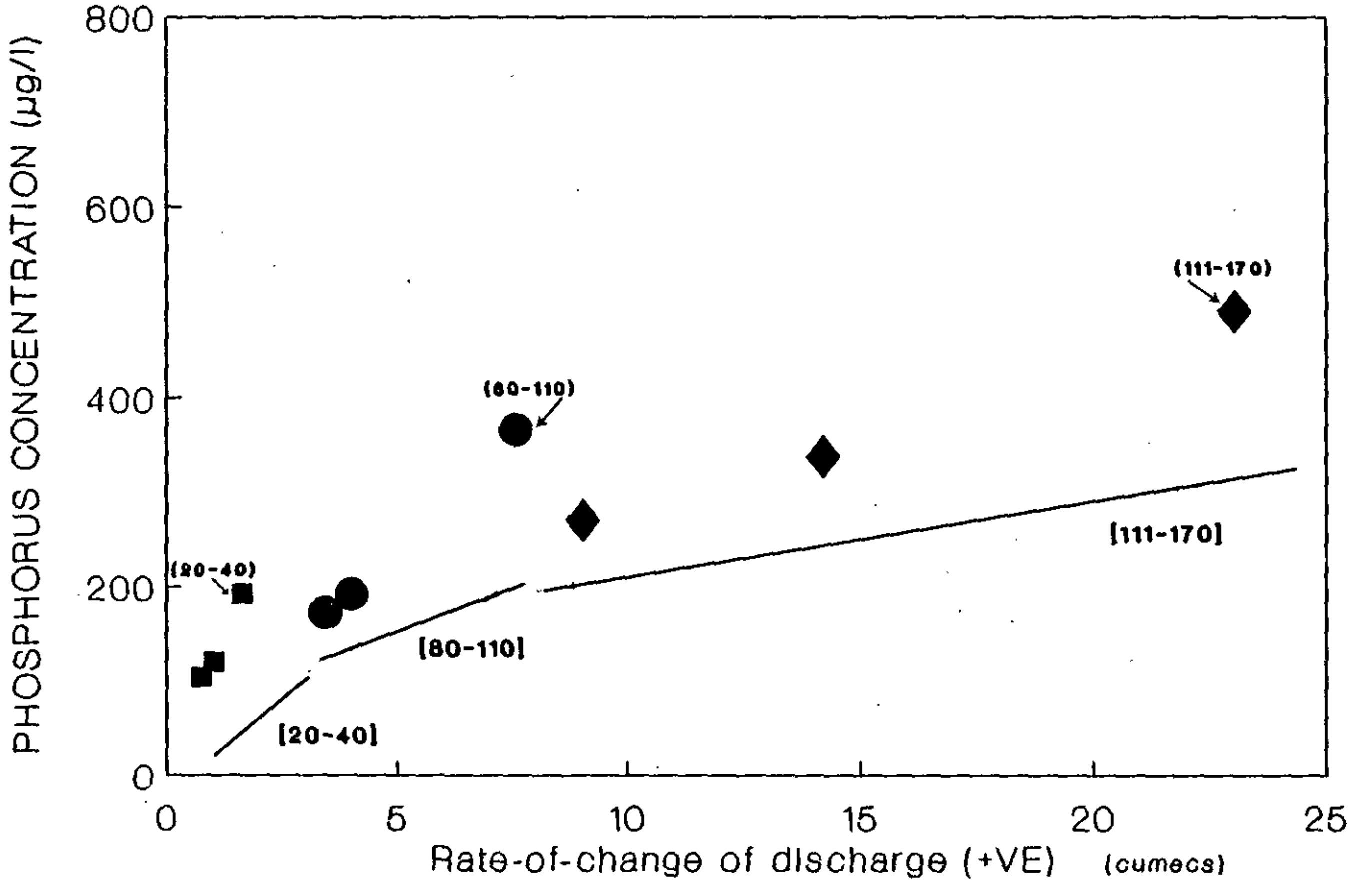


Fig 7.7. Measured and predicted phosphorus concentration data plotted versus the rate-of-change of discharge during the ascending limb of flood hydrographs. The data are grouped into class intervals of discharge with the ranges shown in brackets. The solid line shows the theoretical relationship using Eq (7.8) with constant values obtained from an optimization technique using all available data on the ascending limb of the flood hydrograph.

However, Eq (7.6) would imply that if b3 is negative the possibility exists that at high discharges b2 could be negative and conflict with the recession flow behaviour. Accordingly an exponential formulation was proposed because with appropriate sign for the constants the value of b2 can not decrease below zero. Accept

$$b2 = a3\ EXP\ (b3\ Q) \qquad \ldots\ldots \quad (7.7)$$

where a3 and b3 are constants.

Thus for rising flow conditions ($\Delta Q/\Delta t>0$), from Eqs (7.4, 7.5 and 7.7)

$$TPs = (a1 + b1\ Q) + (a3\ EXP\ (b3\ Q))\ (\Delta Q/\Delta t) \qquad \ldots \quad (7.8)$$

where

Q = instantaneous river discharge,
TPs = instantaneous phosphorus concentration.

In determining the numerical values for a1, b1 and a3, b3, preliminary values of a1 and b1 would be available from analysis of the data on the recession limbs of the hydrographs (Eq 7.4, see Fig 7.5). Terms a3 and b3 can be determined from data on the rising limbs, such as presented in Figs 7.6 and 7.7, using curvilinear regression analysis (program REGRESS, see Appendix 2).

This analysis gave a3=0.01 and b3=-0.003. These values for a1, b1 and a3, b3, must be considered as first estimates. To obtain improved estimates, Eqs (7.4 and 7.8) were incorporated in the program NPSM (see Appendix 2) to simulate a time sequence plot of phosphorus data (chemograph) from the observed time sequence of flow data (hydrograph).

1.3 Adequacy of NPS model formulation

Having accepted a mathematical structure it was necessary to check whether the mathematical formulation of the nonpoint source model is adequate. To accomplish this one period of 180-days was selected to cover both high and low river flow, Period 6. The water quality and flow data set for this period is one of the most comprehensive on the Berg River. The hydrograph over the calibration period and measured phosphorus concentration data are shown in Fig 7.8.

Using the hydrograph and program NPSM the phosphorus chemograph was simulated for Period 6, see Fig 7.9. Comparison of the observed discrete phosphorus measurements with the corresponding simulated values showed that the model predicts the same pattern as the measured – the model formulation as expressed by Eqs (7.4 and 7.8) appeared to be acceptable.

The behavioural pattern exhibited by the formulation is best described by the three dimensional plot (Q, $\Delta Q/\Delta t$, TP) in Fig. 7.10. Under rising flow conditions, at higher Q the slope of the surface with respect to $\Delta Q/\Delta t$ is lower and at lower Q the slope is higher. That is, at higher flows the effect of the rate-of-change of flow is much less then at lower flows. Under recession conditions the $\Delta Q/\Delta t$ has no effect.

Comparing the behavioural form suggested by Johnson et al. (1976) (Eq 7.1 shown in Fig 7.4(c)) and that proposed here (Eqs 7.4 and 7.8, and Fig 7.10) it would seem that the proposal of Johnson et al. (1976) was a most useful one but the relationships between variables are more complicated then envisaged in their model.

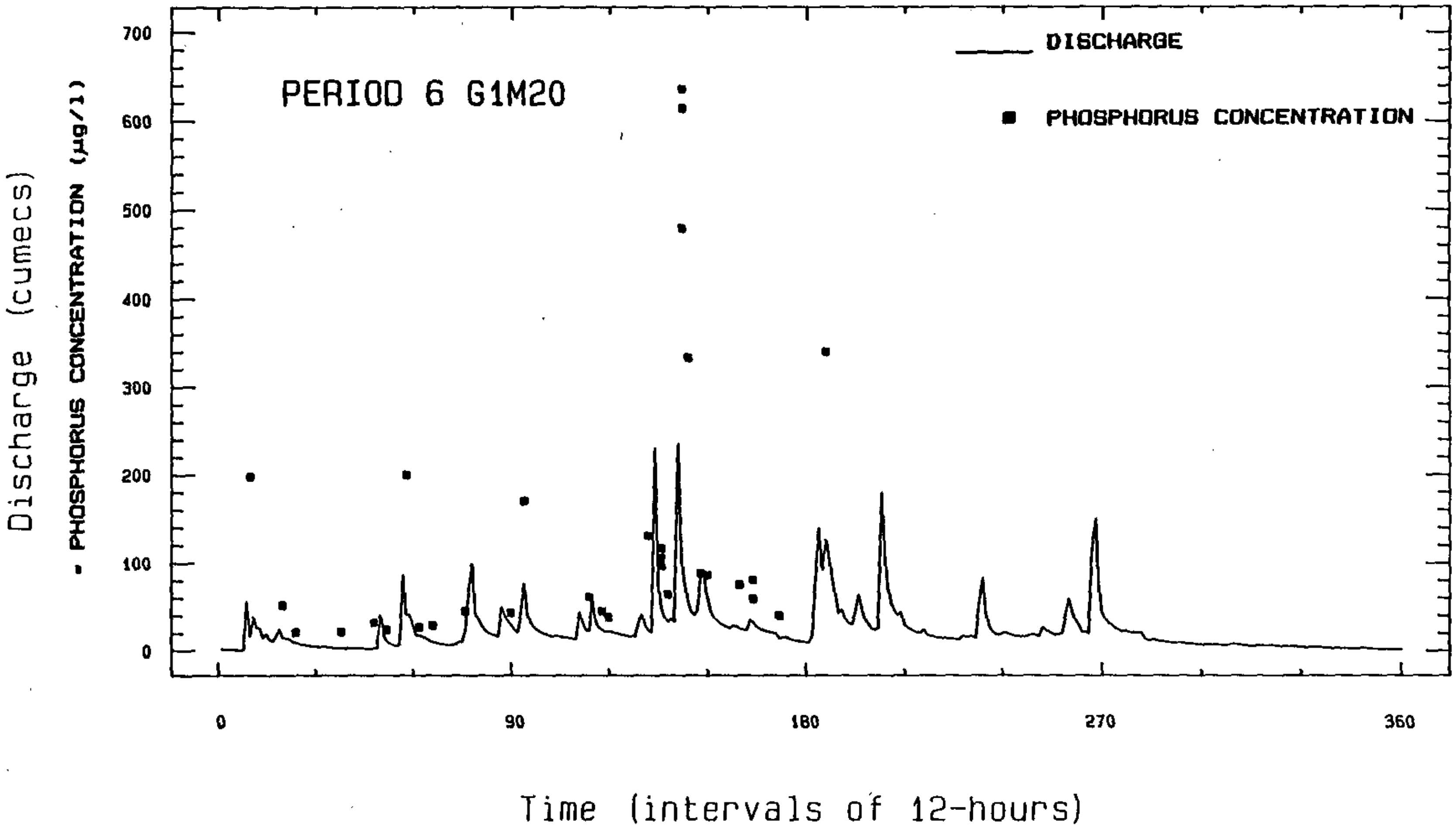


Fig 7.8. Plot of the hydrograph and associated phosphorus concentration data for Station 9A - Period 6.

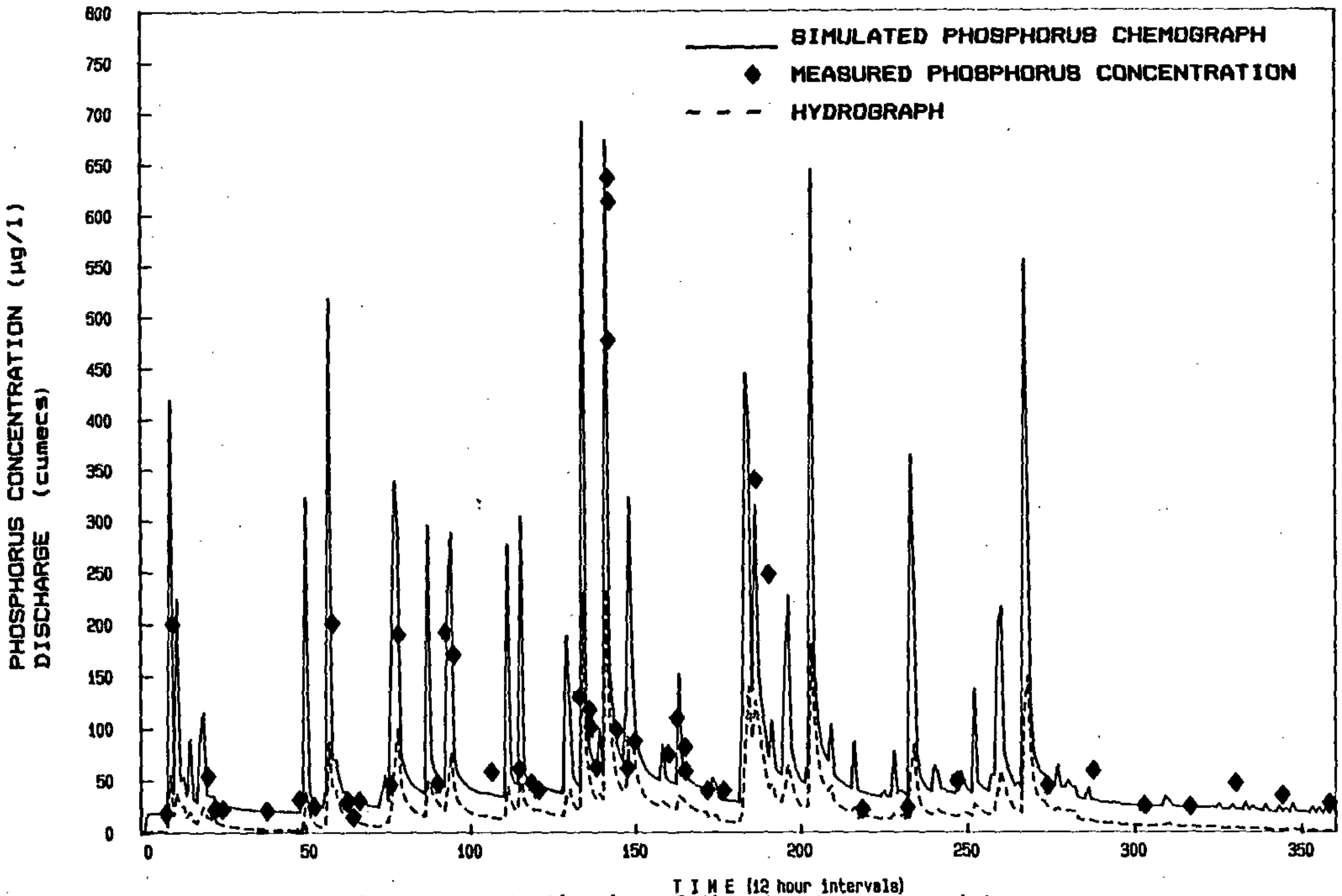
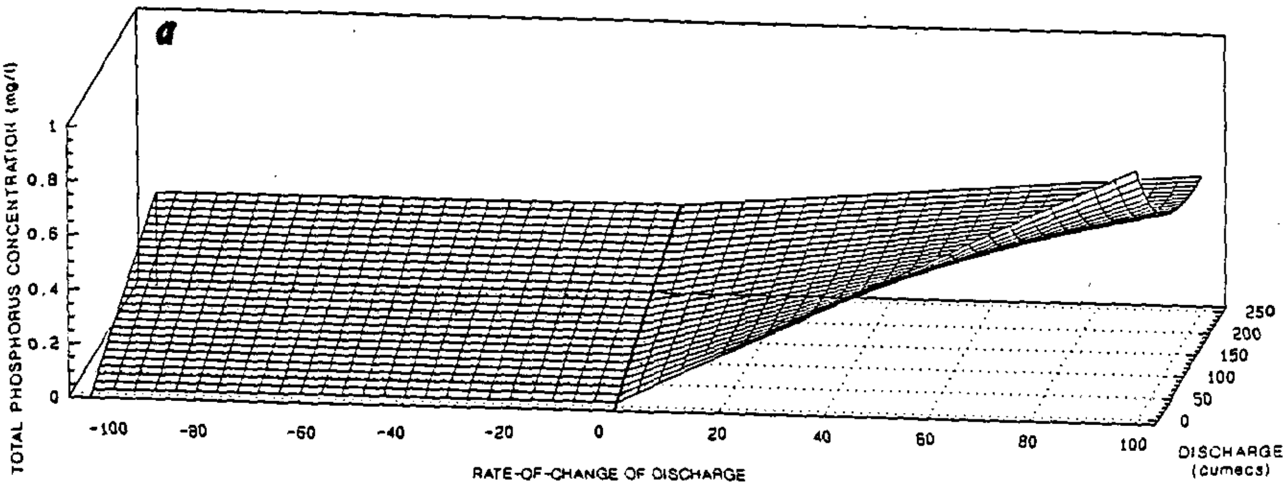


Fig 7.9. Application of the phosphorus nonpoint source model (NPSM) to predict the phosphorus chemograph at Station 9A - Period 6 (winter).



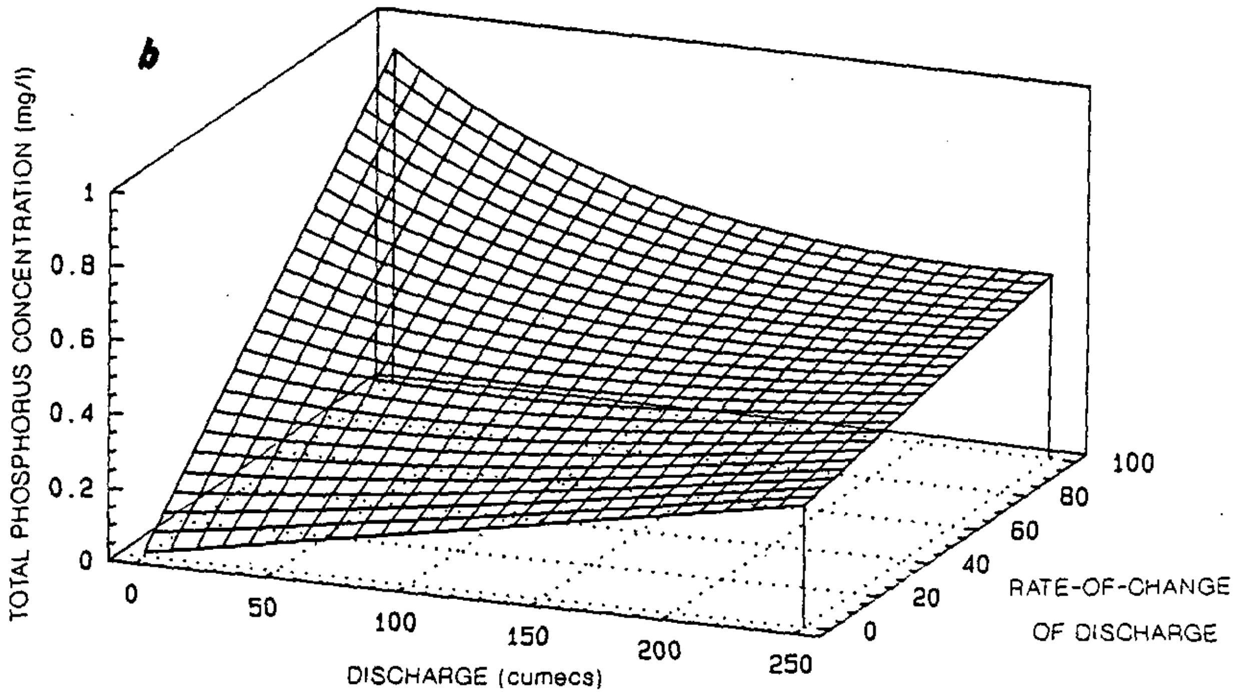


Fig 7.10. (a) Hypothetical three-dimensional surface for the relationship between total phosphorus concentration, river discharge and the rate-of-change of discharge. (b) Example of surface viewed from the discharge/TP plane for positive rate-of-change of discharge.

1.4 NPS model optimization

Although we have developed an apparently adequate mathematical model in terms of which the behaviour of total phosphorus export from a nonpoint source can be described, the constants in the formulation had not been determined optimally.

To obtain optimal values for the constants a1, b1 and a3, b3 over Period 6 the following procedure was used:

(1) Accepting a3 and b3, a matrix of perturbed values of a1 and b1 were simulated until the best visual fit between simulated and observed TPs were obtained over the recession and low steady state flow periods. To facilitate comparison, the measured TP and simulated chemograph of TP were plotted on an extended time scale. The matrix of a1 and b1 values tested are shown in Fig 7.11; the best values were judged to be a1=0.015 (mg/ℓ) and b1=0.0013 (mg/ℓ/cumec).

(2) Having optimized a1 and b1, a matrix of perturbed values of a3 and b3 were tested to obtain the best fit between the measured peak and simulated peak TPs values (phosphorus measurements at the peak flows were found to be critical to calibrating the model optimally over a flood event). The optimal values were judged to be a3=0.009 and b3=-0.007. Referring to Fig 7.7 which supplied data for the prelimanary estimates of a3 of b3, the slopes using the optimal values of a3 and b3 are also shown. Although there appears to be a significant difference it must be remembered that the optimal values of a3 and b3 were obtained by using a large number of data minimizing the residual error.

Using program NPSM over the time Period 6 of 180-days (wet period) with the estimated values for a1, b1 and a3, b3, a simulation of the phosphorus chemograph is shown in Fig 7.9, together with the measured TP values and measured hydrograph. In Fig 7.12(a) a number of flood hydrograph peaks are enlarged to show more clearly the correspondence between the simulated

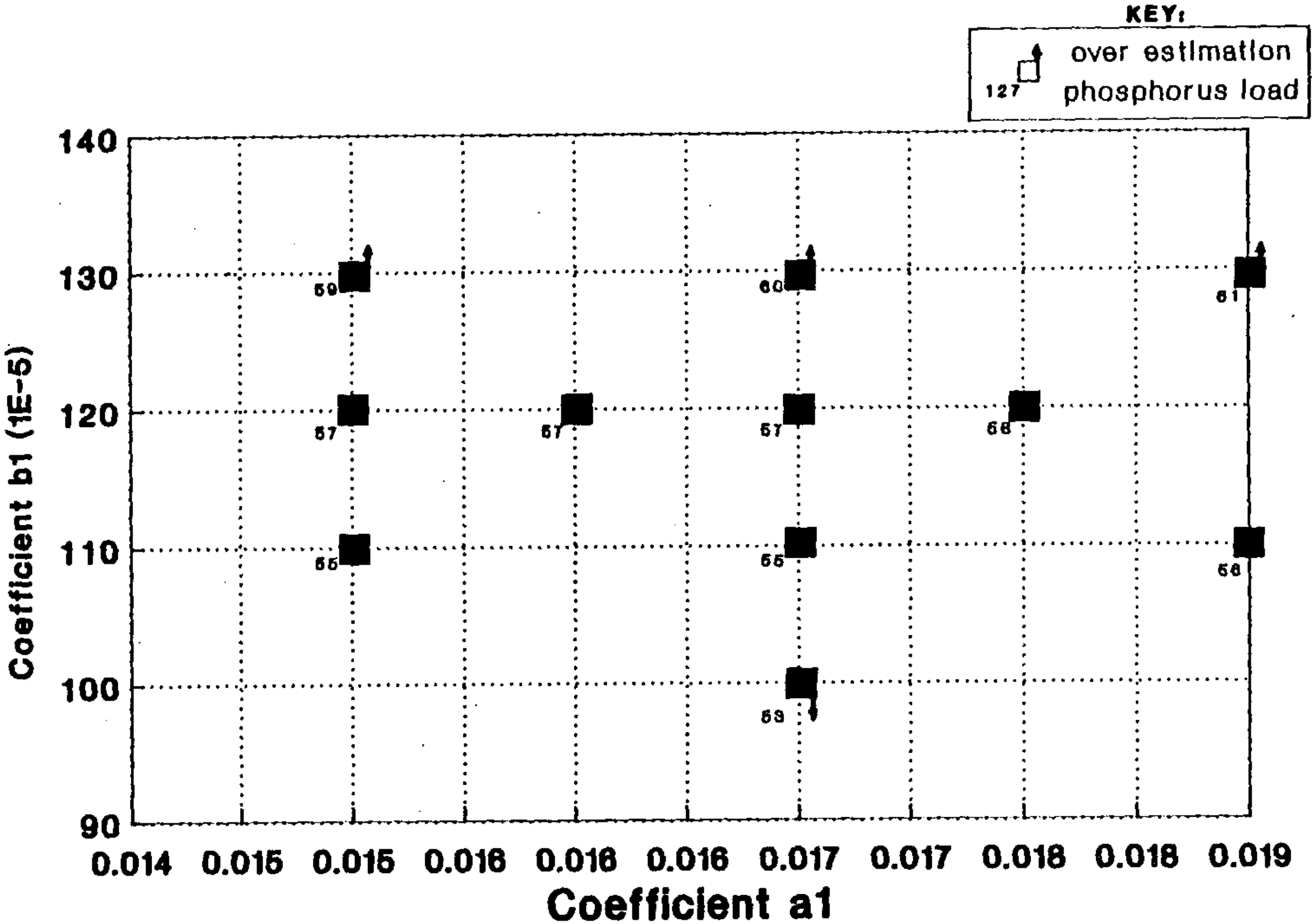


Fig 7.11. Matrix of coefficients a1 and b1 tested in the calibration of the nonpoint source model. The values shown at matrix point indicate the total mass of phosphorus exported during Period 6. Arrows indicate over-estimation or under-estimation by the model.

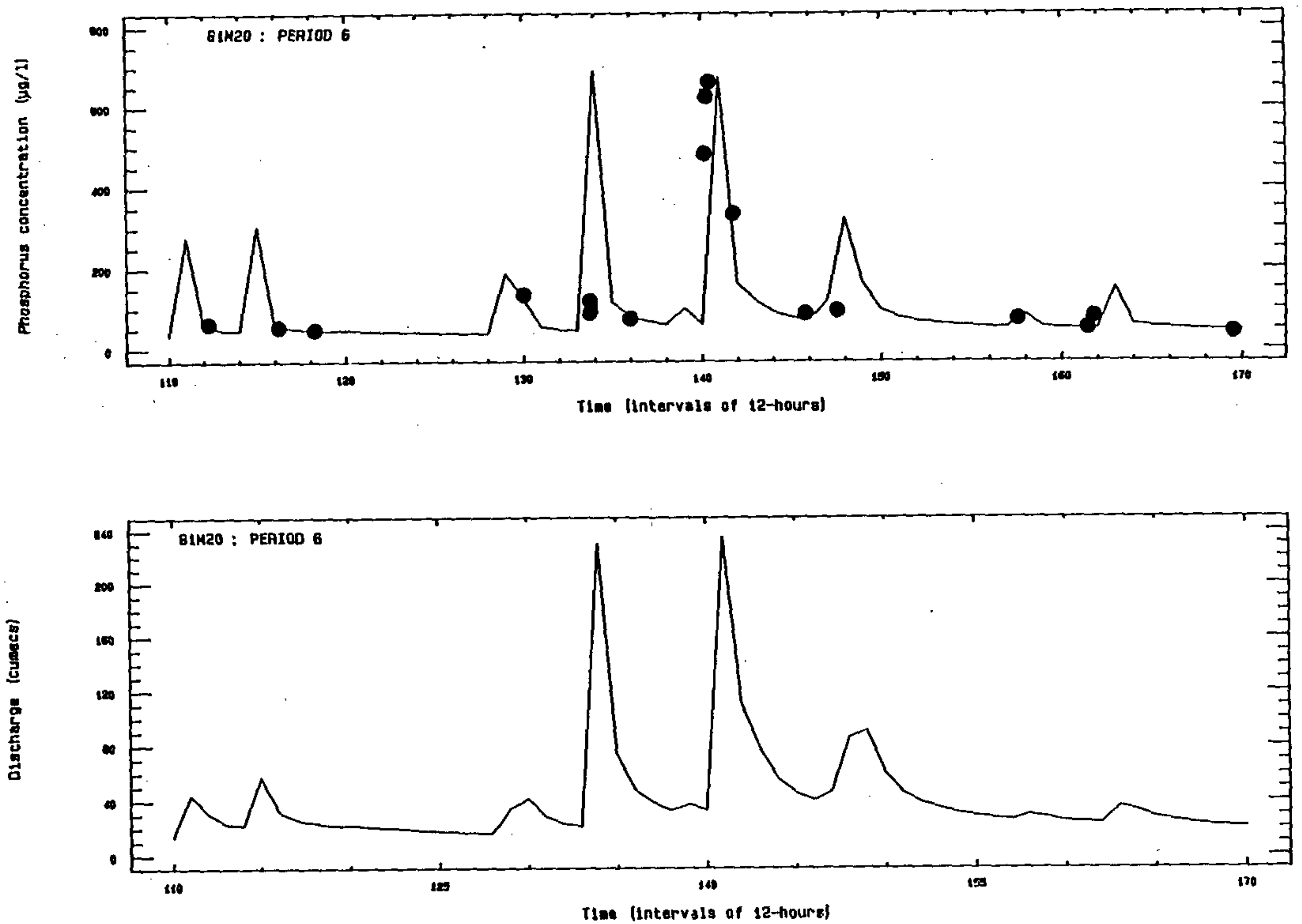


Fig 7.12(a). Simulated and measured phosphorus concentration for a period of one month during flood flow conditions in Period 6. The lower plot shows the associated hydrograph.

and measured phosphorus concentration. From the plot in Fig 7.12(a), the simulated and measured phosphorus concentrations are in reasonable accord. To check for the whole of Period 6, a correlation plot of measured versus predicted data is shown in Fig 7.12(b).

1.5 <u>NPS Model Verification</u>

To obtain some measure of verification of the model the phosphorus chemograph at Paarl (Station 9A) was simulated over the balance of the monitoring period (Periods 1 to 5 – from November 1983 to November 1986) using

(1) the measured channel hydrograph at G1M20,

(2) the coefficients pairs: a1=0.015, b1=0.0013, and a3=0.009, b3=-0.007 obtained from analysis of Period 6.

Simulated and measured phosphorus concentrations at Paarl are shown in Figs 7.13 to 7.17. These plots are useful in producing an overall assessment of the behaviour of the model.

To obtain a quantitative assessment of the predictive power of the model, a correlation plot for the simulated and measured phosphorus concentrations is shown in Fig 7.18. This plot illustrates the close correspondence between the simulated and measured phosphorus concentrations over the three year period, the concentrations ranging from 20 to 700 μg/ℓ.

Having calibrated and verified the model the simulated phosphorus chemograph and measured hydrograph can be used to estimate the phosphorus load over any of the six periods, or indeed any selected period. Program NPSM provides this facility for load estimation. With the final values for a1, b1, a3, and b3, the load estimates for Period 1 to 6 are:

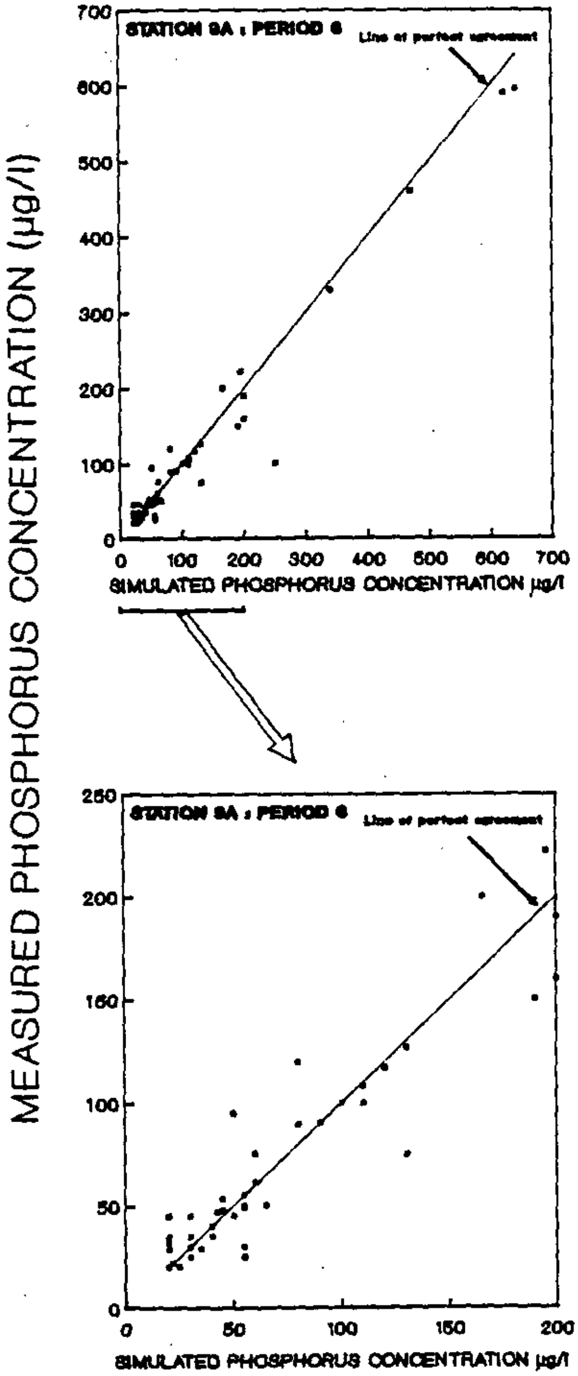


Fig 7.12(b). Plot of the simulated versus measured phosphorus concentration for Station 9A (North Paarl). Simulated values are predicted using the phosphorus nonpoint source model (NPSM) - Period 6.

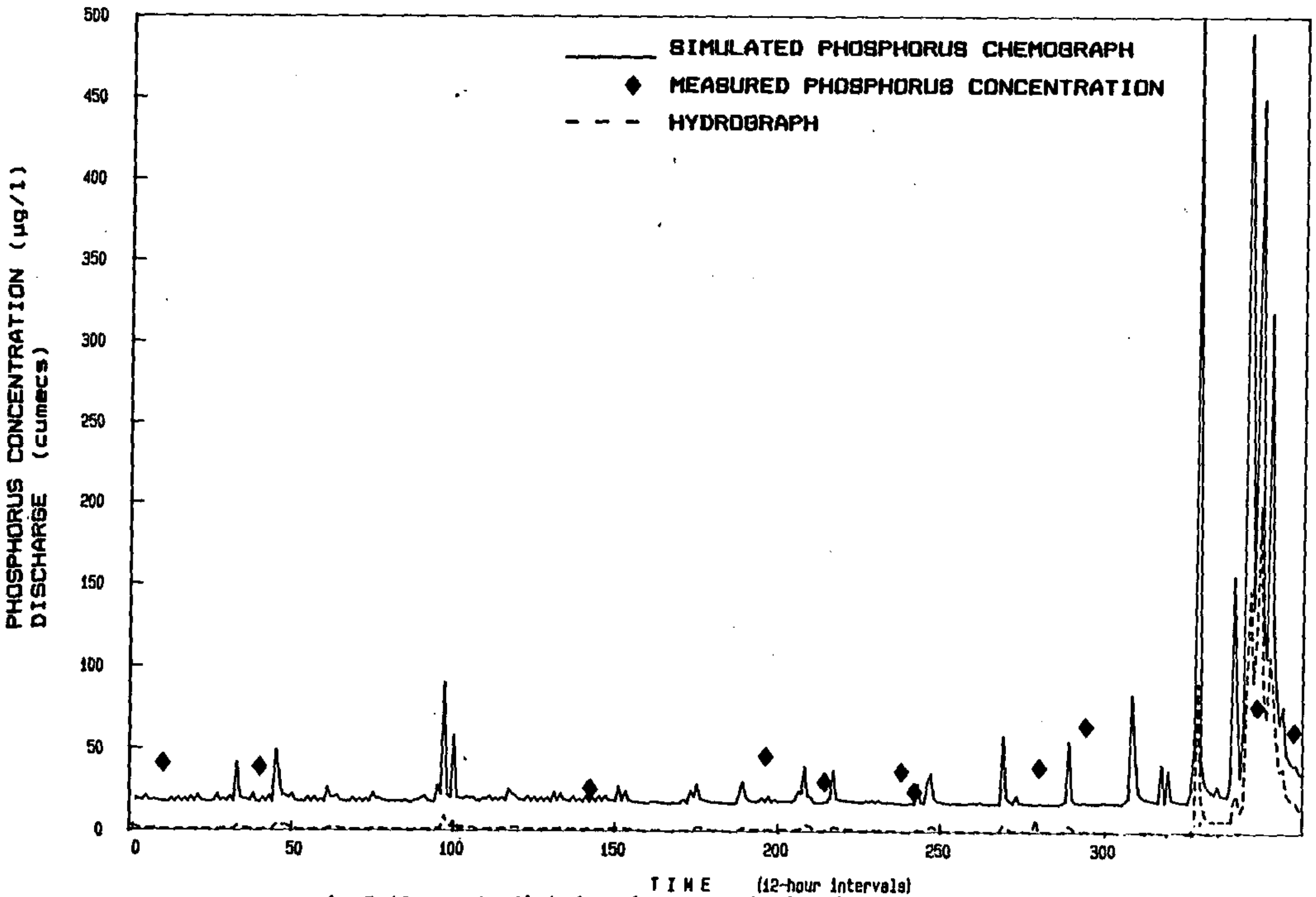


Fig 7.13. Predicted and measured phosphorus chemograph at Station 9A (North Paarl) - Period 1 (summer).

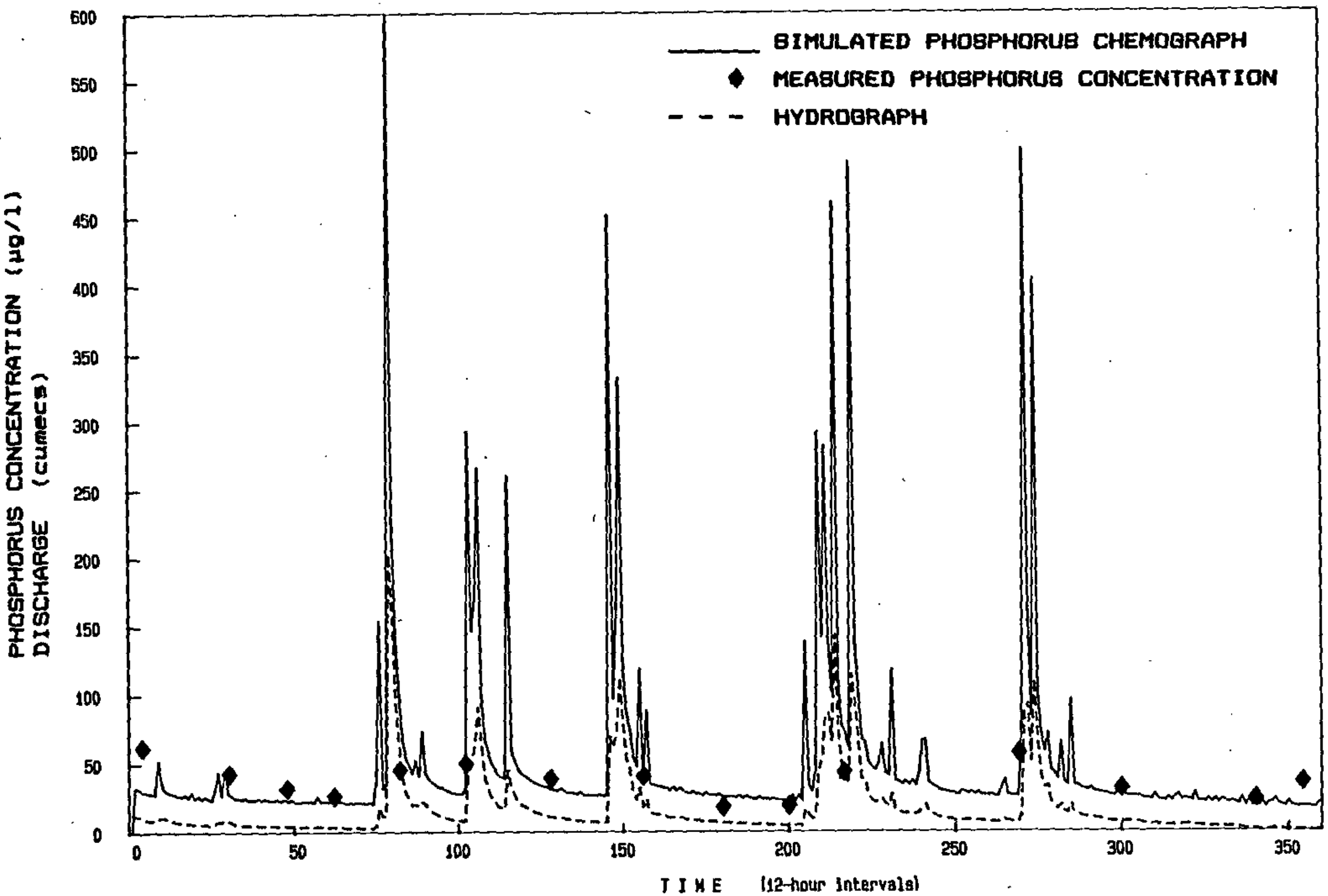


Fig 7.14. Predicted and measured phosphorus chemograph at Station 9A (North Paarl) - Period 2 (winter).

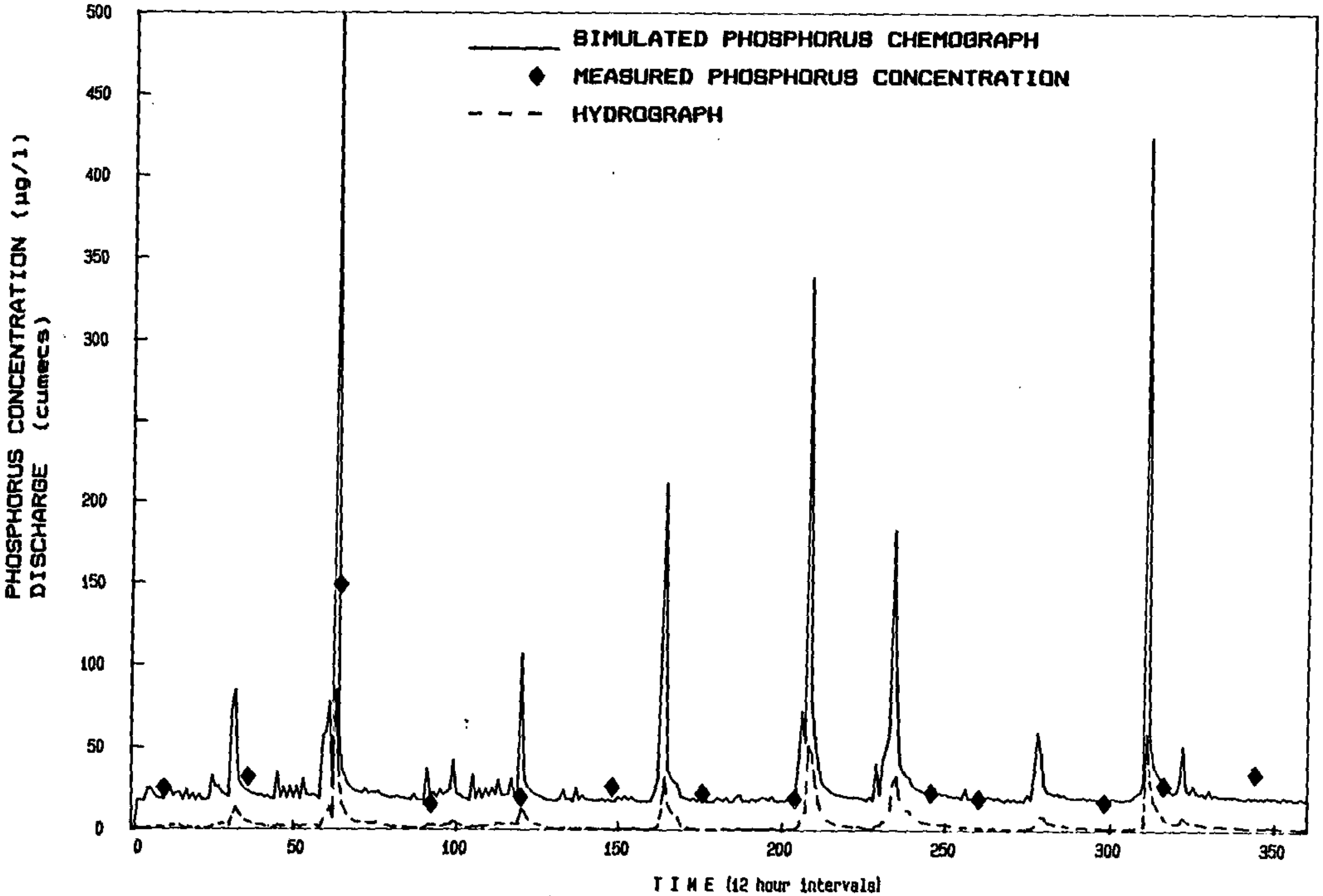


Fig 7.15. Predicted and measured phosphorus chemograph at Station 9A (North Paarl) - Period 3 (summer).

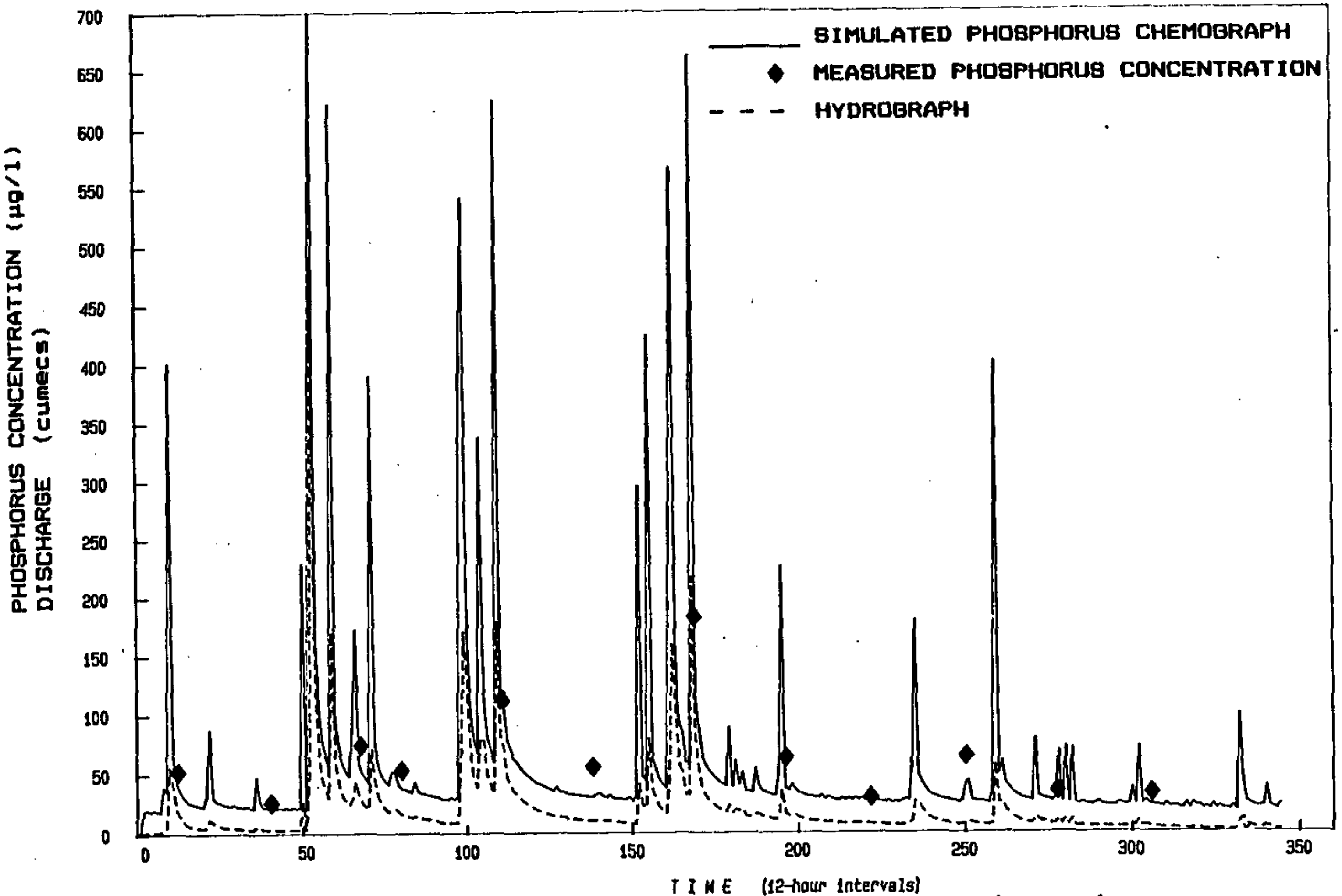


Fig 7.16. Predicted and measured phosphorus chemograph at Station 9A (North Paarl) - Period 4 (winter).

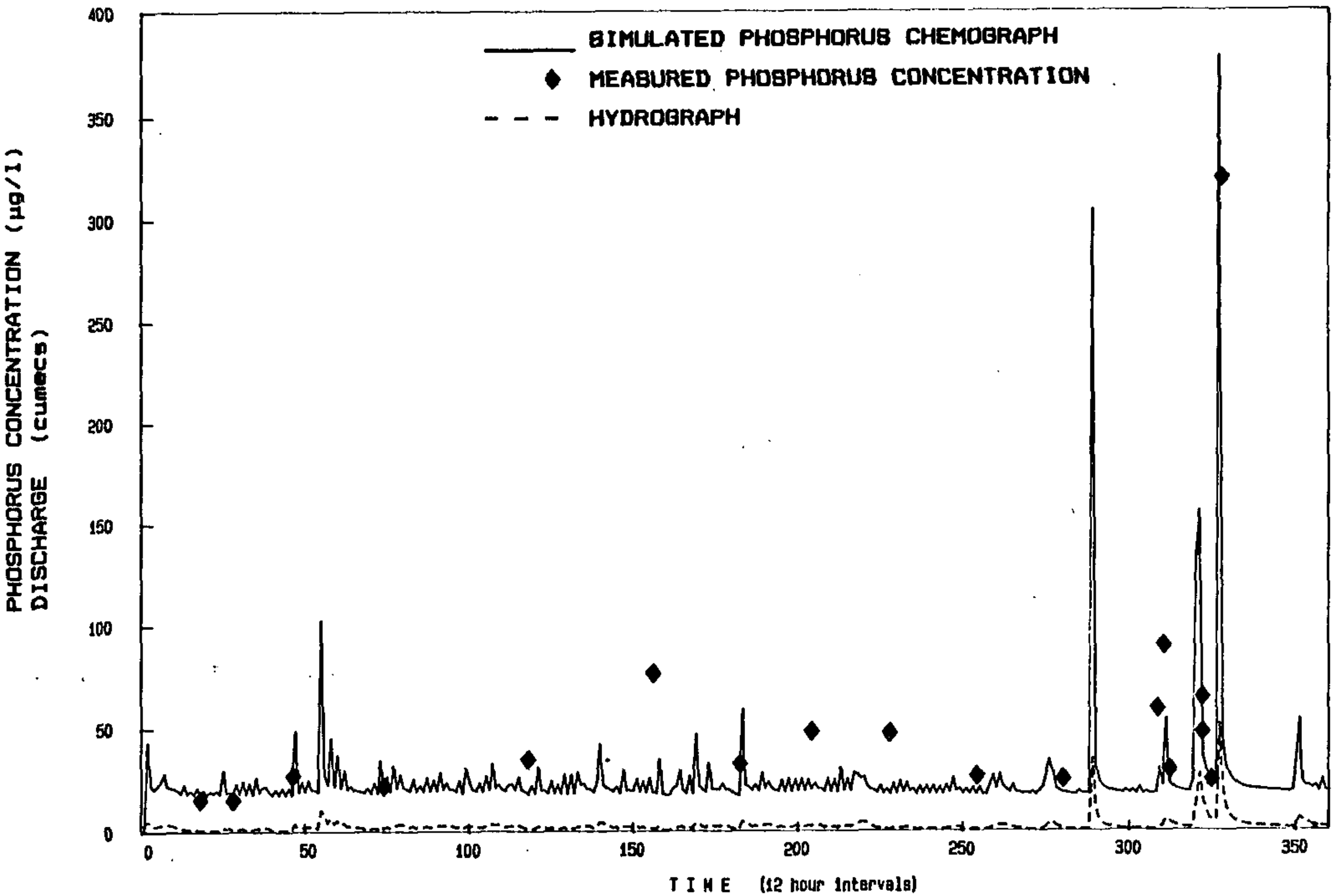


Fig 7.17. Predicted and measured phosphorus chemograph at Station 9A (North Paarl) - Period 5 (summer).

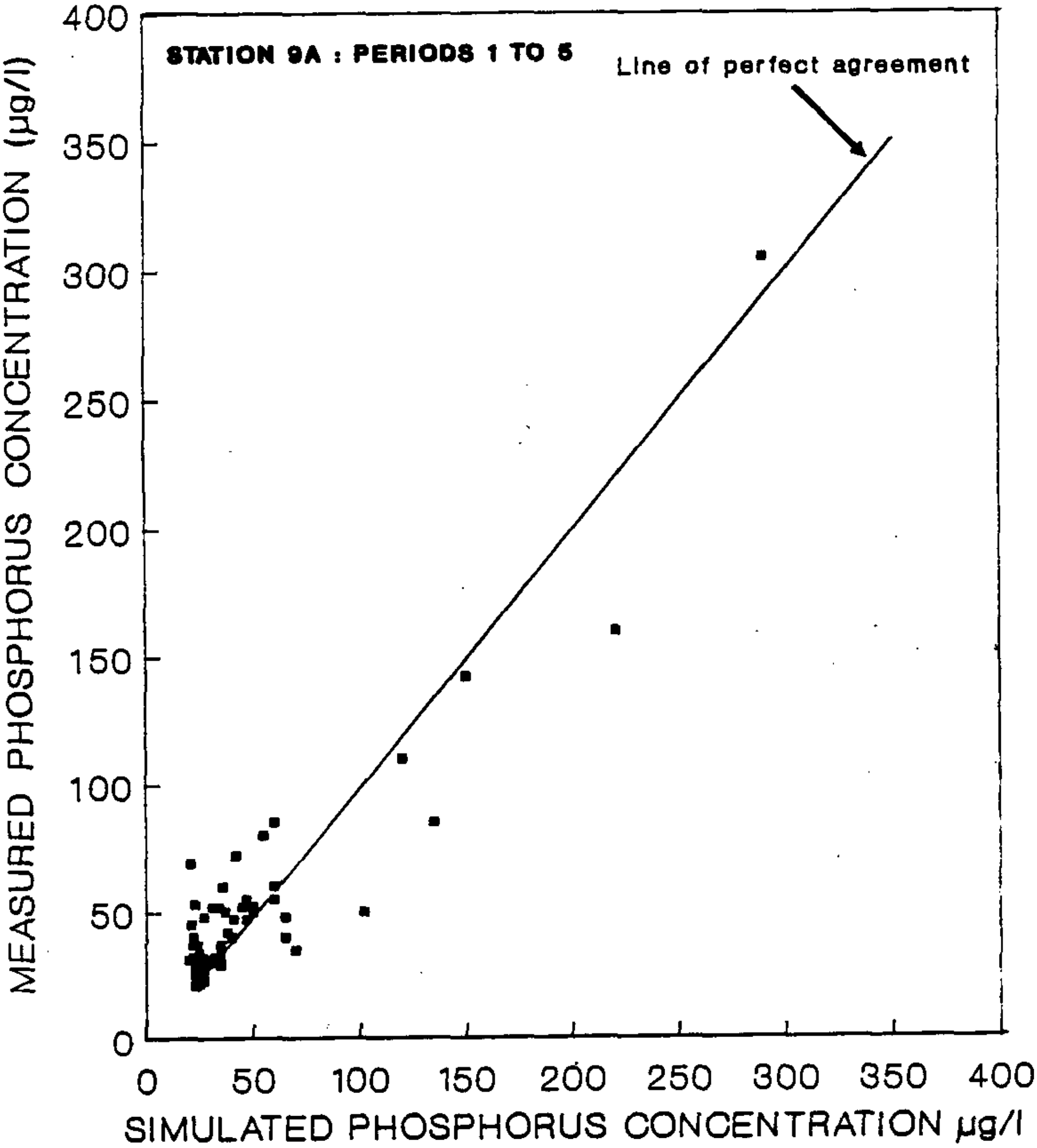


Fig 7.18. Plot of the simulated versus measured phosphorus concentration for Station 9A (North Paarl). Simulated values are predicted using the phosphorus nonpoint source model (NPSM) - Periods 1 to 5.

Period:	TP load estimate: (tons/180 days)
1	17.2
2	34.7
3	5.6
4	57.0
5	2.0
6	57.8

The sensitivity of the load estimates to changes in the constants can be seen in Fig 7.11 for Period 6. It is of interest to note that the estimates marked "high" or "low" in the figure corresponded with chemograph simulations that visually were clearly over- or under-predicting with regard to the measured phosphorus concentrations.

1.6 Application to tributaries

The NPS model was applied to the gauged tributaries, the Krom, Kompagnies and Klein Berg Rivers as well as the Sandspruit (Stations 14B, 17B, 23A, 23B respectively). The procedure to determine a1, b1 and a3, b3 was as follows:

Using Program NPSM, the model was run using the measured hydrograph for the subcatchments and the constant values derived for Station 9A as inputs. Comparing the measured and the simulated TP values, first a1 and b1 were modified until the simulated TP values over the recession and steady flow regions compared as closely as possible to the measured TP. Accepting these values for a1 and b1, the a3 and b3 values were modified until correspondence was attained between the observed and simulated flood flow TP values.

Table 7.1 Optimum values for coefficients a1, b1 and a3, b3 in the NPS model.

Coefficients: Units: River:	a1 (mg/ℓ)	b1	a3 (mg/ℓ)	b3
Krom	.035	.04	.009	-.007
Kompagnies	.025	.02	.009	-.007
Klein Berg	.015	.004	.009	-.007
Sandspruit	.040	.09	.009	-.007
Berg at 9A	.015	.0013	.009	-.007

The best values for a1, b1 and a3, b3 for the four tributaries are shown in Table 7.1. The constants a3 and b3 in Eq (7.8) do not show any marked variation between subcatchments, implying that the processes responsible for the export of phosphorus during the beginning of storm events are similar for the different subcatchments.

The constants a1 and b1, exhibit different values for each of the subcatchments. The wide ranges of values for a1 and b1 were a matter of concern because it implied that no estimates were possible for an ungauged unmonitored area. However, Prairie and Kalff (1986) reported that the size of catchment and hydrology will directly influence the export of phosphorus. Accordingly, the constants a1 and b1 were plotted versus the total subcatchment area and total subcatchment winter runoff (for 180-day period). The plot with subcatchment area exhibit appreciable scatter (Fig 7.19), whereas the plot with winter runoff indicate a definite relationship, see Fig 7.20.

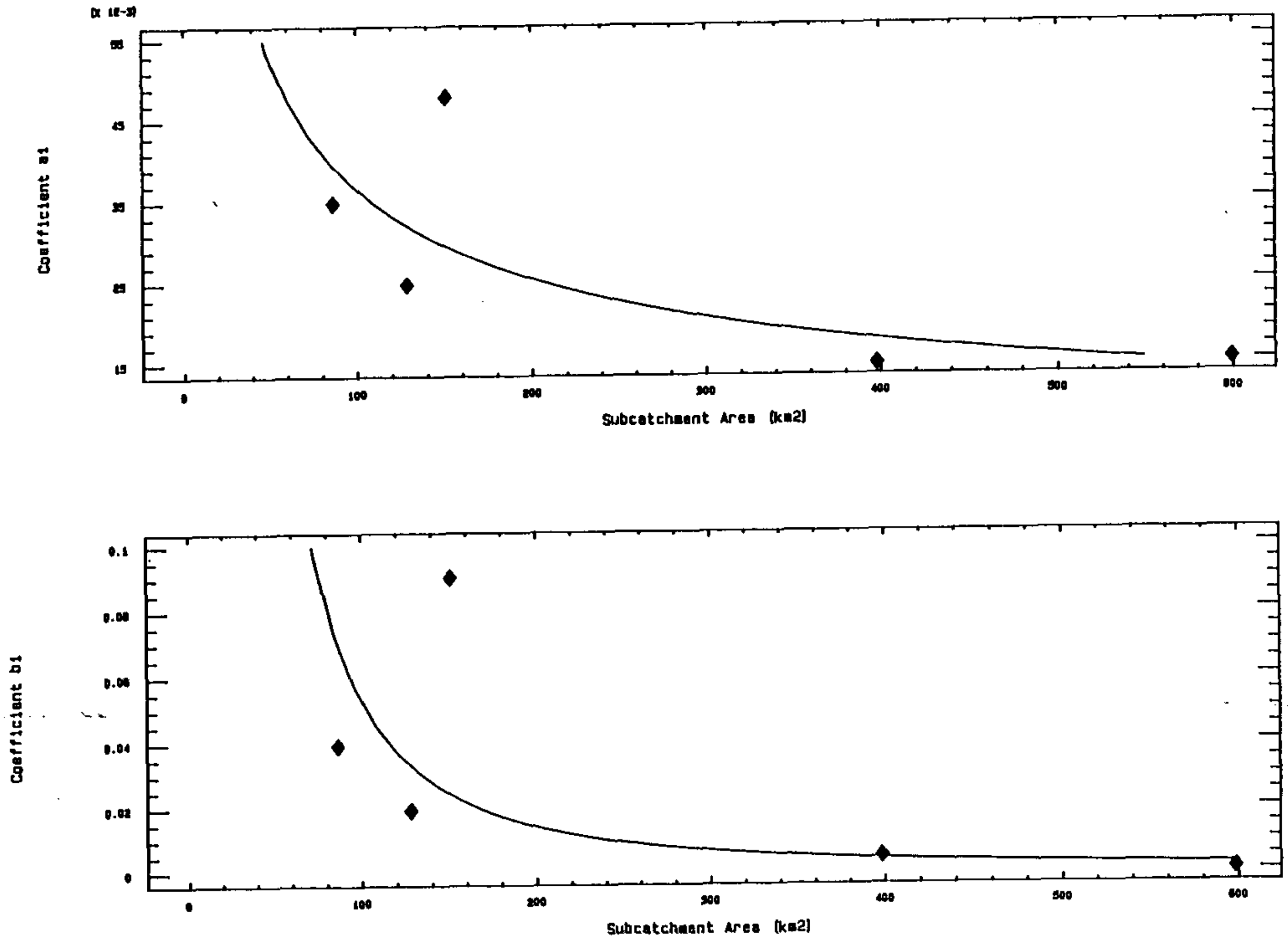
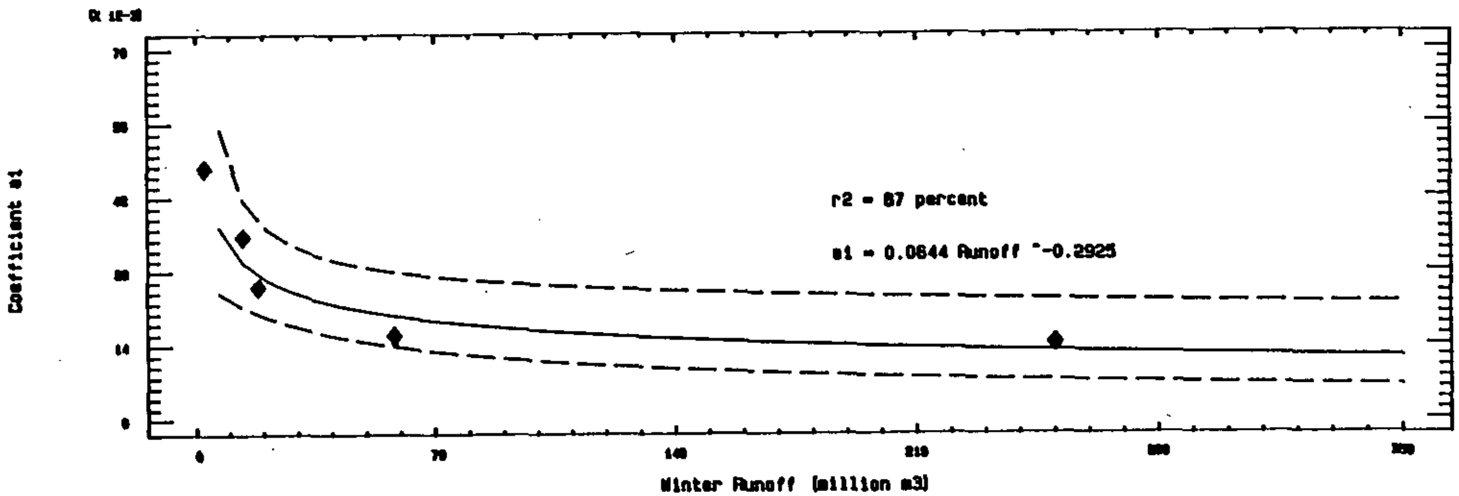


Fig 7.19. Phosphorus nonpoint source model constants a1 and b1 plotted as a function of subcatchment area for a number of monitored subcatchments.



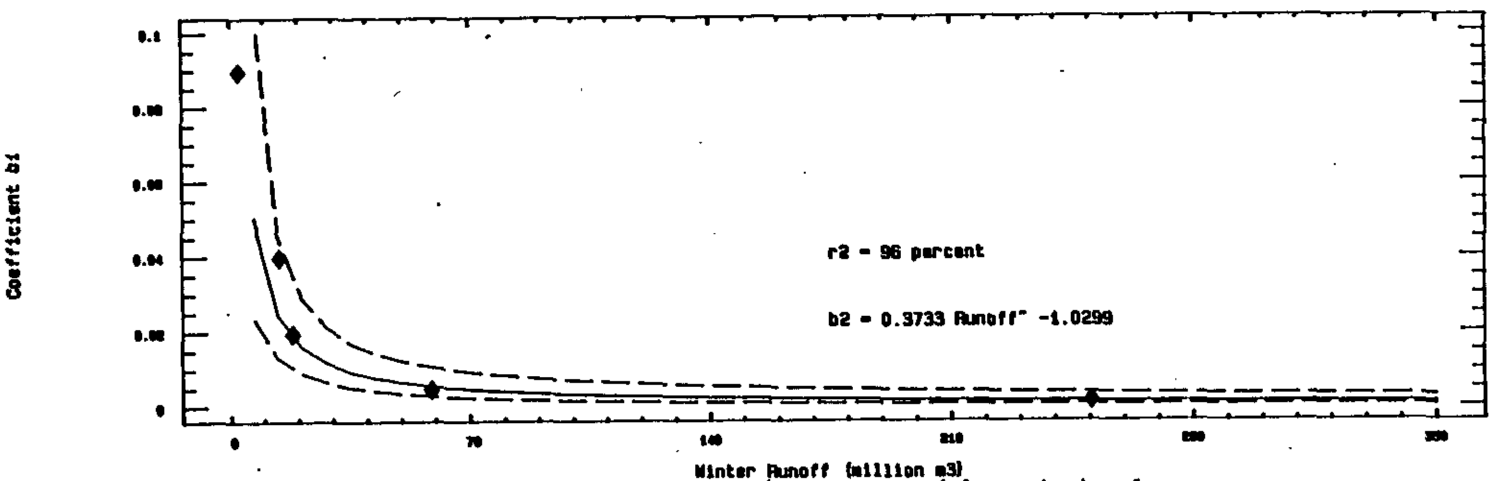


Fig 7.20. Phosphorus nonpoint source model constants a1 and b1 plotted as a function of subcatchment runoff for a number of monitored subcatchments. The volumes of runoff are calculated for a 180-day period covering the winter season.

Clearly the constants a1 and b1 which relate to the recession or low flow conditions decrease with total subcatchment runoff. The land use in these subcatchments are similar; it would seem that the relationship between constants a1 and b1 and winter runoff arises predominately from the hydrology.

As the constants a1 and b1 are strongly linked to the winter mass runoff and because the procedures for estimating discharge from ungauged areas are well developed (Chapter 6) the equations linking the values of a1 and b1 (given in Fig 7.20) now can be used to calibrate the phosphorus transport model for ungauged subcatchments.

1.7 NPS model evaluation

It would seem that the modified looped phosphorus rating approach allows the development of an acceptable method for estimating the phosphorus concentration in both the rising and falling limbs of the flood hydrograph derived from a subcatchment draining nonpoint sources.

The model is largely empirical, yet it reproduces the behavioural patterns observed. By selecting a number of flood waves at station 9A the waves ranged from small to large, the thereotical chemograph could be calculated and the theoretical phosphorus concentration discharge hysteresis curves constructed (see Fig 7.20(a)). Note that the formulated hysteresis curves are functions of discharge and rate-of-change of discharge. The hysteresis effect exhibited by the plot of TP versus Q for a single flood event (Fig 7.3) is closely reproduced, see Fig 7.20 (b) and (c).

Perhaps of greater importance is that by gaining familiarity with the TP responses over a range of conditions it might stimulate the development of mechanistic models that may, in time, provide models of greater power then this one. This is indeed what happened even while developing the model described above, as shall be shown in Section 2 below.

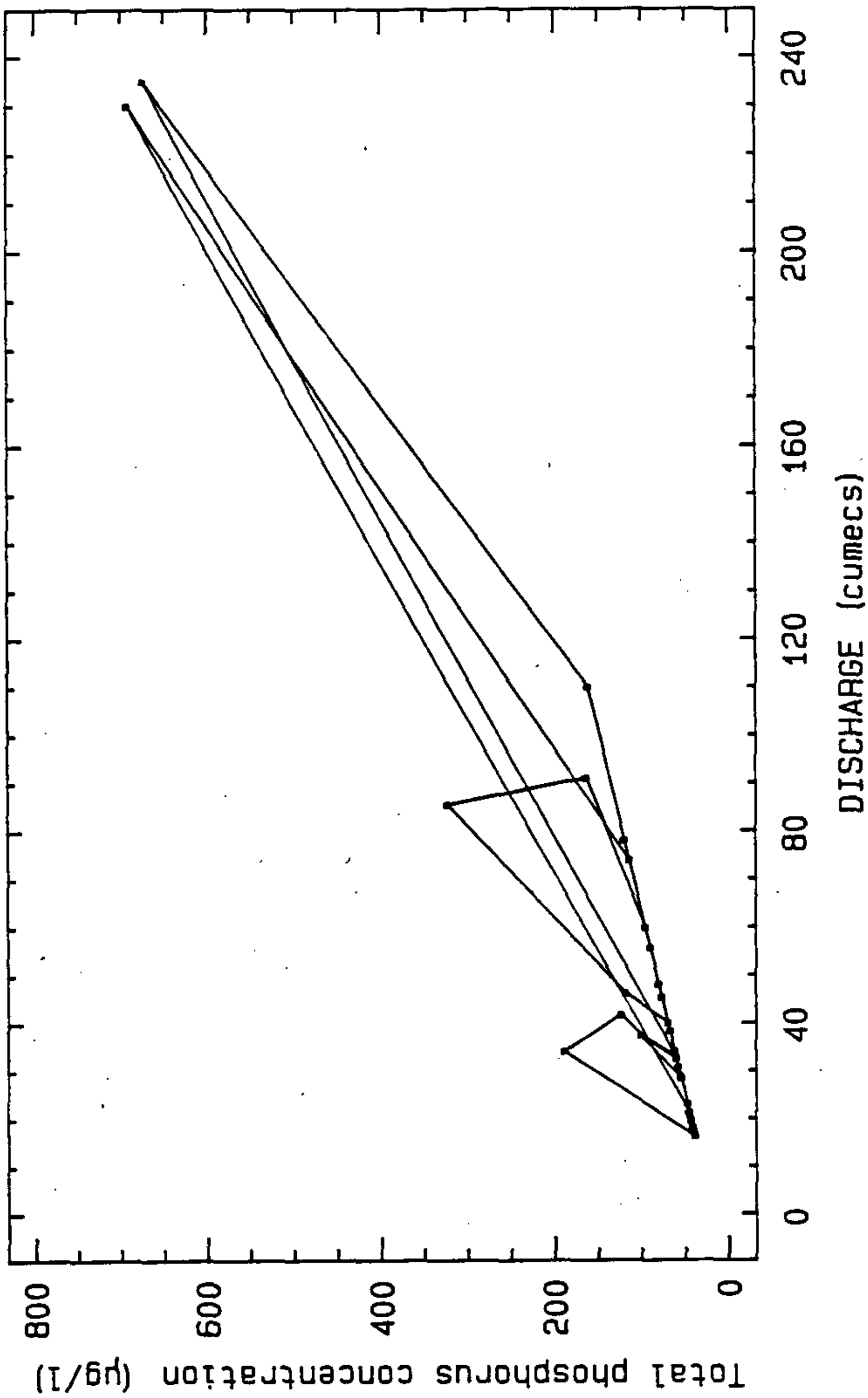


Fig 7.20(a). Simulated phosphorus concentration/discharge hysteresis curves constructed using the output from NPSM and measured discharge data for four flood events during Period 6 at Station 9A (day number 60 to 78).

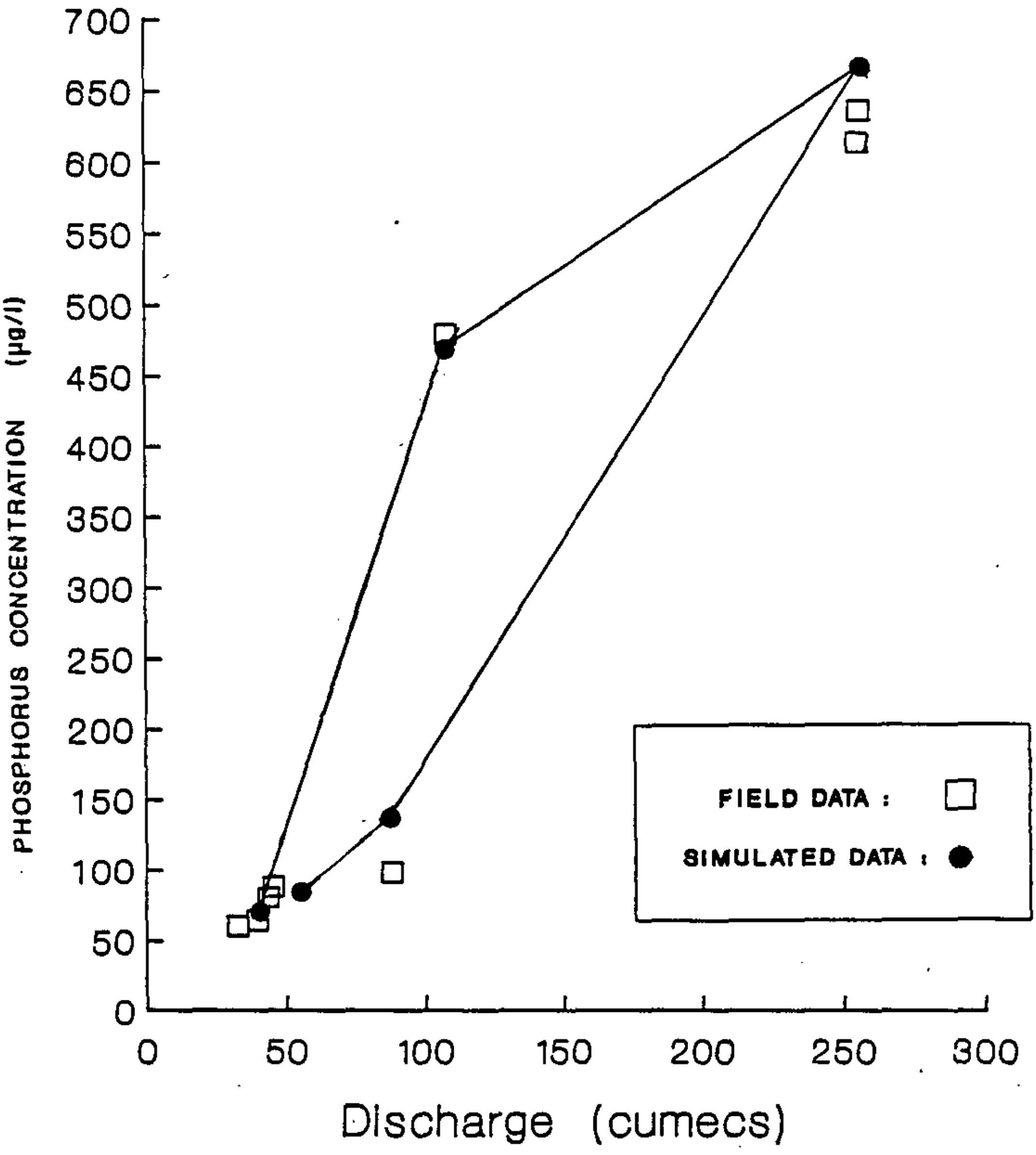


Fig 7.20(b). Measured phosphorus concentration versus discharge showing the hysteresis effect during one flood event. The solid line shows the simulated hysteresis produced by the phosphorus nonpoint source model (NPSM).

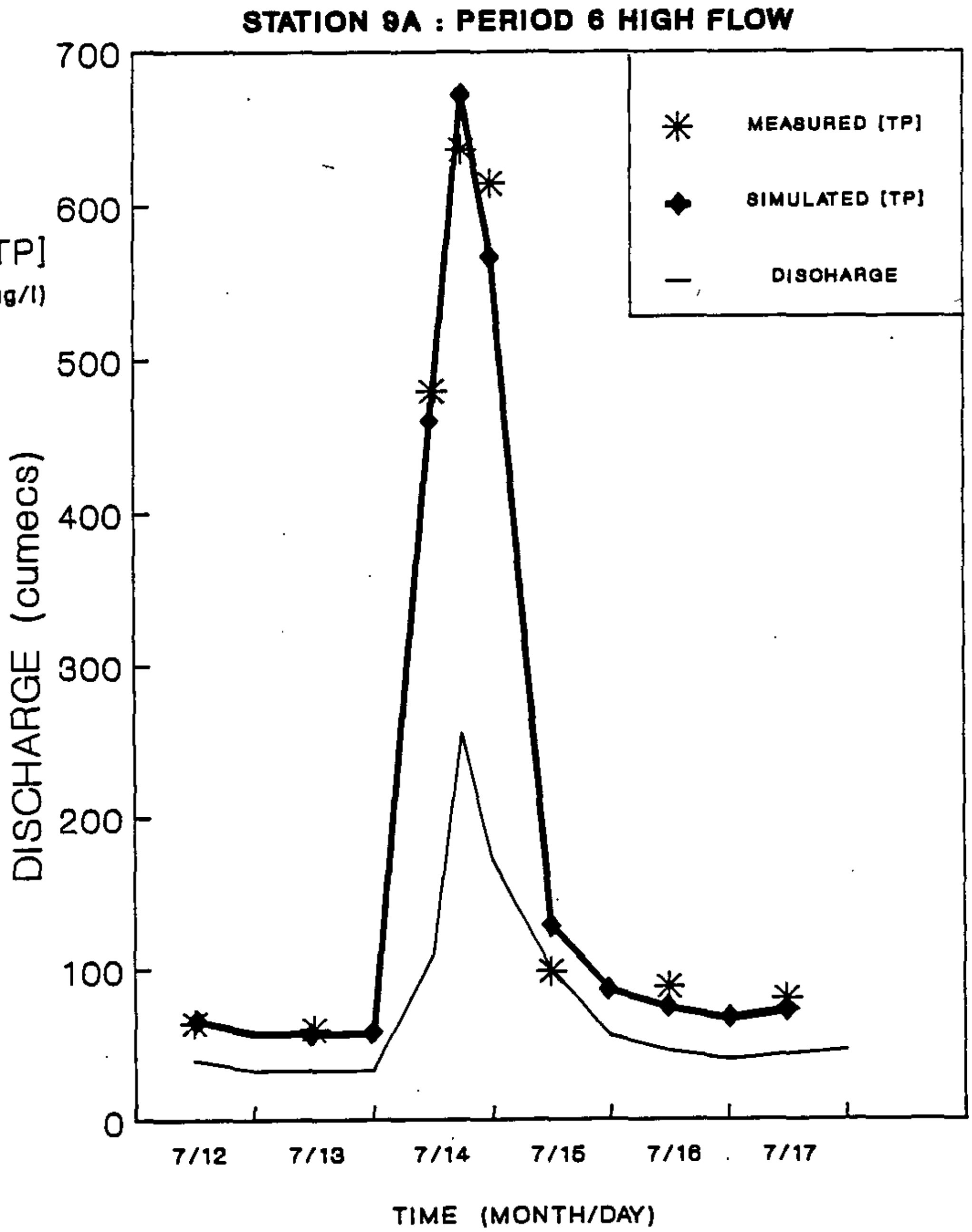


Fig 7.20(c). Measured and simulated phosphorus concentration data for a single flood event plotted as a function of time, with associated discharge data. The simulated phosphorus concentrations are derived from the phosphorus nonpoint source model (NPSM).

2 NPS MODELLING USING HYDROGRAPH DECOMPOSITION APPROACH

- A TENTATIVE APPROACH -

In the development and application of the looped phosphorus discharge rating nonpoint source model we have seen that the instantaneous phosphorus concentration can be modelled in terms of the instantaneous discharge and the rate-of-change of discharge. By means of the latter parameter, the effect of the flow on the rising or falling limbs of the hydrograph could be separated out - two functional relationships were incorporated to describe the total phosphorus in the rising flow and recession flow conditions. We shall now attempt, subjectively, to explain the variation in phosphorus concentration with discharge on the rising and falling limbs of the hydrograph by decomposing the hydrograph into two components - surface and subsurface drainage.

Depending upon the rate at which rain falls, the water either infiltrates completely into the soil or a fraction remains on the surface to produce surface runoff. If the rainfall intensity (neglecting interception, evaporation and deep infiltration losses) is less than the infiltration capacity, all the water will enter the soil profile, ultimately to reach the river as subsurface drainage. However, if the rainfall intensity is in excess of the soil-infiltration rate, a sequence of events occurs, ultimately producing surface runoff: excess water produced by a high-intensity rain first satisfies the interception requirements. When the surface depressions are filled, the surface water begins to move down the slopes in thin films and tiny streams. During this stage, overland flow is influenced by surface tension and friction forces. The paths of the small streams are tortuous and even small obstructions give rise to the resistance of flow until sufficient head is built up to overcome this resistance. Each time the streams merge, the water accelerates on its downhill path increasing the erosion effect, carrying particulate material. These effects in conjunction with the area, shape and slope of the subcatchment give rise to the resultant shape of the surface runoff hydrograph and chemograph at a selected point in the path of flow. In addition, seepage from subsurface drainage will give rise to a base flow hydrograph and baseflow chemograph.

After the rain ends the surface runoff will continue until the discharge per unit surface area is exceeded by the infiltration rate (Gray, 1962; Kersandt and Marais, 1973).

The surface runoff usually contains a high concentration of suspended soil particles including particulate phosphorus, associated with the detachment of soil particles (Cooke, 1988). Logan (1982) estimates that greater than 75 percent of the phosphorus in surface generated runoff from agricultural land is in the particulate form, that is, a minor fraction of phosphorus in surface runoff is in the soluble form. In contrast, subsurface drainage flow will contain virtually no particulate phosphorus because of the filtering action of the water percolating through the soil horizons (Cooke, 1988). Furthermore the subsurface drainage will contain only a small concentration of soluble phosphorus; this concentration is derived from dissolution and desorption processes within the soil, which are relatively slow processes compared to precipitation and adsorption (Logan, 1982). Thus, there are two principle pathways for phosphorus export from drainage basins: transport of principally particulate phosphorus associated with surface runoff and, transport of soluble phosphorus derived principally from subsurface runoff (Logan, 1982), see Fig 7.21.

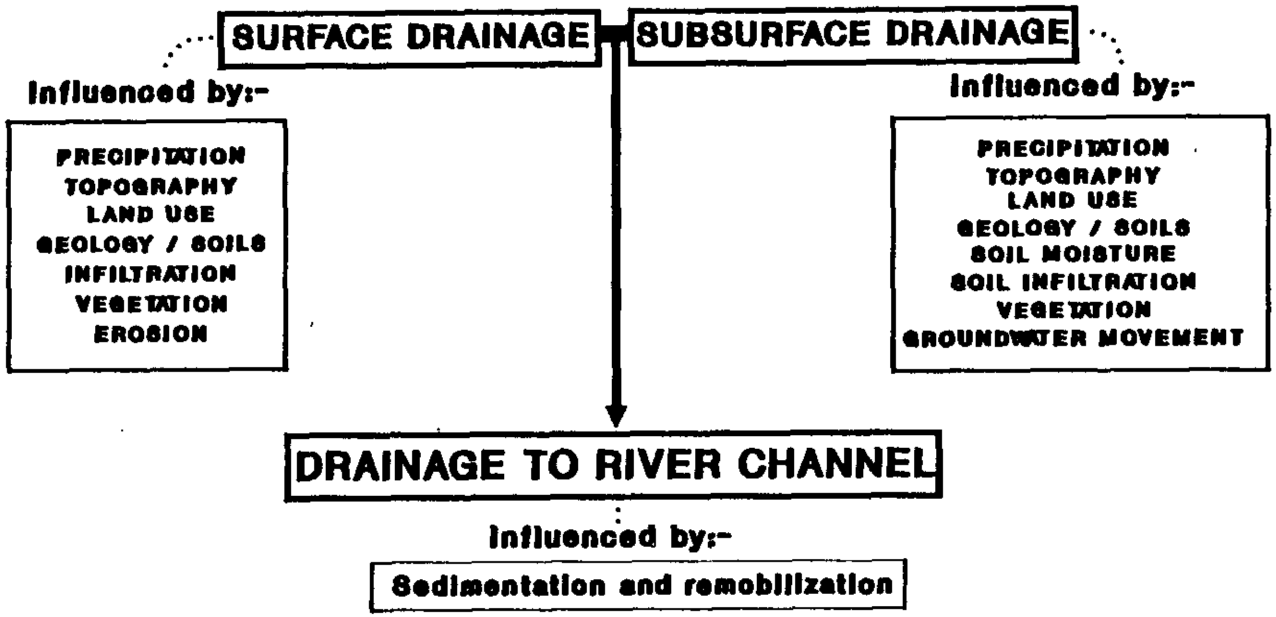


Fig 7.21. Conceptual framework for the release of phosphorus from nonpoint sources.

2.1 Hydrograph decomposition

In Fig 7.22, a hypothetical hydrograph is shown composed of three sub-hydrographs: a surface runoff hydrograph, an interflow hydrograph, and a baseflow hydrograph. The summation of these component hydrographs constitutes the discharge hydrograph as measured at the gauging weir.

Traditional hydrograph separation procedures (Linsley, Kohler and Paulhus, 1975) are essentially empirical; for example they plot the total hydrograph on semi-logarithmic paper and insert three straight lines to accommodate surface runoff, surface runoff and interflow, and finally groundwater recession.

One rational way of separating the hydrograph into its constituent hydrographs is to make use of water quality parameters. The underlying idea is that water from different sources will possess different chemical characteristics and that the relative constituents of the different sources can be identified by measuring both the stream discharge and the chemical quality of the water in the stream (Kunkle, 1965; Pinder and Jones, 1969; Visocky, 1970).

Using the water quality approach to separate the hydrograph, the following assumptions are made:

(1) The phosphorus species in baseflow and interflow will be similar as the drainage is derived from similar catchment processes e.g. infiltration and percolation. Consequently, for modelling purposes interflow and baseflow can be lumped together giving the total subsurface drainage. The remaining portion of the hydrograph constitutes the surface drainage.

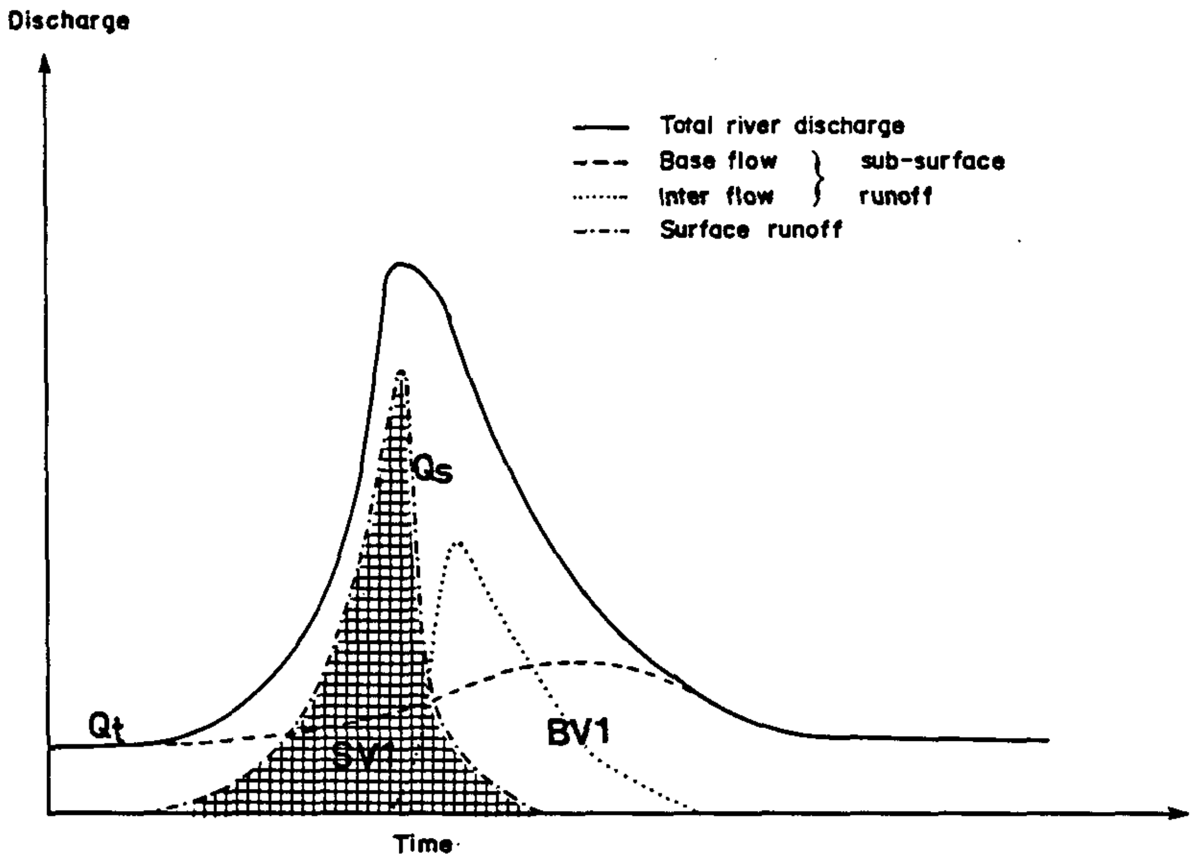


Fig 7.22. Hydrograph (Qt) decomposed into three flow components: surface flow (Qs), interflow (Qi) and baseflow (Qb). SV1 represents the volume of surface runoff and BV1 the volume of subsurface runoff.

(2) To separate the surface runoff hydrograph (SV2 in Fig 7.23) from the subsurface hydrograph (BV2 in Fig 7.23) requires: (i) the determination of the baseflow, Qb, during the beginning of the flood event when the total discharge, Qt, is the product of *surface runoff*, Qs, *and baseflow Qb*; (ii) the recession curve of the surface runoff hydrograph after peak flow. By satisfying both these requirements it is possible to isolate the surface runoff hydrograph, SV2 in Fig 7.23.

(3) Baseflow discharge, Qb, is *related to* the total discharge, Qt, *shown* in Fig 7.23, by

$$Qb = f\ (Qt\ kb) \qquad \ldots\ldots \quad (7.9)$$

where kb is a proportionality constant.

Equation (7.9) is *formulated* on the basis that a fixed relationship exists between the discharge rate of basflow and total river discharge (Linsley et al., 1975).

(4) Recession of the surface *runoff hydrograph*, Qs, shown in Fig 7.23, is described by

$$dQs/dt = -ks\ Qmax \qquad \ldots\ldots \quad (7.10)$$

where

ks is the surface runoff depletion coefficient,
Qmax is the peak surface runoff.

Equation (7.10) is based on the assumption that the depletion rate of the surface runoff hydrograph will closely correspond to the *depletion* rate *of* the total runoff (Qt) (Linsley et al., 1975).

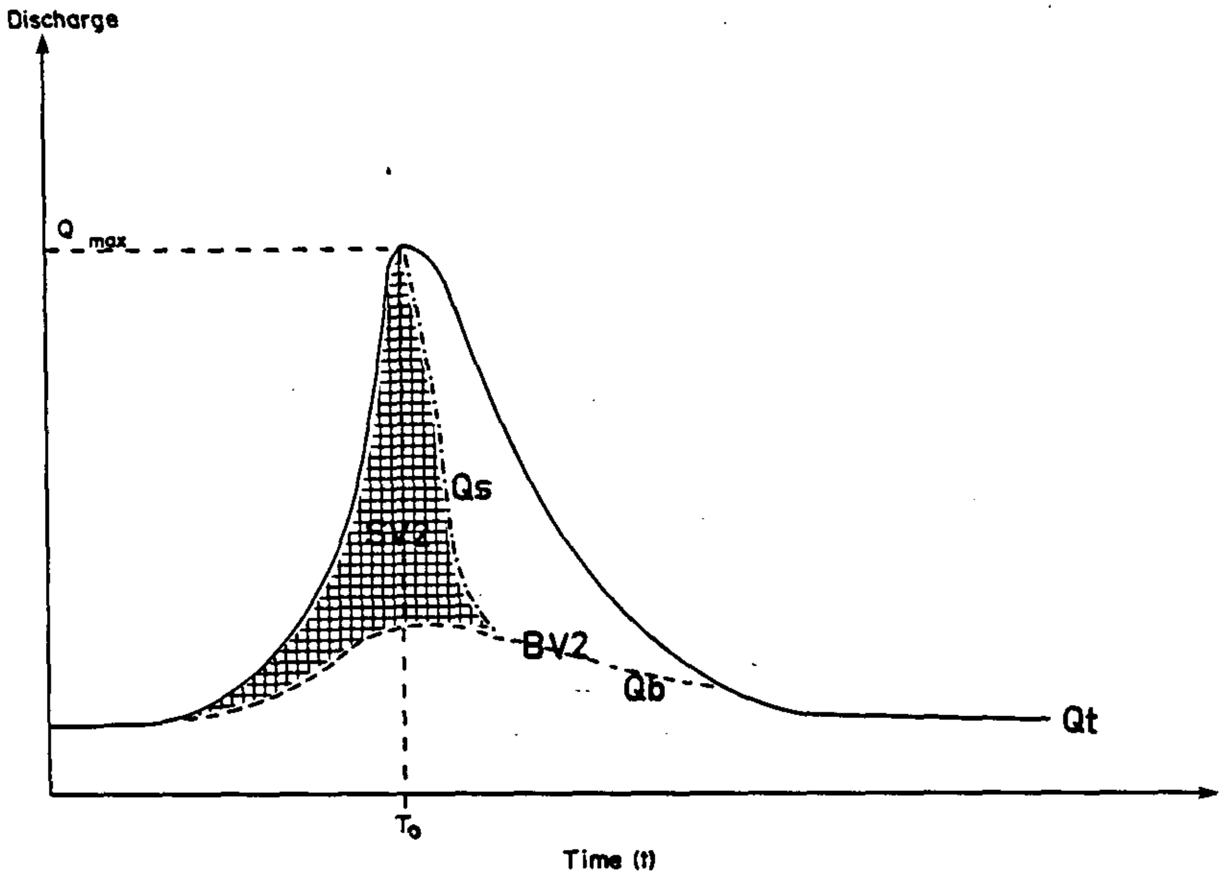


Fig 7.23. Hydrograph divided into component hydrographs (with the same notation as in Fig 7.22). Where SV2 represents the volume of surface runoff and BV2 represents the summation of the interflow and baseflow (subsurface runoff).

(5) The volume of surface runoff represented by the terms SV1 (in Fig 7.22) and SV2 (in Fig 7.23) are approximately equal.

(6) During steady flow conditions the baseflow is equal to the total flow in the river.

(7) The areas BV1 (in Fig 7.22) and BV2 (in Fig 7.23) making up the combined drainage from interflow and baseflow are approximately equal in volume.

Equation (7.9 and 7.10) are solved as follows:

(1) For Eq (7.9) the following explicit form is proposed

$$Qb = a\ Qt^{kb} \qquad \ldots\ldots \quad (7.11)$$

where a and kb are constants and both <1.

(2) The recession limb of the surface runoff, Qs, is measured from the time elapsed from peak surface runoff, Qmax. The solution is,

$$Qs = Qmax\ EXP\ [ks\ (to-t)] \qquad \ldots\ldots \quad (7.12)$$

where

to = time of peak flow and
t = time elapsed since peak flow, see Fig 7.24
ks = negative constant,
Qmax = peak surface runoff (at to).

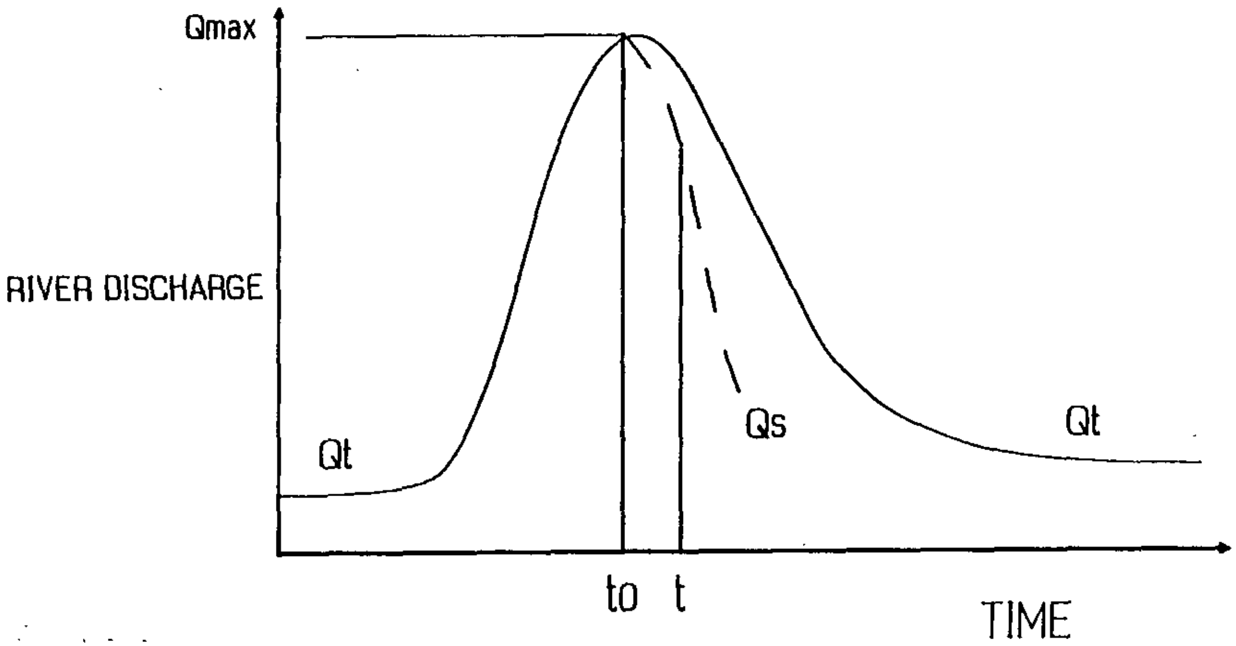


Fig 7.24. Explanation of terms used in Eq (7.12).

For the purposes of the simulation exercise values were selected for the constants ks, and a and kb that essentially were dictated by subjectivity:

The constants kb and a were selected after applying sets of these values to a particular hydrograph and choosing the set that appeared to conform to expectations, giving kb=-0.045 and a=20.

During the collection of the water quality data it was found that the phosphorus concentration diminished to 10 percent of the peak flow concentration within hours after peak flood flow. It was presumed therefore that, the surface runoff hydrograph should show a similar depletion rate; accordingly, constant ks Eq (7.12) was adjusted to give a very rapid reduction in the surface runoff after peak flow, ks=-1.4.

To obtain scientifically based estimates of these constants would require a detailed investigation into the relationships between surface and subsurface flow. This however, was not attempted because the purpose of this simulation exercise was only to illustrate a potentially useful approach to phosphorus export from nonpoint sources, see below.

2.2 Chemograph decomposition

Having separated the hydrograph into surface and subsurface runoff, the next stage is to determine an equation which describes the phosphorus concentration of each flow component i.e. chemograph decomposition. The following methods and assumptions were used:

(1) The phosphorus in drainage basins is in two forms: mobile and fixed. The mobile phase represents the phosphorus transported in the river, either as particulate or soluble material; the fixed phase represents the phosphorus in the soils and immobile riverbed sediments. The particulate phosphorus concentration is estimated as the difference between the measured total phosphorus concentration and soluble phosphorus concentration.

(2) Particulate phosphorus, PP, is principally derived from surface runoff (Logan, 1982), it is assumed that the concentration delivered from this source is proportional to surface discharge, Qs (Cooke, 1988). The differential equation to describe particulate phosphorus export from the catchment surface is given by

$$d[PP]/dQs = ksp\ [PP] \qquad \ldots\ldots \quad (7.13)$$

Equation (7.13) is solved by plotting the particulate phosphorus concentration as a function of surface runoff, illustrated in Fig 7.25. The surface runoff is determined using Eqs (7.11 and 7.12). The slope of the line is equal to the constant, ksp, determined using regression analysis (program REGRESS - Appendix 2).

(3) The soluble phosphorus concentration, [SP], is influenced by adsorption, desorption, biotic uptake, dissolution and organic decay (Logan, 1982). It is assumed that these processes can be lumped together as the export rate of soluble phosphorus to the river is proportional to the subsurface flow rate (Qb), see Eq (7.11). The subsurface flow rate is accepted as equal to the sum of the baseflow and interflow.

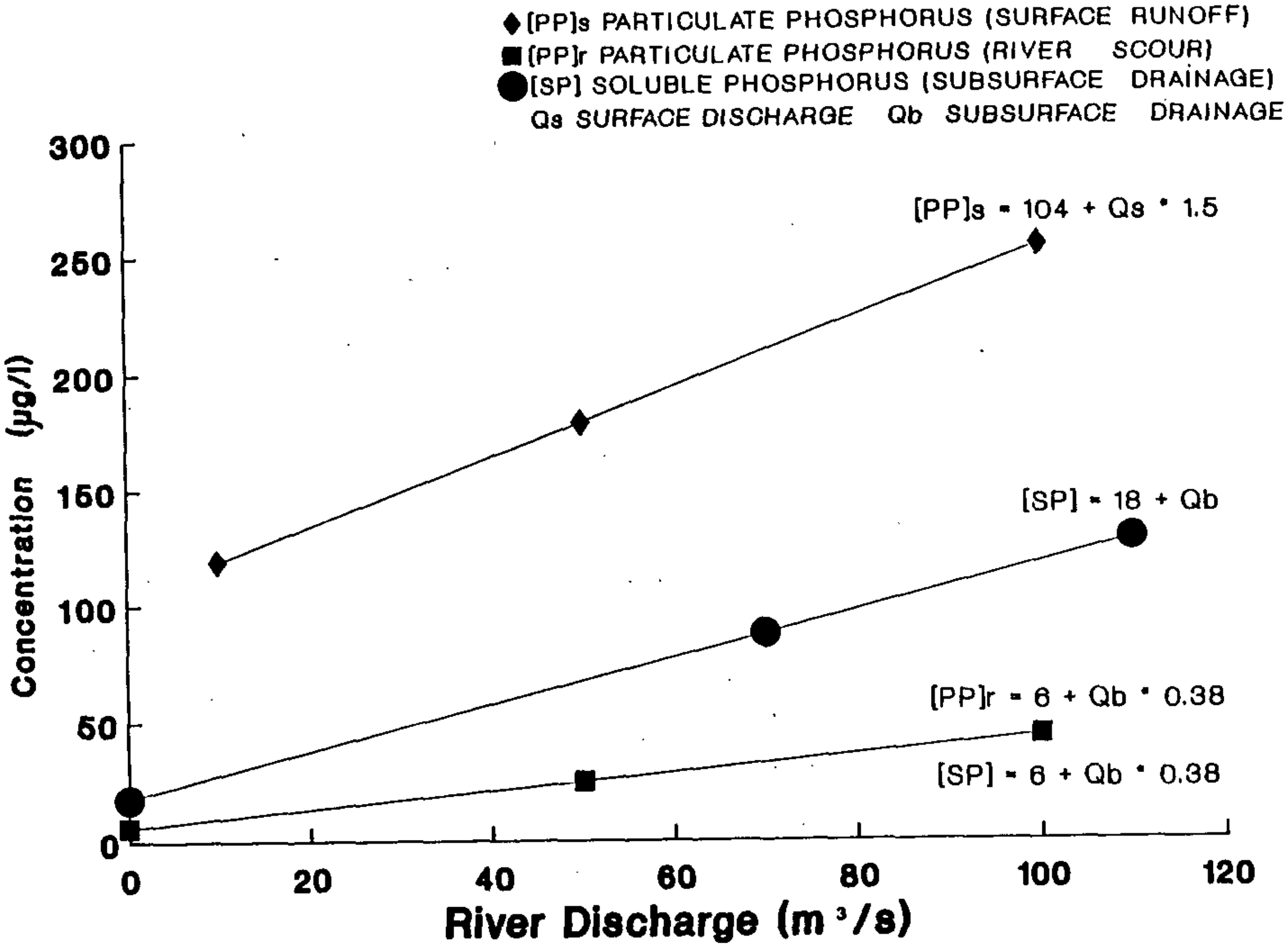


Fig 7.25. Soluble and particulate phosphorus concentration plotted as a function of river discharge for Station 9A (North Paarl) - Period 6.

$$d[SP]/dQb = kad\ [SP] \qquad \ldots\ldots \quad (7.14)$$

The constant, kad, in Eq (7.14) is evaluated by plotting the soluble phosphorus concentration as a function of the basal runoff, illustrated in Fig 7.25. The slope of the line is equal to the constant, kad, and is determined by linear regression analysis.

(4) The particulate phosphorus transported in a river is also convected by scour of benthic material (Keup, 1962). The following differential equation is used to model the transport of particulate phosphorus as a function of the river discharge rate (Qt)

$$d[PP]/dQt = ks\ [PP] \qquad \ldots\ldots \quad (7.15)$$

The constant ks in Eq (7.15) is evaluated by plotting the particulate phosphorus concentration data as a function of the total discharge, Qt, during low flow conditions, see Fig 7.25. The slope of the line is equal to the constant, ks, determined using regression analysis.

The equations described above are presented as a process-component matrix in Table 7.2, and programmed in NPSM-CON (see Appendix 2) to predict the chemograph of soluble and particulate phosphorus. As we are interested only in the mobile phase (export into the river) the mass transfer of phosphorus from the fixed phase is assumed to be unlimited in terms of the rate of supply. This assumption is supported by Johnson et al. (1976); they report that a only 1 percent of the annual phosphorus input via manure and fertilisers to a catchment is transported by rivers. Thus, the export of phosphorus from a catchment into a river channel is principally controlled by the transport processes shown in Table 7.2.

Table 7.2 Matrix approach to nonpoint source model application.

Components on which the processes act:

Process:	Soluble P in river:	Part P in in river:	Part P in fixed phase:	Rate:
Surface runoff		+1	-1	Eq (7.13)
Net sedimentation and remobilization		+1	-1	Eq (7.15)
Adsorption Desorption Dissolution	+1		-1	Eq (7.14)

2.3 Model calibration

To calibrate the model the calibration sequence mentioned in Sections 2.1 and 2.2 should be used; the constants ksp, kad, and ks can be expected to show variation between rivers as well as between river sampling stations.

2.4 Chemograph simulation

The soluble and particulate phosphorus chemographs at Paarl (G1M20) were simulated for Period 6 (the only period with reliable soluble phosphorus concentration data) using

(1) the measured hydrograph at Paarl (G1M20),

(2) the values for the constants shown in Fig 7.25.

The simulated and measured soluble and particulate phosphorus concentration at Paarl are shown in Figs 7.26 and 7.27, respectively.

2.5 Model evaluation

Model performance:

In Figs 7.26 and 7.27, the simulated and measured time plot of soluble and particulate phosphorus are shown for Period 6. The close correspondence between simulated and observed values indicates that the soluble and particulate phosphorus species may be modelled using a hydrograph/chemograph decomposition approach. The approach accepts a relatively simple set of processes associated with the export of phosphorus from nonpoint sources but it should be emphasized that a more complex model would require more accurate separation of the hydrograph, which is beyond the scope of this investigation. The hydrology of the Berg River system is ideal for such simulations because the flood hydrographs are generally separated by extended periods of dry weather, resulting in well defined rising and recession limbs of the flood hydrograph.

Understanding of export processes:

The formulation and manipulation of the approach provides valuable information about the export of phosphorus from nonpoint sources:

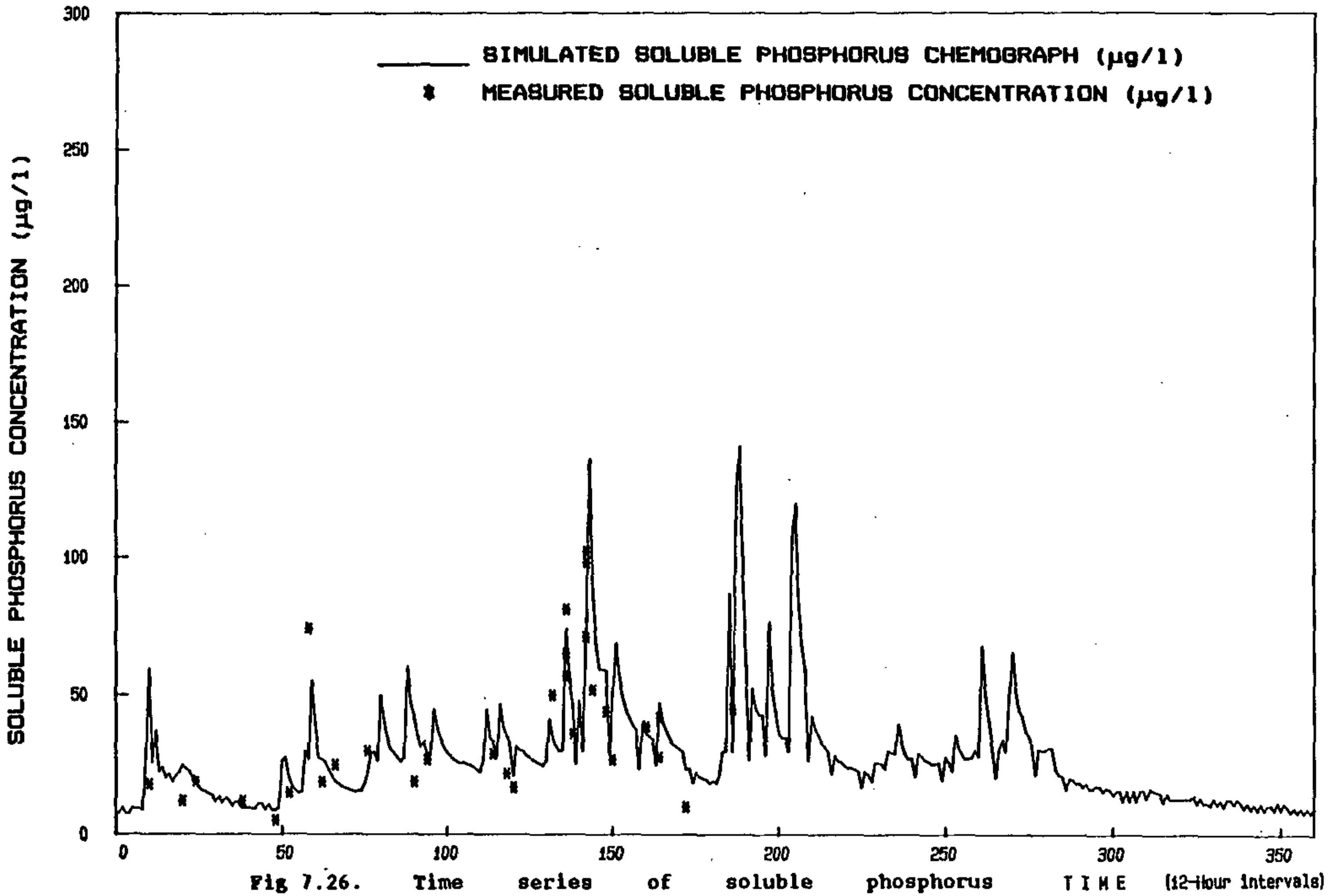


Fig 7.26. Time series of soluble phosphorus concentration simulated using the hydrograph/chemograph decomposition model (NPSM-CON) for Station 9A - Period 6.

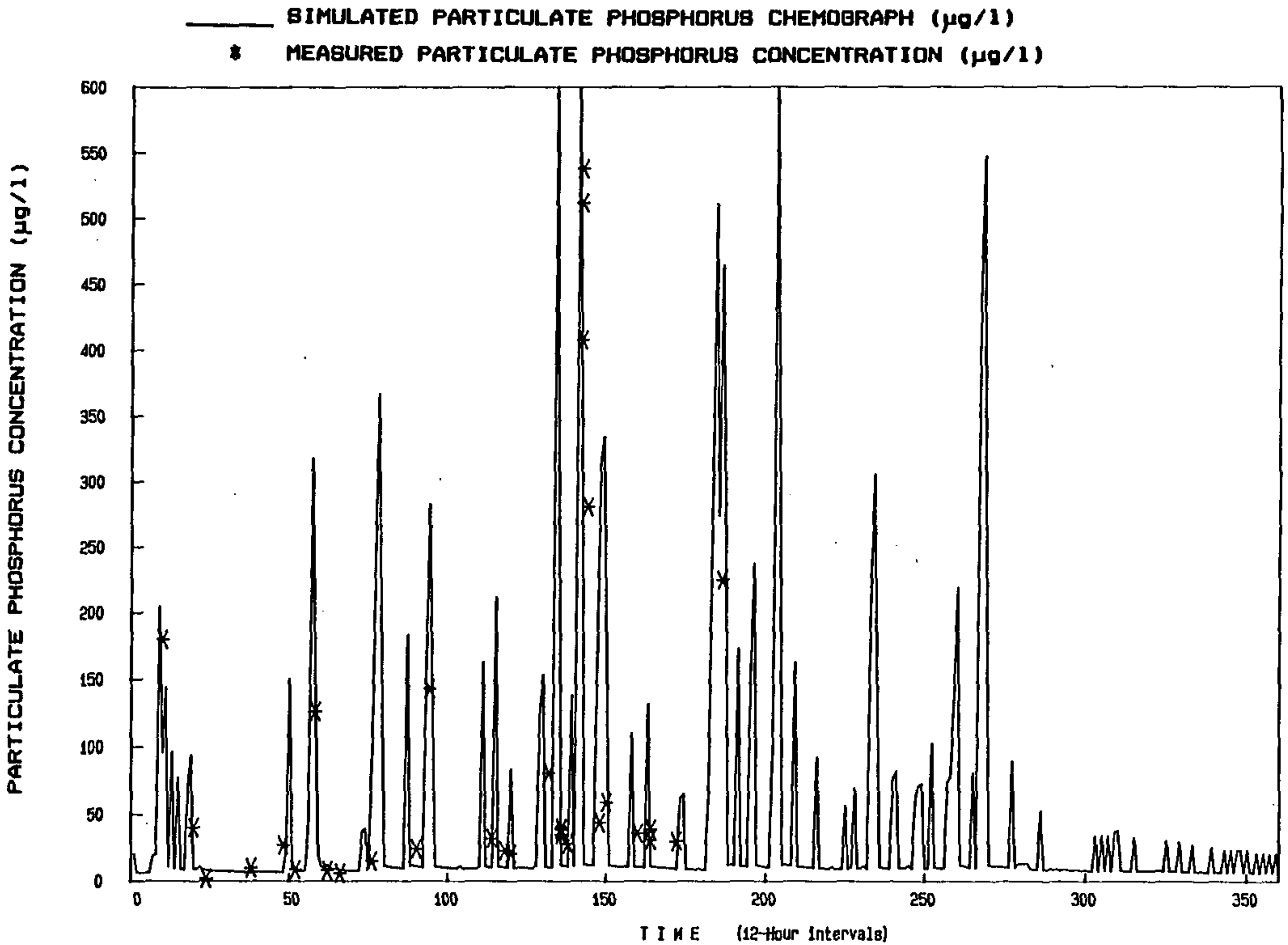


Fig 7.27. Time series of particulate phosphorus concentration simulated using the hydrograph/chemograph decomposition model (NPSM-CON) for Station 9A - Period 6.

(1) The hysteresis effect, which up till now has not been explained, is due to the dual-pathway of phosphorus entering the river associated with surface and subsurface drainage. The surface drainage delivers considerable quantities of particulate phosphorus at the beginning of a storm event. Once the surface runoff has diminished, the ortho-phosphate becomes the predominant species due to the contribution of phosphorus from subsurface drainage. The hysteresis effect therefore is caused by the change in dominance from surface to subsurface discharge, associated with rainfall induced flood events.

(2) Phosphorus export from nonpoint sources is strongly linked to surface runoff during storm events. Indications are that the mass export is principally a function of the discharge under the rising limb of the hydrograph and not significantly affected by sequential storm events.

(3) Generally it has been assumed that the ratio between soluble (ortho-phosphate) and total phosphorus (soluble and particulate) concentration is constant, hence the prediction of the total phosphorus concentration by multiplying the ortho-phosphate concentration by a constant. This approach, to generate total phosphorus from soluble ortho-phosphate data could lead to estimation errors. From the hydrograph/chemograph decomposition approach the ratio of total phosphorus to soluble phosphorus is not constant. The reason for this is that the particulate phosphorus and soluble ortho-phosphate concentrations are influenced by independent processes (Smith and Stewart, 1977). In Fig 7.28, the relationship between ortho-phosphate and particulate phosphorus is presented for Station 9A, showing the non-linear relationship between these chemical species and the wide scatter of data points.

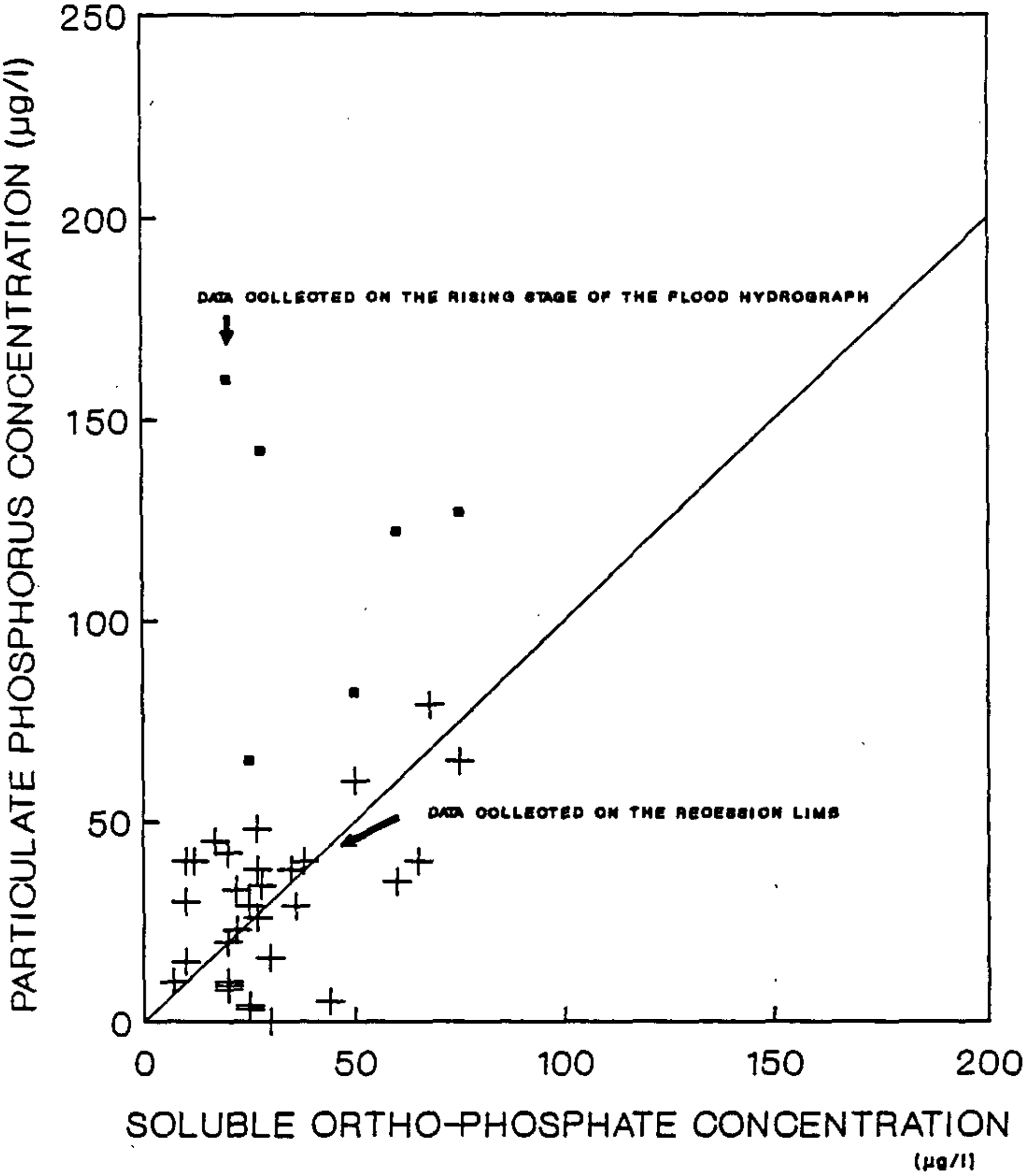


Fig 7.28. Relationship between soluble and particulate phosphorus concentration for Station 9A, Periods 1 to 6.

In Fig 7.28, the data points are plotted in two categories: firstly, the samples collected on the rising limb of the flood hydrograph containing a high proportion of particulate phosphorus giving a high ratio of particulate phosphorus: ortho-phosphate concentration; secondly, the points representing samples collected on the recession limb of the hydrograph containing a high proportion of ortho-phosphate and hence a relatively low particulate phosphorus : ortho-phosphate ratio. These observations support the information provided by the hydrograph/chemograph decomposition approach in that the relative concentration of phosphorus species is related to the relative contributions of surface runoff and subsurface drainage to the river.

In Fig 7.29, the ortho-phosphate and total phosphorus concentration data are graphically presented for Station 23D at Drie Heuwels Weir, collected using an automatic sampling device during two flood events (shown by lines a and b). On the rising limb of the flood hydrograph the river contains high particulate phosphorus concentration, on the falling limb the river contains a high ortho-phosphate concentration. This information further supports the results of the hydrograph/chemograph decomposition approach in that the ratio between particulate and soluble phosphorus is transient, coinciding with the changes in the hydrograph composition.

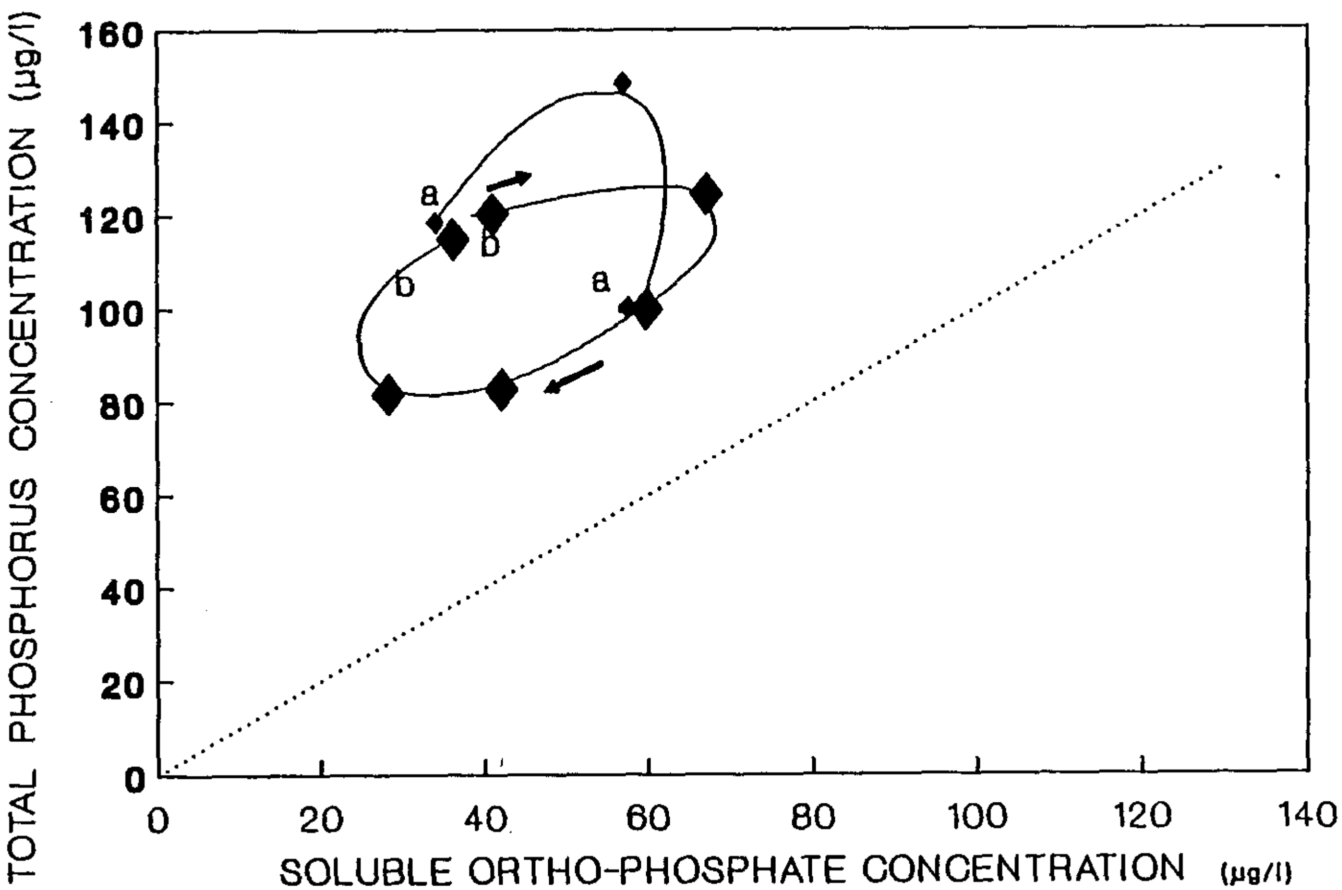


Fig 7.29. Relationship between soluble and total phosphorus concentration for Station 23D (Drie Heuwels Weir), Period 6. The lines represent samples collected sequentially during two flood events (a and b).

Model status:

The hydrograph separation approach provides useful information about the export of phosphorus from nonpoint sources. This approach however can be applied effectively only at sampling stations with an extensive data set of soluble and particulate phosphorus. Compared with the looped phosphorus discharge rating approach, the hydrograph decomposition approach is a step nearer to a basic description then the completely empirical looped rating approach. Future enquiries into modelling phosphorus discharge from nonpoint sources should give serious attention to the hydrograph decomposition model. Until the hydrograph decomposition approach is sufficiently developed, the looped rating approach appears to be the only practical one available for estimating phosphorus export from nonpoint sources.

3 PHOSPHORUS TRANSPORT MODEL

3.1 Introduction

A phosphorus transport model describes the mass movement of phosphorus along the main river channel. Such a model is complex due to the interaction of many processes associated with the transport (Bella and Dobbins, 1968; Keup, 1968; Verhoff and Melfi, 1978; Koussis, 1983; McBride and Rutherford, 1984). Conceptually, the model must take account of the following processes:

- Advection (transfer of phosphorus in the flow along the main river channel, also called the wash load),
- Bed load (transfer of phosphorus in the material moving on the riverbed),
- Sedimentation (transfer of phosphorus from the wash load to the riverbed),
- Remobilization (transfer of phosphorus from bed load to the wash load), and
- Benthic biotic phosphorus assimilation and release.

It is quite a problem defining the processes precisely because such a definition will depend on the measurements being employed. For example, in advection, phosphorus measurements will be taken in the flow above the riverbed (the wash load) but this measurement probably would include material that strictly should be allocated to the bed load. In this fashion virtually every measurement will reflect the effect of one or more processes. In consequence we will lump together the processes biotic release, remobilization and scour (all of which yield phosphorus to the water column) as an in-channel phosphorus source with respect to the water column. Similarly, instead of sedimentation and biotic assimilation we will substitute an in-channel phosphorus sink with respect to the water column. Thus we have two lumped parameters with respect to the water column in the channel, a source of phosphorus and a sink of phosphorus.

We will not concern ourselves with the magnitude of the phosphorus stored on the riverbed by removal from the water column, only with the rate of addition to the water column and rate of abstraction from the water column. Furthermore these two rates can be combined to give a net rate which may be positive (adding phosphorus to the water column) or negative (removing phosphorus from the water column). How can this be quantified? - By linking it to some parameter that appears to be associated with this rate - the *main channel* <u>discharge</u>. When the discharge is high, the rate is likely to be positive i.e. there will be a gain of phosphorus in the water column (in the wash load) due to scour action; when the discharge is low, the rate is likely to be negative, i.e. there will be an abstraction of phosphorus from the water column to the riverbed, by settlement, biotic abstraction and other processes. This simplistic approach can be readily criticised. For example, phosphorus leaving the water column must be stored on the bed; with the first flood some of the stored phosphorus will be scoured so that in the rainy season, when the next flood comes the scour action is likely to be less effective, that is, the rate, for the same discharge will change over the high flow season. Our approach, however will demand a specific rate at a specific discharge. Whether this seasonal effect is significant or not can be evaluated only from observation.

3.2 <u>Model formulation</u>

The basic equation around which the model is constructed is the phosphorus mass continuity equation, Bedford <u>et al</u>. (1983), with terms added to accommodate lateral phosphorus discharge and phosphorus source/sink effects,

$$\partial(AC)/\partial t + \partial(QC)/\partial x = Cl\ q + S^* \qquad \ldots.. \quad (7.16)$$

where

C	=	concentration in main river channel,
Cl	=	concentration of lateral inflow,
q	=	discharge of lateral inflow per unit length of channel,
A	=	flow cross sectional area,
Q	=	discharge of main river channel,
t,x	=	increments of time and river distance,
S*	=	source/sink term.

Use of Eq (7.16), to obtain a solution of the phosphorus concentration, C, at the downstream boundary of a river reach, at any time, requires the following information:

(1) Discharge, Q, and phosphorus concentration, C, at the upstream boundary of the reach, at time t,

(2) Flow cross sectional area of the channel, A,

(3) Lateral discharge, q, with associated phosphorus concentration, Cl, per unit length of reach per unit time,

(4) Remobilization of phosphorus into, and removal of phosphorus out of, the water column per unit channel length per unit time, designated by S* in Eq (7.16).

Examining Eq (7.16), the information listed above is not implicit in the solution for C, but explicit, that is the information can be obtained by independent procedures, and then inserted in Eq (7.16) to obtain a solution for the phosphorus concentration C, for example

(1) The temporal and spatial variation of discharge, Q, in the main river channel and lateral discharge, q, and the flow cross sectional area of the main channel, A, are available from the hydrodynamic flow model, described in Chapter 6, program QMODEL.

(2) The phosphorus concentration in the lateral flows, Cl, from nonpoint sources can be determined from the NPS model, described in Section 2 of this chapter, program NPSM. For point sources the discharge and phosphorus concentration must be measured directly.

(3) The source and sink concepts, to be applied in remobilization and removal of phosphorus in the water column, as proposed conceptually in Section 3, need to be developed, see Section 3.3 below.

3.3 Modelling sources and sinks in the main river channel

This modelling exercise refers to the quantification of S* in Eq (7.16). Simons and Cheng (1985) report that removal of phosphorus from the water column in river they studied, conformed to a two-stage process: a rapid removal according to a first order reaction (with a high rate constant) over the first 10 km below the sewage outfall, followed by a slower removal also according to a first order type reaction (with a low rate constant) in the lower reaches, see Eq (7.17).

$$Ct\ Qt = a\ Co\ Qo\ EXP\ (-k1\ t) + (1-a)\ Co\ Qo\ EXP\ (-k2\ t) \qquad \ldots\ldots \quad (7.17)$$

where

Ct = phosphorus concentration at time t,
Co = initial phosphorus concentration,
Qt = discharge at time t,
Qo = initial discharge,
k1,k2 = rate constants,
a = constant.

To check if this behaviour is also present in the Berg River, profiles of phosphorus concentration were constructed as follows:

During the low flow season, when the inputs from the tributaries were zero or very small, the phosphorus concentration of samples in the water column at all the sampling stations, taken on the same day, were plotted against channel length. The associated discharges, where these were available, were also plotted. The same procedure was repeated at higher steady state discharges during which small lateral discharges were present. To check if the removal followed first order kinetics log phosphorus concentration was plotted versus river distance. Two plots are shown in Fig 7.30 for low and medium discharges. The following observations are pertinent:

(1) Two stage removal is present, as observed by Simons and Cheng (1985).

(2) No conclusion regarding the first stage could be made as the reaction apparently was complete within a 11 km reach and no intermediate phosphorus measurements were made in that reach.

(3) The second stage (slow removal) exhibits first order behaviour, the plots lying on a straight line on the semi-log plot.

(4) The first order rate constant in the second stage appears to decrease as the discharge increases.

The stage with the rapid removal rate (called Stage 1) is the reach of the main river channel that extends from the gauging weir at Paarl (Station 9A) to a point downstream of the sewage outfalls for Paarl and Wellington, at Lady Loch Bridge (Station 13B), a reach of approximately 11 km. The sampling station layout is shown in Fig 7.31. The principal sources of phosphorus entering this reach are in,

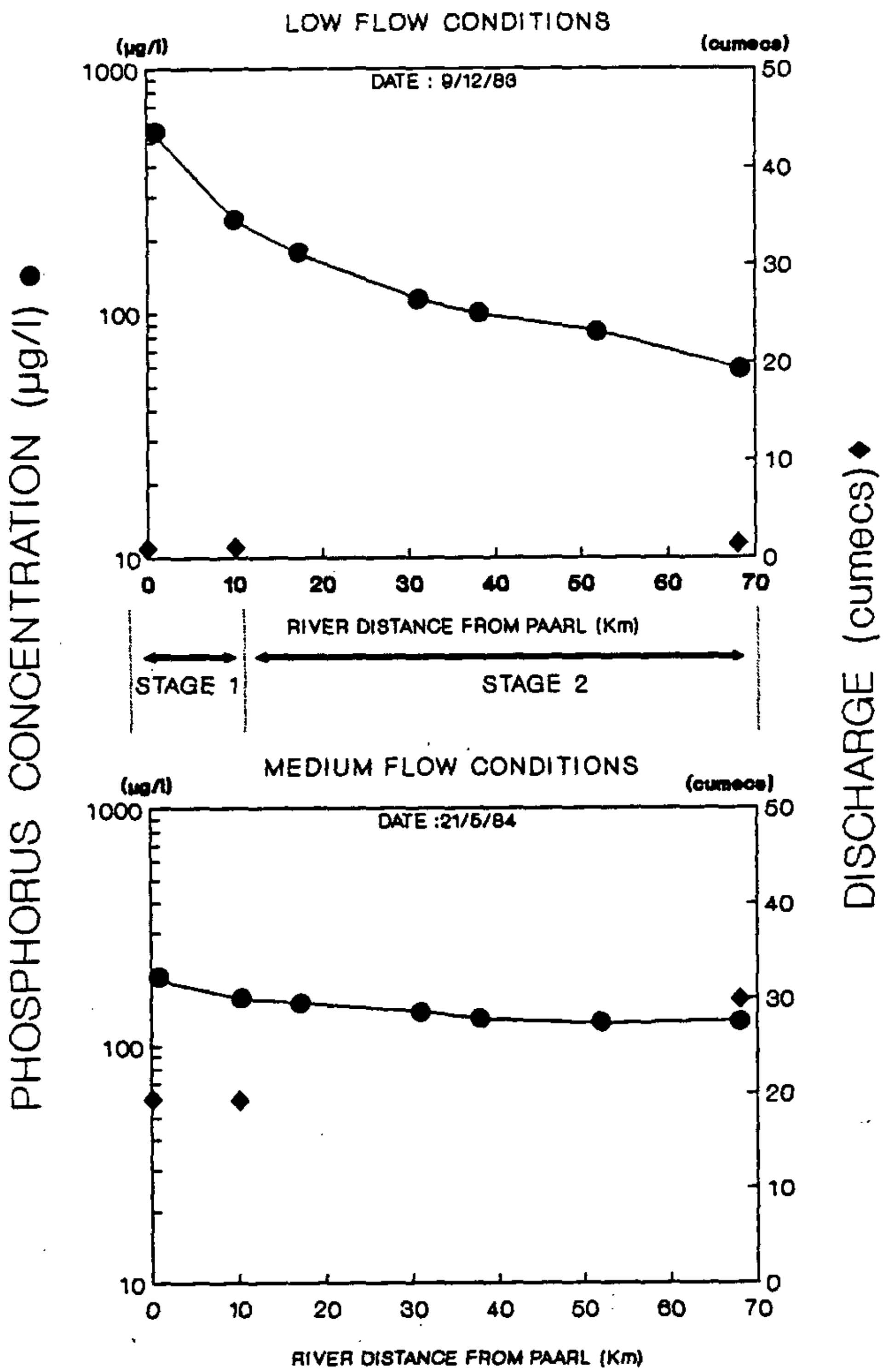
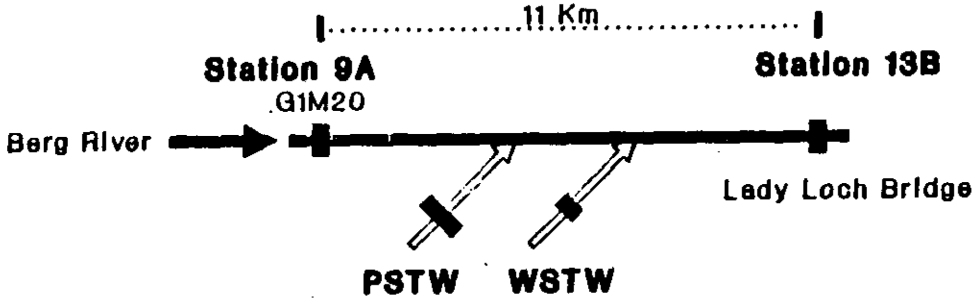


Fig 7.30. **Phosphorus concentration profiles for stations along the main river channel between North Paarl and Drie Heuwels Weir for low and medium flow conditions.**

RAPID REMOVAL STAGE IN THE MAIN RIVER CHANNEL



SLOW REMOVAL STAGE IN THE MAIN RIVER CHANNEL

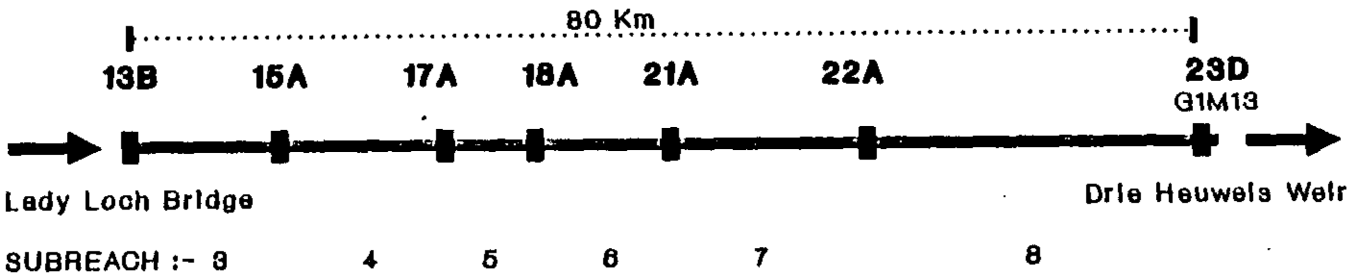


Fig 7.31. Schematic diagram showing the rapid and slow removal stages in the main river channel of the Berg River.

- the discharge of the Berg River entering the upper boundary of the reach at Station 9A; where both the phosphorus concentration and discharge are measured,

- point sources, consisting of Paarl and Wellington sewage works discharges; both the phosphorus concentration and discharge are measured,

- nonpoint sources from the subcatchment draining into this reach from an area of approximately 89 km^2; the lateral flow is estimated by the ungauged lateral flow approach (see Chapter 6), and the phosphorus concentration by the NPS model described in Section 1 of this chapter.

The stage with the slow rate (called Stage 2) extends from Lady Loch Bridge to the gauging weir at Drie Heuwels (Station 23D), a river distance of 89 km. The layout of sampling stations along this reach is shown in Fig 7.31. In this reach the inputs of phosphorus are in,

- the discharge of the Berg River at Lady Loch Bridge; the phosphorus concentration is measured but the discharge is simulated using the hydrodynamic flow model (see Chapter 6),

- nonpoint sources from tributaries draining principally agricultural areas, with a total catchment area of about 2 000 km^2). The lateral discharges are either measured or estimated by the ungauged lateral approach (see Chapter 6), and the phosphorus concentrations in all the lateral discharges are estimated by the NPS model, see Section 1 of this chapter.

In attempting to model the transport of phosphorus through the total river distance of 100 km, it became clear that Stage 1 with the high rate of phosphorus removal, requires to be dealt with in a different manner from Stage 2 with the lower rate of phosphorus removal.

In Stage 1 although one may have expected removal of phosphorus from the water column to be of the first order type, the reach in which the rapid removal takes place is very short, 5 km, and no intermediate values within this distance were available. Furthermore it was not certain whether the rapid removal stage had terminated at Lady Loch Bridge. If intermediate values for the phosphorus concentration below the points of discharge of the wastewater treatment plants had been available then the distance over which the rapid stage acts could have been defined and formulated in a similar manner as for the slow removal reach (Stage 2).

The situation with regard to the short rapid removal stage, encountered in this investigation, is likely to be encountered elsewhere, not necessarily in the same form as encountered here. For example, the channel flow may pass through a stretch of wetlands and one may be limited to having measurements only at the influent and effluent boundaries of the wetland. It is worthwhile therefore to set out in detail the procedures developed to model this type of situation.

3.4 Model for rapid removal stage (Stage 1)

Based on the information derived from the analysis of data (Chapter 5), during low flow, phosphorus is removed by sedimentation, biological assimilation, etc from the water column onto the riverbed; during high flow remobilization causes phosphorus to be removed from the riverbed into the water column. However, it is not clear which independent variable best allows a description of the removal and remobilization of the phosphorus. To obtain information on this aspect a mass balance model was set up over the reach Paarl to Lady Loch Bridge. From this mass balance (see Eqs 7.18 and 7.19) it is possible to calculate the theoretical phosphorus concentration at Lady Loch Bridge from the mass inputs of phosphorus in the main river channel at Paarl and from point and nonpoint sources within the reach, excluding sources and sinks effective in the channel reach.

$$\text{Loadout} = \sum \text{Loadin} \quad \ldots\ldots \quad (7.18)$$

where

Loadout = phosphorus load at Lady Loch Bridge,
Loadin = phosphorus input to river reach, Paarl to Lady Loch Bridge.

Which in terms of the phosphorus concentration gives

$$[TP]sim = \frac{(C1\ Q1) + (C2\ Q2) + (C3\ Q3) + (C4\ Q4)}{Q1 + Q2 + Q3 + Q4} \quad \ldots\ldots \quad (7.19)$$

where

[TP]sim = simulated or calculated phosphorus concentration at Lady Loch Bridge,
C1 = concentration at Station 9A,
Q1 = river discharge at 9A,
C2 = concentration of effluent from Paarl wastewater treatment works,
Q2 = effluent discharge – Paarl works,
C3 = concentration of effluent from Wellington wastewater treatment works,
Q3 = effluent discharge – Wellington works,
C4 = concentration of nonpoint source input from the surrounding catchment of Section 1,
Q4 = discharge of nonpoint source runoff.

Using the mass balance equation with the measured inputs one obtains a set of calculated phosphorus concentration values at Lady Loch Bridge.

In Fig 7.32 the calculated phosphorus concentrations at Lady Loch Bridge are plotted versus the measured values obtained at Lady Loch Bridge. The following observations can be made:

- Grouping data associated with medium high flows, shown in Fig 7.32 as Group 1, there is close correspondence between simulated and measured phosphorus concentrations indicating that either removal and remobilization of phosphorus is minimal during these flow conditions, or more likely, the rates cancel each other out.

- Grouping data associated with low flows, shown in Fig 7.32 as Group 2, the measured phosphorus concentrations are substantially lower than the calculated values indicating that there is a net phosphorus removal.

- Grouping data associated with high flow (flood events), shown in Fig 7.32 as Group 3, the measured values are greater than the calculated indicating that phosphorus is remobilized from the riverbed during flood events.

From these observations it would appear that the <u>discharge</u> is a reasonable parameter in terms of which the removal and remobilization of phosphorus can be described. One may write

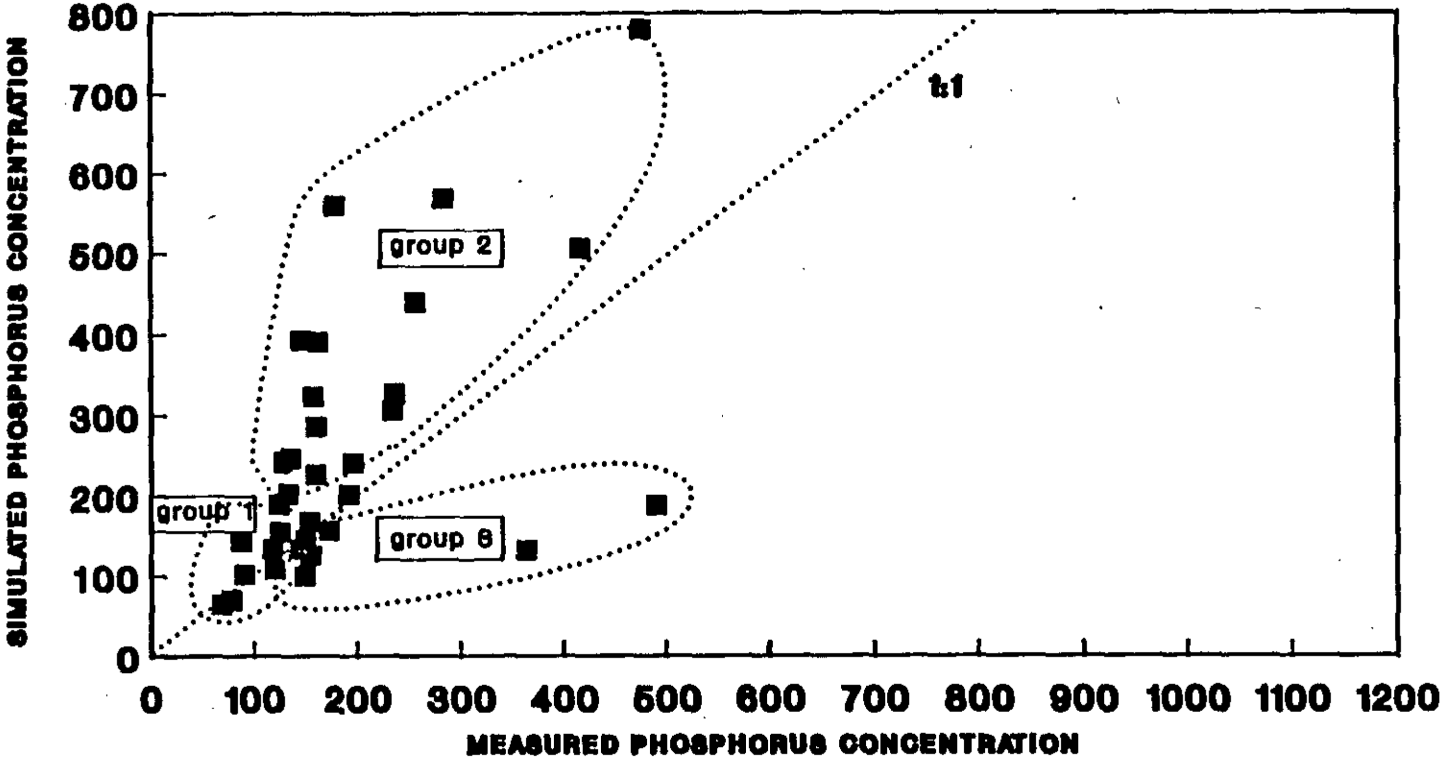


Fig 7.32. Scatter plot of measured versus simulated phosphorus concentration values at Lady Loch Bridge (Station 13B). Group 1 includes data collected during high flow, Group 2 includes data collected during low flow, and Group 3 includes data collected during flood events.

$$[TP]mes = D\,[TP]sim \qquad \ldots\ldots \quad (7.20)$$

where

[TP]mes = phosphorus concentration measured at the outflow of Stage 1 at Lady Loch Bridge,

[TP]sim = simulated phosphorus concentration at Lady Loch Bridge, using Eq (7.19),

D = source/sink term.

solving for the source/sink term gives

$$D = [TP]mes/[TP]sim \qquad \ldots\ldots \quad (7.21)$$

The value of D was determined as follows. For each of the pairs of data, in Fig 7.32, the value of D was calculated and plotted versus discharge, see Fig 7.33. Evidently, the phosphorus source/sink term, D, is dependent on the river discharge. Consequently, by establishing the relationship between D and the river discharge Q it would be possible to simulate the phosphorus concentration at Lady Loch Bridge using a modified mass balance equation of the form

$$[TP]sim = D\left[\frac{(C1\ Q1) + (C2\ Q2) + (C3\ Q3) + (C4\ Q4)}{Q1 + Q2 + Q3 + Q4}\right] \qquad \ldots\ldots \quad (7.22)$$

The best relationship between D and discharge, Q, was found by checking different mathematical formulations. The one that gave the best fit was Eq (7.23),

$$D = k1\ \ln(Q) + c1 \qquad \ldots\ldots \quad (7.23)$$

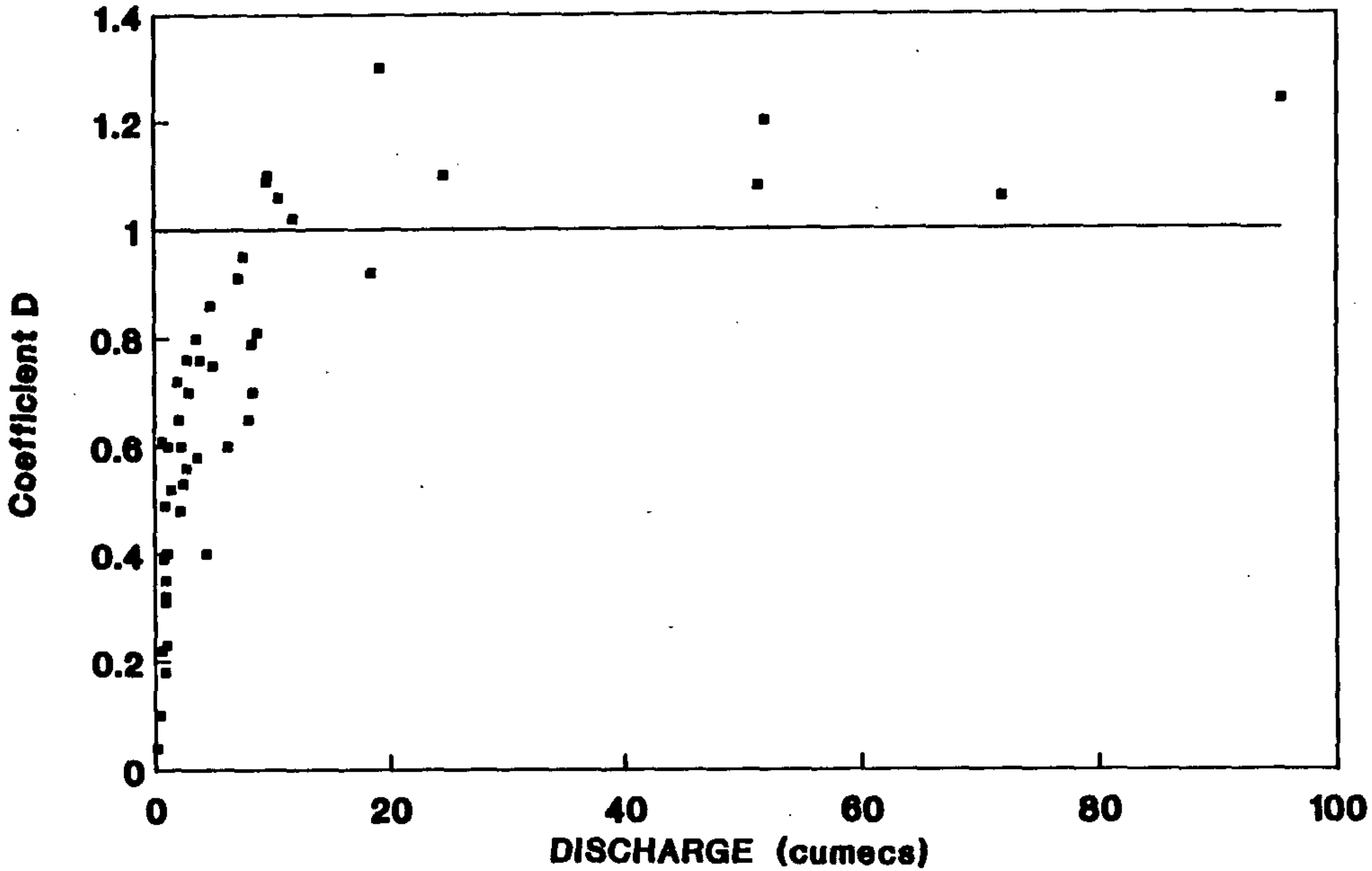


Fig 7.33. Plot of the ratio D (measured/simulated phosphorus concentration) versus river discharge at Lady Loch Bridge (Station 13B) - using data for Periods 2 to 6.

The constants, k1 and c1, were determined using curvilinear regression analysis (program REGRESS) on the data set shown in Fig 7.33; the analysis gave values k1=0.187 and c1=0.45. The plot of Eq (7.23) together with the experimental values are shown in Fig 7.34. From Fig 7.34 one may note that when river discharge exceeds about 17 cumecs, the term, D, exceeds unity - the phosphorus load at Lady Loch Bridge is greater than that determined from the input loads, indicating remobilization of phosphorus to the wash load. When river discharge is less than about 17 cumecs the term, D, is less than unity - the phosphorus load at Lady Loch Bridge is less than that determined from the input loads indicating removal of phosphorus from the wash load.

In Fig 7.34, there is scatter of the data. To determine a possible cause for the scatter, the data were sorted into three groups:

(1) Data associated with the rising limb of a flood hydrograph, D1,

(2) data associated with the recession limb, D2, and

(3) data associated with approximately steady flow conditions, D3.

It would seem that for discharges greater than 20 cumecs D1>D3>D2. Reasons for this may arise from the following:

- The modified mass balance equation, Eq (7.22), requires the same steady flow at the entrance and exit of the reach. When the flow (or phosphorus concentration) is subject to transients, as may occur with flood events, the mass balance equation does not

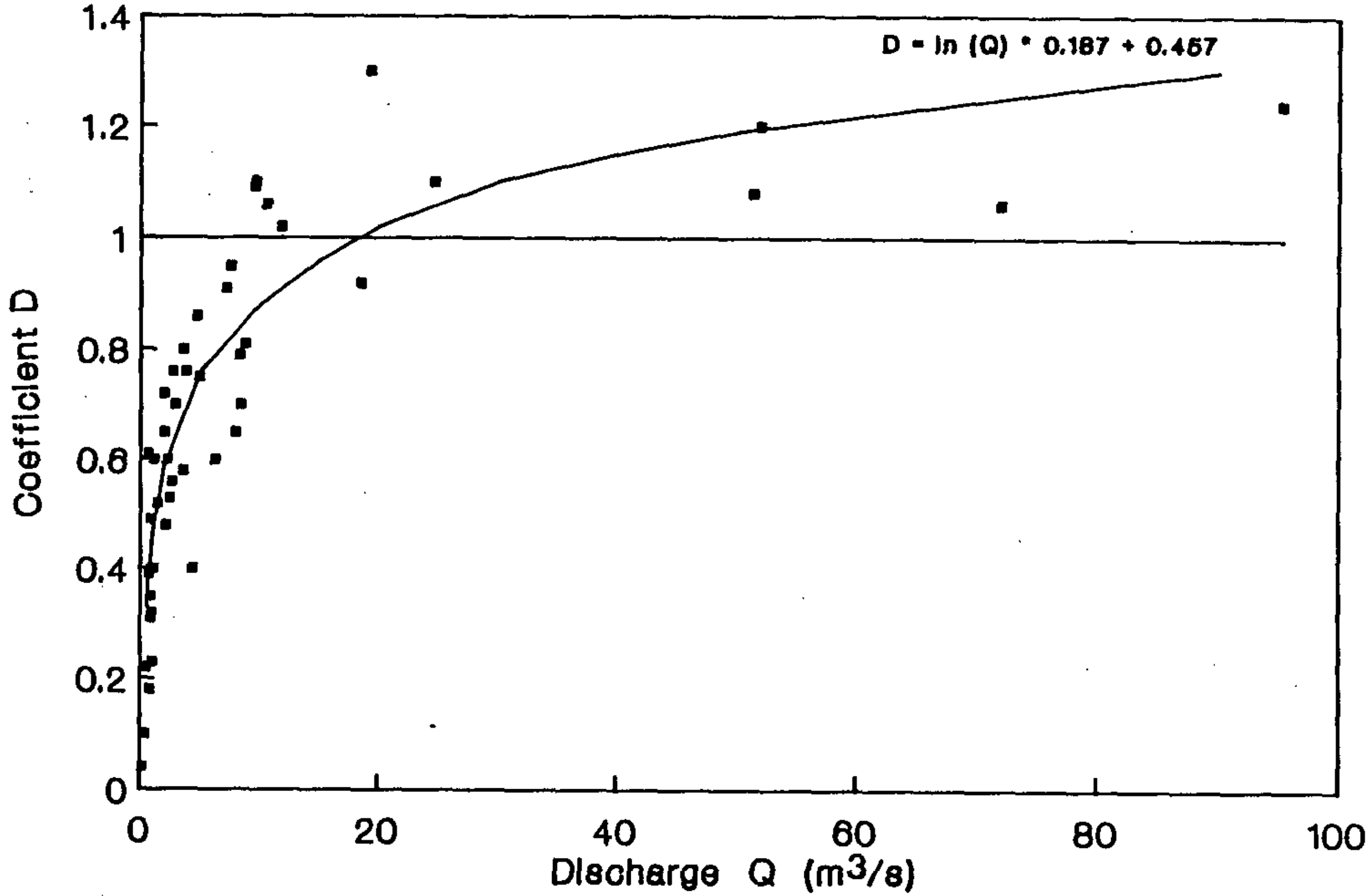


Fig 7.34. Application of logarithmic regression equation, Eq (7.23), to describe the term D as a function of river discharge, Q. When the value of D exceeds unity phosphorus is remobilized from bottom sediments; alternatively, when D is less than unity phosphorus undergoes sedimentation.

strictly apply; for calibration of this type of model, water samples must be collected from the same parcel of water at Stations 9A and 13B. However, during a storm event different parcels of water inevitably will be sampled.

- Greater scour taking place on the rising limb of the flood hydrograph, compared with the falling limb. Possibly for reason that by the time the falling limb flow passes through the reach less of the stored material will remain to be scoured.

The scouring effect can be compensated for empirically by incorporating a looped-rating function, DQ, in Eq (7.24). With this function, on the rising stage, the equation gives a higher value of D compared with the same discharge for steady and recession flow conditions.

$$D = \ln (Q4) (DQ^{Z} k1) + c1 \qquad \ldots\ldots \qquad (7.24)$$

where

D = sedimentation/remobilization term used in Eq (7.22),

Q4 = discharge at Lady Loch Bridge,

k1 = constant (0.187),

DQ = discharge quotient (instantaneous/antecedent discharge) (Q_t/Q_{t-1}),

Z = constant (0.09),

c1 = constant (0.45).

The effect different values of DQ have on the coefficient D, using Eq (7.24), is illustrated in Fig 7.35. For a sharply rising flood, DQ can attain a value as high as 8, with steady flow DQ=0 and with recession flow DQ=0.5; the respective effects are shown by lines D1, D2, and D3. Equation (7.24) intimates that there is a marginal increase or decrease in the coefficient D depending on the rate-of-change of flow.

Ungauged nonpoint sources: Solution of Eq (7.19) requires the estimation of ungauged nonpoint source loading to the river reach between Paarl and Lady Loch Bridge (terms C4 and Q4 in Eq (7.19)). The following assumptions were used as a basis for estimating the nonpoint source loading to the main river channel between Paarl and Lady Loch Bridge:

(1) The specific areal runoff is the same as for the adjacent gauged subcatchment (Krom River, gauged at weir G1M37); this approach is a generalised one for estimating runoff from ungauged areas and is dealt with in detail in Chapter 6.

(2) The phosphorus concentration in the runoff is determined from the NPS model using the flow related model constants, see Section 1.5 of this chapter.

With this approach the phosphorus loading from the subcatchment discharged to the Berg River between Station 9A and Lady Loch Bridge was calculated. During flood events, the nonpoint source loading entering this reach comprises between 2 to 5 percent of the total load passing along the main river channel, indicating that the contribution of nonpoint sources was relatively small during flood events. However, it is included for the sake of completeness.

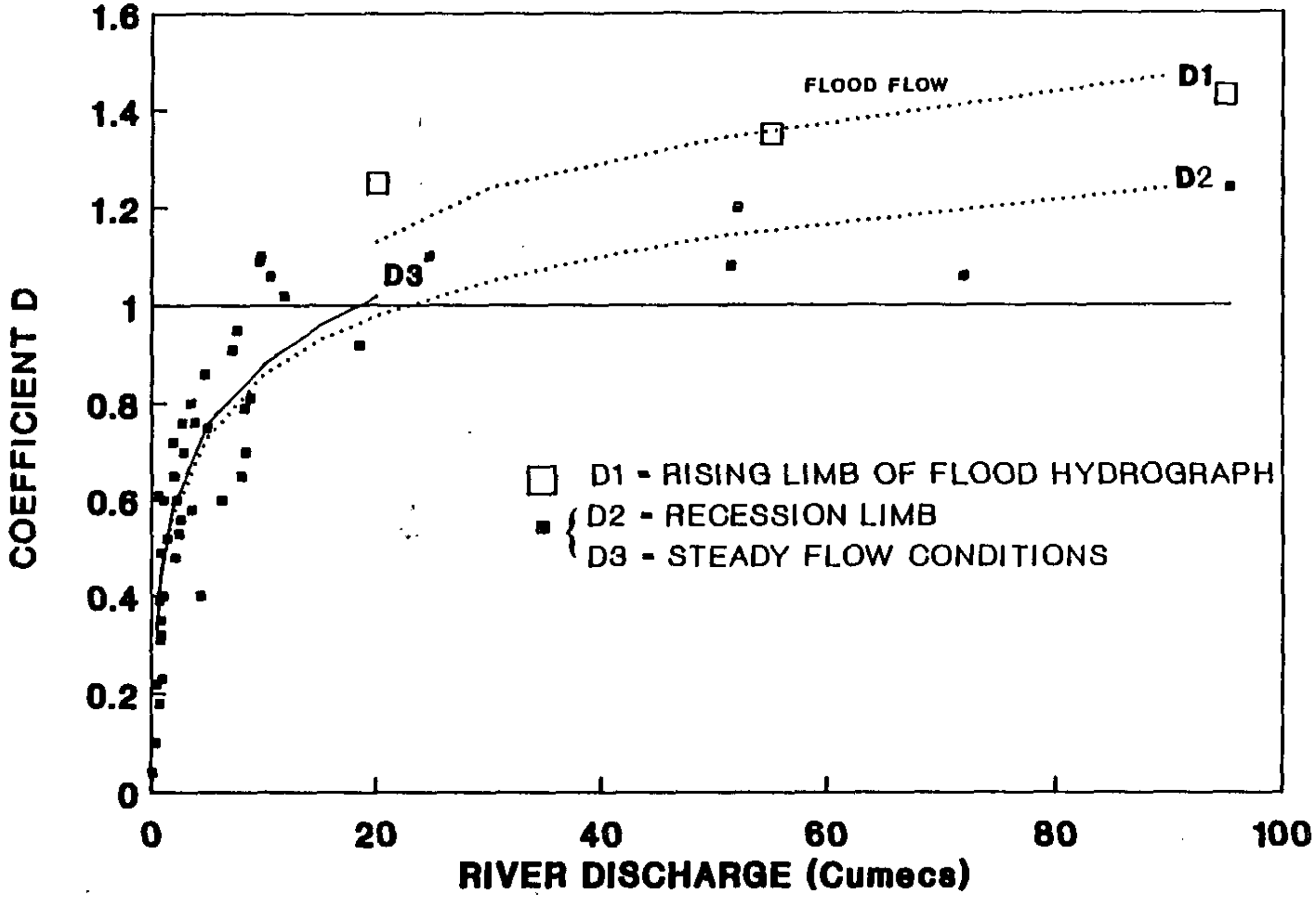


Fig 7.35. Application of looped rating expression for coefficient D to simulate the hysteresis effect observed in the data. Line D1 represents rising limb conditions, Line D2 recession limb, and D3 steady flow.

A transport model based on the discussion above, to simulate the phosphorus chemograph at Lady Loch Bridge is available as program SECTION1.

Model calibration for rapid removal section (Stage 1)

The calibration procedure of the phosphorus transport model for the river reach between Paarl and Lady Loch bridge will now be set out in detail.

(1) Calibration period:

One period of 180-days (Period 5) covering both high and low river flow was used to calibrate the model. The water quality and flow data for Period 5 is one of the most comprehensive for this reach of the river.

(2) Hydrographs and associated water quality data:

Fig 7.36 shows the hydrographs and phosphorus chemographs over the calibration period (Period 5) for the gauging weirs on the main river channel at Station 9A (weir G1M20), the Paarl and Wellington effluent discharge points, and the Krom River (weir G1M37).

(3) Estimation of coefficients Z, k1 and c1 in Eq (7.24):

The most appropriate values for these coefficients were found only after the model was in operation. Initially rough estimates for these coefficients were determined as set out in Section 3.4 above. Afterwards a matrix of perturbed values was tested to determine the influence of these terms on the simulations (see Fig 7.37(a)). The values of: 0.009 for Z, 0.187 for k1, and 0.45 for c1, appeared to provide the most favourable simulation results, see Fig 7.37(b).

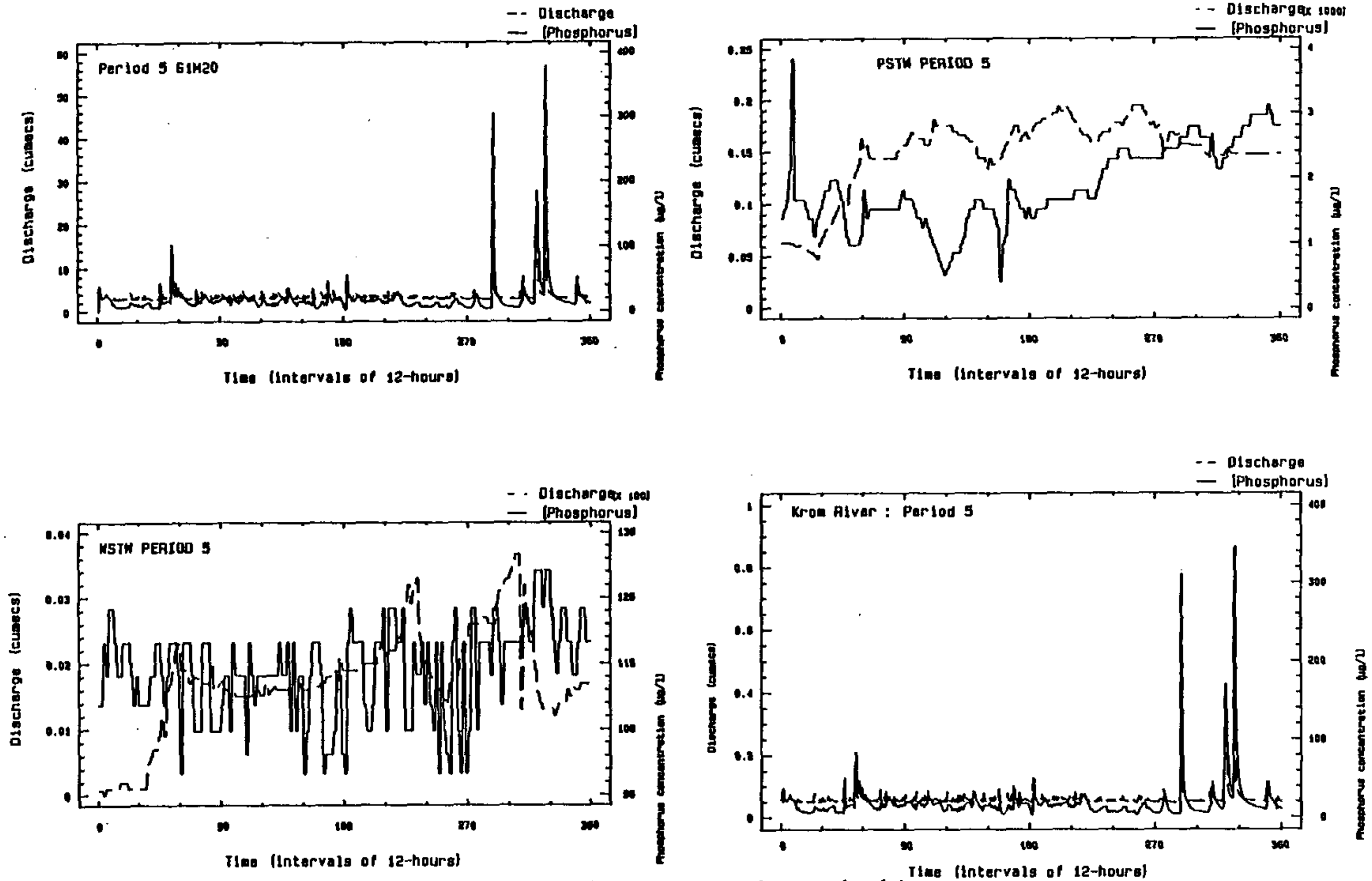


Fig 7.36. Hydrograph and phosphorus chemograph data used in calibration of the phosphorus transport model for Stage 1 of the main river channel (North Paarl to Lady Loch Bridge) - Period 5.

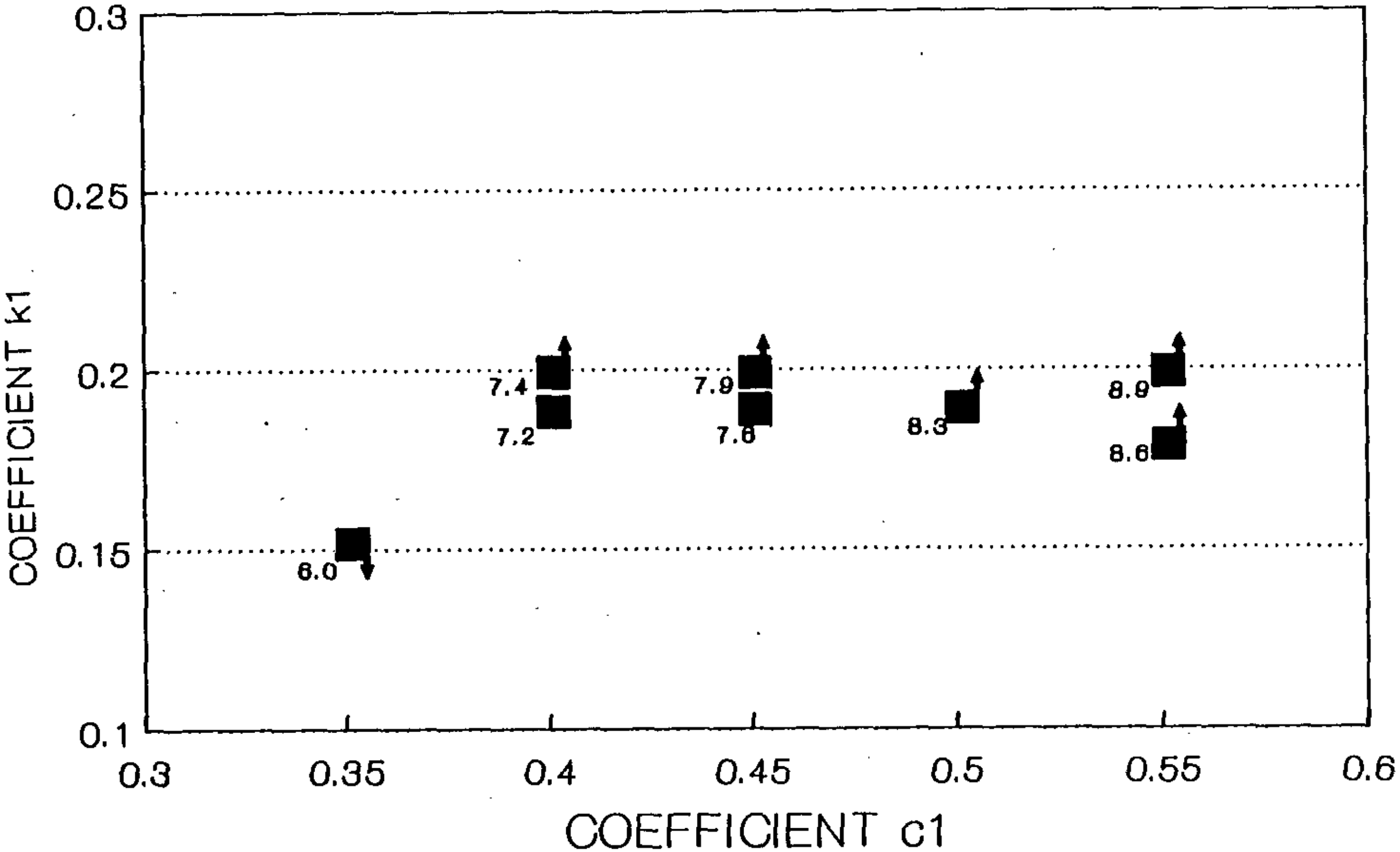


Fig 7.37(a). Matrix used in the selection of values for coefficients k1 and c1. The arrow pointing up indicates model over-estimation and the arrow pointing down indicates model under-estimation.

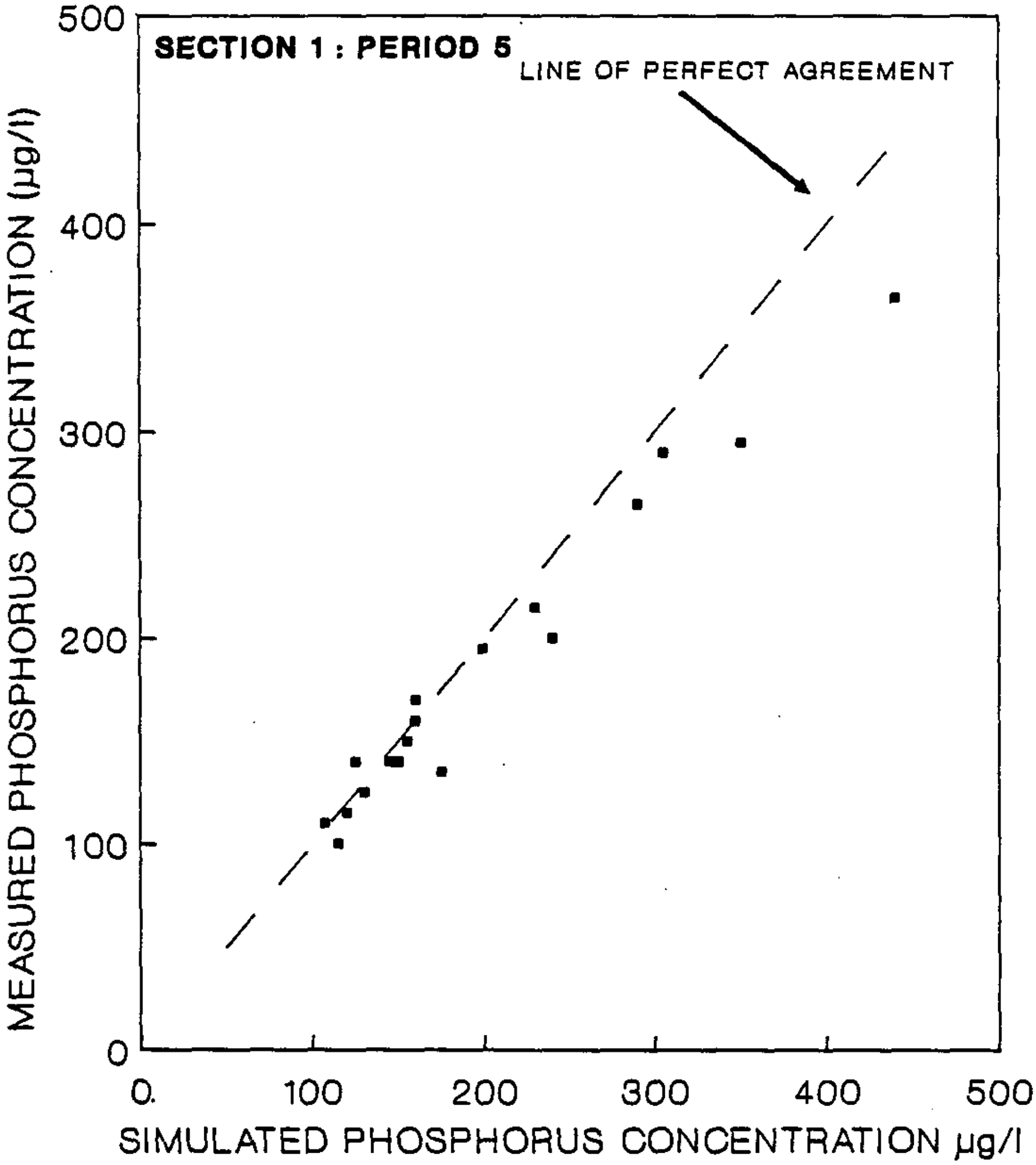


Fig 7.37(b). Plot of the simulated versus measured phosphorus concentration for Station 13B (Lady Loch Bridge). Simulated values are predicted using the phosphorus transport model for Stage 1 of the main river channel (program SECTION1) - Period 5.

Accepting:

(1) the value for the constants given above;

(2) the accuracy of the gauging weirs involved in the mass balance calculation;

a trial simulation was run over the time period of 180-days to determine the phosphorus chemograph at Lady Loch Bridge. In Fig 7.38 the measured and simulated phosphorus concentrations are shown for Lady Loch Bridge.

It is at once apparent that the simulated and measured phosphorus concentrations are in reasonable accord; with the model adequately describing the steep gradients in phosphorus concentration associated with flood events.

During the low flow in Period 5, the measured phosphorus concentrations show some scatter around the simulated values (see Fig 7.38). Such scatter is attributed to quantification errors of the input data as well as sporadic discharges from agricultural and urban areas. These discharges occur at random intervals and hence are impossible to simulate. Fortunately such discharges occur only during low flow and have negligible effect on the total load of phosphorus exported over a period of 180-days.

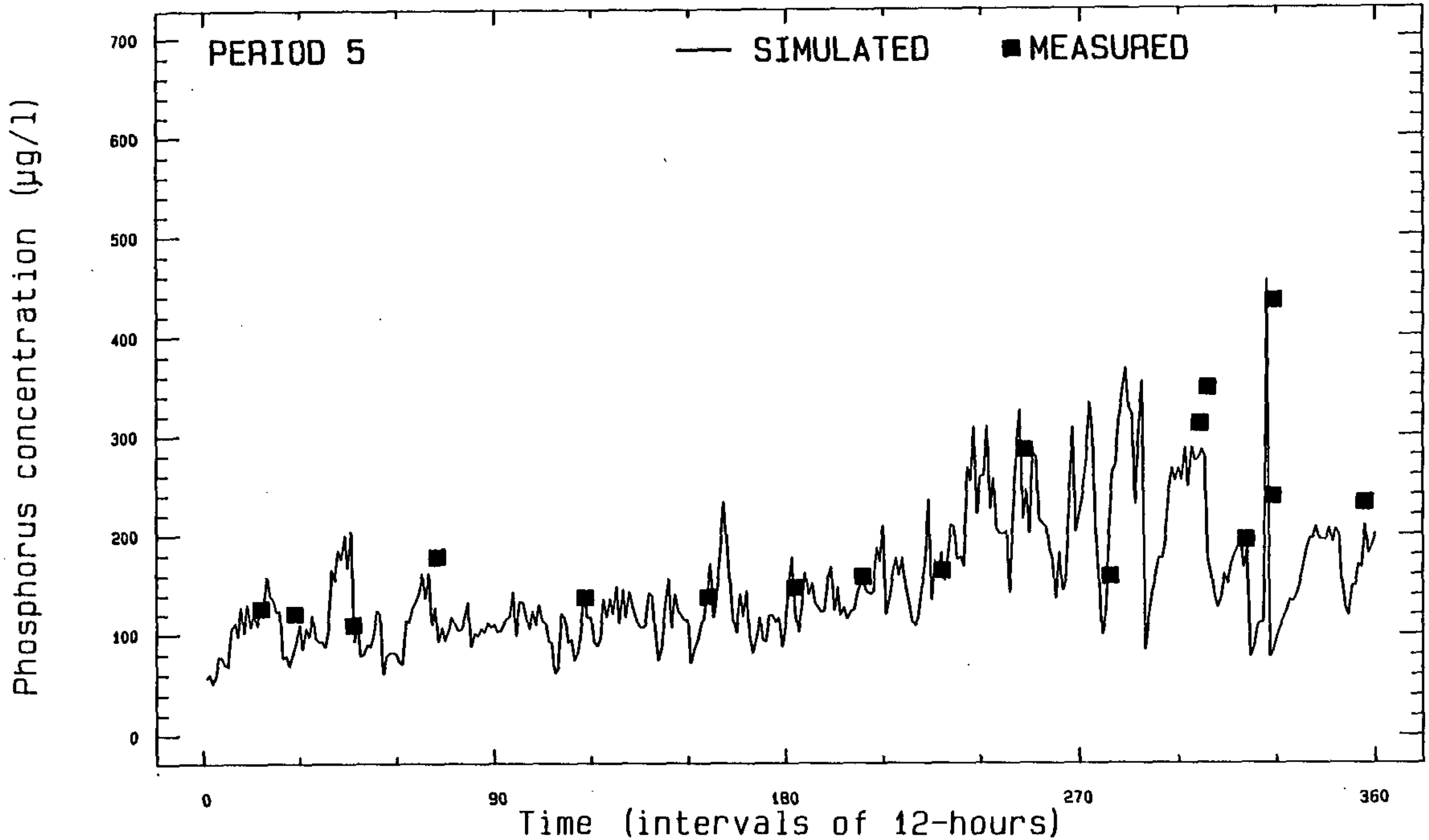


Fig 7.38. Application of the program SECTION1 to simulate the total phosphorus chemograph at Lady Loch Bridge - Period 5.

Model verification

Having calibrated the model using the data for Period 5, the phosphorus chemographs at Lady Loch Bridge were simulated for Periods 1, 2, 3, 4 and 6. The simulated and measured phosphorus concentrations at Lady Loch Bridge are shown in Figs 7.39 to 7.43. A correlation plot of simulated versus measured phosphorus concentration for Periods 1 to 6 is shown in Fig 7.43(a). Evidently the transport model for Stage 1, SECTION1, provides an adequate description of the phosphorus chemograph at Lady Loch Bridge.

The chemograph at Lady Loch Bridge will now serve as the upstream boundary condition for the transport model describing the movement of phosphorus along the main river channel from Lady Loch Bridge to Drie Heuwels Weir, given below.

3.5 Model for the slow removal section (Stage 2)

In the previous section a transport model was developed to deal with the rapid phase of phosphorus removal in a river. The rapid phase appears to be specific to the reaches below the discharge points of municipal and industrial wastes. The reason for the rapid removal of phosphorus is not clear; possibly the form in which the phosphorus is discharged makes it more readily available for biotic assimilation, or the reach has very heavy marginal vegetation so that it acts as a form of wetland.

To simulate the transport of phosphorus along the river channel we have seen that cognizance must be taken of the following aspects (see Fig 7.44).

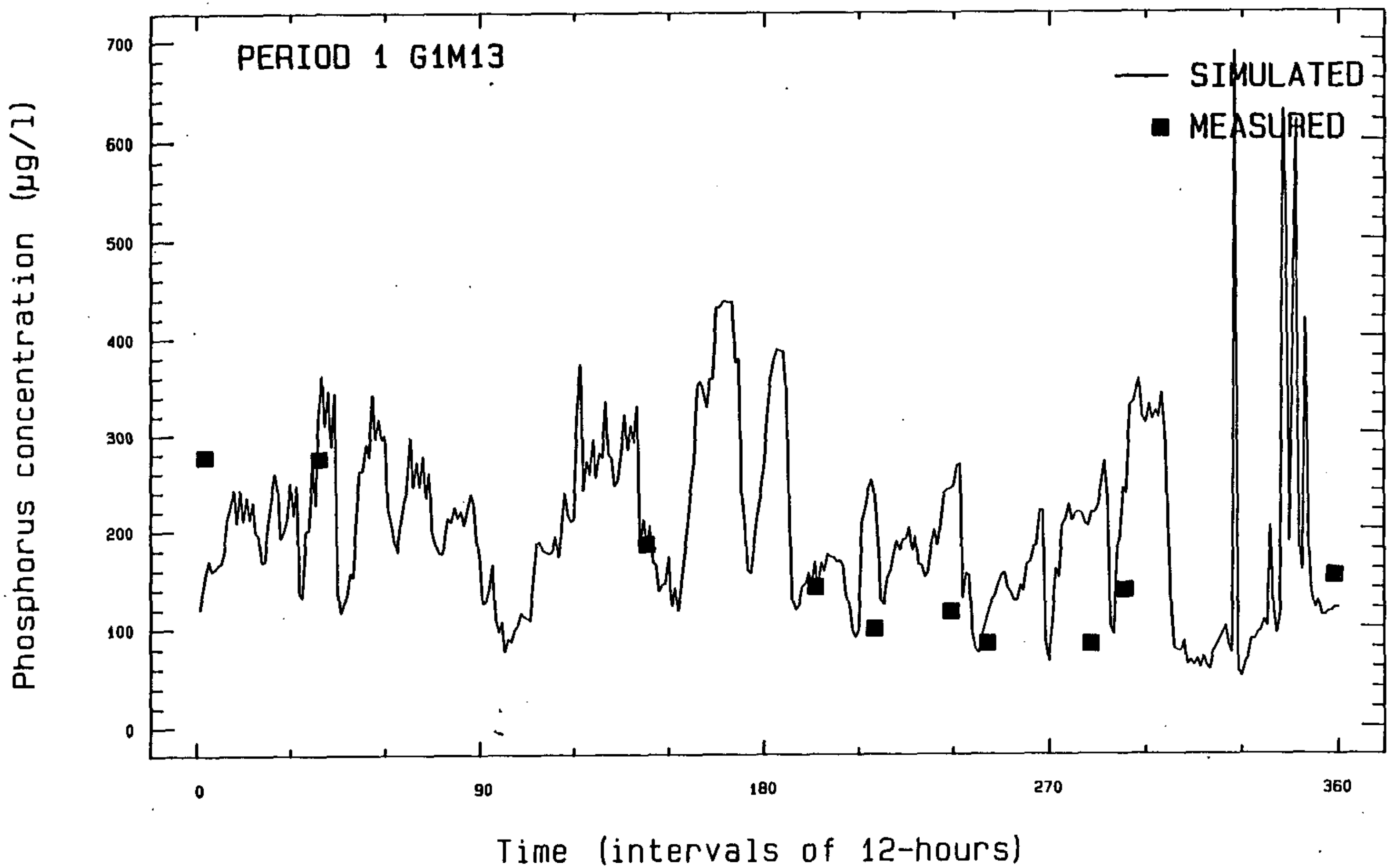


Fig 7.39. **Application of the program SECTION1 to simulate the total phosphorus chemograph at Lady Loch Bridge - Period 1.**

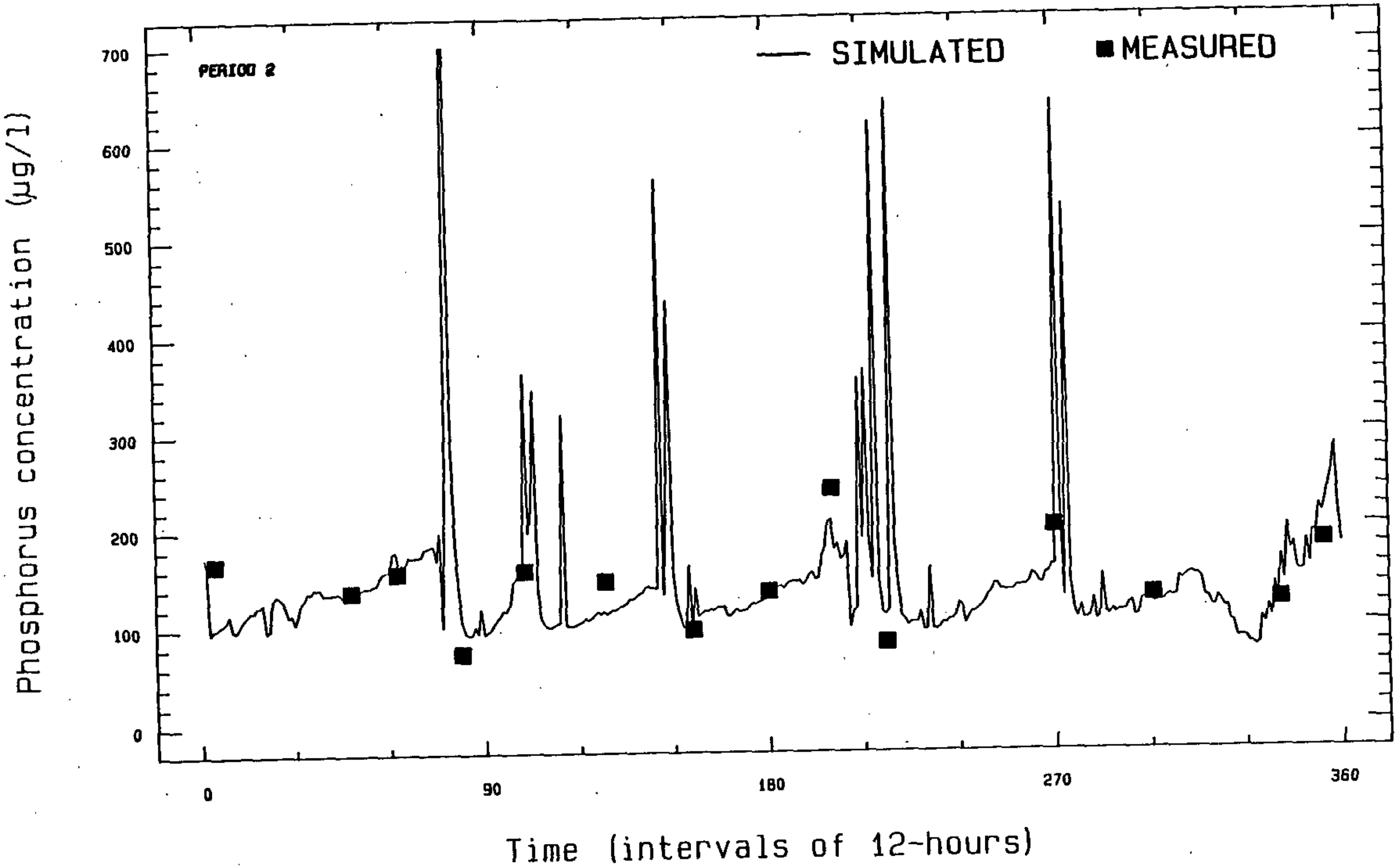


Fig 7.40. **Application of the program SECTION1 to simulate the total phosphorus chemograph at Lady Loch Bridge - Period 2.**

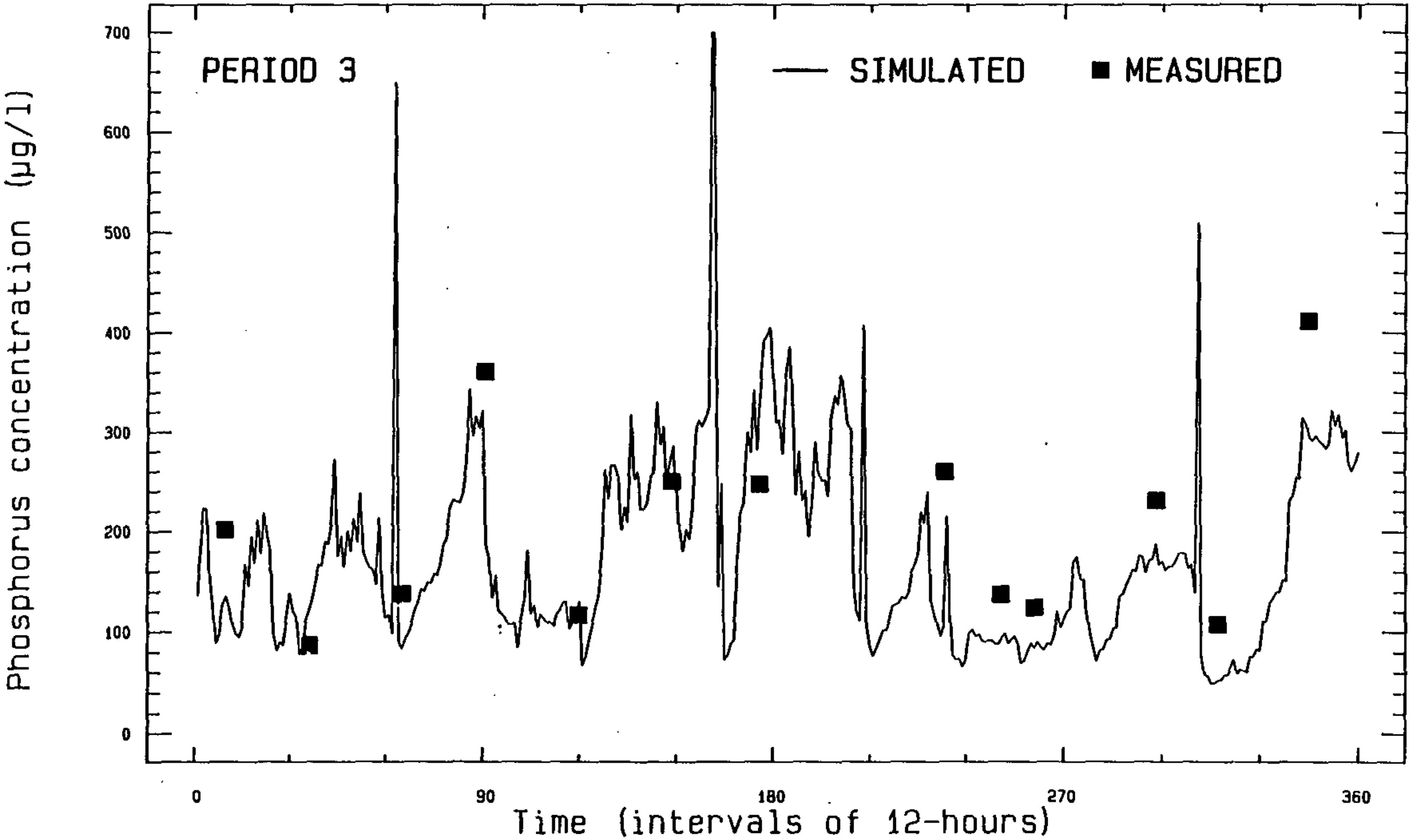


Fig 7.41. **Application of the program SECTION1 to simulate the total phosphorus chemograph at Lady Loch Bridge - Period 3.**

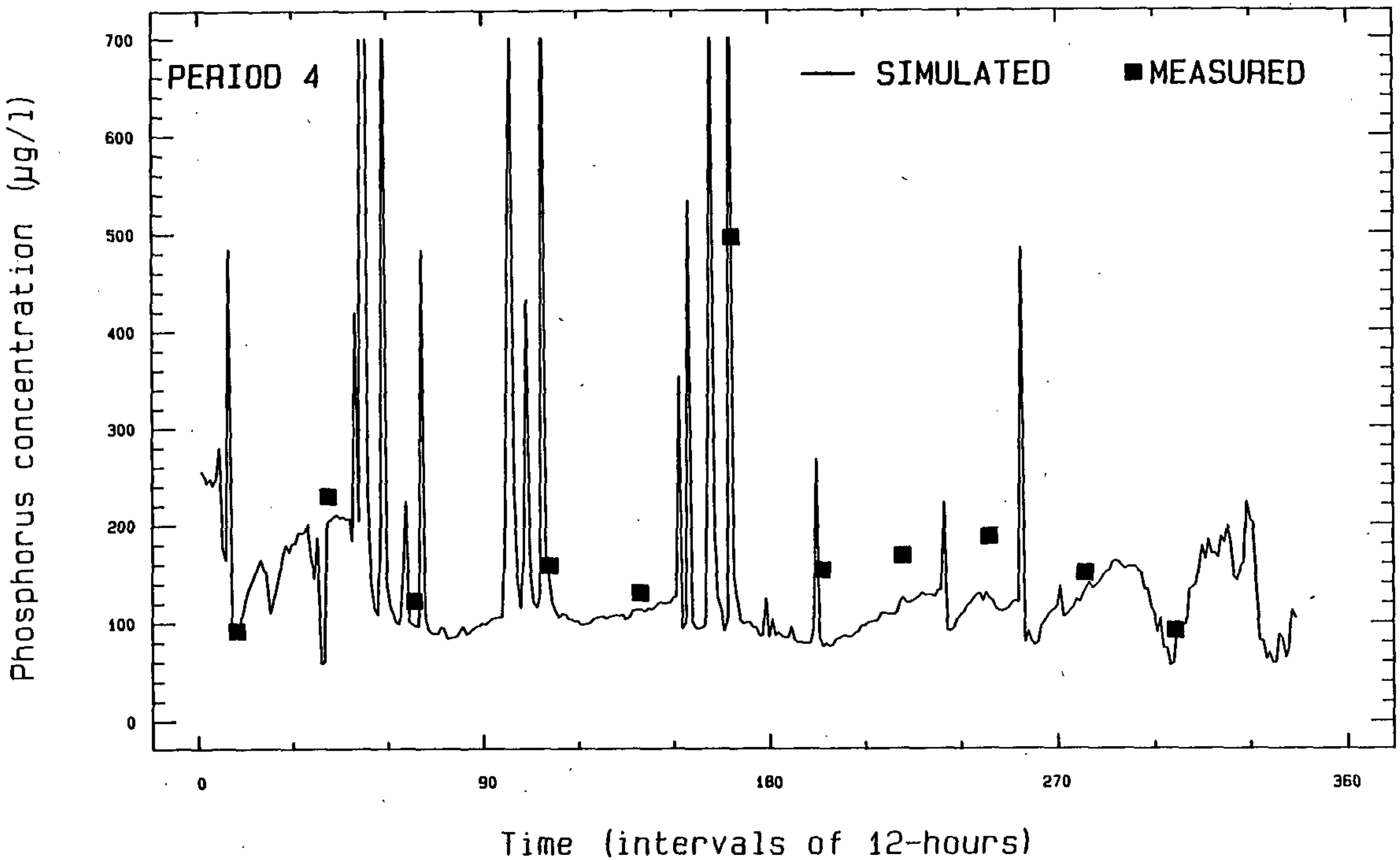


Fig 7.42. **Application of the program SECTION1 to simulate the total phosphorus chemograph at Lady Loch Bridge - Period 4.**

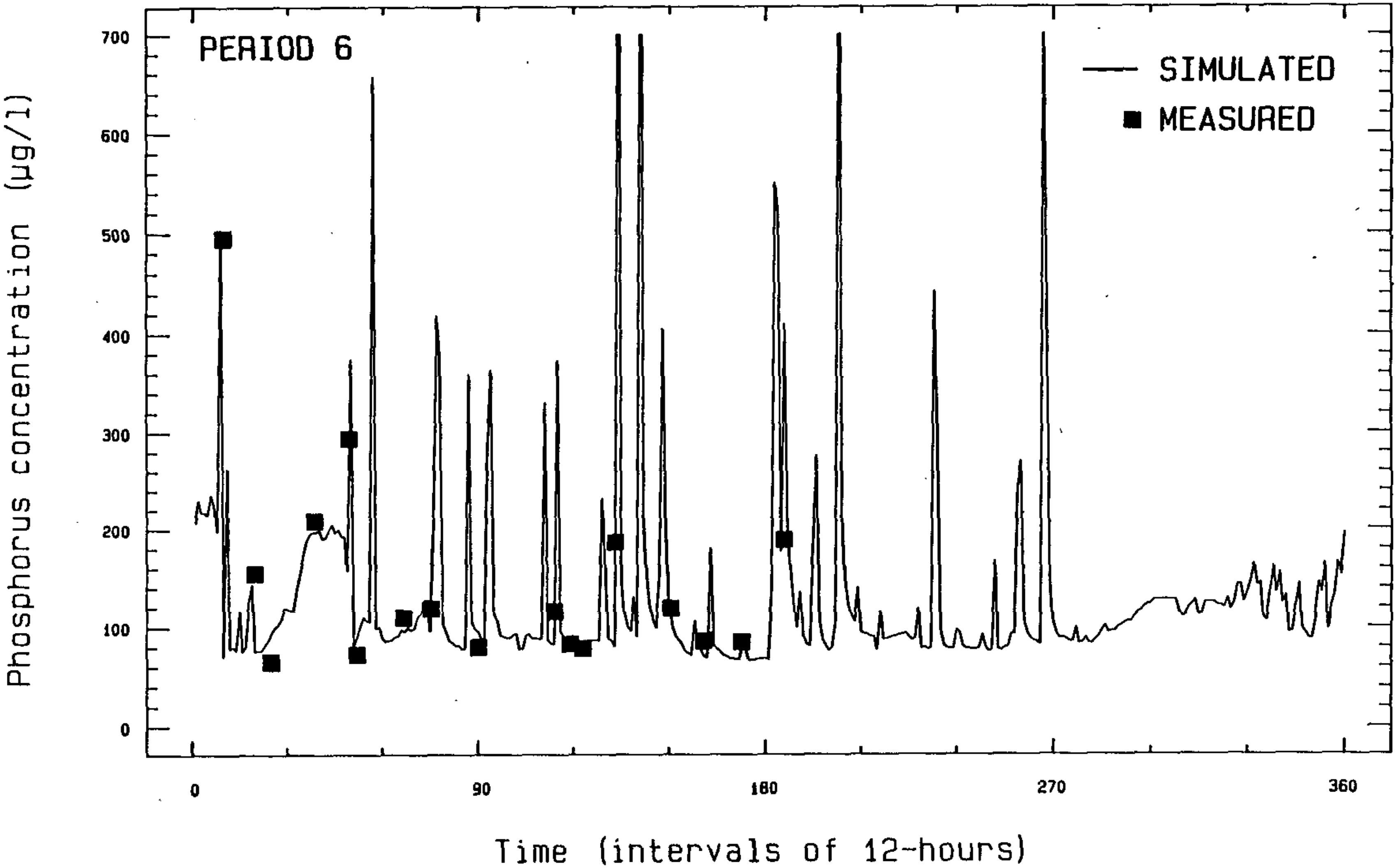


Fig 7.43. Application of the program SECTION1 to simulate the total phosphorus chemograph at Lady Loch Bridge - Period 6.

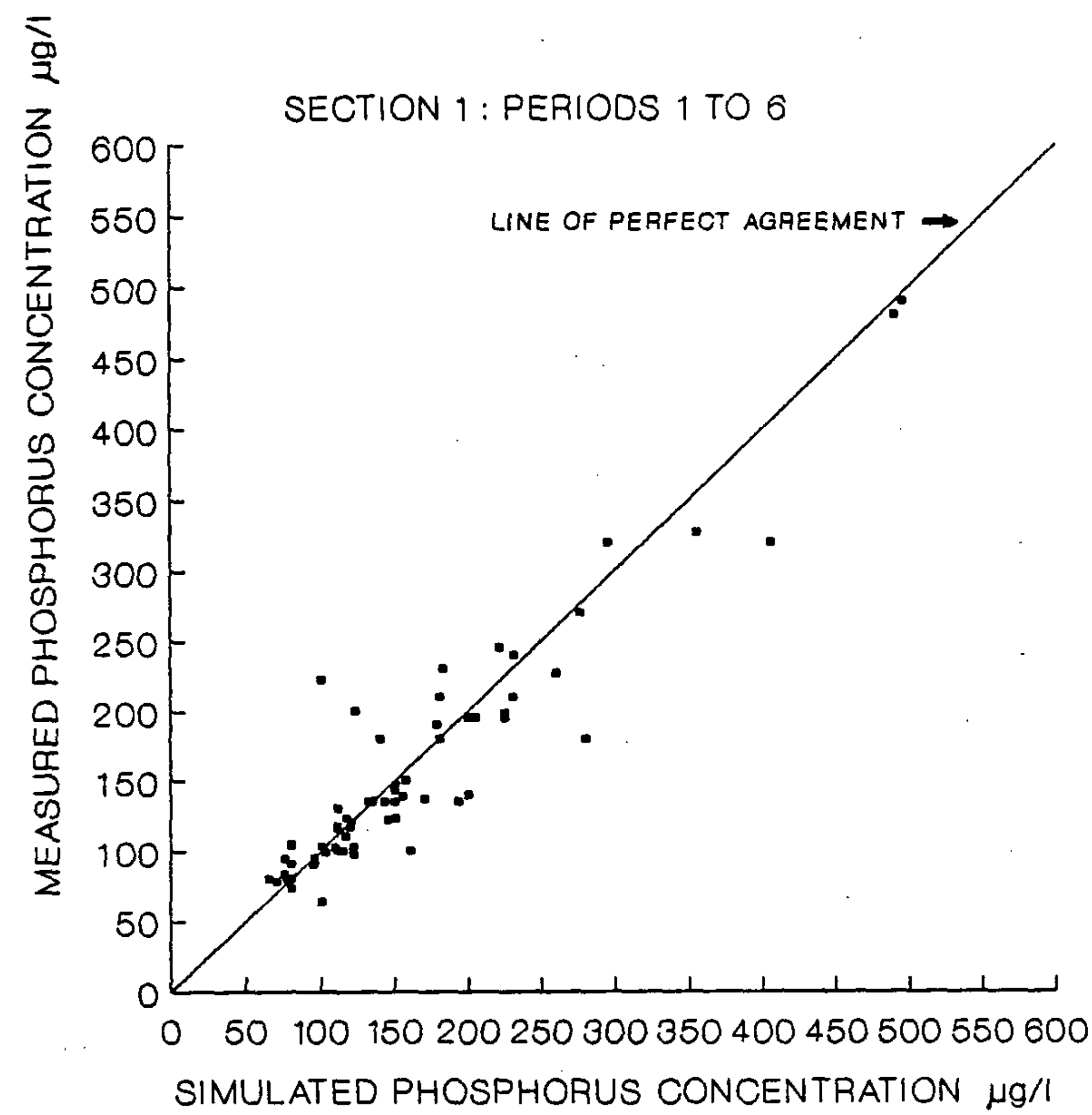


Fig 7.43(a). Correlation plot of the simulated versus measured phosphorus concentration for Station 13B (Lady Loch Bridge). Simulated values are predicted using the phosphorus transport model for the rapid removal stage in the main river channel (program SECTION1) - Periods 1 to 6.

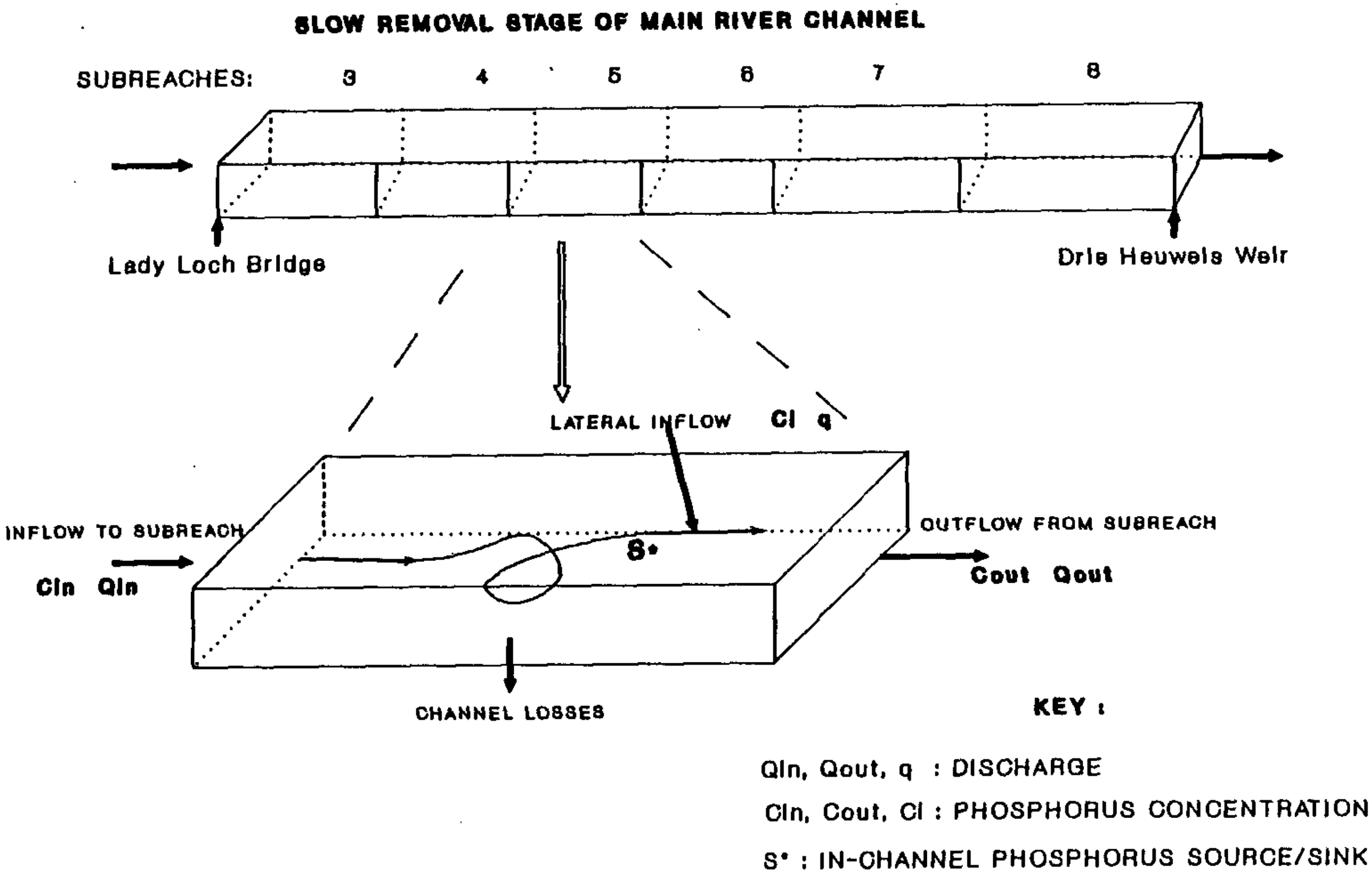


Fig 7.44. Graphical presentation of the sources, sinks and processes influencing the transport of phosphorus along a river channel. One sub-reach is enlarged showing the terms used in the mass continuity equation, Eq (7.16).

(1) Removal and remobilization of TP from and to the water column.

(2) Lateral input of flow and phosphorus from gauged point sources and gauged and ungauged nonpoint sources.

(3) Flow losses due to abstraction and seepage.

For the slow phosphorus removal stage in the Berg River, the removal and remobilization aspects have not been considered yet and need to be resolved.

Modelling of slow phosphorus removal stage

To model the removal and remobilization of phosphorus from and to the water column, accept that the removal is a first order process but that the rate constant decreases as the flow increases. To develop this model, data sets of the phosphorus concentration were collected within 6 hours at discrete points along the river channel. Each data set was plotted against channel distance from Lady Loch Bridge. Data sets were selected which did not show transient flood effects. The selected sets were replotted (log phosphorus concentration versus channel distance). These showed reasonable linearity verifying that the removal rate is approximately first order (the difficulty with this conclusion is that during high steady flows there is disturbance of phosphorus in the channel associated with lateral inflows). Nevertheless, accepting a first order process each set of data was fitted to the following equation using the Program REGRESS.

[TP]x = [TP]o EXP (D2 x) ..... (7.25)

where

[TP]x = phosphorus concentration at distance x,
[TP]o = phosphorus concentration at x=0,
D2 = source/sink term, and
x = river distance (km).

This analysis was applied to 37 sets of phosphorus data giving 37 values for D2. A plot of D2 versus the associated discharge at Lady Loch Bridge for the day the set of phosphorus data were collected is shown in Fig 7.45. The numerical values of D2 increases as the discharge, Q, increases. To model this effect the following equation was fitted to the data in the D2 versus Q plot:

D2 = ln (Q) k2 + c2 ..... (7.26)

where k2 and c2 are constants.

Using curvilinear regression analysis (program REGRESS) the values of k2 and c2 were determined in Eq (7.26) from the 37 data points shown in Fig 7.45.

Modelling the transportation of phosphorus along a river reach requires the following steps:

(1) Divide the river reach into convenient sub-reaches. In the Berg River these sub-reach divisions are given by the phosphorus monitoring stations, see Fig 4.8, Chapter 4.

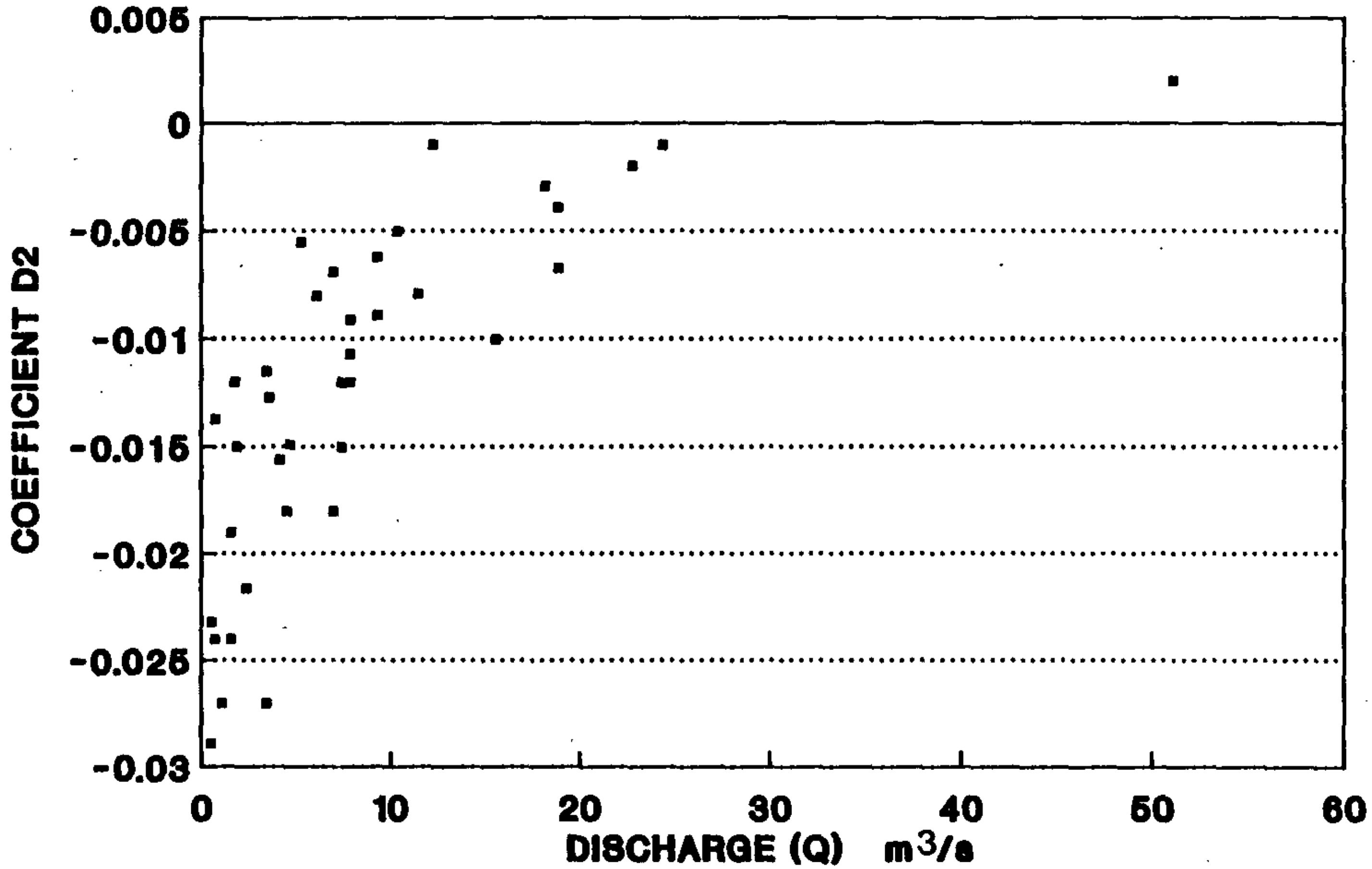


Fig 7.45. Coefficient D2 plotted versus river discharge.

(2) Calculate the hydrograph at every one of the sub-reach divisions. Input data required are the discharge hydrograph at the upper boundary of the upstream sub-reach, in this case the Lady Loch Bridge. In each sub-reach input is required of the gauged and ungauged nonpoint discharge flows. The hydrodynamic solution is set out in Chapter 6, using program QMODEL.

(3) Determine the lateral phosphorus input to each sub-reach: (i) the measured input phosphorus chemograph from point sources, and (ii) the lateral nonpoint phosphorus chemographs from gauged and ungauged areas using the NPS model with the measured or estimated subcatchment hydrographs. These aspects have been dealt with in Section 1 of this chapter.

(4) Determine the phosphorus chemograph at the downstream boundary of each sub-reach along the main river channel using the mass continuity equation, Eq (7.16) (Program SECTION2, Appendix 2). For each sub-reach the input data requirements are the channel hydrograph and chemograph at the upstream boundary of the sub-reach and the hydrographs and chemograph of the lateral discharges to the reach, and the net removal/-remobilization of phosphorus from/to the water column using Eq (7.26). The solution is completed sequentially for the sub-reaches along the river channel, the solution of the upstream sub-reach becoming the channel input to the downstream sub-reach. The input data for the first sub-reach, at Lady Loch Bridge is the simulated solution for the reach Paarl to Lady Loch Bridge described in Section 3 of this chapter.

(5) A flow period is selected (in this case Period 6) and the hydrographs and chemographs simulated for every division of the sub-reach. In this fashion the simulated solution is obtained at Drie Heuwels Weir. Comparison of the measured phosphorus data at Drie Heuwels Weir with the simulated allows judgement on the predictive power of the set of models making up the generation and transport of phosphorus along a river channel.

There is little leeway available to calibrate the phosphorus transport model as only k2 and c2 values can be readily modified. If this does not suffice, a major re-examination of every aspect of the sub-models and their calibration is indicated.

The sequence to model the transport of phosphorus along the Berg River can be summarized as follows:

In Chapter 6 the hydrodynamic model is developed, calibrated and verified using the flow data for the Berg River between Paarl and Drie Heuwels Weir. The model simulates the hydrograph at discrete points along the main river channel and accommodates for river channel losses as well as gauged and ungauged lateral runoff. As a consequence we are in a position to predict the hydrograph at each sub-reach boundary (term Qin and Qout in Fig 7.44). The output data files for the channel hydrographs and lateral inflow hydrographs form the input flow data files to the phosphorus transport model, program SECTION2.

The lateral inflow of phosphorus to each sub-reach (term Cl in Fig 7.44) is simulated using the nonpoint source model (program NPSM) described in Section 1 of this Chapter. The values of the coefficients a1 and b1 in the model for each sub-reach are determined using the rating equation shown in Fig 7.20, giving the values shown in Table 7.3. The values for the coefficients a3 and b3 were the same as those given in

Section 1 because they do not appear to change with sub-reach (see Table 7.1). These constants are inserted into the source code of Program SECTION2.

The phosphorus transport model includes the removal and remobilization of phosphorus from and to the channel water column. This aspect requires the term D2 in Eq (7.25), determined from 37 phosphorus concentration profiles and plotted as a function of channel discharge, see Fig 7.45. The value of D2 is a function of the discharge and the terms k2 and c2 are determined using curvilinear regression analysis of the data shown in Fig 7.46.

With the information described above we are now in a position to use the Program SECTION2 to predict the phosphorus chemograph at each sub-reach boundary along the main river channel between Lady Loch Bridge and Drie Heuwels Weir. A detailed description of the mode of operation of the program is given in Appendix 2.

Table 7.3 Determination of values for coefficients a1 and b1 in the NPS model for each sub-reach of the main river channel using the volume of lateral runoff and the rating equation shown in Fig 7.20.

Sub-reach number:	Volume of runoff (Period 6 million m^3):	a1 (from Fig 7.20):	b1
3	55.2	0.022	0.015
4	21.0	0.026	0.035
5	32.9	0.025	0.020
6	25.4	0.025	0.025
7	24.3	0.025	0.020
8	130.0	0.015	0.003

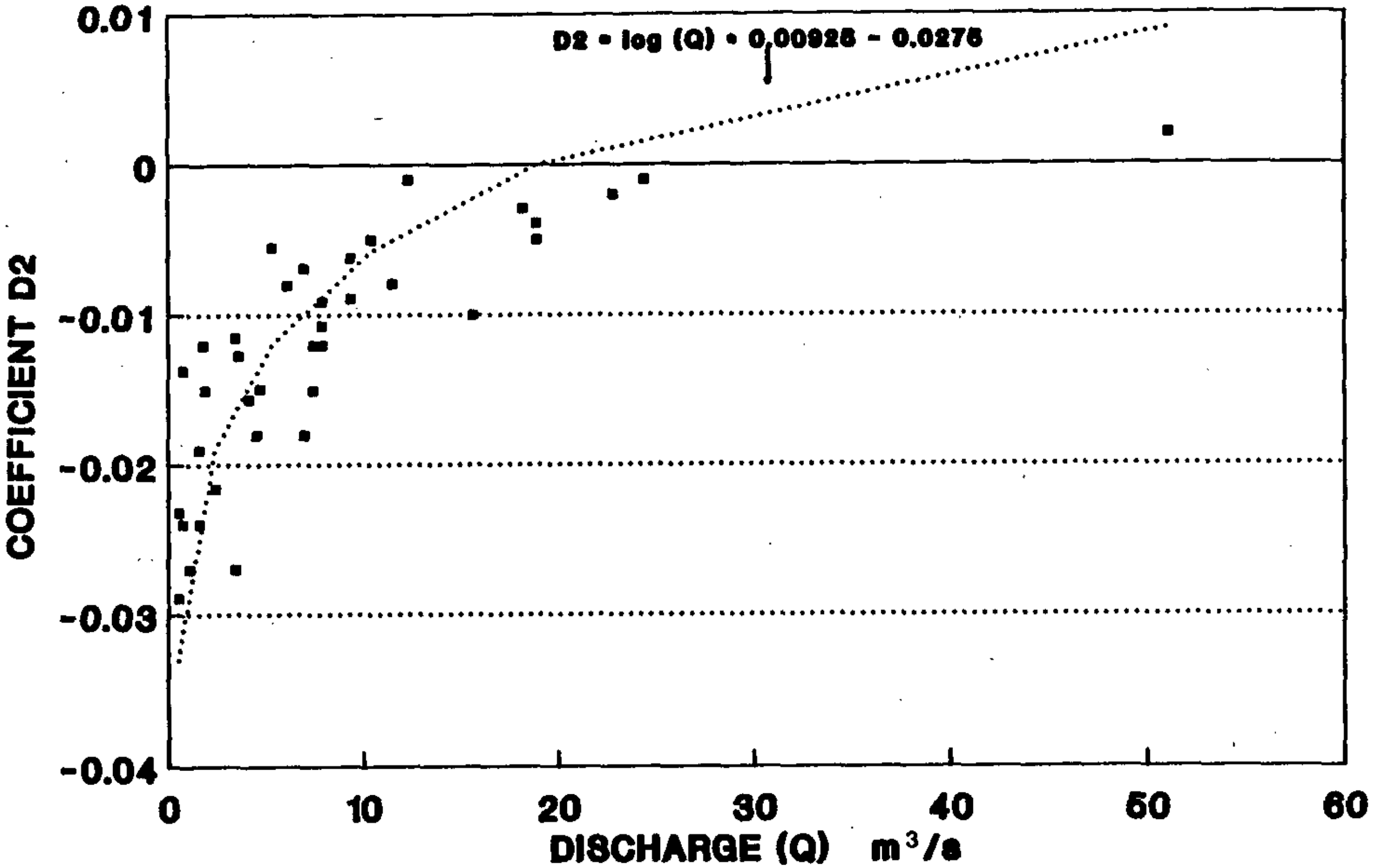


Fig 7.46. Coefficient D2 plotted versus river discharge. The line shown is fitted using values of D2 determined from Eq (7.26).

Calibration of the transport model (Stage 2):

In order to calibrate the phosphorus transport model the following sequence was followed:

(1) Calibration period:

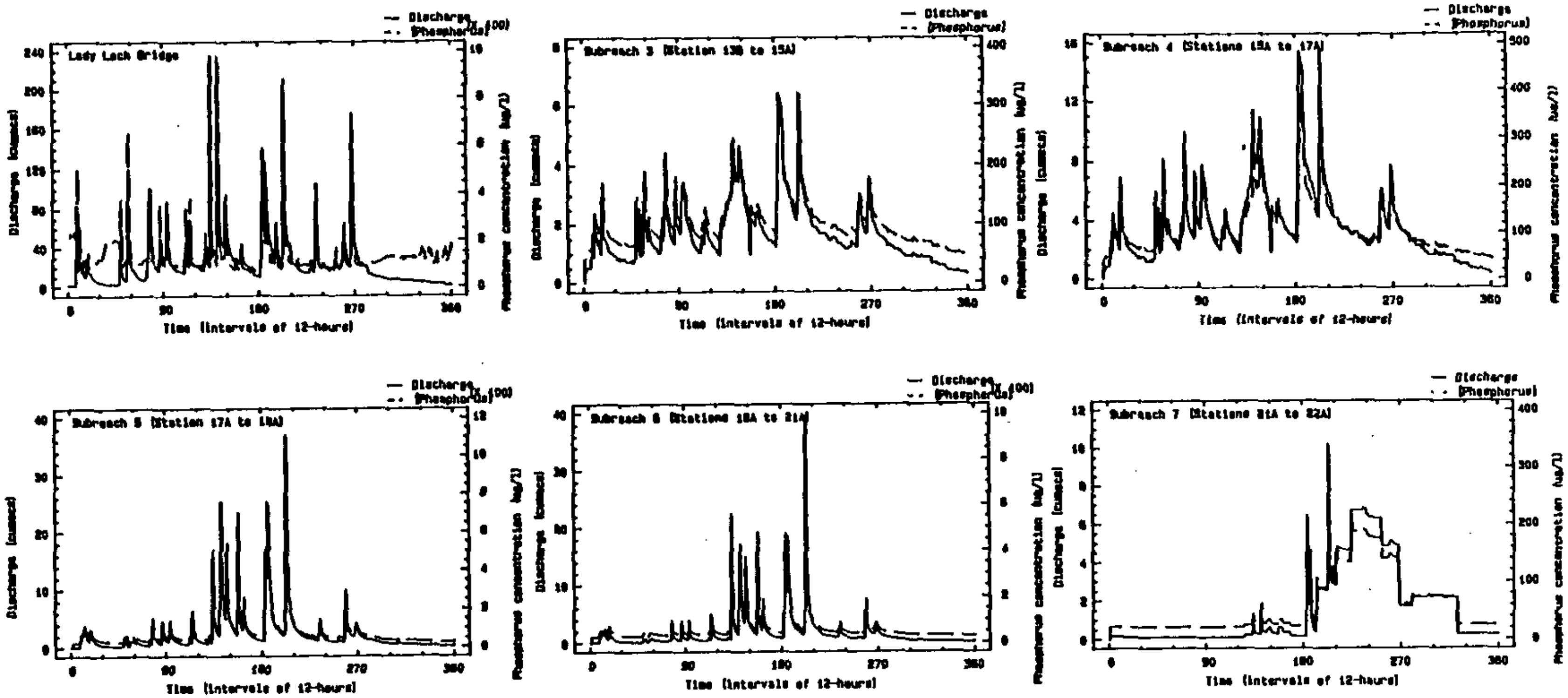
One period of 180-days was used to calibrate the model covering both high and low river flow. The water quality and flow data set for this period (Period 6) is one of the most comprehensive.

(2) Hydrographs and associated water quality data:

The hydrographs over the calibration period for all the gauging weirs and simulated phosphorus concentration data are shown in Fig 7.47.

(3) Estimation of coefficients k2 and c2 in Eq (7.26):

The most appropriate values for these coefficients were found only after the model was in operation. Initially rough estimates for these coefficients were determined as described earlier, afterwards a range of values were tested to determine the influence of these terms on the simulations (see Figs 7.48(a) and 7.48(b)). The value of: 0.0038 for k2, and -0.012 for c2, appeared to provide the most favourable simulation results.



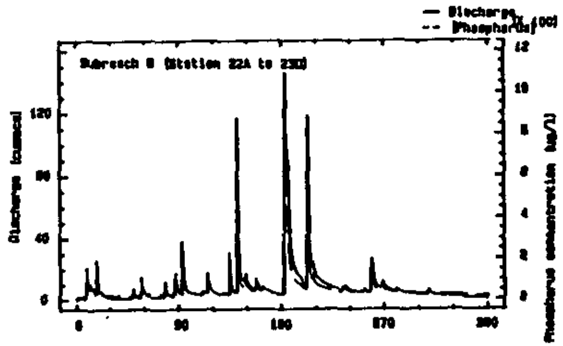


Fig 7.47. Phosphorus concentration and discharge data used in the calibration of the model SECTION 2 simulating the transport of phosphorus along the main river channel between Lady Loch Bridge and Drie Heuwels Weir (slow removal stage).

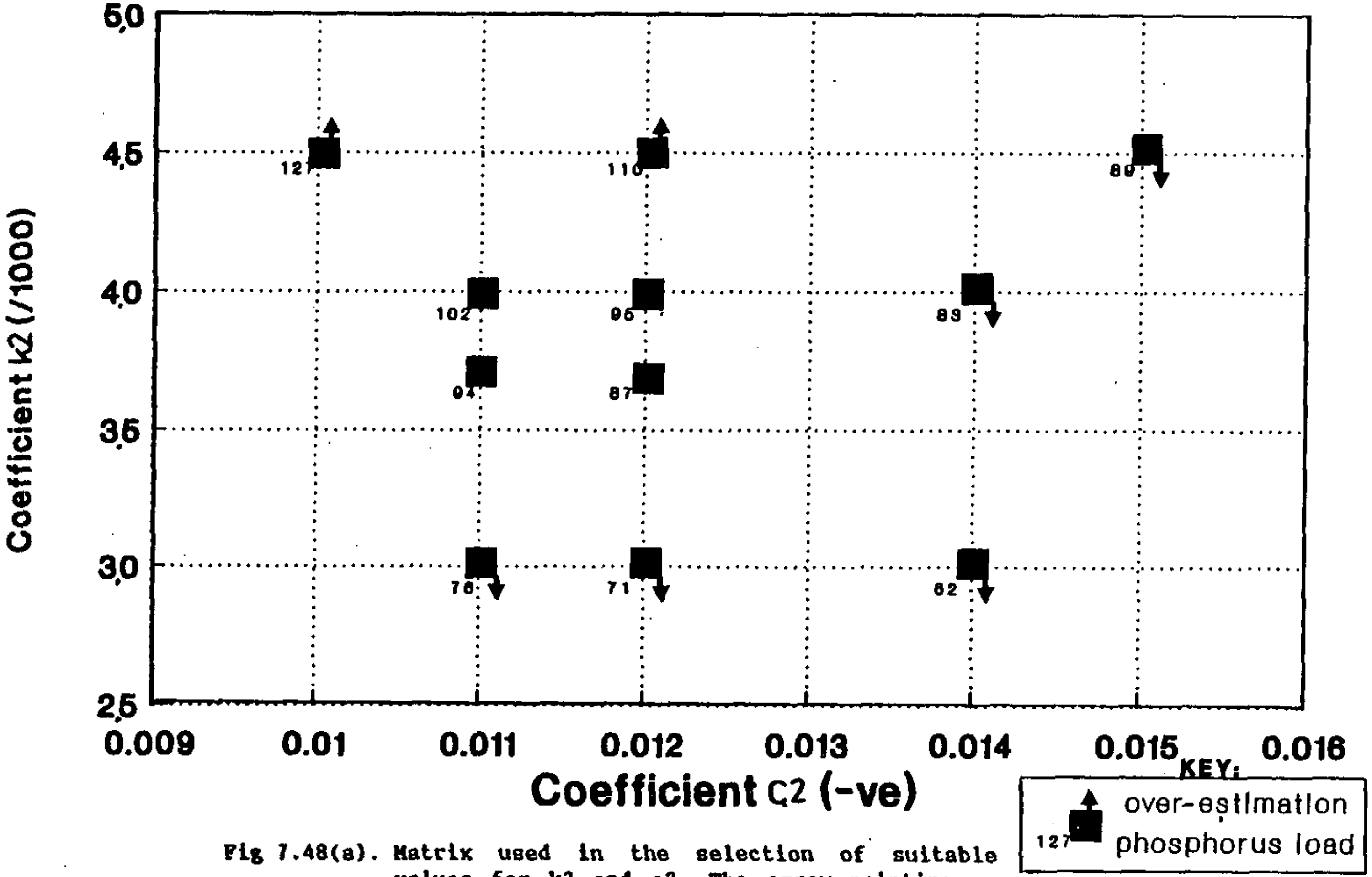


Fig 7.48(a). Matrix used in the selection of suitable values for k2 and c2. The arrow pointing up indicates model over-estimation, and the arrow pointing down indicates model under-estimation.

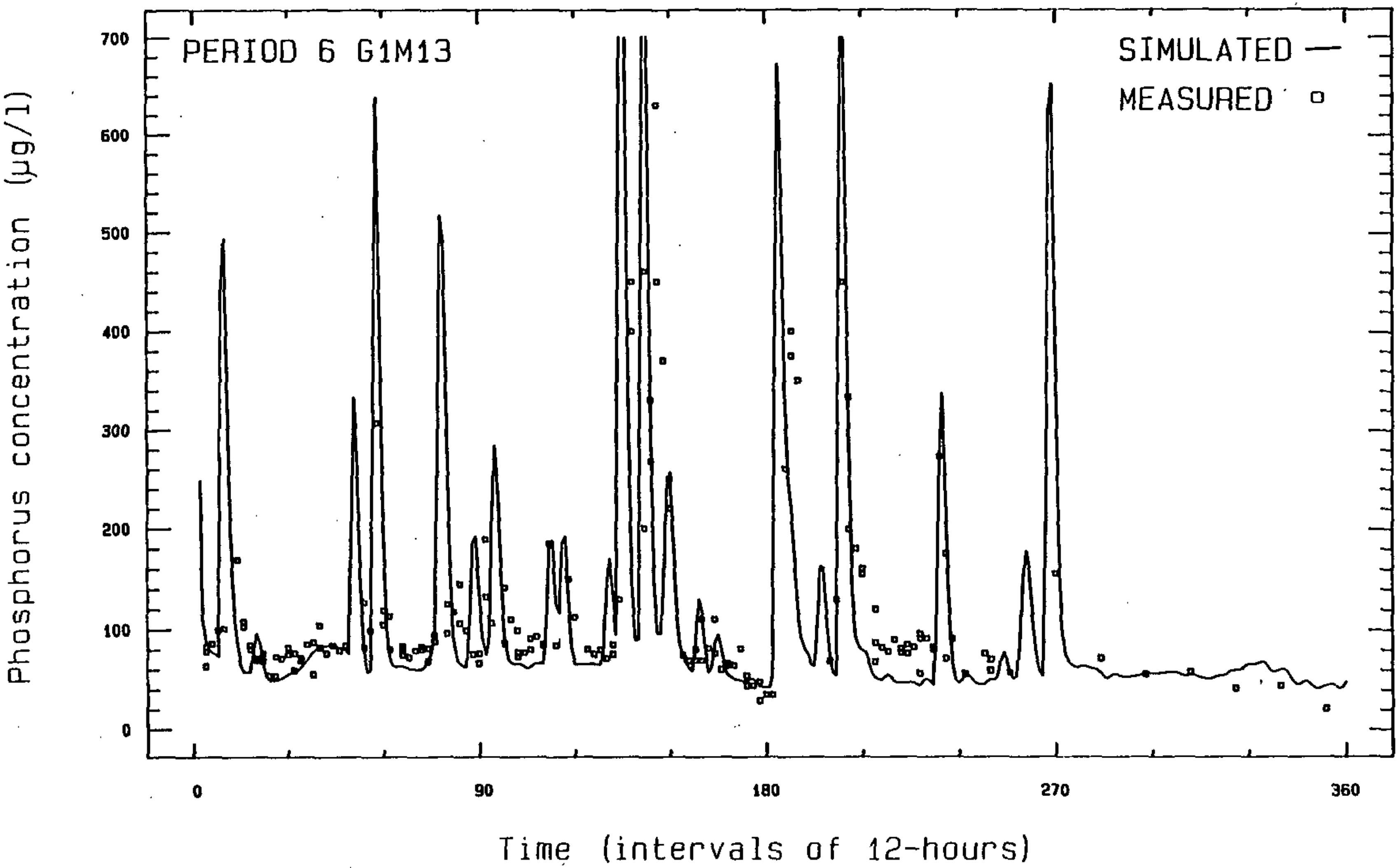


Fig 7.48(b). Simulated and measured total phosphorus concentration data at Drie Heuwels Weir - Period 6.

The input hydrographs and chemographs for Period 6, a wet period (May 1986 to November 1986) are shown in Fig 7.47. Accepting (1) the final values for the constants k2 and c2 given above, and (2) the accuracy of the gauging weirs involved in the mass balance calculations, the simulation of the chemograph at Drie Heuwels Weir for the 180-days of Period 6 was undertaken. In Fig 7.48(b) the measured and simulated phosphorus concentrations are shown, and the correlation plot in Fig 7.49.

It is at once apparent that the simulated and measured phosphorus concentrations are in reasonable accord; and thus it is unfortunate however that the peak phosphorus concentrations were sampled only on a small number of occasions.

During the low flow in Period 6 the measured phosphorus concentrations show some scatter around the simulated values (see Figs 7.48(b)). Such scatter probably arises from a number of causes; one of these would be the sporadic discharges from agricultural and urban areas. Such discharge are virtually impossible to model because of the randomness in occurrence. Fortunately, these are responsible for a relatively small load of phosphorus and occur only during low flow. Consequently, they have only a small influence on the total load of phosphorus for the specific period.

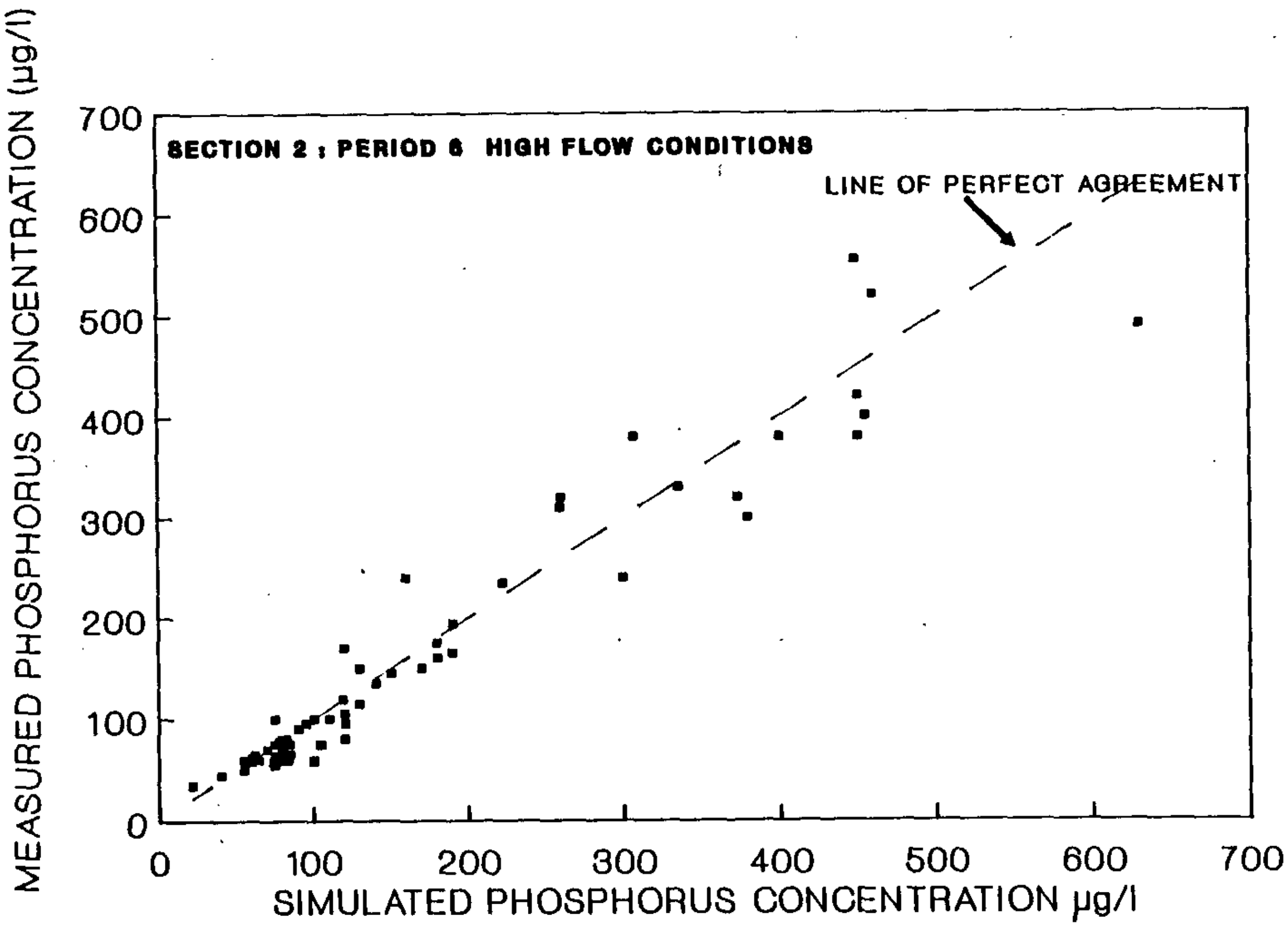


Fig 7.49. Plot of the simulated versus measured phosphorus concentration for Station 23D (Drie Heuwels Weir). Simulated values are predicted using the phosphorus transport model SECTION 2 - Period 6.

3.6 Model verification

The model was verified by simulating the phosphorus chemograph at Drie Heuwels Weir over the monitoring period (Periods 1 to 5), from November 1983 to May 1986 using the program SECTION2 with the values for coefficients: k2=0.0038, c2=-0.012 in Eq (7.26). To solve for the slow reaction stage the following inputs are required

(1) The hydrograph at each sampling station along the main river channel - produced by the hydrodynamic flow model, described in Chapter 6 (program QMODEL).

(2) The chemograph at Lady Loch Bridge - simulated using the program SECTION1, described in Section 3 of this chapter

(3) The influx of phosphorus from nonpoint sources in the reach Lady Loch Bridge to Drie Heuwels Weir - simulated using the nonpoint source model, see Section 1 of this chapter, program NPSM.

The simulated phosphorus chemograph and measured phosphorus concentrations at Drie Heuwels Weir are shown in Figs 7.50 to 7.54; a correlation plot of the simulated versus measured total phosphorus concentration is shown in Fig 7.54(a).

3.7 Model evaluation

Comparing the measured and simulated phosphorus concentrations, the model predicts the concentration during low and intermediate flow conditions very reliably; during flood events unfortunately there are insufficient water quality data for accurate calibration and verification of the model.

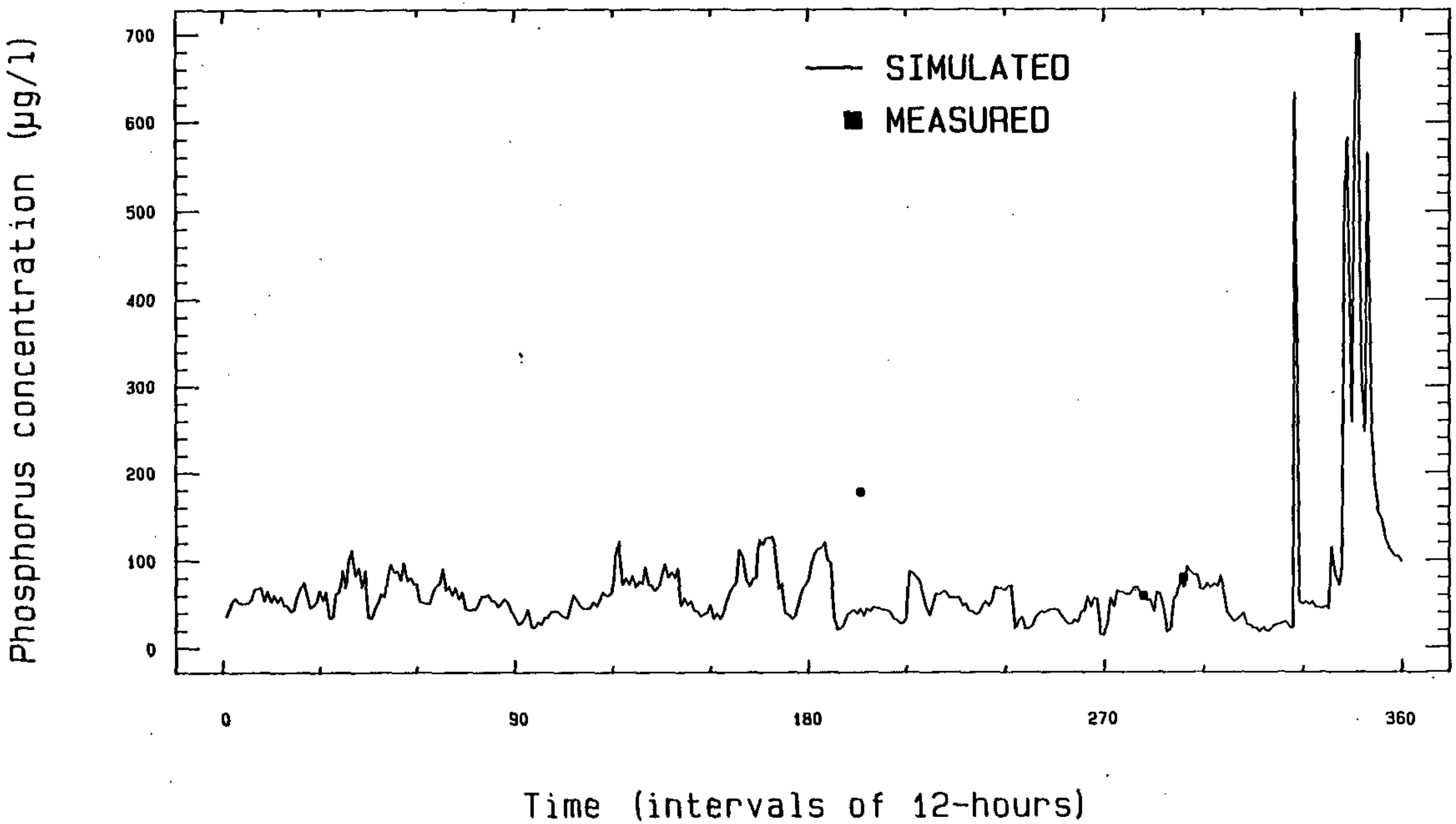


Fig 7.50. **Simulated and measured phosphorus concentration data for Drie Heuwels Weir (Station 23D) - Period 1.**

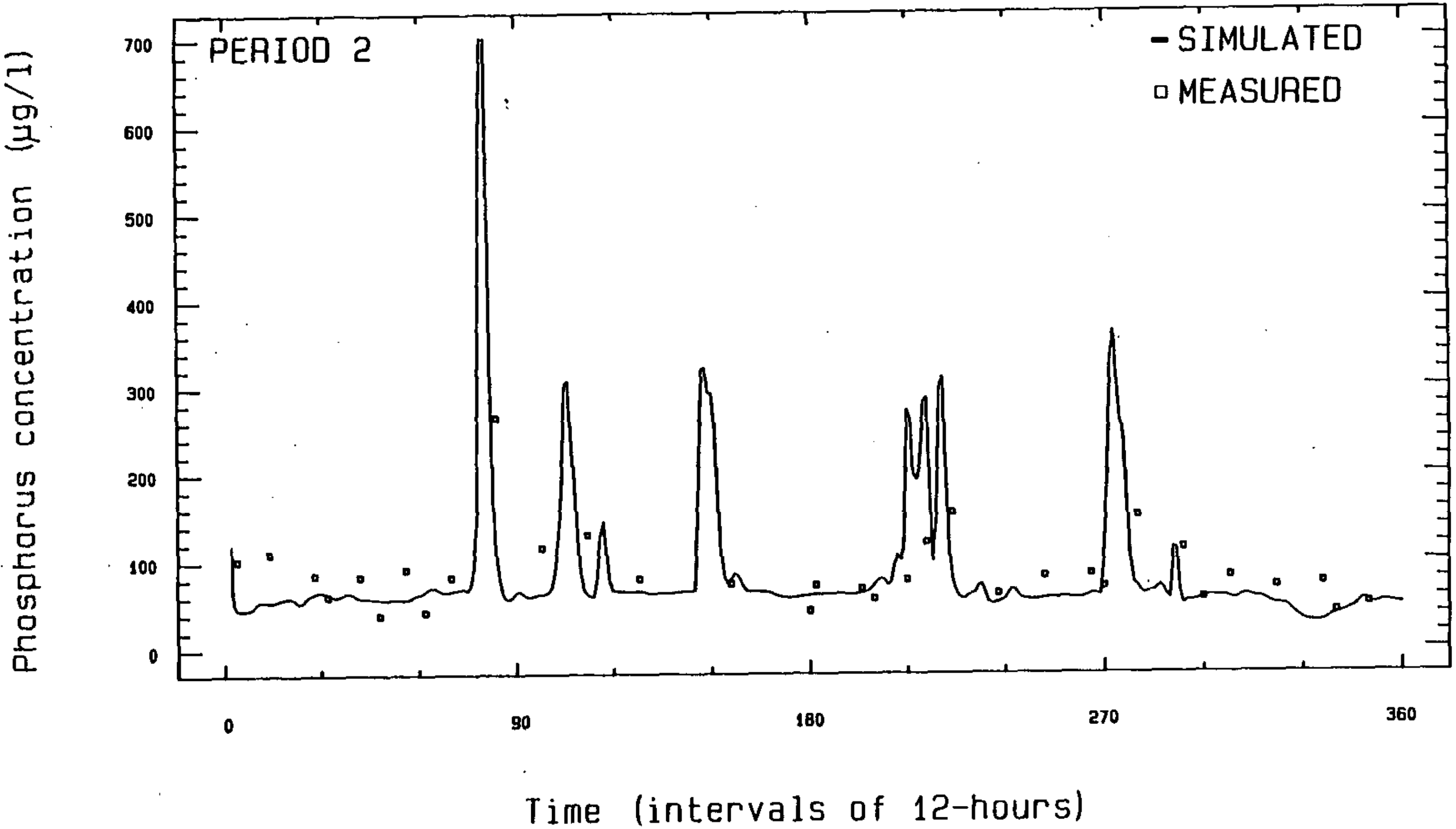


Fig 7.51. Simulated and measured phosphorus concentration data for Drie Heuwels Weir (Station 23D) - Period 2.

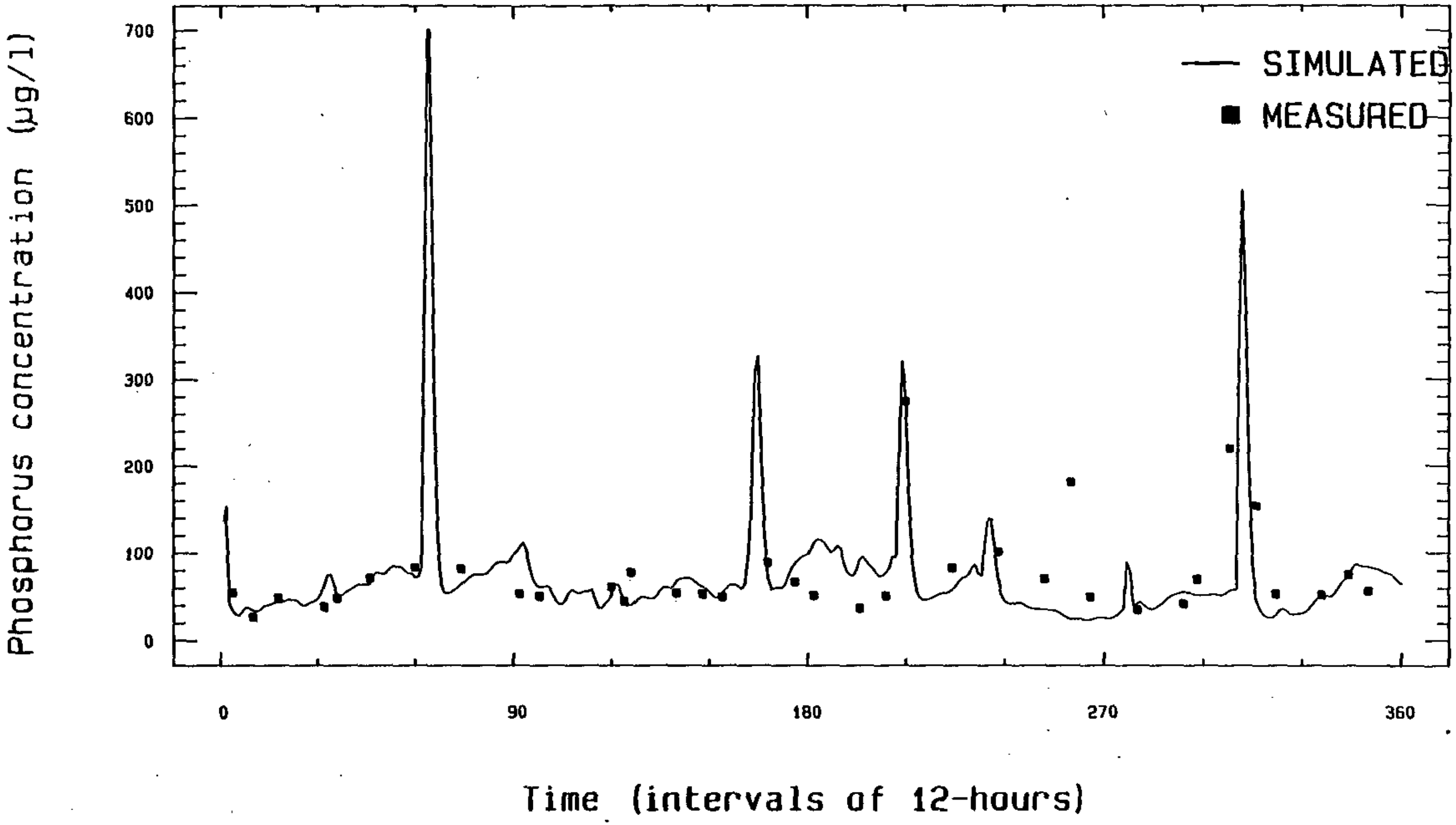


Fig 7.52. **Simulated and measured phosphorus concentration data for Drie Heuwels Weir (Station 23D) - Period 3.**

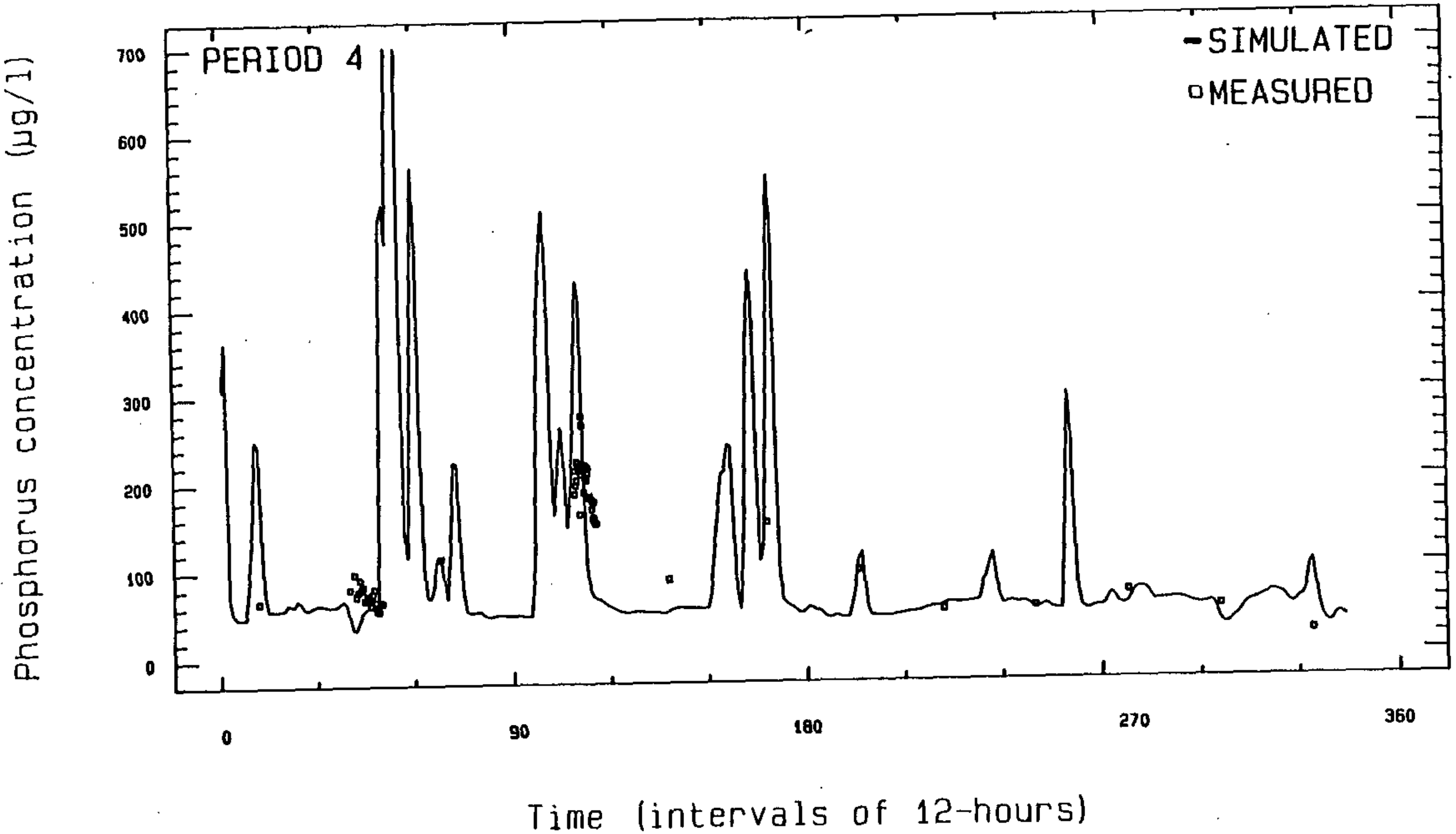


Fig 7.53. Simulated and measured phosphorus concentration data for Drie Heuwels Weir (Station 23D) - Period 4.

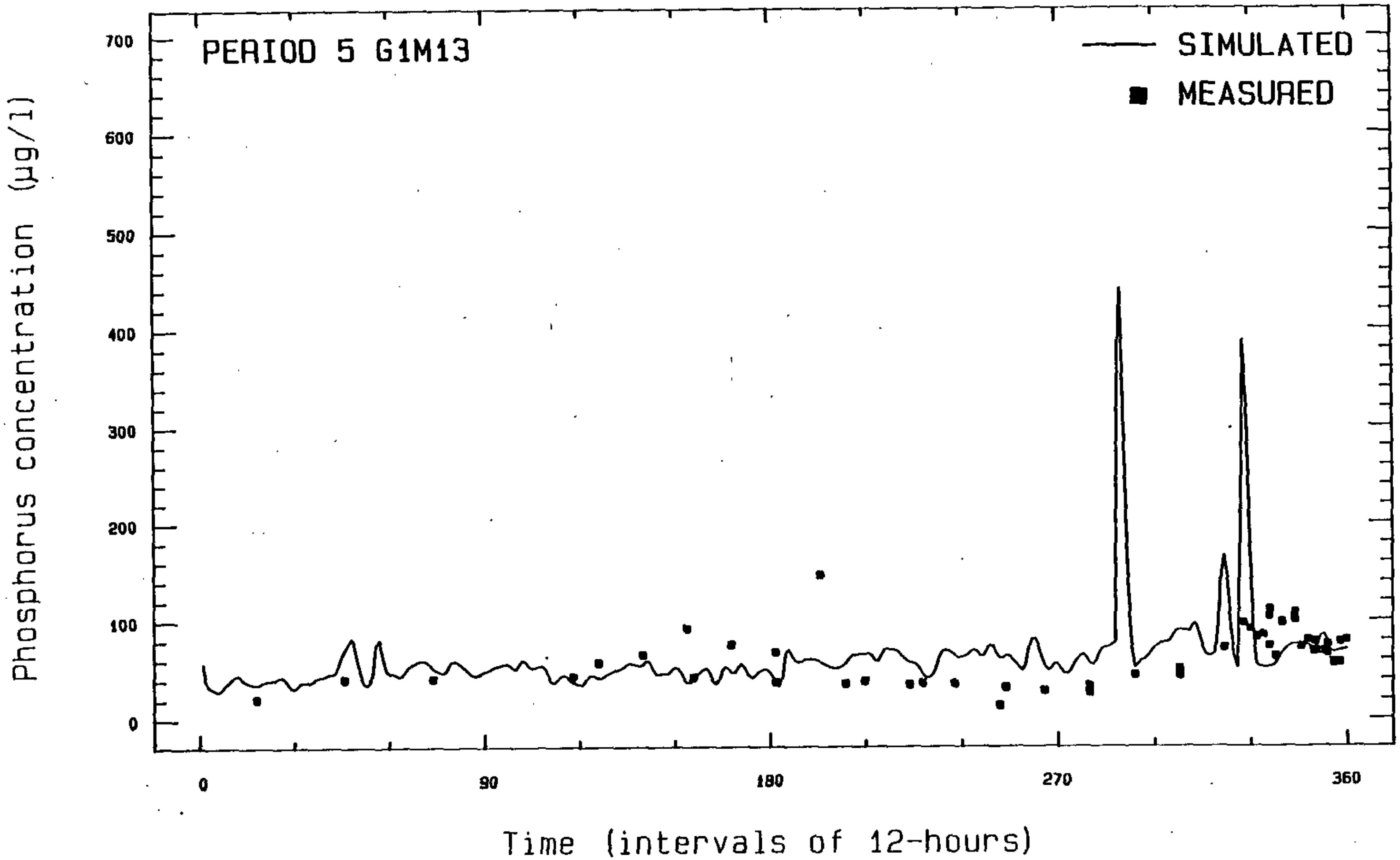


Fig 7.54. **Simulated and measured phosphorus concentration data for Drie Heuwels Weir (Station 23D) - Period 5.**

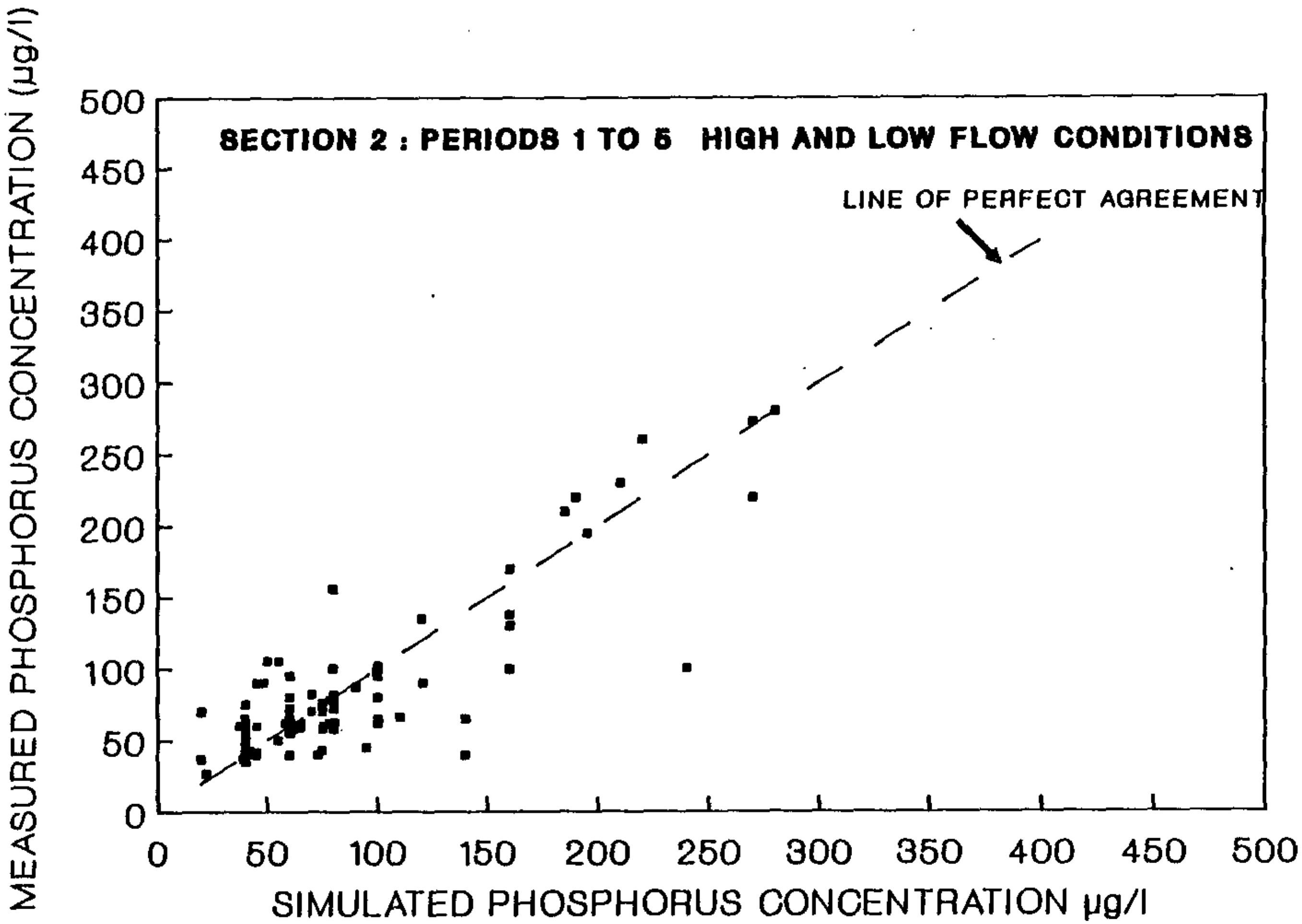


Fig 7.54(a). Correlation plot of the simulated versus measured phosphorus concentration data for Station 23D (Drie Heuwels Weir). Simulated values are predicted using the phosphorus transport model for the slow removal stage of the main river channel (program SECTION2) - Periods 1 to 5.

The plot of the values of D2 versus discharge indicate that a change-over from sedimentation to remobilization takes place at a threshold discharge of around 17 cumecs (Fig 7.46). This critical discharge value is approximately the same as for Stage 1 (see Fig 7.34). Thus, the remobilization of phosphorus in both Stages 1 and 2, is characterised by river discharges in excess of 17 cumecs. At river discharges less than 17 cumecs the flow apparently is insufficient to scour sediments and there is a net removal of phosphorus from the water column to the riverbed.

4 PHOSPHORUS BED LOAD MODEL

The phosphorus transport model (program SECTION2) predicts the phosphorus transportation in the water column of a river channel. However, the phosphorus adsorbed onto river sediments will be transported as bed load. To estimate the mass transport of phosphorus laden bed material, a bed load model must be developed. Such a model is complex and conceptually should take into account the processes shown in Fig 7.55.

Analysis of the experimental data (Chapter 5) shows us that the culmination of the processes in Fig 7.55 result in sharp gradients of wash and bed material during flood events and stable concentrations during steady flow conditions.

To quantify the mass transport of bed material along a series of river sub-reaches we could follow one of two approaches:

(1) Measure the bed load at the inflow of each sub-reach and quantify each of the processes shown in Fig 7.55,

(2) using a lumped parameter approach, quantify the upstream and downstream boundary conditions of each sub-reach.

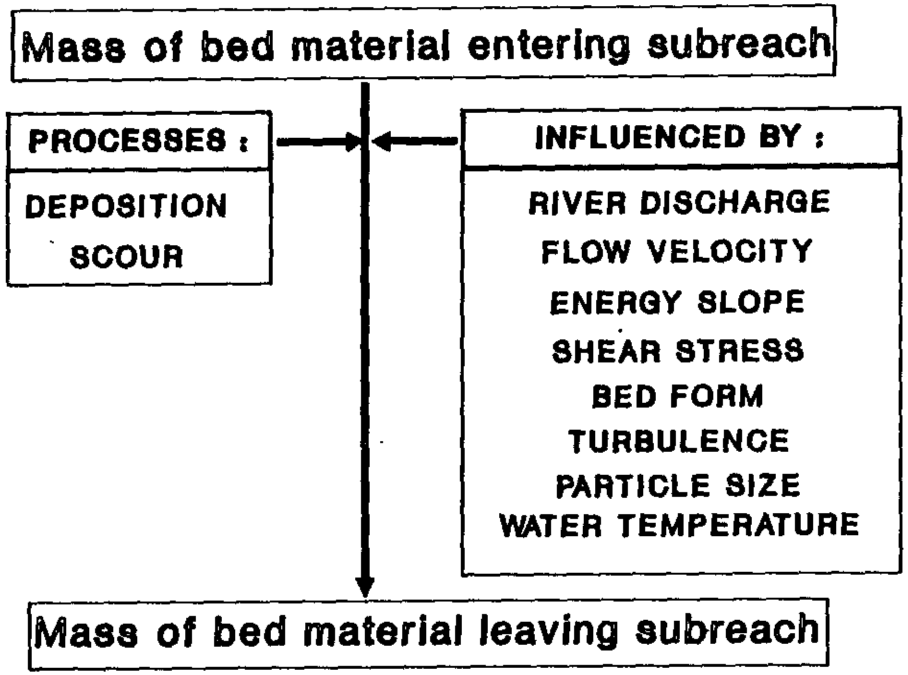


Fig 7.55. Conceptual framework of the processes governing the transport of bed material along a river channel.

By following the first approach we would require an intensive investigation into the transport of bed material along the river channel, which is beyond the scope of this investigation. Alternatively, the second approach provides a more practical solution to the problem. Numerous equations are proposed by different authors to calculate the rate of sediment transport in alluvial channels. Prominent among these approaches are those of Einstein (1950) and modifications by Colby and Hembree (1955), Bagnold (1956, 1966) method based on stream power, and the studies of Engelund and Hansen (1967) using tractive force. Most of these equations are derived under the assumption that the rate of sediment transport depends on one independent variable, such as water discharge, average flow velocity, energy slope, or shear stress.

4.1 Model development

More recently, success in predicting total bed material concentration has been claimed by Yang and Stall (1976). After reviewing the literature they concluded that "the rate of bed material transport in an alluvial channel is dominated by the rate of potential energy expenditure per unit weight of water" i.e. the unit stream power. Using this principle, they formulated an equation of the form

$$Ct = J\,(Ww/vf - Wwc/vf)^{K} \qquad \text{.....} \qquad (7.27)$$

where

Ct	=	concentration of bed material in the flow,
Ww	=	unit stream power, determined as the product of the river velocity and bed slope,
Wwc	=	a critical, or threshold value of Ww below which there is no transport,
vf	=	median fall velocity of the sediment particles,
J,K	=	dimensionless empirical factors dependent on the characteristics of the flow and sediments.

Dingman (1985) states that Eq (7.27) is made dimensionless by the division of the fall velocity, vf, which seems physically reasonable since vf can be considered an index of a particle's "reluctance" to be transported. Yang and Stall (1976) found empirically that the critical velocity for erosion, vc, was related to fall velocity, vf, by

$$vc = 2.05\ vf \qquad \ldots\ldots \quad (7.28)$$

This relationship can then be expressed non-dimensionally and put in terms of the unit stream power simply by multiplying by the slope So and rearrangement (if the erosive Reynolds number Re>70) then

$$Wwc/vf = 2.05\ So \qquad \ldots\ldots \quad (7.29)$$

For flows not fully turbulent, the relation between vc and vf should be a function of Re. From experimental data, Yang and Stall (1976) found that this relation could be expressed as

$$vc = ((2.5/\ (0.434\ \ln Re - 0.06)\ ) + 0.66)\ vf \ \ldots\ldots \quad (7.30)$$

Making the same transformation as before gave the expression for critical stream power in flows that are not fully turbulent (if Re <70) then

$$Wwc/vf = ((2.5/(0.434\ \ln Re - 0.06)) + 0.66)\ So \ \ldots \quad (7.31)$$

To complete their analysis, Yang and Stall (1976) used dimensional considerations to reason that J and K in Eq (7.27) should depend only on the particle Reynolds number, Rp, and the ratio of friction velocity, v*, to fall velocity vf. Multiple regression analysis using over 450 individual measurements from flumes and natural rivers resulted in the following empirical relations

$$J = 27\ 2000/(Rp^{0.286}(v*/vf)^{0.457}) \quad ..... \quad (7.32)$$

$$K = 1.799 - 0.178 \ln Rp - 0.136 \ln (v*/vf) \quad ..: \quad (7.33)$$

Eqs (7.32 to 7.33) used in Eq (7.27) give the predicted bed concentration (Ct) in parts per million. To compute the total sediment discharge or capacity Qs, the following equation is used

$$Qs = 10^6\ Ct\ Ys\ Q \quad .... \quad (7.34)$$

where Qs is in units of weight per unit time, Ys is the weight density of the sediment and Q is the water discharge.

Figure 7.56 compares the measured sediment discharges with those computed by using Eq (7.27) indicating that this approach provides very satisfactory predictions over a wide range of conditions (Yang and Stall, 1976; Dingman, 1985).

Yang and Stall (1976) state that the measurement of the total sediment concentration is attained at a contracted section or at a section with man-made construction such that all sediment could be measured. Under ordinary conditions, only the suspended sediment concentration (wash load) can be measured easily in a river. The sediment transported in suspension includes those with particle sizes within the range of the channel bed composition, and those sediments of finer size. Wash load is defined as that part of the sediment load that consists of grain sizes finer than those of the bed. Bed material discharge equals the product of water discharge and the difference between total suspended concentration and the suspended concentration with particle size in the range of wash load.

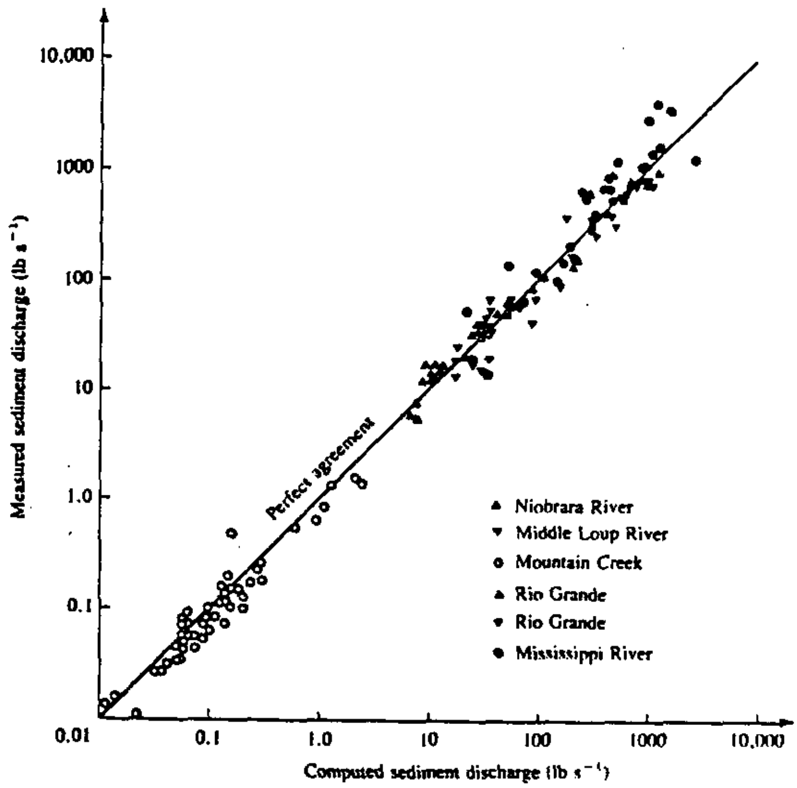


Fig 7.56. Comparison between measured and computed sediment discharge at six river stations using the Unit Stream Power Equation (from Yang and Stall, 1976).

Equations (7.27, 7.29 to 7.34) were used in the program BEDLOAD (see Appendix 2) to predict the total sediment discharge at Station 23D, Drie Heuwels Weir. The mass of phosphorus transported as bed load is estimated from

$$Qp = (Q \cdot Ct)\ Sp \qquad \ldots\ldots \quad (7.35)$$

where

Qp = mass of phosphorus transported (g/s),
Q = instantaneous river discharge (cumecs),
Ct = concentration of bed load material (g/m^3),
Sp = ratio, mass of phosphorus/mass of bed load material (g/g).

In Eq (7.35) the term Sp, is estimated at discrete points along the main river channel by collecting bed sediment samples and determining the proportion of phosphorus per unit mass of sediment. The data for these samples are shown in Table 7.4.

The most important feature in the data, shown in Table 7.4, is that the phosphorus concentration exhibits little spatial variability for samples collected at stations upstream and downstream of the municipal sewage outfalls, Stations 9A and 13B respectively.

Table 7.4 River bed sediment samples collected at a number of sampling points along the main river channel, with mass of phosphorus given per unit mass of sediment. Median sieve size is calculated using granulometric methods.

Date of collection:	Station:	Mass of P in sediments (g P/g sediment):	Median sieve size (mm):
2/5/1986	9A	0.074	0.60
	13B	0.056	0.60
	21A	0.059	0.47
	22A	0.068	0.35

4.2 <u>Model calibration</u>

(1) Hydrograph and associated water quality data:

Of the greatest importance is the availability of accurate hydrographs with the associated water quality data for discrete points along the main river channel between Lady Loch Bridge and Drie Heuwels Weir. This requirement is definitive, without it no reliable calibration is possible. It is essential therefore the gauging weirs are accurate over the full range of flows expected and the water quality data are representative of the conditions in the river at the time of sampling.

(2) Estimation of model coefficients in Eq (7.27):

These coefficients in the numerical scheme can be estimated accurately only through trial simulations using a range of values. Due to a lack of available bed load data the model was calibrated using the values for the coefficients given by Yang and Stall (1976), given in Eqs (7.27 to 7.33) as well as data shown in Table 7.4.

4.3 Model simulation

In Table 7.5, the results of the model application are presented for Periods 1 to 6, giving the total mass of bed material transported, as well as the estimated mass of phosphorus transported in both the water column and bed load.

Table 7.5 Predicted mass of phosphorus exported as bed material and in the water column, for Drie Heuwels Weir. Expressed as tons of phosphorus per 180-days.

Period:	Mass of bed load material:	Estimated mass of phosphorus in: bed load:	water column:
1	5.0	0.00038	36.3
2	13.7	0.00104	70.4
3	2.2	0.00017	10.4
4	19.5	0.00150	125.0
5	1.0	0.00007	4.3
6	19.1	0.00147	107.7

4.4 Model evaluation

Yang and Stall (1976) state that the calibration of a bed load model is difficult because of the problems obtaining representative sediment samples from the riverbed. The total suspended solids samples collected during the monitoring exercise provide an estimate of the magnitude of the wash load transport and not the concentration of bed material. It must be emphasised therefore that the bed load model is calibrated using the coefficients reported by Yang and Stall (1976) and the results will be considered in this light. However, the output from the model shown in Table 7.5 reveals that in terms of the mass of phosphorus transported in the water column the mass of phosphorus in the bed load is relatively insignificant. Consequently, the accuracy of the model provides an approximation of the mass transport of bed material and a comparison between the phosphorus transported in the water column with the phosphorus transported as bed material.

Due to the mean sediment phosphorus concentration being 0.077 mg/g, the resultant mass of phosphorus transported as bed load is relatively low compared with the transport as wash load. Consequently, bed load transport will be ignored from further calculations due to the bed load only making-up less than 1 percent of the total phosphorus load transported by the river (see Table 7.5).

5 CONCLUSIONS

In this chapter a lumped parameter model was developed to simulate the transport of phosphorus along a river channel. It required the development of a number of sub-models:

(1) Phosphorus nonpoint source model,

(2) Phosphorus channel transport model which required the development of:

(i) hydrodynamic flow model,

(ii) phosphorus removal and remobilization model,

(iii) phosphorus bed load model.

The inter-relationships between models is shown in Fig 7.57. The phosphorus bed load model (2(ii)) eventually appears to be relatively unimportant in this model context, and possibly could be omitted. All the other sub-models serve vital functions in the channel phosphorus transport model. The phosphorus nonpoint source and hydrodynamic flow model however can be used independently of the channel phosphorus transport model.

In the next chapter the various sub-models of the phosphorus transport model will be used to show the range of problems which can be addressed by such a model.

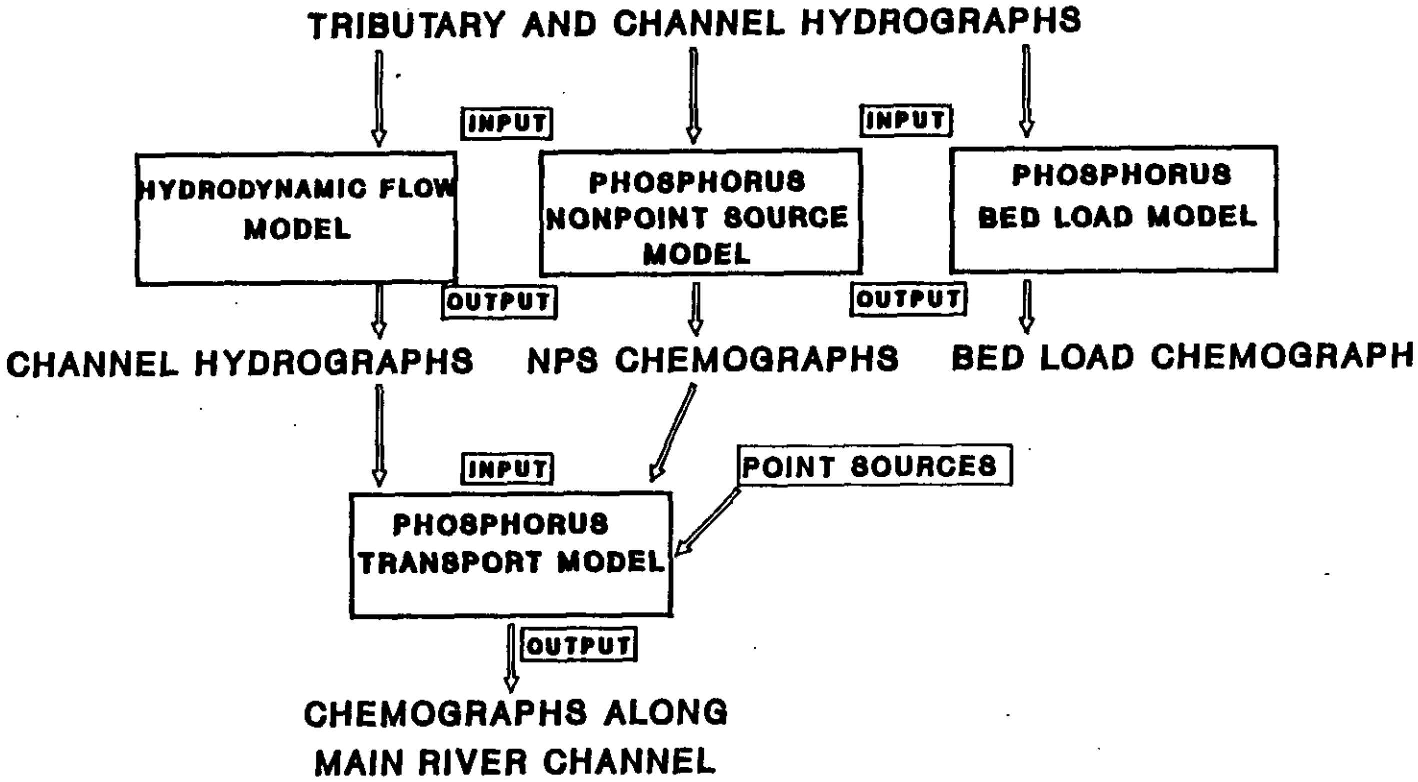


Fig 7.57. Schematic diagram showing the inter-relationships between the various components of the phosphorus transport model.

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7. NOTATION USED IN CHAPTER 7

Phosphorus nonpoint source model:

P	=	ortho-phosphate concentration (mg/ℓ)
A0,A1,A2	=	regression coefficients in Eq (7.1)
$\Delta Q/\Delta t$	=	rate-of-change of discharge (cumecs/12 hours)
Q	=	instantaneous discharge (cumec)
Q_{to}	=	discharge at time of sampling (cumec)
Q_{t-1}	=	discharge 12-hours previously (cumec)
to	=	time of sampling (second)
t-1	=	time 12-hours previously (second)
TPr	=	phosphorus concentration during recession flow (μg/ℓ)
a1,b1	=	regression coefficients in Eq (7.4) (mg/ℓ,mg/ℓ,cumec)
Qr	=	discharge during recession flow (cumec)
TPs	=	phosphorus concentration during rising limb (mg/ℓ)
b2	=	regression coefficients in Eq (7.5a) (mg/ℓ/cumec)
a3,b3	=	regression coefficients in Eq (7.6)(mg/ℓ, mg/ℓ/cumec/12-hours)

<u>Hydrograph decomposition approach</u>:

Qb	=	baseflow discharge (cumec)
Qt	=	total discharge (cumec)
Qs	=	surface runoff discharge (cumec)
kb,ks	=	regression coefficients in Eqs (7.9 and 7.10) (cumec/cumec, cumec/cumec)
SV1,SV2	=	volume of surface runoff (m^3)
BV1,BV2	=	volume of baseflow (m^3)
Qmax	=	peak discharge (cumec)
[PP]	=	particulate phosphorus concentration (µg/ℓ)
ksp	=	regression coefficient in Eq (7.13) (µg/ℓ/cumec)
[SP]	=	soluble phosphorus concentration (µg/ℓ)
kad,ks	=	regression coefficients in Eqs (7.14 and 7.15) (µg/ℓ/cumec)

Phosphorus transport model:

C	=	concentration in main river channel (μg/ℓ)
Cl	=	concentration of lateral inflow (μg/ℓ)
q	=	lateral inflow per unit length of channel (cumec/metre)
A	=	flow cross sectional area (m^2)
Q	=	discharge in main river channel (cumec)
x,t	=	increments of time and space
S*	=	source/sink term
Ct	=	phosphorus concentration at time t (μg/ℓ)
Co	=	phosphorus concentration at time 0 (μg/ℓ)
k1,k2	=	rate constants
Qt	=	discharge at time t (cumec)
Qo	=	discharge at time 0 (cumec)
a	=	constant
Loadout	=	phosphorus load at Lady Loch Bridge (g/s)
Loadin	=	phosphorus load input from upstream and lateral sources (g/s)
C1,C2,C3,C4	=	phosphorus concentrations in Eq (7.19) (μg/ℓ)
Q1,Q2,Q3,Q4	=	discharge values in Eq (7.19) (cumec)
[TP]sim	=	simulated phosphorus concentration (μg/ℓ)
[TP]mes	=	measured phosphorus concentration (μg/ℓ)
D	=	phosphorus source/sink coefficient in Eq (7.22)

k1,c1	=	regression coefficients in Eq (7.23)
DQ	=	discharge quotient
Z	=	constant in Eq (7.24)
[TP]o	=	phosphorus concentration at distance 0 (μg/ℓ)
[TP]x	=	phosphorus concentration at distance x (μg/ℓ)
D2	=	phosphorus source/sink coefficient in Eq (7.26)
k2,c2	=	regression coefficients in Eq (7.26)

Phosphorus bed load model:

Ct	=	bed load concentration (mg/ℓ)
Ww	=	unit stream power
Wwc	=	critical value of Ww
vf	=	median fall velocity (m/s)
J,K	=	regression coefficients in Eq (7.27)
vc	=	critical velocity (m/s)
So	=	bed slope
Re,Rp	=	Reynolds Number
Qs	=	sediment discharge (g/s)
Ys	=	density of sediment
Qp	=	phosphorus discharge on bed material (g/s)

CHAPTER 8

MODEL APPLICATION

1 INTRODUCTION

In this chapter the phosphorus coupled hydrodynamic advective transport model for the Berg River will be used to examine a selection of phosphorus related problems. It must be emphasised that these problems are for the purpose of illustrating the use of the model; it should not be construed that these are issues under consideration by any agency controlling water resource development of the Berg River.

The problems can be stated briefly as follows:

- Misverstand Dam: What would be the phosphorus mass loading on a proposed impoundment at Misverstand?

- Phosphorus point source control: What reduction will be achieved in phosphorus exported by the Berg River to the proposed Misverstand Dam if the 1 mg/ℓ phosphate standard is implemented at the Paarl and Wellington wastewater treatment plants?

- Phosphorus nonpoint source control: What reduction in nonpoint source export to the main river channel can be achieved by constructing short residence time impoundments on the tributaries?

- <u>Pre-impoundments</u>: What reduction and control of the mass of phosphorus transported along the main river channel to the proposed Misverstand Dam can be achieved by construction of a pre-impoundment upstream of Misverstand?

- <u>Inter-catchment transfer</u>: What is the effect of a number of inter-catchment strategies on the phosphorus budget of the Berg River system?

- <u>Voëlvlei Dam</u>: If the Berg River should be utilized to augment the watér supply to Voëlvlei - What strategy must be followed to minimize the phosphorus load to Voëlvlei Dam from the Berg River supply?

2 PROGRAMS USED IN MODEL SIMULATIONS

A menu driven program called PCHAT (Phosphorus Coupled Hydrodynamic Advective Transport) incorporates all the models developed in this investigation, and some others. These are:

(1) QMODEL - The hydrodynamic flow model, to simulate the hydrographs at discrete points (stations) along the main river channel between Paarl and Drie Heuwels Weir.

(2) NPSM - Phosphorus nonpoint source model, to simulate the phosphorus chemograph associated with the hydrograph of each of the nonpoint sources along the main river channel.

(3) SECTION1 - Phosphorus channel transport model, simulating the rapid removal stage between Paarl and Lady Loch Bridge; the output is a phosphorus chemograph at Lady Loch Bridge.

(4) SECTION2 - Phosphorus channel transport model, simulating the slow removal stage between Lady Loch Bridge and Drie Heuwels Weir; the output are phosphorus chemographs at discrete points (stations) along the main river channel.

(5) LOADCALC - To calculate the phosphorus load from a phosphorus chemograph and its associated hydrograph at stations along the main river channel.

(6) DAMP - To simulate the influence of a pre-impoundment on the main river channel, on the downstream phosphorus budget. The input is the phosphorus chemograph and hydrograph for the station just upstream of the pre-impoundment site.

(7) ABSTRACT - To simulate the effect of abstraction from the headwaters of the Berg River (for inter-catchment transfer) on the hydrograph at Paarl (Station 9A).

(8) DURACV1 - To produce a duration/exceedance plot from a time series of phosphorus concentration, flow data or phosphorus load.

In using PCHAT it is assumed that the models 1 to 4 are calibrated for the Berg River (calibration of the flow model (1) is described in Chapter 6 and the transport models (2, 3, and 4) in Chapter 7). Description, documentation and listing of these programs are given in Appendix 2.

3 PHOSPHORUS LOAD ON MISVERSTAND DAM

To meet the anticipated demand for potable water in the Atlantis-Saldanha region, a dam site may be considered on the main river channel of the Berg River at, or near, Misverstand weir. For such a dam, to assess its eutrophication potential, it is necessary to know the (1) mass of phosphorus that would enter the impoundment, (2) the influence of the 1 mg/ℓ phosphorus effluent standard on the mass of phosphorus that would enter the impoundment. It is assumed that the mass of phosphorus exported at Drie Heuwels Weir, just upstream of the Misverstand site will be adequate to make such an assessment (it omits the influence of the Matjies River).

3.1 Quantification of point and nonpoint sources

To quantify the sources of phosphorus entering the main river channel, upstream of Drie Heuwels Weir, the following simulation sequence was followed:

(1) Program NPSM simulates the mass of phosphorus exported from nonpoint sources entering the main river channel upstream of Drie Heuwels Weir; this includes the phosphorus in the Berg River at Station 9A as this phosphorus load also is derived from a nonpoint source.

(2) Program LOADCALC calculates the mass of phosphorus from Paarl and Wellington Sewage works. Inputs are a chemograph and hydrograph established manually from the measured flow and discrete phosphorus measurements.

These two programs will give the nonpoint source contributions for each 180-day period to each of the sub-reaches shown in Fig 7.31, as well as the contribution from Paarl and Wellington wastewater treatment plants for each 180-day period. The simulated annual total input above Drie Heuwels Weir for the point and nonpoint sources are shown in Tables 8.1.

In Table 8.2 the annual mass contributions are split into two periods of 180-days, comprising the respective dry and wet periods.

From Table 8.1, over the period 1983 to 1986, nonpoint sources contribute 322 tons of phosphorus and point sources 68 tons a total of 390 tons; point sources made-up only 18 percent of the phosphorus input.

Table 8.1 Annual mass inputs of phosphorus from point and nonpoint sources to the main river channel above Drie Heuwels Weir, for Periods 1 to 6 (loads given in tons of phosphorus).

Sources:		Mass of phosphorus:			
	Periods:-	1 & 2	3 & 4	5 & 6	Total
Point-	Paarl	18.42	17.93	12.69	
	Wellington	5.23	5.79	7.67	
Total point input:		23.65	23.74	20.36	68
Total nonpoint input:		95.04	129.45	98.34	322
Total:		118.69	153.19	118.70	390

From Table 8.2, during the dry summer periods (Periods 1, 3 and 5) there are minimal nonpoint contributions and the contribution of phosphorus from point sources ranges up to 77 percent of the total mass input to the river (Table 8.2). However, during the wet winter periods (Periods 2, 4 and 6), point sources contribute between 12 and 21 percent of the total input to the river channel, the balance being contributed by nonpoint source runoff, 79 to 88 percent.

Table 8.2 Determination of the phosphorus input loading to the main river channel upstream of Drie Heuwels Weir during summer (low flow) periods (1, 3 and 5) and winter (high flow) periods (2, 4 and 6).

Mass loading of phosphorus (tons):

Period :	Nonpoint source: A	Point source B	Percentage input from point sources (B/A+B)*100
Summer periods:			
1	37.23	7.85	17%
3	6.61	9.57	59%
5	2.26	7.66	77%
Winter periods:			
2	57.81	15.80	21%
4	122.84	14.17	12%
6	96.07	12.70	12%

3.2 Removal and remobilization of phosphorus

It is now of interest to enquire what fraction of the phosphorus input to the main river channel is exported at Drie Heuwels Weir. The mass of phosphorus retained in the river channel is given by

$$MR = MI - MO \qquad \ldots\ldots \quad (8.1)$$

where

MR = mass of phosphorus retained between North Paarl and Drie Heuwels Weir,

MI = total mass of phosphorus input to the river channel,

MO = total mass of phosphorus output from the river channel at Drie Heuwels weir

Values for MI in Eq (8.1) are shown in Table 8.2. To calculate the term MO at Drie Heuwels Weir, the hydrographs first must be simulated at each station along the main river channel; this requires the model QMODEL (details of this model have already been given in Chapter 6). Having simulated the hydrograph, the model SECTION1 will simulate the chemograph at Lady Loch Bridge, and model SECTION2 the chemographs at all stations along the main river channel from Lady Loch Bridge to Drie Heuwels Weir. These two models inter alia incorporate the nonpoint source model.

From Eq (8.1), the mass of phosphorus retained within the river channel between Paarl and Drie Heuwels Weir is calculated and shown in Table 8.3.

Table 8.3 Quantification of phosphorus sinks between Paarl and Drie Heuwels Weir (mass of phosphorus given in tons per 180 day period)

	Mass of P input to the river (MI)	Mass of P exported at Drie Heuwels (MO)	Mass of P retained in channel (MR)	Percentage of input retained MR/MI*100
Period:				
1	45.08	37.94	7.14	16%
2	73.61	70.40	3.21	4%
3	16.18	10.51	5.67	35%
4	137.01	125.00	12.01	8%
5	9.94	4.40	5.54	55%
6	108.77	97.50	11.27	10%
Total	390.59	345.75	44.84	11%

From the data in Table 8.3, we can derive the following information:

(1) During the summer low flow conditions (Periods 1, 3 and 5) phosphorus removal processes are dominant in the main river channel; between 5 and 7 tons of phosphorus appear to be retained within the river channel sediments, comprising 16 to 55 percent of the phosphorus load input to the main river channel.

(2) During the winter flow conditions (Periods 2, 4 and 6) the model still predicts a net removal of phosphorus of between 7 and 12 tons but this only constitutes between 4 and 10 percent of the mass input load.

(3) Over a period of three years, 390 tons of phosphorus were input to the river channel between Paarl and Drie Heuwels Weir, and 345 tons exported at Drie Heuwels i.e. a loss of 45 tons, or 11 percent of the mass input. The following comments are relevant:

(i) Keup (1968) concluded that there is no long term loss of phosphorus during transport along the river channel, only a distribution associated with retention and remobilization of phosphorus, dependent on the flow regime.

(ii) The net loss of 10 percent determined via the simulation is probably within the range of accuracy of the model - so that no definitive statement as to the losses in the channel can be made. However it would seem that, in the Berg River, virtually all the phosphorus entering the channel will be exported. During the low flow summer period there is positive evidence of removal but this is temporary - during winter high flow and storm events, remobilization of the stored material takes place.

3.3 Phosphorus Export pattern

To illustrate the phosphorus export pattern, the phosphorus loadograph can be calculated from the hydrograph and chemograph at Drie Heuwels Weir, and the cumulative loadograph plotted. In Fig 8.1(a) the hydrograph and chemograph are shown for the dry and wet sequence, Periods 5 and 6. In Fig 8.1(b) the loadograph is shown, and in Fig 8.1(c) the cumulative loadograph. Clearly the loadograph shows extreme spikiness. This is reflected in

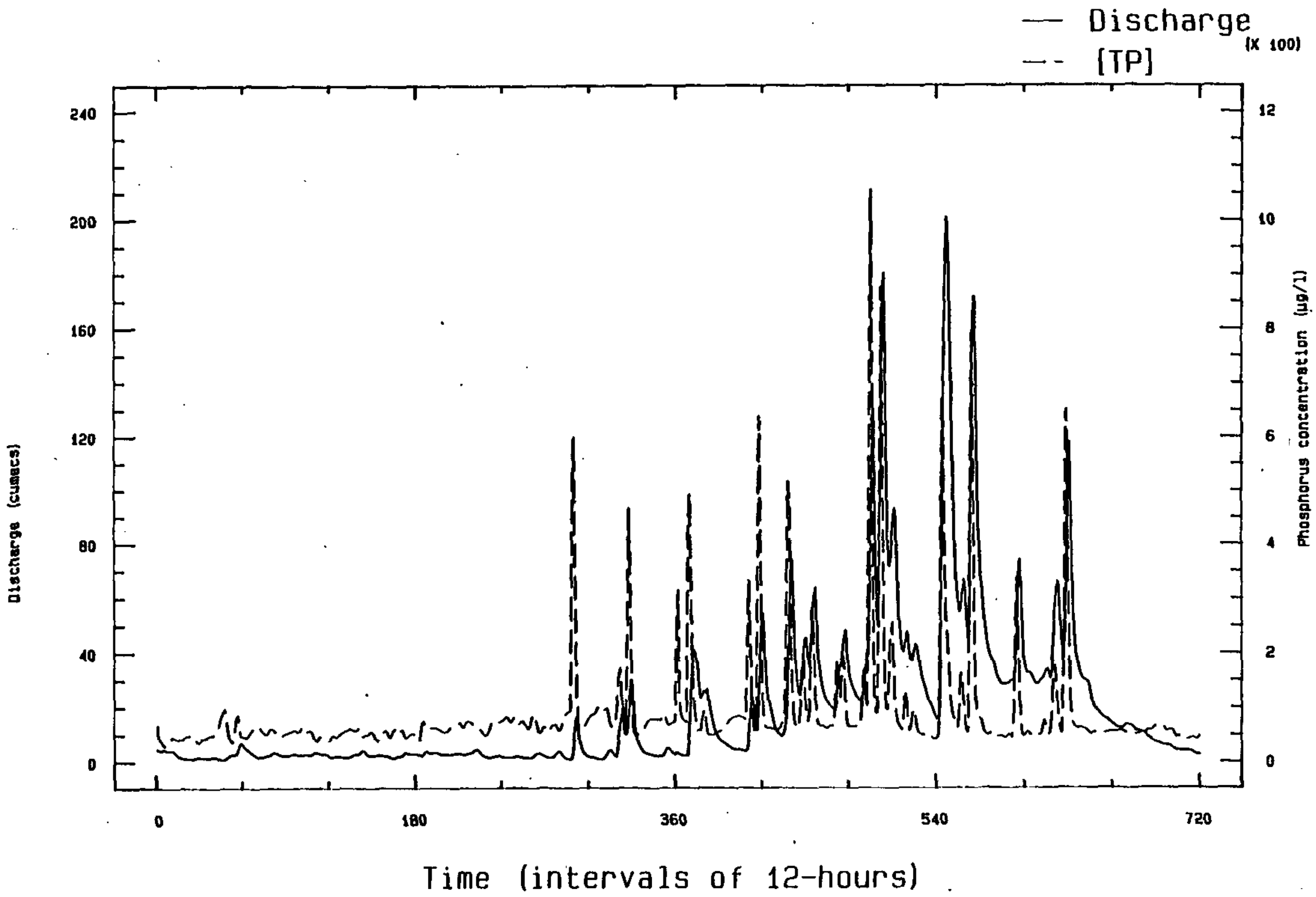

Fig 8.1(a). Hydrograph and phosphorus chemograph at Drie Heuwels Weir simulated using the hydrodynamic flow model and phosphorus transport model respectively - Periods 5 and 6.

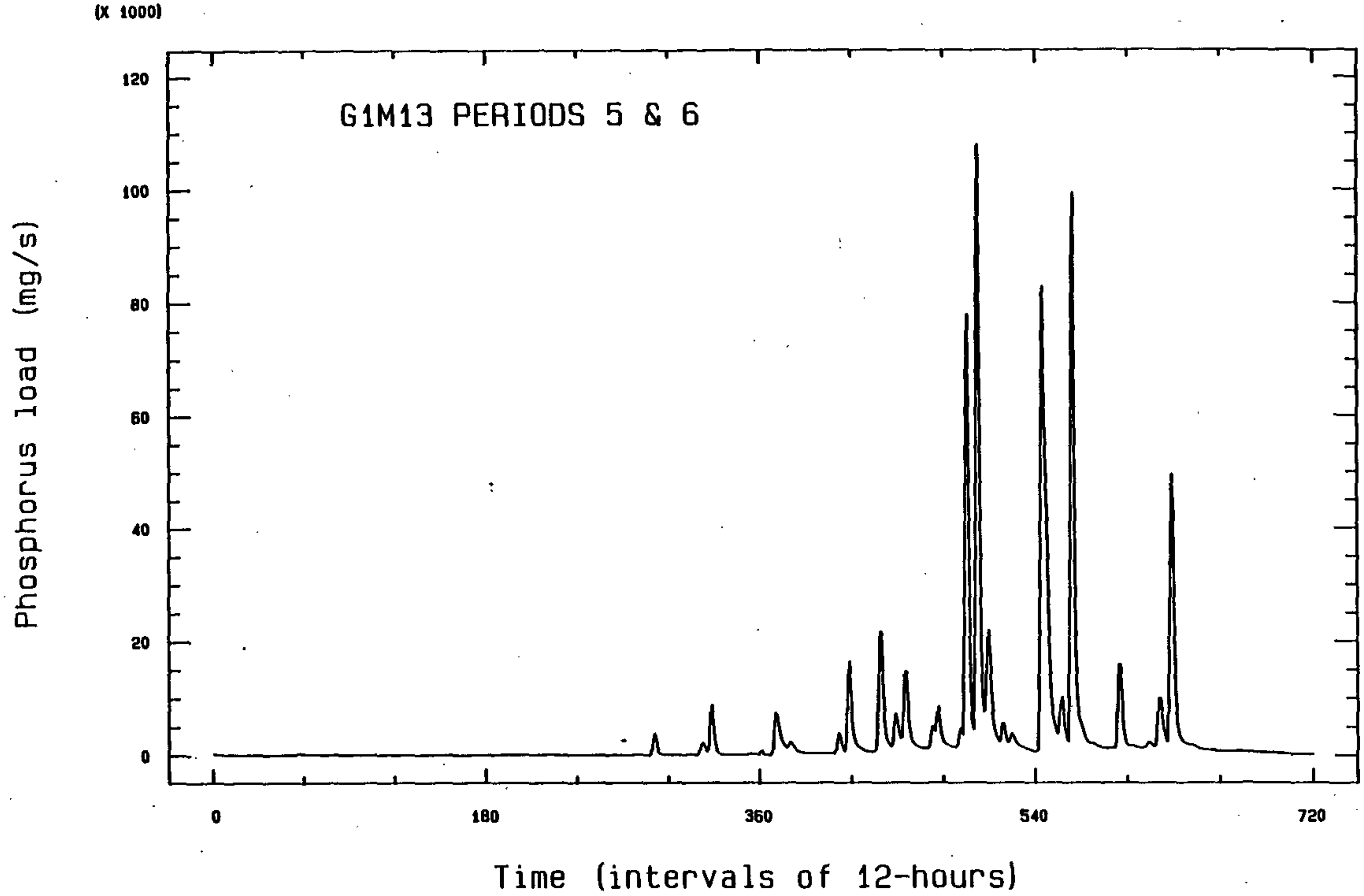

Fig 8.1(b). Phosphorus loadograph at Drie Heuwels Weir calculated from the chemograph and hydrograph shown in Fig 8.1(a) - Periods 5 and 6.

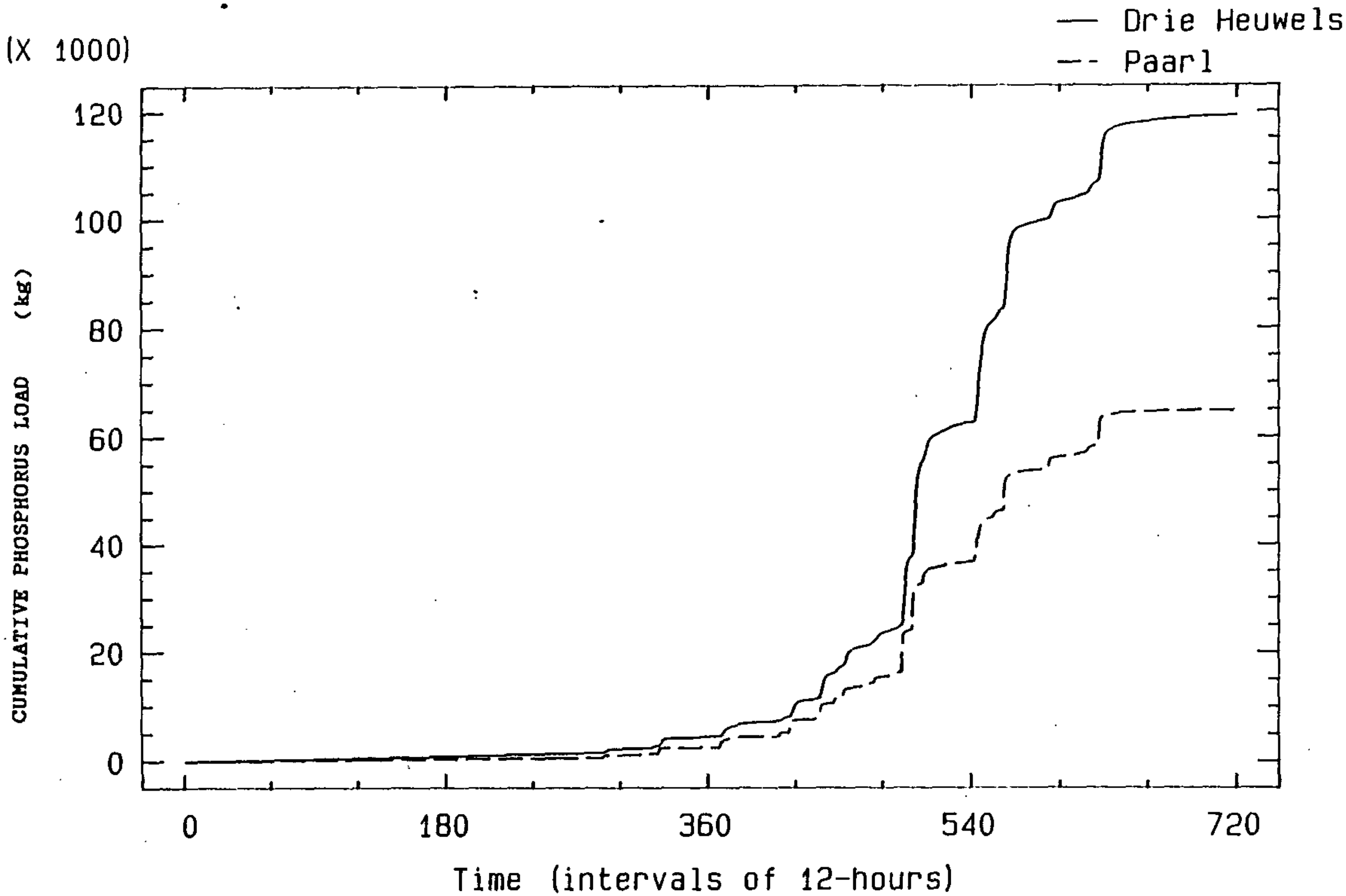

Fig 8.1(c). Cumulative phosphorus loadograph at Drie Heuwels Weir calculated from the loadograph shown in Fig 8.1(b). - Periods 5 and 6.

the cumulative loadograph by sharp vertical rises over each flood event with relatively flat horizontal regions between the flood times. A rough calculation of the mass of phosphorus transport during the flood events indicated that over the 3 year period about 80 percent of the phosphorus was exported during floods, yet the flood events occupied only about 3 percent of the total period. Indeed one is forced to the conclusion that the phosphorus mass export by the Berg River is, (1) completely dominated by flood events which, (2) has its origins totally from nonpoint sources with, (3) point source inputs of relatively minor importance.

3.4 Implementation of 1 mg/l Point Source Control

We will now estimate the influence that compliance with the 1 mg/ℓ phosphate standard would have on the phosphorus budget of the Berg River. The following estimation sequence was followed:

(1) The flow model (QMODEL) predicts the river discharge at each station on the main river channel, for Periods 1 to 6;

(2) The program SECTION1 predicts the phosphorus chemograph at Lady Loch Bridge, assuming the phosphorus concentration of the effluent complies with the 1 mg/ℓ ortho-phosphate standard for 100 percent of the time.

To predict the total phosphorus concentration of the effluent when the works discharge an effluent containing 1 mg/ℓ of ortho-phosphate the following method was used:

- With both sewage works effluents, the total phosphorus concentration was determined from the ratio ortho-phosphate : total phosphorus when the effluent complies with the 1 mg/ℓ ortho-phosphate (as P) standard. For the Paarl effluent, the ortho/total phosphorus ratio ranges from 1:1.16 to 1:1.47, with a median value of 1:1.33. Consequently, compliance with the standard will result in the effluent having a median total phosphorus concentration of 1.3 mg/ℓ. For Wellington sewage effluent, the ortho/total phosphorus ratio lies in the range 1:1.01 to 1:1.25, with a median value of 1:1.12. Compliance will result in a predicted total phosphorus effluent concentration of 1.12 mg/ℓ.

(3) The program SECTION1 uses the effluent concentrations specified above in the mass balance model to generate the phosphorus chemograph at Lady Loch Bridge.

(4) The program SECTION2 uses the upstream chemograph for Lady Loch Bridge to predict the phosphorus chemograph at Drie Heuwels Weir.

In Fig 8.2(a), two simulated chemographs for Drie Heuwels Weir are shown for high flow Period 2, one chemograph represents river conditions without effluent compliance and the second represents the river conditions with effluent compliance. In Fig 8.2(b) is shown the associated phosphorus loadographs.

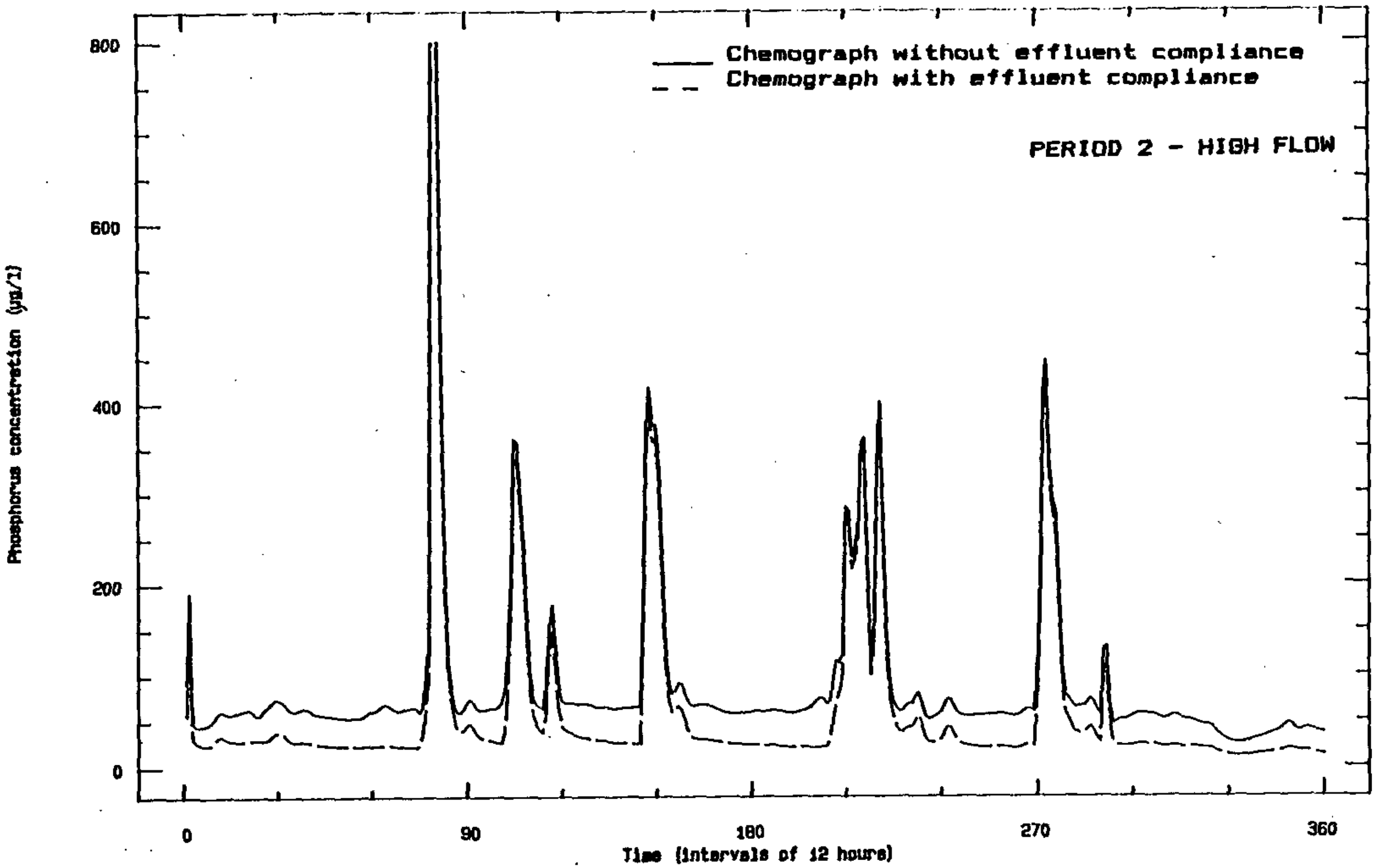

Fig 8.2(a). Simulated phosphorus chemographs for Drie Heuwels Weir during conditions of compliance (broken line) and non-compliance (solid line) with the 1 mg/l phosphate standard for effluents - Period 2.

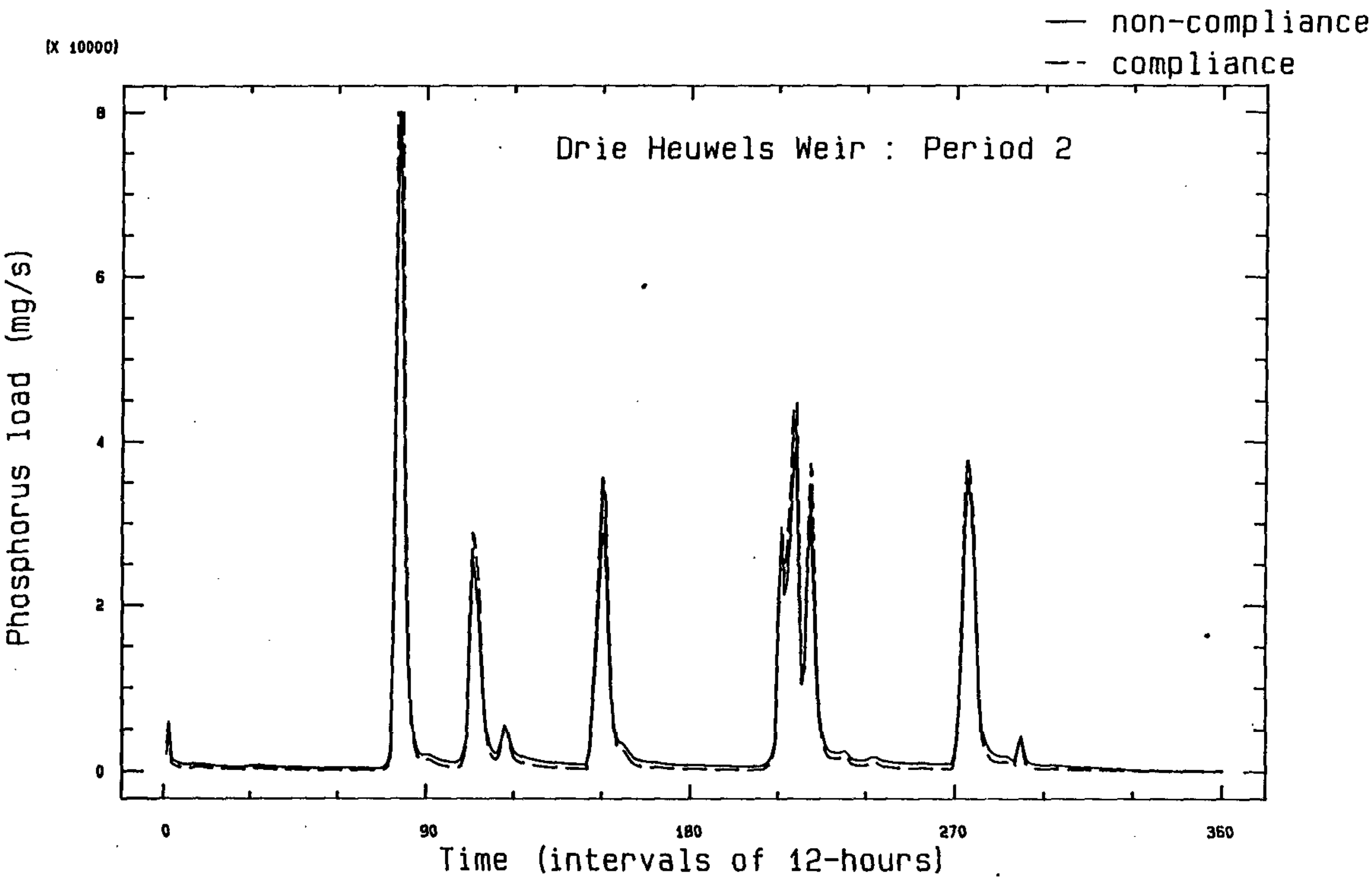

Fig 8.2(b). Simulated phosphorus loadographs for Drie Heuwels Weir during conditions of compliance (broken line) and non-compliance (solid line) with the 1 mg/l phosphate standard for effluents - Period 2.

The loadographs provide little information, however, a concentration duration-exceedance diagram (Fig 8.2(c)) allows perhaps a better assessment of the effect of the implementation of the 1 mg/ℓ P standard than the chemographs shown in Fig 8.2(a). From Fig 8.2(c), it is predicted that implementation of the 1 mg/ℓ P effluent standard will reduce the total phosphorus concentration at Drie Heuwels Weir by a factor of 50 percent for 75 percent of the time (during Period 2). However, during flood events the standard will have negligible influence on the chemograph at Drie Heuwels Weir.

In Figs 8.3 to 8.6 the concentration duration curves are presented for Periods 3, 4, 5 and 6, respectively. During winter high flow periods, it is predicted that the phosphate standard will cause a 50 percent reduction in the phosphorus concentration at Drie Heuwels weir for 70 percent of the time, shifting to 90 percent during the summer low flow conditions, that is, the standard has greatest influence on the phosphorus load at Drie Heuwels Weir during periods of low flow, when nonpoint sources have been shown to have a minimal input to the river channel.

In Table 8.4 the phosphorus loads for point and nonpoint sources entering the main river channel are shown for the 6 data periods for compliance and non-compliance with the 1 mg/ℓ phosphate standard. It is predicted that the compliance will have the following effects:

(1) Over a three year period the input phosphorus load on the Berg River will be reduced by 46 tons, a 12 percent reduction of the total phosphorus load.

(2) During the three year summer periods the phosphorus point source load will be reduced from 25 to 9 tons, a reduction of 16 tons, or 65 percent. During the winter periods, the phosphorus point source load will be reduced from 42 to 13 tons, a reduction 29 tons, or 68 percent.

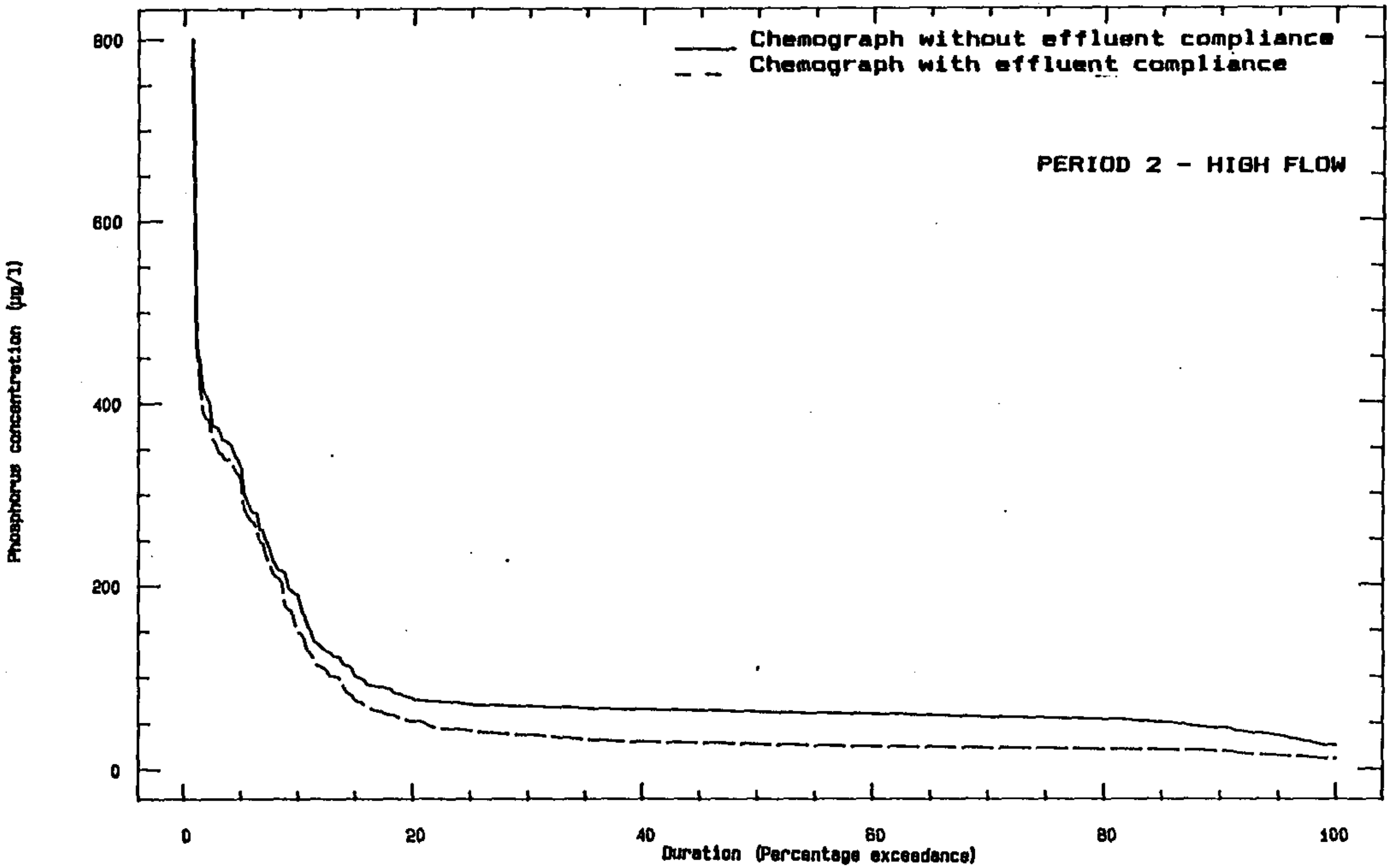

Fig 8.2(c). Duration-exceedance curves for the phosphorus chemographs at Drie Heuwels Weir (see Fig 8.2a) with and without compliance with the 1 mg/l phosphate standard for effluents - Period 2. The non-compliance conditions are shown with the solid line and the compliance conditions with the broken line.

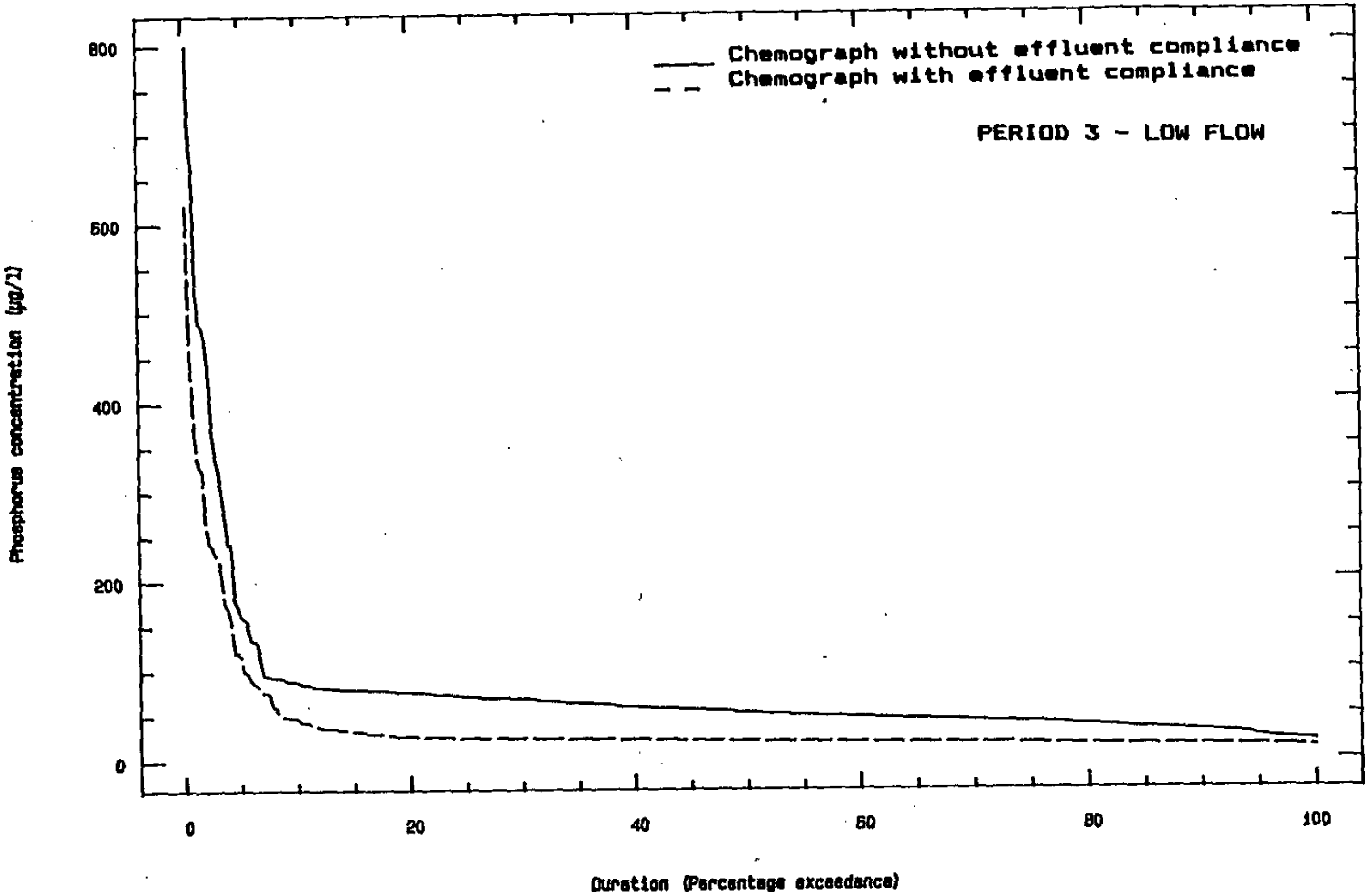

Fig 8.3. Duration-exceedance curves for the phosphorus chemographs at Drie Heuwels Weir (Period 3) with and without compliance with the 1 mg/l phosphate standard for effluents. The non-compliance conditions are shown with the solid line and the compliance conditions with the broken line.

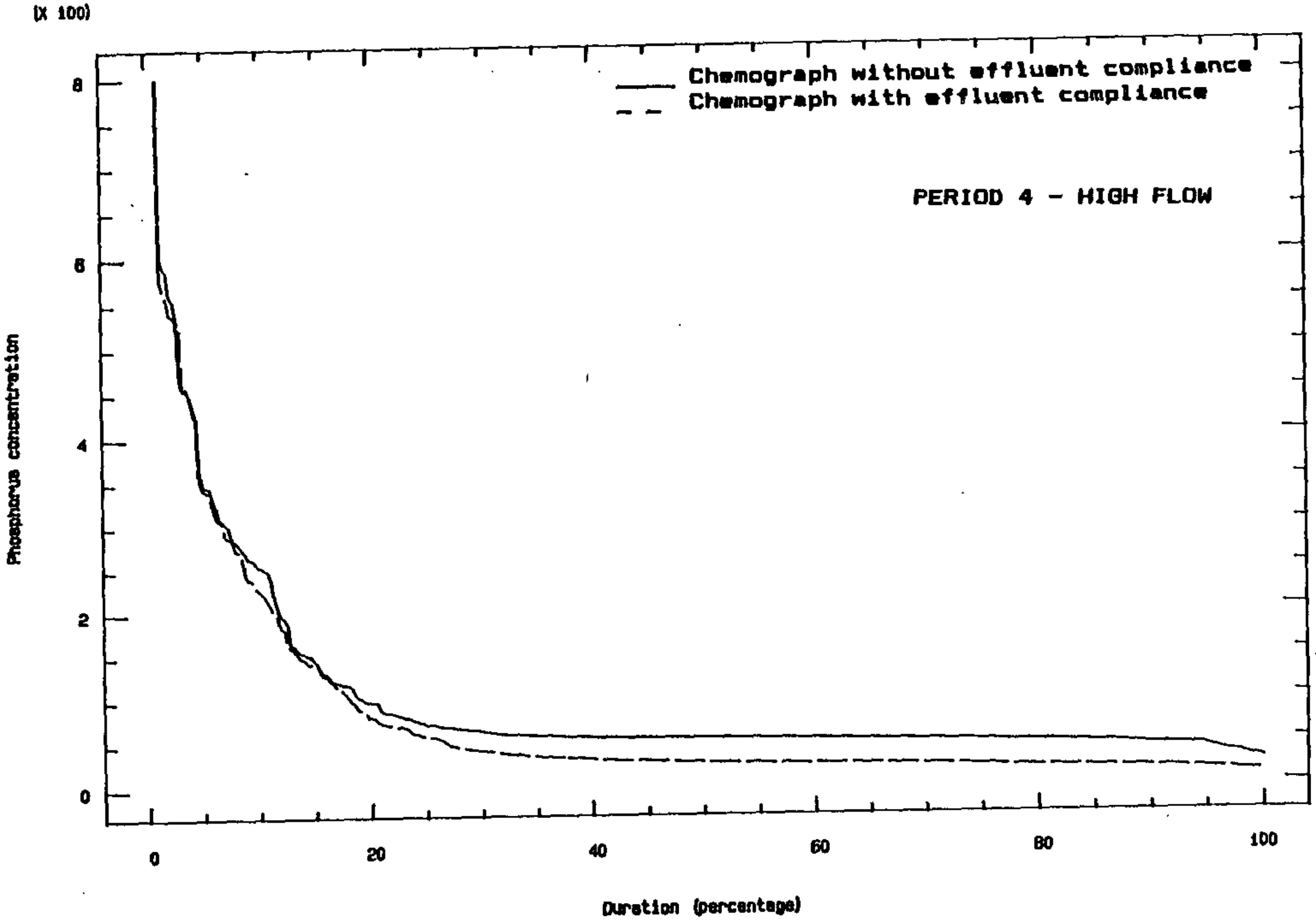

Fig 8.4. Duration-exceedance curves for the phosphorus chemographs at Drie Heuwels Weir (Period 4) with and without compliance with the 1 mg/l phosphate standard for effluents. The non-compliance conditions are shown with the solid line and the compliance conditions with the broken line.

8.20

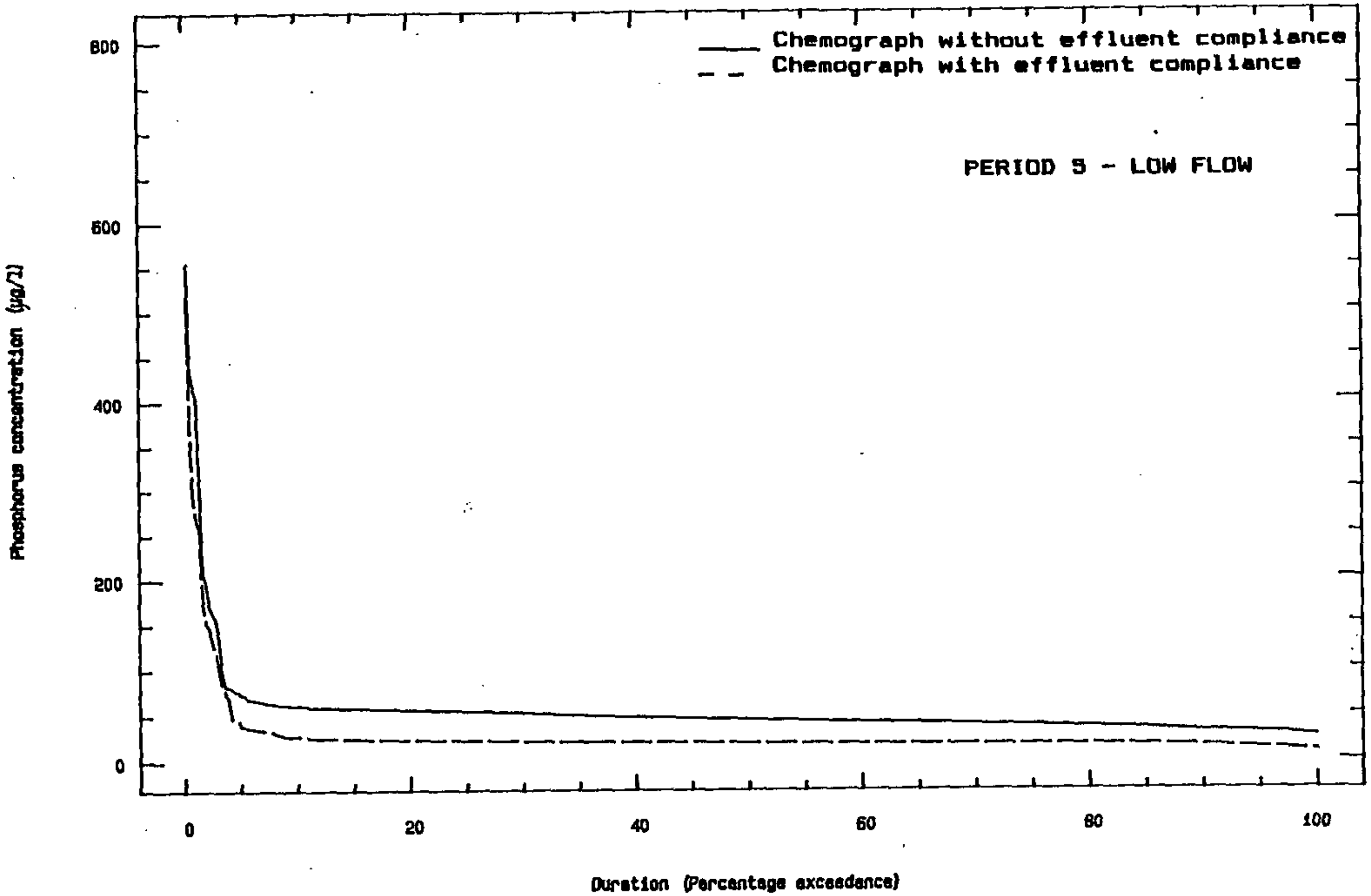

Fig 8.5. Duration-exceedance curves for the phosphorus chemographs at Drie Heuwels Weir (Period 5) with and without compliance with the 1 mg/l phosphate standard for effluents. The non-compliance conditions are shown with the solid line and the compliance conditions with the broken line.

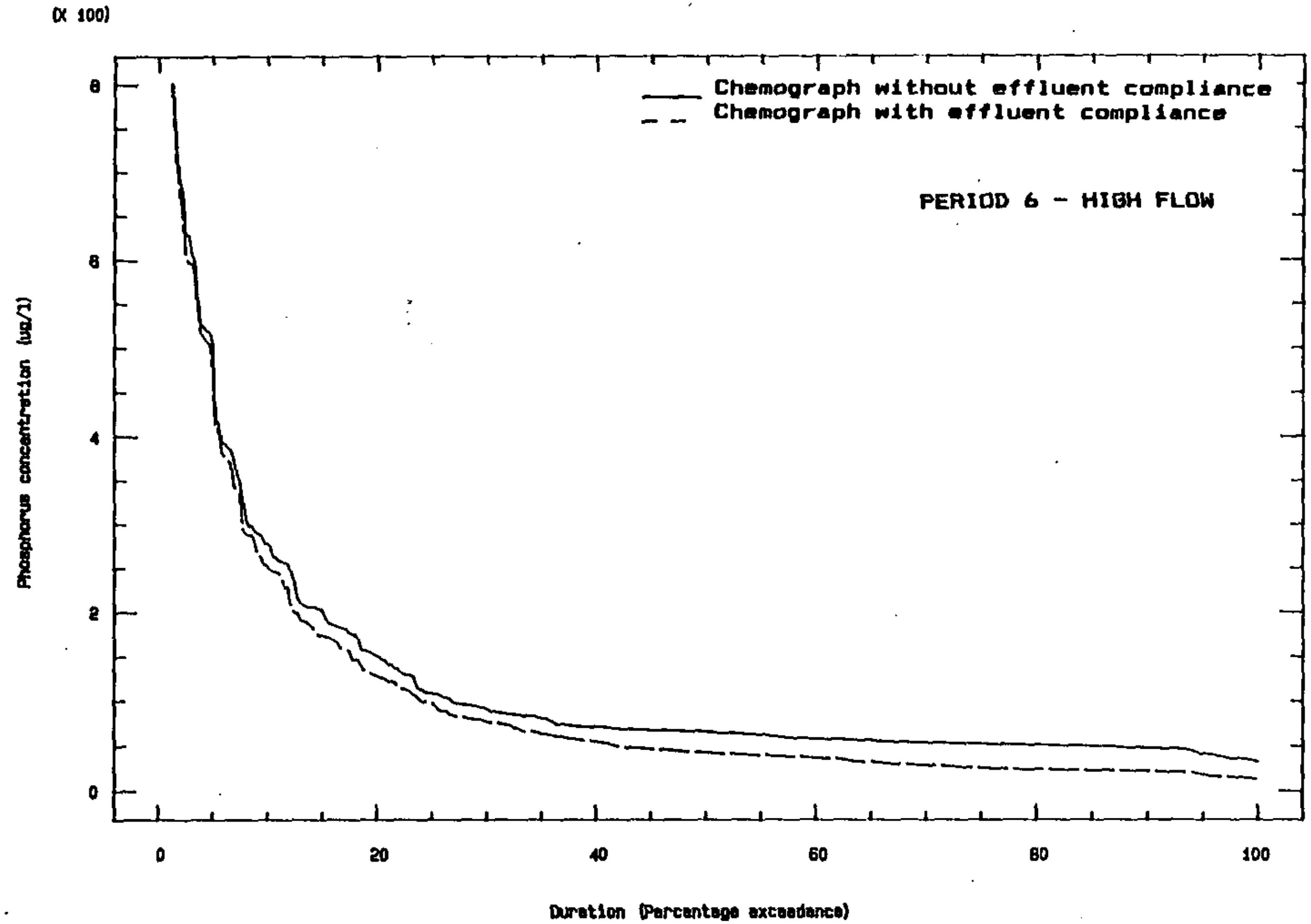

Fig 8.6. Duration-exceedance curves for the phosphorus chemographs at Drie Heuwels Weir (Period 6) with and without compliance with the 1 mg/l phosphate standard for effluents. The non-compliance conditions are shown with the solid line and the compliance conditions with the broken line.

The total annual phosphorus export data (shown in Table 8.4) could be used to estimate the trophic status of a proposed impoundment at Misverstand by means of existing phosphorus load-eutrophication response models (Grobler and Silberbauer, 1984; Grobler, 1985). To determine the seasonal implications of the phosphorus loads as demonstrated above, a dynamic impoundment model would be required. No such model is available, yet one can appreciate that the seasonal phosphorus input must emphasize the need for estimating the dynamic changes in algal biomass from the dynamic input phosphorus loads.

Table 8.4 Determination of the influence of the 1 mg/ℓ phosphate standard on the phosphorus input load to the main river channel.

	Phosphorus loading (tons)				
Period:	Nonpoint source A	Point source B	Point source (compliance) C	Percentage reduction in point source loading (B-C)/B (%)	Percentage reduction in total loading (B-C)/(A+B) (%)
1	37.23	7.85	2.86	64%	11%
2	57.81	15.80	4.41	72%	16%
3	6.61	9.57	3.08	68%	40%
4	122.84	14.17	4.07	71%	7%
5	2.27	7.66	2.90	62%	48%
6	96.07	12.67	4.50	65%	8%
Total:	322.83	67.72	21.82	68%	12%

4 PHOSPHORUS NONPOINT SOURCE CONTROL

From a previous section it has been estimated that approximately 80 percent of the total phosphorus load input to the Berg River is derived from nonpoint sources. Consequently, control of nonpoint sources could result in a substantial reduction in the phosphorus input to the Berg River - if a suitable method could be developed.

The findings of this investigation would indicate that nonpoint source phosphorus is primarily due to surface runoff, with interflow and baseflow delivering only a relatively small proportion of the total nonpoint phosphorus load (see Chapter 7 - Section 2). Consequently, reduction of the total load entering the main river channel from nonpoint sources would be achieved by (1) reducing the phosphorus concentration in the surface runoff itself, and (2) removing some of the phosphorus from the runoff before it reaches the main river channel.

(1) Indirectly, in the Berg River catchment, there are schemes that contribute to controlling phosphorus in surface runoff - incentive schemes for farmers to improve and upgrade agricultural land use, see Chapter 2. In what measure these are, or can be, successful would in itself form the basis for a full scale investigation; it certainly merits consideration, particularly in the Berg River catchment with its extensive and intensive agricultural land use.

(2) Phosphorus can be removed in some measure by separating out the surface runoff component of the flood hydrograph, by suitably operating short retention time storage structures constructed in the flow path of tributaries - termed retention weirs. A retention weir operates by:

(i) Storing the surface runoff for sufficient time to allow particulate phosphorus to settle-out of the water column onto the base of the weir (Maret, Parker and Fannin, 1987; Benndorf and Putz, 1987).

(ii) During baseflow, the tributary flow by-passes the retention weir and enters the river (represented by Example "A" in Fig 8.7).

(iii) During a storm flow, the beginning of the storm water (surface runoff) is contained in the retention-weir (represented by Example "B" in Fig 8.7). Once the weir is full the flow is diverted around the weir to the river (represented by Example "C" in Fig 8.7).

To assess the effect of retention weirs on the nonpoint source contribution in the tributaries entering the main river channel simulation is given by model SECTION2. The sedimentation rate for particulate phosphorus in the pond behind the retention weir is unknown; it is dependent on the mean depth, residence time, biotic assimilation, deposition rate of particulate material, wind stress and the precipitation chemistry of the water (Maret, Parker and Fannin, 1987; Benndorf and Putz, 1987). These processes are not quantifiable with the existing data set; for our purposes we have to make an assumption: the rate of change of phosphorus concentration in the retention weir is equal to the product of a coefficient and the input phosphorus concentration (Chen and Wells, 1976). The following modifications required to be made to the program SECTION2:

(1) The nonpoint source model subroutines are modified so that a proportion of the phosphorus in the runoff is retained at the retention weir. It is assumed that the retention weirs retain between 30 and 50 percent of the inflowing phosphorus load. The model is run twice, using sedimentation retention of 30 and 50 percent.

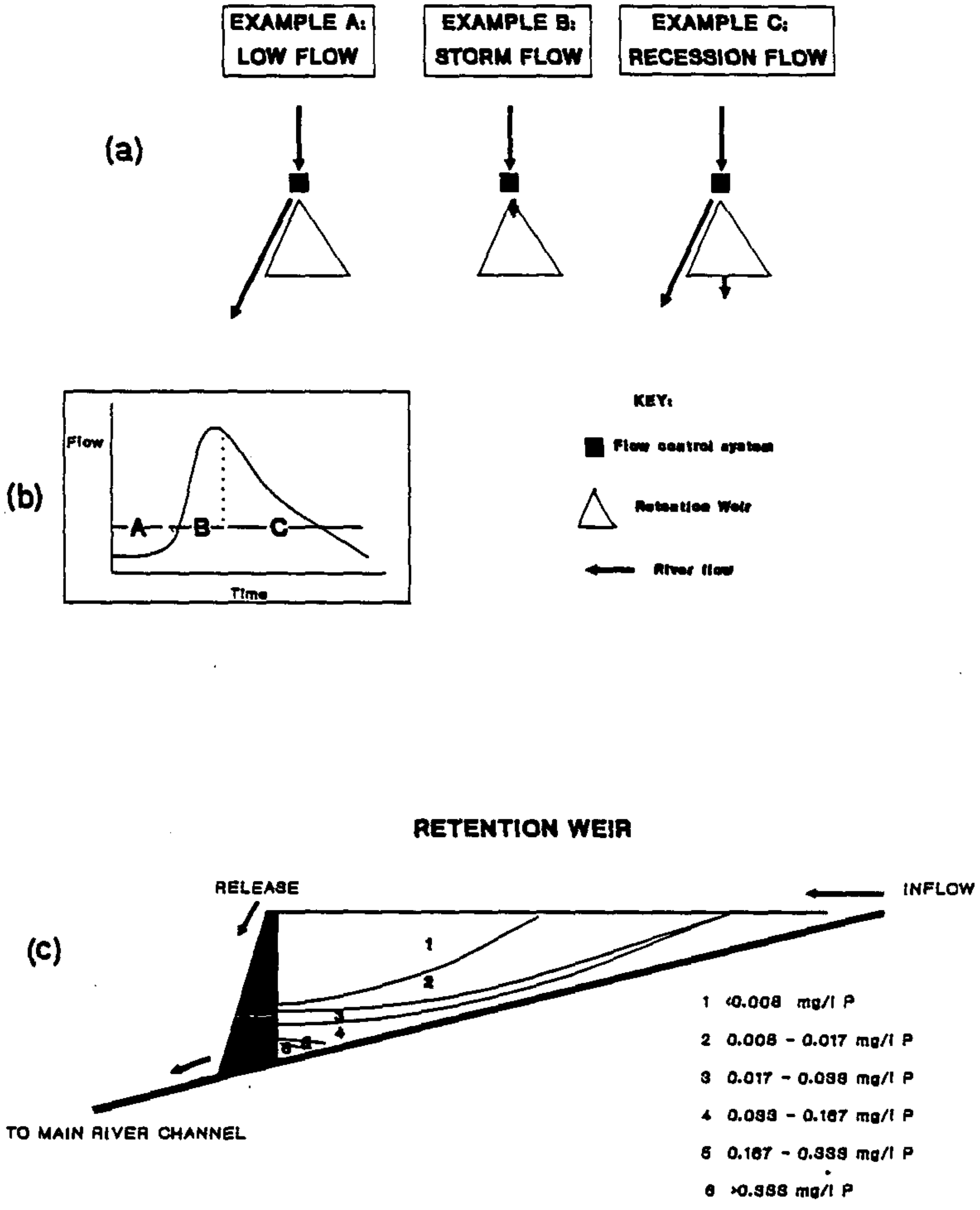

Fig 8.7. Schematic diagram showing the structure and function of retention weirs. (a) Example of the operation of the weirs during a single flood event. (b) Typical flood hydrograph showing the diversion of river water into the weir depending on the flow conditions. (c) Typical resultant ortho-phosphate distribution in the retention weir (from Bendorf and Putz, 1987, slightly altered).

(2) It is assumed that the sedimentation remains constant throughout the simulation exercise.

(3) For modelling purposes it is assumed that a retention weir is constructed in the flow path of each tributary joining the main river channel between Paarl and Drie Heuwels Weir.

In the first simulation, the sedimentation rate of the retention weir is set at 30 percent and the results shown in Table 8.5. The retention weirs cause between 4 and 16 percent reduction in the phosphorus loading at Drie Heuwels Weir, which amounts to a total load reduction, over the three year period, of 43 tons of phosphorus, that is, 11 percent.

Table 8.5 Influence of retention weirs on the control of phosphorus exported from nonpoint sources, for sedimentation set at 30 and 50 percent in the retention weir.

Period	Mass of P from nonpoint source	Mass of P export from weir		Percentage reduction	
		(30%)	(50%)	(30%)	(50%)
1	37.23	31.17	27.13	16%	27%
2	57.81	50.83	46.17	12%	20%
3	6.61	6.31	6.12	5%	7%
4	122.84	103.72	90.98	15%	26%
5	2.27	2.19	2.13	4%	6%
6	96.07	85.14	77.86	11%	19%
Total:	322.83	279.36	250.39	13%	22%

In the second simulation exercise, the sedimentation rate is set at 50 percent resulting in a total load reduction of 72 tons, that is 18 percent.

From the calculations above it would seem that the installation of retention weirs on the tributaries in the reach Paarl to Drie Heuwels Weir result in a relatively small reduction in the total phosphorus load. The reason for this is that about 55 percent of the phosphorus derived from nonpoint sources is exported from the upper catchment of the Berg River (south of Paarl, upstream of Station 9A). The mass of phosphorus exported from this area is derived from a number of tributaries, each of which also should have a retention weir installed. Should this be done, a substantial reduction in the nonpoint source load can be expected.

In hindsight it is now apparent that the water quality and hydrology of the Berg River upstream of Paarl also should have been monitored to the same intensity as the reach between Paarl and Drie Heuwels Weir. However, at the time the monitoring program was devised, the opinion was well established that point sources (in this case Paarl and Wellington wastewater discharges) were the prime contributors of phosphorus. As a result the reach upstream of Paarl was discounted as of little importance. The investigation now has shown that it is of major account. However, with the knowledge gained on monitoring strategy, this omission can be rectified readily in the future.

5 PRE-IMPOUNDMENTS

Short residence time storage structures (pre-impoundments) constructed on the river channel upstream of a large storage impoundment are reported to retain nitrogen and phosphorus (Benndorf and Putz, 1987). Twinch and Grobler (1986) studied a number of mathematical models to investigate the feasibility of a pre-impoundment to reduce the phosphorus loading to the hypertrophic Hartbeespoort Dam, located in the Transvaal (South Africa). They concluded that the construction of a pre-impoundment of 12.8 million cubic metres would reduce the phosphorus input load by between 24 to 55 percent. However, they were of the opinion that even with pre-impoundment and reduction in the phosphorus concentration of the effluents due to the imposition of the standard, the increases in future flow will be such that the phosphorus level will again rise to its present level.

Using the approach of Twinch and Grobler (1986) a simulation exercise was conducted to predict the effect of a pre-impoundment at Drie Heuwels Weir in controlling the phosphorus load on the dam at Misverstand, see Fig 8.8.

Twinch and Grobler (1986) report that the mean phosphorus concentration of water in the impoundment may be determined from

$$P = W / (Q + s V) \qquad \ldots\ldots \quad (8.2)$$

where

P = mean phosphorus concentration in impoundment (mg/ℓ),
Q = inflow (million cubic metres per unit time),
s = sedimentation rate (per unit time),
V = volume of impoundment (million cubic metres),
W = phosphorus input load (kg per unit time).

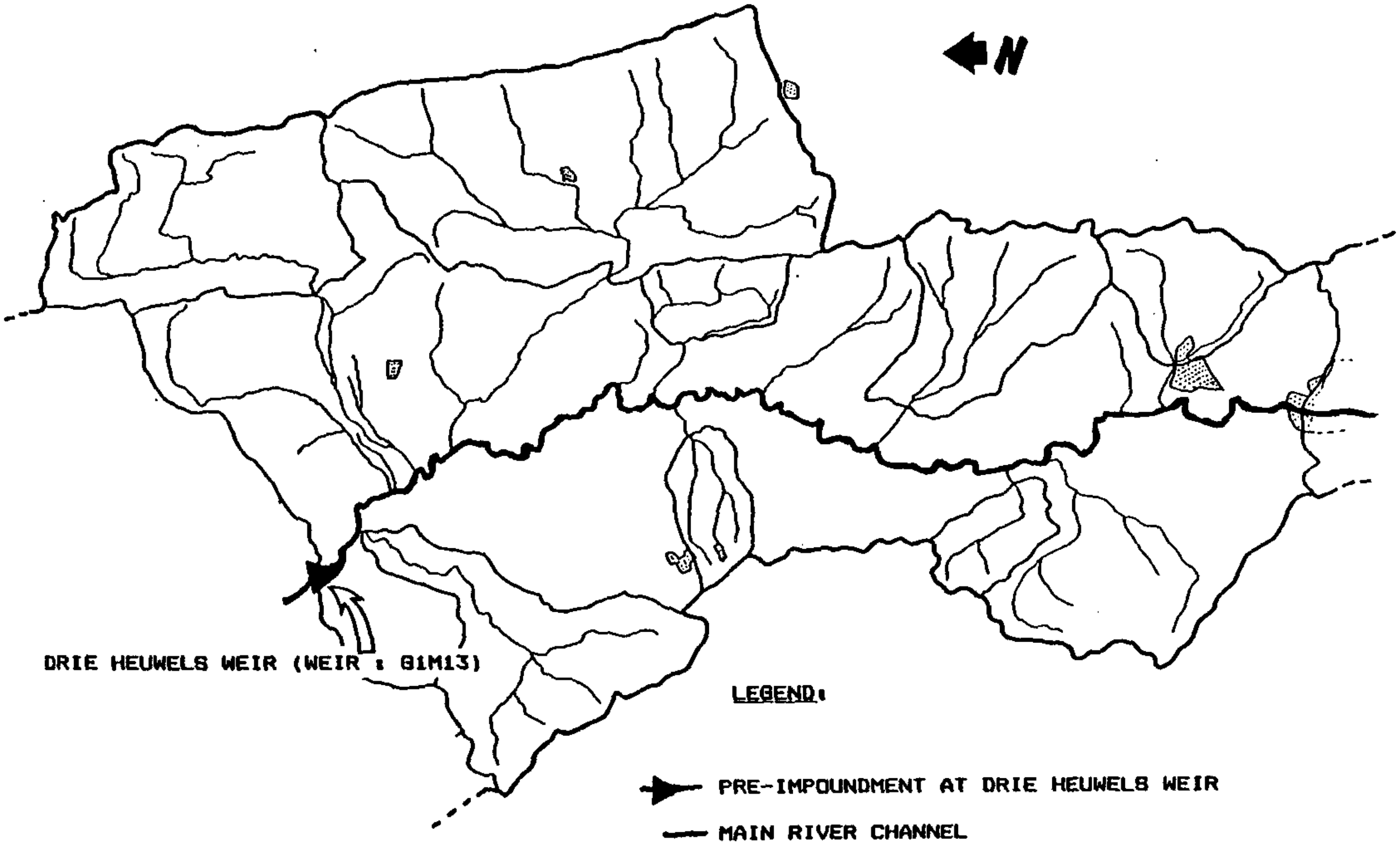

Fig 8.8. Location of hypothetical pre-impoundment at Drie Heuwels Weir.

Grobler (1985) proposes that the in-lake phosphorus *sedimentation* rate is a function of the phosphorus concentration,

$$s = K\ P^2 \qquad \ldots\ldots \quad (8.3)$$

where

K is the parameter calibrated for Hartbeespoort Dam as 0.000023 (phosphorus concentration is given as μg/ℓ).

Assuming the inflow and outflow rates are equal and the water level in the pre-impoundment remains constant, the phosphorus load leaving the pre-impoundment is given by PQ. The proportion retained in the pre-impoundment is calculated from (W-PQ).

Twinch and Grobler (1986) state that Eqs (8.2 and 8.3) have not been validated for short residence-time waterbodies but provide first estimates of the phosphorus retention in pre-impoundments.

Equations (8.2 and 8.3) were used in the program DAMP (see Appendix 2), to estimate the influence of a pre-impoundment at Drie Heuwels Weir on the downstream phosphorus budget (see Fig 8.8). In the simulation exercise two volumes of pre-impoundment were investigated, namely 10 and 30 million cubic metre. The following method was used:

(1) Programs QMODEL and SECTION2 generate a time series of river discharge and phosphorus concentration for Drie Heuwels Weir extending from 1983 to 1986.

(2) The time series generated in (1) are input to the program DAMP, to simulate the sedimentation of phosphorus within the pre-impoundment.

In Table 8.6 the results of the simulation exercises are shown. It is predicted that a pre-impoundment at Drie Heuwels Weir will cause a phosphorus load reduction of between 5 and 19 percent for a 10 million cubic meter waterbody and by 12 and 34 percent for a 30 million cubic meter waterbody.

It was shown earlier that implementation of the phosphorus standard causes a reduction in the chemograph at Drie Heuwels Weir (see Fig 8.1); the hydrographs and chemographs were used in the model DAMP to predict the effect of pre-impoundments on phosphorus during the period of effluent compliance, see Table 8.7. The pre-impoundment removes 61 tons of phosphorus in 3 years. Comparing the simulated loads in Tables 8.6 and 8.7 it is evident that the pre-impoundment is less efficient at retaining phosphorus when the input phosphorus concentration is reduced, a situation that arises with phosphorus removal at the wastewater treatment works.

Due to the high suspended total solids concentration of the lower Berg River (which may exceed 1000 mg/ℓ during flood events) the construction of a pre-impoundment at Drie Heuwels Weir would retain substantial quantities of silt, resulting in the rapid decrease in volume and residence time of the waterbody. Unlike retention weirs, which could be drained and dredged every dry season, dredging of a pre-impoundment would be impractical.

Based on the information above, a preliminary assessment is that a pre-impoundment, to reduce the mass of phosphorus entering an impoundment at Misverstand, is unlikely to provide sufficient reduction in the phosphorus budget of the river. A more practical strategy appears to be the control of phosphorus before it enters the main river channel. This strategy requires improved agricultural practises and the treatment of smaller volumes of water in the tributaries.

Table 8.6 Implications of a pre-impoundment on the nutrient input loading to an impoundment located at Misverstand.

Period	Input load: at 23D	Output load: A	B	% load reduction: A	B
1	36.3	32.0	25.3	13%	31%
2	70.4	66.9	61.6	5%	12%
3	10.6	9.1	7.1	14%	33%
4	125.0	100.2	83.5	19%	33%
5	4.3	3.7	2.9	15%	34%
6	98.3	93.0	84.1	5%	14%

A : pre-impoundment capacity of 10 million cubic metres

B : pre-impoundment capacity of 30 million cubic metres

Table 8.7 Implications of a pre-impoundment (capacity = 30 million cubic metres) on the nutrient input loading to an impoundment located at Misverstand, under conditions of phosphorus removal at the wastewater treatment plants.

Period	Input load:	Output load:	% load reduction:
1	32.9	24.0	27%
2	59.4	53.7	9%
3	6.7	5.4	18%
4	109.4	77.2	29%
5	2.7	2.1	21%
6	90.8	79.1	13%

6 INTER-CATCHMENT TRANSFER

The Theewaterskloof tunnel scheme was designed to transfer water between the upper Berg River, the Theewaterskloof Dam and Eerste River. Increased demand elsewhere in the system may require that a portion of the flow in the upper Berg River be diverted through the tunnel scheme. The phosphorus transport model will be used to estimate the implications of such inter-catchment transfer on the phosphorus dynamics of the lower Berg River. In this simulation exercise two abstraction volumes of approximately 50 and 150 million cubic metres during the wet season are investigated. The following method was used:

(1) Transfer of water from the Berg River at the upper reaches by Robertsvlei, will result in a concurrent reduction in the flow at Station 9A, North Paarl. The program ABSTRACT (see appendix 2) was developed to simulate the effect of inter-catchment transfer on the hydrograph at Paarl, on the basis that firstly, the rate of transfer will never exceed 50 percent of the discharge rate of the Berg River, and secondly, the instantaneous transfer rate will not exceed 10 cumecs. Due to the low flow experienced in the Berg River during the dry summer months, it was assumed that transfer would be carried-out only during periods of high flow (e.g. Periods 2, 4 and 6).

(2) The phosphorus chemograph at Station 9A was assumed to remain as before. This assumption probably underestimates the phosphorus concentration because the diversion at Robertsvlei would remove water containing very little phosphorus, the input of phosphorus to the upper Berg River very likely comes from agricultural activity between Robertsvlei and Paarl. However, having no detailed information on the upper Berg River one was forced to accept the chemograph at Paarl.

(3) The modified hydrograph for Station 9A created using ABSTRACT, was used in the hydrodynamic model (QMODEL) to predict the temporal and spatial variability of flow in the main river channel.

(4) The modified hydrograph also was used in the programs SECTION1 and SECTION2 to generate the chemograph at Lady Loch Bridge and Drie Heuwels Weir, respectively.

(5) The program DURACV1 was used to convert the time series into a duration curve assisting in the visual interpretation of the chemographs predicted for each transfer scenario.

To examine the implications of inter-catchment transfer on the nutrient budget of the river the data set for Period 2 (May 1984 to November 1984) was used. The runoff during Period 2 is the lowest of the winter periods and manipulation of this series will result in a more extreme set of water quality conditions in the main river channel compared with the higher runoff recorded during the winter periods 1985 and 1986 (Periods 4 and 6).

In Figs 8.9(a) and (b), the chemographs and hydrographs at Lady Loch Bridge and Drie Heuwels Weir are shown. In Fig 8.10 (a) and (b) two phosphorus duration curves are shown for Lady Loch Bridge (Station 13B) and Drie Heuwels Weir (Station 23D) representing the chemograph for an "unperturbed" flow regime and the influence of a transfer of 150 million cubic metres. Using these figures it is possible to derive the following information:

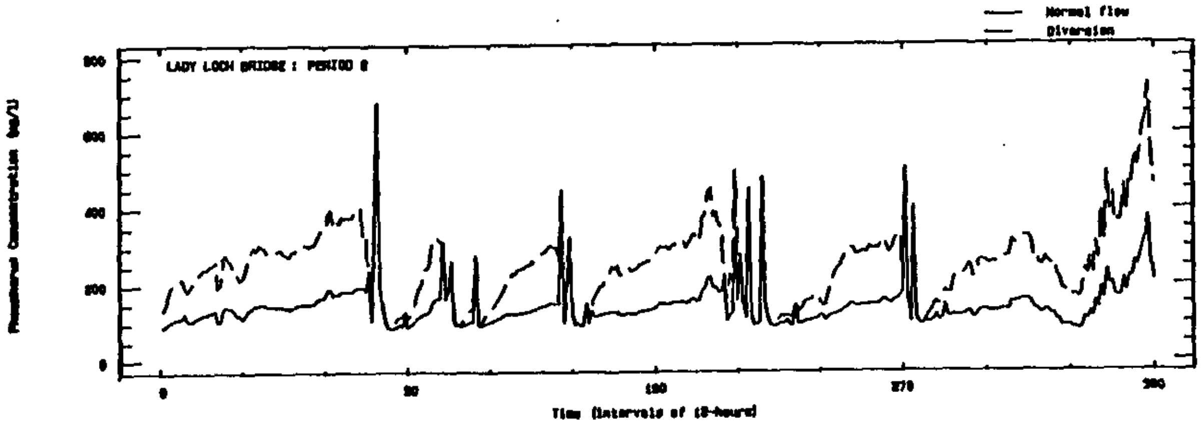

Fig 8.9(a). Simulated phosphorus chemograph at Lady Loch Bridge (Station 13B) for "unperturbed" flow (solid line) and the influence of a transfer of 150 million cubic metres per winter season (broken line).

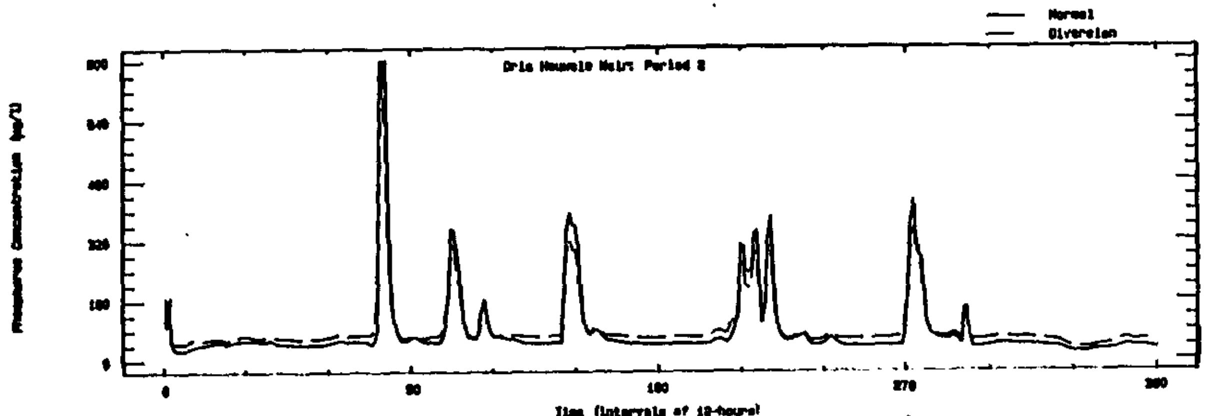

Fig 8.9(b). Simulated phosphorus chemograph at Drie Heuwels Weir (Station 23D) for "unperturbed" flow (solid line) and the influence of a transfer of 150 million cubic metres per winter season (broken line).

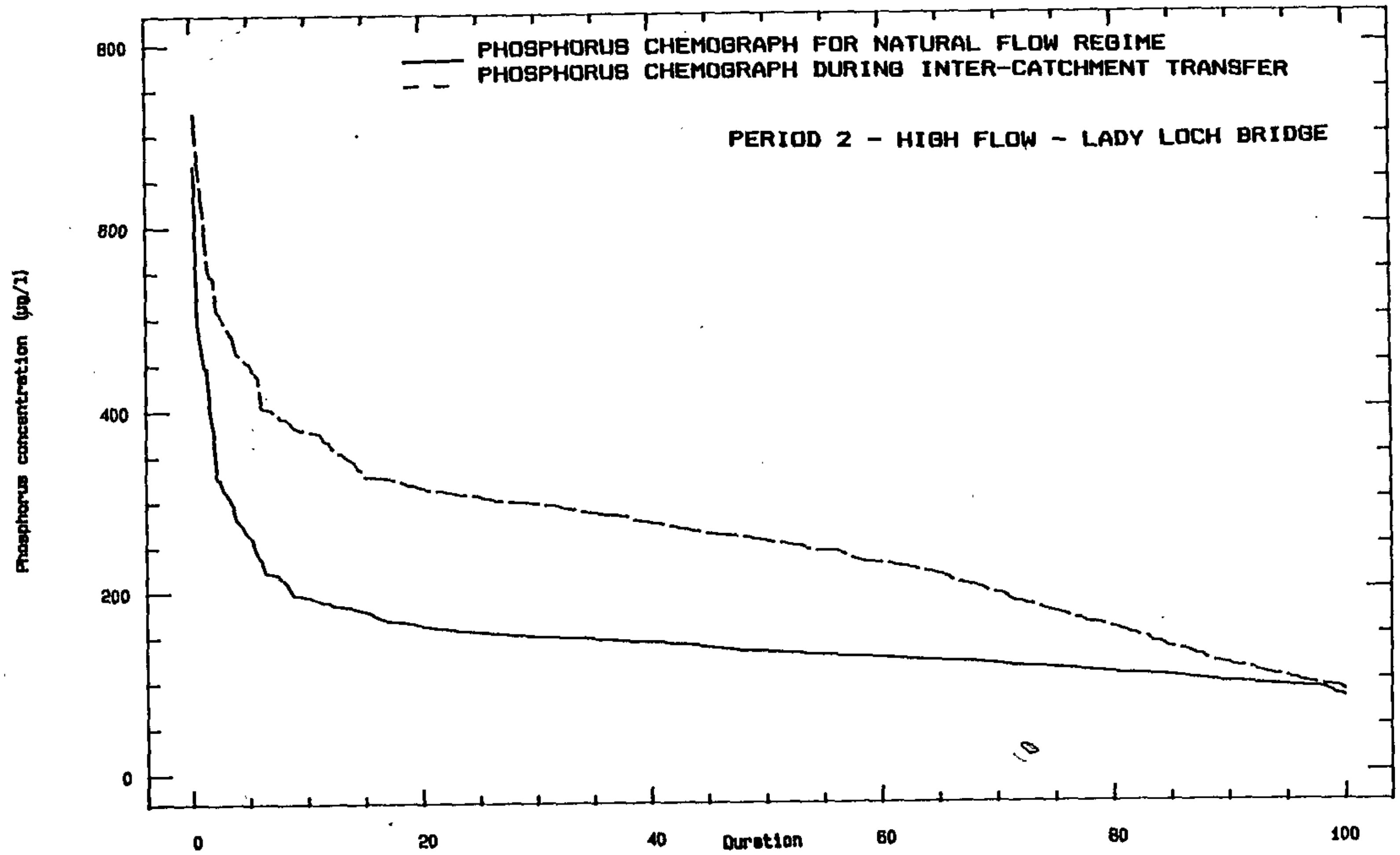

Fig 8.10(a). Duration exceedance curves of the simulated phosphorus chemograph at Lady Loch Bridge (Station 13B) for "unperturbed" flow (solid line) and the influence of a transfer of 150 million cubic metres per winter season (broken line). See Fig 8.9(a) for time series plot.

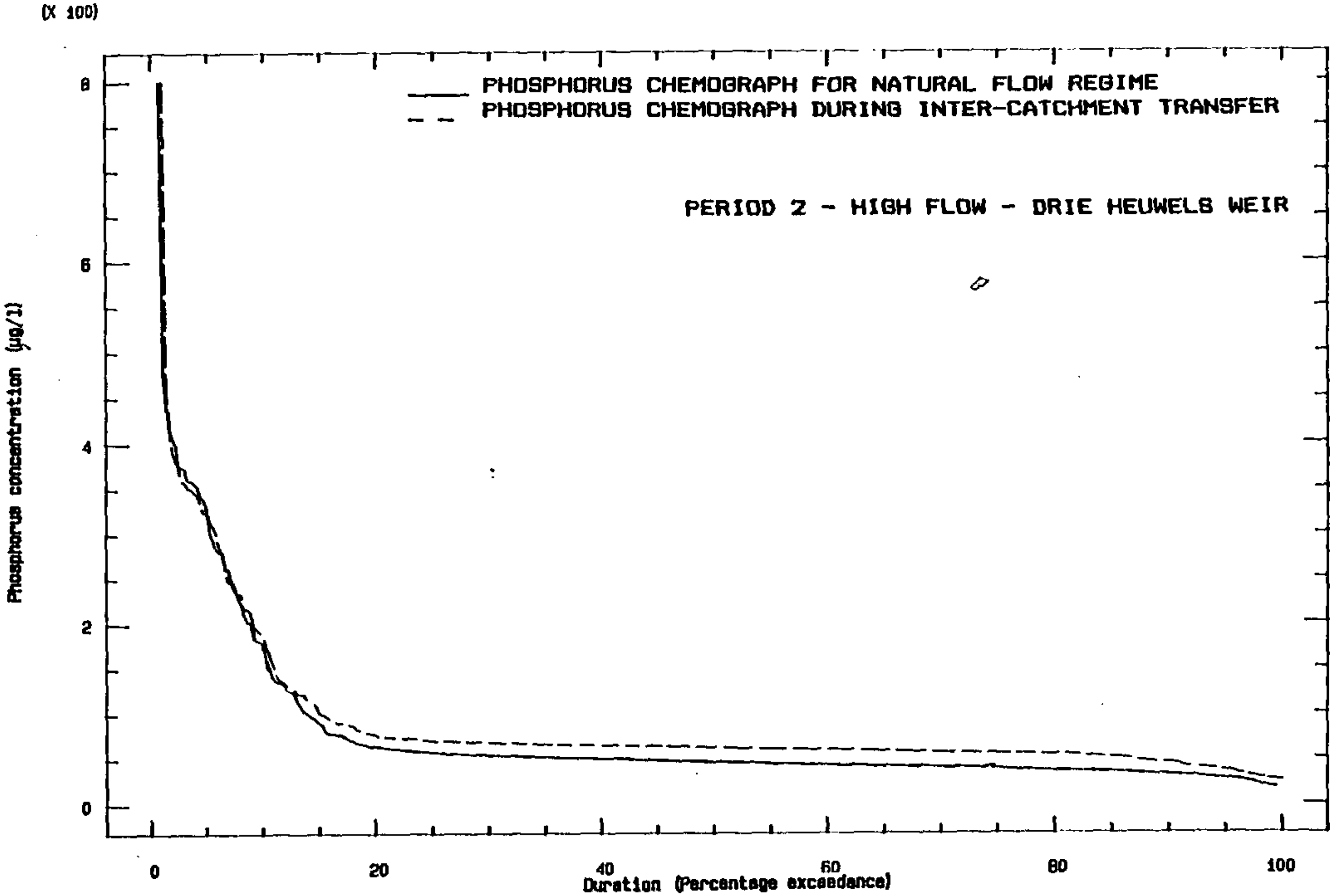

Fig 8.10(b). Duration exceedance curves of the simulated phosphorus chemograph at Drie Heuwels Weir (Station 23D) for "unperturbed" flow (solid line) and the influence of a transfer of 150 million cubic metres per winter season (broken line). See Fig 8.9(b) for time series plot.

(1) During the recession flow, the headwaters provide an important source of dilution for the inputs to the Berg River (from point and nonpoint sources).

(2) Abstraction from the headwaters causes the greatest influence on river quality downstream of the discharges from the wastewater treatment plants (Fig 8.9(a)), but this influence is reduced somewhat at Drie Heuwels Weir (Fig 8.9(b)).

As phosphorus transport along river channels is dependent on the concentration and flow, the effect of reducing the river flow causes a reduction in the dilution capacity of the river, but the effect is partially offset by the increased sedimentation due to the reduced flow velocity in the main river channel.

Based on this information it is evident that transfer of approximately 150 million cubic metres per 180-days (10 cumecs) from the headwaters will have an influence on phosphorus dynamics in the middle and lower reaches, due to the reduction in dilution capacity of the river. As a result, inter-catchment transfer will cause an increase on the phosphorus concentration in the main river channel which may influence:

(1) Riparian users of Berg River water, who abstract downstream of the point source discharges, and impound river water in numerous off-channel irrigation dams. The increased phosphorus concentration entering these dams (which have long residence times) will put these at greater risk of becoming eutrophic, in turn causing blockage of pumps, filters and pipes.

(2) The water treatment works at Withoogte abstracts water from the Berg River at Misverstand for distribution to the Saldanha region. At present, the phosphorus concentration is sufficient to support an algal biomass and necessitates pre-chlorination at the Withoogte Works. It is predicted that an abstraction of 150 million cubic metres of water from the upper catchment will cause an increase in the ambient phosphorus concentration at Misverstand, which is expected to result in increased algal problems experienced at the Withoogte water treatment works.

The model was re-run using the data set for Period 6, which represents one of the highest winter runoff periods in the three year sampling period (1984 - 1986). In Fig 8.11, two phosphorus chemograph duration curves are shown, one curve representing the chemograph for "unperturbed" flow conditions at Drie Heuwels Weir, and one curve representing the chemograph during abstraction of 150 million cubic metres. It is evident from Fig 8.11 that inter-catchment transfer will have minimal influence on the phosphorus chemograph at Drie Heuwels Weir due to the high river flows experienced during Period 6.

The preliminary findings above illustrate how the model can be used to achieve an optimization between transfer from the upper catchment and nutrient increases in the lower Berg River. Clearly more intensive analyses are required before a real life decision can be made but the results indicate that the abstraction of 150 million cubic metres of the winter flow (over a period of 180-days) will cause an elevation in the phosphorus concentration at Drie Heuwels Weir. However, the deterioration in water quality in the lower reaches associated with inter-catchment transfer is related to the magnitude of point and nonpoint source release, as well as the total volume

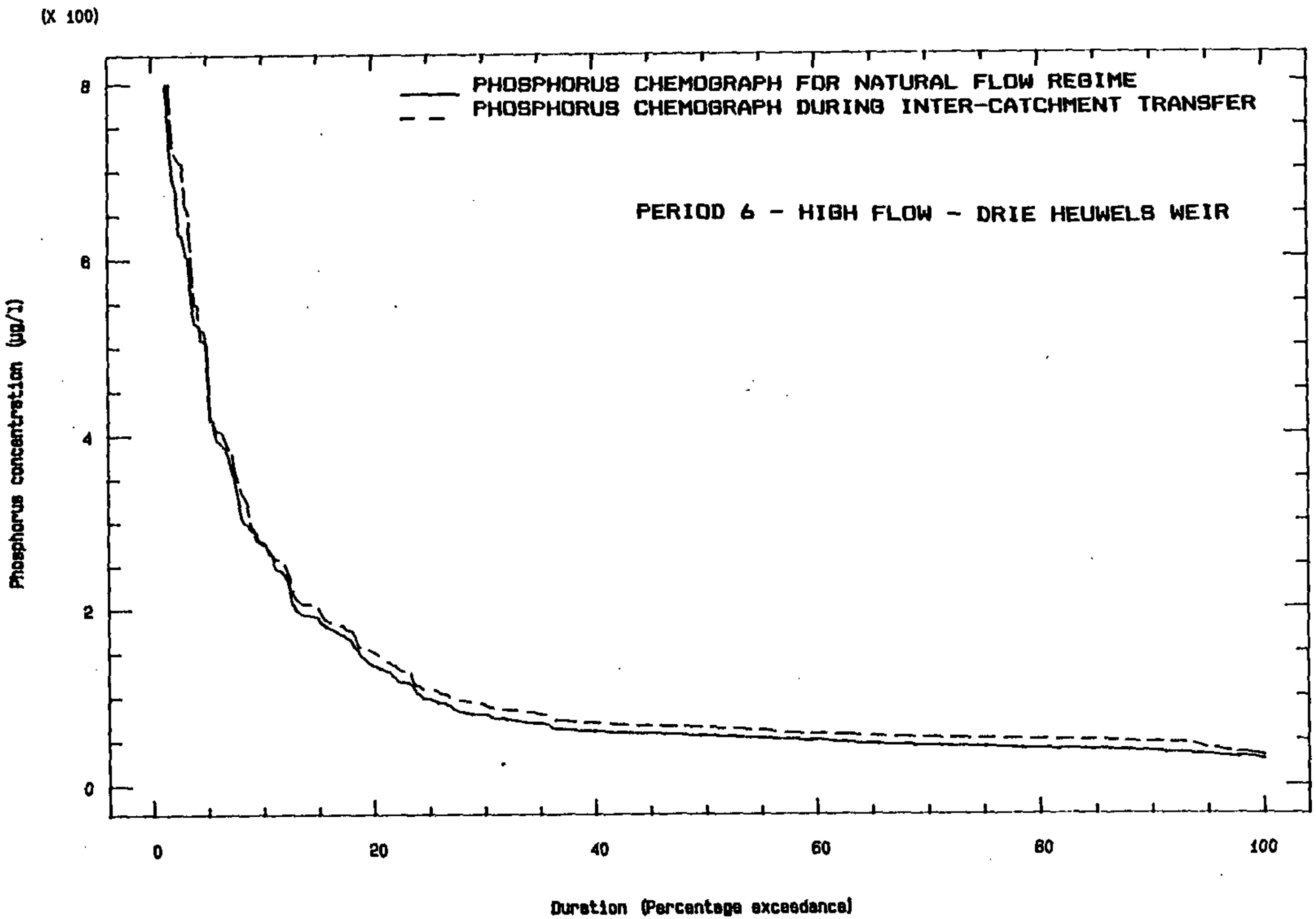

Fig 8.11. Phosphorus concentration duration curves for Drie Heuwels Weir with unperturbed flow regime, solid line, and with river abstraction (150 million cubic metres), broken line - Period 6.

of "natural" runoff from the upper catchment. Should such a plan be considered, one modification that should be tested is that water be transferred from the upper reaches of the Berg River during periods of very high flow to minimise the influence on the phosphorus budget of the lower river reaches.

7 VOëLVLEI DAM

Voëlvlei Dam is an off-channel storage reservoir providing water to the Swartland District and Cape Town. The reservoir is fed by two input canals, diverting water from the Twenty-Four and the Klein Berg Rivers. The increasing demand for water may necessitate the enlargement of the reservoir, requiring modifications to the canals feeding the reservoir. To meet the extra reservoir storage requirements it might be necessary to divert water from the Berg River at Hermon Bridge into the reservoir via an inlet canal (see Fig 8.12). There is no indication at present as to the quantity to be abstracted so that there is little merit in calculating the effect such abstraction will have on the phosphorus concentration in Voëlvlei Dam. Rather attention will be focused on the quality of the Berg River water that will be delivered to Voëlvlei Dam. It can be assumed also that abstraction will take place only during the high flow winter periods.

We will now apply the phosphorus transport model to investigate the following situations

(1) The chemograph expected at Hermon Bridge if 150 million cubic metres is diverted out of the upper Berg River (inter-catchment transfer).

(2) The phosphorus chemograph expected at Hermon Bridge under natural flow conditions.

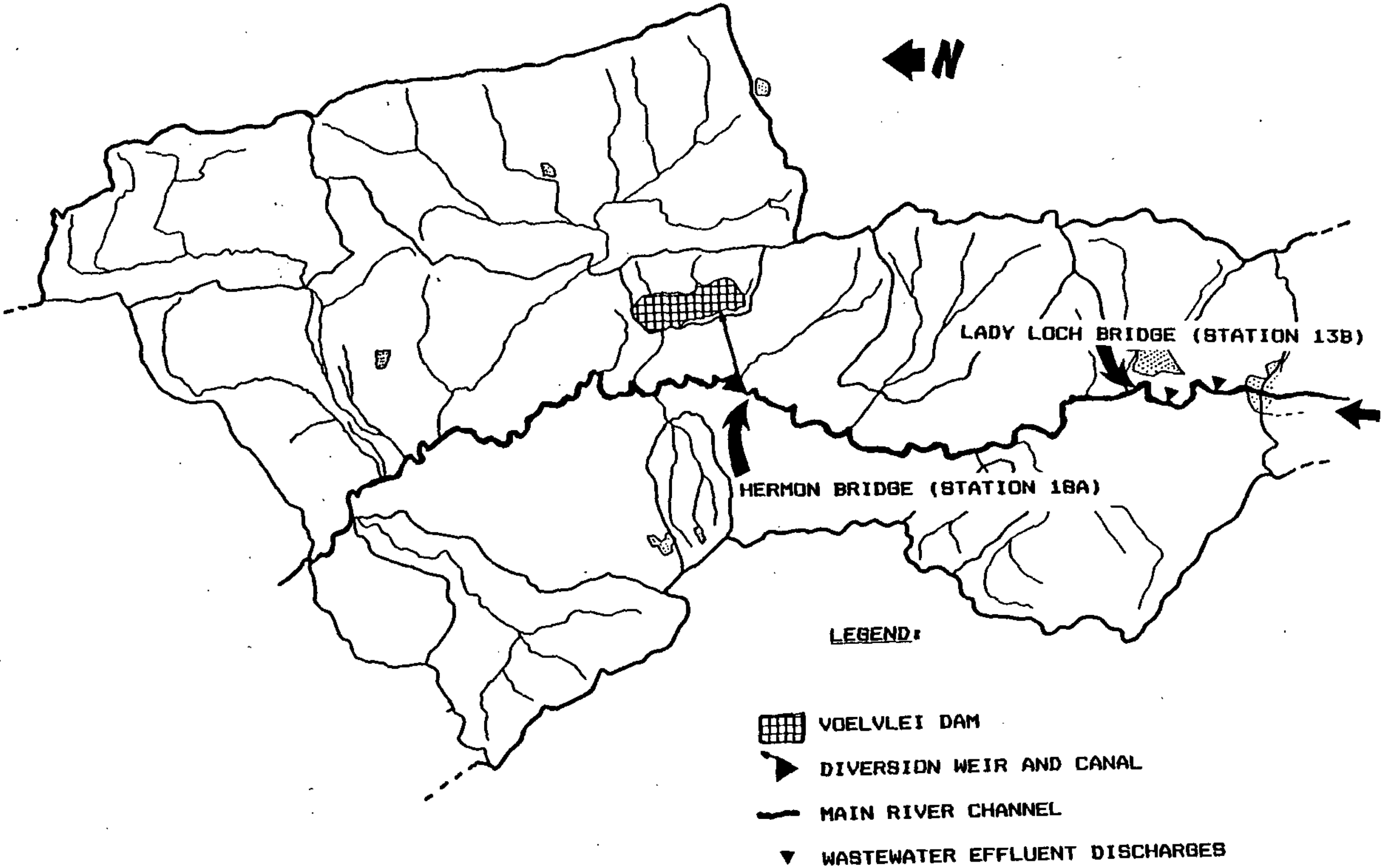

Fig 8.12. Location of hypothetical diversion scheme at Hermon Bridge to divert water from the Berg River to fill Voëlvlei Dam.

(3) The chemograph expected at Hermon Bridge if the 1 mg/ℓ phosphorus effluent standard is implemented at Paarl and Wellington.

To predict the phosphorus concentration of the diverted water the chemograph at Hermon Bridge was simulated, using the following method

(1) Program SECTION1, to predict the chemograph at Lady Loch Bridge for the appropriate inputs to the main river channel at Paarl and the wastewater flows from the two sewage plants.

(2) Program SECTION2, to predict the chemograph at Hermon Bridge (Fig 8.13), and

(3) Program DURACV1, to convert the phosphorus concentration time series plots (Fig 8.13) into a duration curve (Fig 8.14).

(4) The simulated chemographs and hydrographs at Hermon Bridge are shown in Fig 8.13 and duration curves in Fig 8.14.

The following comments are in order:

Abstraction during the recession periods only, will give a flow with median phosphorus concentrations of approximately 170, 120 and 50 (µg/ℓ) for the three situations (1), (2) and (3). Abstraction over the flood periods will give concentrations well in excess of these respective values. These concentrations are to be compared with the water quality of the Klein Berg and Twenty Four Rivers presently being diverted into Voëlvlei Dam (ranging from 20 to 45 µg P/ℓ). Clearly under

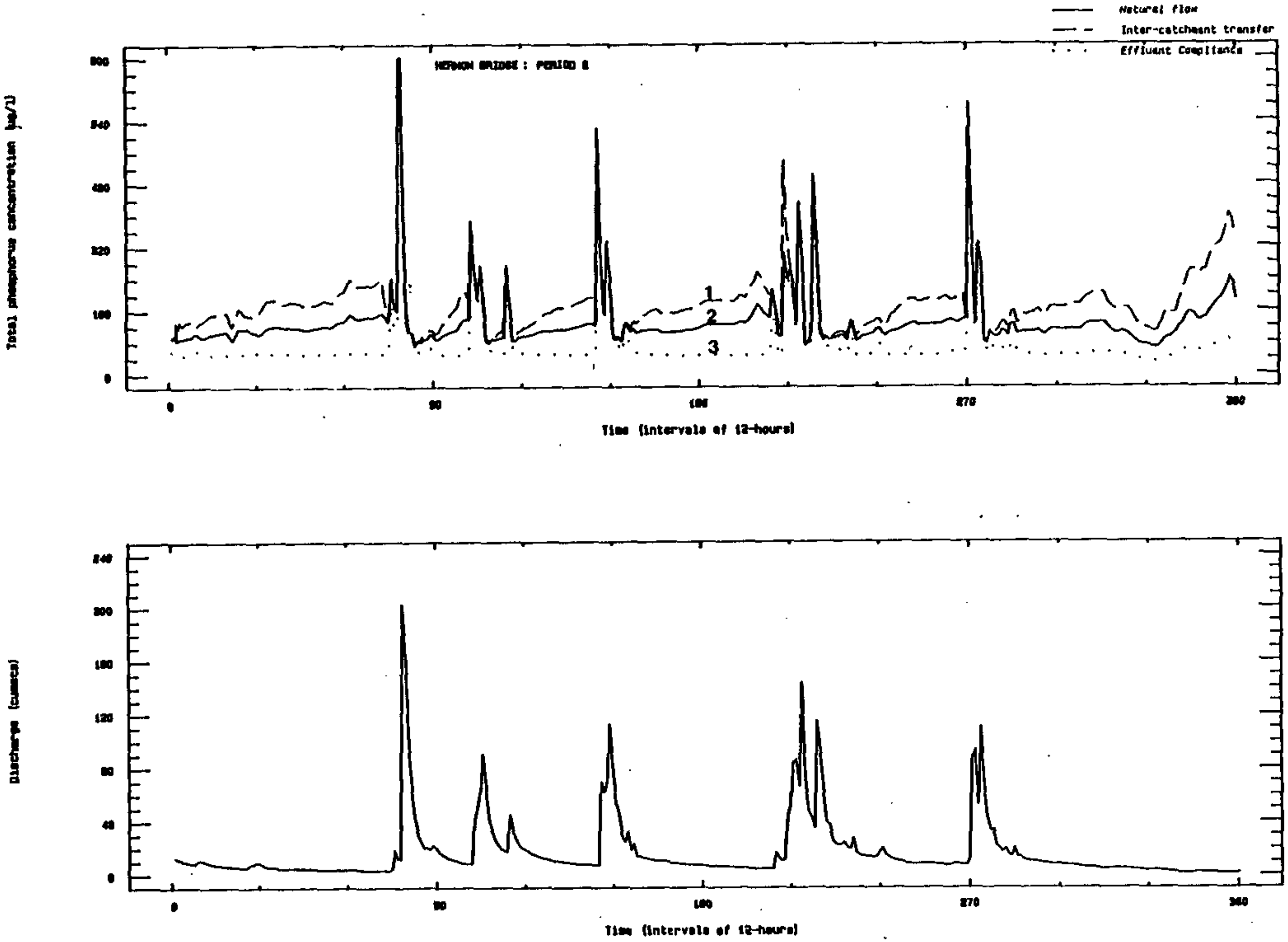

Fig 8.13. Phosphorus chemograph and hydrograph for Station 18A at Hermon Bridge - Period 2. Line 1 shows the influence of inter-catchment transfer; Line 2 shows normal flow conditions; Line 3 the influence of phosphorus removal at Paarl and Wellington wastewater treatment works.

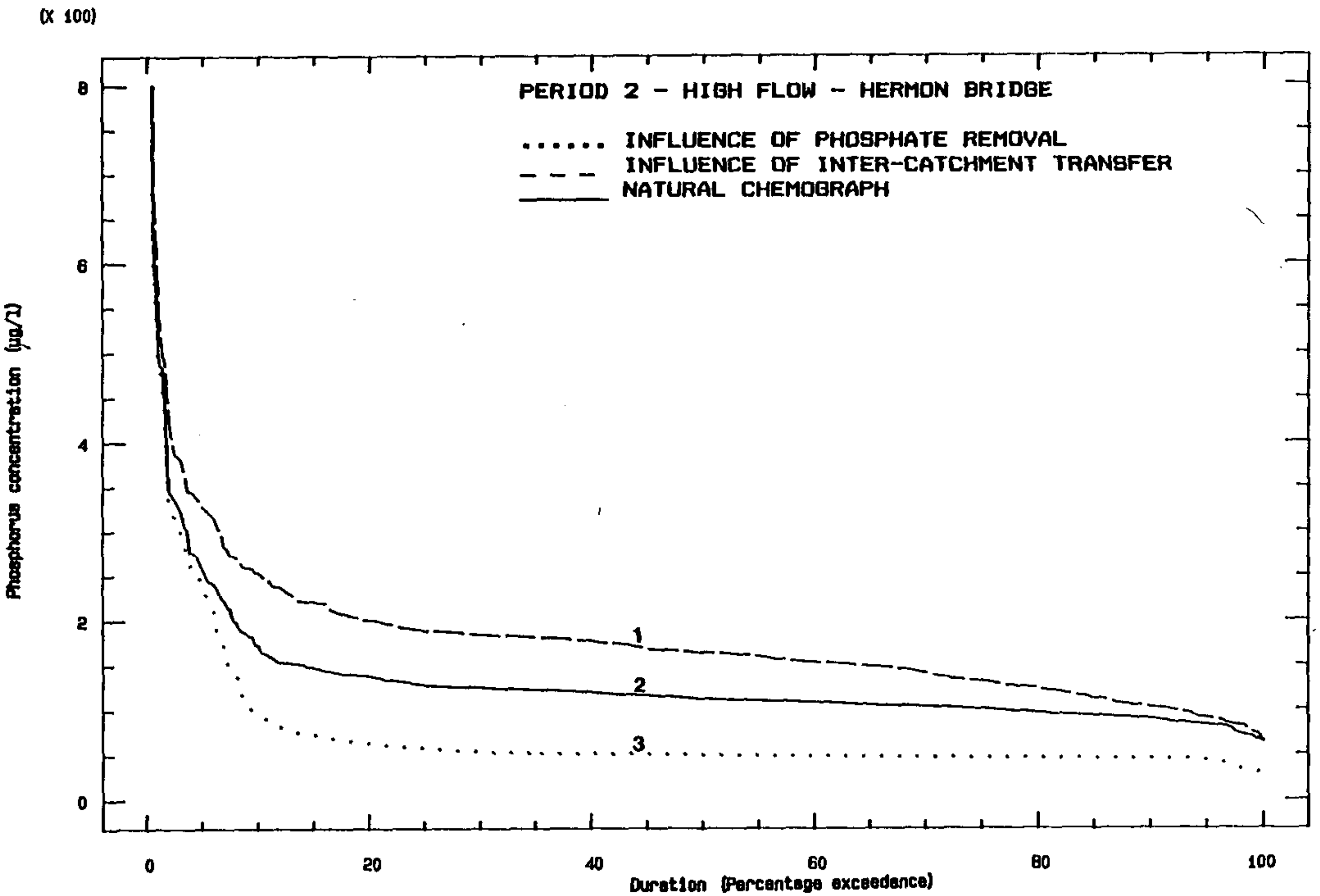

Fig 8.14. Duration exceedance curves for the simulated phosphorus chemographs at Hermon Bridge (Station 18A) - Period 2. Line 1 shows the influence of inter-catchment transfer; Line 2 normal flow conditions; Line 3 the influence of phosphorus removal at Paarl and Wellington wastewater treatment works.

the most favourable conditions the quality of the water from the Berg River is 3 to 7 times poorer. Irrespective of the relative diversion from the Berg River and the Klein Berg and Twenty Four Rivers, the eutrophication potential of Voëlvlei Dam will increase should abstraction from the Berg River be instituted.

Recent trihalomethane (THM) surveys of the drinking water in the Berg River catchment report a median THM concentration of 4.1 µg/ℓ for Voëlvlei Dam water and 82.0 µg/ℓ for Berg River water abstracted at Misverstand, see Table 8.8. Thus, diversion of Berg River water feeding Voëlvlei is expected to increase (1) the phosphorus loading to Voëlvlei Dam, (2) the trophic status of the impoundment and (3) the THM concentration of the water.

Table 8.8 Trihalomethane (THM) concentration of Voëlvlei Dam and the water abstracted at Misverstand Weir (Badenhorst and van Vliet, 1988).

Source:	THM median concentration (µg/ℓ)	90 percentile (µg/ℓ)
Voëlvlei Dam	4.1	13
Misverstand Weir	82.0	134

8 SUMMARY

The objective of this chapter was to illustrate applications of the phosphorus coupled hydrodynamic advective transport model (PCHAT). A number of hypothetical problem situations, that required solution, were suggested; related to the control and transport of phosphorus along the Berg River and catchment-orientated management strategies.

The solutions were developed in outline only, to illustrate the usefulness of the model, not to serve as definitive solutions. Some problems demanded inputs from other disciplines, for example, the settlement of particulate phosphorus in retention weirs on tributaries, in which event crude assumptions had to be made to obtain the phosphorus related solutions. With each problem the model simulation(s) contributed positively and sometimes significantly to finding a relevant solution.

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10 NOTATION USED IN CHAPTER 8

MR	=	Mass of phosphorus retained in the main river channel between Paarl (station 9A) and Drie Heuwels Weir (tons per 180-day period).
MI	=	Mass of phosphorus input to the main river channel between Paarl and Drie Heuwels Weir (tons per 180-day period).
MO	=	Total mass of phosphorus retained in the main river channel between Paarl and Drie Heuwels Weir (tons per 180-day period).
P	=	Mean phosphorus concentration in impoundment (µg/ℓ)
W	=	Phosphorus input load (kg per unit time)
Q	=	Inflow to impoundment (million cubic metre)
s	=	Sedimentation rate of phosphorus (per unit time)
V	=	Volume of pre-impoundment (million cubic metre)
K	=	Coefficient in Eq (8.3).

CHAPTER 9

DISCUSSION

1 OBJECTIVE

The objective of this investigation was to develop a dynamic phosphorus export model that describes the transportation of phosphorus through the Berg River drainage basin. Such a model had to consider (1) generation of phosphorus from diffuse (nonpoint) sources via surface and subsurface drainage and from point sources such as wastewater treatment discharges, (2) transportation of phosphorus in the water column along the river channel, (3) removal and remobilization of phosphorus from and to the water column, and (4) transportation of phosphorus in the bed load.

2 MODEL DEVELOPMENT

In seeking a structure within which a solution could be developed, the following proviso was constantly kept in mind: the model must be practical, in the sense that information to calibrate and run the model must be readily obtainable.

Many processes are involved in the generation and transportation of phosphorus. Although research has been conducted on some of the important processes, it was soon evident that a mechanistic approach, in which the model is composed of various processes, was not feasible because the mathematical descriptions of the processes either were not available, or were inadequate - an empirical or semi-empirical lumped parameter approach appeared to be the only practical one. This approach dominated the development of the different models.

2.1 Nonpoint Source Phosphorus Export Model

In the lumped parameter approach the objective is to seek a parameter, or parameters, in terms of which some or all of the required components can be modelled. In developing the nonpoint source model for phosphorus export, two parameters were identified, the discharge and the rate-of-change of discharge. In any river or catchment monitoring system, discharge would be the parameter most commonly measured. Analysis of sets of phosphorus/discharge data pairs showed that phosphorus concentration exhibits a behaviour pattern apparently related to discharge. For this reason alone selection of discharge as an independent parameter, in terms of which to model the phosphorus component, was not an unreasonable choice. With regard to the use of the rate-of-change of discharge, as an independent parameter, this was not as readily justified. The principal reason for its incorporation is that in a hydrograph from a nonpoint source area, it provides a mathematical structure that allows separation of the phosphorus concentration in the rising and falling limb of the hydrograph.

With the lumped parameters, discharge and rate-of-change of discharge, it was found to be possible to give an adequate description of the phosphorus concentrations in discharges from nonpoint sources - called the looped phosphorus discharge rating method. This method mathematically describes the looped or hysteresis effect in which, for the same discharge, the total phosphorus concentration is higher during the rising limb of a flood hydrograph than during the falling limb. An aspect of practical importance here was that the calibration constants in the looped discharge equation (for subcatchments in the Berg River basin) were found to be related functionally to the magnitude of the total subcatchment winter discharge; this allowed the phosphorus export to be estimated for subcatchments in which no phosphorus measurements had been collected.

The looped rating method also could be applied to subcatchments which were ungauged: in the Berg River basin only about 40 percent of the catchment area between Paarl and Drie Heuwels Weir is gauged. However for ungauged subcatchments between gauged subcatchments, it was found, by interpolating procedures, that the discharge hydrograph for the ungauged subcatchment could be synthesized with reasonable accuracy from the hydrograph of the gauged subcatchments on either side of the ungauged subcatchment. Once the hydrograph for such a subcatchment was available, the chemograph could be synthesized by applying the looped rating method using the functionally related constants, as described in the paragraph above.

In calibrating the looped phosphorus-discharge rating model it was soon evident that phosphorus concentrations at low and medium flows, as well as on the rising and falling limbs of flood flows, were necessary. Importantly, monitoring of phosphorus at regular time intervals provided completely inadequate information to calibrate the model or to estimate the mass of phosphorus exported from a nonpoint source. Flood waves on average lasted only a few days, yet within this period massive changes in phosphorus concentration and discharge (and hence phosphorus load) took place. During steady and low flow conditions monitoring could be at extended intervals, but during flood events monitoring intervals needed to be as low as 4 to 6 hours. From data taken over flood events on the Berg River (appropriately simulated by the model), nearly 80 percent of the phosphorus exported from the basin took place during flood events even though the total time of such events constituted less than 3 percent of the total time period monitored. In the South African region, where sharp transient flood flows are common, associated extreme transient phosphorus concentrations are to be expected — data acquisition strategies always will need to take this behaviour into account. Such a strategy will have to be developed taking due cognisance of the time period over which the flood takes place.

2.2 Phosphorus channel transport model

Advective transport of phosphorus along a river channel implicitly requires solution of the time varying discharge at any point in the length of the channel. During flood events there is a time varying discharge to the channel at different points along the channel. The velocity of flow in the channel at any point will depend on a number of parameters, such as the bed slope, discharge, bed friction forces, channel cross section and others.

Theoretically the flow could be modelled using the momentum and continuity equations of St. Venant. However, the amount of information required to describe the boundary conditions for such a solution has made these equations quite unsuitable for flow routing. As a consequence the literature records various simplifications to the momentum equation, e.g. neglecting some terms in the momentum equation or replacing this equation completely by an empirical one that indirectly includes the energy effects. With the simplified models the boundary effects could be accommodated to a greater or lesser degree, by calibration. Amongst the large number of simplified models, that of Li (1979) proved to be the most practical, for the purposes of this investigation. Li accepted discharge as the independent parameter in terms of which to formulate the energy/velocity effects, an approach also used in other models. The factor that determined the selection of Li's model was that calibration of his model was readily achievable by measurements in the field.

The flow model was calibrated by doing field measurements on the discharge, depth of flow and cross section at a number of points along the flow path. The discharge was determined in each sub-reach as follows: discharge at the upstream end of the sub-reach and hydrographs of the lateral gauged and ungauged tributaries in the sub-reach served as inputs (ungauged tributaries were synthesized by appropriate interpolation of the hydrographs from gauged tributaries to either side of the ungauged tributary). Solving the mass continuity and simplified energy equation, the discharge at the downstream end of the sub-reach was calculated. Minor factors, incorporated empirically, were seepage losses and abstractions.

The performance of the hydrodynamic model was assessed by comparing the simulated channel hydrograph at the downstream boundary of the catchment, with the measured hydrograph — the two hydrographs compared remarkably well over three years of hydrograph data.

Having a reliable flow routing method, the model describing the phosphorus transport along the channel could be developed. The mass of phosphorus transported along the river channel is affected by two processes, removal of phosphorus from the water column by settlement, biotic assimilation and possibly other processes, and remobilization of phosphorus into the water column when the discharge is sufficiently high.

To model the removal/remobilization the phosphorus behaviour along the channel was monitored under steady flow conditions, at different discharges. These showed that the removal conformed to an exponential type formulation with respect to channel distance, but that the exponential constant was a function of discharge. From a number of phosphorus concentration profile plots at different discharges, an empirical relationship between the constant and discharge was established, the constant having high negative values at discharges less then about 17 cumecs and positive values at higher discharges.

The phosphorus transport model was formulated as follows: over a sub-reach the input of phosphorus and discharge is known at the upstream boundary. Along the sub-reach the input of phosphorus and discharge is available from the tributaries hydrographs and chemographs. In the sub-reach the discharge is governed by the hydrodynamic model. Knowing the discharge, the removal/remobilization of phosphorus from/to the water column in the sub-reach is determined. In this fashion the discharge and phosphorus concentration at the downstream end of the sub-reach is determined.

The performance of the transport model also was assessed by comparing the simulated phosphorus chemograph at the downstream boundary of the channel, with the measured chemograph - the correspondence was good. The performance of the phosphorus transport model was all the more acceptable when one considers that there was virtually no calibration leeway available. If the correlation should have been poor it would have required a review of the nonpoint phosphorus export and the removal/-remobilization models. The good correspondence indicated that the structure of the model and the calibration procedures were acceptable.

The modelling approach adopted for the removal or remobilization of phosphorus, in effect ignores the mass of phosphorus stored on the riverbed. Initially it was attempted to model the storage of phosphorus on the bed of the river in order to trace the mass movement in and out of the bed due to removal and remobilization. This attempt was unsuccessful; the model was elaborate and difficulties arose in accommodating the mass stored and the interaction effects of sequential flood flows. Also no meaningful field data on the phosphorus stored on the bed could be obtained. As it was felt that the bed load problem could not be abandoned, an attempt was made to model the bed load transport quite independently of the interaction with the water column above. From the literature a bed load transport model was used virtually *unmodified*, with the assumption that the bed load contains a proportion of phosphorus material. This model indicated that very little phosphorus would be exported with the bed load. Interpretation of the findings of this bed model is not yet clear.

3 MODEL EVALUATION

Having reviewed the development of the hydro-phosphorus transport model it is necessary now to assess in what degree the endeavour was successful. Clearly the model gives a reasonable description of the phosphorus generation into the aqueous phase and phosphorus movement along the river channel. The model has a large empirical content in it, but even the empirical parts usually have directive aspects in them that attempt to mimic, after a fashion, the perceived mechanisms acting on the phenomena. The model therefore has two effects, (1) it resolves the problem set as its objective - the hydro-phosphorus transportation through the Berg River catchment, and (2) it contributes in an indirect fashion to the understanding of the mechanisms that are active in the phenomena, and provides measures for assessment of their relative importance. In this manner the model provides directives and incentives for future research.

The nonpoint source phosphorus export model using the looped phosphorus discharge rating approach, is an example of the two points put forward above. The looped approach provided a reasonable description of nonpoint phosphorus export; with readily simulated solutions thus available, by repeated trial application, familiarity with the response opened the way to reviewing the phenomena in a more basic semi-mechanistic fashion - decomposing the discharge hydrograph into three hydrographs, surface, interflow and baseflow, and allocating a degree of relative importance to these (with flood flows the baseflow hydrograph is not likely to be of as immediate importance as the surface flow hydrograph). With regard to the river water/riverbed phosphorus interaction, by attempting to quantify the mass of phosphorus stored in the bed, although the model attempt was not successful, it does however raise the point that this issue perhaps has not the same importance as others in the transport of phosphorus.

4 MODEL PREDICTIONS

The calibrated model has provided information of significant importance on the behavioural characteristics of phosphorus in the Berg River catchment and the implications of various operational and management strategies:

(1) Of the phosphorus exported at Drie Heuwels, 80 percent is derived from nonpoint sources, the remaining 20 percent from point sources (the municipal effluents from Paarl and Wellington). This finding provides information for the first time in South Africa that nonpoint phosphorus sources may be of much greater importance than realized before.

(2) Phosphorus transportation from a nonpoint source is strongly linked to surface runoff during storm events. The present indications are that the mass exported is principally a function of the discharge under the rising limb of the hydrograph and not significantly affected by sequential storm events.

(3) The major mass of phosphorus exported from nonpoint sources takes place during storm events. In the Berg River 70 to 80 percent of the phosphorus is exported during storm events which take place in less than 3 percent of the yearly hydrologic cycle.

(4) In the main river channel, removal of phosphorus from the water column takes place under low flow conditions and remobilization of phosphorus into the water column under high flows. The indications are that in the long term there is no, or only very little, net removal of phosphorus in the channel. Thus, all phosphorus that discharges to the main river channel eventually will be exported at the lower catchment boundary - phosphorus removal (storage) in the channel is of a temporary nature only.

(5) The indications are that the present inter-catchment diversion facility with regard to export out of the Berg River catchment could feasibly be operated only during the high flow periods, and then only with stringent operational control. Abstraction under low and medium flow conditions will lead to a significant increase in the phosphorus concentration in the lower Berg River which may in turn affect adversely the water treatment facility at the Withoogte Works.

(6) Augmentation of Voëlvlei Dam from the Berg River, by abstraction at Hermon, can be implemented only during high flow periods, but not during storm events. Even during high flow periods (outside storm events) the phosphorus concentration in the river still can be 3 to 7 times that in the Twenty Four and Klein Berg Rivers. During a storm event, the phosphorus concentration could rise to 700 µg/ℓ, up to 14 times more than in the Twenty Four and Klein Berg Rivers.

(7) Should an impoundment be constructed at Misverstand the water quality will be dominated by nonpoint source drainage. Implementation of the 1 mg/ℓ effluent standard at Paarl and Wellington will reduce the total phosphorus load at the dam by only 10 percent. Retention weirs on the tributaries in the reach Paarl to Drie Heuwels Weir, should these be 50 percent effective, will reduce the total phosphorus by about 20 percent. If retention weirs are installed also in the tributaries upstream of Paarl it is roughly estimated (insufficient data on the upper Berg River system are available) that the phosphorus will be reduced by about 50 percent. However, there are no definitive performance data available to verify whether these retention weirs in fact will function effectively.

(8) The high fraction of the phosphorus load delivered from nonpoint sources points to enquiry into methods to reduce phosphorus export from agricultural areas, inter alia, by improved agricultural practices.

5 FUTURE RESEARCH

Research into the following areas may produce results that enhance our capability to improve the model or assist in developing improved control and management strategies.

(1) Origins of phosphorus in the subcatchment, whether from fertilizer application or weathering of base material; rates of input or rates of weathering.

(2) Mobilization of phosphorus into the aqueous environment — phosphorus content of soils and soil structure, effect of rainfall intensity, infiltration etc.; phosphorus in different runoff components, overland flow, interflow and baseflow; catchment configuration.

(3) Role of physical, biological and chemical processes in removing/remobilizing phosphorus from/to the channel flow.

(4) Control of phosphorus in nonpoint source runoff by (i) building retention weirs, and (ii) appropriate agricultural practices.

(5) Application of the model to other catchments, subject to different hydrological regimes, topographies, agricultural activities, soil conditions, etc., to check whether the same empirical approaches developed here, are still appropriate.

(6) From (2) above, to develop the method of decomposition of the flood hydrograph as a viable alternative to the looped phosphorus discharge rating method in phosphorus export from nonpoint sources. Efforts in this regard may be assisted by monitoring both the soluble and particulate phosphorus components.

(7) Application of the model to describe the transportation of dissolved salts in a catchment. Such a study also may assist in developing a method for decomposing the flood hydrograph in (6) above.

6 CONCLUSIONS

From this investigation one may form the following conclusions:

(1) The hydrodynamic phosphorus transportation model, developed in this investigation, provides a reasonably reliable description of the phosphorus generation and phosphorus transportation in the aqueous phase of the Berg River catchment within the Paarl - Drie Heuwels Weir reach.

(2) The model is largely empirical, but in describing the various phosphorus behavioural patterns it indirectly addresses the mechanisms and processes affecting the behaviour; this may provide material for future research.

(3) The model serves as a powerful instrument in assessing the implications of a variety of proposed operational and phosphorus management strategies.

(4) The model provides reliable temporal information on the phosphorus input to any proposed impoundment in the Berg River in the Paarl - Misverstand reach. In this respect the information is probably more extensive and more complete than for any other catchment in South Africa. Evaluation of the trophic status of such an impoundment no longer will be limited by inadequate phosphorus input information, rather by deficiencies in the existing models for assessing the trophic status. It is to be hoped that the availability of a reliable model, to describe the phosphorus mass-time input behaviour to the impoundment, may simulate development of a dynamic eutrophic impoundment model.

(5) The model in its present form is site specific. The model should be applied in other catchments, under different hydrologic regimes, topography, catchment size and configuration, in order to improve or modify it for general application.

APPENDIX 1

DESIGN OF DATA BASE

During data collection a number of requirements were identified concerning the structure of the data base, these were:

(1) The data base must be capable of providing rapid retrieval and storage of data.

(2) The data files must be structured to enable the editing, splitting and merging of files.

(3) The data base should be capable of expanding with data storage needs.

(4) The data files must be accessible by other statistical and graphics programs.

To meet these requirements a data base was developed using sequential formatted ASCII data files. In the following sections the structure and design of the data base will be described.

1 FORMAT OF DATA FILES

The sequential data files used in the data base consist of two components:

(1) A matrix of data values arranged in rows (records) and columns (fields). Figure A1.1 shows a typical data matrix comprising three records and three fields.

(2) To enable the application program to load data files of different numbers of fields and rows three file identifiers are inserted into the data file, consisting of the filename, number of records and number of fields. The file identifiers are read by the application program to set the control loops for data input and verify the correct file has been accessed from disk. In Fig A1.2 a schematic representation of a flow data file is shown containing three file identifiers and 360 data values.

In the following sections a description will be given of the water quality and flow data files used in this investigation.

1.1 Flow Data files

The flow data files for stations along the main river channel and tributaries contain one field and 363 records, consisting of three file identifiers and 360 data values (one value for each 12-hour flow measurement over a period of 180-days), see Fig A1.2.

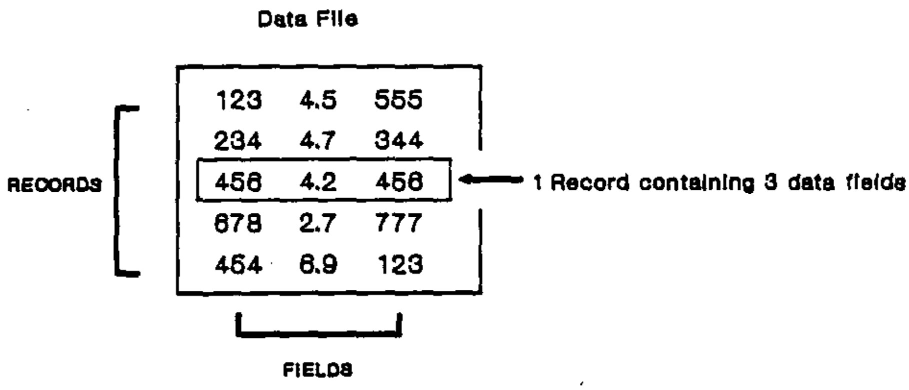

Fig A1.1. Matrix of values in file showing records (rows) and fields (columns) of data.

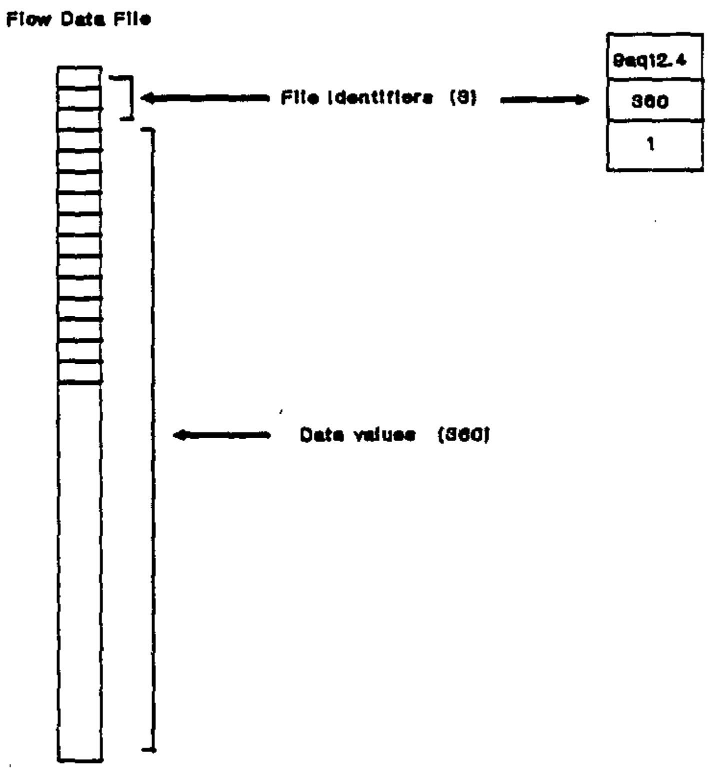

Fig A1.2. Schematic diagram of flow data file showing file identifiers and data values.

1.2 Water Quality data files

The water quality data files differ in format from the flow data files described above in that they contain three fields of data. The first field contains the sequential day number (date code), the second field contains the water quality constituent concentration and the third contains the river discharge measured at the time of sample collection. An example of a water quality data file is shown in Fig A1.3.

1.3 Composite Files

To minimize data access time in programs which require a large number of water quality and flow data files, composite data files were designed. Composite files contain water quality and flow data for specific sampling stations, for example

(1) In the hydrodynamic flow model (QMODEL), the lateral inflow hydrographs are grouped into a single file. The format of the lateral inflow composite file is shown in Fig A1.4.

(2) In the program SECTION1 a composite water quality data file is used, containing both phosphorus concentration and discharge data for Stage 1 of the main river channel, see Fig A1.5.

(3) In the program SECTION2 a composite water quality data file is used to supply measured phosphorus concentration data at sampling stations along the main river channel, see Fig A1.6.

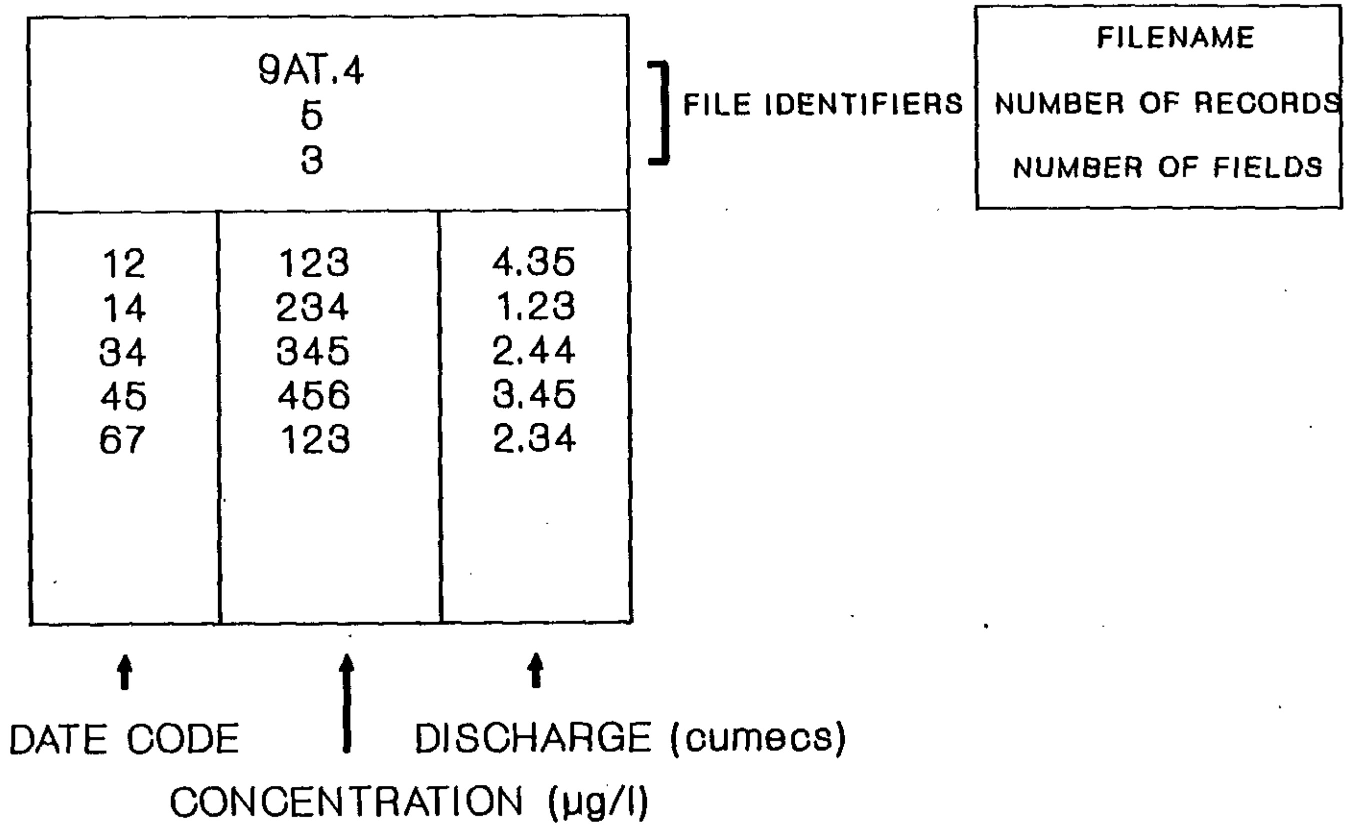

Fig A1.3. Schematic diagram of typical water quality data file showing file identifiers and the data matrix containing three fields of data.

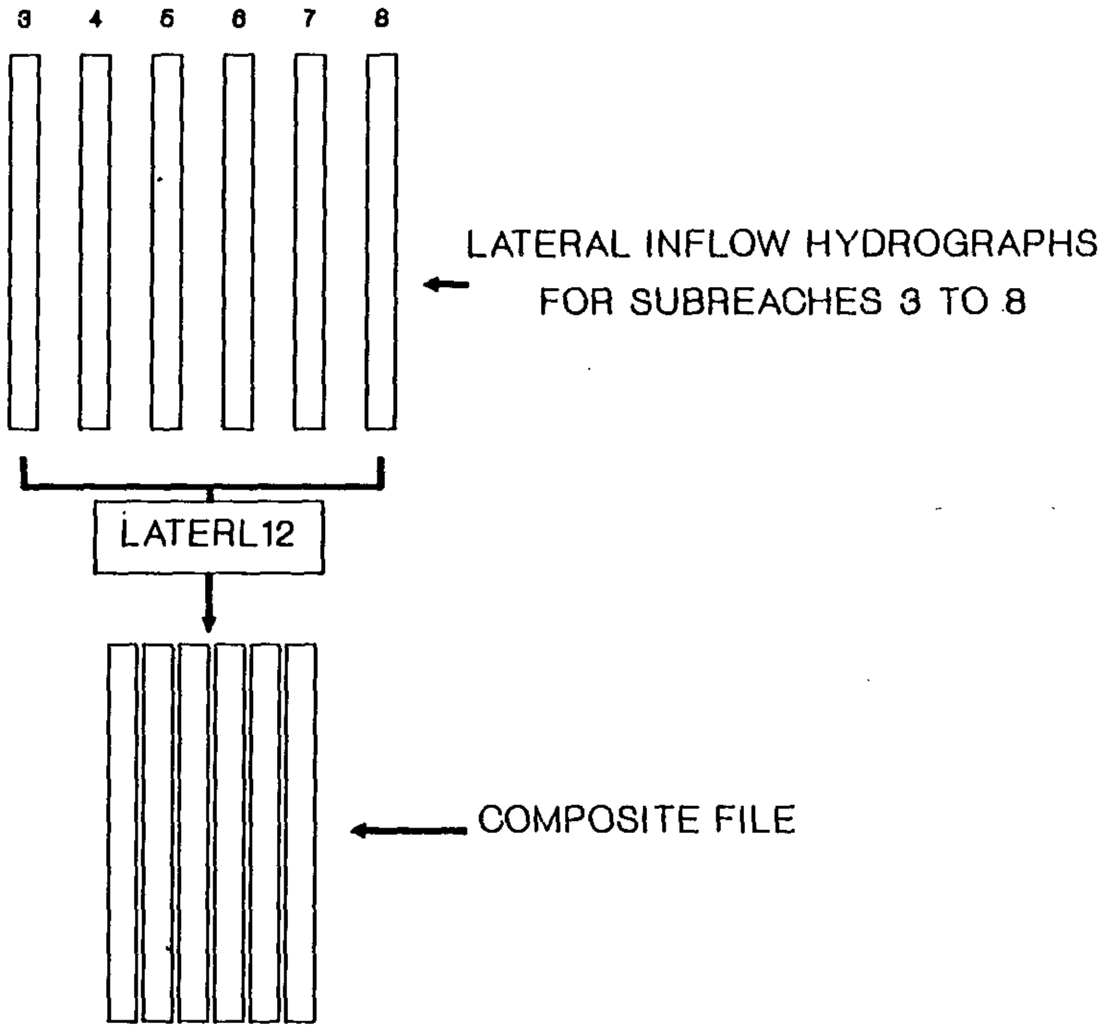

Fig A1.4. Schematic diagram showing the conversion of lateral inflow hydrographs into a composite file using the program LATERL12.

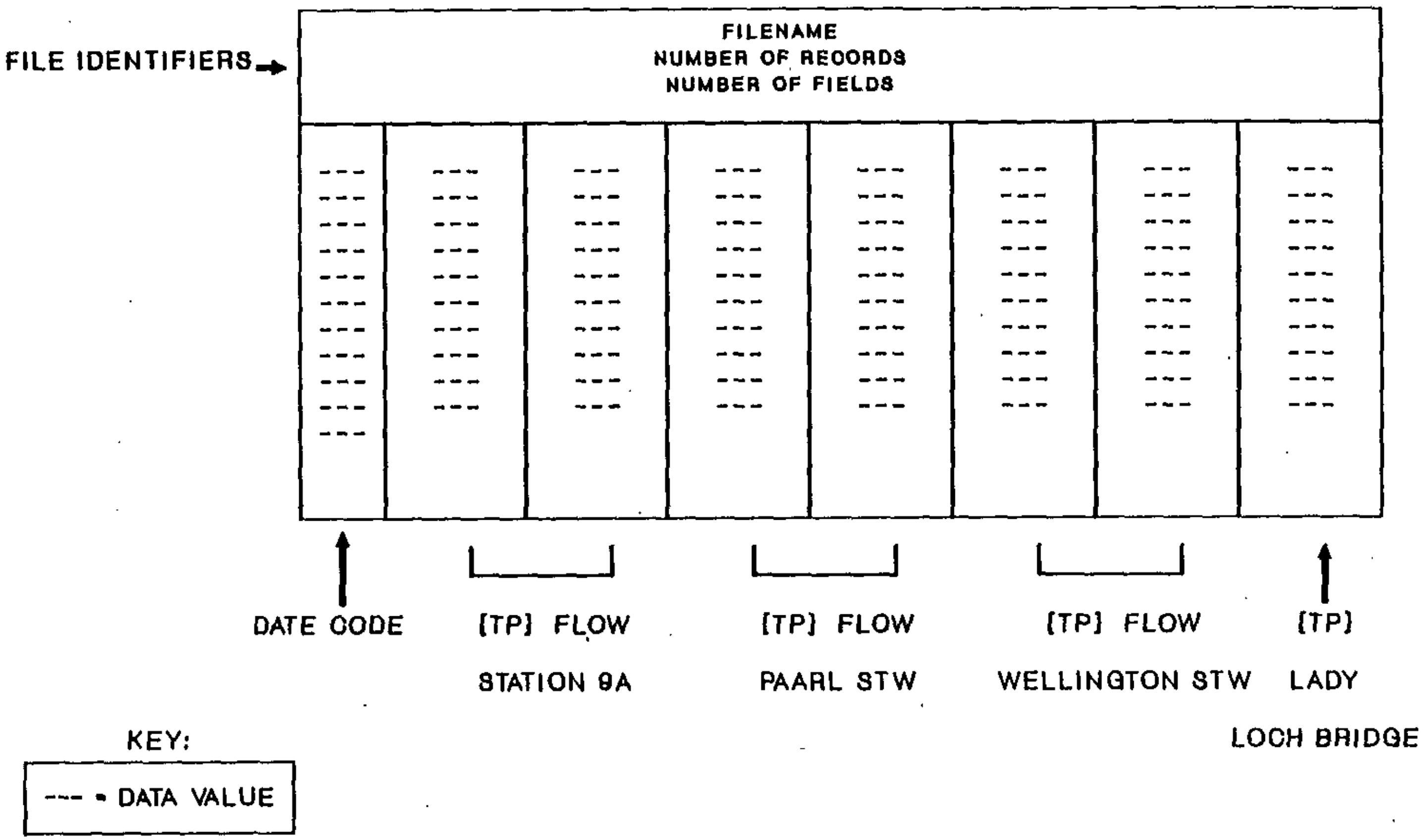

Fig A1.5. **Schematic diagram of composite file used for Stage 1 of the main river channel.**

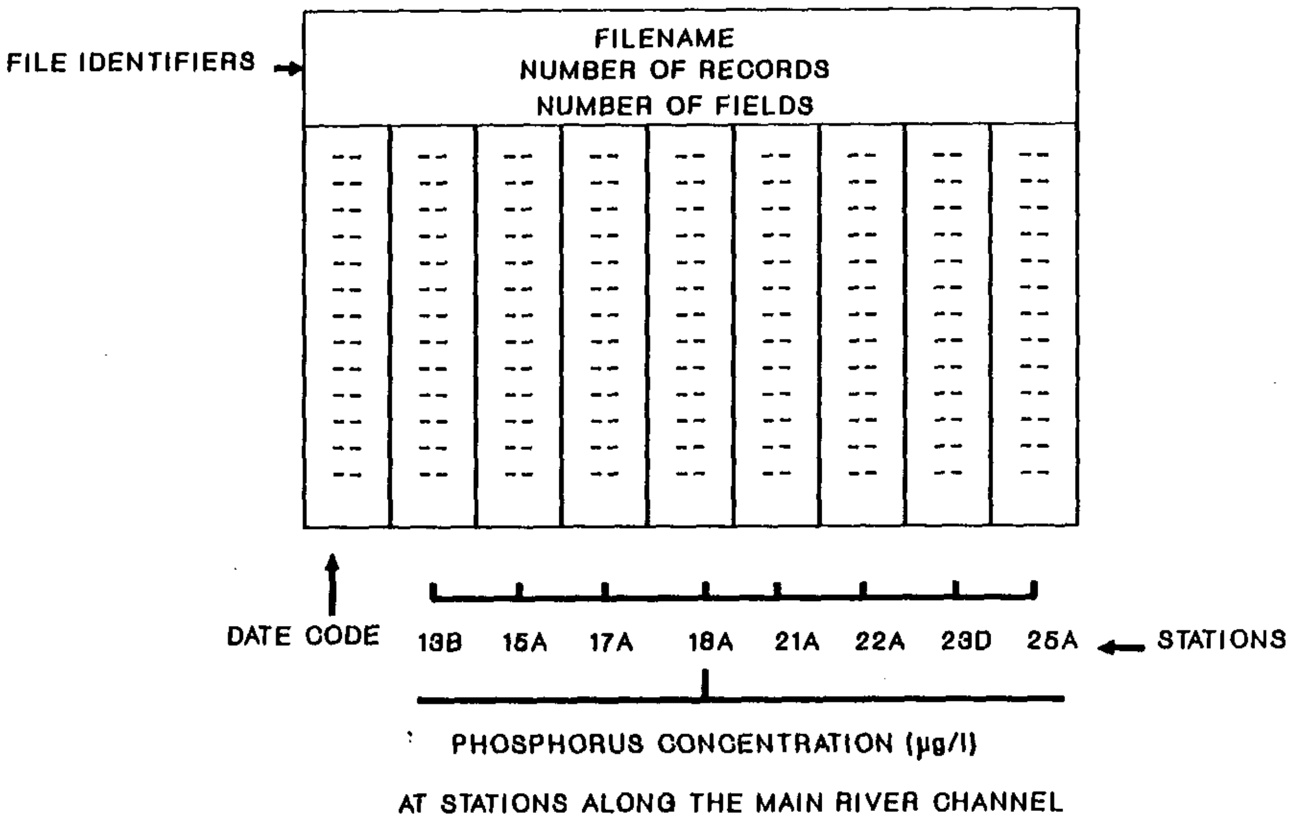

Fig A1.6. Schematic diagram of composite file used for Stage 2 of the main river channel.

2 DATA FILE NOMENCLATURE

Filenames used in this investigation contain the following information about the file:

(1) the station code,

(2) contents of file (flow or water quality data),

(3) time increment of data (12-hourly or daily data),

(4) period of data.

This information is combined in the filename using the template

$$x\ y\ .\ z \qquad \text{.....} \qquad \text{(A1.1)}$$

where

x = station code,
y = type of data,
z = period of data.

Examples of the codes used in the template given above are shown in Tables A1.1 and A1.2.

Table A1.1 Examples of the station codes, data-types and Period numbers as used in filenames.

Station codes (x): 9A, PSTW, WSTW, 14B, 23A, 25A

Type of Data (y):

Q12	-	measured hydrograph data (12-hour).
QP	-	simulated hydrograph (model output).
Q150	-	simulated hydrograph with inter-catchment transfer of 150 million cubic metres abstracted during period.
T	-	measured phosphorus concentration data.
TP12	-	simulated phosphorus chemograph 12-hour.
SS	-	measured suspended solids concentration data.
O	-	measured ortho-phosphate concentration data.
TPR	-	simulated phosphorus chemograph during P removal at wastewater treatment works.
TP12C	-	simulated phosphorus chemograph during abstraction from headwaters,
A	=	abstraction of 50 million cubic metres,
B	=	abstraction of 100 million cubic metres
C	=	abstraction of 150 million cubic metres.

Data Period numbers (z): 1 to 6

Table A1.2. Examples of filenames.

Filename:	Description:
9AQ12.4	12-hourly flow data for Station 9A, Period 4.
9AT.6	Phosphorus concentration data for Station 9A, Period 6.
23DTP12.5	Simulated phosphorus chemograph at Station 23D, Period 5.
ST1TQ.4	Phosphorus concentration data for Section 1 of the main river channel, Period 4.

APPENDIX 2

SOFTWARE DOCUMENTATION

The programs written for this investigation use GW-BASIC and HPGl(Hewlett-Packard Graphics Language) under the MS-DOS operating system (version 2.11). To obtain minimum run time, all programs were compiled into machine code.

To simplify debugging, and make each subroutine more understandable, each BASIC program was formatted using a template shown in Table A2.1.

Table A2.1 Structure of programs.

a.	Main subroutine	lines 1-999
b.	subroutine for initialization	lines 1000-1999
c.	subroutine for loading data	lines 2000-2999
d.	subroutine for calculation	lines 3000-3999
e.	subroutine for plotting data	lines 4000-4999
f.	subroutine for saving data	lines 5000-5999

Each subroutine has a specific function and overall program control is carried-out by the main subroutine. The first subroutine involves program initialization involving input of information by the user (i.e. numeric values, character strings or boolean) and enables the program to: load the correct datafile, use the correct algorithms and direct the output to the specified device. During initialization the user must enter the necessary data then press the return key. In some programs the default value is given in square brackets, to accept the default value the user must press the return key.

Some attempt was made to maintain a standard use of terms in computer program listings. In Table A2.2 the most frequently used terms are shown, with a description of their function.

Table A2.2 Notation used in programs.

Term:	Description:
M%, M1%	number of rows in data file
K%, K1%	number of columns in data file
N%	number of rows in data file 2
C%	number of column in data file 2
I	row counter
J	column counter
N$, NN$, F$, P$	filename
A(,), B(,), Q(,)	data arrays
W(,), V(,), l(,)	data arrays
MQ, MX, XP, YP	screen plotting delimiters

In the following sections a description will be given of each program, with a worked example, and finally a listing of the BASIC source code. For convenience the programs will be presented under the following headings:

(1) Data management and system utilities,
(2) Plotting and descriptive functions,
(3) Model development, and
(4) Model application.

1 DATA MANAGEMENT AND SYSTEM UTILITIES

This section introduces the programs responsible for the management of data, including all "housekeeping" tasks associated with creating, storing and manipulating data files. The procedures are summarized below and described in detail in the following sections:

Procedure	Description
File Editor	Allows data files to be created and edited in a suitable format for use by all other programs.
File Merger	Allows merging of lateral inflow hydrograph files for use by the hydrodynamic flow model.
File splitter	Allows the splitting of composite data files produced by the transport model and hydrodynamic flow model.
File modifier	Allows the modification of flow data files to compensate for inter-catchment transfer.
Load integrator	Allows the calculation of instantaneous and total loads for a given chemograph and hydrograph.

Data File Editor

Command : DISKIO.EXE

Definition:

DISKIO (disk input / output program) stores, retrieves and edits sequential ASCII data files. The general features of the program are:

(1) The program is fully interactive, enabling the user to read, write, edit and present data files.

(2) The program outputs the data file to the monitor and/or printer.

(3) Error handling subroutine is included to prevent accidental loss of data during transfer to disk.

Data Entry:

The program is initiated from the operating system prompt and requests the following input

Prompt	Expected Input
Read or Write Mode ?	Enter "r" to read a file from Disk or "w" to create a data file.
Reading data from disk file:	
name of file -	Enter the name of the file to be read from disk.
test disk ?	If you wish to test the read/write operation of the disk and drive.
individual changes ?	If you want to edit a specific record in the file.
string of changes ?	If you want to change a series of data values in the file.
Re-run ?	If you want to re-run the program enter "y", or quit the program type "n".
Writing data to disk file:	
number of rows of data -	Enter the number of rows of the data matrix.
number of column of data-	Enter the number of fields of the data matrix to be created.
value -	Enter the data value.

Example:

In the example given below a data file is read from disk and edited, then saved back to disk.

Prompt	Reply	Program Response
Read or Write ?	"r"	
name of file -	"9aq12.2"	
		- the file will be read from disk
test disk ?	"n"	
		- the file will be displayed
individual changes ?	"y"	
row number -	"12"	
column number -	"1"	
		- the existing record will be displayed
new value -	"3.78"	
		- the new value will be inserted
more changes ?	"n"	- to save edited file, or:
	"y"	- to make more changes to the records.
Re-run ?	"n"	- to quit or
	"y"	- to re-run the program.

In the following example the program is used to create a data file ("test") which is saved on disk

Prompt	Reply	Program Response
read or write ?	"w"	
file name -	"test"	
number of rows of data -	"2"	
number of columns of data -	"1"	
value -		Enter a numeric value for each component in the data matrix
individual changes ?	"n"	- the file will be saved on disk.

Listing of source code:

```
1 CLEAR : DIM A$(400,10)
2 '                          +++++++ DISKIO ++++++++

5 COLOR 3,12
'------------ main routine:---------------
10 GOSUB 100             ' Initialization
20 IF O$="w"THEN 40
30 IF O$="r"THEN 70
40 GOSUB 1010           ' INPUT DATA
45 GOSUB 2210           ' DISPLAY DATA
50 GOSUB 2910           ' CHANGE VALUES
55 GOSUB 3910           ' WRITE TO FILE
60 GOSUB 4930           ' READ DATA FROM DISK
65 GOSUB 2210           ' DISPLAY DATA ON SCREEN
67 INPUT "re-run (y/n)";RN$ : IF RN$="y" THEN 1 ELSE END
70 GOSUB 4930           ' READ DATA FROM DISK FILE
75 GOSUB 2210           ' DISPLAY VALUES ON SCREEN
80 GOSUB 2910           ' CHANGE VALUES
83 IF CH$="n" AND CX$="n" THEN 95
85 GOSUB 3910           ' SAVE DATA ON DISK
90 GOSUB 2210           ' DISPLAY DATA ON SCREEN
95 INPUT "re-run (y/n)";RN$ : IF RN$="y" THEN 1 ELSE END
96 ' END OF MAIN ROUTINE ----------------------------

100 '-------------------------------------INITIALIZATION
110 CLS
120 PRINT " ==================DISKIO====================="
140 PRINT ""
150 INPUT " read or write mode  ? (w/r)";O$
155  INPUT"name of file";NN$
157  INPUT" test disk          ? (y/n)";TS$
158  IF TS$="y" THEN GOSUB 8000   ELSE  160
160 IF O$="w" OR O$="r" THEN 170  ELSE GOTO 150
170 RETURN

1010 '---------------------------------------- data input
1020 CLS
1030 PRINT " ----------- DATA INPUT: "NN$"----------------"
1035 :
1040 INPUT "number of rows of data";M%
1050 INPUT "number of columns of data";K%
1060 ' dimensioned array in line 1
1070   FOR J=1 TO K%
1080          FOR I=1 TO M%
1090                PRINT ""I""J
1100                INPUT "value";X$:A$(I,J)=X$
1200    NEXT:NEXT
1202 PRINT "                end of data input "
1205 RETURN

2210 '-------------------------------------- display data
2410   FOR J= 1 TO K%
2420           FOR I= 1 TO M%
2500                PRINT A$(I,J),    ' display values in array
2600    NEXT:NEXT                      ' display identifiers
2610     PRINT"# rows="M%" # cols="K%" name of file="NN$
2700 RETURN

2910 '--------------------------- change values in array
2990 PRINT""
3000 INPUT "          individual changes???? (y/n)";CH$
3010 IF CH$="y" THEN 3100
3012 IF CH$<>"n" THEN 3000
3015 INPUT "          string  of changes???? (y/n)";CX$
3020 IF CX$="y" THEN 7000
3025 IF CX$<>"n" THEN 3015
3030 RETURN

3100 INPUT "row number";RW:INPUT "column number";CL
3200 IF RW>M% OR CL >K% THEN 3100
3210 PRINT "  value=" A$(RW,CL)
3220 INPUT "  new value =";V$
3230 A$(RW,CL)=V$
3240 INPUT "more changes ? y/n"; MC$
3250 IF MC$="y" THEN  3100
3255 IF MC$<>"n" THEN 3240
3260 RETURN
```

```
3910 '------------------------------ write data to disk
4000                              : ON ERROR GOTO 4910
4010                              : OPEN "O",1,NN$
4020                              : ON ERROR GOTO 0
4050 PRINT#1,NN$
4100 PRINT#1,M%
4200 PRINT#1,K%
4210    FOR J= 1 TO K%
4220           FOR I=1 TO  M%
4230                 PRINT#1, A$(I,J)
4240      NEXT:NEXT
4300 CLOSE#1
4310 RETURN

4900 '------------------------------------ error handling
4910 INPUT " check drive / disk <<< RETURN >>>";CH$
4920 RESUME 4010
4925 :

4930 '-----------------------------read data from disk
5000                              : ON ERROR GOTO 5730
5010                              : OPEN "i",1,NN$
5020 ON ERROR GOTO 0
5050 INPUT#1,N$
5100 INPUT#1,M%                          ' read file identifiers
5200 INPUT#1,K%
5300 IF O$="w" THEN 5410
5350 ' array dimensioned in line1
5410    FOR J=1 TO K%
5420          FOR I=1 TO M%
5430               INPUT#1,A$(I,J)   ' read values into array
5440    NEXT:NEXT
5480 PRINT""
5490 PRINT" name of file ="N$
5500 PRINT " number of rows="M%   ' print identifiers on screen
5600 PRINT" number of columns="K%
5610 CLOSE#1
5620 RETURN

5700 :                                ' error handling - drive error
5715 :
5730 INPUT " check drive/disk       <<< RETURN >>>";CH$
5740 IF ERR=53 THEN 5745 ELSE 5750
5745 INPUT "name of file";NN$
5750 RESUME 5010

7000 '------------------------- routine for string changes
7010 PRINT
7020 INPUT" row number at start of sequence  "; START
7030 INPUT" row number at end of sequence    "; DNE
7040 INPUT" col number                       "; CL
7050 IF DNE > M%  THEN 7030  :  IF CL > K% THEN 7040
7060 :
7070    FOR RW= START TO DNE
7080          PRINT"  ("RW","CL") :"
7090           INPUT"                 ";V$
7100             A$(RW,CL)=V$
7120    NEXT RW
7200   RETURN
7300 '------------------------------------------------
7500 '
8000 '---------------------------------- disk verification
8100 ON ERROR GOTO 8500
8150 OPEN "o",1,"TEST"
8170 ON ERROR GOTO 0
8200 PRINT#1,TEST
8300 CLOSE#1                   : PRINT"   ----- ok -----"
8330 KILL"test"
8350    FOR PAUSE=1 TO 2000:NEXT
8400 RETURN
8450 :
8499 '---------------------------- error handling routine
8500 INPUT "drive or drive error    <<< RETURN >>>";CH$
8550 RESUME 8150
8600 '-----------------------------------------------------
```

Data File Merger

Command : LATERL12

Definition

LATERL12 (lateral inflow data file creation- 12 hourly) creates a composite lateral inflow data file using tributary flow data (see Appendix 1). The program uses an areal weighting system to predict the ungauged lateral runoff (for further details see Chapter 6). The output data file containing the lateral inflow is used by the hydrodynamic flow model (QMODEL).

Data Entry

The program is initiated from the operating system prompt and requests the following input

Prompt	Expected Input
Period of data required -	Enter the numeric for the Data Period required (value between 1 and 6).
Name of new file -	Enter a name for the file to be created (see Appendix 1).

Example

In the following example a lateral inflow data file is created for Period 2.

Prompt	Reply	Program Response
Period of data required -	"2"	
Name of new file -	"latinfl2.2"	The lateral inflow data files are loaded from drive A, processed and the lateral flow data file is saved on drive B.

Listing of source code

```
2 COLOR 0,3 : CLEAR :
5 ' ================ LATERL12 ===========================
10 '   THIS PROGRAMME COLLECTS LATERAL INFLOW DATA
              AND LOADS IT INTO 1 ARRAY.
15 '   THIS PROGRAMME ALSO FEATURES THE COMPENSATION
              OF UNGAUGED LATERAL INFLOW.
17 '   THIS PROGRAMME USES THE 12 HOURLY DATA FILES
20 CLS
25 PRINT"________ LATERAL INFLOW DATA COLLECTION (12HR) _______"
30 PRINT""
40 INPUT "PERIOD OF DATA REQUIRED";P$
50 INPUT "FILE NAME TO BE DESIGNATED: {latinf12.___}";FI$
60 PRINT"---------------------------------------------------------"
100 IF P%=4 THEN M%=344 ELSE M%=360
120 DIM L(360,8),A(360,1)
125 :
126 '    ************ PSTW
130 F$="pstwq12."+P$ : OPEN "i",1,F$
140 NX=2:              ' this is used to put data into correct
                        slot in array.
145 IN=1:              ' this is the compensation factor used .
150 GOSUB 1000
155 '    ************ WSTW
170 F$="wstwq12."+P$ : OPEN "i",1,F$
180 NX=2
185 IN=1
190 GOSUB 2000
195 '   ************** 14b
200 F$="14bq12."+P$ : OPEN "i",1,F$
210 NX=2
215 IN=1.134
220 GOSUB 2000
221 F$="14bq12."+P$ : OPEN "i",1,F$
222 NX=3                  ************** subreach 3
225 IN=2.846
227 GOSUB 1000
230 '   ************** 15d *********** subreach 4
240 F$="15dq12."+P$ : OPEN "i",1,F$
250 NX=4
255 IN=7.08
260 GOSUB 1000
261 '   ************** 17b
262 F$="17bq12."+P$ : OPEN "i",1,F$
263 NX=4
264 IN=.3
265 GOSUB 2000
266 '   ************** 17b *********** subreach 5
270 F$="17bq12."+P$ : OPEN "i",1,F$
280 NX=5
282 IN=1.233
285 GOSUB 1000
290 '    ************ 20A ************ subreach 6
295 F$="20aq12."+P$  : OPEN "i",1,F$
300 NX=6
305 IN=2.846
306 GOSUB 1000
307 '   ************** 17b
308 F$="17bq12."+P$ : OPEN "i",1,F$
309 NX=6
310 IN=.7666
311 GOSUB 2000
315 '    ************ 21D   ********** subreach 7
320 F$="21dq12."+P$  : OPEN "i",1,F$
325 NX=7
330 IN=1
333 GOSUB 1000
334 F$="23bq12."+P$   : OPEN "i",1,F$
335 NX=7
336 IN=1.142
337 GOSUB 2000
340 '    ************ REACH8
350 F$="23aq12."+P$   : OPEN "i",1,F$
355 NX=8
357 IN=1.807
360 GOSUB 1000
370 F$="23bq12."+P$   : OPEN "i",1,F$
380 NX=8
385 IN=1.986
```

```
390 GOSUB 2000
500 GOSUB 3000
550 PRINT"END--------------------------------":END
800 :
900 :
1000 REM INPUT DATA TO ARRAY L
1005 INPUT#1,NN$,M%,K%
1030     FOR I = 1 TO M%
1040         INPUT#1,L$  : L(I,NX)=VAL(L$)*IN
1050     NEXT I
1060 CLOSE#1
1070 RETURN
1080 :
1090 :
2000 REM INPUT DATA TO ARRAY A ( BUFFER )
2005 INPUT#1,NN$,M%,K%
2030     FOR I = 1 TO M%
2040         INPUT#1,A$:A(I,1)=VAL(A$)*IN:
                     L(I,NX)=L(I,NX)+A(I,1)
2050     NEXT I
2060  CLOSE#1
2070 RETURN
2080 :
2090 :
3000 REM ************** SAVE DATA
3005 INPUT " Is the disk-drive ready";JI$
3010 PRINT "                              SAVING DATA:"FI$
3020 OPEN "O",1,FI$
3030 K%=8
3040 PRINT#1,FI$
3050 PRINT#1,M%
3060 PRINT#1,K%
3070   FOR J = 1 TO K%
3080          FOR I = 1 TO M%
3090                PRINT#1,L(I,J)
3100     NEXT :NEXT
3110 CLOSE#1
3120 RETURN
3333 :
4444 :
5555 :-----------------------------------------
```

Data File Splitter

Command: CHANDATA.EXE

Definition

The program CHANDATA (channel flow data file) is used to split the output composite data file from the hydrodynamic flow model and obtain individual hydrographs for stations along the main river channel.

Data Entry

The program is initiated from the operating system promptand the following input must be entered

Prompt	Expected Input
State Period of data required -	Enter a numeric between 1 and 6 for the period of data required.
Specify the station number -	Enter a numeric between 1 and 8 corresponding to the Station on the main river channel.
Specify name of input file -	Enter the name of the file to be split.
Specify name of output file -	Enter the name of the file to be created (see Appendix 1).

Example

In the example given below the flow data for Drie Heuwels Weir is split from the output data file from the hydrodynamic flow model.

Prompt	Reply	Program Response
State period of data required-	"2"	
Specify station number required-	"8"	
Specify name of input file -	"chanql2.2"	
Specify name of output file -	"23dqpl2.2"	
		The data file "chanql2.2" will be read from the disk and split up to give the predicted hydrograph at Drie Heuwels Weir, which is saved on disk.

Listing of source code

```
5 '                  ----------- chandata -----------------

10 CLS : CLEAR :
20 PRINT"THIS PROGRAM IS DESIGNED TO OPEN-UP chanq._ FILES AND
         ENABLE TO SAVE SPECIFIC ARRAY COMPONENTS "
30 '
40 FOR I=1 TO  3000 : NEXT I     ' pause.loop
45 CLS
50 PRINT
60 PRINT"------- CHANNEL FLOW DATA OUTPUT -----------------"
70 PRINT

80 '--------------------------------------------------
90 '   MAIN ROUTINE
100      GOSUB 1000          'OPTIONS/MENU
110      GOSUB 2000          'LOAD DATA
120      GOSUB 3000          'CALCULATE / SAVE DATA
150      END
160 '--------------------------------------------------

1000 ' OPTIONS/MENU ---------------
1010 PRINT"              ------------ MENU --------------"
1020 PRINT
1030 INPUT "  STATE PERIOD OF DATA REQUIRED  ( 1 TO 8 )";P$
1040 PRINT
1050  PRINT"   The data files are divided into 8 columns, as
follows:"
1060 PRINT
1070 PRINT"                   #1 ==  9a "
1080 PRINT"                   #2 ==  13b"
1090 PRINT"                   #3 ==  15a "
1100 PRINT"                   #4 ==  17a  "
1110 PRINT"                   #5 ==  18a  "
1120 PRINT"                   #6 ==  21a  "
1130 PRINT"                   #7 ==  22a "
1140 PRINT"                   #8 ==  23d "
1150 INPUT "   Specify station number required ";SC%
1160 INPUT" Specify name of input file (ie. chanq.-)";I$
1170 INPUT" Specify name of output file (ie. 23dqp.-)";F$
1180PRINT"-----------------------------------------------"
1190 PRINT" Loading data :  "
1200 RETURN

2000 '  loading data--------------------
2020    OPEN "i",1,I$
2030    INPUT#1,NN$,M%,K%
2040    DIM Q(360,8)  :   PRINT"          " NN$"  " M%"  "K%
2050     FOR J= 1 TO K%
2060           FOR I= 1 TO M%
2070                  INPUT #1,Q(I,J)
2080     NEXT :NEXT
2090 CLOSE#1
2100 PRINT"                    loading_complete........."
2110 PRINT
2120 RETURN

3000 'output to disk of selected flow data from array Q(_,_)
3010 '
3015 '
3017  INPUT "  Disk drive ready   ";QUEST$  '    prompt
3019   K1%=1 :
3020    OPEN "o",1,F$
3030    PRINT #1,F$
3040    PRINT #1,M%
3050    PRINT #1,K1%
3055  PRINT" saving:"F$"   m%="M%" k%="K1%
3060          FOR I = 1 TO M%
3070              PRINT #1, Q(I,SC%)
3080          NEXT I
3090 CLOSE#1
3100 PRINT"    data transfer now complete........"
3110 RETURN
```

Data File Modifier

Command : ABSTRACT.EXE

Definition

To determine the influence of inter-catchment transfer from the headwaters on the nutrient status of the lower Berg River, it is necessary to estimate the influence of the abstraction on the hydrograph at Station 9A (North Paarl). The program ABSTRACT simulates the influence of inter-catchment on the hydrograph at Paarl using the following assumptions:

- The abstraction would be undertaken during winter periods.

- The maximum instantaneous abstraction would be limited by pumping and diversion facilities which would range from between 8 and 12 cumecs.

- The abstraction rate never exceeds 50 percent of the natural river discharge.

- The maximum total volume of water abstracted during the data period is input by the user.

The modified hydrograph is saved on disk and is used by SECTION1 to predict the influence of inter-catchment transfer on the chemograph at Lady Loch Bridge.

Data Entry

The program is initiated from the operating system prompt and the following input is requested

Prompt	Expected Input
Input file name which requires adjustment -	Enter the filename of the hydrograph at Paarl.
Maximum abstraction from headwaters -	Enter a value for the maximum abstraction rate from the headwaters of the Berg River (units: cumecs).
Output filename -	Enter a name for the file containing the modified hydrograph (see Appendix 1).
Maximum volume abstracted-	Enter the value for the maximum abstraction rate from the headwaters of the Berg River (units: million cubic metres).

Example

In the following example the hydrograph at Paarl for Period 6 is used to simulate a modified hydrograph representing the total abstraction of 150 million cubic metres, with a maximum abstraction rate of 8 cumecs.

Prompt	Reply
Name of flow data file which requires adjustment-	"9aq12.6"
Maximum abstraction from river -	"8"
Output filename -	"9aq150.6"
Maximum volume abstracted during period -	"150"

The hydrograph for Station 9A (Period 6) is loaded from disk, processed and saved on disk under the new filename.

Listing of source code

```
10 '----------------------Abstract------------------

30 '+++++++++++++++main routine++++++++++++++++
35 CLEAR:
40 GOSUB 1000            ' initialization of program
50 GOSUB 2000            ' load hydrograph for modification
60 GOSUB 3000            ' processes of file
70 GOSUB 4000            ' save data file to disk

80 INPUT" re-run (y/n)";RR$ :
          IF RR$="y" OR RR$="Y" THEN 35 ELSE END
100 '+++++++++++++++++++++++++++++++++++++++++++++

1000 PRINT"                          +++ initialize +++"
1050 CLS:SCREEN 0,0,0: DIM A(360,8), B(360,1)
1070 PRINT"------------------ABSTRACT-------------"
1080 PRINT
1100 INPUT " Input name of flow data file which requires
             adjustment";N$
1200 INPUT " Maximum abstraction from river (8 to 15 cumecs) ";MAX
1300 INPUT " Output filename (eg  ...Q50...)";NO$
1400 INPUT " Maximum volume abstracted during period
                 (million m3)";ABSMAX
1450 PRINT
1500 RETURN

2000 PRINT"                                  +++ load data file"
2100 OPEN "i",1,N$
2200      INPUT#1,NN$
2210      INPUT#1,M%
2220      INPUT#1,K%
2230        FOR J=1 TO K%
2240             FOR I= 1 TO M%
2250                  INPUT#1, A(I,J)
2260             NEXT
2270        NEXT
2280   CLOSE#1
2290   PRINT" the data file contains "K% " fields"   ' display and
                                             select a specific field
2300 INPUT "select field number required";FD
2350 PRINT
2400  RETURN

3000 PRINT"                                      +++ calculations +++"
3005 PRINT
3010 TOTALFLOW=0  : IF M%>=344 THEN TIME=43200! ELSE TIME=86400!
3020   FOR I=1 TO M%
3030        Q=A(I,FD)
3040        TOTALFLOW=TOTALFLOW+(Q*TIME)   ' calculate total discharge
3050    NEXT I
3060 PRINT"total flow ="TOTALFLOW
3070 PRINT
3080 '                          ---  abstraction- flow adjustment
3090  AA=(ABSMAX*1000000!)/TOTALFLOW   ' calculate percentage
                                       reduction (AA)
3100 PRINT" flow reduction factor ="AA
3110 FOR I =1 TO M%
3120      Q=A(I,FD)
3130      IF (Q*AA)>MAX THEN B(I,1)=Q-MAX
3140      IF (Q*AA)<MAX THEN B(I,1)=Q*(1-AA) ' calculate flow values
3150 NEXT I
3160 :                         TOTALFLOWB=0
3170 FOR I= 1 TO M%
3180      TOTALFLOWB=TOTALFLOWB+(B(I,1)*TIME)
3190      NEXT I
3200 PRINT"total flow minus abstraction=" TOTALFLOWB
3210 PRINT"difference between flows="TOTALFLOW-TOTALFLOWB
3215 PRINT
3220 RETURN

4000 PRINT"              +++ saving new data file +++"
4010 :
4020 OPEN "o",1,NO$
4030        PRINT#1,NO$
4040        PRINT#1,M%
4050        PRINT#1,K%
4060   FOR J= 1 TO K%
```

```
4070        FOR I = 1 TO M%
4080          PRINT#1,B(I,1)
4090        NEXT
4100  NEXT
4110 CLOSE#1
4120 PRINT
4130 RETURN
```

Load integration

Command: LOADCALC

Definition

LOADCALC is used to determine the total load of phosphorus exported for a specific station by integrating the chemograph and hydrograph using Simpson's Approximation.

Data Entry

The program is initiated from the operating system prompt and the following data must be entered

Prompt	Expected Input
filename of chemograph -	Enter the name of the file which contains the chemograph used in the calculation (see Appendix 1).
filename of hydrograph -	Enter the name of the file which contains the hydrograph data used in the calculation (see Appendix 1).
Do you wish to save file ?	Enter "y" to save loadograph and "n" to give the total load displayed on the screen.
re-run program ?	Enter "y" to rerun program or "n" to quit.

Example

In the following example the program is used to determine the total load exported via Drie Heuwels Weir for Period 6.

Prompt	Reply	Program Response
filename of chemograph -	"23dtpl2.6"	
filename of hydrograph -	"23dql2.6"	
Do you wish to save the data ?	"n"	
		The program will now load the data files from disk and tabulate the calculated load of phosphorus, volume of runoff and mean phosphorus concentration (calculated from the total load divided by the total runoff).

Listing of source code

```
10 PRINT"----------------load calculation -----------------"
20 :

40 '---------main routine-----------------------------------
45 CLEAR              ' clear variables
50 GOSUB 1000         ' initialization
60 GOSUB 2000         ' load data files
70 GOSUB 3000         ' calculations and screen output
80 GOSUB 4000         ' save data files

90 INPUT "re-run program (y/n)";RR$ : IF RR$="y" THEN 45 ELSE END
100 '------------------------------------------------------

1000 CLS: SCREEN 0,0,0 : DIM A(360,8), B(360,8), C(360,1)
1001 PRINT"----------------- loadograph generation ---------
1010 PRINT:PRINT
1050 PRINT"- - - - - - - initialization - - - - - -  -"
1060 PRINT
1100 INPUT" filename of chemograph                  "; NC$
1200 INPUT" filename of hydrograph                  "; NH$
1250 INPUT " Do you wish to save data file  (y/n)";SVE$
1260 IF SVE$="y" THEN 1300 ELSE 1400
1300 INPUT" filename of output file                 "; NL$
1400 PRINT
1500 PRINT
1600 RETURN

2000 PRINT"- - - - - - - load data files - - - - - - - "
2100 OPEN "i",1,NC$
2110 INPUT#1,NN$,M%,K%
2120 FOR J= 1 TO K%
2130       FOR I= 1 TO M%
2140             INPUT#1,A(I,J)
2150       NEXT
2160  NEXT
2170 CLOSE#1                             'load chemograph----------
2180 PRINT"file contains "K%"field(s)"
2190 INPUT "select one field required";FD1
2195 IF FD1=0 THEN 2190
2199 :
2200 OPEN "i",1,NH$
2210 INPUT#1,NN$,N%,C%
2220 FOR J= 1 TO C%
2230       FOR I= 1 TO N%
2240             INPUT#1,B(I,J)
2250       NEXT
2260  NEXT
2270 CLOSE#1                             'load hydrograph-----
2280 PRINT"file contains "C%"field(s)"
2290 INPUT" select one field required";FD2
2295 IF FD2=0 THEN 2290
2300 RETURN

3000 PRINT"- - - - - -  calculation - - - - - - - -
3100 TOTALFLOW=0  :TOTALLOAD=0
3110 IF M%<>N% THEN PRINT"error in data file length":END
3120 IF M%=>344 THEN TIME = 43200!
3125 IF M%<=180 THEN TIME = 86400!
3130 :
3200 FOR I=1 TO M%
3250       C(I,1) = A(I,FD1)*B(I,FD2)*.001
3260       TOTALLOAD= TOTALLOAD + (C(I,1)*TIME)
3270       TOTALFLOW= TOTALFLOW + (B(I,FD2)*TIME)
3280 NEXT I
3290 PRINT"-------------------------------------------------"
3300 PRINT" total load for period=" TOTALLOAD " g"
3330 PRINT" total flow for period=" TOTALFLOW " m3"
3335 PRINT" mean concentration   =" TOTALLOAD/TOTALFLOW "mg/1"
3340 PRINT"---------------------------------------------------"
3350 RETURN

4000'----------saving data file-----------
4005 IF SVE$="y" THEN 4010 ELSE 4330
4010 PRINT"- - - - - - -  saving data file - - - - - - -
4100 OPEN "o",1,NL$
4120    PRINT#1,NL$
```

```
4125    PRINT#1,M%
4130    PRINT#1,1
4135 :
4200 FOR J= 1 TO 1
4210      FOR I= 1 TO M%
4230           PRINT#1,C(I,1)
4240      NEXT
4250 NEXT
4300 CLOSE#1
4310 PRINT:PRINT:PRINT
4320 PRINT" finished saving "
4330 RETURN
```

2 PLOTTING AND DESCRIPTIVE FUNCTIONS

Four plotting procedures are used in this investigation which are summarized below (see Fig A2.1), and described in detail in the following sections.

Procedure	Number of variables	Description
Scatter plot	2	Produces scatter plots of concentration versus discharge. Options include scaling in both axes. Output is direct to the graphics display.
Hydrograph plot	1	Produces a time series plot of the hydrograph data. Options include scaling of the y-axis and additional hydrographs can be plotted on the screen. The total runoff is calculated for the period.

Duration curve	1	Produces a duration exceedance curve of hydrographs, chemographs or loadographs. Options include scaling of y-axis as well as the use of more than one time series.
Time series plot	3	Produces a time series plot of hydrograph and chemograph as well as measured data values. Options include scaling of both axes and insertion of text. Output is directed to a graphics plotter.

Scatter plot

Command WQ-PLOT

Definition

This program produces a scatter plot of water quality versus discharge on the graphics screen. The graphics screen may be printed by pressing the Print-Screen key combination.

Data Entry

Prompt	Expected Input
number of data periods -	Enter the number of data files which must be read from disk (maximum is 9).
filename -	Enter the name of the file which has the relevant data.
maximum flow plotted -	Enter the highest discharge value to be plotted on the x-axis (units: cumecs).
max. conc. plotted -	Enter the highest concentration to be plotted on the y-axis (units: μg/ℓ).

Example

In the following example the program is used to plot the measured phosphorus concentration versus the discharge for Station 9A during periods 2 and 4.

Prompt	Reply	Program Response
number of data periods -	"2"	
filename -	"9AT.2"	
filename -	"9AT.4"	
max.flow plotted -	"125"	
max.conc.plotted -	"345"	
		- The program loads the data files and plots the phosphorus concentration values versus discharge on the graphics screen.

Listing of source code

```
1 '---------------------- WQ-PLOT ----------------------
5 CLS :CLEAR :SCREEN 0,0,0
10 DIM A(360,23) 'Dimensions array used for storage of data
20 :
30 '************** plot of wq data as a function of flow ****

50 PRINT"----------------- WQ DATA PLOT -------------------"
55 PRINT
56 PRINT"          <<<<  place wq data in drive A  >>>>"
60 INPUT " number of data-periods ";N%   :  DIM CN$(9)
65 IF N%=0 THEN 60
70 FOR H = 1 TO N%
80       INPUT "File number ie: st1tq.2 ";CN$(H)
90 NEXT H
100 INPUT " max.flow plotted  (m3/s)";MX
110 INPUT " max.conc.plotted  (ug/l)";MQ
140 PRINT"-----------------------------------------------"

170 GOSUB 1000              ' graphics screen
180 FOR H= 1 TO N%
190    GOSUB 2000           ' load data files
200    GOSUB 3000           ' process and plot data
210 NEXT H

260 INPUT "re-run [_\n]";AZ$ : IF AZ$="" THEN 1 ELSE END
270 END

1000 '+++++++++++++ graphics screen +++++++++++++++++++
1010 SCREEN 2,0,0,0
1020 LINE (1,1)-(1,180),1
1030 LINE (1,180)-(630,180),1
1035 '
1040 FOR I = 180 TO 0 STEP -(1800/MQ)    ' tick marks x-axis
1050        PSET(2,I),1
1060 NEXT I
1070 :
1080 FOR I= 0 TO 630 STEP (630/MX)      ' tick marks y-axis
1090          PSET(I,181),1
1100 NEXT I
1150 '
1160 PRINT"[TP]     [TP] PLOTTED AS A FUNCTION OF DISCHARGE"
1200     RETURN

2000 '************** input data **********************
2010 OPEN "i",1,CN$(H)
2020 INPUT#1,NN$,M%,K%
2030      FOR J= 1 TO K%
2040           FOR I= 1 TO M%
2050                INPUT#1,A(I,J)
2060      NEXT :NEXT
2070 CLOSE#1
2080 RETURN
3000 '&&&&&&&&&&&&& calculate and plot &&&&&&&&&&&&&
3010  FOR I= 1 TO M%
3020       T=A(I,2):Q=A(I,3)
3030            T=180-(180/MQ*T)   ' fit values to
                                     screen coordinates
3040            Q=630/MX*Q
3050            : IF T<0 THEN T=0      ' maximum values
3060            : IF Q>630 THEN Q=630
3070       CIRCLE (Q,T),2             ' plot
3080  NEXT I
3100  RETURN
```

Hydrograph plot

Command : FLOWPLOT

Definition

This program plots up to nine hydrographs on the graphics screen and using Simpson's Approximation integrates each hydrograph to calculate the total volume of water discharged.

Data Entry

The program is initiated from the operating system prompt and requests the following input

Prompt	Expected Input
Number of datafiles -	Enter the number of hydrographs to be presented on the graphics screen.
File number -	The file name of each hydrograph.
max.flow plotted -	The maximum value plotted on the y-axis.

Example

In the following example the program is used to plot the hydrographs for Stations 9A and 23D, during Period 2.

Prompt	Reply	Program Response
Number of data files -	"2"	
File number -	"9AQ12.2"	
File number -	"23DQ12.2"	
max.flow plotted -	"350"	
		- The program will now plot the hydrographs on the screen and integrate the total discharge for each hydrograph.

Listing of source code

```
1 '---------------------- FLOWPLOT ---------------------
2 SCREEN 0,0,0
3 COLOR 12,0
5 CLS  : CLEAR
10 DIM A(360,1) 'Dimensions array used for storage of data

30 '*************** plot of flow data as a function of time **

50 PRINT"----------------- FLOW DATA PLOT -------------------"
60 INPUT " Number of data-periods (MAX.= 25)";N%  :DIM C$(25)
65 IF N%=0 THEN 60
70 FOR H = 1 TO N%
80      INPUT " File number ie: 9aq.2     ";C$(H)
90 NEXT H
100 INPUT " Max.flow plotted (m3/s)";MX
140 PRINT"------------------------------------------------"
'    ------ main routine:----------------------------------
170 GOSUB 1000              ' preparation of graphics screen
180 FOR H= 1 TO N%
190     GOSUB 2000           ' input data
200     GOSUB 3000           ' calculate and plot data
205     GOSUB 5000           ' flow integration
210 NEXT H
260 INPUT"re-run [_/n]";AZ$ : IF AZ$="" THEN 1 ELSE END
270 END '------------------------------------------------


1000 '+++++++++++++ graphics screen
1010 SCREEN 2,0,0,0
1020 LINE (0,0)-(0,180),1
1030 LINE (0,180)-(630,180),1
1040 FOR I = 180 TO 0 STEP -(1800/MX) ' tick marks on y-axis
1050        PSET(1,I),1
1060 NEXT I
1070 :
1080 FOR I= 0 TO 630 STEP 3.444445    ' tick marks on x-axis
1090          PSET(I,181),1
1100 NEXT I
1200 RETURN

2000 '************* input data
2010 OPEN "i",#1,C$(H)
2020 INPUT#1,NN$,M%,K%
2030      FOR J= 1 TO K%
2040           FOR I= 1 TO M%
2050                INPUT#1,A(I,J)
2060      NEXT :NEXT
2070 CLOSE#1
2080 RETURN

3000 '&&&&&&&&&&&&& calculate and plot
3010  FOR I= 1 TO M%
3020             Q=A(I,1)
3030             Q=180-(180/MX*Q)
3040             T=(I*(630/M%))
3050              : IF Q<0 THEN Q=0
3060              : IF I=1 THEN 3075
3070          LINE(T,Q)-(TT,QQ),1
3075              : TT=T:QQ=Q
3080  NEXT I
3100  RETURN

4000 :
5000 'Total Flow Calculation ----Simpson's approx.
5100 '
5150 TQE=0  : TQO=0
5200 FOR I= 2 TO M%-2 STEP 2
5250      QE=A(I,1)*4   :TQE=TQE+QE
5500      QO=A(I,1)*2  :TQO=TQO+QO
5600 NEXT
5650 '
5700      Q=(TQE+TQO+A(1,1)+A(M%,1))*28800*180/M%
5800 PRINT" TOTAL FLOW = :"Q"m3    FILE NO:"C$(H)
5900 RETURN
```

Duration curve

Command : DURACV1

Definition

Duration exceedance plots are used to present and compare time series. This program uses a "Monkey Puzzle Sort" routine to sort the data file which is plotted as the percentage exceedance on the graphics screen.

Data Entry

The program is initiated from the operating system prompt and the following data must be entered

Prompt	Expected Input
Input number of files -	Enter the number of time series to be plotted on the screen.
Input file name to be presented -	Enter the files to be plotted
Maximum data plotted on screen -	Enter the maximum value to be plotted on the y-axis of the duration curve plot
Do you wish to save sorted data -	Enter "y" to save sorted file.

Example

In the following example the program is used to plot the hydrograph measured at Station 9A during Period 2.

Prompt	Reply	Program Response
Input number of files -	"1"	
Input file name to be presented -	"9aq12.2"	
Maximum data plotted on screen -	"200"	- The data file is loaded, sorted and plotted in the form of a duration curve.

Listing of source code

```
10 'this PROGRAM sorts and displays data in the form
              of a duration curve

50 '----------------------main routine-----------------
60 '
65 CLEAR:SCREEN 0,0,0 :DIM F$(9), A(360,8), A2(360,1),
                    L(360), R(360)

70 GOSUB 1000                        'initialization
75 FOR B = 1 TO NUMFILES
80      GOSUB 2000                   'load data
90      GOSUB 3000                   'sort data
100     GOSUB 4000                   'calculate and plot
112 NEXT B
115 INPUT "",FDFD
117 INPUT "Re-run (y/n)",RR$ : IF RR$="y" OR RR$="Y"
                                  THEN 65 ELSE END
120 END
160 '----------------------------------------------------

1000 '----------------initialization------------------
1010 '
1020 CLS
1030 PRINT
1040 PRINT"---------DURATION CURVE MK1------------------"
1050 PRINT
1055 INPUT "   Input number of files          ";NUMFILES
1058         FOR I= 1 TO NUMFILES
1060 INPUT "   Input file name to be presented  ";F$(I)
1062         NEXT I
1065 INPUT "   Maximum data plotted on screen  ";MX
1100 PRINT
1110 PRINT"---------------------------------------------"
1200 RETURN

2000 '---------------------loading data-----------------
2100 '
2200 OPEN "i",1,F$(B)
2300 INPUT#1,NN$,M%,K%
2450 FOR J=1 TO K%
2460     FOR I=1 TO M%
2470          INPUT#1,A( I , J )
2480 NEXT   :NEXT
2490 CLOSE#1
2491   IF B>1 THEN 2500 ELSE 2492
2492 PRINT" file contains: "K%"  fields":
           INPUT " Select a field ";FD
2500 RETURN

3000 '--data sort using the MONKEY PUZZLE METHOD--------
3015 '
3020 '
3030 L( 1 )=0   :R( 1 )=0
3040   FOR I=2 TO M%
3050          L(I)=0   :  R(I)=0    :  J=1
3060          IF A(I,FD)>A(J,FD) THEN       3100
3070          IF L(J )=0 THEN              3090
3080          J=L(J)   :  GOTO            3060
3090          R(I)=-J  : L(J)=I  : GOTO 3130
3100          IF R(J)<=0 THEN              3120
3110          J=R(J)   : GOTO              3060
3120          R(I)=R(J)  : R(J)=I
3130  NEXT I
3140 '
3150  J=1 : K=1        :        GOTO 3170
3160  J=L(J)
3170  IF L(J)>0 THEN               3160
3180 A2(K,1)=A(J,FD)    :      K=K+1
3190 IF R(J)=0 THEN                3230
3200 IF R(J)<0 THEN                3220
3210 J=R(J)   :                 GOTO 3170
3220 J=-R(J) :                  GOTO 3180
3230 '
```

```
3240        IF MX=0 THEN MX=A2(M%,1)
3250 RETURN

4000 '-----------------data presentation-------------
4100 ' ----- graphics screen ----
4150 SCREEN 2,0,0,0
4200     LINE (10,0)-(10,180),1  :  LINE (10,180)-(630,180),1
4210     LINE (10,0)-(630,0),1  :  LINE (630,0)-(630,180),1
4220 '---------------------------
4250    FOR I=1 TO 10:PL=(I*62)+10: PSET (PL,181),1     : NEXT I
4257    FOR I=MX TO 0 STEP-100     : PSET (9,180/MX*I),1: NEXT I
4260 XP=630 : YP=180
4270      FOR I=1 TO M%
4300           A=A2(I,1)              ' sorted array
4350           EXC=(M%-I)/M%*100
4360           Y=(180-(180/MX*A))
4370           X=(EXC*620/100)+10
4390           LINE (X,Y)-(XP,YP),1
4400          XP=X  :  YP=Y
4450      NEXT I
4470  RETURN
4480 '
4490 '
```

Time series plots

Commands: PLOTFLO2 and PLOTWQ2

Definition

To obtain high quality hardcopies of time series, two programs are used which send the output to a graphics plotter. The program PLOTFLO2 plots two hydrographs or chemographs, and PLOTWQ2 plots a predicted chemograph and hydrograph as well as the corresponding water quality data.

Data Entry

When the programs are initiated from the operating system prompt the following data must be entered

Prompt	Expected Input
xmin -	
xmax -	Enter the minimum and maximum values
ymin -	for the x and y axes.
ymax -	
x axis title -	Enter the text to be placed on the x and
y axis title -	y axes, as well as on the main legend.
y axis title2 -	
main title -	
tick interval x -	Enter the interval between tick marks
tick interval y -	on the x and y axes.
Name of data file 1 -	Enter the file name of the time series
Name of data file 2 -	to be plotted.

Example

In the following example the program is used to plot the time series plots for Station 9A and 23D.

Prompt	Reply
Is the plotter loaded with paper ?	This prompt is cleared by pressing return.
xmin -	"0"
xmax -	"360" y
min -	"0" y
max -	"700"
x axis title -	"Time"
y axis title -	"Discharge (m3/s)"
y axis title2 -	""
main title -	"Hydrographs Stations 9A & 23D"
tick interval x -	"50"
tick interval y -	"50"
Name of data file 1 -	"9aq12.4"
Name of data file 2 -	"23dq12.4"
are you happy with configuration ?	Enter "y" to continue and "n" to re-initialize.

The data are loaded from disk, processed and the time series plotted on the graphics plotter.

The procedure PLOTWQ2 is similar to the example given above except that the user must specify the name of the water quality files to be plotted. Default values are also included in the initialization procedure.

Listing of source code : PLOTFLO2

```
1 'THIS PROGRAM PLOTS TWO HYDROGRAPHS
                          (i.e. PREDICTED & MEASURED DATA)

3 '-----------------------plotflo2----------------------
5 CLS

15 PRINT" THIS PROGRAM PLOTS TWO TIME SERIES:
          ONE DOTTED & ONE SOLID LINE":PRINT
16 INPUT "       Is the plotter loaded with paper and set-up";UI$
17 CLS

21 PRINT"------------------------ Initialization ----------"
22 INPUT" xmin=";XMIN    ' specify the world plotting coordinates
23 INPUT" xmax=";XMAX
24 INPUT" ymin=";YMIN
25 INPUT" ymax=";YMAX
40 '
50 INPUT "  x axis title ";X$        ' titles of axes
70 INPUT "  y axis title" ;Y$
72 INPUT "  y axis title2";Y2$
88 INPUT " main title        "; TITLE$
89 '
90 INPUT " space interval x  "; SPACEX      ' tick mark interval
93 INPUT " space interval y  "; SPACEY :
   PRINT" The first series is plotted in dotted lines
          the second as a solid line"
94 INPUT " NAME OF DATA FILE 1 ";F1$ :INPUT " field number:";FD1
95 INPUT " NAME OF DATA FILE 2 ";F2$ :INPUT " field number:";FD2
96 INPUT " are you happy with the configuration ? (y/n)";CF$ :
         IF CF$="y" THEN 97 ELSE 17

97  GOSUB 1000         ' loading data file ---->

100 '----------------------------------------plotter routine
105  OPEN "com1:9600,n,8,1,rs,ds,cd"AS#1
110 NPAPER =1                    '---------set plotting grid etc.
120 PRINT#1, "IN;SP1;IP1250,750,9250,6250;"                    :
130 PRINT#1, "SC";XMIN;XMAX;YMIN;YMAX;  +CHR$(3)               :
140 PRINT#1, "PU";XMIN;YMIN;";pd";                             :
          XMAX;YMIN;XMAX;YMAX;XMIN;YMAX;XMIN;YMIN;";PU"

150 PRINT#1, "PU0";YMIN;"PD0,";YMAX;";PU"                      :
160 PRINT#1, "SI.1,.2;TL 1,0"                                  :
170 FOR DUMMY = 1 TO 1000     :NEXT DUMMY    '<<pause loop>>
180 '
190 FOR X= XMIN TO XMAX STEP SPACEX          '--mark ticks on x axis
200     PRINT#1, "pa ";X;YMIN;"xt;"
210     PRINT#1, "CP -1.5,-1;LB";USING "###";X
220     PRINT#1,     +CHR$(3)
225                           FOR DUMMY=1 TO 1000 :NEXT DUMMY
230             NEXT X
240 '
270 FOR DUMMY = 1 TO 1000     :NEXT DUMMY
280 '
290 FOR Y= YMIN TO YMAX STEP SPACEY          '--mark ticks on y axis
300     PRINT#1, "PA";XMIN;Y;";YT;"
310     PRINT#1, "CP -6,-.25;LB";USING "###";Y
320     PRINT#1,     +CHR$(3)
325                           FOR DUMMY = 1 TO 1000: NEXT DUMMY
330             NEXT Y
335 '
340                           FOR DUMMY =1 TO 10000 :NEXT DUMMY

350             '-----plot text---
360 PRINT#1, "PA";((XMAX-XMIN)/2+XMIN);YMIN;"CP -7,-2.5;
             LB";X$; +CHR$(3)
370 PRINT#1, "PA";XMIN;YMAX;";CP -5,2.5;LB";Y$; +CHR$(3)
375 PRINT#1, "CP -11,-1;LB"Y2$; +CHR$(3)
380 PRINT#1, "PA";((XMAX-XMIN)/2.5+XMIN);YMAX;";SI .2,.4;
             CP -12.5,2.0"
390 PRINT#1, "lb";TITLE$; +CHR$(3)
400 PRINT#1, "SI .1,.2"; +CHR$(3)
405                           FOR DUMMY=1 TO 10000:NEXT DUMMY

420 '                  --plot time series--
422 PRINT#1, "LT2,1;"
425    FOR J=1 TO KX
```

```
430        FOR I=1 TO M%
437    IF Q(I,FD1)>YMAX THEN Q(I,FD1)=YMAX
440              PRINT#1, "PA";I;Q(I,FD1);"PD;"
442                                   FOR DUMMY=1 TO 666 :NEXT DUMMY
450  NEXT : NEXT
452 PRINT#1, "PU ;"
455 :
462 PRINT#1, "LT;"
465   FOR J=1 TO K1%
470        FOR I=1 TO M1%
477    IF Q2(I,FD2)>YMAX THEN Q2(I,FD2)=YMAX
480              PRINT#1, "PA";I;Q2(I,FD2);"PD;"
482                                   FOR DUMMY=1 TO 666 :NEXT DUMMY
490  NEXT : NEXT
492 PRINT#1, "PU ;"
500 CLOSE#1
525 PRINT"--------------- END ----------------------------"
555 END

1000 '+++++++++++++++ LOADING FLOW DATA FILE++++++++++++
1010 OPEN "I",1,F1$
1020 INPUT#1,NN$,M%,K%
1025    DIM Q(M%,K%)
1030       FOR J= 1 TO K%
1040              FOR I=1 TO M%
1050                  INPUT#1,Q(I,J)
1060       NEXT :NEXT
1070 CLOSE#1

2000 '+++++++++++++++ LOADING FLOW DATA FILE 2 +++++++++
2010 OPEN "I",1,F2$
2020 INPUT#1,NN$,M1%,K1%
2025    DIM Q2(M1%,K1%)
2030       FOR J= 1 TO K1%
2040              FOR I=1 TO M1%
2050                  INPUT#1,Q2(I,J)
2060       NEXT :NEXT
2070 CLOSE#1
2080 RETURN
```

Listing of source code ; PLOTWQ2

```
1  '  this program plots one chemograph and one hydrograph

3 '-----------------------plotwq2-----------------------
5 CLS

13 PRINT
14 PRINT "        Is the "MODE" statement correct????"
15 PRINT
16 INPUT "        Is the plotter loaded with paper and set-up";UI$
17 CLS

21 PRINT"----------- plotter routine ----------------------"
22 INPUT" xmin=[0]";XMIN : IF XMIN=0 THEN XMIN=0
23 INPUT" xmax=[360]";XMAX : IF XMAX=0 THEN XMAX=360
24 INPUT" ymin=[0]";YMIN : IF YMIN=0 THEN YMIN=0
25 INPUT" ymax=[700]";YMAX : IF YMAX=0 THEN YMAX=700
27 PRINT
40 INPUT " Do you require a rough plot (y/n)";QUICK$ :
        IF QUICK$="y"THEN 90
45 PRINT
47 PRINT" NB:- the hydrograph is plotted as a broken line
   while chemograph is represented as a solid line, measured data
             are plotted as asteri"
49 PRINT
50 INPUT "  x axis title [TIME (12-Hour intervals)] ";X$
55    IF X$="" THEN X$="T I M E    (12-Hour intervals)"
70 INPUT "  y axis title [Total phosphorus conc.]" ;Y$
71 IF Y$="" THEN Y$="Total phosphorus concentration (ug/l)  ---"
72 INPUT "  y axis title2 [Discharge (m3/s) - - - -]";Y2$
74 IF Y2$="" THEN  Y2$="Discharge (m3/s) - - - -"
88 INPUT " main title         "; TITLE$
89 PRINT
90 INPUT " Space interval x [50] "; SPACEX :
                               IF SPACEX =0 THEN SPACEX=50
91 INPUT " Space interval y [50] "; SPACEY :
```

```
                        IF SPACEY =0 THEN SPACEY=50:
  PRINT"Do not type file paths:-"
92 INPUT " NAME OF DATA FILE 1 drive A ";F1$
93 INPUT " NAME OF WQ   FILE 2 drive B ";F2$
94 INPUT " NAME OF WQ   FILE 3 drive B ";WQ$
95 INPUT " WQ DATA FIELD ALLOCATION #(1-8)";AL%

96  GOSUB 1000                         '++++++++ LOADING DATA FILE

105  OPEN "com1:9600,N,8,1,rs,ds,cd"AS#1
110 NPAPER =1                           ' prepare plotting grid
120 PRINT#1, "IN;SP1;IP1250,750,9250,6250;"
130 PRINT#1, "SC";XMIN;XMAX;YMIN;YMAX;  +CHR$(3)
140 PRINT#1, "PU";XMIN;YMIN;";pd";XMAX;YMIN;XMAX;YMAX;XMIN
              ;YMAX;XMIN;YMIN;";PU"
150 PRINT#1, "PU0";YMIN;"PD0,";YMAX;";PU"
160 PRINT#1, "SI.1,.2;TL 1,0"
165 IF QUICK$="y" THEN 410
170 FOR DUMMY = 1 TO 1000     :NEXT DUMMY
180 '
190 FOR X= XMIN TO XMAX STEP SPACEX       ' plot tick marks (x)
200      PRINT#1, "pa ";X;YMIN;"xt;"
210      PRINT#1, "CP -1.5,-1;LB";USING "###";X
220      PRINT#1,    +CHR$(3)
225                       FOR DUMMY=1 TO 2500 :NEXT DUMMY
230             NEXT X
240 '
270                  FOR DUMMY = 1 TO 3000     :NEXT DUMMY
280 '
290 FOR Y= YMIN TO YMAX STEP SPACEY       ' plot tick marks (Y)
300      PRINT#1, "PA";XMIN;Y;";YT;"
310      PRINT#1, "CP -6,-.25;LB";USING "###";Y
320      PRINT#1,    +CHR$(3)
325                  FOR DUMMY = 1 TO 2000: NEXT DUMMY
330             NEXT Y
335 '
340                  FOR DUMMY =1 TO 12500 :NEXT DUMMY
350 '      ---------text---------
360 PRINT#1, "PA";((XMAX-XMIN)/2+XMIN);YMIN
           ;"CP -7,-2.5;LB";X$; +CHr$(3)
365                  FOR DUMMY=1 TO 12000:NEXT DUMMY
370 PRINT#1, "PA";XMIN;YMAX;";CP -5,2.5;LB";Y$; +CHR$(3)
375                  FOR DUMMY=1 TO 12000:NEXT DUMMY
376 PRINT#1, "cp-11,-1;lb"Y2$; +CHR$(3)
379                  FOR DUMMY=1 TO 17000:NEXT DUMMY
380 PRINT#1, "PA";((XMAX-XMIN)/2.5+XMIN);YMAX;";SI .2,.4
           ;CP -12.5,2.0"
390 PRINT#1, "lb";TITLE$; +CHR$(3)
400 PRINT#1, "SI .1,.2"; +CHR$(3)
405                  FOR DUMMY=1 TO 17000:NEXT DUMMY

420 '        ------- time series plots-----------
422 PRINT#1, "LT2,1;"
425   FOR J=1 TO K%
430        FOR I=1 TO M%
437    IF Q(I,J)>YMAX THEN Q(I,J)=YMAX
440             PRINT#1, "PA";I;Q(I,J);"PD;"
442                  FOR DUMMY=1 TO 750 :NEXT DUMMY
450  NEXT : NEXT
452 PRINT#1, "PU ;"
462 PRINT#1, "LT;"
465   FOR J=1 TO K1%
470        FOR I=1 TO M1%  :  Q2=Q2(I,J)
477    IF Q2>YMAX THEN Q2=YMAX
480             PRINT#1, "PA";I;Q2;"PD;"
482                  FOR DUMMY=1 TO 500 :NEXT DUMMY
490  NEXT : NEXT
492 PRINT#1, "PU ;" :FOR DUMMY=1 TO 10000 :NEXT DUMMY

493 ' print out wq data file +++++++++++++++++
494  J=8   :  IF M%>180 THEN COMPEN=2 ELSE COMPEN=1
495        FOR I=1 TO M2%  :  WQ=WQ(I,AL%) :  Z=WQ(I,1)*COMPEN
496    IF WQ>YMAX THEN WQ=YMAX
497             PRINT#1, "PU;SM*;PA";Z;WQ;"PD;"
498                  FOR DUMMY=1 TO 2000 :NEXT DUMMY
499             PRINT#1, "SM;PU";
500    NEXT I
501 PRINT#1, "PU ;"
510 CLOSE#1
```

```
525 PRINT"------------- END ------------------------"
555 END

1000 '++++++++++ LOADING FLOW DATA FILE+++++++++++++
1010 OPEN "I",1,F1$
1020 INPUT#1,NN$,M%,K%
1025    DIM Q(M%,K%)
1030       FOR J= 1 TO K%
1040                FOR I=1 TO M%
1050                      INPUT#1,Q(I,J)
1060    NEXT :NEXT
1070 CLOSE#1

2000 '+++++++++ LOADING FILE 2 +++++++++
2010 OPEN "I",1,"b:"+F2$
2020 INPUT#1,NN$,M1%,K1%
2025    DIM Q2(M1%,K1%)
2030       FOR J= 1 TO K1%
2040                FOR I=1 TO M1%
2050                      INPUT#1,Q2(I,J)
2060       NEXT : NEXT
2070 CLOSE#1

3000 '++++++++++  LOADING WQ DATA FILE  ++++++++++++
3010 OPEN "I",1,"B:"+WQ$
3020 INPUT#1,NN$,M2%,K2%
3025    DIM WQ(M2%,K2%)
3030       FOR J= 1 TO K2%
3040                FOR I=1 TO M2%
3050                      INPUT#1,WQ(I,J)
3060       NEXT :NEXT
3070 CLOSE#1
3080 RETURN
```

3 MODEL DEVELOPMENT

Seven modelling procedures are described in this section which are summarized below and described in detail in the following sections.

Procedure	Description
Regression Analysis	Performs a least squares regression using one independent variable. Estimates linear or selected non-linear models.
Phosphorus nonpoint source model	Using a regression equation, simulates the phosphorus chemograph using the hydrograph for a specific station. Options include interactive model calibration, scaling of axes and saving of simulated data.
Hydrodynamic flow model	This procedure simulates the hydrographs at sampling stations along the main river channel, using upstream hydrograph and lateral inflow data.

Transport model: SECTION1

This procedure simulates the *phosphorus chemograph* at Lady Loch Bridge. Options include interactive model calibration, scaling of axes and saving of simulated data.

Transport model: SECTION2

This procedure simulates the phosphorus chemograph at sampling stations along the main river channel between Lady Loch Bridge (Station 13B) and Drie Heuwels Weir (Station 23D).

Phosphorus bed load model

This procedure simulates the mass of phosphorus transported as bed material.

Pre-impoundment model

This procedure simulates the mass of phosphorus retained within a *pre-impoundment* located at Drie Heuwels Weir. Options include interactive model calibration.

Regression analysis

Command : REGRESS

Definition

The procedure fits a model relating one dependent variable to one independent variable by minimizing the sum of the squares of the residuals for the fitted line. Any four models can be fitted

linear	$y = a + b\ x$
power	$y = a\ x^{b}$
exponential	$y = a\ EXP\ (x\ b)$
logarithmic	$y = \log x\ b + a$

In the power, logarithmic and exponential regression models "linearization" is achieved through logarithmic transformation. Once calculated the fitted line and data values are plotted on the graphics screen.

The procedure also performs the following calculations on the data set:

- mean of x and y,
- standard deviation of x and y,
- regression coefficients (a and b),
- correlation coefficient (r).

Data Entry

When the program is initiated from the operating system prompt the following data must be entered

Field	Expected Input
what type of regression do you require ?	Enter 1 for linear, 2 for logarithmic, 3 for exponential and 4 for power regression.
number of data pairs to be input -	Enter the number of pairs of data to be entered via the keyboard.
name of data set -	Enter the name of the data set.

At this point the data are entered and the specified regression calculations are done with the statistics given in tabular form and plotted on the graphics screen.

Example

In the following example a linear regression equation is done on a data set containing three pairs of data.

Prompt	Reply
what type of regression do you require ?	"1"
number of data pairs to be input ?	"3"
name of data set ?	"test"

- At this point the program will ask for the data to be entered.

1
x ?
y ? Enter a data value for each x and y prompt.

- The statistics of the data set are calculated and presented in a tabular form. To continue to the graphics output press the return key.

input max. x plotted - Enter numeric for maximum value to be plotted on the x-axis.

input max. y plotted - Enter numeric for maximum value to be plotted on the y-axis.

The program plots the input data and regression line within the screen plotting limits specified above.

Listing of source code

```
5 PRINT " loaded fix ??????"          ' emulation for Hercules card
        : FOR I=1 TO 5000: NEXT       ' pause loop

10 CLEAR :CLS : SCREEN 0,0,0
20 PRINT"      LINEAR AND CURVI-LINEAR STATS      "

40 '----main routine-----------------------------------------
50 '
60   GOSUB 1000                    'initialisation
70   GOSUB 2000                    'data input
80   GOSUB 3000                    'calculation and output
90   GOSUB 4000                    'graphics
100  INPUT "re-run ? (y/n)";QU$ : IF QU$="n" THEN 110 ELSE 10
110  SCREEN 0,0,0 : END
120 '--------------------------------------------------------

1000 PRINT"------------------ INITIALISATION --------------"
1100 PRINT
1200 PRINT"  what type of regression do you require ? "
1220 PRINT"                                        linear : 1"
1230 PRINT"                                        log    : 2"
1240 PRINT"                                        exp    : 3"
1250 PRINT"                                        power  : 4"
1260 '
1270 INPUT "        ( 1-4 )                              ";TYPE
1280              IF TYPE <1 OR TYPE >4 THEN 1270
1290 INPUT "number of data pairs to be input ( MAX = 150 )";N%
1300              IF N%>150 THEN 1290 ELSE 1320
1320 INPUT "name of data set                             ";NAM$
1340 RETURN

2000 CLS : PRINT"---------- Data input via keyboard ---------"
2100 '
2200  DIM XI(150),X(150),YI(150),Y(150)
2220  FOR I=1 TO N%
2230       PRINT I : INPUT " x "; XI(I)
2240               : INPUT " y "; YI(I)
2250  NEXT I
2260  PRINT"         end of data input        "
2265 '
2270     RETURN

3000 PRINT "------------------ CALCULATIONS -----------"
3010   GOSUB 3500      ' data format
3020   GOSUB 3100      ' mean
3030   GOSUB 3200      ' standard deviation  (sample)
3040   GOSUB 3300      ' regression coefficients

3050 '
3060 PRINT"name of data-set :"NAM$ "    regression code: "TYPE
3070 PRINT"number of samples " N%
3072 PRINT"mean   x    "MX "   mean   y   " MY
3074 PRINT"sd     x    "SDX "  sd     y   " SDY
3076 PRINT"lra         "LRA "  lrb         " LRB
3078 PRINT"cor         " R "   r^2         "RS
3080  INPUT "<<<  RETURN FOR GRAPHIX  >>>";QU$
3090 RETURN

3100 '---------mean
3110           FOR I=1 TO N%
3120               SX=SX+X(I)  : SY=SY+Y(I)
3125           NEXT I
3130    MX=SX/N%    : MY=SY/N%
3140    RETURN

3200 '--------standard deviation
3210           FOR I=1 TO N%
3220               SDX=SDX+((X(I)-MX)^2)
3225               SDY=SDY+((Y(I)-MY)^2)
3230           NEXT I
3240    SDX= (SDX/(N%-1))^.5
3245    SDY= (SDY/(N%-1))^.5
3250     RETURN

3300 '-----regression and correlation coefficients:-
3310           FOR I=1 TO N%
```

```
3320              SXY=SXY+(X(I)*Y(I))
3325              SXS=SXS+(X(I)^2)
3327              SYS=SYS+(Y(I)^2)
3328          NEXT I
3330              LRB=((N%*SXY)-(SX*SY))/((N%*SXS)-(SX^2))
3340              LRA=(SY-(LRB*SX))/N%
3345              IF TYPE >=3 THEN 3350  ELSE 3355
3350              LRA= EXP(LRA)
3355              R=((N%*SXY)-(SX*SY))
3365              R=R/((((N%*SXS)-SX^2)*((N%*SYS)-SY^2))^.5)
3370              RS=R^2
3375:
3380   RETURN

3500 '----------------- data format---------------------
3520      ON TYPE GOSUB 3600,3610,3620,3630
3530      RETURN

3550 '
3600  FOR I=1 TO N% : X(I)=XI(I) : Y(I)=YI(I) : NEXT I : RETURN
3610  FOR I=1 TO N% : X(I)=LOG(XI(I)): Y(I)=YI(I) :NEXT I:RETURN
3620  FOR I=1 TO N% : X(I)= XI(I) : Y(I)=LOG(YI(I)):NEXT I:RETURN
3630  FOR I=1 TO N% : X(I)=LOG(XI(I)): Y(I)=LOG(YI(I)): NEXT I :
 RETURN

4000 CLS : PRINT"--------------------graphix------------------
4100 INPUT " input max x plotted  ";MAXX
4110 INPUT " input max y plotted  ";MAXY
4120 SCREEN 2,0,0,0
4130 PRINT" name of data-set :"NAM$ "      max. Y "MAXY
4140 LINE (10,0)-(10,180),1 : LINE (10,180)-(630,180),1
4150 '
4160                    FOR I=1 TO N%
4170                         XP=(630/MAXX*XI(I))+10
4180                         YP=180-(180/MAXY*YI(I))
4190                         CIRCLE (XP,YP),2
4200                    NEXT I
4210 '
4220    FOR X=1 TO MAXX STEP .5              'plot best fit
4230       ON TYPE GOSUB 4300,4400,4500,4600
4240       YP=180-(180/MAXY*Y)
4250       XP=(630/MAXX*X)+10
4260       PSET (XP,YP),1
4270    NEXT X
4280 RETURN

4300 Y=(LRB*X)+LRA        : RETURN
4400 Y=(LRB*LOG(X))+LRA   : RETURN
4500 Y=(EXP(LRB*X))*LRA   : RETURN
4600 Y= (X^LRB)*LRA       : RETURN
```

Phosphorus nonpoint source model

Command : NPSM

Definition

NPSM (Nonpoint Source Model) is a fully interactive graphics program used to calibrate and verify the nonpoint source model for stations receiving phosphorus export from nonpoint sources. The total phosphorus load for the period is calculated using Simpson's approximation. The output from this program is directed to the graphics screen where the chemograph, hydrograph and measured data are displayed. A description of the formulation of the model is given in Chapter 7, Section 1 and presented in Fig A2.2.

Data Entry

The program is initiated from the operating system and the following data must be entered

Prompt	Expected Input
Station number -	Enter the station code number.
Period of data -	Enter the numeric corresponding to the period of data required (value between 1 and 6).
Max.flow data plotted-	Enter the maximum discharge value plotted on the graphics screen (units: cumecs).
Max.wq data plotted -	Enter the maximum value of the concentration data plotted on the graphics screen (units: µg/ℓ).

Do you wish to save data ? The predicted chemograph for the station may be saved on disk using this option.

Is there a wq data file ? The program uses the measured phosphorus concentration values to calibrate the model. However, the program may still be used if no data is available for a specific station.

values for B - From the table presented in the menu,

A - enter values for each of the model coefficients

B2 -

A2 -

Name of flow data file - Enter the filename of the flow data file containg the hydrograph.

Example

In the following example the nonpoint source model is used to predict the phosphorus chemograph at Station 9A, during Period 6.

Prompt	Reply	Program Response
Station number -	"9a"	
Period of data -	"6"	
Max.flow data plotted - [300]	"250"	
Max.wq data plotted - [700]	"550"	
Do you wish to save data ?	"n"	
Is there a wq data file ?	"y"	
value for B -	"0.0013" value for	
value for A - [0.017]	"0.017" value for	
value for B2 - [-.007]	"-.007" value for	
A2 -[0.009]	"0.009"	
Name of flow data file -	"9aql2"	
Are you happy with the initialization ?	""	- The program reads the files from disk, processes the data and displays the hydrograph, simulated phosphorus chemograph and measured phosphorus data for Station 9A.

Listing of source code

```
2 '                                          -- NPSM --
3 '                                          <<<<<>>>>>
4 CLEAR : SCREEN 0,0,0 : CLS
5 '
10 ' THIS PROGRAM FEATURES:     1.LINEAR LRC APPROACH
11 '                              2.MODIFICATION FOR LOW FLOW FX
15 '                              3.CALCULATES TOTAL LOAD AND FLOW
30 '
32 '
33 '

35 '++++++++++++++++initialization++++++++++++++++++++++++++++

40 PRINT"------------------------------ NPS MODEL ------------"
50 PRINT  :
55 PRINT"<<  Place flow data in drive A & wq data in drive B >>"
56 PRINT"                ---------------------------------------"
58 PRINT
59 TG$="y"
60 INPUT " Station number (ie 9a 23d 14b 17b)   :";ST$
75 INPUT " Period of data (ie 1 to 6)           :";P$
80 INPUT " Max.flow data plotted (m3/s) [300]   :";MX :
     IF MX=0 THEN MX=300
90 INPUT " Max. wq  data plotted (ug/l) [700]   :";MQ
    :IF MQ=0 THEN MQ=700
91 INPUT " Do you wish to save data(y/n)        :";QQQ$
92 INPUT " Is there a wq data file (y/n)        :";ZZ$
93 PRINT""
94 PRINT"  STATIONS :  --9A ----14B----17B----23A----23D--23b--"
95 PRINT"  values for LRB .0013¦ .040 ¦ .020 ¦ .004 ¦ .0005¦ .09"
99 INPUT " LRB  :";LRB
100 PRINT
101 PRINT"  STATIONS :  --9A ----14B----17B----23A----23D--23b--"
102 PRINT" values for LRA.017 ¦ .035 ¦ .025 ¦ .015 ¦ .035 ¦ .045"
104 INPUT " LRA               :";LRA
105 INPUT " LRB2 [-.007]     :";LRB2 : IF LRB2=0 THEN LRB2=-.007
106 INPUT " LRA2 [ .009]     :";LRA2:
     IF LRA2=0 THEN LRA2=8.999999E-03
107 INPUT " Name of flow data file
(excluding extension i.e. 9aq12)";Q$
108        Q$=Q$+"."+P$                      ' flow data file name
109       WQ$=ST$+"t."+P$                    ' wq data file name
111 '
119 '
142 '
145 '
150 PRINT"-------------------------------------------"
160 PRINT :
165 INPUT"Are you HAPPY with the initialisation above? (_/n)     ";
      INIT$:
170 IF INIT$="n" OR INIT$="N" THEN 4 ELSE 200
177 PRINT
180 '
190 '

200 '++++++++++-main routine-++++++++++++++++++++++++
210   GOSUB 400                 ' load data                 ¦
220   GOSUB 300                 ' graphics screen           ¦
230   GOSUB 500                 ' plot q data               ¦
240   GOSUB 600                 ' plot wq data              ¦
242   GOSUB 2000                ' calculation               ¦
245   GOSUB 5000                ' save data (chemograph)    ¦
246   GOSUB 6000                ' residual calculation      ¦
247 INPUT "+",PROMPT            '                           ¦
248 IF PROMPT=0 THEN  4         '                           ¦
250   END '++++++++++++++++++++++++++++++++++++++++++++++++

300   '------graphics screen---------------------------------
310   SCREEN 2,0,0,0
320   LINE  (10,0)-(10,180),1
325   LINE  (10,180)-(630,180),1
327  FOR I= 180 TO 0 STEP -(1800/MQ) : PSET (9,I),1 : NEXT I
329  FOR I= 1 TO 630 STEP (630/180) : PSET (I+10,181),1 : NEXT I
```

```
333 RETURN

400 '--------- Load data------------------------------------
402 PRINT "    loading flow data                                "
403 :
404                 ON ERROR GOTO 7010
405   OPEN "i",1,Q$
407                 ON ERROR GOTO 0
410   INPUT#1,NN$,M%,K%
420     DIM Q(360,1)
425      FOR J= 1 TO K%
427             FOR I=1 TO M%
430                  INPUT#1,Q(I,J)
435      NEXT :NEXT
440                          CLOSE#1
441 IF ZZ$="y" THEN 442 ELSE RETURN
442 PRINT "                                 loading wq data"
450 WQ$="b:"+WQ$
452                 ON ERROR GOTO 7020
455 OPEN "i",1,WQ$
457                 ON ERROR GOTO 0
460   INPUT#1,NN$,N%,C%
465     DIM WQ(360,3)
470      FOR J= 1 TO C%
475             FOR I=1 TO N%
480                  INPUT#1,WQ(I,J)
485      NEXT :NEXT
490 CLOSE#1
498 RETURN

500 '----- plot hydrograph----------

510      FOR I= 1 TO M%
520           Q=Q(I,1)      :   X=(I*630/M%)+10
525               Q=(180-(180/MX*Q))
530      IF          I=1 THEN 537
535                    LINE(X,Q)-(XP,QP),1
537                          QP=Q:XP=X
540      NEXT I
542 '     venetian blind
543 FOR I=1 TO 177 STEP 3: LINE (11,I)-(629,I),0 : NEXT I

546 '----- plot wq data--------------

550 IF ZZ$="y" THEN 555 ELSE RETURN
555    FOR I= 1 TO N%
560         T=WQ(I,2) : Z=WQ(I,1)    : X=(Z*3.4445)+11
565              T=(180-(180/MQ*T)) : IF T<0 THEN T=1
570                  CIRCLE (X,T),4   :
575    NEXT I
580 RETURN

600 '++++++++++++calculations+++++++++++++++++++

620   : LOUT=0 : DIM LP(360),SD(360,1)
630 FOR I=1 TO M%
640      Q=Q(I,1)                                 '----Equation 6.40---
645      IF I=1  THEN  690
655             DQ=ABS (Q-QQ)     :  SLOPE=(LRA2 *EXP(LRB2*Q))
660   IF Q>QQ THEN     TP=((LRB *Q)+LRA)+(SLOPE*DQ)
                ELSE     TP=(LRB *Q)+LRA           '----Equation 6.41---
670
672     LOUT=TP*Q*86400!*180/M%*.001:LP(I)=TP*Q:
        SD(I,1)=TP*1000
675                       X=(I*630/M%)+10
680                           T=(180-(180/MQ*TP*1000))
682                 IF         I=2 THEN 690
685                               LINE(X,T)-(XX,TT),1
690                                   QQ=Q :XX=X:TT=T
695   NEXT I
700   RETURN

2000 '---------- calculation of the total load of TP using
                       Simpson's approximation ---------------
2200 TLE=0 :TLO=0
2300  FOR I= 2 TO M%-2 STEP 2
2400           LE=LP(I)*4    :   TLE=TLE+LE
2500           LO=LP(I+1)*2    :   TLO=TLO+LO
2600  NEXT I
2700 TOTALLOAD=(LP(1)+TLE+TLO+LP(M%))*28800*(180/M%)
```

```
2750 PRINT" TOTAL LOAD="TOTALLOAD"  g        ---
     STATION:"ST$" --- PERIOD:"P$

3100 '------------calculation of the total flow---------
3200 TQE=0 :TQO=0
3300  FOR I= 2 TO M%-2 STEP 2
3400          QE=Q(I,1)*4    :  TQE=TQE+QE
3500          QO=Q(I+1,1)*2    :  TQO=TQO+QO
3600  NEXT I
3700 TOTALFLOW=(Q(1,1)+TQE+TQO+ Q(M%,1))*28800*(180/M%)
3750 PRINT" TOTAL flow="TOTALFLOW"  m3
     [TP]="TOTALLOAD/TOTALFLOW
3800 RETURN

5000 '-- save data from model prediction at the specific station
       and period------------------------------------------
5200 '
5300 IF QQQ$="y" THEN 5400 ELSE RETURN
5400 '
5500 SDF$=ST$+"tp12."+P$
5550                               ON ERROR GOTO 7030
5600  OPEN "o",1,"b:"+SDF$
5650                               ON ERROR GOTO 0
5700                        PRINT #1,SDF$
5710                        PRINT #1,M%
5720                        PRINT #1,K%
5730                     FOR J=1 TO K%
5740                        FOR I=1 TO M%
5750                            PRINT #1,SD(I,J)
5760                    NEXT : NEXT
5770  CLOSE#1
5780 RETURN

6000 '----- residual stat. analysis --------------------------
6100 SS=0 : MS=0 : T12=0 : T11=0 : T21=0
6200  FOR I=1 TO N%
6300          Z= WQ(I,1)*2-1
6350          OBS= WQ(I,2)
6400          PRED= SD(Z,1)
6500          EI= (OBS-PRED)
6550          SS=SS+(EI^2)
6600          T21=T21+(EI^2*PRED)
6620          T11=T11+(EI  *PRED)
6650          T12=T12+(EI*PRED^2)
6700   NEXT I
6800    MS= SS/(N%-2)
6900 PRINT
"sum of squar="SS"  mean square="MS" t21="T21" t11="T11 " t12="T12
6999  RETURN

7000 '-------- error handling ------------------------------
7010 INPUT "ERROR- CHECK DRIVE/DISK <<return>> ",ER$ :RESUME 405
7020 INPUT "ERROR- CHECK DRIVE/DISK <<return>> ",ER$ :RESUME 455
7030 INPUT "ERROR- CHECK DRIVE/DISK <<return>> ",ER$ :RESUME 5600
7050 ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
```

Listing of source code in NPSM CON: Hydrograph/chemograph decomposition model, see Chapter 7, Section 2.

The same procedures and intialization are used in this model as shown above. The calculation procedure is as follows:

```
600 '+++++++++++++++++++++++++ calculations +++++++++++++++++++++
610  ' this approach uses a mechanistic approach to TP modelling by
dividing the hydrograph and chemograph into surface and subsurface
drainage components (see Chapter 6 : Phosphorus Nonpoint Source
model)...

620  : LOUT=0 : DIM LP(360),SD(360,1)
625  COUNT=0
630  FOR I=STRT  TO  FIN      ' part of the time sequence may be
                                specified by the user.........
635     COUNT=COUNT+1
640     Q=Q(I,1) : QP=Q(I-1,1) : QF=Q(I+1,1)
                 'QP = antecedant flow QF = next flow value.

642  IF Q>QP AND Q>QF THEN 645 ELSE 650        ' ie peak flow
645  GOSUB 800      : QSURF=Q-QBASAL : QSUBSURF=0 : T=0 :QPEAK=Q

648 ' Q = instantaneous flow QBASAL = basal flow QPEAK = peak flow

650  IF Q<QP           THEN 655 ELSE 660        'recession flow
655        T=T+1:GOSUB 800:  QSURF=QPEAK*EXP(-1.4*T)  ' recession of
                                                   surface runoff
                                                   (QSURF)

656     IF QSURF<QBASAL THEN QSURF=0
657                              QSUBSURF=Q-(QSURF+QBASAL)
658 '
660  IF Q=QP THEN 665 ELSE 670                'steady flow conditions
665          QBASAL=Q :QSURF=0 :QSUBSURF=0
667 '
670  IF Q>QP AND Q<QF THEN 675 ELSE 677       'rising flow conditions
675          GOSUB 800     : QSURF=Q-QBASAL

677        '---phosphorus load for surface (LOADSURF) and subsurface
               (LOADSUBSURF) drainage.......

680  LOADSURF=(.104+(.0035*Q))*QSURF         'pp from surface runoff
682  LOADSUBSURF=(.025+(.0025*QSUBSURF))*QSUBSURF
                                              sp from subsurface
683  LOADBASAL1=(.006+(.0012*QBASAL))*QBASAL
                                             'sp from basal flow
684  LOADBASAL2=(.006+(.00035*QBASAL))*QBASAL
                                             'pp from basal flow scour
685 ON SPECIES GOSUB 687, 688, 689
686 IF TP=>0 THEN 690 ELSE PRINT"error in loadings"
687  TP=(LOADSURF+LOADSUBSURF+LOADBASAL1+LOADBASAL2)/Q*1000!
:RETURN:                              ' predicted tp
688  TP=((LOADSUBSURF+LOADBASAL1)/(QSUBSURF+QBASAL))*1000
:RETURN:                              ' predicted sp
689  TP=((LOADSURF+LOADBASAL2)/(QSURF+QBASAL))*1000
:RETURN:                              ' predicted pp
690  SD(I,1)=TP : LP(I)=TP*Q*.001 : X=COUNT*(630/RANGE)+10:
                                     Y=180-(180/MQ*TP)
691 IF I=STRT THEN 694                 ' graphics output
692      LINE(X,Y)-(XP,YP),1
694      XP=X : YP=Y
695  NEXT I
700  RETURN
730 '
800               ' routine for estimating the basal flow ...
810                   QBASAL=20 *(1-(EXP(-.045*Q))) :
        IF QBASAL>Q THEN QBASAL=Q
820     RETURN
```

Hydrodynamic flow model

Command QMODEL

Definition

QMODEL is an interactive graphics program predicting the river hydrograph at eight discrete points along the main river channel using a finite difference solution of the mass continuity equation. The model plots the measured and predicted hydrographs at Drie Heuwels Weir on the graphics screen, and integrates the hydrograph to calculate the total volume discharged. A detailed description of model formulation is given in Chapter 6. Figure A2.3 illustrates the data files and utility programs used in conjunction with the flow model.

Data Entry

The procedure is initiated and calls for the following input (see Chapter 6 for more details on the coefficients and input to the model).

Prompt	Expected Input
Time weighting factor	Enter the space and time weighting factor coefficients.
Do you require both linear and nonlinear scheme ?	The linear scheme may be run independently of the nonlinear scheme showing the initiation values produced by the linear scheme.
Do you require 12-hourly flow data ?	The model is designed to use daily and 12-hourly input data.
Non-linear tolerance (%)	Iteration in the nonlinear scheme will continue until the specified level of tolerance is achieved.
Period of data required	Enter the period of data required in the model simulation (integer from 1 to 6).

Maximum flow plotted (m^3/s)	Enter the maximum flow plotted on the graphics screen.
File name for lateral inflow	Enter the name of file containing the lateral inflow hydrographs (see Appendix 1).
File name for flow at 9a	Enter the name of the file containing the hydrograph at Paarl.
Quantity of lateral abstraction	Enter a numeric value for the rate of losses from the main river channel associated with in-channel losses and abstraction during the summer periods (1,3 and 5).
Do you wish to save simulated data ?	Enter a character (y or n) if you wish to save the predicted hydrographs for the main river channel.

Example

In the following example the hydrodynamic flow model is used to simulate the hydrographs at sampling stations along the main river channel for Period 3.

Prompt	Default	Reply
Time weighting factor (0<=a<=0.5)	[.4]	""
Space weighting factor (0<=a<=0.5)	[.4]	""
Do you require both linear and nonlinear scheme (y/n)		"y"
Do you require 12-hourly flow data (y/n)		"y"
Non-linear tolerance (%)	[1]	""
Period of data required		"3"
Maximum flow plotted (m3/s)	[300]	""
File name for lateral inflow	[latinf12]	""
File name for flow at 9a	[9aq12]	""
Quantity of lateral abstraction (0.0-0.04)		"0.04"
Do you wish to save predicted data (y/_)		"y"

***************are you happy with initialization ? ""

The data file are loaded from disk and processed. Once the procedure is complete, the simulated and measured hydrographs for Drie Heuwels Weir are plotted on the graphics screen, the simulated channel flow is saved on disk.

Listing of source code

```
10 '------------------:::: QMODEL ::::------------
20 '
30 '
40 '
50 ' This PROGRAM uses the method described by Li 1979
 to route flow with adjusted lateral inflow data..

65 PRINT" FOR HERCULES GRAPHICS- LOAD FIX": ' use emulation
        FOR I=1 TO 1800:NEXT I:CLS          ' pause loop
70 SCREEN 0,0,0 : CLS

75'++++++++++++++++++++++MAIN ROUTINE++++++++++++++++
80 GOSUB 210              '    initialization
85      IF RERUN$="y" THEN 100
90 GOSUB 560              '    read data files
100 GOSUB 400             '    graphics screen
110 GOSUB 790             '    calculations
120 GOSUB 1690            '    read data G1M13 (observed)
130 GOSUB 1800            '    graphics output  (observed)
140 GOSUB 1540            '    graphics output (calculated)
145 GOSUB 3000            '    residual analysis
150 INPUT "",PL$
160 IF PO$="y" THEN 170 ELSE 175
170 GOSUB 1970            '    save data array
175 INPUT "Re-run period (y/n)";RERUN$ : IF RERUN$="y" THEN 70
177 INPUT "Re-run NEW period  ";RRUN$  : IF RRUN$="y" THEN 70
190 END '++++++++++++++++++++++++++++++++++++++++++++

200 :CLS
210 '    ******* options ****************
220 '
230 PRINT
" << PLACE CHANNEL FLOW DATA IN DRIVE A & LATERAL DATA IN B >>"
240 PRINT
250 PRINT
" Stream flow Routing - 4 Point Implicit Finite Difference Method
255 PRINT"           [Dont give extensions in filenames] "
260 PRINT"---------------------------------------------"
270 INPUT " Time weighting factor (0<=a<=0.5)  [.4]    ";AA
        IF AA=0 THEN AA=.4
280 INPUT " Space weighting factor (0<=b<=0.5)  [.3]    ";BB
        IF BB=0 THEN BB=.3
285 INPUT
 " Do you require both the linear & non-linear models(y/n)";MD$
287 INPUT
 " Do you require 12 hourly flow data            (y/n)";TW$
288 IF MD$="y" THEN 290 ELSE 300
290 INPUT " Non-linear scheme tolerance (%)    [1%]     ";E3 :
     IF E3=0 THEN E3=1
295  IF RERUN$="y" THEN 310
300 INPUT " Period of data required                      ";P$
310 INPUT " Maximum flow plotted              [300]      ";MX :
    IF MX=0 THEN MX=300
320 INPUT " File name for LATERALINFLOW     [latinf12]   ";LA$ :
    IF LA$="" THEN LA$="latinf12"
321 LA$=LA$+"."+P$
322 INPUT " File name for flow at 9a          [9aq12]  ";NA$:
 IF NA$="" THEN NA$="9aq12"
323 NA$=NA$+"."+P$
324 INPUT " Quantity of lateral abstraction  (0.0-0.03)   ";LAT
325 INPUT " Do you wish to save  data                (y/n)";PO$
327  IF PO$="y" THEN 329 ELSE 360
329  IF MD$<>"y" THEN 340 ELSE 330
330 INPUT
"File name for channel flow data - non-lin.[chanq12] ";V$:
     IF V$="" THEN V$="chanq12"
335 V$=V$+"."+P$
340 '
360 INPUT " ****** Are you happy with the initialization";INIT$
365 IF INIT$="n" THEN 200 ELSE 370
370 PRINT"-------------------------------------------"
380 RETURN

400 '******** graphics screen *********************
410 :
420 SCREEN 2,0,0,0
```

```
430 LINE (10,0)-(10,180),1   : LINE (629,180)-(629,0),1
440 LINE (10,180)-(630,180),1: LINE (629,0)  -(10,0),1
450      FOR I = 1 TO MX  STEP 10
460            Y=180-(180/MX*I)
470                 PSET (9,Y),1
480      NEXT I
490      FOR I = 1 TO 180
500            X=10+(I*620/180)
510                 PSET (X,181),1
520      NEXT I
530 PRINT"Q (m3/s) "MX"   DRIE HEUWELS HYDROGRAPH PERIOD  "P$
540 RETURN

560 '  ***********  read data for G1M20 and boundary conditions
565 '               for main river channel.....
570 INPUT " Ready to load data @ 9A? (y/n)";IO$
573 IF IO$="n" THEN 200 ELSE 575
575      ON ERROR GOTO 5010
580 OPEN "i",1,NA$
585      ON ERROR GOTo 0
590 INPUT#1,NN$,M%,K%
600                    DIM W(360,8)
610  FOR J=1 TO K%
620       FOR I=1 TO M%
630             INPUT#1,W(I,J)
640  NEXT :NEXT
650 CLOSE#1
660 :
670 INPUT " Ready to load lateral inflow data?";IO%
680 '     ******** read lateral inflow data **********
685      ON ERROR GOTO 5020
690 OPEN "i",1,"B:"+LA$
695      ON ERROR GOTO 0
700 INPUT#1,NN$,M%,K%
710                   DIM L(360,8)
720  FOR J=1 TO K%
730       FOR I=1 TO M%
740             INPUT#1,L(I,J)
750  NEXT :NEXT
760 CLOSE#1
770 RETURN

790 ' ********** calculations ************************
800 K2=(1-BB)/(86400!*180/M%)       ' set constants (time and space)
810 K3=(1-AA)
820 K4=(1-BB)
830 :
840  '-------  boundary,  or initial flow  conditions in main
                river channel at the beginning of the period
850 DIM V(360,8)
860 FOR X=1 TO M%
870      V(X,1)=W(X,1)  :  NEXT X
880 '
885      ON ERROR GOTO 5030
890    OPEN "i",1,"b:bound."+P$
895      ON ERROR GOTO 0
900        INPUT #1,NN$,MB%,KB%    :  FOR J= 2 TO 8
910            INPUT #1,W(1,J)     :   NEXT J
920    CLOSE#1
930 :
940 :  FOR J= 2 TO 8 : V(1,J)=W(1,J) :NEXT J
950 :
960 DIM D(9),A(9),B(9)
970 PSET (320,395),2

980 D(2)=11000:D(3)=7000:D(4)=14000:D(5)=7000:D(6)=14000:D(7)=16000:
    D(8)=20000    river distance between stations on main channel

990 A(2)=1.8:A(3)=1.85:A(4)=1.65:A(5)=1.75:A(6)=1.85:A(7)=2.47:
    A(8)=2.2       channel geometry constants (alpha)

1000 B(2)=.85:B(3)=.87:B(4)=.95:B(5)=.86:B(6)=.85:B(7)=.95:
     B(8)=.99      channel geometry constants (beta)

1010 ' - - - - - - - main calculations - - - - - - - - - - -
1020 FOR I=2 TO M%    '           beginning of linear scheme
1030 FOR J= 2 TO 8    ' see Equations 6.21 to 6.23
1040 D=D(J)           ' D = length of specific subreach
1050 K5=B(J)-1 : K1=(1-AA)/D
1060 K6=A(J)*B(J)*(((W(I,J-1)+W(I-1,J))/2)^K5)
```

```
1070 :
1080 P1=(K1+(K6*K2))^-1
1090 P4=((K4*(L(I,J)-LAT)/D)+(BB*(L(I,J-1)-LAT)/D)+
        (K4*(L(I-1,J)-LAT)/D)+(BB*(L(I-1,J-1)-LAT)/D))*.5
1100 P3=((W(I-1,J)/86400!/180*M%)*K4)-((W(I,J-1)-
        W(I-1,J-1))/86400!/180*M%)*BB
1110 P2=(W(I,J-1)/D*K3)-(((W(I-1,J)-W(I-1,J-1))/D)*AA)+(K6*P3)+P4
1120 W(I,J)=P1*P2
1130IF MD$ <> "y" THEN 1490 '---------------end of linear scheme--
1140 R0=W(I,J)                '---------------nonlinear scheme -----
                                    using iterative methods
1150 :
1160 S1=86400!*180/M%/D                           '----Equation 6.8:-
1170 S2=(V(I,J-1)*K3-(V(I-1,J)-V(I-1,J-1))*AA)*S1
1180 S3=A(J)*((V(I-1,J)^B(J))*K4-((A(J)*V(I,J-1)^B(J))-
        (A(J)*V(I-1,J-1)^B(J)))*BB)
1190 S4=(K4*(L(I,J)+L(I-1,J))+BB*(L(I,J-1)+L(I-1,J-1)))
        *86400!*180/M%/2
1200 S5=S2+S3+(S4/D)
1210 :
1220 FR=S1*K3*R0+(A(J)*K4*(R0^B(J)))              '----Eq.6.15
1230 FR1=S1*K3+(A(J)*B(J)*K4*(R0^(B(J)-1)))       '----Eq.6.16
1240 FR2=A(J)*B(J)*(B(J)-1)*K4*(R0^(B(J)-2))      '----Eq.6.17
1250 :
1260 FD=((FR1/FR2)^2)-(2*(FR-S5)/FR2)             '----Eq.6.14
1270 IF FD<0 THEN FD=0
1280 :
1290 R1=R0-(FR1/FR2)+(FD^.5)                      '----Eq.6.14
1300 R2=R0-(FR1/FR2)-(FD^.5)                      '----Eq.6.14

1310 :
1320 IF R1<0 THEN R1=0
1330 IF R2<0 THEN R2=0
1340 :
1350 FRA=S1*K3*R1+(A(J)*K4*(R1^B(J)))
1360 FRB=S1*K3*R2+(A(J)*K4*(R2^B(J)))
1370 :
1380 E1=ABS(FRA-S5)
1390 E2=ABS(FRB-S5)
1400 IF (E1-E2)<=0 THEN 1410 ELSE 1440
1410 E=E1
1420 R0=R1
1430 GOTO 1460
1440 E=E2
1450  R0=R2                ' iteration repeated until
                       tolerance level is achieved (See Chapter 6)
1460 E4=E3*S5*.01
1470 IF E<=E4 THEN 1480 ELSE 1210
1480 V(I,J)=R0
1490 NEXT J
1500  PSET (I+140,195),1      ' plot marker on screen to show progress
                               in calculations
1510 NEXT I       '--------end of non-linear scheme-----------
1520 RETURN

1540 ' ********** graphics output **********************
1545 T3=0:TT=0:Q3=0:QQ=0:T4=0:TT=0:Q4=0:QQV=0
1550 FOR I=1 TO M%
1560    TT=(620/M%*I)+10
1570    Q=W(I,8): QV=V(I,8)
1580    QQ=(180-(Q*180/MX)): QQV=180-QV*180/MX
1590  IF QQ<0 THEN QQ=0
1600  IF QQV<0 THEN QQV=0
1610  IF T3=0 THEN 1650
1620  IF T4=0 THEN 1650
1630    LINE (T3,Q3)-(TT,QQ),1  : IF MD$<>"y" THEN 1650
1640    LINE (T4,Q4)-(TT,QQV),1
1650      T3=TT:Q3=QQ:T4=TT:Q4=QQV
1660 NEXT I
1670 RETURN

1690 '    ********* load data G1M13 **********************
1695  IF TW$="y" THEN I$="23dq12."+P$ ELSE I$="23dq."+P$
1700  IF TW$="y" THEN I$="23dq12."+P$ ELSE I$="23dq."+P$
1703                ON ERROR GOTO 5040
1705  OPEN "i",1,I$
1707                ON ERROR GOTO 0
1710 INPUT#1,NN$,N%,C%
1720 DIM R(360,1)
1730      FOR J= 1 TO C%
```

```
1740          FOR I= 1 TO N%
1750             INPUT#1,R(I,J)
1760        NEXT :NEXT
1770 CLOSE#1
1780 RETURN

1800 '    ********** display G1M13 ************************
1805 T5=0:TT=0:Q5=0:QP=0
1810 FOR I = 1 TO N%
1820          Q=R(I,1):TT=(I*620/M%)+10
1830             QP=180-(180/MX*Q)
1840              IF QP<0 THEN QP=0
1850              IF T5=0 THEN 1870
1860               LINE (T5,Q5)-(TT,QP),1
1870                T5=TT: Q5=QP
1880 NEXT I
1890 FOR I=9 TO 178 STEP 2
1900    LINE(11,I) - (628,I),0
1910 NEXT I
1920 RETURN

1970 '*************** save data ************************
1980 INPUT "     READY TO SAVE MAIN CHANNEL DATA IN DRIVE B ";DUM$
1990 PRINT" PERIOD OF DATA    : "P$
2000 '   Save data (main channel)
2005                               IF MD$<>"y" THEN 2100
2010  OPEN "o",1,"b:"+V$
2020  PRINT#1,V$
2030  PRINT#1,M%
2040  PRINT#1,K%
2050     FOR J=1 TO 8
2060         FOR I=1 TO M%
2070              PRINT#1,V(I,J)
2080     NEXT : NEXT
2090  CLOSE#1
2100 :
2190 PRINT "     DATA SAVED ON DISK"
2200 RETURN

3000 '---------- residuals analysis ------------------
3200 SS=0 : MS=0 : T11=0 : T12=0 : T21=0
3300 '
3400  FOR I=1 TO N%
3500         OBS=R(I,1)
3550        PRED=V(I,8)
3600          EI=OBS-PReD
3650          SS=SS+(E1^2)
3700          T12=T12+(EI*PRED^2)
3750          T21=T21+(EI^2*PRED)
3800          T11=T11+(E1*pRED)
3900  NEXT I
3950         MS=SS/(N%-2)
4000 PRINT"sum squares="SS" mean squares="MS" t12"T12" t11="T11"
           t21="T21
4100 RETURN

5000 '-------- error handling --------------------------
5001 '
5010 INPUT "ERROR- check drive/disk  <<RETURN>>";ER$ : RESUME 580
5020 INPUT "ERROR- check drive/disk  <<RETURN>>";ER$ : RESUME 690
5030 INPUT "ERROR- check drive/disk  <<RETURN>>";ER$ : RESUME 890
5040 INPUT "ERROR- check drive/disk  <<RETURN>>";ER$ : RESUME 1705
5090 '
5100 '----------------------------------------------
```

Transport model : Section 1

Command : SECTION1

Definition

SECTION1 is an interactive graphics program designed to predict the phosphorus chemograph at Lady Loch Bridge. The output from this program is used by SECTION2 to predict the chemograph at stations along the main river channel (see Fig A3).

SECTION1 uses the chemograph from NPSM, in addition to the chemographs and hydrographs for Paarl and Wellington sewage treatment works to predict the chemograph at Lady Loch Bridge, using a modified mass balance model (see Chapter 7, Section 3).

Data Entry

The procedure is initiated and requires the following input

Prompt	Expected Input
Coefficient a in sed/rem model [0.45] -	Enter coefficient
Coefficient b in sed/rem model [.187] -	used in model calibration
Coefficient z in sed/rem model [0.009]-	
Max [TP] plotted [700] -	Enter the maximum
Max flow plotted [300] -	phosphorus concentration plotted on the display.
Do you wish to have effluent compliance (y/n) ?	Enter a character if you wish to simulate the influence of the phosphate standard.
Do you require a print out of totals loads (y/n) ?	Enter a character if you wish to print-out the total loads exported during the period.
Do you wish to save data file (y/n) ?	Enter a character if you wish to save the simulated chemograph at Lady Loch Bridge on disk.
State file for model output to drive B -	Enter the file name for the data to saved on disk.

Example

In the following example the phosphorus nonpoint source model is used to simulate the phosphorus chemograph at Lady Loch Bridge.

Prompt	Reply
Enter Period of data Required -	"2"
Coefficient a in sed/rem model [0.45] -	""
Coefficient b in sed/rem model [.187] -	""
Coefficient z in sed/rem model [0.009] -	""
Max [TP] plotted [700] -	""
Max flow plotted [300] -	""
Do you wish to have effluent compliance (y/n) ?	"n"
Do you require a print out of totals (y/n) ?	"n"
Do you wish to save data file (y/n) ?	"y"
State file for model output to drive B (ie 13btp)-	"13btp12"

The data files are read from disk, processed, and the simulated chemograph plotted on the display. The measured phosphorus concentrations are also plotted.

Listing of source code

```
1  '""""""""""""""""""""""""""""""""""""Section1""""""""""""""""""""""""""
2  '
3 CLEAR:     DIM TB(360,1),LT1(360),
              LT2(360),LT3(360),LTL(360),LT4(360),LT5(360)
5  SCREEN 0,0,0 : COLOR 10,9
6
10 '---------------- SECTION 1 MODEL -----------------
12 '
13 '
15 '
20 'THIS PROG. RUNS THE DISCHARGE-RATING CURVES FOR STATION 9A IN
ADDITION  TO THE MODIFIED MASS-BALANCE FOR SECTION1,THEN COMPARES
OBSERVED/MEASURED DATA
25 '
27 '
28 '
30 '____________________________________________________
40 '
50 '--------------- main routine -----------------
60 '
70 GOSUB 100                  :'options
75                                      IF RERUN$="y" THEN 90
80 GOSUB 200                  :'loading data
90 GOSUB 600                  :'hires screen
94 GOSUB 700                  :'calculation and plot
95 GOSUB 950                  :'plot
96 IF QP$="y" THEN  GOSUB 7000          ' save data
97 IF QQ$="y" THEN  GOSUB 8000          ' printout data to printer
98 GOSUB 9000                 :'residuals analysis
99 INPUT "rerun (y/n)";RERUN$ : IF RERUN$="y" THEN 5  ELSE
3                           :
100 CLS
101 PRINT
104 PRINT"<<<<<< PLACE FLOW DATA IN DRIVE -A- AND WQ DATA IN -B-
>>>>>>>>"
105 PRINT
110 PRINT"---------- SECTION 1    MODEL EVALUATION ----------"
111 PRINT"       Default values given as: [..]
<<12-Hour>>"
112 PRINT
115                            IF RERUN$="y" THEN 122
120 INPUT "            Period of data required :";P$
121 PRINT
122 INPUT " Coefficient a in sed/rem model [0.45]";LRAK
:                                    IF LRAK=0 THEN LRAK=.45
124 INPUT " Coefficient b in sed/rem model [.187]";LRBK
:                                    IF LRBK=0 THEN LRBK=.187
126 INPUT " Coefficient z in sed/rem model [.0009]";ZX
                                     IF ZX=0 THEN ZX=9.000001E-04
127 PRINT
128 :
129 PRINT
130 INPUT "           Max [tp] plotted [700]"; MX
:                                         IF MX=0 THEN MX=700
131 INPUT "           Max flow plotted [300]" ;MQ
:                                         IF MQ=0 THEN MQ=300 :
PRINT
132 INPUT " Do you wish to have effluent compliance (y/n) ";EF$
141 INPUT " Do you require a print out of totals    (y/n) ";QQ$
142 INPUT " Do you wish to save data file           (y/n) ";QP$
143       IF QP$="y" OR QP$="Y" THEN  144  ELSE 145
144 INPUT " State file for model output to drive B (ie 13BTP._)
";FO$
145 PRINT : IF EF$="y" OR EF$="Y" THEN 146 ELSE 148
146 INPUT " State [TP] of Paarl STW effluent @ 1mg/l PO4 [1.3]
";PSTWEFF:              IF PSTWEFF=0 THEN PSTWEFF=1.3
147 INPUT " State [TP] of Wel'gton STW effluent @ 1mg/l PO4
[1.14]";WSTWEFF:                IF WSTWEFF=0 THEN WSTWEFF=1.14
148 PRINT"____________________________________________________"
149 PRINT
150 PRINT"                 Loading data files:"
151 RETURN
160 '
200 ' loading data
205 INPUT " place flow data disk in drive .............",PROMT
```

```
210 INPUT " Name of file for 9A [9aq12]";F1$
:                                              IF F1$="" THEN
F1$="9aq12"
211 F1$=F1$+"."+P$
212                     ON ERROR GOTO 10010
213 OPEN "i",1,F1$
214                     ON ERROR GOTO 0
215 INPUT#1,NN$,M1%,K1%: PRINT NN$
220      DIM Q1(360,1)
225      FOR J= 1 TO K1%
230            FOR I =1 TO M1%
235                   INPUT#1,Q1(I,J)
240     NEXT :NEXT
245 CLOSE#1
250
260 F7$="14bq12."+P$    : OPEN "i",1,F7$
265 INPUT#1,NN$,M7%,K7%: PRINT NN$
270      DIM QL(360,1)
280      FOR J= 1 TO K7%
285            FOR I =1 TO M7%
290                   INPUT#1,QL(I,J)
295      NEXT :NEXT
297  CLOSE#1
300
310 F2$="pstwq12."+P$    : OPEN "i",1,F2$
320 INPUT#1,NN$,M2%,K2%:PRINT NN$
325      DIM Q2(360,1)
330      FOR J= 1 TO K2%
340            FOR I =1 TO M2%
350                   INPUT#1,Q2(I,J)
360     NEXT :NEXT
370 CLOSE#1
380
410 F3$="wstwq12."+P$    : OPEN "i",1,F3$
420 INPUT#1,NN$,M3%,K3%: PRINT NN$
425      DIM Q3(360,1)
430      FOR J= 1 TO K3%
440            FOR I =1 TO M3%
450                   INPUT#1,Q3(I,J)
460      NEXT :NEXT
470 CLOSE#1
480
490 INPUT "Place wq data in drive................",PROMT
510 F4$="b:st1tq."+P$
512                     ON ERROR GOTO 10020
515 OPEN "i",1,F4$
517                     ON ERROR GOTO 0
520 INPUT#1,NN$,M4%,K4% : PRINT NN$
525      DIM  T(45,10)
530      FOR J= 1 TO K4%
540            FOR I =1 TO M4%
550                   INPUT#1,T(I,J)
560      NEXT :NEXT
570 CLOSE#1
573 IF EF$="y" OR EF$="Y" THEN 599 ELSE 575
575 F5$="b:pstwt."+P$     : OPEN "i",1,F5$
576 INPUT#1,NN$,M5%,K5% : PRINT NN$
577      DIM  PT(180,1)
578      FOR J= 1 TO K5%
579            FOR I =1 TO M5%
580                   INPUT#1,PT(I,J)
581     NEXT :NEXT
582 CLOSE#1
583
590 '
591 F6$="b:wstwt."+P$     : OPEN "i",1,F6$
592 INPUT#1,NN$,M6%,K6% : PRINT NN$
593      DIM  WT(180,1)
594      FOR J= 1 TO K6%
595            FOR I =1 TO M6%
596                   INPUT#1,WT(I,J)
597     NEXT :NEXT
598 CLOSE#1
599 RETURN
600 '------------------------------------- graphics screen
610 SCREEN 2,0,0,0
620 LINE (10,0)-(10,180),1    : LINE(10,0)-(640,0),1
630 LINE (10,180)-(640,180),1 : LINE(639,0)-(639,180),1
635 FOR I= 1 TO M1% : P=(I*3.4445)+10 :  PSET(P,181),1 : NEXT I
637 FOR I= 0 TO MX  STEP 10 : PSET(9,180-(180/MX*I)),1 : NEXT I
```

```
638 PRINT"[TP] "MX" ug/l    ---- SECTION 1 PERIOD "P$
640 RETURN
650 '
700 '--------------------------------------calculations
705 GOSUB 880
710   FOR I =1 TO M2%
720       Q1=Q1(I,1)    : IF QQ1=0 THEN QQ1=Q1
722  '
725  DQ=ABS(Q1-QQ1) :  DQK=Q1/QQ1 : LRZ=(8.999999E-03*EXP(-.007*Q1))
726  V=INT((1+I)/2)         'This expands data
                            file from 24-12  hour........
727 IF Q1>QQ1 THEN  T1=((.0012*Q1)+.015)+(LRZ*DQ)  ELSE
                    T1=((.0012*Q1)+.015)
729 '
740       Q2=Q2(I,1) :IF EF$="y" THEN T2=PSTWEFF ELSE
                                      T2=PT(V,1)/1000
742 IF QL(I,1)=0 THEN 750
745       QL=QL(I,1)                  :IF QQL=0 THEN QQL=QL
746       DQL=ABS(QL-QQL)             :
                               LRZ=(8.999999E-03*EXP(-.007*QL))
748       IF Q1>QQ1 THEN TL=((.03*QL)+.035)+(LRZ*DQL)  ELSE
                         TL=((.03*QL)+.035)
749       '
750       Q3=Q3(I,1): IF EF$="y" THEN T3=WSTWEFF ELSE
                                      T3=WT(V,1)/1000
755 '
760       L1=T1*Q1                    : LT1(I)= L1
770       L2=T2*Q2                    : LT2(I)=L2
780       L3=T3*Q3                    : LT3(I)=L3
785       LL=TL*QL                    : LTL(I)=LL
790       Q4=Q1+Q2+Q3+QL              : LT5(I)=L1+L2+L3+LL
810       K=(LOG(Q4)*(LRBK*(DQK^ZX)))+LRAK
818       T5=(L1+L2+L3+LL)/Q4
819       L5=T5*Q4*43200!
820       T4=T5*K         : TIMETRAVEL=11000/(Q4/(1.8*Q4^.85))
825       L4=T4*Q4*43200!
840      T4=T4*1000! :  TB(I,1)=T4        : LT4(I)=(T4*Q4/1000)
850       T4=(180-(180/MX*T4)):XI=TIMETRAVEL/(86400!*180/M2%):
                            X=((XI+I)*630/M2%)+10
855   IF I=1 THEN 865
860     LINE (X,T4)-(XP,TV),1  :     QQ1=Q1
865                  TV=T4   :  XP=X  :     QQL=QL
870  NEXT I
875  RETURN
877  '
880  '+++++++++++++++++++++++++++++++++++++ plot of flow data 9a
890 FOR I= 1 TO M1%
895     Q=Q1(I,1)     : X=(I*630/M2%)+10
900        Q=(180-(180/MQ*Q))
905           IF I=1 THEN                    915
910                 LINE (X,Q)-(XP,QP),1
915                        QP=Q:XP=X
920  NEXT I
925   RETURN
950  '        plot of measured data for 13b (lady loch bridge)
955     FOR I =1 TO M4%
960                 Z=(T(I,1)*3.4445)+8    : T=T(I,8)
965                       T=(180-(180/MX*T))
970                           CIRCLE (Z,T),3
980     NEXT I
990   RETURN
7000  '
7010   ' save data routine ++++++++++++++++++++++++++++++
7015 FZ$="b:"+FO$
7020  OPEN "o",1,FZ$
7030  PRINT #1,FO$
7032  PRINT #1,M2%
7034  PRINT #1,K2%
7040  FOR J=1 TO K2%
7050      FOR I=1 TO M2%
7060            PRINT #1,TB(I,J)
7070  NEXT :NEXT
7080  CLOSE#1
7090  RETURN
7100  '
7200  '
8000  ' print out routine
8010   '9a g1m20 north paarl
8020  FOR I=1 TO M2%-2 STEP 2
8031      LE=LT1(I)*4      :TLE=TLE+LE
```

```
8033        LO=LT1(I+1)*2       :TLO=TLO+LO
8035   NEXT I
8045   TOTAL=(LT1(1)+TLE+TLO+LT1(M2%))*28800*(180/M2%)
8050   LPRINT"        total load from 9a="TOTAL          "g"
8070  TOTAL=0      : TLE =0 : TLO=0
8110   'pstw
8120   FOR I=1 TO M2%-2 STEP 2
8131        LE=LT2(I)*4       :TLE=TLE+LE
8133        LO=LT2(I+1)*2       :TLO=TLO+LO
8135   NEXT I
8145   TOTAL  =(LT2(1)+TLE+TLO+LT2(M2%))*28800*(180/M2%)
8150   LPRINT"        total load from pstw="TOTAL          "g"
8170  TOTAL=0     : TLO=0:           TLE=0
8210   'wstw
8220   FOR I=1 TO M2%-2 STEP 2
8231        LE=LT3(I)*4       :TLE=TLE+LE
8233        LO=LT3(I+1)*2       :TLO=TLO+LO
8235   NEXT I
8245   TOTAL  =(LT3(1)+TLE+TLO+LT3(M2%))*28800*(180/M2%)
8250   LPRINT"        total load from wstw="TOTAL          "g"
8270  TOTAL=0        :    TLE=0     : TLO=0
8310   '13b
8320   FOR I=1 TO M2%-2 STEP 2
8331        LE=LT4(I)*4       :TLE=TLE+LE
8333        LO=LT4(I+1)*2       :TLO=TLO+LO
8335   NEXT I
8345   TOTAL  =(LT4(1)+TLE+TLO+LT4(M2%))*28800*(180/M2%)
8350   LPRINT"        total load from 13b ="TOTAL          "g"
8370  TOTAL=0     :TLO=0       :TLE=0
8410   'total input load to section 1
8420   FOR I=1 TO M2%-2 STEP 2
8431        LE=LT5(I)*4       :TLE=TLE+LE
8433        LO=LT5(I+1)*2       :TLO=TLO+LO
8435   NEXT I
8445   TOTAL  =(LT5(1)+TLE+TLO+LT5(M2%))*28800*(180/M2%)
8450   LPRINT"        total load input    ="TOTAL          "g"
8470  TOTAL=0     : TLO=0 :          TLE=0
8510   'lateral input
8520   FOR I=1 TO M2%-2 STEP 2
8531        LE=LTL(I)*4       :TLE=TLE+LE
8533        LO=LTL(I+1)*2       :TLO=TLO+LO
8535   NEXT I
8545   TOTAL  =(LTL(1)+TLE+TLO+LTL(M2%))*28800*(180/M2%)
8550   LPRINT"        lateral input       ="TOTAL          "g"
8570  TOTAL=0        : TLO=0 : TLE=0
8600  RETURN
8700  '
8800  '
8900  '
9000  '---------  residuals analysis ---------------------
9100  SS=0 : MS=0 : T12=0 : T11=0 :T21=0
9200  '
9250     FOR I=1 TO M4%
9300            Z=T(I,1)*2-1 : IF Z<0 THEN Z=0
9350            OBS=T(I,8)
9400            PRED=TB(Z,1)
9450            EI=(OBS-PRED)
9500            SS=SS+(EI^2)
9550            T21=T21+(EI^2*PRED)
9600            T12=T12+(EI*PRED^2)
9650            T11=T11+(EI*PRED)
9700    NEXT I
9750       MS=SS/(M4%-2)
9800  PRINT"sum of squares="SS" mean squares="MS"t21="T21" t12="T12"
t11="T11
9999  RETURN
10000 '--------error handling ------------------------------
10010 INPUT "ERROR check drive/disk <<< return >>>",ER$ : RESUME 213
10020 INPUT "ERROR check drive/disk <<< return >>>",ER$ : RESUME 515
10030 '____________________________________________________
```

Transport model : Section 2

Command : SECTION2

Definition

SECTION2 uses a modified version of the mass continuity equation to predict the temporal and spatial variation in the phosphorus load at discrete points along the main river channel (see Chapter 7 for details on the model).

The model uses the simulated chemograph at Lady Loch Bridge (from program SECTION1) to predict the chemograph at each station along the main river channel between Lady Loch Bridge and Drie Heuwels Weir (see Fig A2.4).

Data Entry

The program is initiated and the following data must be entered

Prompt		Expected Input
Period of data required		- Enter the period of data required for the model simulation.
Maximum [TP] plotted	[700]	- Enter the maximum value of the phosphorus concentration plotted on the y-axis (in μg/ℓ).
value of time weighting coeff [.4]-		Enter the coefficients used in the model.
value of space weighting coeff [.4]-		
Do you wish to save wq data (y/_) ?		Enter the character if you wish to save the ouput data
Do you wish to plot wq data at 18a (y/_) ?		
Decay coefficient A [-.015] -		Enter coefficients used in sedimentation equation
Decay coefficient B [.005] -		
File name for channel flow [chanq12] -		
File name for chemograph at 13b [13btp12]-		Enter filenames of composite flow data file and chemograph at Lady Loch Bridge.

Example

In the following example the model is used to simulate the phosphorus chemograph for stations along the main river channel (Section 2).

Prompt		Reply
Period of data required		- "2"
Maximum [TP plotted	[700]	- ""
value of time weighting coeff	[.4]	- ""
value of space weighting coeff	[.4]	- ""
Do you wish to save wq data	(y/_) ?	""
Do you wish to plot wq data at 18a	(y/_) ?	""
Decay coefficient A	[-.015]	- ""
Decay coefficient B	[.005]	- ""
File name for channel flow	[chanq12]	- ""
File name for chemograph at 13b	[13btp12]	- ""

Once the data are entered the procedure loads the data from disk, processes the data and displays the simulated chemograph at Drie Heuwels Weir. The measured phosphorus concentrations are also displayed.

Listing of source code

```
1 '                             SECTION2
(based on the advective routing scheme devised by Li (1979)
2 '
5 '
7 '
10 CLEAR : COLOR 10,9 :
  DIM L(360,8),TPL(360),Q(360,8),C(360,8),TP(380,3),TM(60,9)

20 '                              + USING L.R.C  LATERAL INPUT
40 '++++++---main routine--       + ALSO PLOTS [TP] AT 18A
45 SCREEN 0,0,0
50 GOSUB 1000                  'options
55           IF RERUN$="y" THEN 70
60 GOSUB 2000                  'load data
70 GOSUB 3000                  'hires screen
80 GOSUB 4000                  'plot input data
90 GOSUB 5000                  'calculate and plot output
95 GOSUB 6000                  'plot [tp] data at G1M13
96 GOSUB 8000                  'calculation of total TP load at 23d
97 GOSUB 9900                  'saving output data files

99   INPUT " Rerun same period of data (y/n)";RERUN$ :
           IF RERUN$="y" THEN 45
100  INPUT " Rerun other period of data(y/n)";RRUN$ :
           IF RRUN$="y" THEN 45
105 SCREEN 0,0,0 : END


1000 '-----------------options-------------------------
1010 CLS
1012 PRINT"<place FLOW data in drive A & wq data in drive B>"
1013 PRINT
1015PRINT"-------- SECTION 2  MODEL 12 HOUR ---------------"
1020PRINT"<<Do not include extensions in file name >>
          [____] -default values
1025 PRINT                : IF RERUN$="y" THEN 1035
1030 INPUT "  Period of data required              " ;P$
1035 INPUT "  Maximum [TP] plotted     [700 ug/l]  " ;MT
1037          IF MT=0 THEN MT=700
1040 INPUT "  Value of time-weighting coeff   [.4]    " ;AA
1042          IF AA=0 THEN AA=.4
1045 INPUT "  Value of space weighting coeff  [.4]    " ;BB
1047          IF BB=0 THEN BB=.4
1053 INPUT "  Do you wish to save wq data   (y/_)     ";SV$
1054 INPUT "  Do you wish to plot wq data at 18a (y/_)";QS$
1055 INPUT "  Do you wish to plot flow data (y/_)     ";QQ$
1056          IF QQ$="y" THEN 1058 ELSE 1060
1058 INPUT "  Maximum flow plotted                    ";MQ
1060 INPUT "   Decay coefficient A [ -.015]           " ;DECA
1061      IF DECA=0 THEN DECA=-.015
1062 INPUT "   Decay coefficient B [.0050]            " ;DECB
1063      IF DECB=0 THEN DECB=.005
1064 IF RERUN$="y" THEN 1074
1065 INPUT "   File name for channel flow [chanq12]    "; F2$
1067 IF F2$="" THEN F2$="chanq12."+P$ ELSE F2$=F2$+"."+P$
1068 IF SV$="y" THEN INPUT " specify name of output file:";FDH$
            ELSE 1070
1069 IF FDH$="" THEN 1068 ELSE 1070
1070 INPUT "   File name for chemograph @ 13B  [13btp12]  "; F3$
1071 IF  F3$="" THEN F3$="13btp12."+P$ ELSE F3$=F3$+"."+P$
1074 PRINT"                     ---------" :FDH$=FDH$+"."+P$
1075INPUT"Are you happy with the initialisation (_/n)";NZ$
         IF NZ$="n" THEN 1000
1076 PRINT
1077 PRINT"-----------------------------------------------------"
1080 PRINT" Loading data:"
1090 PRINT
1100 RETURN

2000 '-----------------load data-------------------------
2010 '
2020               F1$="latinf12."+P$
2025                    ON ERROR GOTO 2600
2030 OPEN "i",1,F1$
2035                    ON ERROR GOTO 0
2040 INPUT #1,NN$,M1%,K1%          :PRINT NN$
2060        FOR J=1 TO K1%
```

```
2070          FOR I=1 TO M1%
2080              INPUT #1,L(I,J)
2090      NEXT :NEXT
2100 CLOSE#1
2101 '
2103 '       CHANNEL FLOW DATA:-
2104                                  ON ERROR GOTO 2610
2105 OPEN "i",1,F2$
2106                                  ON ERROR GOTO 0
2107 INPUT #1,NN$,M2%,K2%                  :PRINT NN$
2108      FOR J=1 TO K2%
2109          FOR I=1 TO M2%
2110              INPUT #1,Q(I,J)
2112      NEXT :NEXT
2114 CLOSE#1
2119 :
2200 INPUT "   Place WQ data in drive B:-------<<RETURN>> ",PROMPT
2220 F3$="b:"+F3$
2225                                  ON ERROR GOTO 2620
2230 OPEN "i",1,F3$
2235                                  ON ERROR GOTO 0
2240 INPUT #1,NN$,M3%,K3%                  :PRINT NN$
2260      FOR J= 2 TO 2
2270          FOR I=1 TO M3%
2280              INPUT #1,C(I,2)
2290      NEXT :NEXT
2300 CLOSE#1
2310 FOR I= 1 TO M3% :C(I,2)=C(I,2)/1000 :NEXT I
2320 F4$="b:23dt."+P$
2325                          ON ERROR GOTO 2630
2330 OPEN "i",1,F4$
2335                          ON ERROR GOTO 0
2340 INPUT #1,NN$,M4%,K4%                  :PRINT NN$
2360      FOR J=1 TO K4%
2370          FOR I=1 TO M4%
2380              INPUT #1,TP(I,J)
2390      NEXT :NEXT
2400 CLOSE#1
2410 IF QS$="y" THEN 2420 ELSE 2550
2420 F5$="b:SCT2.T"+P$
2425                          ON ERROR GOTO 2640
2430 OPEN "i",1,F5$
2435                          ON ERROR GOTO 0
2440 INPUT #1,NN$,M5%,K5%                  :PRINT NN$
2460      FOR J=1 TO K5%
2470          FOR I=1 TO M5%
2480              INPUT #1,TM(I,J)
2490      NEXT :NEXT
2500 CLOSE#1
2550 RETURN
2600 INPUT "ERROR- check drive/disk <<return>>",ER$ : RESUME 2030
2610 INPUT "ERROR- check drive/disk <<return>>",ER$ : RESUME 2105
2620 INPUT "ERROR- check drive/disk <<return>>",ER$ : RESUME 2230
2630 INPUT "ERROR- check drive/disk <<return>>",ER$ : RESUME 2330
2640 INPUT "ERROR- check drive/disk <<return>>",ER$ : RESUME 2430

3000 '-----------------------graphics screen------------------
3020 SCREEN 2,0,0,0
3030 LINE (10,0)-(10,180),1 :LINE (639,0)-(639,180),1
3040 LINE (10,180)-(640,180),1 : LINE (10,0)-(640,0),1
3050 FOR I=1 TO 180 : X=(I*3.55556)+10 : PSET (X,181),1 : NEXT I
3055 PRINT" [TP] "MT"  -- SECTION 2 F.D. MODEL PERIOD "P$
3060 RETURN

4000 '-----------------------plot input data------------
4010 '
4020 '    [tp]
4040 FOR I=1 TO M3%
4050      TP=C(I,2)*1000!
4060        Y=(180-(180/MT*TP))
4070        X=(I*630/M3%)+10
4080    IF I=1 THEN 4100
4090        LINE (X,Y)-(XP,YP),1
4100      XP=X : YP=Y
4120 NEXT I
4140 '
4200 '
4300 FOR I=9 TO 178 STEP 2
4320    LINE (11,I)-(637,I),0
4330 NEXT I
```

```
4360 ' flow
4370                    IF QQ$="y" THEN 4440 ELSE RETURN
4440 FOR I=1 TO M2%
4450      Q=Q(I,2)
4460      Y=(180-(180/MQ*Q))
4470      X=(I*630/M2%)+10
4480        IF I=1 THEN 4500
4490      LINE (X,Y)-(XP,YP),1
4500     XP=X : YP=Y
4520 NEXT I
4550 RETURN

5000 '-------------------calculate and plot---------------
5500 : TOTALLAT=0 : TOTAL13B=0   ' constants
5512 K2=(1-BB)/(86400! *180/M1%)
5514 K3=(1-AA)
5516 K4=(1-BB)
5520 :
5550 '------- boundary conditions
5555 FOR X=2 TO 8
5560       C(2,X)=C(2,2)
5561       C(1,X)=C(1,2)
5562       Q(2,X)=Q(2,2)
5565 NEXT X
5566                     DIM D(9),A(9),B(9)
5567 :
5568 :D(3)=7000:D(4)=14000:D(5)=7000:D(6)=14000:D(7)=16000:
      D(8)=20000        ' subreach lengths (m)
5569 :A(3)=1.85:A(4)=1.65:A(5)=1.75:A(6)=1.85:A(7)=2.47:A(8)=2.2
5570 :B(3)=.87:B(4)=.95:B(5)=.86:B(6)=.85:B(7)=.95:B(8)=.99
5571 '   channel geometry coefficients (alpha and beta)

5572                      PSET (320,185),1
'    mass balance calculations ------------using Eq.6.49------
5575 FOR I=2 TO M1%
5580   FOR J= 3 TO 8
5582                   DL=D(J) : K5= B(J)-1 : K1= (1-AA)/DL

5585      GOSUB 7000     '<----------lateral inflow [tp]------>

5586      K6=A(J)*B(J)*((((Q(I,J-1)*C(I,J-1))+(C(I-1,J)*
            Q(I-1,J)))/2)^K5)
5587      P1=1/(K1+(K6*K2))
5588      P4=((K4*CL4*L(I,J)/DL)+(BB*CL2*L(I,J-1)/DL)+
             (K4*CL3*L(I-1,J)/DL)+(BB*CL1*L(I-1,J-1)/DL))*.5
5589
P3=(-(((Q(I-1,J)*C(I-1,J))/86400!/180*M1%)*K4))+((((C(I,J-1)*
             Q(I,J-1))-(C(I-1,J-1)*Q(I-1,J-1))))/86400!/180*M1%)*B)
5590      P2=(((C(I,J-1)*Q(I,J-1))/DL*K3)-((((C(I-1,J)*
             Q(I-1,J))-(C(I-1,J-1)*Q(I-1,J-1))))/DL)*AA)-(K6*P3)+P4
5592 :                              '---- Equation 6.58-----
5595      C(I,J)=(P1*P2)/Q(I,J)     : KK=DECA+(DECB*LOG(Q(I,J)))
5596 :               '----Eq.6.57-------
5597      C(I,J)= C(I,J)*EXP(KK*DL*.001):IF C(I,J)<0 THEN C(I,J)=.04
5598      TPL(I)=C(I,J)*Q(I,J)
5599 NEXT J
5600 PSET (I+140,189),1
5601 NEXT I
5805 RETURN

6000 '-------------------plot [tp] data at g1m13-----------
6010  IF QS$="y" THEN 6120 ELSE 6020
6020 FOR I=1 TO M4%
6030    TP=TP(I,2)     :  Z=TP(I,1)
6040        TP=180-(180/MT*TP) :  Z=(Z*3.5)+9
6050             CIRCLE (Z,TP),2
6060  NEXT I
6061 FOR I = 1 TO M1%
6062       Q=C(I,8)*1000!  : TT=(I*630/M1%)+10
6063       QP=180-(180/MT*Q)
6064            IF QP<0 THEN QP=0
6065            IF I=1 THEN 6067
6066       LINE (T4,Q4)-(TT,QP),1
6067            T4=TT: Q4=QP
6068 NEXT I
6080 : RETURN
6120 FOR I=1 TO M5%
6130        TM=TM(I,5)     :   Z=TM(I,1)
6140        TM=180-(180/MT*TM) :  Z=(Z*3.5)+9
6150             CIRCLE (Z,TM),3
```

```
6160 NEXT I
6170 :
6200 :
6261 FOR I = 1 TO M1%
6262      Q=C(I,4)*1000!  : TT=(I*630/M1%)+10
6263      QP=180-(180/MT*Q)
6264          IF QP<0 THEN QP=0
6265          IF I=1 THEN 6067
6266      LINE (T4,Q4)-(TT,QP),1
6267          T4=TT: Q4=QP
6268 NEXT I
6280 :RETURN

7000 '------------------NPS model calculations----------
7003 IF J=3 THEN LRA= .022 AND LRB=.015
7004 IF J=4 THEN LRA= .026 AND LRB=.035
7005 IF J=5 THEN LRA= .025 AND LRB=.020
7006 IF J=6 THEN LRA= .025 AND LRB=.025
7007 IF J=7 THEN LRA= .025 AND LRB=.02
7008 IF J=8 THEN LRA= .015 AND LRB=.003
7010 ' nps model algorithms:-
7011 :
7012 Q1=L(I-1,J-1):Q2=L(I,J-1):Q3=L(I-1,J):Q4=L(I,J):
     Q5=L(I-2,J-1):Q6=L(I-2,J)
7013 IF Q1>Q5 THEN
    CL1=((LRB*Q1)+LRA)+((8.999999E-03*EXP(-.007*Q1))*(ABS(Q1-Q5)))
    ELSE CL1=(LRB*Q1)+LRA
7014 IF Q2>Q1 THEN
    CL2=((LRB*Q2)+LRA)+((8.999999E-03*EXP(-.007*Q2))*(ABS(Q2-Q1)))
    ELSE CL2=(LRB*Q2)+LRA
7015 IF Q3>Q6 THEN
    CL3=((LRB*Q3)+LRA)+((8.999999E-03*EXP(-.007*Q3))*(ABS(Q3-Q6)))
    ELSE CL3=(LRB*Q3)+LRA
7016 IF Q4>Q3 THEN
    CL4=((LRB*Q4)+LRA)+((8.999999E-03*EXP(-.007*Q4))*(ABS(Q4-Q3)))
    ELSE CL4=(LRB*Q4)+LRA
7020 TOTALLAT=TOTALLAT+((CL1*Q1)+(CL2*Q2)+(CL3*Q3)+(CL4*Q4))*43200!
7030  RETURN

8100 '------------total tp load calculation using Simpsons rule
8200 TLE=0 :TLO=0                       '<<<load at 23d>>>
8250  FOR I= 2 TO M3%-2 STEP 2
8300      LE=TPL(I)*4    : TLE=TLE+LE
8350      LO=TPL(I+1)*2   : TLO=TLO+LO
8400  NEXT I
8450        TOTALLOAD= (TPL(1)+TLE+TLO+TPL(M3%))*28800*(180/M3%)
8460                               '<<<LOAD AT 13B>>>
8470     FOR I = 1 TO M1%
8475        TOTAL13B=TOTAL13B+(C(I,2)*Q(I,2)*43200!)
8480     NEXT I
8490 '
8500  PRINT
 "-LOAD @ 23D="TOTALLOAD"-LATERAL INP="TOtALLAT"-TOTAL @ 13B=
 "TOTAL13B
8600 RETURN
9000  TP=TPOUT*1000 : TH=(180-(180/MT*TP))
9100 G=(((TIME/86400!)+I)*3.5)+10       'converts secs to days
9200 IF I=1 THEN 9400
9300  LINE (G,TH)-(GP,PH),1
9400                         GP=G : PH=TH
9500 RETURN

9900 'save data from model ouput--------------------------
9903  IF QS$="y" THEN J=4  ELSE 9905
9904 FOR I=1 TO M3%: C(I,J)=C(I,J)*1000 :NEXT I
9905  IF SV$="y" THEN 9910 ELSE 9999
9910 : FDH$="b:"+FDH$
9920 OPEN "o",1,FDH$
9930  PRINT#1,FDH$
9940  PRINT#1,M3%
9945  PRINT#1,K3%
9960          FOR I=1 TO M3%
9970                PRINT#1,C(I,J)
9980          NEXT
9990 CLOSE#1
9999  RETURN ::::::::::::::::::::::::::::::::::::::::::::
```

Phosphorus Bed load model

Command BEDTRAN

Definition

BEDTRAN uses the unit stream power equation to estimate the mass of sediment and phosphorus transported as bed load (see Chapter 7, Section 4). The model calculates the mass transport and plots the simulated results on the graphics screen. Fig A2.5 shows the datafiles and utility programs used in conjunction with the bed load model.

Data Entry

The procedure is initiated and calls for the following input

Prompt	Expected Input
PERIOD OF DATA REQUIRED AT G1M13 (1-6) -	Enter the period of data required for the simulation.
MEDIAN SEDIMENT DIAMETER (.3-.7 mm) [.3] -	Enter the median sediment size of the substrate at Drie Heuwels Weir.
MAXIMUM SED. CONC. PLOTTED [125] -	Enter the maximum sediment concentration plotted on the graphics screen.
MAXIMUM FLOW PLOTTED [125] -	Enter the maximum discharge plotted on the screen.

Example

In the following example the model is used to predict the total mass of bed material exported at Drie Heuwels Weir for Period 2.

Prompt:	Response:
PERIOD OF DATA REQUIRED AT G1M13 (1-6)	- "2"
MEDIAN SEDIMENT DIAMETER (.3-.7 mm) [.3]	- ""
MAXIMUM SED. CONC. PLOTTED [125]	- ""
MAXIMUM FLOW PLOTTED [125]	- ""

The data are loaded from disk, processed and the chemograph of bed material is displayed in addition to the hydrograph for Drie Heuwels Weir. The total mass of bed load is calculated using Simpson's Approximation.

Listing of source code

```
2 '********************** up-dated 30.4.88 *****************

5          SCREEN 0,0,0: CLEAR
10 '    bed load transport using the unit stream equation devised by
20 '                   YANG & STALL  ( 1976 )
30 '    -----------------------------------------------------
40 '
45 ' ( this method uses the flow data for drie heuwels only and does
     not accommodate for temperature fx or wash load determination.
48 '
60 '++++++++++++ MAIN  ROUTINE ++++++++++++++++++++++++++++++
70 '
80   GOSUB 1000           '  OPTIONS
90   GOSUB 2000           '  LOAD FLOW DATA FOR G1M13
100  GOSUB 3000           '  HIRES SCREEN
110  GOSUB 4000           '  CALCULATION & PLOT OF OUTPUT DATA
115  GOSUB 5000           '  PLOT OF SS DATA
120  INPUT" re-run? {y/n} ";QE$: IF QE$="y" THEN 5 ELSE END
130'+++++++++++++++++++++++++++++++++++++++++++++++++++++++++

1000 '---------------------------initialization----
1010 CLS
1030 PRINT"<< place flow data in drive A & wq data in B:>>"
1040 PRINT
1050 PRINT"-----------BED LOAD TRANSPORT MODEL: BEDTRAN1--------
1060 PRINT"                              --G1M13--"
1070 PRINT
1075 PRINT
1100 '
1200 INPUT" PERIOD OF DATA REQUIRED AT G1M13 (1-6)"; P$
1300 INPUT" MEDIAN SEDIMENT DIAMETER  (.3-.7: mm) [.3] "; D:
       IF D=0 THEN D=.3   : D=D/1000
1400 INPUT" MAXIMUM SED. CONC.PLOTTED         [125]     ";MAX :
       IF MAX=0 THEN MAX=125
1500 INPUT" MAXIMUM FLOW  PLOTTED             [125]     ";MAXQ:
       IF MAXQ=0 THEN MAXQ=125
1600 PRINT
1700 PRINT" - - - - - - - - - - - - - - - - - - - - - - - - - -"
1800 RETURN

2000 '-----------------------------load flow data g1m13
2100 '
2200 FL$= "23dq12."+P$
2300                 OPEN "i",1,FL$
2400                 INPUT#1,NN$,M%,K%
2450
2500                 DIM Q(360,1)
2555          FOR J=1 TO K%
2560               FOR I=1 TO M%
2570                    INPUT#1, Q(I,J)
2600           NEXT : NEXT
2650              CLOSE#1
2700 IF P$="1" OR P$="2" OR P$="3" THEN 2900 ELSE 2800
2800 SS$= "B:23DSS."+P$
2810                 OPEN "i",1,SS$
2815                 INPUT#1,NN$,M1%,K1%
2820                 DIM S(60,3)
2830          FOR J=1 TO K1%
2835               FOR I=1 TO M1%
2840                    INPUT#1, S(I,J)
2845           NEXT : NEXT
2850              CLOSE#1
2900 RETURN

3000 '--------------------------graphics screen------
3100 '
3200 SCREEN 2,0,0,0
3300 LINE (10,0)-(10,180),1 : LINE (10,180)-(630,180),1
3400 FOR I=1 TO M%:X=(I*3.44445)+10 : PSET(X,181),1: NEXT I
3500 PRINT"Ct "MAX" Q "MAXQ                  "period:"P$"  d:"D
3600  RETURN

4000 '--------------------------------calculation and plot
4100 '
4150           TOTALSEDLOAD=0  :  KV=1.307E-06      : SO=.00041
4175           P=999!          :  G=9.8             : U=.001307
```

```
4180 '
4190 FOR I=1 TO M% '-----------
4200             Q=Q(I,1)
4220 '           AREA= 2.2*(Q^.99)   :  V=Q/AREA   : R=AREA/35
4225 '
4230 ' shear velocity:
4235                                 VX=(G*R*SO)^.5
4240 ' fall  velocity:
4250 VF=((3.48*U^2+(.0884 * P * G * (2650-999)*D^3))^.5)-(1.87*U)
4260                                 VF=VF/(.265*P*D)
4270 ' reynolds particle no.
4280                                 RP=(VF*D*P)/U
4290 ' reynolds erosion no.
4295                                 RE=(VX*D)/KV
4300 ' unit stream power equation
4310                                 WW=SO*V
4320 ' empirical factor J
4325                                 J=272000!/((RP^.286)*((VX/VF)^.457))
4330 '    '    '      factor K
4335                                 K=1.799-(.178*LOG(RP))-(.136*LOG(VX/VF))
4340 '
4350  IF RE >=70 THEN WCVF=2.05*SO
                 ELSE WCVF=SO*((2.5/((.434*LOG(RE)-.06)))+.66)
4370 '
4444 '  yang  and stall equation
4450                                   CT=((WW/VF)-WCVF)
4460           IF CT<=0 THEN CT=0
4470           CT=(CT^K)*J
4475           IF CT<=0 THEN CT=0
4480           QSED= 1E-09 * CT * 2.65 * P * G * Q
4490           TOTALSEDLOAD = TOTALSEDLOAD + QSED
4495 '
4500 '  plot sediment concentration
4520            CT=(180-(180/MAX*CT))    :   IF CT<0 THEN CT=0
4530            X=(I*(630/M%))+10
4540          CIRCLE (X,CT),2
4550 '
4560 '  plot flow data (line graph)
4580            Q=(180-(180/MAXQ*Q))
4585            IF I=1 THEN 4600
4590            LINE (XP,QP)-(X,Q),1
4600            XP=X : QP=Q
4650 NEXT I'---------
4700 '
4710 PRINT" total sed. load:" TOTALSEDLOAD" (ton)"
4800 RETURN

5000 '-------------------------- PLOT SS DATA ------------
5100 '
5200  FOR I = 1 TO M1%
5250      Z = S(I,1)   :   SS=S(I,2)
5270       SP = (180-(180/MAX*SS)) : IF SP<0 THEN SP=0
5300       Z  = (Z + 10)
5400       CIRCLE (Z,SP),3
5500  NEXT I
5600 RETURN
```

Pre-impoundment model

Command : DAMP

Definition

DAMP is an interactive program which simulates the sedimentation of phosphorus in pre-impoundments. The program uses the simulated chemograph and hydrograph at Drie Heuwels Weir (Station 23D) to estimate the mass of phosphorus sedimented within the waterbody. The volume of the waterbody may be selected as well as the sedimentation rate. The phosphorus budget is calculated over periods of one month, with the final output given in tabular form. For more details on the approach adopted see Chapter 8.

Data Entry

Once initiated the following data must be entered

Prompt	Expected Input
filename of chemograph -	Enter the filename of the chemograph and hydrograph
filename of hydrograph -	for Drie Heuwels Weir which will be used in the simulation.
sed. const [.00002] -	Enter the sedimentation constant used in the equation to simulate the removal of phosphorus from the water column of the waterbody.
volume of pre-imp.(million m^3) -	Enter the volume of the waterbody used in the simulation exercise.

Example

In the following example the procedure is used to predict the influence of a pre-impoundment at Drie Heuwels Weir on the phosphorus budget of the downstream river for Period 2.

Prompt	Reply
filename of chemograph -	"a:23dtpl2.2"
filename of hydrograph -	"b:chanql2.2"
sed. const [.00002] -	""
volume of pre-imp.(million m3) -	"30"

The program loads the specific data files; if a file contains more than one field then the user is requested to select the field required:

```
- - - - - - - - - -load data files - - - - - - - - -
file contains 1
field(s) file contains
8 field(s)
select one field
required-        "8"
```

The data are processed and output to the monitor in the following format:

```
--------------------output data-------------------------------
  [files:a:23dtpl2.2 + b:chanql2.2]
     volume    of     imp.:30          sed.const:      .00002
--------------------------------------------------------------
month   inputload   inputQ   Pin    Pout   loadout loadret
1
2
3
4
5
6
--------------------------------------------------------------
total   input=              total   output=          %retention
--------------------------------------------------------------
```

where: inputQ is the monthly discharge (m^3)
Pin is the mean [TP] of the inflow
Pout is the mean [TP] of the outflow

The program asks the user if DAMP must be re-run

re-run program (y/n)

If "y" is entered the program is re-initialized and if not, the procedure is quit and the operating system prompt is displayed.

Listing of source code

```
10 :
20 ' program:  DAMP predicts the influence of a
30 ' pre-impoundment on the nutrient budget of a river

50 '--------main routine---------------------------
55 CLEAR
60 GOSUB 1000   ' initialization
70 GOSUB 2000   ' load data files
80 GOSUB 3000   ' calculation
95 INPUT "re-run program (y/n)";RR$ :
     IF RR$<>"y" AND RR$<>"n" THEN 95 ELSE 97
97  IF RR$="y" THEN 55 ELSE SCREEN 0,0,0: END
98'-------------------------------------------------

1000 CLS: SCREEN 0,0,0 : DIM A(360,8), B(360,8),
     C(360,1), W(60), Q(60), P(60), S(60), PO(60)
1001 PRINT"                              DAMP          "
1003 PRINT
1004 PRINT"   Demonstration of the influence of pre-impoundments"
1005 PRINT
1050 PRINT"- - - - - - - initialization - - - - - - -"
1060 PRINT
1100 INPUT" filename of chemograph"; NC$
1200 INPUT" filename of hydrograph"; NH$
1400 INPUT" sed. const.k [.00002] "; K  :
     IF K=0 THEN K=.00002
1450 INPUT" volume of pre-imp.(million of m3)";V :
     IF V=0 THEN V=30
1500 PRINT
1600 RETURN

2000 PRINT"- - - - - - - load data files - - - - - - - "
2100 OPEN "i",1,NC$
2110 INPUT#1,NN$,M%,K%
2120 FOR J= 1 TO K%
2130       FOR I= 1 TO M%
2140             INPUT#1,A(I,J)
2150       NEXT
2160  NEXT
2170 CLOSE#1                                'load chemograph
2180 PRINT"file contains "K%"field(s)" : IF K%=1 THEN FD1=1  :
     GOTO 2199
2190 INPUT" select one field required";FD1
2195 IF FD1=0 THEN 2190
2199 :
2200 OPEN "i",1,NH$
2210 INPUT#1,NN$,N%,C%
2220 FOR J= 1 TO C%
2230       FOR I= 1 TO N%
2240             INPUT#1,B(I,J)
2250       NEXT
2260  NEXT
2270 CLOSE#1                               'load hydrograph
2280 PRINT"file contains "C%"field(s)" : IF C%=1 THEN FD2=1 :
     GOTO 2295
2290 INPUT" select one field required";FD2
2295 IF FD2=0 THEN 2290
2300 RETURN
```

' monthly mass balances will now be calculated using the input hydrograph and chemograph as well as simulating the mass sedimentation of phosphorus within the preimpoundment.

```
3000 PRINT"- - - - calculation - - - - - - -
3010 TOTALLOAD=0 : TOTALFLOW=0
3012 IF M%<> N% THEN PRINT"error with data files: ": END
3020 IF M%=>344 THEN TIME =43200!
3030 IF M%=180 THEN TIME =86400!
3040 :
3050 FOR I= 1 TO (M%/6)          '++++ Month number one +++++++++++
3060          C(I,1)=A(I,FD1) * B(I,FD2)*.001
3070    TOTALLOAD= TOTALLOAD + (C(I,1) *TIME)
3080    TOTALFLOW= TOTALFLOW + (B(I,FD2)* TIME)
```

```
3089 NEXT I
3090 I=1
3091 W(I) = TOTALLOAD/1000
3092 Q(I) = TOTALFLOW/1000000!
3093 P(I) = TOTALLOAD / TOTALFLOW
3094 S(I) = K*((P(I)*1000)^2)  ' sedimentation rate model
3095 PO(I)= ( W(I)/(Q(I)+(S(I)*V)) )*1000
3099 : :
3110 TOTALLOAD=0 : TOTALFLOW=0
3150 FOR I= (M%/6) TO (M%/3)   '+++++ Month number two ++++++++++++
3160         C(I,1)=A(I,FD1) * B(I,FD2)*.001
3170    TOTALLOAD= TOTALLOAD + (C(I,1) *TIME)
3180    TOTALFLOW= TOTALFLOW + (B(I,FD2)* TIME)
3189 NEXT I
3190 I=2
3191 W(I) = TOTALLOAD/1000
3192 Q(I) = TOTALFLOW/1000000!
3193 P(I) = TOTALLOAD / TOTALFLOW
3194 S(I) = K*((P(I)*1000!)^2)   ' sedimentation rate model
3195 PO(I)= ( W(I)/(Q(I)+(S(I)*V)) )*1000
3199 : :
3210 TOTALLOAD=0:TOTALFLOW=0
3250 FOR I= (M%/3) TO (M%/2)   '+++++ Month number three ++++++++++
3260         C(I,1)=A(I,FD1) * B(I,FD2)*.001
3270    TOTALLOAD= TOTALLOAD + (C(I,1) *TIME)
3280    TOTALFLOW= TOTALFLOW + (B(I,FD2)* TIME)
3289 NEXT I
3290 I=3
3291 W(I) = TOTALLOAD/1000
3292 Q(I) = TOTALFLOW/1000000!
3293 P(I) = TOTALLOAD / TOTALFLOW
3294 S(I) = K*((P(I)*1000!)^2)  ' sedimentation rate model
3295 PO(I)= ( W(I)/(Q(I)+(S(I)*V)) )*1000
3299 : :
3310 TOTALLOAD=0 : TOTALFLOW=0
3350 FOR I= (M%/2) TO (M%/1.5)    '+++++ Month number four ++++++++
3360         C(I,1)=A(I,FD1) * B(I,FD2)*.001
3370    TOTALLOAD= TOTALLOAD + (C(I,1) *TIME)
3380    TOTALFLOW= TOTALFLOW + (B(I,FD2)* TIME)
3389 NEXT I
3390 I=4
3391 W(I) = TOTALLOAD/1000
3392 Q(I) = TOTALFLOW/1000000!
3393 P(I) = TOTALLOAD / TOTALFLOW
3394 S(I) = K*((P(I)*1000!)^2)
3395 PO(I)= ( W(I)/(Q(I)+(S(I)*V)) )*1000
3399 : :
3410 TOTALLOAD=0 : TOTALFLOW=0
3450 FOR I=  (M%/1.5) TO (M%/1.2)    '+++ Month number five ++++++++
3460         C(I,1)=A(I,FD1) * B(I,FD2)*.001
3470    TOTALLOAD= TOTALLOAD + (C(I,1) *TIME)
3480    TOTALFLOW= TOTALFLOW + (B(I,FD2)* TIME)
3489 NEXT I
3490 I=5
3491 W(I) = TOTALLOAD/1000
3492 Q(I) = TOTALFLOW/1000000!
3493 P(I) = TOTALLOAD / TOTALFLOW
3494 S(I) = K*((P(I)*1000!)^2)
3495 PO(I)= ( W(I)/(Q(I)+(S(I)*V)) )*1000
3499 : :
3510 TOTALLOAD=0 : TOTALFLOW=0
3550 FOR I= (M%/1.2) TO M%          '+++ Month number six
3560         C(I,1)=A(I,FD1) * B(I,FD2)*.001
3570    TOTALLOAD= TOTALLOAD + (C(I,1) *TIME)
3580    TOTALFLOW= TOTALFLOW + (B(I,FD2)* TIME)
3589 NEXT I
3590 I=6
3591 W(I) = TOTALLOAD/1000
3592 Q(I) = TOTALFLOW/1000000!
3593 P(I) = TOTALLOAD / TOTALFLOW
3594 S(I) = K*((P(I)*1000!)^2)
3595 PO(I)= ( W(I)/(Q(I)+(S(I)*V)) )*1000!

3600 PRINT:'-------- data output ---------------
3602 :
3610 PRINT"--------------------output data--------------
3620 PRINT"[ files:"nC$ " + "NH$ "]"
3622 PRINT" Volume of imp:"V"   Sed. const:"K
3623 PRINT
3625 PRINT"----------------------------------------------"
```

```
3630 PRINT"month inputload inputQ Pin Pout loadout load ret"
3640 FOR I =1 TO 6
3650  PRINT I"" W(I) Q(I) P(I) PO(I) (Q(I)*pO(I)/1000)
          (W(I)-(Q(I)*PO(I)/1000))
3660 NEXT I
3670 PRINT
3680 PRINT"-----------------------------------------------"
3690 FOR I= 1 TO 6
3692   TOTALINP=TOTALINP+W(I) : TOTALOUT=TOTALOUT+(Q(I)*PO(I)/1000!)
3693 NEXT I
3694 PERCENT=100-((TOTALOUT/TOTALINP)*100!)
3696 PRINT"total input="TOTALINP"
          total output="TOTALOUT" % retention"PERCENT
3698 PRINT"-----------------------------------------------"
3700 RETURN
```

4 INTERACTIVE PROGRAM APPLICATION

Command : PCHAT.BAT

Definition

This interactive batch program is designed to use each of the procedures described above so that the user may edit, process and analyse the data files as well as run the various models.

Data Entry

The procedure is initiated and the following data must be entered.

Prompt	Expected Input
Press key	From the list of procedures shown on the menu enter a character representing the procedure to be initiated.

The procedure is loaded from disk and once completed the main menu is displayed.

Example

In the following example the procedure is used to display a hydrograph and then re-display the same hydrograph in the form of a duration curve.

Prompt	Reply	Program Response
Press Key	"g"	The procedure for displaying a time series will be initiated. Once the program is finished the main menu is displayed
Press Key	"h"	The procedure for displaying a duration curve will be initiated. Once the program is complete the main menu is then displayed.
Press key	"q"	The procedure returns to the operating system.

Figs A2.1 to A2.5 shown how the procedures in the previous sections may be used interactively using this program.

Listing of source code

```
ECHO OFF
CLS
ASK " Do you wish to load CGA emulation ? (y/n)", yn
IF ERRORLEVEL 2  GOTO RUN       £for use with Hercules Cards
only !!!
IF ERRORLEVEL 1 GOTO EMULATE
:EMULATE
HGCIBM /H
:RUN
:RERUN
REM -- INTERACTIVE P-CHAT BATCH FILE -- CLS
TYPE MAINMENU.TXT
ASK    "Press    key:    A    -    Q    ",
ABCDEFGHIJKLMNOPQ
IF ERRORLEVEL 17 GOTO Q
IF ERRORLEVEL 16 GOTO P
IF ERRORLEVEL 15 GOTO O
IF ERRORLEVEL 14 GOTO N
IF ERRORLEVEL 13 GOTO M
IF ERRORLEVEL 12 GOTO L
IF ERRORLEVEL 11 GOTO K
IF ERRORLEVEL 10 GOTO J
IF ERRORLEVEL 9 GOTO I
IF ERRORLEVEL 8 GOTO H
IF ERRORLEVEL 7 GOTO G
IF ERRORLEVEL 6 GOTO F
IF ERRORLEVEL 5 GOTO E
IF ERRORLEVEL 4 GOTO D
IF ERRORLEVEL 3 GOTO C
IF ERRORLEVEL 2 GOTO B
IF ERRORLEVEL 1 GOTO A
```

```
:A
DISKIO.EXE
GOTO RERUN
:B
LATINF12.EXE
GOTO RERUN
:C
CHANDATA.EXE
GOTO RERUN
:D
ABSTRACT.EXE
GOTO RERUN
:E
LOADCALC.EXE
GOTO RERUN
:F
WQ-PLOT.EXE
GOTO RERUN
:G
FLOWPLOT.EXE
GOTO RERUN
:H
DURACV1.EXE
GOTO RERUN
:I
REGRESS.EXE
GOTO RERUN
:J
NPSM.EXE
GOTO RERUN
:K
QMODEL.EXE
GOTO RERUN
:L
SECTION1.EXE
GOTO RERUN
:M
SECTION2.EXE
GOTO RERUN
:N
BEDTRAN.EXE
GOTO RERUN
:O
DAMP.EXE
GOTO RERUN
:P
DIR B: /P
GOTO RERUN
:Q
```

Listing of text file (MAINMENU.TXT) displayed during execution of the procedure:-

```
---------MAIN MENU: P_CHAT ---------Ctrl-C : return to menu

                --DATA MANAGEMENT--
A  Data Editor
B  Data file merger   (lateral inflow)
C  Data file splitter (channel data files)
D  Data file modifier (hydrograph modification)
E  Load integration
        --PLOTTING AND DESCRIPTIVE PROCEDURES--
F  Scatter plot
G  Hydrograph plot
H  Duration curve
                --MODEL DEVELOPMENT--
I  Regression analysis
J  Phosphorus nonpoint source model
K  Hydrodynamic flow model
L  Phosphorus transport model : Section 1
M  Phosphorus transport model : Section 2
N  Phosphorus bed load model
O  Pre-impoundment model
P  ----------Directory
Q  ----------Quit (Exit to DOS)
```

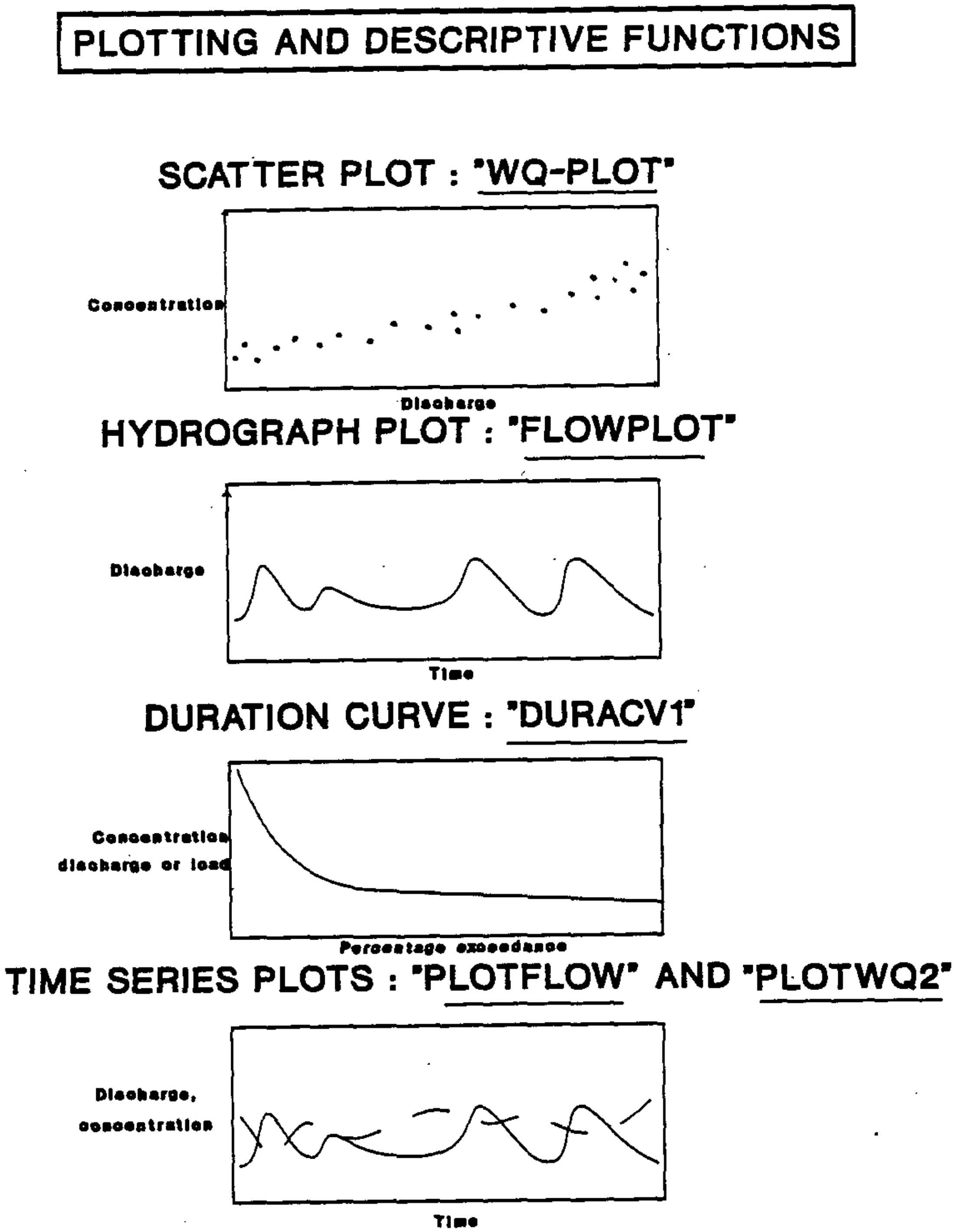

Fig A2.1. Schematic presentation of the plotting and descriptive functions used in this investigation.

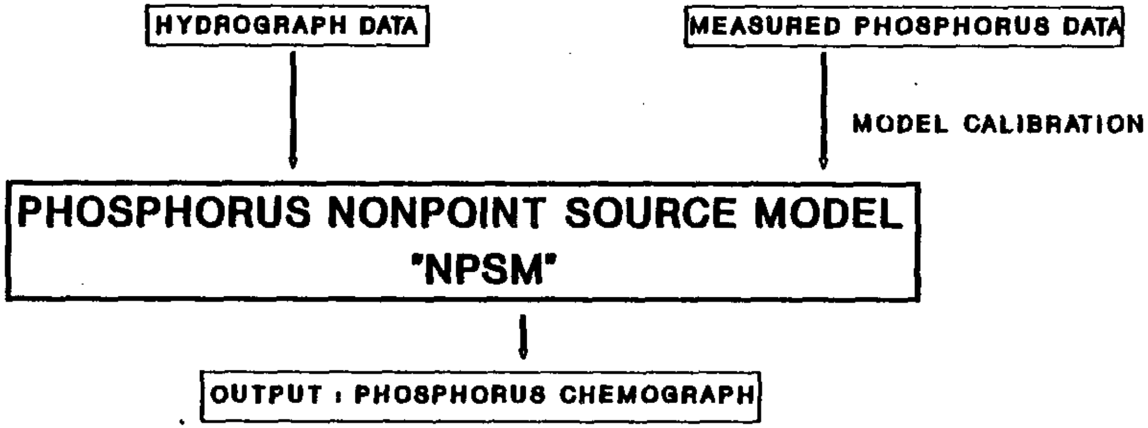

Fig A2.2. Graphic presentation of the input and output data files used in the nonpoint source model (NPSM).

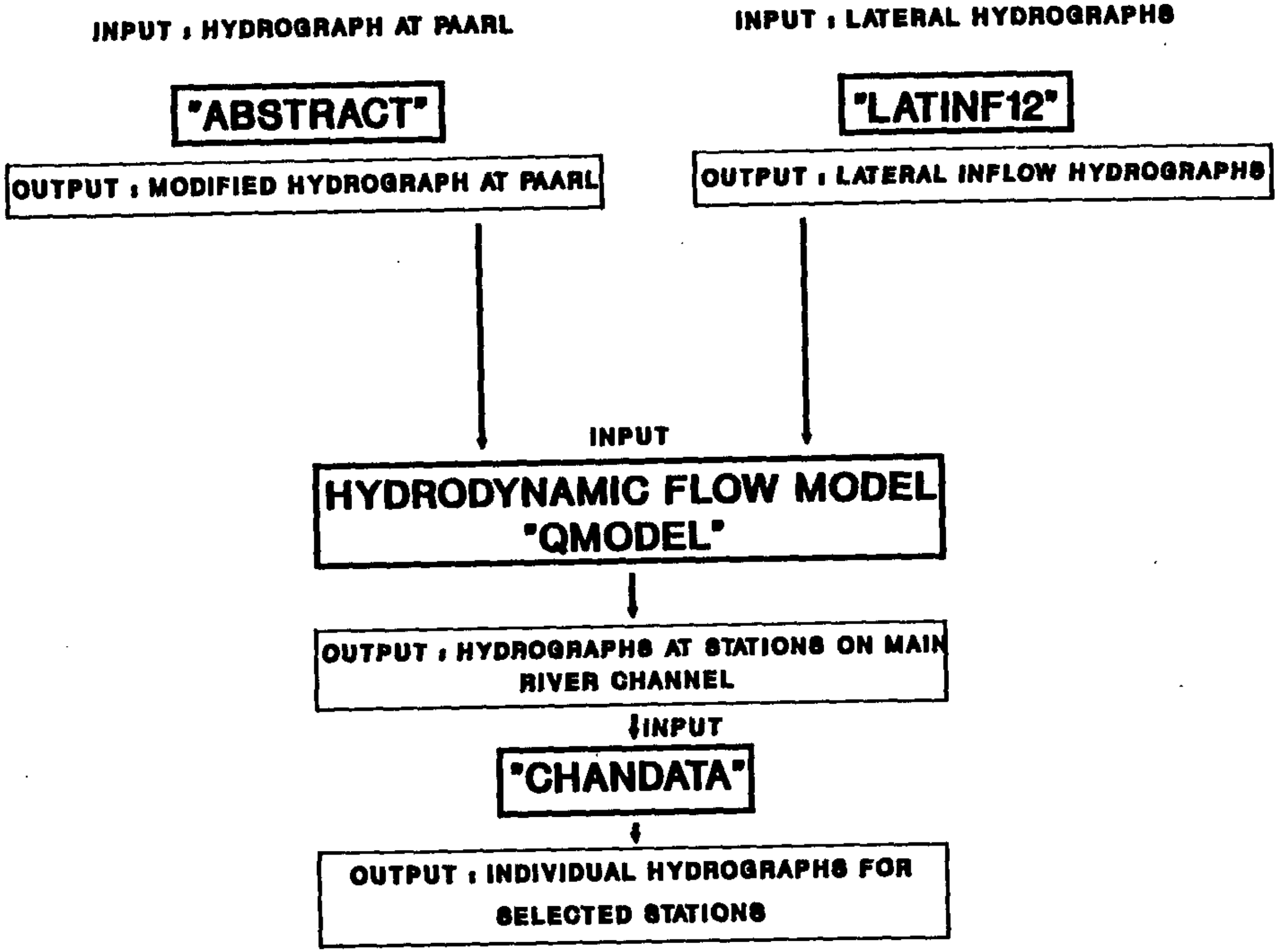

Fig A2.3. Graphic presentation of the data files and utility programs used with the hydrodynamic flow model (QMODEL).

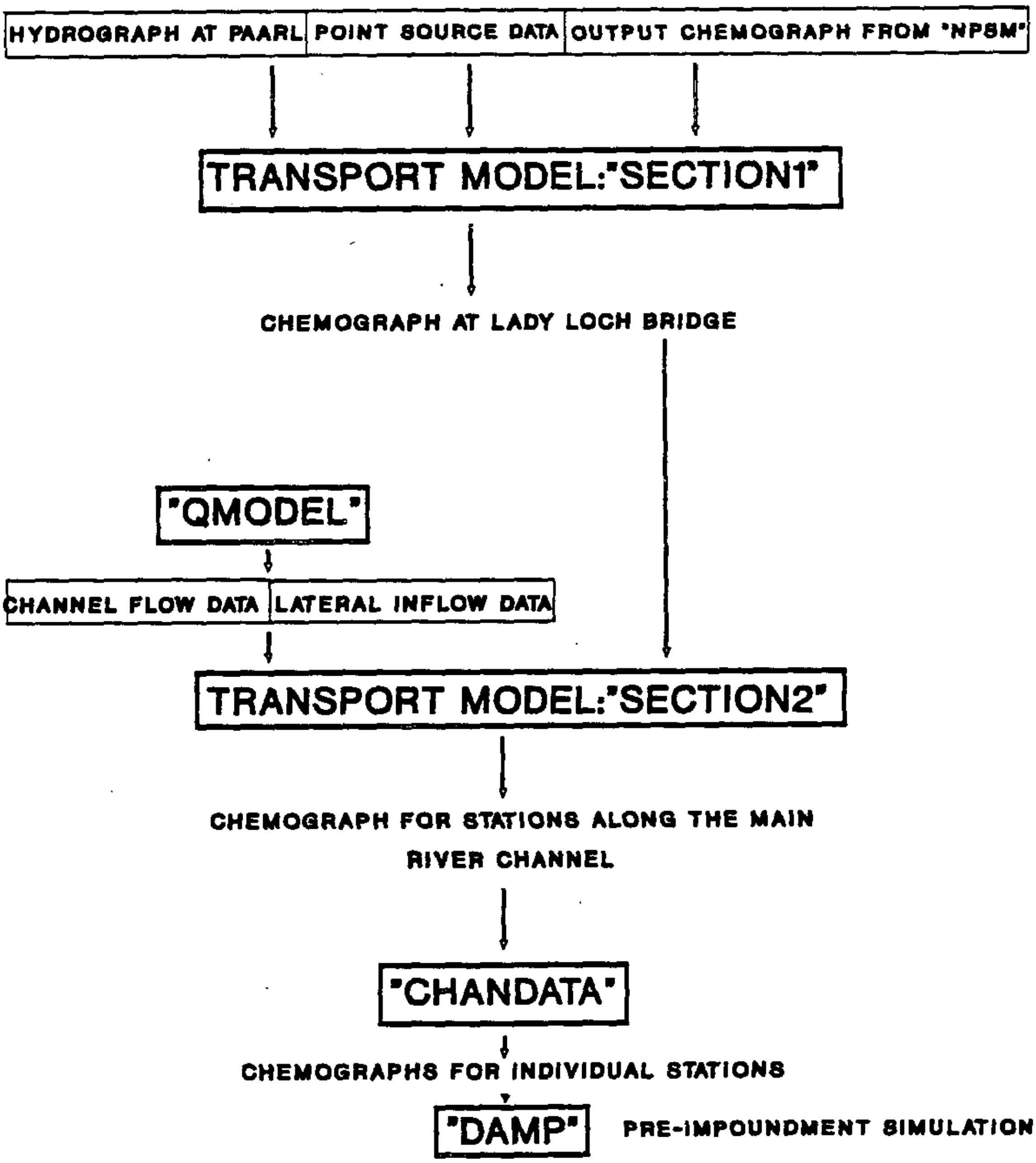

Fig A2.4. Graphic presentation of the data files and utility programs used with the phosphorus transport model (programs SECTION1 and SECTION2).

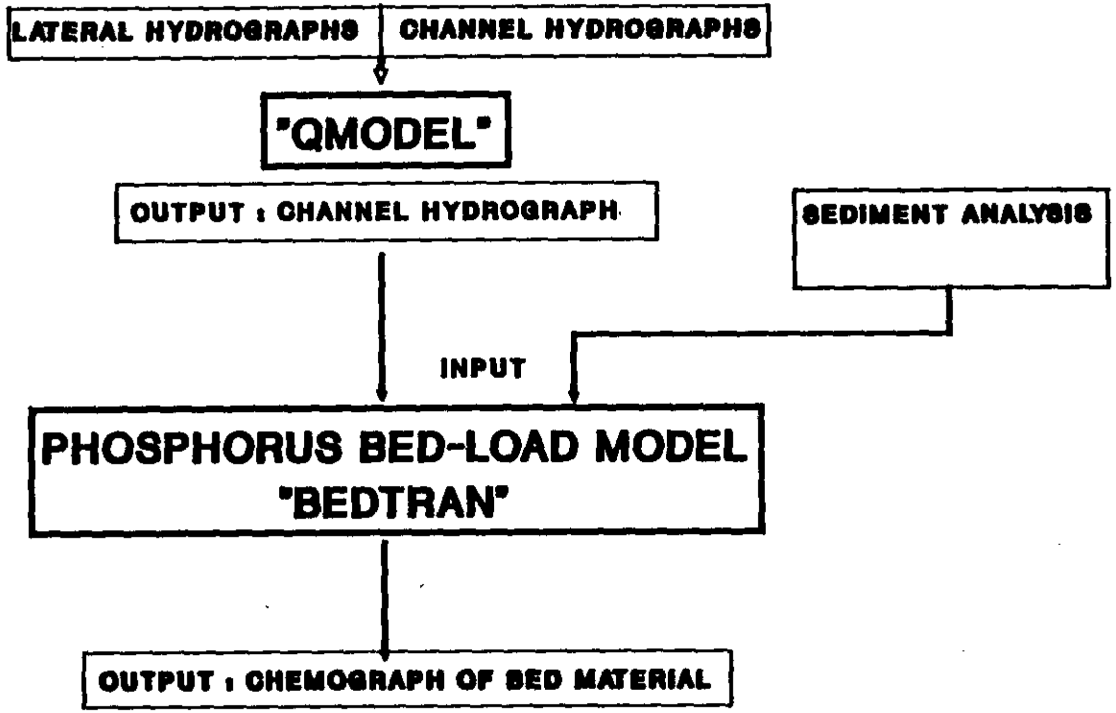

Fig A2.5. Graphic presentation of the data files and utility programs used with the phosphorus bed load model (program BEDTRAN).

APPENDIX 3

WATER QUALITY AND FLOW DATA

1 WATER QUALITY DATA

Water quality data used in this investigation are presented in the following groups

(1) Total phosphorus data for stations located along the main river channel from Paarl to Lady Loch Bridge and from Lady Loch Bridge to Drie Heuwels Weir (page A3.3 to A3.4).

(2) Total phosphorus concentration data for the sampling stations located on the discharge lines of Paarl and Wellington wastewater treatment plants (pages A3.5 to A3.10).

(3) Total phosphorus concentration and discharge data for tributaries of the Berg River e.g.

Krom River	-	Station 14B	page A3.11
Doringspruit	-	Station 15D	page A3.11
Kompagnies River	-	Station 17B	page A3.12
Klein Berg River	-	Station 23A	page A3.13
Sandspruit	-	Station 23B	page A3.13

as well as for the two sampling stations located on the main river channel at:

Paarl	-	Station 9A	page A3.14
Drie Heuwels Weir	-	Station 23D	page A3.15

A blank record signifies no data available. All phosphorus concentration data are expressed in μg/ℓ and discharge in cumecs.

(4) Total suspended solids concentration (expressed in mg/ℓ) and discharge data are collected at

Drie Heuwels Weir	-	Station 23D	page A3.17
Klein Berg River	-	Station 23A	page A3.18
Berg River at Paarl	-	Station 9A	page A3.19
Krom River	-	Station 14B	page A3.20

2 FLOW DATA

The discharge data used in this investigation are presented in block-form with incremental readings taken at 12-hour intervals for gauging weirs shown below

River and location	Weir	Station	page
Berg River at Paarl	G1M20	9A	A3.21
Paarl wastewater plant	G1Q01	PSTW	A3.27
Wellington wastewater	G1Q01	WSTW	A3.33
Krom River	G1M37	14B	A3.39
Doringspruit	G1M39	15D	A3.45
Kompagnies River	G1M41	17B	A3.51
Vis River	G1M40	20A	A3.57
Voëlvlei Dam release	G1R01	21D	A3.63
Klein Berg River	G1M08	23A	A3.69
Sandspruit	G1M35	23B	A3.76
Berg River at Drie Heuwels	G1M13	23D	A3.83

Water Quality data for Section 1 of the main river channel Period 1

KEY: TP - Total phosphorus concentration Q - discharge

Date:	TP 9a	Q 9a	TP PSTW	Q PSTW	TP WSTW	Q WSTW	TP 13b
1							280
20	39	1.06					273
71	27	1.59					102
98	47	1.28					137
107	3	.57					95
119	37	.28					112
126							81
141							79
147							136
179	62	16.9	251	.3	700	.04	158

Water Quality data for Section 1 of the main river channel Period 2

KEY: TP - Total phosphorus concentration Q - discharge

Date:	TP 9a	Q 9a	TP PSTW	Q PSTW	TP WSTW	Q WSTW	TP 13b
2	44	9.34	2950	.20	7275	.04	185
24	33	4.72	2770	.21	7000	.04	133
31	28	4.18	3360	.20	7400	.03	156
41	46	70.83	4130	.21	7200	.05	69
51	50	7.90	4900	.21	7000	.05	160
64	40	11.46	4430	.21	7270	.05	150
78	40	18.22	4360	.21	7880	.04	97
90	18	6.99	3380	.21	7346	.03	137
100	18	4.53	5050	.21	8970	.02	244
109	42	61.10	4930	.25	7100	.05	78
135	56	7.90	5070	.21	7880	.07	198
150	31	7.90	4080	.21	6840	.03	125
170	24	1.90	2850	.09	6800	.01	124
177	34	.77	2880	.11	9180	.02	179

Water Quality data for Section 1 of the main river channel Period 3

KEY: TP - Total phosphorus concentration Q - discharge

Date:	TP 9a	Q 9a	TP PSTW	Q PSTW	TP WSTW	Q WSTW	TP 13b
5	26	1.56	2470	.08	8800	.02	208
18	33	8.13	4130	.12	10000	.02	87
32	49	15.63	4230	.12	10770	.04	130
46	15	.74	4090	.15	9650	.02	368
60	19	3.48	4110	.08	10380	.01	118
74	27	.54	4010	.08	9500	.01	250
88	22	.74	4330	.14	9860	.01	244
102	20	.61	3330	.10	9690	.01	476
116	9	3.46	2870	.15	9700	.01	256
128	24	4.53	1960	.15	8640	.02	143
130	20	2.26	1800	.14	10320	.03	129
149	17	1.79	3140	.17	8090	.01	236
156	27	12.30	393	.20	7870	.03	112
172	36	2.41	5310	.21	8390	.02	418

Water Quality data for Section 1 of the main river channel Period 4

KEY: TP - Total phosphorus concentration Q - discharge

Date:	TP 9a	Q 9a	TP PSTW	Q PSTW	TP WSTW	Q WSTW	TP 13b
8							
20	53	22.83	4820	.18	9500	.03	91
34	27	3.82	4580	.21	9510	.02	234
55	73	24.42	3420	.18	5420	.05	120
69	111	95	3780	.24	5570	.09	155
84	56	10.40	4190	.21	4360	.03	156
98	183	216	3240	.22	5490	.11	491
111	62	18.88	3170	.18	5550	.04	149
125	29	7.45	3650	.21	6970	.03	173
139	65	7.45	4350	.20	7480	.03	192
153	38	8.99	4570	.18	7200	.02	154
168	35	5.31	3760	.09	8480	.03	90

Water Quality data for Section 1 of the main river channel Period 5

KEY: TP - Total phosphorus concentration Q - discharge

Date:	TP 9a	Q 9a	TP PSTW	Q PSTW	TP WSTW	Q WSTW	TP 13b
9	15	1.30	960	.10	9670	.02	125
14	14	1.90	750	.19	8580	.02	124
23	27	.90	1580	.11	11980	.03	109
37	22	2.80	2290	.10	11340	.01	161
59	35	2.02	2800	.03	11130	.02	139
78	77	2.15	2210	.09	11270	.02	138
91	32	.77	2480	.10	13140	.01	148
102	48	2.54	3090	.10	11600	.03	161
114	48	1	2530	.11	12640	.01	182
127	27	.88	3110	.18	11050	.02	283
140	28	2.15	2700	.18	12270	.02	158
154	59	.74	2370	.17	13270	.02	316
155	90	2.02	2330	.17	10930	.02	351
156	29	5.72	2330	.16	12430	.03	434
161	84	27.60	2400	.17	11150	.05	199
162	24	10.13	2330	.15	11000	.03	
164	320	51.80	2350	.18	10900	.04	236
178	29	2.54	2720	.20	11310	.03	235

Water Quality data for Section 1 of the main river channel Period 6

KEY: TP - Total phosphorus concentration Q - discharge

Date:	TP 9a	Q 9a	TP PSTW	Q PSTW	TP WSTW	Q WSTW	TP 13b
5	198	78.07	2530	.15	10920	.02	492
10	52	35.77	2420	.17	11790	.02	158
12	21	10.70					82
19	22	2.98	2960	.18	11570	.03	213
24	32	2.27					293
26	24	21.80	2850	.18	11050	.02	70
33	29	11.78	2520	.17	10590	.04	111
38	45	9.68					115
45	43	33.30	2520	.21	9110	.03	78
57	61	23.84					115
59	45	26.66					84
60	38	22.30					83
66	131	29.60	2290	.21	7100	.07	185

DATA FOR SECTION 2 PERIOD:1

STATIONS ON MAIN RIVER CHANNEL:-

Date:	13b	15a	17a	18a	21a	22a	23d	25a
16	272	216	113	74	90	39	-	-
69	145	180	107	114	75	69	-	-
98	137	262	149	120	117	63	177	-
119	112	102	106	103	117	170	200	-
126	81	123	104	98	109	89	-	-
140	79	117	42	97	74	50	39	-
147	112	103	68	79	32	49	82	-
179	158	162	142	129	122	127	-	-

DATA FOR SECTION 2 PERIOD:2

STATIONS ON MAIN RIVER CHANNEL:-

Date:	13b	15a	17a	18a	21a	22a	23d	25a
2	168	174	148	140	160	130	102	-
18	130	127	116	118	112	93	81	-
26	133	119	58	53	80	66	38	-
31	156	124	87	87	82	82	43	-
41	88	84	-	65	123	194	-	-
51	160	150	120	110	100	90	-	-
64	150	140	130	120	110	100	80	-
70	87	86	83	94	80	90	74	-
90	130	171	101	120	84	-	42	-
100	244	-	103	143	120	34	57	-
108	78	82	-	65	-	197	120	-
135	188	172	-	128	124	118	88	-
150	123	117	-	34	56	88	56	-
170	124	105	-	56	58	47	40	-

DATA FOR SECTION 2 PERIOD:

STATIONS ON MAIN RIVER CHANNEL:-

Date:	13b:	15a:	17a:	18a:	21a:	22a:	23d:	25a:
6	208	147	-	28	48	47	27	-
18	87	84	-	153	140	93	48	-
32	138	118	-	60	163	138	37	-
46	300	218	-	88	80	84	54	-
60	118	158	-	113	108	82	82	-
74	250	108	134	-	78	40	53	-
88	264	174	118	107	112	108	67	-
102	470	285	88	-	83	31	87	-
118	258	188	88	-	74	84	-	-
130	128	138	53	-	111	74	81	-
148	238	172	124	-	88	73	70	89
158	113	131	87	-	101	173	154	74
172	418	270	237	-	181	112	78	58

DATA FOR SECTION 2 PERIOD:4

STATIONS ON MAIN RIVER CHANNEL:-

Date:	13b:	15a:	17a:	18a:	21a:	22a:	23d:	25a:
0	91	107	-	-	-	139	85	85
20	234	188	248	-	180	88	80	84
34	120	123	-	121	-	160	113	38
55	138	182	-	278	-	183	221	312
80	158	144	-	118	-	-	87	104
84	481	481	-	374	-	202	151	-
98	148	127	-	175	-	100	95	83
111	173	104	-	111	-	80	30	-
125	192	173	-	134	151	87	53	53
139	134	135	-	120	-	74	88	84
153	90	82	-	52	-	85	52	52

DATA FOR SECTION 2 PERIOD:5

STATIONS ON MAIN RIVER CHANNEL:-

Date:	13b:	15a:	17a:	18a:	21a:	22a:	23d:	25a:
9	125	88	-	38	32	24	21	22
23	109	65	-	88	87	48	41	82
37	101	132	-	88	72	87	41	106
58	138	134	-	80	108	83	43	88
70	138	158	-	104	105	73	42	122
81	168	145	-	107	105	53	37	227
102	181	143	113	101	88	57	35	82
116	182	138	127	134	143	74	38	68
127	283	272	-	131	81	38	31	81
140	158	235	180	140	111	35	28	170
156	318	192	108	108	88	88	50	115
164	238	152	-	81	84	82	84	-
170	235	178	-	182	158	91	55	75

DATA FOR SECTION 2 PERIOD:6

STATIONS ON MAIN RIVER CHANNEL:-

Date:	13b:	15a:	17a:	18a:	21a:	22a:	23d:	25a:
5	492							
10	158	152		85	78	84	48	81
12	82							
19	213	170		118	101	78	55	81
24	283							
28	70	75		287		85	87	
33	111	104		88	71		74	
38	113							
45	78	78		108		83	68	
57	115							
58	84			101				
60	63	77		83		98	112	
68	185			152			75	

A3.4

Variable: PSTWT1.pstwt_1 (length = 180)

(1) 2470	(19) 4130	(37) 4230	(55) 4100	(73) 4014	(91) 3900
(2) 2470	(20) 4130	(38) 4230	(56) 4100	(74) 4010	(92) 3850
(3) 2470	(21) 4130	(39) 4230	(57) 4100	(75) 4010	(93) 3800
(4) 2470	(22) 4200	(40) 4230	(58) 4111	(76) 4010	(94) 3700
(5) 2470	(23) 4200	(41) 4230	(59) 4111	(77) 4014	(95) 3600
(6) 2470	(24) 4200	(42) 4100	(60) 4111	(78) 4010	(96) 3550
(7) 2470	(25) 4200	(43) 4100	(61) 4110	(79) 4200	(97) 3550
(8) 2470	(26) 4200	(44) 4100	(62) 4111	(80) 4250	(98) 3550
(9) 2470	(27) 4200	(45) 4100	(63) 4111	(81) 4250	(99) 3450
(10) 2450	(28) 4200	(46) 4090	(64) 4111	(82) 4250	(100) 3400
(11) 2450	(29) 4210	(47) 4090	(65) 4111	(83) 4300	(101) 3300
(12) 2450	(30) 4210	(48) 4090	(66) 4111	(84) 4300	(102) 3300
(13) 2450	(31) 4200	(49) 4100	(67) 4050	(85) 4300	(103) 3300
(14) 2470	(32) 4230	(50) 4100	(68) 4050	(86) 4300	(104) 3300
(15) 3000	(33) 4230	(51) 4100	(69) 4050	(87) 4250	(105) 3200
(16) 3100	(34) 4200	(52) 4100	(70) 4050	(88) 4300	(106) 3220
(17) 3200	(35) 4230	(53) 4100	(71) 4040	(89) 4300	(107) 3320
(18) 4130	(36) 4230	(54) 4100	(72) 4040	(90) 4000	(108) 3220

(109) 3220	(127) 1850	(145) 2800	(163) 900
(110) 3320	(128) 1800	(146) 2900	(164) 1000
(111) 3200	(129) 1800	(147) 3000	(165) 1230
(112) 3100	(130) 1800	(148) 3100	(166) 2000
(113) 3090	(131) 1800	(149) 3140	(167) 2500
(114) 2850	(132) 1800	(150) 2900	(168) 2600
(115) 2700	(133) 1800	(151) 2800	(169) 2700
(116) 2650	(134) 2000	(152) 2700	(170) 4500
(117) 2670	(135) 1800	(153) 2600	(171) 4700
(118) 2500	(136) 1800	(154) 2500	(172) 5310
(119) 2400	(137) 1999	(155) 2400	(173) 5310
(120) 2300	(138) 2100	(156) 1700	(174) 5310
(121) 2300	(139) 2200	(157) 700	(175) 5310
(122) 2200	(140) 2300	(158) 393	(176) 5310
(123) 1960	(141) 2400	(159) 500	(177) 5310
(124) 1900	(142) 2500	(160) 555	(178) 5310
(125) 1850	(143) 2600	(161) 789	(179) 5310
(126) 1850	(144) 2700	(162) 800	(180) 5310

Variable: PSTWT2.pstwt_2 (length = 180)

(1) 2510	(19) 2950	(37) 4100	(55) 4500	(73) 4150	(91) 4200
(2) 2940	(20) 2900	(38) 4100	(56) 4400	(74) 4200	(92) 4300
(3) 2940	(21) 2900	(39) 4100	(57) 4430	(75) 4200	(93) 4400
(4) 2940	(22) 2900	(40) 4100	(58) 4430	(76) 4600	(94) 4500
(5) 2940	(23) 2900	(41) 4130	(59) 4400	(77) 4380	(95) 4500
(6) 2940	(24) 2777	(42) 4130	(60) 4400	(78) 4200	(96) 4500
(7) 3030	(25) 2777	(43) 4100	(61) 4400	(79) 4200	(97) 4510
(8) 3030	(26) 2777	(44) 4100	(62) 4400	(80) 4200	(98) 4650
(9) 3030	(27) 2800	(45) 4100	(63) 4400	(81) 4200	(99) 4950
(10) 3030	(28) 2900	(46) 4100	(64) 4250	(82) 4100	(100) 5555
(11) 3000	(29) 3360	(47) 4100	(65) 4000	(83) 4000	(101) 5100
(12) 3000	(30) 3360	(48) 4100	(66) 4100	(84) 4040	(102) 5000
(13) 3000	(31) 3480	(49) 4100	(67) 4000	(85) 4000	(103) 5000
(14) 3000	(32) 3480	(50) 4900	(68) 4000	(86) 4000	(104) 5000
(15) 2950	(33) 3480	(51) 4900	(69) 4000	(87) 4000	(105) 5000
(16) 2950	(34) 3400	(52) 4900	(70) 4100	(88) 4100	(106) 5000
(17) 2950	(35) 3400	(53) 4500	(71) 4200	(89) 4100	(107) 4910
(18) 2950	(36) 3900	(54) 4500	(72) 4100	(90) 4200	(108) 4500

(109) 4900	(127) 4910	(145) 4560	(163) 3000
(110) 4900	(128) 4920	(146) 4500	(164) 2900
(111) 4900	(129) 4920	(147) 4400	(165) 2900
(112) 4900	(130) 4950	(148) 4200	(166) 2900
(113) 4900	(131) 4950	(149) 4100	(167) 2900
(114) 4900	(132) 4950	(150) 4080	(168) 2900
(115) 4900	(133) 4950	(151) 3900	(169) 2850
(116) 4900	(134) 5000	(152) 3800	(170) 2850
(117) 4900	(135) 5070	(153) 3800	(171) 2850
(118) 4900	(136) 5000	(154) 3750	(172) 2800
(119) 4900	(137) 5000	(155) 3750	(173) 2800
(120) 4900	(138) 5000	(156) 3750	(174) 2800
(121) 4900	(139) 5000	(157) 3600	(175) 2700
(122) 4900	(140) 4900	(158) 3500	(176) 2600
(123) 4900	(141) 4800	(159) 3400	(177) 2600
(124) 4910	(142) 4700	(160) 3300	(178) 2600
(125) 4910	(143) 4600	(161) 3320	(179) 2600
(126) 4910	(144) 4555	(162) 3200	(180) 2600

Phosphorus concentration of Paarl wastewater effluent: Periods 1 and 2

Variable: PSTWT3.pstwt_3 (length = 180)

(1)	2470	(19)	4130	(37)	4230	(55)	4100	(73)	4014	(91)	3900
(2)	2470	(20)	4130	(38)	4230	(56)	4100	(74)	4010	(92)	3850
(3)	2470	(21)	4130	(39)	4230	(57)	4100	(75)	4010	(93)	3800
(4)	2470	(22)	4200	(40)	4230	(58)	4111	(76)	4010	(94)	3700
(5)	2470	(23)	4200	(41)	4230	(59)	4111	(77)	4014	(95)	3600
(6)	2470	(24)	4200	(42)	4100	(60)	4111	(78)	4010	(96)	3550
(7)	2470	(25)	4200	(43)	4100	(61)	4110	(79)	4200	(97)	3550
(8)	2470	(26)	4200	(44)	4100	(62)	4111	(80)	4250	(98)	3550
(9)	2470	(27)	4200	(45)	4100	(63)	4111	(81)	4250	(99)	3450
(10)	2450	(28)	4200	(46)	4090	(64)	4111	(82)	4250	(100)	3400
(11)	2450	(29)	4210	(47)	4090	(65)	4111	(83)	4300	(101)	3300
(12)	2450	(30)	4210	(48)	4090	(66)	4111	(84)	4300	(102)	3300
(13)	2450	(31)	4200	(49)	4100	(67)	4050	(85)	4300	(103)	3300
(14)	2470	(32)	4230	(50)	4100	(68)	4050	(86)	4300	(104)	3300
(15)	3000	(33)	4230	(51)	4100	(69)	4050	(87)	4250	(105)	3200
(16)	3100	(34)	4200	(52)	4100	(70)	4050	(88)	4300	(106)	3220
(17)	3200	(35)	4230	(53)	4100	(71)	4040	(89)	4300	(107)	3320
(18)	4130	(36)	4230	(54)	4100	(72)	4040	(90)	4000	(108)	3220

(109)	3220	(127)	1850	(145)	2800	(163)	900
(110)	3320	(128)	1800	(146)	2900	(164)	1000
(111)	3200	(129)	1800	(147)	3000	(165)	1230
(112)	3100	(130)	2150	(148)	3100	(166)	2000
(113)	3090	(131)	1800	(149)	3140	(167)	2500
(114)	2850	(132)	1800	(150)	2900	(168)	2600
(115)	2700	(133)	1800	(151)	2800	(169)	2700
(116)	2650	(134)	2000	(152)	2700	(170)	4500
(117)	2670	(135)	1800	(153)	2600	(171)	4700
(118)	2500	(136)	1800	(154)	2500	(172)	5720
(119)	2400	(137)	1999	(155)	2400	(173)	5310
(120)	2300	(138)	2100	(156)	1700	(174)	5310
(121)	2300	(139)	2200	(157)	700	(175)	5310
(122)	2200	(140)	2300	(158)	393	(176)	5310
(123)	1960	(141)	2400	(159)	500	(177)	5310
(124)	1900	(142)	2500	(160)	555	(178)	5310
(125)	1850	(143)	2600	(161)	789	(179)	5310
(126)	2275	(144)	2700	(162)	800	(180)	5310

Variable: PSTWT4.pstwt_4 (length = 172)

(1)	4620	(19)	4650	(37)	3400	(55)	3780	(73)	4190	(91)	3200
(2)	4620	(20)	4600	(38)	3400	(56)	3780	(74)	4190	(92)	3200
(3)	4620	(21)	4560	(39)	3500	(57)	3800	(75)	4120	(93)	3200
(4)	4620	(22)	4500	(40)	3500	(58)	3900	(76)	4200	(94)	3200
(5)	4600	(23)	4440	(41)	3500	(59)	3950	(77)	4230	(95)	3200
(6)	4600	(24)	4400	(42)	3650	(60)	3900	(78)	4312	(96)	3100
(7)	4600	(25)	4300	(43)	3600	(61)	3900	(79)	4000	(97)	3200
(8)	4600	(26)	4300	(44)	3650	(62)	4000	(80)	3900	(98)	3700
(9)	4600	(27)	4200	(45)	3650	(63)	4100	(81)	3600	(99)	3200
(10)	4600	(28)	4100	(46)	3650	(64)	4100	(82)	3400	(100)	3200
(11)	4600	(29)	4000	(47)	3655	(65)	4100	(83)	3240	(101)	3200
(12)	4500	(30)	3900	(48)	3666	(66)	4100	(84)	3200	(102)	3200
(13)	4555	(31)	3900	(49)	3650	(67)	4100	(85)	3200	(103)	3200
(14)	4600	(32)	3900	(50)	3600	(68)	4110	(86)	3200	(104)	3200
(15)	4610	(33)	3800	(51)	3600	(69)	4500	(87)	3200	(105)	3200
(16)	4620	(34)	3800	(52)	3800	(70)	4190	(88)	3200	(106)	3200
(17)	4600	(35)	3800	(53)	3780	(71)	4190	(89)	3200	(107)	3200
(18)	4600	(36)	3400	(54)	3780	(72)	4190	(90)	3200	(108)	3450

(109)	3500	(127)	4350	(145)	4200	(163)	3400
(110)	3600	(128)	4350	(146)	4150	(164)	3400
(111)	4100	(129)	4350	(147)	4100	(165)	3400
(112)	3700	(130)	4400	(148)	4000	(166)	3400
(113)	3700	(131)	4500	(149)	3950	(167)	3400
(114)	3800	(132)	4500	(150)	3900	(168)	3400
(115)	3850	(133)	4500	(151)	3800	(169)	3380
(116)	3850	(134)	4600	(152)	3700	(170)	3380
(117)	4100	(135)	4600	(153)	2900	(171)	3380
(118)	4150	(136)	4600	(154)	3760	(172)	3380
(119)	4200	(137)	4600	(155)	3700		
(120)	4250	(138)	4600	(156)	3700		
(121)	4230	(139)	4600	(157)	3600		
(122)	4230	(140)	4600	(158)	3500		
(123)	4300	(141)	4555	(159)	3500		
(124)	4350	(142)	4500	(160)	3500		
(125)	4350	(143)	4400	(161)	3500		
(126)	4350	(144)	4300	(162)	3500		

Phosphorus concentration of Paarl wastewater effluent: Periods 3 and 4

Variable: PSTWT5.pstwt_5 (length = 180)

(1)	1000	(19)	1300	(37)	2290	(55)	2600	(73)	2300	(91)	2700
(2)	1000	(20)	1400	(38)	2300	(56)	2900	(74)	2300	(92)	2800
(3)	1000	(21)	1500	(39)	2300	(57)	2800	(75)	2130	(93)	2850
(4)	1000	(22)	1580	(40)	2300	(58)	2800	(76)	2300	(94)	2850
(5)	1000	(23)	1580	(41)	2300	(59)	2800	(77)	2200	(95)	2900
(6)	960	(24)	1600	(42)	2300	(60)	2800	(78)	2200	(96)	2900
(7)	960	(25)	1600	(43)	2400	(61)	2800	(79)	2210	(97)	2950
(8)	970	(26)	1900	(44)	2500	(62)	2800	(80)	2300	(98)	2950
(9)	970	(27)	2000	(45)	2500	(63)	2700	(81)	2400	(99)	2999
(10)	900	(28)	2100	(46)	2500	(64)	2700	(82)	2500	(100)	3000
(11)	870	(29)	2200	(47)	2600	(65)	2650	(83)	2600	(101)	3100
(12)	650	(30)	2600	(48)	2700	(66)	2650	(84)	2700	(102)	3020
(13)	600	(31)	2400	(49)	2600	(67)	2650	(85)	2800	(103)	3000
(14)	750	(32)	2500	(50)	2600	(68)	2600	(86)	2800	(104)	3090
(15)	1000	(33)	2300	(51)	2600	(69)	2550	(87)	2560	(105)	3000
(16)	1100	(34)	2290	(52)	2600	(70)	2550	(88)	2650	(106)	2900
(17)	1200	(35)	2290	(53)	2500	(71)	2550	(89)	2700	(107)	2850
(18)	1300	(36)	2290	(54)	2500	(72)	2300	(90)	2600	(108)	2850

(107)	2700	(127)	3000	(145)	2500	(163)	2350
(110)	2650	(128)	3111	(146)	2500	(164)	2350
(111)	2650	(129)	3111	(147)	2500	(165)	2350
(112)	2600	(130)	3111	(148)	2500	(166)	2350
(113)	2530	(131)	3111	(149)	2480	(167)	2350
(114)	2520	(132)	3000	(150)	2480	(168)	2350
(115)	2530	(133)	2900	(151)	2480	(169)	2350
(116)	2650	(134)	2800	(152)	2480	(170)	2350
(117)	2700	(135)	2850	(153)	2400	(171)	2350
(118)	2700	(136)	2750	(154)	2350	(172)	2350
(119)	2700	(137)	2800	(155)	2300	(173)	2350
(120)	2800	(138)	2600	(156)	2666	(174)	2350
(121)	2850	(139)	2400	(157)	2333	(175)	2350
(122)	2850	(140)	2555	(158)	2330	(176)	2350
(123)	2850	(141)	2700	(159)	2340	(177)	2350
(124)	2800	(142)	2700	(160)	2330	(178)	2350
(125)	2900	(143)	2650	(161)	2400	(179)	2356
(126)	2985	(144)	2650	(162)	2400	(180)	2356

Variable: PSTWT6.pstwt_6 (length = 180)

(1)	2530	(19)	2960	(37)	3000	(55)	3450	(73)	2200	(91)	1700
(2)	2530	(20)	2960	(38)	2900	(56)	3450	(74)	2200	(92)	1700
(3)	2530	(21)	2960	(39)	2850	(57)	3450	(75)	2100	(93)	1720
(4)	2530	(22)	2900	(40)	2800	(58)	3400	(76)	2100	(94)	2200
(5)	2530	(23)	2900	(41)	2700	(59)	3400	(77)	2200	(95)	1850
(6)	2530	(24)	2900	(42)	2600	(60)	3400	(78)	1900	(96)	1900
(7)	2500	(25)	2900	(43)	2600	(61)	3400	(79)	1900	(97)	1950
(8)	2400	(26)	2850	(44)	2550	(62)	3400	(80)	2300	(98)	2100
(9)	2400	(27)	2850	(45)	2520	(63)	3450	(81)	1800	(99)	2400
(10)	2420	(28)	2800	(46)	2600	(64)	3500	(82)	1800	(100)	2500
(11)	2420	(29)	2800	(47)	2700	(65)	3500	(83)	1800	(101)	2500
(12)	2420	(30)	2700	(48)	2800	(66)	2290	(84)	1800	(102)	4000
(13)	2500	(31)	2700	(49)	2950	(67)	2200	(85)	1750	(103)	4000
(14)	2500	(32)	2600	(50)	3200	(68)	2200	(86)	1760	(104)	3950
(15)	2600	(33)	2520	(51)	3400	(69)	2200	(87)	2200	(105)	3960
(16)	2600	(34)	2500	(52)	2200	(70)	2200	(88)	1750	(106)	3900
(17)	2800	(35)	2500	(53)	3450	(71)	2200	(89)	1750	(107)	3800
(18)	2850	(36)	2900	(54)	3450	(72)	2200	(90)	1750	(108)	2500

(109)	3600	(127)	2800	(145)	3200	(163)	3600
(110)	3500	(128)	2800	(146)	3300	(164)	4300
(111)	3500	(129)	3100	(147)	3400	(165)	3960
(112)	3400	(130)	2800	(148)	3500	(166)	3600
(113)	3200	(131)	2800	(149)	3600	(167)	3542
(114)	3100	(132)	2800	(150)	3600	(168)	3500
(115)	2800	(133)	2800	(151)	3600	(169)	3500
(116)	2800	(134)	2800	(152)	3600	(170)	3400
(117)	2800	(135)	2800	(153)	3600	(171)	3100
(118)	2800	(136)	2500	(154)	3600	(172)	3500
(119)	2800	(137)	2850	(155)	3600	(173)	3800
(120)	2800	(138)	2850	(156)	3600	(174)	2300
(121)	2800	(139)	2900	(157)	4200	(175)	2687
(122)	2800	(140)	3000	(158)	3600	(176)	3856
(123)	2800	(141)	3100	(159)	3600	(177)	3542
(124)	2800	(142)	3100	(160)	3600	(178)	2300
(125)	2800	(143)	3500	(161)	3600	(179)	2999
(126)	2800	(144)	3200	(162)	3600	(180)	3111

Phosphorus concentration of Paarl wastewater effluent: Periods 5 and 6

Variable: WSTWT1.wstwt_1 (length = 180)

(1)	8600	(19)	10000	(37)	9600	(55)	9900	(73)	
(2)	8600	(20)	10000	(38)	9600	(56)	10000	(74)	
(3)	8600	(21)	10000	(39)	9600	(57)	10000	(75)	
(4)	8600	(22)	9995	(40)	9600	(58)	10000	(76)	
(5)	8500	(23)	9999	(41)	9600	(59)	10000	(77)	
(6)	8600	(24)	9500	(42)	9550	(60)	10000	(78)	
(7)	8500	(25)	9500	(43)	9550	(61)	10380	(79)	
(8)	8700	(26)	9600	(44)	9550	(62)	10000	(80)	
(9)	8770	(27)	9600	(45)	9650	(63)	9700	(81)	
(10)	8770	(28)	9600	(46)	9650	(64)	9700	(82)	
(11)	8700	(29)	9600	(47)	9650	(65)	9600	(83)	
(12)	8890	(30)	9700	(48)	9700	(66)	9600	(84)	
(13)	9200	(31)	9700	(49)	9800	(67)	9600	(85)	
(14)	9500	(32)	9700	(50)	9800	(68)	9650	(86)	
(15)	9600	(33)	9700	(51)	9800	(69)	9600	(87)	
(16)	9700	(34)	9700	(52)	9900	(70)	9500	(88)	
(17)	9800	(35)	9800	(53)	9900	(71)		(89)	
(18)	10000	(36)	9700	(54)	9900	(72)		(90)	

(91)		(109)		(127)		(145)		(163)	8010
(92)		(110)		(128)		(146)		(164)	8100
(93)		(111)		(129)		(147)		(165)	8200
(94)		(112)		(130)		(148)	6100	(166)	8300
(95)		(113)		(131)		(149)	6090	(167)	8300
(96)		(114)		(132)		(150)	6200	(168)	8350
(97)		(115)		(133)		(151)	6300	(169)	8350
(98)		(116)		(134)		(152)	6400	(170)	8350
(99)		(117)		(135)		(153)	6800	(171)	8390
(100)		(118)		(136)		(154)	7000	(172)	8390
(101)		(119)		(137)		(155)	7200	(173)	8390
(102)		(120)		(138)		(156)	7500	(174)	8390
(103)		(121)		(139)		(157)	7600	(175)	8400
(104)		(122)		(140)		(158)	7800	(176)	8500
(105)		(123)		(141)		(159)	7870	(177)	8400
(106)		(124)		(142)		(160)	7870	(178)	8300
(107)		(125)		(143)		(161)	7870	(179)	8200
(108)		(126)		(144)		(162)	8000	(180)	8100

Variable: WSTWT2.wstwt_2 (length = 180)

(1)	7000	(19)	7410	(37)	7000	(55)	7200	(73)	7500	(91)	7600
(2)	7000	(20)	7211	(38)	7200	(56)	7200	(74)	7600	(92)	7650
(3)	7000	(21)	7200	(39)	7200	(57)	7200	(75)	7800	(93)	7777
(4)	7000	(22)	7200	(40)	7361	(58)	7220	(76)	7800	(94)	7800
(5)	7100	(23)	7200	(41)	7000	(59)	7200	(77)	7800	(95)	7900
(6)	7100	(24)	7200	(42)	7000	(60)	7220	(78)	7800	(96)	8100
(7)	7000	(25)	7321	(43)	7000	(61)	7270	(79)	7960	(97)	8300
(8)	7200	(26)	7200	(44)	7200	(62)	7270	(80)	7600	(98)	8500
(9)	6980	(27)	7210	(45)	7200	(63)	7270	(81)	7600	(99)	8800
(10)	7200	(28)	7210	(46)	7200	(64)	7770	(82)	7600	(100)	9750
(11)	720	(29)	7210	(47)	7200	(65)	7270	(83)	7430	(101)	8990
(12)	7200	(30)	7210	(48)	7200	(66)	7270	(84)	7430	(102)	8500
(13)	7000	(31)	7210	(49)	7520	(67)	7270	(85)	7430	(103)	8200
(14)	7000	(32)	7210	(50)	7520	(68)	7300	(86)	7430	(104)	8100
(15)	7000	(33)	7000	(51)	7500	(69)	7300	(87)	7430	(105)	7900
(16)	7520	(34)	7222	(52)	7891	(70)	7400	(88)	7500	(106)	7800
(17)	7589	(35)	7333	(53)	7410	(71)	7450	(89)	7600	(107)	7700
(18)	7521	(36)	7444	(54)	7411	(72)	7400	(90)	7600	(108)	7050

(109)	7100	(127)	7600	(145)	6900	(163)	6800
(110)	7100	(128)	7600	(146)	6900	(164)	6800
(111)	7100	(129)	7600	(147)	6700	(165)	6800
(112)	7100	(130)	7600	(148)	6800	(166)	6800
(113)	7100	(131)	7600	(149)	6800	(167)	6800
(114)	7200	(132)	7531	(150)	6800	(168)	6800
(115)	7200	(133)	7660	(151)	6800	(169)	6800
(116)	7200	(134)	7660	(152)	6800	(170)	6800
(117)	7200	(135)	7660	(153)	6800	(171)	6900
(118)	7300	(136)	7666	(154)	6800	(172)	7200
(119)	7320	(137)	7666	(155)	6800	(173)	7500
(120)	7330	(138)	7666	(156)	6800	(174)	7800
(121)	7400	(139)	7666	(157)	6800	(175)	8500
(122)	7450	(140)	7500	(158)	6800	(176)	8600
(123)	7400	(141)	7400	(159)	6800	(177)	8600
(124)	7600	(142)	7300	(160)	6800	(178)	8500
(125)	7600	(143)	7200	(161)	6800	(179)	9100
(126)	7600	(144)	7000	(162)	6800	(180)	9100

Phosphorus concentration of Wellington wastewater effluent: Periods 1 and 2

Variable: WSTWT3.wstwt_3 (length = 180)

(1)	8600	(19)	10000	(37)	9600	(55)	9900	(73)	9500
(2)	8600	(20)	10000	(38)	9600	(56)	10000	(74)	9500
(3)	8600	(21)	10000	(39)	9600	(57)	10000	(75)	9500
(4)	8600	(22)	9995	(40)	9600	(58)	10000	(76)	9500
(5)	8600	(23)	9999	(41)	9600	(59)	10000	(77)	9600
(6)	8600	(24)	9500	(42)	9550	(60)	10000	(78)	9650
(7)	8600	(25)	9500	(43)	9550	(61)	10380	(79)	9700
(8)	8700	(26)	9600	(44)	9550	(62)	10000	(80)	9700
(9)	8770	(27)	9600	(45)	9650	(63)	9700	(81)	97000
(10)	8770	(28)	9600	(46)	9650	(64)	9700	(82)	9700
(11)	8700	(29)	9600	(47)	9650	(65)	9600	(83)	9700
(12)	8890	(30)	9700	(48)	9700	(66)	9600	(84)	9800
(13)	9200	(31)	9700	(49)	9800	(67)	9600	(85)	9800
(14)	9500	(32)	9700	(50)	9800	(68)	9650	(86)	9800
(15)	9600	(33)	9700	(51)	9800	(69)	9600	(87)	9800
(16)	9700	(34)	9700	(52)	9900	(70)	9500	(88)	9850
(17)	9800	(35)	9800	(53)	9900	(71)	9500	(89)	9860
(18)	10000	(36)	9700	(54)	9900	(72)	9500	(90)	9860

(91)	9860	(107)	9700	(127)	9900	(145)	6300	(163)	8010
(92)	9860	(110)	9700	(128)	10100	(146)	6200	(164)	8100
(93)	9800	(111)	9700	(129)	10200	(147)	6100	(165)	8200
(94)	9800	(112)	9700	(130)	12345	(148)	6100	(166)	8300
(95)	9700	(113)	9700	(131)	10320	(149)	6090	(167)	8300
(96)	9700	(114)	9700	(132)	10320	(150)	6200	(168)	8350
(97)	9700	(115)	9700	(133)	10333	(151)	6300	(169)	8350
(98)	9700	(116)	9700	(134)	8000	(152)	6400	(170)	8350
(99)	9700	(117)	9700	(135)	8100	(153)	6800	(171)	8390
(100)	9700	(118)	9700	(136)	7800	(154)	7000	(172)	8790
(101)	9700	(119)	9200	(137)	7700	(155)	7200	(173)	8390
(102)	9690	(120)	8900	(138)	7200	(156)	7500	(174)	8390
(103)	9600	(121)	8700	(139)	6900	(157)	7600	(175)	8400
(104)	9600	(122)	8650	(140)	6900	(158)	7800	(176)	8500
(105)	9600	(123)	8640	(141)	6800	(159)	7870	(177)	8400
(106)	9600	(124)	8800	(142)	6700	(160)	7870	(178)	8300
(107)	9700	(125)	8900	(143)	6500	(161)	7870	(179)	8200
(108)	9700	(126)	9960	(144)	6400	(162)	8000	(180)	8100

Variable: WSTWT4.wstwt_4 (length = 172)

(1)	9500	(19)	9500	(37)	5420	(55)	5500	(73)	4360	(91)	5500
(2)	9500	(20)	9500	(38)	5400	(56)	5500	(74)	4360	(92)	5555
(3)	9500	(21)	9510	(39)	5400	(57)	5510	(75)	4360	(93)	5555
(4)	9500	(22)	9510	(40)	5500	(58)	5570	(76)	4360	(94)	5555
(5)	9500	(23)	9510	(41)	5500	(59)	5570	(77)	4326	(95)	5555
(6)	9500	(24)	9510	(42)	5500	(60)	5570	(78)	4360	(96)	5550
(7)	9500	(25)	9510	(43)	5600	(61)	5560	(79)	4360	(97)	5500
(8)	9500	(26)	9510	(44)	5500	(62)	5500	(80)	4500	(98)	5950
(9)	9500	(27)	9510	(45)	5500	(63)	5000	(81)	4700	(99)	5500
(10)	9500	(28)	9510	(46)	5500	(64)	4900	(82)	4700	(100)	5555
(11)	9500	(29)	9510	(47)	5600	(65)	4800	(83)	4900	(101)	5555
(12)	9500	(30)	9510	(48)	5500	(66)	4700	(84)	5000	(102)	5555
(13)	9500	(31)	9510	(49)	5500	(67)	4600	(85)	5100	(103)	5550
(14)	9500	(32)	8000	(50)	5600	(68)	4500	(86)	5300	(104)	5550
(15)	9500	(33)	7500	(51)	5600	(69)	4750	(87)	5490	(105)	5700
(16)	9500	(34)	6800	(52)	5600	(70)	4380	(88)	5490	(106)	5800
(17)	9500	(35)	6000	(53)	5500	(71)	4390	(89)	5400	(107)	5900
(18)	9500	(36)	5700	(54)	5800	(72)	4360	(90)	5400	(108)	6000

(109)	6300	(127)	7400	(145)	7400	(163)	8800
(110)	6400	(128)	7400	(146)	7500	(164)	8800
(111)	6999	(129)	7400	(147)	7600	(165)	8890
(112)	6700	(130)	7400	(148)	7700	(166)	9000
(113)	6900	(131)	7400	(149)	7608	(167)	9100
(114)	6970	(132)	7300	(150)	7710	(168)	9100
(115)	6970	(133)	7300	(151)	7900	(169)	9100
(116)	6970	(134)	7300	(152)	8010	(170)	9100
(117)	6970	(135)	7300	(153)	7350	(171)	9120
(118)	6970	(136)	7200	(154)	8210	(172)	9120
(119)	6970	(137)	7200	(155)	8210		
(120)	6970	(138)	7200	(156)	8480		
(121)	7000	(139)	7200	(157)	8400		
(122)	7100	(140)	7200	(158)	8400		
(123)	7200	(141)	7200	(159)	8400		
(124)	7300	(142)	7200	(160)	8500		
(125)	7300	(143)	7300	(161)	8600		
(126)	7400	(144)	7300	(162)	8700		

Phosphorus concentration of Wellington wastewater effluent: Periods 3 and 4

Variable: WSTWT5.wstwt_5 (length = 180)

(1)	9670	(19)	10100	(37)	11370	(55)	11100	(73)	11200
(2)	9670	(20)	10200	(38)	11400	(56)	11100	(74)	11300
(3)	9600	(21)	10300	(39)	11300	(57)	11130	(75)	11200
(4)	9700	(22)	10300	(40)	11300	(58)	11210	(76)	11200
(5)	9700	(23)	10500	(41)	11300	(59)	11210	(77)	11200
(6)	9700	(24)	10800	(42)	11600	(60)	11120	(78)	11250
(7)	9700	(25)	10500	(43)	11200	(61)	11130	(79)	11250
(8)	9700	(26)	11200	(44)	11230	(62)	11310	(80)	11250
(9)	9800	(27)	11300	(45)	11300	(63)	11130	(81)	11250
(10)	9800	(28)	11500	(46)	11340	(64)	11200	(82)	11300
(11)	9800	(29)	11800	(47)	11200	(65)	11250	(83)	11300
(12)	9700	(30)	11900	(48)	11200	(66)	11200	(84)	11400
(13)	9700	(31)	11500	(49)	11200	(67)	11200	(85)	11400
(14)	9700	(32)	11500	(50)	11200	(68)	11200	(86)	11500
(15)	9700	(33)	11500	(51)	11100	(69)	11200	(87)	11500
(16)	9700	(34)	11300	(52)	11100	(70)	11200	(88)	11200
(17)	9700	(35)	11360	(53)	11100	(71)	11200	(89)	11700
(18)	9700	(36)	11400	(54)	11100	(72)	11200	(90)	11500

(91)	11500	(109)	11800	(127)	11050	(145)	12200	(163)	10900
(92)	11500	(110)	11990	(128)	11000	(146)	12500	(164)	10900
(93)	11500	(111)	12100	(129)	11300	(147)	12700	(165)	10900
(94)	11500	(112)	12100	(130)	11300	(148)	12800	(166)	10900
(95)	11500	(113)	12500	(131)	11300	(149)	12870	(167)	10800
(96)	11500	(114)	12800	(132)	11500	(150)	12900	(168)	10900
(97)	11600	(115)	12500	(133)	11800	(151)	13000	(169)	11000
(98)	11600	(116)	12800	(134)	11700	(152)	13100	(170)	11000
(99)	11600	(117)	12900	(135)	11900	(153)	13270	(171)	11000
(100)	11600	(118)	12000	(136)	12200	(154)	13270	(172)	11200
(101)	11600	(119)	11800	(137)	12200	(155)	10900	(173)	11100
(102)	11600	(120)	11600	(138)	12200	(156)	12800	(174)	11230
(103)	11800	(121)	11500	(139)	12200	(157)	12200	(175)	11200
(104)	11900	(122)	11400	(140)	12270	(158)	12100	(176)	11200
(105)	11800	(123)	11320	(141)	12300	(159)	12000	(177)	11300
(106)	11700	(124)	11200	(142)	12300	(160)	11500	(178)	11300
(107)	11800	(125)	11200	(143)	12200	(161)	11150	(179)	11300
(108)	11800	(126)	11100	(144)	12200	(162)	11000	(180)	11200

Variable: WSTWT6.wstwt_6 (length = 180)

(1)	10920	(19)	11570	(37)	10770	(55)	6500	(73)	5400
(2)	10920	(20)	11400	(38)	10000	(56)	6500	(74)	4300
(3)	10920	(21)	11400	(39)	10000	(57)	6200	(75)	3600
(4)	10920	(22)	11400	(40)	10000	(58)	7200	(76)	3700
(5)	10920	(23)	11500	(41)	9000	(59)	6100	(77)	3750
(6)	11000	(24)	11500	(42)	9500	(60)	6000	(78)	3750
(7)	11000	(25)	11200	(43)	9100	(61)	5900	(79)	4200
(8)	11500	(26)	11050	(44)	10500	(62)	5800	(80)	3999
(9)	11900	(27)	11050	(45)	9110	(63)	5700	(81)	4000
(10)	11790	(28)	11000	(46)	8500	(64)	5500	(82)	4100
(11)	11500	(29)	10590	(47)	8500	(65)	5400	(83)	4200
(12)	11500	(30)	10590	(48)	8500	(66)	7100	(84)	4100
(13)	11500	(31)	10590	(49)	8200	(67)	7000	(85)	4200
(14)	11500	(32)	10590	(50)	8000	(68)	7000	(86)	4800
(15)	11500	(33)	10590	(51)	7900	(69)	7000	(87)	4400
(16)	11500	(34)	10590	(52)	7600	(70)	6500	(88)	4450
(17)	11500	(35)	10590	(53)	7500	(71)	6100	(89)	4505
(18)	11550	(36)	10700	(54)	7400	(72)	5600	(90)	4545

(91)	4550	(109)	5900	(127)	6500	(145)	7600	(163)	8300
(92)	4600	(110)	5055	(128)	8700	(146)	7600	(164)	7000
(93)	4680	(111)	5555	(129)	6900	(147)	7600	(165)	7605
(94)	4700	(112)	5400	(130)	6900	(148)	7800	(166)	7500
(95)	4800	(113)	5300	(131)	7000	(149)	7900	(167)	7000
(96)	4900	(114)	7100	(132)	7000	(150)	7600	(168)	6542
(97)	4857	(115)	5421	(133)	7000	(151)	7600	(169)	6500
(98)	4900	(116)	5555	(134)	7000	(152)	7600	(170)	8200
(99)	4900	(117)	5600	(135)	7000	(153)	7600	(171)	6500
(100)	4900	(118)	5642	(136)	7000	(154)	7600	(172)	6500
(101)	7500	(119)	5700	(137)	7100	(155)	7000	(173)	6500
(102)	8000	(120)	5800	(138)	7200	(156)	8300	(174)	6500
(103)	7400	(121)	7400	(139)	7300	(157)	7000	(175)	5555
(104)	6500	(122)	5900	(140)	7400	(158)	7000	(176)	5400
(105)	6200	(123)	6100	(141)	7300	(159)	7000	(177)	8400
(106)	6200	(124)	6100	(142)	7400	(160)	7500	(178)	5577
(107)	6700	(125)	6200	(143)	7500	(161)	6500	(179)	5789
(108)	6000	(126)	6500	(144)	7500	(162)	6500	(180)	5897

Phosphorus concentration of Wellington wastewater effluent: Periods 5 and 6

Station:14b	Period:3	
Date:	[TP]	Discharge
18	110	.44
32	293	4.33
46	188	.12
60	64	.22
74	23	.15
88	58	.15
102	69	.05
116	68	.15
130	82	.12
148	75	.15
158	78	.47
172	48	.28

Station:14b	Period:5	
Date:	[TP]	Discharge
9	49	.07
23	68	.01
37	63	.01
59	71	.00
78	91	.01
91	74	.01
114	63	.00
127	54	.00
140	41	.07
154	48	.15
164	1090	4.88

Station:15d	Period:4	
Date:	[TP]	Dischar
8	289	.0
34	413	.0

Station:14b	Period:4	
Date:	[TP]	Discharge
6	89	1.24
20	49	.36
34	154	2.45
55	400	5.05
69	75	.94
84	330	6.02
98	71	1.45
111	62	.77
125	248	1.29
139	55	.61
153	63	.44
167	25	.28

Station:14b	Period:6	
Date:	[TP]	Discharge
10	142	2.05
19	33	.47
26	69	1.04
29	131	1.24
33	61	.94
38	143	1.24
45	123	1.45
57	74	.94
60	90	1.04
71	262	3.98
75	130	3.49
80	150	1.68
86	32	1.24
93	400	4.15

Station:17a		Period:1
Date:	[TP]	Discharge
5	56	.01
21	78	.02
26	70	.03
61	101	.02
71	33	.01
88	98	.01
120	67	.01
127	87	.03
141	53	.02
179	55	2.18

Station:17a		Period:2
Date:	[TP]	Discharge
2	50	1.01
16	47	.45
24	21	.22
28	58	.21
37	23	.16
41	175	7.47
64	30	.78
78	27	1.42
80	24	.40
100	32	.22
108	37	3.52
135	303	.60
150	28	.45
170	42	.10

Station:17a		Period:3
Date:	[TP]	Discharge
5	27	.03
18	99	.14
32	115	2.52
46	37	.01
60	64	.08
74	31	.01
102	31	.01
116	1060	.02
130	114	.08
149	37	.04
158	3640	.66

Station:17a		Period:4
Date:	[TP]	Discharge
34	71	2.18
55	237	17.57
69	43	.78
84	437	15.43
98	62	1.87
111	49	.60
125	31	.55
139	23	.40
153	61	.28
167	0	.12

Station:17a		Period:5
Date:	[TP]	Discharge
9	0	0
23	15	.00
37	63	.02
164	0	.30

Station:17a		Period:6
Date:	[TP]	Discharge
10	98	2.52
19	27	.19
26	48	.92
33	24	.50
45	73	1.15
60	29	.99
75	180	5.20
86	30	1.42
93	100	11.15

Station:23a	Period:4	
Date:	[TP]	Discharge
6	39	5.36
34	39	5.36
55	185	48.01
69	29	3.77
84	217	42.01
98	44	7.87
111	22	2.44
125	24	2.61
139	16	2.26
153	16	1.25

Station:23a	Period:5	
Date:	[TP]	Discharge
23	18	.14
37	15	.16
59	18	.14
78	30	.09
91	29	.11
102	27	.12
114	20	.12
140	20	.27
154	17	.20
161	161	7.15
164	14	.80

Station:23a	Period:6	
Date:	[TP]	Discharge
2	14	
9	15	
16	10	
23	10	
30	53	
37		
44		
51	7	
58	18	
65	13	
72	126	
79	33	
86	21	
93	203	
100	36	
107	43	
114	24	
121	24	
128	22	
135	27	
142	23	
149	15	
156	13	
163	15	
170	13	
177	54	
10	64	2.44
19	14	.70
26	25	2.28
33	14	1.26
45	70	4.53
60	22	3.31
75	65	9.91
86		2.44
93	400	47

Station:23b	Period:1	
Date:	[TP]	Discharge
111	780	.03
166	330	.04
173	870	.85

Station:23b	Period:2	
Date:	[TP]	Discharge
7	120	.22
14	60	.17
21	60	.05
28	90	.03
35	90	.03
42	270	.19
49	60	.06
56	150	.12
77	330	.19
91	30	.04
98	30	.02
105	60	.55
112	150	.25
119	90	.08
126	90	.03
133	60	.03
140	220	.14
147	90	.04
154	150	.01
161	120	.01

Station:9a Period:1

Date:	[TP]	Discharge
5	42	1.13
20	38	1.08
51		3.46
71	27	1.59
88	47	1.28
107	30	.57
118	37	.28
121	25	.09
140	40	.09
147	65	.82
173	75	84.45
178	82	18.88

Station:9a Period:2

Date:	[TP]	Discharge
2	62	8.34
15	44	8.34
24	33	4.72
31	26	4.16
41	46	70.83
51	50	7.90
64	40	11.48
78	40	18.22
90	18	7.00
100	18	4.53
108	42	51.09
135	56	7.90
150	31	7.90
170	24	1.90
177	36	.78

Station:9a Period:3

Date:	[TP]	Discharge
5	26	1.58
18	33	15.63
32	148	6.13
46	15	.74
60	19	3.46
74	27	.54
88	22	.74
102	20	.51
116	8	3.48
123	24	4.53
130	20	2.28
149	17	1.79
158	27	12.30
172	36	2.41

Station:8a Period:4

Date:	[TP]	Discharge
6	53	22.38
20	27	3.62
34	73	24.42
40	54	16.20
55	111	95
69	56	10.40
84	183	218
98	62	16.89
111	29	7.45
125	65	7.45
139	36	7.00
153	35	5.31
167	0	7.90

Station:8a Period:5

Date:	[TP]	Discharge
8	15	1.29
14	14	1.91
23	27	.90
37	22	2.63
59	35	2.02
78	77	2.15
91	32	.77
102	48	2.54
114	48	1
127	27	.87
140	26	2.15
154	59	.74
155	90	2.02
156	29	5.72
161	64	27.64
162	24	10.13
164	320	51.85

Station:9a Period:6

Date:	[TP]	Discharge
4	18	
5	198	78.07
10	52	35.77
11	17	
12	21	10.70
18		
19	22	2.98
24	32	2.27
24		
26	24	21.67
29	200	94.70
31	27	19
32	17	
33	29	11.76
38	45	9.66
39	190	
45	43	33.30
46	190	
47	170	32.47
53	60	
57	61	23.64
59	45	26.86
60	38	22.38
60	40	
66	131	29.60
68	116	88.90
68	105	82.30
68	86	74.80
69	64	39.50
71	479	107
71	636	171
71	614	255
72	98	100
74	68	43.50
74	62	
75	66	103
80	75	27.60
81	110	
82	59	27.60
82	81	30.02
86	40	19.60
88	40	
93	340	237
95	250	
102	28	
109	18	
116	18	
123	50	
130	20	
137	42	

Station:23d Period:2

Date:	[TP]	Discharge
2	102	29.10
7	110	
14	85	
16	81	11.10
21	83	
24	38	7.40
28	91	
31	43	6.40
35	82	
42	265	
49	115	
56	130	
64	80	24.30
78	74	87.80
90	43	10.40
91	72	
98	66	
100	57	9.10
105	78	
108	120	169
112	154	
119	62	
126	82	
133	84	
135	69	12.70
140	150	
147	113	
150	58	12.70
154	81	
161	70	
168	74	
170	40	4.40
175	50	

Station:23d Period:3

Date:	[TP]	Discharge
2	55	
5	27	1.29
9	49	
16	39	
18	49	4.25
23	72	
30	84	
32	37	4.25
37	82	
46	54	1.80
49	51	
58	231	
60	62	4.38
62	45	
63	78	
70	55	
74	53	1.33
77	50	
84	69	
86	67	4.04
91	52	
98	37	
102	51	.65
105	274	
112	83	
119	101	
126	70	
130	161	5.54
133	60	
140	35	
147	42	
149	70	4.38
154	79	
156	154	24.60
161	53	
168	52	
172	75	5.13
175	57	

Station:23d Period:4

Date:	[TP]	Discharge
4	63	
8	85	33.90
11	83	
18	75	
20	80	10.60
21	97	11.10
21	72	11.10
21	77	11.10
22	91	11.10
22	80	11.10
22	83	10.40
22	88	10.40
23	88	9.80
23	73	9.80
23	70	9.80
23	61	9.80
24	74	9.80
24	80	9.80
24	65	9.10
24	56	9.10
25	55	9.10
25	65	9.10
25	64	9.10
25	200	
32	400	
34	113	68.10
39	110	
46	82	
53	505	
55	212	232
55	165	220
55	195	215
55	201	207
55	221	364
55	223	198
55	215	235
55	213	275
55	162	315
56	208	356
56	275	325
56	264	300
56	219	275
56	187	254
56	204	247
56	219	240
56	201	235
57	209	232
57	218	232
57	181	232
57	183	232

Date	[TP]	Discharge
57	278	232
57	188	220
57	176	210
57	156	200
58	158	191
58	176	177
58	151	162
58	151	157
60	260	
67	115	
69	87	26.50
74	62	
81	230	
84	151	276
88	150	
95	105	
98	95	38.70
102	86	
109	64	
111	50	17.10
116	60	
123	103	
125	53	17.10
130	78	
137	65	
139	69	17.10
144	61	
151	64	
153	52	10.40
158	45	
165	65	
167	22	3.15
172	55	

Station:23d Period:5

Date:	[TP]	Discharge
8	21	2.55
23	41	.51
37	41	1.49
59	43	2.60
63	57	1.14
70	65	.60
77	92	1.20
78	42	1.28
84	75	.70
91	37	1.80
91	67	1.73
98	146	2.02
102	35	1.33
105	38	1.59
112	34	2.74
114	36	2.94
119	35	.91
128	13	.65
127	31	.70
133	28	.65
140	28	1.36
140	33	1.26
147	44	5.54
154	60	1.80
154	43	1.73
161	71	3.72
164	96	12.70
164	55	12.70
165	90	9.10
166	82	8.25
166	81	24.60
167	84	20.40
168	103	12.70
168	110	9.10
168	73	8.50
169	62	7.40
170	96	6.40
170	97	5.54
171	118	5.13
172	108	4.74
172	89	4.38
173	72	4.04
174	79	3.72
175	119	3.42
175	77	3.42
175	67	3.42
176	67	3.42
177	65	3.42
177	74	3.15
178	55	3.15
178	56	3.15
179	77	4.38
179	58	5.13
180	79	4.38

Station:23d Period:6

Date:	[TP]	Discharge
2	63	4.04
2	78	3.42
2	83	
3	88	3.15
4	99	2.94
5	101	2.55
6	78	11.10
6	74	8
7	69	19.20
8	103	25.20
8	108	30.40
8	84	27.10
9	80	
10	71	22.10
10	69	21.50
11	76	20.40
11	68	18.20
12	54	24.60
13	54	21.50
13	73	18.20
14	71	15.20
15	75	10.40
15	82	9.80
16	76	8.50
16	59	
17	71	8
17	69	7.40
18	85	6.90
19	87	6.40
19	55	6.19
20	104	5.97
20	82	5.97
21	78	5.54
22	64	5.54
22	84	5.13
23	79	4.74
23	55	
24	64	4.74
26	67	4.21
27	127	4.74
27	62	12.70
28	99	22.70
29	107	16.20
29	81	11.90
30	119	26.50
30	105	
31	80	23.30
31	113	44.20
32	125	42.70
33	83	27.80
33	81	23.30
33	74	25.80
34	72	21.50
35	79	17.10
36	80	14.30
36	83	11.80
37	61	10.40
37	68	
38	94	10.40
38	88	9.80
39	84	9.60
40	85	12.70
40	96	20.40
41	117	45
42	145	64.20
42	108	40.40
43	89	29.10
44	75	25.80
44		
45	76	23.30
45	66	24.60
46	89	24.60
46	132	38.90
47	106	33.90
48	100	102.10
48	86	43.50
49	142	72
50	110	62.50
51	99	38.20
51	77	29.10
51	73	
52	77	28.50
53	80	24.80
53	91	22.70
54	83	22.10
55	85	20.40
55	84	20.40
56	84	20.40
57	64	20.40
58	85	24.60
58	81	33.20
58	76	
59	150	30.40
60	500	38.70
60	150	39.70
60	112	41.20
61	110	30.40
62	80	27.60
62	80	26.50
63	75	25.20
64	80	24.60
64	80	23.30
65	71	
68	85	24
66	75	21.50
67	130	32.50
68	140	50.60
69	400	144.90
69	450	77.10
70		122.80
71	200	
71	460	
72	330	173
72	268	
73	630	
73	450	
74	370	118
75	220	
75	250	
75	220	101
76	270	92.80
77	74	
78	68	
78	69	
79	69	42.70
79	80	
80	69	
80	110	
81	81	59
82	76	
82	110	
83	60	35.30
84	64	
84	66	
85	64	34.60
86	30	29.45
86	61	
87	54	
87	44	
88	44	24.60
89	48	23.30
89	29	
90	35	20.40
91	35	
92		
92		
93	280	424
93	172	
94	400	
94	375	
95	350	398
96	275	
96	350	
97		135
98		
99		
99		
100		71.60
100	69	
101		
101	130	
102	450	58.40
103	333	
103	189	
104	180	258
105	160	
105	155	
107	120	
107	87	
107	88	
108	82	53.10
109	78	
110	90	
111	61	41.20
111	77	
112	76	
112	85	
113	62	
114	91	
114	96	
114	56	
115	91	29.80
116	62	
116	80	
117	73	29.10
118	75	
118	71	
119	91	78.10
120	150	
121	150	
121	180	33.60
121	56	
122	150	
123	120	
123	95	
124	76	26.50
125	70	
125	59	
128	57	
135	55	
142	71	
149	55	
156	58	
163	41	
170	44	
177	21	

SUSPENDED SOLIDS CONCENTRATION DATA:

STATION 23D PERIOD 4		
DATE	[SS]	DISCHARGE
84	100	276
98	0	39.70
111	13	17.10
125	13	17.10
139	10	17.10
153	12	10.40
167	28	3.15

STATION 23D PERIOD 5		
DATE	[SS]	DISCHARGE
9	6	2.55
23	14	.51
37	12	1.49
59	0	2.60
78	24	1.26
91	1	1.80
102	9	1.33
114	36	2.94
127	13	.70
140	12	1.36
154	36	1.80
164	19	12.70
178	14	3.15

STATION 23D PERIOD 6		
DATE	[SS]	DISCHARGE
10	13	21.50
19	23	6.19
26	13	4.21
33	20	25.80
45	17	24.60
60	57	41.20
66	87	21.50
75	60	101
86	20	29.45
93	235	424
106	22	90

STATION 23A PERIOD 4		
DATE	[SS]	DISCHARGE
34	22	5.36
55	50	48
69	11	3.77
84	0	42
98	30	7.87
111	2	2.44
125	9	2.81
139	2	2.28
153	2	1.25
167	2	.81

STATION 23A PERIOD 5		
DATE	[SS]	DISCHARGE
9	3	.21
23	5	.14
37	10	.16
78	12	.09
91	3	.11
102	3	.12
114	3	.12
127	8	.07
140	10	.27
154	2	.20
164	2	.80

STATION 23A PERIOD 6		
DATE	[SS]	DISCHARGE
10	3	2.44
26	9	2.28
33	6	1.26
45	26	4.53
60	4	3.31
75	8	8.91
93	230	47

STATION 9A PERIOD 4		
DATE	[SS]	DISCHARGE
84	265	216
98	15	18.90
111	3	7.45
125	7	7.45
139	1	7.00
153	1	5.31
167	4	7.90

STATION 9A PERIOD 5		
DATE	[SS]	DISCHARGE
9	2	1.29
23	23	.90
37	8	2.83
78	4	2.15
91	17	.77
102	2	2.54
114	6	1
127	4	.87
140	6	2.15
154	7	.74

STATION 9A PERIOD 6					
DATE	[SS]	DISCHARGE	DATE	[SS]	DISCHARGE
5	186	78.07	71	570	107.8
10	18	35.77	71	1700	171.0
12	2	10.70	71	1460	255.0
19	1	2.99	74	50	43.5
24	2	2.28	80	11	27.6
26	6	21.67	82	12	27.6
29	96	94.70	82	45	30.0
31	8	19.83	86	9	19.6
33	3	11.76	93	315	237.6
38	4	9.66			
45	6	33.30			
47	52	32.47			
57	8	23.84			
59	4	26.86			
60	4	22.38			
66	120	88.98			
68	21	82.23			
68	19	74.85			
69	11	39.50			

STATION 14B PERIOD 6

DATE	[SS]	DISCHARGE
10	150	2.05
19	3	.47
26	27	1.04
29	24	1.24
33	15	.94
38	30	1.24
45	20	1.45
57	14	.94
60	5	1.04
71	220	3.98
75	79	3.49
80	21	1.68
86	6	1.24
93	165	4.15

Variable: PAARLQ.var1 (length = 360)

(1)	2.76	(19)	0.866	(37)	1	(55)	1	(73)	0.87
(2)	2.276	(20)	0.867	(38)	1.426	(56)	0.624	(74)	0.682
(3)	1.44	(21)	1.21	(39)	0.741	(57)	0.93	(75)	1.2
(4)	1.14	(22)	1.14	(40)	0.541	(58)	0.772	(76)	1.326
(5)	1.44	(23)	0.8	(41)	0.77	(59)	0.93	(77)	1.44
(6)	1.364	(24)	0.568	(42)	0.568	(60)	0.867	(78)	1.448
(7)	1.27	(25)	0.465	(43)	0.93	(61)	1.68	(79)	1.13
(8)	1.268	(26)	0.541	(44)	0.596	(62)	1.791	(80)	0.867
(9)	0.931	(27)	0.999	(45)	3.72	(63)	1.93	(81)	0.741
(10)	0.624	(28)	0.867	(46)	5.111	(64)	2.149	(82)	0.624
(11)	0.57	(29)	0.999	(47)	3.75	(65)	1.5	(83)	0.68
(12)	0.514	(30)	0.682	(48)	3.459	(66)	1.213	(84)	0.624
(13)	0.741	(31)	0.999	(49)	2.47	(67)	0.93	(85)	0.74
(14)	0.514	(32)	0.741	(50)	2.688	(68)	0.624	(86)	0.624
(15)	0.741	(33)	3.1	(51)	1.44	(69)	0.87	(87)	0.54
(16)	0.568	(34)	2.688	(52)	1	(70)	0.682	(88)	0.624
(17)	0.741	(35)	1.68	(53)	1.03	(71)	0.87	(89)	0.74
(18)	0.568	(36)	1.689	(54)	0.712	(72)	0.653	(90)	0.966

(181)	0.42	(199)	1.07	(217)	2.76	(235)	0.62	(253)	0.366
(182)	0.278	(200)	0.9	(218)	2.544	(236)	0.438	(254)	0.278
(183)	0.182	(201)	0.93	(219)	1.93	(237)	0.22	(255)	0.2
(184)	0.132	(202)	0.966	(220)	1.791	(238)	0.2	(256)	0.183
(185)	0.076	(203)	0.999	(221)	1.36	(239)	0.11	(257)	0.16
(186)	0.103	(204)	1	(222)	1.213	(240)	0.103	(258)	0.165
(187)	0.076	(205)	1.14	(223)	1.14	(241)	0.076	(259)	0.24
(188)	0.803	(206)	1.791	(224)	1	(242)	0.076	(260)	0.278
(189)	2	(207)	2.2	(225)	0.37	(243)	1.29	(261)	0.24
(190)	2.149	(208)	4.155	(226)	0.772	(244)	0.772	(262)	0.321
(191)	1.68	(209)	3.75	(227)	0.87	(245)	0.624	(263)	0.16
(192)	1.288	(210)	3.178	(228)	0.741	(246)	1.907	(264)	0.149
(193)	1.24	(211)	0.75	(229)	0.87	(247)	3.5	(265)	0.06
(194)	1.069	(212)	0.653	(230)	0.867	(248)	2.985	(266)	0.103
(195)	1.28	(213)	0.57	(231)	1	(249)	1.36	(267)	0.076
(196)	0.933	(214)	0.514	(232)	0.933	(250)	1.14	(268)	0.076
(197)	1.28	(215)	0.568	(233)	0.74	(251)	0.741	(269)	4.2
(198)	0.9	(216)	0.867	(234)	0.624	(252)	0.653	(270)	3.459

(91)	1.29	(109)	1.03	(127)	1.29	(145)	1.28	(163)	0.321
(92)	1.213	(110)	1.14	(128)	1.069	(146)	1.288	(164)	0.321
(93)	0.89	(111)	1.44	(129)	1.28	(147)	1.62	(165)	0.133
(94)	0.624	(112)	1.448	(130)	0.867	(148)	1.448	(166)	0.132
(95)	1.59	(113)	1.59	(131)	1.44	(149)	1.44	(167)	0.105
(96)	1.907	(114)	1.364	(132)	1.448	(150)	1.035	(168)	0.091
(97)	9.16	(115)	1.52	(133)	1.9	(151)	1.93	(169)	0.076
(98)	3.797	(116)	1.213	(134)	1.791	(152)	1.448	(170)	0.103
(99)	2.76	(117)	1.93	(135)	1.36	(153)	2.05	(171)	0.34
(100)	6.559	(118)	2.276	(136)	1.069	(154)	1.448	(172)	0.321
(101)	2.47	(119)	2.47	(137)	1.36	(155)	0.93	(173)	1.08
(102)	2.276	(120)	2.41	(138)	1.14	(156)	0.653	(174)	1.364
(103)	2.01	(121)	1.44	(139)	1.28	(157)	0.59	(175)	2.33
(104)	2.149	(122)	1.14	(140)	1	(158)	0.438	(176)	2.276
(105)	2.19	(123)	1.44	(141)	1.28	(159)	0.2	(177)	1.68
(106)	2.276	(124)	1.14	(142)	0.933	(160)	0.183	(178)	1.251
(107)	1.36	(125)	1.39	(143)	1.14	(161)	0.25	(179)	0.9
(108)	0.867	(126)	1.069	(144)	0.933	(162)	0.3	(180)	0.712

(271)	1.68	(289)	4.05	(307)	0.75	(325)	1.07	(343)	91.2
(272)	0.653	(290)	2.832	(308)	7.447	(326)	1.791	(344)	147
(273)	1.1	(291)	0.931	(309)	9.66	(327)	5.18	(345)	91.2
(274)	0.514	(292)	0.803	(310)	5.514	(328)	91.09	(346)	122
(275)	0.42	(293)	0.48	(311)	3.72	(329)	21.23	(347)	200
(276)	0.366	(294)	0.514	(312)	2.832	(330)	11.48	(348)	86.66
(277)	0.22	(295)	0.36	(313)	2.1	(331)	7.73	(349)	68.7
(278)	0.183	(296)	0.321	(314)	1.791	(332)	6.134	(350)	107
(279)	9	(297)	0.34	(315)	1.44	(333)	4.8	(351)	86.7
(280)	0.065	(298)	0.321	(316)	1.105	(334)	5.31	(352)	55.72
(281)	0.053	(299)	0.41	(317)	3.39	(335)	4.42	(353)	37.8
(282)	0.053	(300)	0.438	(318)	1.177	(336)	4.155	(354)	39.16
(283)	0.076	(301)	0.38	(319)	3.07	(337)	3.85	(355)	24.1
(284)	0.076	(302)	0.413	(320)	2.276	(338)	4.72	(356)	21.32
(285)	0.076	(303)	0.38	(321)	1.68	(339)	19.2	(357)	18.8
(286)	0.076	(304)	0.413	(322)	1.448	(340)	23.84	(358)	18.8
(287)	0.105	(305)	0.29	(323)	1.29	(341)	12.9	(359)	14.67
(288)	0.278	(306)	0.438	(324)	1.14	(342)	16.59	(360)	14.6

River discharge data at 12-hourly intervals for Station: 9A
Period : 1

Variable: PAARLQ.var1 (length = 360)

(1)	13.2	(19)	6.998	(37)	5.31	(55)	4.16	(73)	3.459
(2)	12.01	(20)	6.39	(38)	5.18	(56)	4.1	(74)	2.8
(3)	11.48	(21)	6.56	(39)	5.31	(57)	4.53	(75)	4.53
(4)	10	(22)	5.98	(40)	5.18	(58)	4.2	(76)	18.82
(5)	9.86	(23)	6.13	(41)	5.31	(57)	4.155	(77)	12.04
(6)	9.16	(24)	5.7	(42)	5.18	(60)	4.1	(78)	12.34
(7)	8.84	(25)	5.72	(43)	4.912	(61)	4.155	(79)	203
(8)	8.4	(26)	6.4	(44)	4.792	(62)	4.1	(80)	162
(9)	10.93	(27)	8.36	(45)	4.912	(63)	4.155	(81)	97
(10)	11.4	(28)	7.95	(46)	4.79	(64)	4	(82)	66.7
(11)	10.93	(29)	9.86	(47)	4.912	(65)	3.797	(83)	41.77
(12)	9.66	(30)	9.16	(48)	4.4	(66)	3.4	(84)	29.6
(13)	8.84	(31)	7.902	(49)	4.53	(67)	3.459	(85)	24.6
(14)	8.2	(32)	6.39	(50)	4.2	(68)	3.4	(86)	19.83
(15)	7.902	(33)	6.13	(51)	4.16	(69)	3.459	(87)	20.96
(16)	7.3	(34)	5.57	(52)	4.1	(70)	3.4	(88)	18.82
(17)	7.447	(35)	5.72	(53)	4.16	(71)	3.459	(89)	22.4
(18)	6.6	(36)	5.3	(54)	4.1	(72)	3.4	(90)	20.5

(181)	6.559	(179)	4.53	(217)	42.6	(235)	13.8	(253)	8.36
(182)	6.6	(200)	4.5	(218)	34.7	(236)	13.48	(254)	8.2
(183)	6.559	(201)	4.91	(219)	115	(237)	13.8	(255)	8.36
(184)	6.4	(202)	4.5	(220)	93.5	(238)	12.9	(256)	8.2
(185)	6.559	(203)	4.91	(221)	65.71	(239)	13.8	(257)	8.36
(186)	6	(204)	4.5	(222)	39.3	(240)	17.17	(258)	7.73
(187)	6.134	(205)	16.91	(223)	37.45	(241)	20.26	(259)	7.45
(188)	6	(206)	12.9	(224)	26.4	(242)	14.67	(260)	7.3
(189)	5.72	(207)	9.86	(225)	23.11	(243)	13.2	(261)	7.45
(190)	5.57	(208)	11.48	(226)	21.9	(244)	11.8	(262)	7
(191)	5.72	(209)	44.43	(227)	22.4	(245)	10.93	(263)	6.99
(192)	5.37	(210)	53.31	(228)	24.45	(246)	10.2	(264)	7.73
(193)	5.31	(211)	84.45	(229)	20.26	(247)	9.86	(265)	8.84
(194)	5.2	(212)	86.7	(230)	18.82	(248)	9.16	(266)	8.2
(195)	5.31	(213)	65.7	(231)	27.6	(249)	8.84	(267)	7.447
(196)	5.2	(214)	143.5	(232)	15.9	(250)	8.4	(268)	7.27
(197)	4.91	(215)	70.83	(233)	15.01	(251)	7.902	(269)	6.99
(198)	4.5	(216)	47.4	(234)	13.48	(252)	8.2	(270)	12.34

(91)	16.91	(109)	32.47	(127)	12.04	(145)	7.447	(163)	11.48
(92)	15.3	(110)	26	(128)	11.23	(146)	67.7	(164)	10.7
(93)	13.8	(111)	22.4	(129)	10.93	(147)	61.64	(165)	10.93
(94)	12.34	(112)	19.15	(130)	10.2	(148)	71.75	(166)	10.2
(95)	12.04	(113)	18.22	(131)	10.39	(149)	113	(167)	10.4
(96)	10.7	(114)	17.17	(132)	10.2	(150)	81.2	(168)	10.2
(97)	10.4	(115)	45.33	(133)	9.34	(151)	53.78	(169)	9.34
(98)	9.16	(116)	32.6	(134)	9.16	(152)	44.9	(170)	8.7
(99)	8.84	(117)	27.64	(135)	8.84	(153)	29.21	(171)	8.84
(100)	8.4	(118)	22.6	(136)	8.2	(154)	24.13	(172)	8.4
(101)	8.36	(119)	20.26	(137)	8.36	(155)	32.47	(173)	8.36
(102)	8.67	(120)	18.82	(138)	7.9	(156)	18.48	(174)	7.7
(103)	41.77	(121)	17.56	(139)	7.902	(157)	23.84	(175)	7.902
(104)	51.73	(122)	15.9	(140)	7.73	(158)	14.06	(176)	7.7
(105)	63.67	(123)	15.01	(141)	7.447	(159)	13.79	(177)	7.447
(106)	91.2	(124)	14.06	(142)	7.3	(160)	12.9	(178)	7.27
(107)	63.67	(125)	13.2	(143)	7.447	(161)	12.62	(179)	7.447
(108)	40.1	(126)	12.34	(144)	7.3	(162)	11.8	(180)	6.83

(271)	87.8	(289)	10.93	(307)	5.72	(325)	3.459	(343)	0.93[illegible]
(272)	93.5	(290)	10.2	(308)	5.57	(326)	3.7	(344)	1.21
(273)	51.8	(291)	10.4	(309)	4.91	(327)	3.459	(345)	1.448
(274)	110.3	(292)	9.9	(310)	5.3	(328)	3.72	(346)	1.93
(275)	67.8	(293)	9.34	(311)	4.91	(329)	3.14	(347)	2.022
(276)	42.46	(294)	8.9	(312)	4.79	(330)	3.38	(348)	1.93
(277)	32.47	(295)	8.36	(313)	4.155	(331)	3.46	(349)	1.069
(278)	34.02	(296)	8.15	(314)	4.42	(332)	3.38	(350)	1.44
(279)	21.67	(297)	7.447	(315)	4.155	(333)	3.46	(351)	1.14
(280)	19.83	(298)	7.27	(316)	4.42	(334)	3.2	(352)	1.14
(281)	16.91	(299)	7.447	(317)	4.912	(335)	2.28	(353)	0.867
(282)	19.83	(300)	7.5	(318)	4.79	(336)	2.76	(354)	0.931
(283)	15.01	(301)	7.447	(319)	4.912	(337)	1.79	(355)	0.74
(284)	13.48	(302)	7.27	(320)	4.79	(338)	2.2	(356)	0.624
(285)	20.26	(303)	6.99	(321)	4.155	(339)	1.36	(357)	0.624
(286)	13.2	(304)	6.95	(322)	4.79	(340)	1.77	(358)	0.5
(287)	13.2	(305)	6.56	(323)	4.155	(341)	1.14	(359)	0.803
(288)	11.4	(306)	6.4	(324)	4.06	(342)	1.52	(360)	1.14

River discharge data at 12-hourly intervals for Station: 9A
Period : 2

Variable: PAARLQ.var1 (length = 360)

(1)	1.14	(19)	1.29	(37)	4.06	(55)	2.76	(73)	4.06
(2)	0.682	(20)	0.803	(38)	3.299	(56)	2.832	(74)	4.155
(3)	0.4	(21)	1.14	(39)	2.76	(57)	2.76	(75)	4.06
(4)	0.413	(22)	0.741	(40)	2.832	(58)	1.448	(76)	4.155
(5)	1.143	(23)	0.624	(41)	2.19	(59)	5.18	(77)	3.39
(6)	1.791	(24)	0.741	(42)	2.276	(60)	8.84	(78)	2.832
(7)	2	(25)	2.2	(43)	1.68	(61)	14.06	(79)	2.47
(8)	1.587	(26)	2.832	(44)	1	(62)	7.447	(80)	1.907
(9)	1.44	(27)	3.39	(45)	2.62	(63)	84.51	(81)	1.93
(10)	1.288	(28)	3.459	(46)	2.022	(64)	32.06	(82)	2.022
(11)	1.68	(29)	3.22	(47)	2.62	(65)	15.27	(83)	1.93
(12)	2.276	(30)	2.276	(48)	1.791	(66)	10.39	(84)	1.791
(13)	2.31	(31)	7.73	(49)	2.47	(67)	7.73	(85)	1.44
(14)	2.544	(32)	13.79	(50)	1.791	(68)	6.347	(86)	0.867
(15)	2.76	(33)	10.18	(51)	2.47	(69)	5.18	(87)	1.21
(16)	1.14	(34)	7.675	(52)	1.587	(70)	4.527	(88)	1.035
(17)	1.68	(35)	5.7	(53)	2.76	(71)	4.06	(89)	1
(18)	0.933	(36)	4.912	(54)	2.832	(72)	4.341	(90)	0.9

(181)	0.802	(199)	0.57	(217)	3.54	(235)	33.3	(253)	3.07
(182)	0.803	(200)	0.653	(218)	3.459	(236)	19.38	(254)	2.832
(183)	1	(201)	0.514	(219)	3.07	(237)	14.67	(255)	1.9
(184)	0.568	(202)	0.653	(220)	2.832	(238)	12.62	(256)	2.544
(185)	0.413	(203)	0.77	(221)	2.76	(239)	11.78	(257)	2.19
(186)	0.682	(204)	0.835	(222)	2.544	(240)	8.36	(258)	2.022
(187)	1.07	(205)	3.38	(223)	2.47	(241)	6.83	(259)	2.19
(188)	0.741	(206)	8.6	(224)	2.276	(242)	6.347	(260)	1.791
(189)	0.802	(207)	11.23	(225)	1.93	(243)	5.18	(261)	1.68
(190)	0.741	(208)	51.85	(226)	1.326	(244)	4.912	(262)	1.448
(191)	0.866	(209)	47.42	(227)	1.52	(245)	4.42	(263)	1.68
(192)	0.624	(210)	30.43	(228)	1.177	(246)	4.72	(264)	1.791
(193)	0.741	(211)	18.82	(229)	3.39	(247)	4.06	(265)	1.68
(194)	0.966	(212)	10.39	(230)	3.459	(248)	4.155	(266)	1.791
(195)	1.14	(213)	7.728	(231)	5.77	(249)	3.72	(267)	1.68
(196)	1.14	(214)	6.347	(232)	8.36	(250)	3.797	(268)	1.069
(197)	1.36	(215)	5.18	(233)	11.78	(251)	3.39	(269)	1.21
(198)	0.741	(216)	4.341	(234)	29.21	(252)	3.138	(270)	1.035

(91)	2.76	(109)	2.47	(127)	2.19	(145)	0.741	(163)	11.23
(92)	2.832	(110)	2.544	(128)	1.069	(146)	0.653	(164)	32.47
(93)	3.07	(111)	3.07	(129)	1.07	(147)	0.741	(165)	15.27
(94)	2.276	(112)	3.138	(130)	0.803	(148)	0.624	(166)	11.48
(95)	2.76	(113)	4.06	(131)	0.741	(149)	0.463	(167)	9.66
(96)	2.832	(114)	3.459	(132)	0.867	(150)	0.712	(168)	8.84
(97)	3.07	(115)	3.39	(133)	1.48	(151)	0.802	(169)	3.07
(98)	3.459	(116)	3.459	(134)	1.213	(152)	1.069	(170)	2.022
(99)	5.57	(117)	4.42	(135)	1.29	(153)	1.14	(171)	1.68
(100)	4.155	(118)	3.459	(136)	0.488	(154)	1.288	(172)	1
(101)	3.39	(119)	3.72	(137)	1.29	(155)	1.14	(173)	1.14
(102)	1.907	(120)	12.62	(138)	1.177	(156)	0.568	(174)	0.741
(103)	1.68	(121)	11.23	(139)	1.44	(157)	0.514	(175)	0.9
(104)	0.933	(122)	7.447	(140)	1.448	(158)	0.568	(176)	0.596
(105)	2.47	(123)	5.18	(141)	1.36	(159)	0.514	(177)	0.514
(106)	1.907	(124)	3.976	(142)	1.14	(160)	0.488	(178)	0.514
(107)	2.47	(125)	3.39	(143)	1.07	(161)	1.067	(179)	0.463
(108)	1.907	(126)	2.832	(144)	0.624	(162)	2.276	(180)	0.682

(271)	1.14	(289)	2.47	(307)	1.68	(325)	5.57	(343)	2.19
(272)	1	(290)	2.276	(308)	2.022	(326)	5.31	(344)	2.276
(273)	1.07	(291)	2.19	(309)	2.47	(327)	4.06	(345)	2.19
(274)	1	(292)	2.276	(310)	3.459	(328)	4.155	(346)	2.276
(275)	1.39	(293)	1.93	(311)	59	(329)	3.39	(347)	2.19
(276)	1.426	(294)	2.022	(312)	30.02	(330)	3.797	(348)	2.276
(277)	3.06	(295)	1.93	(313)	18.48	(331)	3.39	(349)	2.19
(278)	6.998	(296)	1.689	(314)	14.4	(332)	3.459	(350)	2.276
(279)	9.2	(297)	1.68	(315)	12.34	(333)	3.39	(351)	2.19
(280)	8.36	(298)	1.448	(316)	8.84	(334)	3.138	(352)	1.791
(281)	4.91	(299)	1.68	(317)	5.98	(335)	3.07	(353)	1.93
(282)	4.912	(300)	1.587	(318)	5.717	(336)	3.138	(354)	1.791
(283)	4.06	(301)	1.68	(319)	4.79	(337)	2.76	(355)	1.9
(284)	4.155	(302)	1.587	(320)	4.912	(338)	2.832	(356)	1.791
(285)	3.39	(303)	1.52	(321)	5.57	(339)	2.61	(357)	1.68
(286)	3.459	(304)	1.448	(322)	8.36	(340)	2.544	(358)	1.791
(287)	2.76	(305)	1.52	(323)	6.4	(341)	2.19	(359)	1.68
(288)	2.688	(306)	1.518	(324)	5.111	(342)	2.276	(360)	1.587

River discharge data at 12-hourly intervals for Station: 9A
Period : 3

Variable: PAARLQ4.var1 (length = 344)

(1)	1.587	(19)	5.31	(37)	6.56	(55)	68.77	(73)	31.64
(2)	1.68	(20)	4.79	(38)	4.06	(56)	46.6	(74)	24.9
(3)	1.791	(21)	5.72	(39)	3.79	(57)	37.45	(75)	21.67
(4)	1.68	(22)	12.34	(40)	3.72	(58)	30.4	(76)	19.15
(5)	1.791	(23)	10.4	(41)	3.46	(59)	171	(77)	20.26
(6)	1.68	(24)	8.1	(42)	3.38	(60)	61.85	(78)	21.23
(7)	1.448	(25)	7.45	(43)	3.46	(61)	42.65	(79)	18.69
(8)	3.47	(26)	5.98	(44)	3.38	(62)	32.6	(80)	16.2
(9)	4.912	(27)	5.72	(45)	3.46	(63)	27.6	(81)	15.63
(10)	56.23	(28)	5.18	(46)	3.38	(64)	24.13	(82)	14.7
(11)	40.03	(29)	5.31	(47)	3.46	(65)	29.21	(83)	13.79
(12)	19.83	(30)	4.79	(48)	3.38	(66)	44.08	(84)	14.7
(13)	15.01	(31)	4.53	(49)	3.46	(67)	32.41	(85)	14.4
(14)	11.23	(32)	4.06	(50)	27.2	(68)	26.41	(86)	12.9
(15)	8.84	(33)	4.16	(51)	2.92	(69)	23.11	(87)	12.62
(16)	7.27	(34)	4.06	(52)	49.9	(70)	20.52	(88)	11.78
(17)	6.56	(35)	3.79	(53)	491	(71)	71.88	(89)	11.48
(18)	5.98	(36)	6.39	(54)	121.8	(72)	44.9	(90)	10.7

(181)	19.57	(199)	15.01	(217)	8.36	(235)	26.98	(253)	7.447
(182)	18.5	(200)	12.9	(218)	8.19	(236)	24.88	(254)	7.27
(183)	19.57	(201)	12.04	(219)	8.36	(237)	19.57	(255)	6.998
(184)	14.06	(202)	11.23	(220)	7.73	(238)	15.58	(256)	6.4
(185)	13.8	(203)	10.4	(221)	7.902	(239)	12.62	(257)	6.134
(186)	13.5	(204)	10.18	(222)	7.27	(240)	11.23	(258)	7.27
(187)	15.63	(205)	9.86	(223)	7.447	(241)	10.4	(259)	58.65
(188)	15.9	(206)	9.66	(224)	7.27	(242)	9.16	(260)	24.88
(189)	14.4	(207)	9.86	(225)	6.998	(243)	8.84	(261)	26.09
(190)	13.48	(208)	9.16	(226)	6.83	(244)	8.19	(262)	18.82
(191)	12.62	(209)	9.34	(227)	6.998	(245)	7.902	(263)	16.26
(192)	11.78	(210)	9.16	(228)	6.45	(246)	7.73	(264)	13.48
(193)	11.48	(211)	8.34	(229)	6.559	(247)	7.447	(265)	12.04
(194)	13.5	(212)	8.19	(230)	6.4	(248)	6.4	(266)	10.7
(195)	36.61	(213)	8.36	(231)	6.559	(249)	6.559	(267)	9.34
(196)	16.5	(214)	8.19	(232)	6.83	(250)	8.19	(268)	8.67
(197)	14.4	(215)	8.36	(233)	6.998	(251)	9.86	(269)	8.36
(198)	14.97	(216)	8.19	(234)	9.92	(252)	8.19	(270)	7.73

(91)	10.39	(109)	179	(127)	15.01	(145)	9.34	(163)	107
(92)	9.66	(110)	80.15	(128)	14.06	(146)	9.16	(164)	59
(93)	9.34	(111)	69.8	(129)	13.79	(147)	8.84	(165)	51.85
(94)	9.163	(112)	47.4	(130)	12.9	(148)	8.57	(166)	32.6
(95)	9.34	(113)	41.77	(131)	12.62	(149)	8.34	(167)	32.47
(96)	9.163	(114)	35.5	(132)	12.3	(150)	7.9	(168)	216
(97)	9.34	(115)	33.3	(133)	12.04	(151)	8.36	(169)	74.9
(98)	59.95	(116)	29.6	(134)	11.51	(152)	41.65	(170)	54.41
(99)	171	(117)	26.83	(135)	11.48	(153)	23.84	(171)	36.61
(100)	128.4	(118)	24.9	(136)	10.98	(154)	21.23	(172)	31.16
(101)	71.88	(119)	23.11	(137)	10.93	(155)	80.17	(173)	27.6
(102)	47.4	(120)	21.23	(138)	10.7	(156)	36.24	(174)	24.88
(103)	39.16	(121)	19.57	(139)	10.93	(157)	29.2	(175)	22.4
(104)	81.23	(122)	18.6	(140)	11.23	(158)	21.93	(176)	20.5
(105)	78.07	(123)	17.56	(141)	10.93	(159)	18.7	(177)	18.9
(106)	49.12	(124)	16.5	(142)	10.18	(160)	16.52	(178)	17.7
(107)	40.9	(125)	15.63	(143)	10.39	(161)	44.4	(179)	23.11
(108)	33.3	(126)	14.67	(144)	9.66	(162)	160.8	(180)	17.2

(271)	13.2	(289)	4.912	(307)	4.155	(325)	2.276	(343)	2.022
(272)	10.7	(290)	5.175	(308)	4.06	(326)	2.47	(344)	2.47
(273)	9.34	(291)	4.912	(309)	3.459	(327)	2.276		
(274)	8.67	(292)	4.79	(310)	3.72	(328)	2.19		
(275)	8.36	(293)	4.53	(311)	3.459	(329)	1.364		
(276)	7.27	(294)	4.42	(312)	3.39	(330)	1.679		
(277)	7.447	(295)	4.155	(313)	3.459	(331)	1.448		
(278)	11.78	(296)	4.42	(314)	2.76	(332)	9.66		
(279)	6.998	(297)	4.53	(315)	2.276	(333)	11.48		
(280)	11.78	(298)	4.42	(316)	2.76	(334)	6.83		
(281)	6.56	(299)	4.53	(317)	2.276	(335)	5.31		
(282)	11.23	(300)	5.98	(318)	2.76	(336)	4.06		
(283)	5.917	(301)	5.31	(319)	2.883	(337)	3.459		
(284)	5.57	(302)	10.2	(320)	3.067	(338)	3.38		
(285)	5.717	(303)	5.717	(321)	2.276	(339)	3.459		
(286)	5.57	(304)	5.98	(322)	2.47	(340)	5.17		
(287)	4.912	(305)	5.31	(323)	2.022	(341)	4.155		
(288)	4.79	(306)	4.79	(324)	2.47	(342)	3.06		

River discharge data at 12-hourly intervals for Station: 9A
Period : 4

Variable: PAARL05.vari (length = 360)

(1)	3.067	(19)	1.14	(37)	2.0222	(55)	10.39	(73)	2.832
(2)	5.31	(20)	0.741	(38)	2.276	(56)	8.131	(74)	1.791
(3)	4.155	(21)	0.933	(39)	2.022	(57)	4.527	(75)	2.544
(4)	2.985	(22)	1	(40)	0.867	(58)	6.779	(76)	1.907
(5)	3.138	(23)	1.18	(41)	1.104	(59)	4	(77)	3.138
(6)	3.459	(24)	1.14	(42)	0.741	(60)	5.514	(78)	3.138
(7)	4.155	(25)	2.276	(43)	1.069	(61)	3.5	(79)	3.797
(8)	3.797	(26)	1.791	(44)	0.803	(62)	4.341	(80)	3.459
(9)	3.459	(27)	1.79	(45)	1.14	(63)	3	(81)	2.832
(10)	3.138	(28)	1.288	(46)	0.741	(64)	3.138	(82)	2.276
(11)	2.544	(29)	1.75	(47)	3.797	(65)	2.5	(83)	2.832
(12)	1.518	(30)	1.213	(48)	1.791	(66)	2.276	(84)	2.022
(13)	1.91	(31)	1.79	(49)	2.276	(67)	2	(85)	2.276
(14)	1.14	(32)	1.069	(50)	2.022	(68)	1.587	(86)	1.907
(15)	1.288	(33)	1.587	(51)	2.544	(69)	1.8	(87)	2.544
(16)	0.966	(34)	1	(52)	2.544	(70)	1.288	(88)	2.022
(17)	1.288	(35)	1.79	(53)	2.544	(71)	1.79	(89)	2.544
(18)	0.933	(36)	1.791	(54)	1.791	(72)	1.288	(90)	2.276

(181)	0.624	(199)	2.544	(217)	3.138	(235)	2.022	(253)	1.14
(182)	0.39	(200)	2.149	(218)	3.797	(236)	0.835	(254)	0.867
(183)	4.527	(201)	2.69	(219)	4.15	(237)	1.213	(255)	1.18
(184)	3.976	(202)	2.022	(220)	4.527	(238)	0.803	(256)	0.568
(185)	3.459	(203)	2.544	(221)	3.797	(239)	1.18	(257)	0.462
(186)	2.276	(204)	2.544	(222)	2.544	(240)	0.835	(258)	0.933
(187)	2.544	(205)	2.832	(223)	2.149	(241)	1.213	(259)	1.79
(188)	2.149	(206)	2.832	(224)	1.251	(242)	0.835	(260)	1.907
(189)	2.99	(207)	2.832	(225)	1.587	(243)	1.14	(261)	2.67
(190)	2.985	(208)	1.791	(226)	0.933	(244)	0.867	(262)	2.832
(191)	3.29	(209)	2.41	(227)	1.14	(245)	1.288	(263)	2.544
(192)	3.138	(210)	1.689	(228)	0.867	(246)	1.326	(264)	1.448
(193)	2.276	(211)	2.276	(229)	1.364	(247)	2.022	(265)	1.79
(194)	2.022	(212)	1.689	(230)	1	(248)	1.907	(266)	1.426
(195)	2.544	(213)	2.832	(231)	1.587	(249)	2.022	(267)	1.288
(196)	1.791	(214)	2.276	(232)	1.587	(250)	0.867	(268)	0.803
(197)	2.41	(215)	2.832	(233)	2.022	(251)	1.104	(269)	0.867
(198)	2.022	(216)	2.276	(234)	1.907	(252)	0.835	(270)	0.682

(91)	3.138	(109)	3.459	(127)	1.689	(145)	2.022	(163)	1.213
(92)	2.832	(110)	2.688	(128)	1.105	(146)	1.177	(164)	2.276
(93)	3.138	(111)	2.276	(129)	2.022	(147)	2.276	(165)	2.276
(94)	2.832	(112)	2.544	(130)	1.14	(148)	2.276	(166)	1.213
(95)	2.832	(113)	2.832	(131)	2.022	(149)	2.276	(167)	2.022
(96)	2.022	(114)	2.544	(132)	1.288	(150)	2.276	(168)	1.288
(97)	2.54	(115)	3.138	(133)	2.276	(151)	2.832	(169)	4.1
(98)	1.364	(116)	2.41	(134)	2.544	(152)	1.791	(170)	3.976
(99)	2.544	(117)	1.79	(135)	2.832	(153)	2.276	(171)	2.544
(100)	2.985	(118)	0.966	(136)	2.832	(154)	1.587	(172)	1.791
(101)	2.832	(119)	1.364	(137)	2.832	(155)	2.27	(173)	3.138
(102)	2.149	(120)	1.288	(138)	1.791	(156)	1.448	(174)	2.688
(103)	2.544	(121)	2.544	(139)	2.276	(157)	1.213	(175)	2.544
(104)	1.791	(122)	2.41	(140)	4.527	(158)	2.832	(176)	2.544
(105)	2.544	(123)	2.276	(141)	4.527	(159)	1.069	(177)	2.832
(106)	2.544	(124)	1.213	(142)	3.138	(160)	0.624	(178)	2.544
(107)	3.797	(125)	1.791	(143)	2.544	(161)	0.568	(179)	2.544
(108)	3.299	(126)	1.288	(144)	1.791	(162)	0.867	(180)	1.587

(271)	0.803	(289)	34.95	(307)	0.741	(325)	4.912	(343)	1.791
(272)	0.568	(290)	11.48	(308)	0.803	(326)	4.912	(344)	1.791
(273)	0.741	(291)	5.717	(309)	2.022	(327)	51.85	(345)	1.791
(274)	1.069	(292)	3.797	(310)	2.276	(328)	20.96	(346)	1.587
(275)	2.022	(293)	2.832	(311)	5.717	(329)	11.48	(347)	1.587
(276)	3.459	(294)	2.276	(312)	4.912	(330)	7.902	(348)	1.364
(277)	4.155	(295)	1.79	(313)	3.459	(331)	5.717	(349)	1.448
(278)	2.688	(296)	1.426	(314)	2.544	(332)	4.72	(350)	2.832
(279)	1.79	(297)	1.288	(315)	2.276	(333)	3.797	(351)	6.134
(280)	1.105	(298)	1	(316)	1.791	(334)	3.138	(352)	4.912
(281)	1.069	(299)	1.14	(317)	1.587	(335)	2.832	(353)	3.459
(282)	0.741	(300)	1	(318)	1.448	(336)	2.544	(354)	3.459
(283)	0.624	(301)	1.14	(319)	2.022	(337)	2.544	(355)	2.544
(284)	0.514	(302)	0.835	(320)	13.79	(338)	2.276	(356)	2.688
(285)	0.682	(303)	1.14	(321)	27.64	(339)	2.276	(357)	1.448
(286)	0.712	(304)	0.772	(322)	15.01	(340)	2.022	(358)	2.022
(287)	0.741	(305)	0.867	(323)	10.13	(341)	2.022	(359)	1.791
(288)	0.624	(306)	0.835	(324)	6.134	(342)	1.791	(360)	1.587

River discharge data at 12-hourly intervals for Station: 9A
Period : 5

Variable: PAARL06.varl (length = 360)

(1)	1.587	(19)	24.96	(37)	2.832	(55)	5.717	(73)	7.447
(2)	1.288	(20)	15.01	(38)	2.832	(56)	7.447	(74)	10.39
(3)	1.288	(21)	13.79	(39)	2.832	(57)	86.66	(75)	10.39
(4)	1.288	(22)	13.79	(40)	2.832	(58)	40.9	(76)	26.09
(5)	1.251	(23)	10.39	(41)	2.832	(59)	40.9	(77)	67.75
(6)	1	(24)	8.84	(42)	2.832	(60)	27.64	(78)	100
(7)	1.14	(25)	7.447	(43)	2.544	(61)	17.56	(79)	42.65
(8)	1.518	(26)	6.559	(44)	2.41	(62)	17.56	(80)	34.13
(9)	55.72	(27)	6.134	(45)	2.41	(63)	16.26	(81)	27.64
(10)	16.26	(28)	5.514	(46)	2.276	(64)	13.79	(82)	23.11
(11)	39.16	(29)	4.912	(47)	2.276	(65)	11.48	(83)	20.26
(12)	25.33	(30)	4.912	(48)	2.276	(66)	9.6	(84)	18.89
(13)	25.71	(31)	4.527	(49)	3.459	(67)	8.84	(85)	17.56
(14)	14.4	(32)	4.527	(50)	40.9	(68)	7.902	(86)	16.26
(15)	20.26	(33)	4.155	(51)	17.56	(69)	7.447	(87)	49.94
(16)	12.04	(34)	3.459	(52)	10.93	(70)	6.998	(88)	40.47
(17)	9.6	(35)	3.459	(53)	8.131	(71)	6.559	(89)	32.47
(18)	16.26	(36)	2.985	(54)	6.559	(72)	6.134	(90)	29.21

(181)	9.34	(199)	30.43	(217)	18.22	(235)	42.65	(253)	24.21
(182)	18.89	(200)	24.58	(218)	16.59	(236)	27.25	(254)	20.96
(183)	82.27	(201)	23.48	(219)	16.26	(237)	22.38	(255)	18.89
(184)	140	(202)	26.09	(220)	15.01	(238)	18.89	(256)	17.24
(185)	91.09	(203)	180	(221)	15.01	(239)	17.24	(257)	18.89
(186)	127	(204)	110	(222)	14.4	(240)	19.92	(258)	20.26
(187)	105	(205)	70.63	(223)	13.79	(241)	21.67	(259)	39.16
(188)	80.17	(206)	52.81	(224)	13.2	(242)	18.89	(260)	59.64
(189)	61.64	(207)	45.33	(225)	13.79	(243)	18.22	(261)	44.88
(190)	42.65	(208)	40.03	(226)	13.2	(244)	16.91	(262)	34.95
(191)	47.15	(209)	44.43	(227)	13.2	(245)	16.91	(263)	28.42
(192)	35.77	(210)	29.21	(228)	17.89	(246)	15.63	(264)	20.96
(193)	31.24	(211)	26.09	(229)	15.95	(247)	15.95	(265)	21.32
(194)	29.62	(212)	24.21	(230)	16.26	(248)	18.22	(266)	19.57
(195)	42.65	(213)	22.38	(231)	16.26	(249)	18.89	(267)	117
(196)	64.68	(214)	20.96	(232)	14.1	(250)	17.89	(268)	150
(197)	49.47	(215)	19.57	(233)	59.64	(251)	16.26	(269)	74.45
(198)	35.77	(216)	24.58	(234)	83.35	(252)	27.64	(270)	43.53

(91)	23.84	(109)	13.79	(127)	16.26	(145)	45.33	(163)	35.77
(92)	20.96	(110)	13.79	(128)	16.26	(146)	40.03	(164)	32.47
(93)	44.43	(111)	44.43	(129)	34.13	(147)	46.24	(165)	27.64
(94)	77.04	(112)	30.83	(130)	41.77	(148)	85.56	(166)	25.33
(95)	40.9	(113)	23.11	(131)	28.42	(149)	91.09	(167)	23.11
(96)	30.83	(114)	22.38	(132)	23.11	(150)	59.84	(168)	21.67
(97)	26.09	(115)	57.67	(133)	21.32	(151)	45.33	(169)	20.96
(98)	23.11	(116)	32.06	(134)	230	(152)	38.3	(170)	20.26
(99)	20.96	(117)	26.09	(135)	73.92	(153)	34.13	(171)	19.57
(100)	19.38	(118)	23.84	(136)	48.07	(154)	30.83	(172)	13.79
(101)	18.22	(119)	21.67	(137)	38.3	(155)	28.82	(173)	15.63
(102)	16.91	(120)	22.03	(138)	32.47	(156)	26.86	(174)	16.59
(103)	16.26	(121)	20.96	(139)	37.45	(157)	25.71	(175)	12.62
(104)	16.26	(122)	19.92	(140)	32.89	(158)	29.62	(176)	11.48
(105)	15.95	(123)	19.57	(141)	235	(159)	27.25	(177)	10.93
(106)	15.32	(124)	18.22	(142)	110	(160)	24.58	(178)	10.39
(107)	15.01	(125)	17.56	(143)	78.07	(161)	23.84	(179)	10.39
(108)	14.4	(126)	16.91	(144)	55.72	(162)	23.11	(180)	9.86

(271)	35.77	(289)	10.4	(307)	6.559	(325)	5.31	(343)	2.83
(272)	30.83	(290)	9.34	(308)	6.55	(326)	4.527	(344)	2.544
(273)	29.21	(291)	9.34	(309)	7.447	(327)	4.527	(345)	2.83
(274)	25.33	(292)	8.84	(310)	7.902	(328)	4.527	(346)	2.022
(275)	23.84	(293)	8.84	(311)	7.447	(329)	4.912	(347)	2.83
(276)	21.67	(294)	8.84	(312)	6.55	(330)	4.155	(348)	2.832
(277)	23.84	(295)	8.36	(313)	6.134	(331)	4.155	(349)	2.83
(278)	20.26	(296)	7.902	(314)	5.717	(332)	3.459	(350)	2.832
(279)	20.26	(297)	7.902	(315)	6.134	(333)	4.155	(351)	2.544
(280)	20.96	(298)	7.447	(316)	5.717	(334)	3.797	(352)	1.448
(281)	20.96	(299)	6.998	(317)	5.717	(335)	4.155	(353)	2.022
(282)	20.96	(300)	6.998	(318)	5.717	(336)	4.155	(354)	1.288
(283)	13.79	(301)	6.559	(319)	5.717	(337)	3.797	(355)	1.79
(284)	12.04	(302)	6.55	(320)	5.717	(338)	2.83	(356)	1.069
(285)	11.48	(303)	6.559	(321)	5.717	(339)	3.459	(357)	1.587
(286)	12.62	(304)	6.55	(322)	5.717	(340)	2.544	(358)	1
(287)	10.93	(305)	6.559	(323)	5.717	(341)	2.544	(359)	1.79
(288)	10.4	(306)	6.55	(324)	4.912	(342)	2.276	(360)	1.069

River discharge data at 12-hourly intervals for Station: 9A
Period : 6

Variable: PARLSTW1.pstwq12_1 (length = 360)

(1) 0.113	(19) 0.113	(37) 0.113	(55) 0.122	(73) 0.0771
(2) 0.113	(20) 0.113	(38) 0.113	(56) 0.122	(74) 0.0771
(3) 0.113	(21) 0.113	(39) 0.113	(57) 0.123	(75) 0.0771
(4) 0.113	(22) 0.113	(40) 0.113	(58) 0.123	(76) 0.0771
(5) 0.113	(23) 0.113	(41) 0.113	(59) 0.122	(77) 0.0771
(6) 0.113	(24) 0.113	(42) 0.113	(60) 0.122	(78) 0.0771
(7) 0.113	(25) 0.113	(43) 0.113	(61) 0.122	(79) 0.069
(8) 0.113	(26) 0.113	(44) 0.113	(62) 0.122	(80) 0.069
(9) 0.113	(27) 0.113	(45) 0.113	(63) 0.113	(81) 0.069
(10) 0.113	(28) 0.113	(46) 0.113	(64) 0.113	(82) 0.069
(11) 0.113	(29) 0.113	(47) 0.113	(65) 0.104	(83) 0.069
(12) 0.113	(30) 0.113	(48) 0.113	(66) 0.104	(84) 0.069
(13) 0.113	(31) 0.113	(49) 0.111	(67) 0.095	(85) 0.069
(14) 0.113	(32) 0.113	(50) 0.111	(68) 0.095	(86) 0.069
(15) 0.113	(33) 0.113	(51) 0.113	(69) 0.086	(87) 0.069
(16) 0.113	(34) 0.113	(52) 0.113	(70) 0.086	(88) 0.069
(17) 0.113	(35) 0.113	(53) 0.113	(71) 0.086	(89) 0.0607
(18) 0.113	(36) 0.113	(54) 0.113	(72) 0.086	(90) 0.0607

(181) 0.1333	(199) 0.113	(217) 0.1632	(235) 0.143	(253) 0.113
(182) 0.1333	(200) 0.113	(218) 0.1632	(236) 0.143	(254) 0.113
(183) 0.133	(201) 0.118	(219) 0.1632	(237) 0.143	(255) 0.118
(184) 0.133	(202) 0.118	(220) 0.1632	(238) 0.143	(256) 0.118
(185) 0.133	(203) 0.118	(221) 0.1632	(239) 0.143	(257) 0.104
(186) 0.133	(204) 0.118	(222) 0.1632	(240) 0.143	(258) 0.104
(187) 0.123	(205) 0.123	(223) 0.153	(241) 0.153	(259) 0.104
(188) 0.123	(206) 0.123	(224) 0.153	(242) 0.153	(260) 0.104
(189) 0.113	(207) 0.128	(225) 0.143	(243) 0.153	(261) 0.113
(190) 0.113	(208) 0.128	(226) 0.143	(244) 0.153	(262) 0.113
(191) 0.104	(209) 0.133	(227) 0.143	(245) 0.153	(263) 0.123
(192) 0.104	(210) 0.133	(228) 0.143	(246) 0.153	(264) 0.123
(193) 0.104	(211) 0.133	(229) 0.137	(247) 0.158	(265) 0.133
(194) 0.104	(212) 0.133	(230) 0.137	(248) 0.158	(266) 0.133
(195) 0.104	(213) 0.133	(231) 0.137	(249) 0.143	(267) 0.143
(196) 0.104	(214) 0.133	(232) 0.137	(250) 0.143	(268) 0.143
(197) 0.105	(215) 0.133	(233) 0.143	(251) 0.133	(269) 0.153
(198) 0.105	(216) 0.133	(234) 0.143	(252) 0.133	(270) 0.153

(91) 0.053	(109) 0.081	(127) 0.133	(145) 0.108	(163) 0.128
(92) 0.053	(110) 0.081	(128) 0.133	(146) 0.108	(164) 0.128
(93) 0.047	(111) 0.095	(129) 0.133	(147) 0.1	(165) 0.133
(94) 0.047	(112) 0.095	(130) 0.133	(148) 0.1	(166) 0.133
(95) 0.047	(113) 0.104	(131) 0.123	(149) 0.1	(167) 0.133
(96) 0.047	(114) 0.104	(132) 0.123	(150) 0.1	(168) 0.133
(97) 0.0607	(115) 0.113	(133) 0.123	(151) 0.098	(169) 0.133
(98) 0.0607	(116) 0.113	(134) 0.123	(152) 0.098	(170) 0.133
(99) 0.0607	(117) 0.123	(135) 0.123	(153) 0.095	(171) 0.133
(100) 0.0607	(118) 0.123	(136) 0.123	(154) 0.095	(172) 0.133
(101) 0.064	(119) 0.128	(137) 0.123	(155) 0.095	(173) 0.133
(102) 0.064	(120) 0.128	(138) 0.123	(156) 0.095	(174) 0.133
(103) 0.068	(121) 0.133	(139) 0.123	(157) 0.104	(175) 0.133
(104) 0.068	(122) 0.133	(140) 0.123	(158) 0.104	(176) 0.133
(105) 0.068	(123) 0.133	(141) 0.117	(159) 0.113	(177) 0.133
(106) 0.068	(124) 0.133	(142) 0.117	(160) 0.113	(178) 0.133
(107) 0.072	(125) 0.133	(143) 0.113	(161) 0.123	(179) 0.133
(108) 0.072	(126) 0.133	(144) 0.113	(162) 0.123	(180) 0.133

(271) 0.174	(289) 0.133	(307) 0.153	(325) 0.153	(343) 0.184
(272) 0.174	(290) 0.133	(308) 0.153	(326) 0.153	(344) 0.184
(273) 0.185	(291) 0.143	(309) 0.143	(327) 0.153	(345) 0.195
(274) 0.185	(292) 0.143	(310) 0.143	(328) 0.153	(346) 0.195
(275) 0.174	(293) 0.143	(311) 0.143	(329) 0.158	(347) 0.22
(276) 0.174	(294) 0.143	(312) 0.143	(330) 0.158	(348) 0.22
(277) 0.133	(295) 0.143	(313) 0.133	(331) 0.158	(349) 0.23
(278) 0.133	(296) 0.143	(314) 0.133	(332) 0.158	(350) 0.23
(279) 0.123	(297) 0.153	(315) 0.133	(333) 0.153	(351) 0.23
(280) 0.123	(298) 0.153	(316) 0.133	(334) 0.153	(352) 0.23
(281) 0.113	(299) 0.158	(317) 0.133	(335) 0.153	(353) 0.252
(282) 0.113	(300) 0.158	(318) 0.133	(336) 0.153	(354) 0.252
(283) 0.113	(301) 0.163	(319) 0.143	(337) 0.163	(355) 0.241
(284) 0.113	(302) 0.163	(320) 0.143	(338) 0.163	(356) 0.241
(285) 0.123	(303) 0.163	(321) 0.143	(339) 0.163	(357) 0.241
(286) 0.123	(304) 0.163	(322) 0.143	(340) 0.163	(358) 0.241
(287) 0.133	(305) 0.163	(323) 0.153	(341) 0.174	(359) 0.241
(288) 0.133	(306) 0.163	(324) 0.153	(342) 0.174	(360) 0.241

River discharge data at 12-hourly intervals for Station: PSTW
Period : 1

Variable: PARLSTW2.pstwq12_2 (length = 360)

(1) 0.229	(19) 0.218	(37) 0.218	(55) 0.185	(73) 0.163
(2) 0.229	(20) 0.218	(38) 0.218	(56) 0.185	(74) 0.163
(3) 0.218	(21) 0.218	(39) 0.206	(57) 0.185	(75) 0.174
(4) 0.218	(22) 0.218	(40) 0.206	(58) 0.185	(76) 0.174
(5) 0.218	(23) 0.218	(41) 0.206	(59) 0.185	(77) 0.174
(6) 0.218	(24) 0.218	(42) 0.206	(60) 0.185	(78) 0.174
(7) 0.218	(25) 0.218	(43) 0.195	(61) 0.185	(79) 0.185
(8) 0.218	(26) 0.218	(44) 0.195	(62) 0.185	(80) 0.185
(9) 0.218	(27) 0.218	(45) 0.185	(63) 0.185	(81) 0.185
(10) 0.218	(28) 0.218	(46) 0.185	(64) 0.185	(82) 0.185
(11) 0.218	(29) 0.218	(47) 0.185	(65) 0.174	(83) 0.195
(12) 0.218	(30) 0.218	(48) 0.185	(66) 0.174	(84) 0.195
(13) 0.218	(31) 0.218	(49) 0.185	(67) 0.174	(85) 0.195
(14) 0.218	(32) 0.218	(50) 0.185	(68) 0.174	(86) 0.195
(15) 0.218	(33) 0.218	(51) 0.185	(69) 0.174	(87) 0.195
(16) 0.218	(34) 0.218	(52) 0.185	(70) 0.174	(88) 0.195
(17) 0.218	(35) 0.218	(53) 0.185	(71) 0.163	(89) 0.195
(18) 0.218	(36) 0.218	(54) 0.185	(72) 0.163	(90) 0.195

(181) 0.206	(199) 0.185	(217) 0.195	(235) 0.174	(253) 0.195
(182) 0.206	(200) 0.185	(218) 0.195	(236) 0.174	(254) 0.195
(183) 0.206	(201) 0.174	(219) 0.195	(237) 0.174	(255) 0.195
(184) 0.206	(202) 0.174	(220) 0.195	(238) 0.174	(256) 0.195
(185) 0.195	(203) 0.174	(221) 0.195	(239) 0.174	(257) 0.195
(186) 0.195	(204) 0.174	(222) 0.195	(240) 0.174	(258) 0.195
(187) 0.195	(205) 0.163	(223) 0.195	(241) 0.174	(259) 0.195
(188) 0.195	(206) 0.163	(224) 0.195	(242) 0.174	(260) 0.195
(189) 0.185	(207) 0.174	(225) 0.195	(243) 0.185	(261) 0.195
(190) 0.185	(208) 0.174	(226) 0.195	(244) 0.185	(262) 0.195
(191) 0.185	(209) 0.185	(227) 0.185	(245) 0.185	(263) 0.206
(192) 0.185	(210) 0.185	(228) 0.185	(246) 0.185	(264) 0.206
(193) 0.185	(211) 0.185	(229) 0.174	(247) 0.185	(265) 0.206
(194) 0.185	(212) 0.185	(230) 0.174	(248) 0.185	(266) 0.206
(195) 0.185	(213) 0.195	(231) 0.163	(249) 0.195	(267) 0.218
(196) 0.185	(214) 0.195	(232) 0.163	(250) 0.195	(268) 0.218
(197) 0.185	(215) 0.185	(233) 0.163	(251) 0.195	(269) 0.218
(198) 0.185	(216) 0.185	(234) 0.163	(252) 0.195	(270) 0.218

(91) 0.195	(109) 0.218	(127) 0.206	(145) 0.206	(163) 0.195
(92) 0.195	(110) 0.218	(128) 0.206	(146) 0.206	(164) 0.195
(93) 0.206	(111) 0.218	(129) 0.206	(147) 0.206	(165) 0.195
(94) 0.206	(112) 0.218	(130) 0.206	(148) 0.206	(166) 0.195
(95) 0.206	(113) 0.218	(131) 0.206	(149) 0.206	(167) 0.195
(96) 0.206	(114) 0.218	(132) 0.206	(150) 0.206	(168) 0.195
(97) 0.206	(115) 0.218	(133) 0.206	(151) 0.206	(169) 0.195
(98) 0.206	(116) 0.218	(134) 0.206	(152) 0.206	(170) 0.195
(99) 0.218	(117) 0.218	(135) 0.206	(153) 0.206	(171) 0.195
(100) 0.218	(118) 0.218	(136) 0.206	(154) 0.206	(172) 0.195
(101) 0.218	(119) 0.218	(137) 0.206	(155) 0.206	(173) 0.195
(102) 0.218	(120) 0.218	(138) 0.206	(156) 0.206	(174) 0.195
(103) 0.218	(121) 0.218	(139) 0.206	(157) 0.206	(175) 0.195
(104) 0.218	(122) 0.218	(140) 0.206	(158) 0.206	(176) 0.195
(105) 0.229	(123) 0.206	(141) 0.206	(159) 0.206	(177) 0.195
(106) 0.229	(124) 0.206	(142) 0.206	(160) 0.206	(178) 0.195
(107) 0.218	(125) 0.206	(143) 0.206	(161) 0.197	(179) 0.195
(108) 0.218	(126) 0.206	(144) 0.206	(162) 0.197	(180) 0.195

(271) 0.218	(289) 0.206	(307) 0.195	(325) 0.104	(343) 0.1132
(272) 0.218	(290) 0.206	(308) 0.195	(326) 0.104	(344) 0.1132
(273) 0.218	(291) 0.206	(309) 0.206	(327) 0.077	(345) 0.1326
(274) 0.218	(292) 0.206	(310) 0.206	(328) 0.077	(346) 0.1326
(275) 0.218	(293) 0.206	(311) 0.206	(329) 0.069	(347) 0.1326
(276) 0.218	(294) 0.206	(312) 0.206	(330) 0.069	(348) 0.1326
(277) 0.218	(295) 0.195	(313) 0.195	(331) 0.0607	(349) 0.1326
(278) 0.218	(296) 0.195	(314) 0.195	(332) 0.0607	(350) 0.1326
(279) 0.218	(297) 0.195	(315) 0.195	(333) 0.0687	(351) 0.1228
(280) 0.218	(298) 0.195	(316) 0.195	(334) 0.0687	(352) 0.1228
(281) 0.218	(299) 0.195	(317) 0.185	(335) 0.086	(353) 0.1228
(282) 0.218	(300) 0.195	(318) 0.185	(336) 0.086	(354) 0.1228
(283) 0.218	(301) 0.195	(319) 0.174	(337) 0.095	(355) 0.1132
(284) 0.218	(302) 0.195	(320) 0.174	(338) 0.095	(356) 0.1132
(285) 0.218	(303) 0.195	(321) 0.163	(339) 0.104	(357) 0.104
(286) 0.218	(304) 0.195	(322) 0.163	(340) 0.104	(358) 0.104
(287) 0.218	(305) 0.195	(323) 0.143	(341) 0.1132	(359) 0.086
(288) 0.218	(306) 0.195	(324) 0.143	(342) 0.1132	(360) 0.086

River discharge data at 12-hourly intervals for Station: PSTW
Period : 2

Variable: PARLSTW3.pstwq12_3 (length = 360)

(1) 0.086	(19) 0.095	(37) 0.133	(55) 0.123	(73) 0.163
(2) 0.086	(20) 0.095	(38) 0.133	(56) 0.123	(74) 0.163
(3) 0.095	(21) 0.095	(39) 0.133	(57) 0.104	(75) 0.174
(4) 0.095	(22) 0.095	(40) 0.133	(58) 0.104	(76) 0.174
(5) 0.095	(23) 0.095	(41) 0.133	(59) 0.104	(77) 0.174
(6) 0.095	(24) 0.095	(42) 0.133	(60) 0.104	(78) 0.174
(7) 0.095	(25) 0.086	(43) 0.133	(61) 0.113	(79) 0.174
(8) 0.095	(26) 0.086	(44) 0.133	(62) 0.113	(80) 0.174
(9) 0.095	(27) 0.086	(45) 0.133	(63) 0.128	(81) 0.174
(10) 0.095	(28) 0.086	(46) 0.133	(64) 0.128	(82) 0.174
(11) 0.086	(29) 0.095	(47) 0.143	(65) 0.133	(83) 0.174
(12) 0.086	(30) 0.095	(48) 0.143	(66) 0.133	(84) 0.174
(13) 0.0771	(31) 0.104	(49) 0.153	(67) 0.133	(85) 0.163
(14) 0.0771	(32) 0.104	(50) 0.153	(68) 0.133	(86) 0.163
(15) 0.086	(33) 0.113	(51) 0.153	(69) 0.143	(87) 0.153
(16) 0.086	(34) 0.113	(52) 0.153	(70) 0.143	(88) 0.153
(17) 0.095	(35) 0.123	(53) 0.143	(71) 0.153	(89) 0.143
(18) 0.095	(36) 0.123	(54) 0.143	(72) 0.153	(90) 0.143

(181) 0.133	(199) 0.153	(217) 0.123	(235) 0.163	(253) 0.133
(182) 0.133	(200) 0.153	(218) 0.123	(236) 0.163	(254) 0.133
(183) 0.133	(201) 0.163	(219) 0.123	(237) 0.163	(255) 0.123
(184) 0.133	(202) 0.163	(220) 0.123	(238) 0.163	(256) 0.123
(185) 0.133	(203) 0.163	(221) 0.133	(239) 0.143	(257) 0.123
(186) 0.133	(204) 0.163	(222) 0.133	(240) 0.143	(258) 0.123
(187) 0.133	(205) 0.143	(223) 0.133	(241) 0.163	(259) 0.123
(188) 0.133	(206) 0.143	(224) 0.133	(242) 0.163	(260) 0.123
(189) 0.123	(207) 0.143	(225) 0.143	(243) 0.153	(261) 0.133
(190) 0.123	(208) 0.143	(226) 0.143	(244) 0.153	(262) 0.133
(191) 0.113	(209) 0.143	(227) 0.143	(245) 0.153	(263) 0.133
(192) 0.113	(210) 0.143	(228) 0.143	(246) 0.153	(264) 0.133
(193) 0.123	(211) 0.143	(229) 0.143	(247) 0.143	(265) 0.143
(194) 0.123	(212) 0.143	(230) 0.143	(248) 0.143	(266) 0.143
(195) 0.133	(213) 0.133	(231) 0.153	(249) 0.143	(267) 0.143
(196) 0.133	(214) 0.133	(232) 0.153	(250) 0.143	(268) 0.143
(197) 0.143	(215) 0.123	(233) 0.153	(251) 0.133	(269) 0.143
(198) 0.143	(216) 0.123	(234) 0.153	(252) 0.133	(270) 0.143

(91) 0.143	(109) 0.077	(127) 0.133	(145) 0.113	(163) 0.123
(92) 0.143	(110) 0.077	(128) 0.133	(146) 0.113	(164) 0.123
(93) 0.123	(111) 0.077	(129) 0.133	(147) 0.113	(165) 0.123
(94) 0.123	(112) 0.077	(130) 0.133	(148) 0.113	(166) 0.123
(95) 0.104	(113) 0.086	(131) 0.133	(149) 0.104	(167) 0.133
(96) 0.104	(114) 0.086	(132) 0.133	(150) 0.104	(168) 0.133
(97) 0.086	(115) 0.095	(133) 0.143	(151) 0.086	(169) 0.133
(98) 0.086	(116) 0.095	(134) 0.143	(152) 0.086	(170) 0.133
(99) 0.086	(117) 0.104	(135) 0.143	(153) 0.086	(171) 0.133
(100) 0.086	(118) 0.104	(136) 0.143	(154) 0.086	(172) 0.133
(101) 0.077	(119) 0.104	(137) 0.143	(155) 0.086	(173) 0.143
(102) 0.077	(120) 0.104	(138) 0.143	(156) 0.086	(174) 0.143
(103) 0.077	(121) 0.104	(139) 0.133	(157) 0.095	(175) 0.143
(104) 0.077	(122) 0.104	(140) 0.133	(158) 0.095	(176) 0.143
(105) 0.077	(123) 0.113	(141) 0.133	(159) 0.113	(177) 0.153
(106) 0.077	(124) 0.113	(142) 0.133	(160) 0.113	(178) 0.153
(107) 0.077	(125) 0.123	(143) 0.123	(161) 0.123	(179) 0.143
(108) 0.077	(126) 0.123	(144) 0.123	(162) 0.123	(180) 0.143

(271) 0.153	(289) 0.174	(307) 0.185	(325) 0.195	(343) 0.195
(272) 0.153	(290) 0.174	(308) 0.185	(326) 0.195	(344) 0.195
(273) 0.163	(291) 0.174	(309) 0.185	(327) 0.195	(345) 0.195
(274) 0.163	(292) 0.174	(310) 0.185	(328) 0.195	(346) 0.195
(275) 0.163	(293) 0.174	(311) 0.195	(329) 0.195	(347) 0.195
(276) 0.163	(294) 0.174	(312) 0.195	(330) 0.195	(348) 0.195
(277) 0.163	(295) 0.143	(313) 0.195	(331) 0.195	(349) 0.195
(278) 0.163	(296) 0.143	(314) 0.195	(332) 0.195	(350) 0.195
(279) 0.153	(297) 0.143	(315) 0.195	(333) 0.195	(351) 0.195
(280) 0.153	(298) 0.143	(316) 0.195	(334) 0.195	(352) 0.195
(281) 0.143	(299) 0.143	(317) 0.195	(335) 0.195	(353) 0.185
(282) 0.143	(300) 0.143	(318) 0.195	(336) 0.195	(354) 0.185
(283) 0.143	(301) 0.143	(319) 0.195	(337) 0.195	(355) 0.174
(284) 0.143	(302) 0.143	(320) 0.195	(338) 0.195	(356) 0.174
(285) 0.143	(303) 0.143	(321) 0.195	(339) 0.195	(357) 0.143
(286) 0.143	(304) 0.143	(322) 0.195	(340) 0.195	(358) 0.143
(287) 0.174	(305) 0.174	(323) 0.195	(341) 0.195	(359) 0.143
(288) 0.174	(306) 0.174	(324) 0.195	(342) 0.195	(360) 0.143

River discharge data at 12-hourly intervals for Station: PSTW
Period : 3

Variable: PARLSTW4.pstwq12_4 (length = 344)

(1) 0.153	(19) 0.185	(37) 0.206	(55) 0.206	(73) 0.195
(2) 0.153	(20) 0.185	(38) 0.206	(56) 0.206	(74) 0.195
(3) 0.153	(21) 0.195	(39) 0.026	(57) 0.195	(75) 0.195
(4) 0.153	(22) 0.195	(40) 0.026	(58) 0.195	(76) 0.195
(5) 0.153	(23) 0.195	(41) 0.206	(59) 0.185	(77) 0.195
(6) 0.153	(24) 0.195	(42) 0.206	(60) 0.185	(78) 0.195
(7) 0.153	(25) 0.206	(43) 0.206	(61) 0.185	(79) 0.195
(8) 0.153	(26) 0.206	(44) 0.206	(62) 0.185	(80) 0.195
(9) 0.174	(27) 0.206	(45) 0.206	(63) 0.185	(81) 0.195
(10) 0.174	(28) 0.206	(46) 0.206	(64) 0.185	(82) 0.195
(11) 0.174	(29) 0.206	(47) 0.206	(65) 0.185	(83) 0.195
(12) 0.174	(30) 0.206	(48) 0.206	(66) 0.185	(84) 0.195
(13) 0.174	(31) 0.206	(49) 0.206	(67) 0.185	(85) 0.195
(14) 0.174	(32) 0.206	(50) 0.206	(68) 0.185	(86) 0.195
(15) 0.174	(33) 0.206	(51) 0.218	(69) 0.185	(87) 0.206
(16) 0.174	(34) 0.206	(52) 0.218	(70) 0.185	(88) 0.206
(17) 0.174	(35) 0.206	(53) 0.218	(71) 0.195	(89) 0.206
(18) 0.174	(36) 0.206	(54) 0.218	(72) 0.195	(90) 0.206

(181) 0.185	(199) 0.153	(217) 0.206	(235) 0.218	(253) 0.163
(182) 0.185	(200) 0.153	(218) 0.206	(236) 0.218	(254) 0.163
(183) 0.174	(201) 0.163	(219) 0.206	(237) 0.206	(255) 0.163
(184) 0.174	(202) 0.163	(220) 0.206	(238) 0.206	(256) 0.163
(185) 0.163	(203) 0.163	(221) 0.206	(239) 0.206	(257) 0.163
(186) 0.163	(204) 0.163	(222) 0.206	(240) 0.206	(258) 0.163
(187) 0.163	(205) 0.174	(223) 0.206	(241) 0.195	(259) 0.153
(188) 0.163	(206) 0.174	(224) 0.206	(242) 0.195	(260) 0.153
(189) 0.153	(207) 0.185	(225) 0.206	(243) 0.195	(261) 0.153
(190) 0.153	(208) 0.185	(226) 0.206	(244) 0.195	(262) 0.153
(191) 0.153	(209) 0.195	(227) 0.206	(245) 0.195	(263) 0.163
(192) 0.153	(210) 0.195	(228) 0.206	(246) 0.195	(264) 0.163
(193) 0.153	(211) 0.195	(229) 0.206	(247) 0.185	(265) 0.163
(194) 0.153	(212) 0.195	(230) 0.206	(248) 0.185	(266) 0.163
(195) 0.163	(213) 0.195	(231) 0.206	(249) 0.174	(267) 0.163
(196) 0.163	(214) 0.195	(232) 0.206	(250) 0.174	(268) 0.163
(197) 0.153	(215) 0.206	(233) 0.218	(251) 0.174	(269) 0.163
(198) 0.153	(216) 0.206	(234) 0.218	(252) 0.174	(270) 0.163

(91) 0.206	(109) 0.252	(127) 0.24	(145) 0.229	(163) 0.229
(92) 0.206	(110) 0.252	(128) 0.24	(146) 0.229	(164) 0.229
(93) 0.218	(111) 0.24	(129) 0.229	(147) 0.218	(165) 0.229
(94) 0.218	(112) 0.24	(130) 0.229	(148) 0.218	(166) 0.229
(95) 0.218	(113) 0.24	(131) 0.229	(149) 0.229	(167) 0.229
(96) 0.218	(114) 0.24	(132) 0.229	(150) 0.229	(168) 0.229
(97) 0.241	(115) 0.24	(133) 0.229	(151) 0.229	(169) 0.218
(98) 0.241	(116) 0.24	(134) 0.229	(152) 0.229	(170) 0.218
(99) 0.229	(117) 0.229	(135) 0.218	(153) 0.229	(171) 0.218
(100) 0.229	(118) 0.229	(136) 0.218	(154) 0.229	(172) 0.218
(101) 0.241	(119) 0.24	(137) 0.218	(155) 0.229	(173) 0.206
(102) 0.241	(120) 0.24	(138) 0.218	(156) 0.229	(174) 0.206
(103) 0.241	(121) 0.24	(139) 0.229	(157) 0.229	(175) 0.206
(104) 0.241	(122) 0.24	(140) 0.229	(158) 0.229	(176) 0.206
(105) 0.241	(123) 0.24	(141) 0.229	(159) 0.229	(177) 0.195
(106) 0.241	(124) 0.24	(142) 0.229	(160) 0.229	(178) 0.195
(107) 0.252	(125) 0.24	(143) 0.229	(161) 0.229	(179) 0.195
(108) 0.252	(126) 0.24	(144) 0.229	(162) 0.229	(180) 0.195

(271) 0.174	(289) 0.195	(307) 0.095	(325) 0.143	(343) 0.086
(272) 0.174	(290) 0.195	(308) 0.095	(326) 0.143	(344) 0.086
(273) 0.174	(291) 0.195	(309) 0.104	(327) 0.143	
(274) 0.174	(292) 0.195	(310) 0.104	(328) 0.143	
(275) 0.185	(293) 0.185	(311) 0.1132	(329) 0.133	
(276) 0.185	(294) 0.185	(312) 0.1132	(330) 0.133	
(277) 0.185	(295) 0.174	(313) 0.123	(331) 0.123	
(278) 0.185	(296) 0.174	(314) 0.123	(332) 0.123	
(279) 0.195	(297) 0.153	(315) 0.133	(333) 0.095	
(280) 0.195	(298) 0.153	(316) 0.133	(334) 0.095	
(281) 0.195	(299) 0.123	(317) 0.143	(335) 0.069	
(282) 0.195	(300) 0.123	(318) 0.143	(336) 0.069	
(283) 0.195	(301) 0.104	(319) 0.153	(337) 0.053	
(284) 0.195	(302) 0.104	(320) 0.153	(338) 0.053	
(285) 0.195	(303) 0.086	(321) 0.143	(339) 0.053	
(286) 0.195	(304) 0.086	(322) 0.143	(340) 0.053	
(287) 0.195	(305) 0.095	(323) 0.143	(341) 0.061	
(288) 0.195	(306) 0.095	(324) 0.143	(342) 0.061	

River discharge data at 12-hourly intervals for Station: PSTW
Period : 4

A3.30

Variable: PARLSTW5.pstwq12_5 (length = 360)

(1) 0.086	(19) 0.095	(37) 0.123	(55) 0.0607	(73) 0.095
(2) 0.086	(20) 0.095	(38) 0.123	(56) 0.0607	(74) 0.095
(3) 0.095	(21) 0.086	(39) 0.123	(57) 0.061	(75) 0.095
(4) 0.095	(22) 0.086	(40) 0.123	(58) 0.061	(76) 0.095
(5) 0.104	(23) 0.086	(41) 0.123	(59) 0.069	(77) 0.095
(6) 0.104	(24) 0.086	(42) 0.123	(60) 0.069	(78) 0.095
(7) 0.133	(25) 0.0687	(43) 0.113	(61) 0.113	(79) 0.095
(8) 0.133	(26) 0.0687	(44) 0.113	(62) 0.113	(80) 0.095
(9) 0.241	(27) 0.086	(45) 0.104	(63) 0.086	(81) 0.095
(10) 0.241	(28) 0.086	(46) 0.104	(64) 0.086	(82) 0.095
(11) 0.104	(29) 0.095	(47) 0.086	(65) 0.095	(83) 0.095
(12) 0.104	(30) 0.095	(48) 0.086	(66) 0.095	(84) 0.095
(13) 0.104	(31) 0.104	(49) 0.068	(67) 0.095	(85) 0.095
(14) 0.104	(32) 0.104	(50) 0.068	(68) 0.095	(86) 0.095
(15) 0.104	(33) 0.113	(51) 0.0607	(69) 0.095	(87) 0.104
(16) 0.104	(34) 0.113	(52) 0.0607	(70) 0.095	(88) 0.104
(17) 0.104	(35) 0.113	(53) 0.0607	(71) 0.095	(89) 0.113
(18) 0.104	(36) 0.113	(54) 0.0607	(72) 0.095	(90) 0.113

(131) 0.086	(199) 0.104	(217) 0.113	(235) 0.133	(253) 0.143
(182) 0.086	(200) 0.104	(218) 0.113	(236) 0.133	(254) 0.143
(183) 0.086	(201) 0.104	(219) 0.113	(237) 0.143	(255) 0.143
(184) 0.086	(202) 0.104	(220) 0.113	(238) 0.143	(256) 0.143
(185) 0.095	(203) 0.104	(221) 0.113	(239) 0.143	(257) 0.143
(186) 0.095	(204) 0.104	(222) 0.113	(240) 0.143	(258) 0.143
(187) 0.095	(205) 0.104	(223) 0.104	(241) 0.143	(259) 0.143
(188) 0.095	(206) 0.104	(224) 0.104	(242) 0.143	(260) 0.143
(189) 0.095	(207) 0.104	(225) 0.104	(243) 0.143	(261) 0.143
(190) 0.095	(208) 0.104	(225) 0.104	(244) 0.143	(262) 0.143
(191) 0.095	(209) 0.104	(227) 0.104	(245) 0.153	(263) 0.143
(192) 0.095	(210) 0.104	(228) 0.104	(246) 0.153	(264) 0.143
(193) 0.104	(211) 0.104	(229) 0.113	(247) 0.153	(265) 0.143
(194) 0.104	(212) 0.104	(230) 0.113	(248) 0.153	(266) 0.143
(195) 0.104	(213) 0.113	(231) 0.123	(249) 0.153	(267) 0.143
(196) 0.104	(214) 0.113	(232) 0.123	(250) 0.153	(268) 0.143
(197) 0.104	(215) 0.113	(233) 0.133	(251) 0.153	(269) 0.143
(198) 0.104	(216) 0.113	(234) 0.133	(252) 0.153	(270) 0.143

(91) 0.104	(109) 0.068	(127) 0.053	(145) 0.104	(163) 0.069
(92) 0.104	(110) 0.068	(128) 0.053	(146) 0.104	(164) 0.069
(93) 0.104	(111) 0.061	(129) 0.053	(147) 0.095	(165) 0.123
(94) 0.104	(112) 0.061	(130) 0.053	(148) 0.095	(166) 0.123
(95) 0.104	(113) 0.053	(131) 0.061	(149) 0.095	(167) 0.113
(96) 0.104	(114) 0.053	(132) 0.061	(150) 0.095	(168) 0.113
(97) 0.095	(115) 0.045	(133) 0.068	(151) 0.095	(169) 0.113
(98) 0.095	(116) 0.045	(134) 0.068	(152) 0.095	(170) 0.113
(99) 0.086	(117) 0.038	(135) 0.086	(153) 0.095	(171) 0.104
(100) 0.086	(118) 0.038	(136) 0.086	(154) 0.095	(172) 0.104
(101) 0.086	(119) 0.032	(137) 0.095	(155) 0.086	(173) 0.095
(102) 0.086	(120) 0.032	(138) 0.095	(156) 0.086	(174) 0.095
(103) 0.0771	(121) 0.038	(139) 0.095	(157) 0.0771	(175) 0.095
(104) 0.0771	(122) 0.038	(140) 0.095	(158) 0.0771	(176) 0.095
(105) 0.086	(123) 0.045	(141) 0.104	(159) 0.025	(177) 0.086
(106) 0.086	(124) 0.045	(142) 0.104	(160) 0.025	(178) 0.086
(107) 0.0771	(125) 0.053	(143) 0.104	(161) 0.0607	(179) 0.096
(108) 0.0771	(126) 0.053	(144) 0.104	(162) 0.0607	(180) 0.096

(271) 0.143	(289) 0.163	(307) 0.163	(325) 0.153	(343) 0.185
(272) 0.143	(290) 0.163	(308) 0.163	(326) 0.153	(344) 0.185
(273) 0.143	(291) 0.163	(309) 0.163	(327) 0.163	(345) 0.185
(274) 0.143	(292) 0.163	(310) 0.163	(328) 0.163	(346) 0.185
(275) 0.143	(293) 0.163	(311) 0.153	(329) 0.163	(347) 0.185
(276) 0.143	(294) 0.163	(312) 0.153	(330) 0.163	(348) 0.185
(277) 0.153	(295) 0.174	(313) 0.143	(331) 0.163	(349) 0.185
(278) 0.153	(296) 0.174	(314) 0.143	(332) 0.163	(350) 0.185
(279) 0.153	(297) 0.174	(315) 0.133	(333) 0.174	(351) 0.195
(280) 0.153	(298) 0.174	(316) 0.133	(334) 0.174	(352) 0.195
(281) 0.153	(299) 0.174	(317) 0.133	(335) 0.174	(353) 0.185
(282) 0.153	(300) 0.174	(318) 0.133	(336) 0.174	(354) 0.185
(283) 0.153	(301) 0.174	(319) 0.143	(337) 0.174	(355) 0.174
(284) 0.153	(302) 0.174	(320) 0.143	(338) 0.174	(356) 0.174
(285) 0.153	(303) 0.163	(321) 0.143	(339) 0.185	(357) 0.174
(286) 0.153	(304) 0.163	(322) 0.143	(340) 0.185	(358) 0.174
(287) 0.153	(305) 0.163	(323) 0.153	(341) 0.185	(359) 0.174
(288) 0.153	(306) 0.163	(324) 0.153	(342) 0.185	(360) 0.174

River discharge data at 12-hourly intervals for Station: PSTW
Period : 5

Variable: PARLSTW6.pstwq12_6 (length = 360)

(1)	0.163	(19)	0.1738	(37)	0.184	(55)	0.163	(73)	0.174
(2)	0.163	(20)	0.1738	(38)	0.184	(56)	0.163	(74)	0.174
(3)	0.1528	(21)	0.18	(39)	0.19	(57)	0.174	(75)	0.184
(4)	0.1528	(22)	0.18	(40)	0.19	(58)	0.174	(76)	0.184
(5)	0.1528	(23)	0.18	(41)	0.195	(59)	0.184	(77)	0.195
(6)	0.1528	(24)	0.18	(42)	0.195	(60)	0.184	(78)	0.195
(7)	0.1528	(25)	0.18	(43)	0.195	(61)	0.18	(79)	0.195
(8)	0.1528	(26)	0.18	(44)	0.195	(62)	0.18	(80)	0.195
(9)	0.1528	(27)	0.18	(45)	0.2	(63)	0.18	(81)	0.2
(10)	0.1528	(28)	0.18	(46)	0.2	(64)	0.18	(82)	0.2
(11)	0.163	(29)	0.184	(47)	0.184	(65)	0.174	(83)	0.2
(12)	0.163	(30)	0.184	(48)	0.184	(66)	0.174	(84)	0.2
(13)	0.163	(31)	0.163	(49)	0.184	(67)	0.174	(85)	0.195
(14)	0.163	(32)	0.163	(50)	0.184	(68)	0.174	(86)	0.195
(15)	0.163	(33)	0.174	(51)	0.18	(69)	0.174	(87)	0.206
(16)	0.163	(34)	0.174	(52)	0.18	(70)	0.174	(88)	0.206
(17)	0.163	(35)	0.184	(53)	0.174	(71)	0.174	(89)	0.206
(18)	0.163	(36)	0.184	(54)	0.174	(72)	0.174	(90)	0.206

(91)	0.218	(109)	0.195	(127)	0.218	(145)	0.23	(163)	0.206
(92)	0.218	(110)	0.195	(128)	0.218	(146)	0.23	(164)	0.206
(93)	0.229	(111)	0.195	(129)	0.206	(147)	0.24	(165)	0.206
(94)	0.229	(112)	0.195	(130)	0.206	(148)	0.24	(166)	0.206
(95)	0.218	(113)	0.206	(131)	0.206	(149)	0.23	(167)	0.206
(96)	0.218	(114)	0.206	(132)	0.206	(150)	0.23	(168)	0.206
(97)	0.218	(115)	0.206	(133)	0.195	(151)	0.23	(169)	0.206
(98)	0.218	(116)	0.206	(134)	0.195	(152)	0.23	(170)	0.206
(99)	0.218	(117)	0.206	(135)	0.206	(153)	0.24	(171)	0.206
(100)	0.218	(118)	0.206	(136)	0.206	(154)	0.24	(172)	0.206
(101)	0.218	(119)	0.206	(137)	0.206	(155)	0.218	(173)	0.206
(102)	0.218	(120)	0.206	(138)	0.206	(156)	0.218	(174)	0.206
(103)	0.206	(121)	0.21	(139)	0.206	(157)	0.218	(175)	0.2
(104)	0.206	(122)	0.21	(140)	0.206	(158)	0.218	(176)	0.2
(105)	0.206	(123)	0.218	(141)	0.218	(159)	0.218	(177)	0.195
(106)	0.206	(124)	0.218	(142)	0.218	(160)	0.218	(178)	0.195
(107)	0.195	(125)	0.218	(143)	0.23	(161)	0.206	(179)	0.195
(108)	0.195	(126)	0.218	(144)	0.23	(162)	0.206	(180)	0.195

(181)	0.195	(199)	0.173	(217)	0.195	(235)	0.206	(253)	0.184
(182)	0.195	(200)	0.173	(218)	0.195	(236)	0.206	(254)	0.184
(183)	0.206	(201)	0.174	(219)	0.195	(237)	0.206	(255)	0.184
(184)	0.206	(202)	0.174	(220)	0.195	(238)	0.206	(256)	0.184
(185)	0.206	(203)	0.19	(221)	0.2	(239)	0.206	(257)	0.19
(186)	0.206	(204)	0.19	(222)	0.2	(240)	0.206	(258)	0.19
(187)	0.218	(205)	0.195	(223)	0.218	(241)	0.206	(259)	0.206
(188)	0.218	(206)	0.195	(224)	0.218	(242)	0.206	(260)	0.206
(189)	0.218	(207)	0.195	(225)	0.206	(243)	0.206	(261)	0.206
(190)	0.218	(208)	0.195	(226)	0.206	(244)	0.206	(262)	0.206
(191)	0.206	(209)	0.195	(227)	0.206	(245)	0.195	(263)	0.206
(192)	0.206	(210)	0.195	(228)	0.206	(246)	0.195	(264)	0.206
(193)	0.206	(211)	0.206	(229)	0.206	(247)	0.19	(265)	0.206
(194)	0.206	(212)	0.206	(230)	0.206	(248)	0.19	(266)	0.206
(195)	0.195	(213)	0.195	(231)	0.2	(249)	0.184	(267)	0.206
(196)	0.195	(214)	0.195	(232)	0.2	(250)	0.184	(268)	0.206
(197)	0.184	(215)	0.195	(233)	0.206	(251)	0.184	(269)	0.206
(198)	0.184	(216)	0.195	(234)	0.206	(252)	0.184	(270)	0.206

(271)	0.206	(289)	0.195	(307)	0.206	(325)	0.185	(343)	0.095
(272)	0.206	(290)	0.195	(308)	0.206	(326)	0.185	(344)	0.095
(273)	0.206	(271)	0.195	(309)	0.195	(327)	0.185	(345)	0.086
(274)	0.206	(292)	0.195	(310)	0.195	(328)	0.185	(346)	0.086
(275)	0.206	(293)	0.195	(311)	0.195	(329)	0.174	(347)	0.086
(276)	0.206	(294)	0.195	(312)	0.195	(330)	0.174	(348)	0.086
(277)	0.206	(295)	0.195	(313)	0.195	(331)	0.174	(349)	0.086
(278)	0.206	(296)	0.195	(314)	0.195	(332)	0.174	(350)	0.086
(279)	0.206	(297)	0.195	(315)	0.195	(333)	0.163	(351)	0.086
(280)	0.206	(298)	0.195	(316)	0.195	(334)	0.163	(352)	0.086
(281)	0.206	(299)	0.195	(317)	0.195	(335)	0.153	(353)	0.086
(282)	0.206	(300)	0.195	(318)	0.195	(336)	0.153	(354)	0.086
(283)	0.2	(301)	0.195	(319)	0.19	(337)	0.133	(355)	0.086
(284)	0.2	(302)	0.195	(320)	0.19	(338)	0.133	(356)	0.086
(265)	0.195	(303)	0.195	(321)	0.19	(339)	0.122	(357)	0.1
(286)	0.195	(304)	0.195	(322)	0.19	(340)	0.122	(358)	0.1
(287)	0.195	(305)	0.195	(323)	0.185	(341)	0.113	(359)	0.113
(288)	0.195	(306)	0.195	(324)	0.185	(342)	0.113	(360)	0.113

River discharge data at 12-hourly intervals for Station: PSTW
Period : 6

Variable: WSTWQ1.wstwq12_1 (length = 360)

(1) 0.0284	(19) 0.018	(37) 0.018	(55) 0.018	(73) 0.018
(2) 0.0284	(20) 0.018	(38) 0.018	(56) 0.018	(74) 0.018
(3) 0.0232	(21) 0.018	(39) 0.0198	(57) 0.018	(75) 0.018
(4) 0.0232	(22) 0.018	(40) 0.0198	(58) 0.018	(76) 0.018
(5) 0.0232	(23) 0.018	(41) 0.018	(59) 0.018	(77) 0.018
(6) 0.0232	(24) 0.018	(42) 0.018	(60) 0.018	(78) 0.018
(7) 0.0232	(25) 0.018	(43) 0.018	(61) 0.018	(79) 0.018
(8) 0.0232	(26) 0.018	(44) 0.018	(62) 0.018	(80) 0.018
(9) 0.018	(27) 0.018	(45) 0.018	(63) 0.018	(81) 0.012
(10) 0.018	(28) 0.018	(46) 0.018	(64) 0.018	(82) 0.012
(11) 0.018	(29) 0.018	(47) 0.0189	(65) 0.018	(83) 0.012
(12) 0.018	(30) 0.018	(48) 0.0189	(66) 0.018	(84) 0.012
(13) 0.018	(31) 0.018	(49) 0.018	(67) 0.018	(85) 0.012
(14) 0.019	(32) 0.018	(50) 0.018	(68) 0.018	(86) 0.012
(15) 0.018	(33) 0.018	(51) 0.018	(69) 0.018	(87) 0.0132
(16) 0.018	(34) 0.018	(52) 0.018	(70) 0.018	(88) 0.0132
(17) 0.018	(35) 0.018	(53) 0.018	(71) 0.018	(89) 0.012
(18) 0.018	(36) 0.018	(54) 0.018	(72) 0.018	(90) 0.012

(91) 0.01	(109) 0.01	(127) 0.014	(145) 0.0342	(163) 0.0284
(92) 0.01	(110) 0.01	(128) 0.014	(146) 0.0342	(164) 0.0284
(93) 0.01	(111) 0.01	(129) 0.02	(147) 0.0232	(165) 0.0284
(94) 0.01	(112) 0.01	(130) 0.02	(148) 0.0232	(165) 0.0284
(95) 0.01	(113) 0.01	(131) 0.03	(149) 0.013	(167) 0.0137
(96) 0.01	(114) 0.01	(132) 0.03	(150) 0.013	(168) 0.0137
(97) 0.01	(115) 3E-3	(133) 0.034	(151) 0.0232	(169) 0.0137
(98) 0.01	(116) 3E-3	(134) 0.034	(152) 0.0232	(170) 0.0137
(99) 0.01	(117) 0.03	(135) 0.03	(153) 0.0137	(171) 0.0137
(100) 0.01	(118) 0.03	(136) 0.03	(154) 0.0137	(172) 0.0137
(101) 0.01	(119) 0.03	(137) 0.03	(155) 0.0232	(173) 0.0137
(102) 0.01	(120) 0.03	(138) 0.03	(156) 0.0232	(174) 0.0137
(103) 0.01	(121) 0.04	(139) 0.03	(157) 0.0137	(175) 0.0137
(104) 0.01	(122) 0.04	(140) 0.03	(158) 0.0137	(176) 0.0137
(105) 0.01	(123) 0.014	(141) 0.0137	(159) 0.0342	(177) 0.0137
(106) 0.01	(124) 0.014	(142) 0.0137	(160) 0.0342	(178) 0.0137
(107) 0.01	(125) 0.018	(143) 0.0137	(161) 0.0284	(179) 0.0137
(108) 0.01	(126) 0.018	(144) 0.0137	(162) 0.0284	(180) 0.0137

(181) 0.0137	(199) 0.0182	(217) 0.02	(235) 0.0284	(253) 0.0232
(182) 0.0137	(200) 0.0182	(218) 0.02	(236) 0.0284	(254) 0.0232
(183) 0.0182	(201) 0.0182	(219) 0.02	(237) 9.7E-3	(255) 0.0137
(184) 0.0182	(202) 0.0182	(220) 0.02	(238) 9.7E-3	(256) 0.0137
(185) 0.0182	(203) 0.0182	(221) 0.02	(239) 0.0284	(257) 0.0284
(186) 0.0182	(204) 0.0182	(222) 0.02	(240) 0.0284	(258) 0.0284
(187) 0.0182	(205) 0.0182	(223) 0.032	(241) 0.0137	(259) 0.0284
(188) 0.0182	(206) 0.0182	(224) 0.032	(242) 0.0137	(260) 0.0284
(189) 0.0182	(207) 0.0182	(225) 0.02	(243) 0.0284	(261) 0.0284
(190) 0.0182	(208) 0.0182	(226) 0.02	(244) 0.0284	(262) 0.0284
(191) 0.0182	(209) 0.0232	(227) 0.02	(245) 0.0284	(263) 0.0284
(192) 0.0182	(210) 0.0232	(228) 0.02	(246) 0.0284	(264) 0.0284
(193) 0.0182	(211) 0.0232	(229) 0.02	(247) 0.0284	(265) 0.0182
(194) 0.0182	(212) 0.0232	(230) 0.02	(248) 0.0284	(266) 0.0182
(195) 0.0182	(213) 0.02	(231) 0.02	(249) 0.0284	(267) 0.0137
(196) 0.0182	(214) 0.02	(232) 0.02	(250) 0.0284	(268) 0.0137
(197) 0.0182	(215) 0.02	(233) 0	(251) 0.0232	(269) 0.013
(198) 0.0182	(216) 0.02	(234) 0	(252) 0.0232	(270) 0.013

(271) 0.013	(289) 0.013	(307) 0.013	(325) 0.0135	(343) 0.0135
(272) 0.013	(290) 0.013	(308) 0.013	(326) 0.0135	(344) 0.0135
(273) 0.013	(291) 0.0213	(309) 0.0135	(327) 0.013	(345) 0.0135
(274) 0.013	(292) 0.0213	(310) 0.0135	(328) 0.013	(346) 0.0135
(275) 0.0137	(293) 0.0135	(311) 0.0135	(329) 0.0135	(347) 0.0135
(276) 0.0137	(294) 0.0135	(312) 0.0135	(330) 0.0135	(348) 0.0135
(277) 0.0135	(295) 0.0135	(313) 0.0135	(331) 0.013	(349) 0.013
(278) 0.0135	(296) 0.0135	(314) 0.0135	(332) 0.013	(350) 0.013
(279) 0.0135	(297) 0.0135	(315) 0.01354	(333) 0.0135	(351) 0.013
(280) 0.0135	(298) 0.0135	(316) 0.01354	(334) 0.0135	(352) 0.013
(281) 0.0135	(299) 0.0135	(317) 0.0135	(335) 0.013	(353) 0.013
(282) 0.0135	(300) 0.0135	(318) 0.0135	(336) 0.013	(354) 0.013
(283) 0.0135	(301) 0.0135	(319) 0.0135	(337) 0.013	(355) 0.013
(284) 0.0135	(302) 0.0135	(320) 0.0135	(338) 0.013	(356) 0.013
(285) 0.013	(303) 0.0135	(321) 0.0135	(339) 0.013	(357) 0.0213
(286) 0.013	(304) 0.0135	(322) 0.0135	(340) 0.013	(358) 0.0213
(287) 0.013	(305) 0.0135	(323) 0.0135	(341) 0.0135	(359) 0.013
(288) 0.013	(306) 0.0135	(324) 0.0135	(342) 0.0135	(360) 0.013

A3.33

River discharge data at 12-hourly intervals for Station: WSTW
Period : 1

Variable: WSTWQ2.wstwq12_2 (length = 360)

(1) 0.04	(19) 0.04	(37) 0.04	(55) 0.04	(73) 0.04
(2) 0.04	(20) 0.04	(38) 0.04	(56) 0.04	(74) 0.04
(3) 0.04	(21) 0.04	(39) 0.04	(57) 0.04	(75) 0.04
(4) 0.04	(22) 0.04	(40) 0.04	(58) 0.04	(76) 0.04
(5) 0.04	(23) 0.041	(41) 0.04	(59) 0.04	(77) 0.04
(6) 0.04	(24) 0.041	(42) 0.04	(60) 0.04	(78) 0.04
(7) 0.04	(25) 0.04	(43) 0.04	(61) 0.054	(79) 0.04
(8) 0.04	(26) 0.04	(44) 0.04	(62) 0.054	(80) 0.04
(9) 0.04	(27) 0.04	(45) 0.04	(63) 0.04	(81) 0.04
(10) 0.04	(28) 0.04	(46) 0.04	(64) 0.04	(82) 0.04
(11) 0.04	(29) 0.04	(47) 0.04	(65) 0.04	(83) 0.04
(12) 0.04	(30) 0.04	(48) 0.04	(66) 0.04	(84) 0.04
(13) 0.04	(31) 0.04	(49) 0.04	(67) 0.04	(85) 0.04
(14) 0.04	(32) 0.04	(50) 0.04	(68) 0.04	(86) 0.04
(15) 0.04	(33) 0.04	(51) 0.04	(69) 0.04	(87) 0.04
(16) 0.04	(34) 0.04	(52) 0.04	(70) 0.04	(88) 0.04
(17) 0.04	(35) 0.04	(53) 0.04	(71) 0.04	(89) 0.04
(18) 0.04	(36) 0.04	(54) 0.04	(72) 0.04	(90) 0.04

(91) 0.04	(109) 0.04	(127) 0.04	(145) 0.04	(163) 0.0534
(92) 0.04	(110) 0.04	(128) 0.04	(146) 0.04	(164) 0.0534
(93) 0.04	(111) 0.04	(129) 0.04	(147) 0.04	(165) 0.0534
(94) 0.04	(112) 0.04	(130) 0.04	(148) 0.04	(166) 0.0534
(95) 0.045	(113) 0.04	(131) 0.04	(149) 0.04	(167) 0.0342
(96) 0.045	(114) 0.04	(132) 0.04	(150) 0.04	(168) 0.0342
(97) 0.04	(115) 0.04	(133) 0.04	(151) 0.04	(169) 0.0342
(98) 0.04	(116) 0.04	(134) 0.04	(152) 0.04	(170) 0.0342
(99) 0.04	(117) 0.045	(135) 0.04	(153) 0.0402	(171) 0.0284
(100) 0.04	(118) 0.045	(136) 0.04	(154) 0.0402	(172) 0.0284
(101) 0.05	(119) 0.045	(137) 0.04	(155) 0.0402	(173) 0.0284
(102) 0.05	(120) 0.045	(138) 0.04	(156) 0.0402	(174) 0.0284
(103) 0.05	(121) 0.045	(139) 0.04	(157) 0.0466	(175) 0.0284
(104) 0.05	(122) 0.045	(140) 0.04	(158) 0.0466	(176) 0.0284
(105) 0.05	(123) 0.045	(141) 0.04	(159) 0.0534	(177) 0.028
(106) 0.05	(124) 0.045	(142) 0.04	(160) 0.0534	(178) 0.028
(107) 0.04	(125) 0.0466	(143) 0.04	(161) 0.0534	(179) 0.028
(108) 0.04	(126) 0.0466	(144) 0.04	(162) 0.0534	(180) 0.028

(181) 0.028	(199) 0.0284	(217) 0.0402	(235) 0.0284	(253) 0.0284
(182) 0.028	(200) 0.0284	(218) 0.0402	(236) 0.0284	(254) 0.0284
(183) 0.023	(201) 0.0284	(219) 0.0534	(237) 0.0342	(255) 0.0284
(184) 0.023	(202) 0.0284	(220) 0.0534	(238) 0.0342	(256) 0.0284
(185) 0.023	(203) 0.0232	(221) 0.0466	(239) 0.0342	(257) 0.0284
(186) 0.023	(204) 0.0232	(222) 0.0466	(240) 0.0342	(258) 0.0284
(187) 0.023	(205) 0.0232	(223) 0.0342	(241) 0.0342	(259) 0.0232
(188) 0.023	(206) 0.0232	(224) 0.0342	(242) 0.0342	(260) 0.0232
(189) 0.0232	(207) 0.0232	(225) 0.0466	(243) 0.0342	(261) 0.0232
(190) 0.0232	(208) 0.0232	(226) 0.0466	(244) 0.0342	(262) 0.0232
(191) 0.0184	(209) 0.0402	(227) 0.0402	(245) 0.0284	(263) 0.0284
(192) 0.0184	(210) 0.0402	(228) 0.0402	(246) 0.0284	(264) 0.0284
(193) 0.0232	(211) 0.0604	(229) 0.0342	(247) 0.0284	(265) 0.0284
(194) 0.0232	(212) 0.0604	(230) 0.0342	(248) 0.0284	(266) 0.0284
(195) 0.0137	(213) 0.0534	(231) 0.0342	(249) 0.0284	(267) 0.0232
(196) 0.0137	(214) 0.0534	(232) 0.0342	(250) 0.0284	(268) 0.0232
(197) 0.0232	(215) 0.0466	(233) 0.0284	(251) 0.0342	(269) 0.0284
(198) 0.0232	(216) 0.0466	(234) 0.0284	(252) 0.0342	(270) 0.0284

(271) 0.0466	(289) 0.0184	(307) 0.0182	(325) 0.0232	(343) 0.0182
(272) 0.0466	(290) 0.0184	(308) 0.0182	(326) 0.0232	(344) 0.0182
(273) 0.0604	(291) 0.0182	(309) 0.0232	(327) 0.0232	(345) 0.0182
(274) 0.0604	(292) 0.0182	(310) 0.0232	(328) 0.0232	(346) 0.0182
(275) 0.0342	(293) 0.0284	(311) 0.0232	(329) 0.0232	(347) 0.0182
(276) 0.0342	(294) 0.0284	(312) 0.0232	(330) 0.0232	(348) 0.0182
(277) 0.0342	(295) 9.7E-3	(313) 0.0232	(331) 0.0232	(349) 9.7E-3
(278) 0.0342	(296) 9.7E-3	(314) 0.0232	(332) 0.0232	(350) 9.7E-3
(279) 0.0342	(297) 0.0284	(315) 0.0232	(333) 0.0182	(351) 0.0182
(280) 0.0342	(298) 0.0284	(316) 0.0232	(334) 0.0182	(352) 0.0182
(281) 0.0342	(299) 0.0284	(317) 0.0182	(335) 0.0182	(353) 0.0182
(282) 0.0342	(300) 0.0284	(318) 0.0182	(336) 0.0182	(354) 0.0182
(283) 0.0182	(301) 0.0284	(319) 0.0182	(337) 0.0137	(355) 0.0182
(284) 0.0182	(302) 0.0284	(320) 0.0182	(338) 0.0137	(356) 0.0182
(285) 0.0284	(303) 0.0284	(321) 0.0232	(339) 0.0137	(357) 0.0232
(286) 0.0284	(304) 0.0284	(322) 0.0232	(340) 0.0137	(358) 0.0232
(287) 0.0232	(305) 0.0284	(323) 0.0232	(341) 0.0137	(359) 0.0232
(288) 0.0232	(306) 0.0284	(324) 0.0232	(342) 0.0137	(360) 0.0232

River discharge data at 12-hourly intervals for Station: WSTW
Period : 2

Variable: WSTWQ3.wstwq12_3 (length = 360)

(1)	0.0137	(19)	0.0232	(37)	0.0182	(55)	0.0182	(73)	0.0182
(2)	0.0137	(20)	0.0232	(38)	0.0182	(56)	0.0182	(74)	0.0182
(3)	0.0137	(21)	0.0232	(39)	0.0182	(57)	0.0182	(75)	0.0182
(4)	0.0137	(22)	0.0232	(40)	0.0182	(58)	0.0182	(76)	0.0182
(5)	0.0182	(23)	0.0137	(41)	0.0182	(59)	0.0284	(77)	0.0137
(6)	0.0182	(24)	0.0137	(42)	0.0182	(60)	0.0284	(78)	0.0137
(7)	6.2E-3	(25)	9.7E-3	(43)	0.0137	(61)	0.0284	(79)	9.7E-3
(8)	6.2E-3	(26)	9.7E-3	(44)	0.0137	(62)	0.0284	(80)	9.7E-3
(9)	0.0137	(27)	0.0182	(45)	0.0137	(63)	0.0402	(81)	0.0137
(10)	0.0137	(28)	0.0182	(46)	0.0137	(64)	0.0402	(82)	0.0137
(11)	0.0182	(29)	0.0232	(47)	6.2E-3	(65)	0.0284	(83)	0.0137
(12)	0.0182	(30)	0.0232	(48)	6.2E-3	(66)	0.0284	(84)	0.0137
(13)	0.0182	(31)	0.0284	(49)	6.2E-3	(67)	0.0222	(85)	0.0182
(14)	0.0182	(32)	0.0284	(50)	6.2E-3	(68)	0.0222	(86)	0.0182
(15)	0.0232	(33)	0.0284	(51)	9.7E-3	(69)	0.0182	(87)	0.0232
(16)	0.0232	(34)	0.0284	(52)	9.7E-3	(70)	0.0182	(88)	0.0232
(17)	0.0232	(35)	0.0232	(53)	0.0137	(71)	0.0182	(89)	0.0182
(18)	0.0232	(36)	0.0232	(54)	0.0137	(72)	0.0182	(90)	0.0182

(181)	0.0182	(199)	0.0137	(217)	0.0232	(235)	0.0342	(253)	0.0137
(182)	0.0182	(200)	0.0137	(218)	0.0232	(236)	0.0342	(254)	0.0137
(183)	0.0182	(201)	0.0137	(219)	0.0182	(237)	0.0284	(255)	9.7E-3
(184)	0.0182	(202)	0.0137	(220)	0.0182	(238)	0.0284	(256)	9.7E-3
(185)	0.0182	(203)	0.0137	(221)	0.0137	(239)	0.02184	(257)	1E-3
(186)	0.0182	(204)	0.0137	(222)	0.0137	(240)	0.02184	(258)	1E-3
(187)	9.7E-3	(205)	0.0182	(223)	0.0232	(241)	0.0402	(259)	1E-3
(188)	9.7E-3	(206)	0.0182	(224)	0.0232	(242)	0.0402	(260)	1E-3
(189)	6.2E-3	(207)	0.0402	(225)	0.0182	(243)	0.0284	(261)	1E-3
(190)	6.2E-3	(208)	0.0402	(226)	0.0182	(244)	0.0284	(262)	1E-3
(191)	3.3E-3	(209)	0.0342	(227)	0.0232	(245)	0.0232	(263)	1E-3
(192)	3.3E-3	(210)	0.0342	(228)	0.0232	(246)	0.0232	(264)	1E-3
(193)	0.0182	(211)	0.0284	(229)	0.0182	(247)	0.0232	(265)	1E-3
(194)	0.0182	(212)	0.0284	(230)	0.0182	(248)	0.0232	(266)	1E-3
(195)	0.0182	(213)	0.0284	(231)	0.0182	(249)	0.0182	(267)	1E-3
(196)	0.0182	(214)	0.0284	(232)	0.0182	(250)	0.0182	(268)	1E-3
(197)	0.0182	(215)	0.0232	(233)	0.0342	(251)	0.0137	(269)	1E-3
(198)	0.0182	(216)	0.0232	(234)	0.0342	(252)	0.0137	(270)	1E-3

(91)	0.0182	(109)	9.7E-3	(127)	0.0137	(145)	0.0182	(163)	0.0182
(92)	0.0182	(110)	9.7E-3	(128)	0.0137	(146)	0.0182	(164)	0.0182
(93)	9.7E-3	(111)	0.0137	(129)	6.2E-3	(147)	9.7E-3	(165)	0.0137
(94)	9.7E-3	(112)	0.0137	(130)	6.2E-3	(148)	9.7E-3	(166)	0.0137
(95)	6.2E-3	(113)	0.0232	(131)	6.2E-3	(149)	9.7E-3	(167)	0.0182
(96)	6.2E-3	(114)	0.0232	(132)	6.2E-3	(150)	9.7E-3	(168)	0.0182
(97)	0.0137	(115)	0.0232	(133)	3.3E-3	(151)	9.7E-3	(169)	0.0232
(98)	0.0137	(116)	0.0232	(134)	3.3E-3	(152)	9.7E-3	(170)	0.0232
(99)	0.0232	(117)	9.7E-3	(135)	1.1E-3	(153)	0.0182	(171)	0.0182
(100)	0.0232	(118)	9.7E-3	(136)	1.1E-3	(154)	0.0182	(172)	0.0182
(101)	6.2E-3	(119)	9.7E-3	(137)	0.0137	(155)	0.0232	(173)	0.0137
(102)	6.2E-3	(120)	9.7E-3	(138)	0.0137	(156)	0.0232	(174)	0.0137
(103)	9.7E-3	(121)	9.7E-3	(139)	0.0137	(157)	0.0182	(175)	6.2E-3
(104)	9.7E-3	(122)	9.7E-3	(140)	0.0137	(158)	0.0182	(176)	6.2E-3
(105)	9.7E-3	(123)	9.7E-3	(141)	0.0137	(159)	9.7E-3	(177)	9.7E-3
(106)	9.7E-3	(124)	9.7E-3	(142)	0.0137	(160)	9.7E-3	(178)	9.7E-3
(107)	6.2E-3	(125)	9.7E-3	(143)	0.0182	(161)	0.0182	(179)	0.0182
(108)	6.2E-3	(126)	9.7E-3	(144)	0.0182	(162)	0.0182	(180)	0.0182

(271)	3.3E-3	(289)	0.0182	(307)	0.0182	(325)	0.0182	(343)	0.0182
(272)	3.3E-3	(290)	0.0182	(308)	0.0182	(326)	0.0182	(344)	0.0182
(273)	0.0137	(291)	0.0182	(309)	0.0342	(327)	0.0232	(345)	0.0182
(274)	0.0137	(292)	0.0182	(310)	0.0342	(328)	0.0232	(346)	0.0182
(275)	0.0137	(293)	0.0182	(311)	0.0402	(329)	0.0182	(347)	0.01[illegible]2
(276)	0.0137	(294)	0.0182	(312)	0.0402	(330)	0.0182	(348)	0.0182
(277)	0.0182	(295)	0.0182	(313)	0.0342	(331)	0.0182	(349)	0.01[illegible]
(278)	0.0182	(296)	0.0182	(314)	0.0342	(332)	0.0182	(350)	0.0137
(279)	0.0232	(297)	0.0182	(315)	0.0284	(333)	0.0182	(351)	0.0137
(280)	0.0232	(298)	0.0182	(316)	0.0284	(334)	0.0182	(352)	0.0137
(281)	0.0182	(299)	0.0182	(317)	0.0232	(335)	0.0182	(353)	0.0182
(282)	0.0182	(300)	0.0182	(318)	0.0232	(336)	0.0182	(354)	0.0182
(283)	0.0182	(301)	0.0182	(319)	0.0232	(337)	0.0182	(355)	0.0182
(284)	0.0182	(302)	0.0182	(320)	0.0232	(338)	0.0182	(356)	0.0182
(285)	0.0182	(303)	0.0182	(321)	0.0232	(339)	0.0182	(357)	0.0182
(286)	0.0182	(304)	0.0182	(322)	0.0232	(340)	0.0182	(358)	0.0182
(287)	0.0182	(305)	0.0137	(323)	0.0232	(341)	0.0137	(359)	0.0182
(288)	0.0182	(306)	0.0137	(324)	0.0232	(342)	0.0137	(360)	0.0182

River discharge data at 12-hourly intervals for Station: WSTW
Period : 3

Variable: WSTW04.wstwq12_4 (length = 344)

(1) 0.0137	(19) 0.0232	(37) 0.0137	(55) 0.0342	(73) 0.0534
(2) 0.0137	(20) 0.0232	(38) 0.0137	(56) 0.0342	(74) 0.0534
(3) 0.0137	(21) 0.0182	(39) 0.0137	(57) 0.0534	(75) 0.0534
(4) 0.0137	(22) 0.0182	(40) 0.0137	(58) 0.0534	(76) 0.0534
(5) 0.0137	(23) 0.0182	(41) 0.0137	(59) 0.0834	(77) 0.0466
(6) 0.0137	(24) 0.0182	(42) 0.0137	(60) 0.0834	(78) 0.0466
(7) 0.0182	(25) 0.0182	(43) 0.0182	(61) 0.0677	(79) 0.0342
(8) 0.0182	(26) 0.0182	(44) 0.0182	(62) 0.0677	(80) 0.0342
(9) 0.0182	(27) 0.0284	(45) 0.0182	(63) 0.0604	(81) 0.0342
(10) 0.0182	(28) 0.0284	(46) 0.0182	(64) 0.0604	(82) 0.0342
(11) 0.0232	(29) 0.0232	(47) 0.0182	(65) 0.0916	(83) 0.0402
(12) 0.0232	(30) 0.0232	(48) 0.0182	(66) 0.0916	(84) 0.0402
(13) 0.0232	(31) 0.0182	(49) 0.0182	(67) 0.0677	(85) 0.0342
(14) 0.0232	(32) 0.0182	(50) 0.0182	(68) 0.0677	(86) 0.0342
(15) 0.0284	(33) 0.0182	(51) 0.0182	(69) 0.0677	(87) 0.0342
(16) 0.0284	(34) 0.0182	(52) 0.0182	(70) 0.0677	(88) 0.0342
(17) 0.0284	(35) 0.0182	(53) 0.0182	(71) 0.0604	(89) 0.0342
(18) 0.0284	(36) 0.0182	(54) 0.0182	(72) 0.0604	(90) 0.0342

(91) 0.0284	(109) 0.0834	(127) 0.0402	(145) 0.0342	(163) 0.0402
(92) 0.0284	(110) 0.0834	(128) 0.0402	(146) 0.0342	(164) 0.0402
(93) 0.0232	(111) 0.0754	(129) 0.0402	(147) 0.0342	(165) 0.0342
(94) 0.0232	(112) 0.0754	(130) 0.0402	(148) 0.0342	(166) 0.0342
(95) 0.0232	(113) 0.0604	(131) 0.0402	(149) 0.0284	(167) 0.0466
(96) 0.0232	(114) 0.0604	(132) 0.0402	(150) 0.0284	(168) 0.0466
(97) 0.0284	(115) 0.0916	(133) 0.0342	(151) 0.0232	(169) 0.1
(98) 0.0284	(116) 0.0916	(134) 0.0342	(152) 0.0232	(170) 0.1
(99) 0.0284	(117) 0.0754	(135) 0.0284	(153) 0.0342	(171) 0.0834
(100) 0.0284	(118) 0.0754	(136) 0.0284	(154) 0.0342	(172) 0.0834
(101) 0.0604	(119) 0.0604	(137) 0.0284	(155) 0.0342	(173) 0.109
(102) 0.0604	(120) 0.0604	(138) 0.0284	(156) 0.0342	(174) 0.109
(103) 0.1	(121) 0.0402	(139) 0.0342	(157) 0.0402	(175) 0.0834
(104) 0.1	(122) 0.0402	(140) 0.0342	(158) 0.0402	(176) 0.0834
(105) 0.0677	(123) 0.0342	(141) 0.0342	(159) 0.0466	(177) 0.0534
(106) 0.0677	(124) 0.0342	(142) 0.0342	(160) 0.0466	(178) 0.0534
(107) 0.0834	(125) 0.0402	(143) 0.0284	(161) 0.0534	(179) 0.0466
(108) 0.0834	(126) 0.0402	(144) 0.0284	(162) 0.0534	(180) 0.0466

(181) 0.0604	(199) 0.0342	(217) 0.0284	(235) 0.0232	(253) 0.0232
(182) 0.0604	(200) 0.0342	(218) 0.0284	(236) 0.0232	(254) 0.0232
(183) 0.0534	(201) 0.0402	(219) 0.0232	(237) 0.0232	(255) 0.0232
(184) 0.0534	(202) 0.0402	(220) 0.0232	(238) 0.0232	(256) 0.0232
(185) 0.0534	(203) 0.0402	(221) 0.0232	(239) 0.0284	(257) 0.0232
(186) 0.0534	(204) 0.0402	(222) 0.0232	(240) 0.0284	(258) 0.0232
(187) 0.0466	(205) 0.0284	(223) 0.0284	(241) 0.0342	(259) 0.0132
(188) 0.0466	(206) 0.0284	(224) 0.0284	(242) 0.0342	(260) 0.0132
(189) 0.0466	(207) 0.0284	(225) 0.0284	(243) 0.0342	(261) 0.0182
(190) 0.0466	(208) 0.0284	(226) 0.0284	(244) 0.0342	(262) 0.0182
(191) 0.0402	(209) 0.0342	(227) 0.0284	(245) 0.0342	(263) 0
(192) 0.0402	(210) 0.0342	(228) 0.0284	(246) 0.0342	(264) 0
(193) 0.0342	(211) 0.0342	(229) 0.0232	(247) 0.0232	(265) 0.0284
(194) 0.0342	(212) 0.0342	(230) 0.0232	(248) 0.0232	(266) 0.0284
(195) 0.0402	(213) 0.0342	(231) 0.0232	(249) 0.0232	(267) 0.0284
(196) 0.0402	(214) 0.0342	(232) 0.0232	(250) 0.0232	(268) 0.0284
(197) 0.0342	(215) 0.0342	(233) 0.0232	(251) 0.0232	(269) 0.0284
(198) 0.0342	(216) 0.0342	(234) 0.0232	(252) 0.0232	(270) 0.0284

(271) 0.0284	(289) 0.0284	(307) 9.7E-3	(325) 9.7E-3	(343) 9.7E-3
(272) 0.0284	(290) 0.0284	(308) 9.7E-3	(326) 9.7E-3	(344) 9.7E-3
(273) 0.0232	(291) 0.0232	(309) 9.7E-3	(327) 0.0137	
(274) 0.0232	(292) 0.0232	(310) 9.7E-3	(328) 0.0137	
(275) 0.0182	(293) 0.0232	(311) 0.0284	(329) 0.0232	
(276) 0.0182	(294) 0.0232	(312) 0.0284	(330) 0.0232	
(277) 0.0137	(295) 0.0232	(313) 0.0284	(331) 0.0232	
(278) 0.0137	(296) 0.0232	(314) 0.0284	(332) 0.0232	
(279) 0.0232	(297) 0.0232	(315) 0.0284	(333) 0.0232	
(280) 0.0232	(298) 0.0232	(316) 0.0284	(334) 0.0232	
(281) 0.0182	(299) 0.0232	(317) 0.0284	(335) 9.7E-3	
(282) 0.0182	(300) 0.0232	(318) 0.0284	(336) 9.7E-3	
(283) 0.0182	(301) 0.0182	(319) 0.0284	(337) 6.2E-3	
(284) 0.0182	(302) 0.0182	(320) 0.0284	(338) 6.2E-3	
(285) 0.0284	(303) 0.0137	(321) 0.0284	(339) 0.0232	
(286) 0.0284	(304) 0.0137	(322) 0.0284	(340) 0.0232	
(287) 0.0284	(305) 1E-3	(323) 0.0284	(341) 9.7E-3	
(288) 0.0284	(306) 1E-3	(324) 0.0284	(342) 9.7E-3	

River discharge data at 12-hourly intervals for Station: WSTW
Period : 4

Variable: WSTWQ5.wstwq12_5 (length = 360)

(1) 0.0137	(19) 0.0232	(37) 0.0137	(55) 0.0232	(73) 9.7E-3
(2) 0.0137	(20) 0.0232	(38) 0.0137	(56) 0.0232	(74) 9.7E-3
(3) 0.0137	(21) 0.0232	(39) 0.0182	(57) 0.0232	(75) 9.7E-3
(4) 0.0137	(22) 0.0232	(40) 0.0182	(58) 0.0232	(76) 9.7E-3
(5) 0.0232	(23) 0.0232	(41) 0.0182	(59) 0.0182	(77) 0.0232
(6) 0.0232	(24) 0.0232	(42) 0.0182	(60) 0.0182	(78) 0.0232
(7) 0.0182	(25) 0.0182	(43) 0.0232	(61) 3.3E-3	(79) 0.0232
(8) 0.0182	(26) 0.0182	(44) 0.0232	(62) 3.3E-3	(80) 0.0232
(9) 0.0284	(27) 0.0137	(45) 0.0232	(63) 0.0232	(81) 0.0232
(10) 0.0284	(28) 0.0137	(46) 0.0232	(64) 0.0232	(82) 0.0232
(11) 0.0284	(29) 0.0182	(47) 0.0182	(65) 0.0232	(83) 9.7E-3
(12) 0.0284	(30) 0.0182	(48) 0.0182	(66) 0.0232	(84) 9.7E-3
(13) 0.0232	(31) 0.0137	(49) 0.0137	(67) 0.02321	(85) 9.7E-3
(14) 0.0232	(32) 0.0137	(50) 0.0137	(68) 0.02321	(86) 9.7E-3
(15) 0.0182	(33) 0.0137	(51) 0.0182	(69) 0.0182	(87) 9.7E-3
(16) 0.0182	(34) 0.0137	(52) 0.0182	(70) 0.0182	(88) 9.7E-3
(17) 0.0182	(35) 0.0137	(53) 0.0232	(71) 9.7E-3	(89) 9.7E-3
(18) 0.0182	(36) 0.0137	(54) 0.0232	(72) 9.7E-3	(90) 9.7E-3

(181) 3.3E-3	(199) 9.7E-3	(217) 0.0284	(235) 0.0182	(253) 9.7E-3
(182) 3.3E-3	(200) 9.7E-3	(218) 0.0284	(236) 0.0182	(254) 9.7E-3
(183) 0.0232	(201) 0.0137	(219) 0.0232	(237) 0.0232	(255) 6.2E-3
(184) 0.0232	(202) 0.0137	(220) 0.0232	(238) 0.0232	(256) 6.2E-3
(185) 0.0284	(203) 0.0232	(221) 0.0232	(239) 0.0137	(257) 3.3E-3
(186) 0.0284	(204) 0.0232	(222) 0.0232	(240) 0.0137	(258) 3.3E-3
(187) 0.0232	(205) 0.0232	(223) 0.0284	(241) 0.0232	(259) 0.0232
(188) 0.0232	(206) 0.0232	(224) 0.0284	(242) 0.0232	(260) 0.0232
(189) 0.0232	(207) 0.0232	(225) 9.7E-3	(243) 0.0137	(261) 0.0284
(190) 0.0232	(208) 0.0232	(226) 9.7E-3	(244) 0.0137	(262) 0.0284
(191) 0.0232	(209) 0.0284	(227) 9.7E-3	(245) 9.7E-3	(263) 9.7E-3
(192) 0.0232	(210) 0.0284	(228) 9.7E-3	(246) 9.7E-3	(264) 9.7E-3
(193) 0.0232	(211) 9.7E-3	(229) 9.7E-3	(247) 0.0232	(265) 3.3E-3
(194) 0.0232	(212) 9.7E-3	(230) 9.7E-3	(248) 0.0232	(266) 3.3E-3
(195) 0.0137	(213) 0.0284	(231) 0.0232	(249) 3.3E-3	(267) 0.0232
(196) 0.0137	(214) 0.0284	(232) 0.0232	(250) 3.3E-3	(268) 0.0232
(197) 9.7E-3	(215) 0.0284	(233) 0.0182	(251) 0.0232	(269) 3.3E-3
(198) 9.7E-3	(216) 0.0284	(234) 0.0182	(252) 0.0232	(270) 3.3E-3

(91) 0.0137	(109) 6.2E-3	(127) 0.0182	(145) 9.7E-3	(163) 0.0182
(92) 0.0137	(110) 6.2E-3	(128) 0.0182	(146) 9.7E-3	(164) 0.0182
(93) 0.0182	(111) 0.0232	(129) 0.0182	(147) 0.0182	(165) 3.3E-3
(94) 0.0182	(112) 0.0232	(130) 0.0182	(148) 0.0182	(166) 3.3E-3
(95) 0.0182	(113) 0.0182	(131) 0.0182	(149) 0.0182	(167) 6.2E-3
(96) 0.0182	(114) 0.0182	(132) 0.0182	(150) 0.0182	(168) 6.2E-3
(97) 9.7E-3	(115) 0.0137	(133) 0.0232	(151) 3.3E-3	(169) 6.2E-3
(98) 9.7E-3	(116) 0.0137	(134) 0.0232	(152) 3.3E-3	(170) 6.2E-3
(99) 0.0232	(117) 0.0182	(135) 0.0182	(153) 9.7E-3	(171) 6.2E-3
(100) 0.0232	(118) 0.0182	(136) 0.0182	(154) 9.7E-3	(172) 6.2E-3
(101) 0.0182	(119) 0.0182	(137) 0.0182	(155) 0.0182	(173) 9.7E-3
(102) 0.0182	(120) 0.0182	(138) 0.0182	(156) 0.0182	(174) 9.7E-3
(103) 0.0182	(121) 0.0182	(139) 0.0232	(157) 0.0232	(175) 0.0182
(104) 0.0182	(122) 0.0182	(140) 0.0232	(158) 0.0232	(176) 0.0182
(105) 0.0182	(123) 0.0182	(141) 9.7E-3	(159) 0.0232	(177) 0.0182
(106) 0.0182	(124) 0.0182	(142) 9.7E-3	(160) 0.0232	(178) 0.0182
(107) 0.0182	(125) 0.0182	(143) 0.0232	(161) 0.0232	(179) 6.2E-3
(108) 0.0182	(126) 0.0182	(144) 0.0232	(162) 0.0232	(180) 6.2E-3

(271) 9.7E-3	(289) 0.0284	(307) 0.0232	(325) 0.0284	(343) 0.0232
(272) 9.7E-3	(290) 0.0284	(308) 0.0232	(326) 0.0284	(344) 0.0232
(273) 0.0284	(291) 0.0284	(309) 0.0232	(327) 0.0342	(345) 0.0232
(274) 0.0284	(292) 0.0284	(310) 0.0232	(328) 0.0342	(346) 0.0232
(275) 0.0284	(293) 0.0232	(311) 0.0284	(329) 0.0342	(347) 0.0182
(276) 0.0284	(294) 0.0232	(312) 0.0284	(330) 0.0342	(348) 0.0182
(277) 9.9E-3	(295) 0.0137	(313) 0.0284	(331) 0.0284	(349) 0.0182
(278) 9.9E-3	(296) 0.0137	(314) 0.0284	(332) 0.0284	(350) 0.0182
(279) 0.0232	(297) 0.0232	(315) 0.0232	(333) 0.0232	(351) 0.0232
(280) 0.0232	(298) 0.0232	(316) 0.0232	(334) 0.0232	(352) 0.0232
(281) 0.0232	(299) 0.0232	(317) 0.0232	(335) 0.0184	(353) 0.0284
(282) 0.0232	(300) 0.0232	(318) 0.0232	(336) 0.0184	(354) 0.0284
(283) 0.0232	(301) 0.0232	(319) 0.0342	(337) 0.0232	(355) 0.0284
(284) 0.0232	(302) 0.0232	(320) 0.0342	(338) 0.0232	(356) 0.0284
(285) 0.0232	(303) 0.0232	(321) 0.0342	(339) 0.0284	(357) 0.0232
(286) 0.0232	(304) 0.0232	(322) 0.0342	(340) 0.0284	(358) 0.0232
(287) 0.0182	(305) 0.0232	(323) 0.0342	(341) 0.0284	(359) 0.0232
(288) 0.0182	(306) 0.0232	(324) 0.0342	(342) 0.0284	(360) 0.0232

River discharge data at 12-hourly intervals for Station: WSTW
Period : 5

Variable: WSTW06.wstwq12_6 (length = 360)

(1) 0.023	(19) 0.023	(37) 0.034	(55) 0.023	(73) 0.034
(2) 0.023	(20) 0.023	(38) 0.034	(56) 0.023	(74) 0.034
(3) 0.023	(21) 0.023	(39) 0.034	(57) 0.0285	(75) 0.034
(4) 0.023	(22) 0.023	(40) 0.034	(58) 0.0285	(76) 0.034
(5) 0.023	(23) 0.023	(41) 0.0285	(59) 0.0466	(77) 0.04
(6) 0.023	(24) 0.023	(42) 0.0285	(60) 0.0466	(78) 0.04
(7) 0.023	(25) 0.023	(43) 0.028	(61) 0.04	(79) 0.0466
(8) 0.023	(26) 0.023	(44) 0.028	(62) 0.04	(80) 0.0466
(9) 0.023	(27) 0.023	(45) 0.023	(63) 0.043	(81) 0.04
(10) 0.023	(28) 0.023	(46) 0.023	(64) 0.043	(82) 0.04
(11) 0.028	(29) 0.023	(47) 0.023	(65) 0.04	(83) 0.034
(12) 0.028	(30) 0.023	(48) 0.023	(66) 0.04	(84) 0.034
(13) 0.028	(31) 0.023	(49) 0.023	(67) 0.034	(85) 0.0285
(14) 0.028	(32) 0.023	(50) 0.023	(68) 0.034	(86) 0.0285
(15) 0.023	(33) 0.028	(51) 0.0285	(69) 0.0285	(87) 0.06
(16) 0.023	(34) 0.028	(52) 0.0285	(70) 0.0285	(88) 0.06
(17) 0.023	(35) 0.034	(53) 0.0285	(71) 0.0285	(89) 0.068
(18) 0.023	(36) 0.034	(54) 0.0285	(72) 0.0285	(90) 0.068

(91) 0.05	(109) 0.034	(127) 0.0285	(145) 0.068	(163) 0.06
(92) 0.05	(110) 0.034	(128) 0.0285	(146) 0.068	(164) 0.06
(93) 0.06	(111) 0.03	(129) 0.06	(147) 0.076	(165) 0.065
(94) 0.06	(112) 0.03	(130) 0.06	(148) 0.076	(166) 0.065
(95) 0.09	(113) 0.0285	(131) 0.068	(149) 0.08	(167) 0.053
(96) 0.09	(114) 0.0285	(132) 0.068	(150) 0.08	(168) 0.053
(97) 0.0466	(115) 0.053	(133) 0.053	(151) 0.06	(169) 0.0466
(98) 0.0466	(116) 0.053	(134) 0.053	(152) 0.06	(170) 0.0466
(99) 0.0372	(117) 0.053	(135) 0.104	(153) 0.053	(171) 0.04
(100) 0.0372	(118) 0.053	(136) 0.104	(154) 0.053	(172) 0.04
(101) 0.04	(119) 0.04	(137) 0.083	(155) 0.04	(173) 0.034
(102) 0.04	(120) 0.04	(138) 0.083	(156) 0.04	(174) 0.034
(103) 0.04	(121) 0.04	(139) 0.057	(157) 0.04	(175) 0.04
(104) 0.04	(122) 0.04	(140) 0.057	(158) 0.04	(176) 0.04
(105) 0.04	(123) 0.034	(141) 0.076	(159) 0.0466	(177) 0.04
(106) 0.04	(124) 0.034	(142) 0.076	(160) 0.0466	(178) 0.04
(107) 0.034	(125) 0.034	(143) 0.092	(161) 0.043	(179) 0.04
(108) 0.034	(126) 0.034	(144) 0.092	(162) 0.043	(180) 0.04

(181) 0.034	(199) 0.0466	(217) 0.04	(235) 0.04	(253) 0.034
(182) 0.034	(200) 0.0466	(218) 0.04	(236) 0.04	(254) 0.034
(183) 0.053	(201) 0.0466	(219) 0.0466	(237) 0.034	(255) 0.034
(184) 0.053	(202) 0.0466	(220) 0.0466	(238) 0.034	(256) 0.034
(185) 0.083	(203) 0.068	(221) 0.0466	(239) 0.034	(257) 0.0372
(186) 0.083	(204) 0.068	(222) 0.0466	(240) 0.034	(258) 0.0372
(187) 0.076	(205) 0.06	(223) 0.04	(241) 0.034	(259) 0.076
(188) 0.076	(206) 0.06	(224) 0.04	(242) 0.034	(260) 0.076
(189) 0.076	(207) 0.053	(225) 0.034	(243) 0.034	(261) 0.053
(190) 0.076	(208) 0.053	(226) 0.034	(244) 0.034	(262) 0.053
(191) 0.068	(209) 0.0466	(227) 0.034	(245) 0.034	(263) 0.053
(192) 0.068	(210) 0.0466	(228) 0.034	(246) 0.034	(264) 0.053
(193) 0.0466	(211) 0.04	(229) 0.034	(247) 0.034	(265) 0.04
(194) 0.0466	(212) 0.04	(230) 0.034	(248) 0.034	(266) 0.04
(195) 0.0466	(213) 0.04	(231) 0.034	(249) 0.034	(267) 0.0466
(196) 0.0466	(214) 0.04	(232) 0.034	(250) 0.034	(268) 0.0466
(197) 0.0466	(215) 0.04	(233) 0.04	(251) 0.034	(269) 0.06
(198) 0.0466	(216) 0.04	(234) 0.04	(252) 0.034	(270) 0.06

(271) 0.053	(289) 0.034	(307) 0.0285	(325) 9E-3	(343) 6E-3
(272) 0.053	(290) 0.034	(308) 0.0285	(326) 9E-3	(344) 6E-3
(273) 0.053	(291) 0.034	(309) 0.023	(327) 9E-3	(345) 0.0285
(274) 0.053	(292) 0.034	(310) 0.023	(328) 9E-3	(346) 0.0285
(275) 0.0466	(293) 0.034	(311) 0.023	(329) 9E-3	(347) 0.0285
(276) 0.0466	(294) 0.034	(312) 0.023	(330) 9E-3	(348) 0.0285
(277) 0.04	(295) 0.034	(313) 9E-3	(331) 0.0285	(349) 0.023
(278) 0.04	(296) 0.034	(314) 9E-3	(332) 0.0285	(350) 0.023
(279) 0.04	(297) 0.034	(315) 9E-3	(333) 0.0285	(351) 0.018
(280) 0.04	(298) 0.034	(316) 9E-3	(334) 0.0285	(352) 0.018
(281) 0.034	(299) 0.034	(317) 0.023	(335) 6E-3	(353) 0.018
(282) 0.034	(300) 0.034	(318) 0.023	(336) 6E-3	(354) 0.018
(283) 0.034	(301) 0.034	(319) 0.023	(337) 0.04	(355) 0.018
(284) 0.034	(302) 0.034	(320) 0.023	(338) 0.04	(356) 0.018
(285) 0.034	(303) 0.034	(321) 0.023	(339) 0.0285	(357) 0.018
(286) 0.034	(304) 0.034	(322) 0.023	(340) 0.0285	(358) 0.018
(287) 0.034	(305) 0.034	(323) 0.023	(341) 0.023	(359) 0.023
(288) 0.034	(306) 0.034	(324) 0.023	(342) 0.023	(360) 0.023

River discharge data at 12-hourly intervals for Station: WSTW
Period : 6

Variable: KRQM1.var1 (length = 360)

(1)	0.411	(19)	0.054	(37)	0.072	(55)	0.13	(73)	0.021
(2)	0.305	(20)	0.072	(38)	0.054	(56)	0.094	(74)	0.021
(3)	0.32	(21)	0.07	(39)	0.038	(57)	0.072	(75)	0.054
(4)	0.356	(22)	0.094	(40)	0.054	(58)	0.094	(76)	0.061
(5)	0.26	(23)	0.026	(41)	0.038	(59)	0.072	(77)	0.07
(6)	0.26	(24)	0.072	(42)	0.054	(60)	0.094	(78)	0.072
(7)	0.28	(25)	0.038	(43)	0.038	(61)	0.054	(79)	0.07
(8)	0.26	(26)	0.072	(44)	0.054	(62)	0.094	(80)	0.072
(9)	0.181	(27)	0.054	(45)	0.642	(63)	0.13	(81)	0.021
(10)	0.148	(28)	0.094	(46)	0.356	(64)	0.148	(82)	0.017
(11)	0.094	(29)	0.072	(47)	0.28	(65)	0.094	(83)	0.013
(12)	0.054	(30)	0.094	(48)	0.26	(66)	0.094	(84)	0.013
(13)	0.083	(31)	0.117	(49)	0.26	(67)	0.119	(85)	9E-3
(14)	0.054	(32)	0.094	(50)	0.218	(68)	0.072	(86)	9E-3
(15)	0.072	(33)	0.083	(51)	0.148	(69)	0.072	(87)	0.026
(16)	0.054	(34)	0.119	(52)	0.119	(70)	0.072	(88)	0.017
(17)	0.062	(35)	0.146	(53)	0.094	(71)	0.061	(89)	0.017
(18)	0.094	(36)	0.119	(54)	0.218	(72)	0.061	(90)	0.026

(91)	0.026	(109)	0.013	(127)	5E-3	(145)	2E-3	(163)	2E-3
(92)	0.026	(110)	5E-3	(128)	2E-3	(146)	2E-3	(164)	0
(93)	9E-3	(111)	0.013	(129)	2E-3	(147)	2E-3	(165)	1E-3
(94)	9E-3	(112)	0	(130)	2E-3	(148)	2E-3	(166)	0
(95)	2E-3	(113)	9E-3	(131)	5E-3	(149)	5E-3	(167)	2E-3
(96)	3E-3	(114)	0	(132)	2E-3	(150)	2E-3	(168)	2E-3
(97)	7E-3	(115)	7E-3	(133)	2E-3	(151)	0.119	(169)	2E-3
(98)	5E-3	(116)	5E-3	(134)	2E-3	(152)	9E-3	(170)	0
(99)	0.054	(117)	0.017	(135)	2E-3	(153)	9E-3	(171)	0
(100)	0.017	(118)	9E-3	(136)	2E-3	(154)	9E-3	(172)	0
(101)	0.026	(119)	0.023	(137)	2E-3	(155)	5E-3	(173)	0
(102)	0.026	(120)	9E-3	(138)	2E-3	(156)	2E-3	(174)	0
(103)	9E-3	(121)	0.013	(139)	2E-3	(157)	2E-3	(175)	0
(104)	0.026	(122)	2E-3	(140)	2E-3	(158)	2E-3	(176)	0
(105)	0.038	(123)	7E-3	(141)	2E-3	(159)	1E-3	(177)	0
(106)	0.026	(124)	2E-3	(142)	2E-3	(160)	2E-3	(178)	0
(107)	0.018	(125)	5E-3	(143)	2E-3	(161)	0.094	(179)	0
(108)	0.026	(126)	2E-3	(144)	2E-3	(162)	0	(180)	0

(181)	0	(199)	0.083	(217)	1.797	(235)	0.046	(253)	0.054
(182)	0	(200)	9E-3	(218)	0.537	(236)	0.054	(254)	0.026
(183)	0	(201)	0.046	(219)	0.28	(237)	0.054	(255)	0.054
(184)	0	(202)	5E-3	(220)	0.218	(238)	0.054	(256)	0.038
(185)	0	(203)	0.038	(221)	0.181	(239)	0.064	(257)	0.046
(186)	2E-3	(204)	5E-3	(222)	0.148	(240)	0.054	(258)	0.094
(187)	2E-3	(205)	0.046	(223)	0.119	(241)	0.054	(259)	0.106
(188)	2E-3	(206)	5E-3	(224)	0.119	(242)	0.038	(260)	0.054
(189)	2E-3	(207)	3E-3	(225)	0.119	(243)	0.054	(261)	0.026
(190)	5E-3	(208)	2E-3	(226)	0.094	(244)	0.072	(262)	0.017
(191)	3E-3	(209)	9E-3	(227)	0.094	(245)	0.064	(263)	0.026
(192)	5E-3	(210)	2E-3	(228)	0.072	(246)	0.411	(264)	9E-3
(193)	2E-3	(211)	7E-3	(229)	0.094	(247)	0.094	(265)	3E-3
(194)	2E-3	(212)	2E-3	(230)	0.094	(248)	0.148	(266)	5E-3
(195)	2E-3	(213)	5E-3	(231)	0.094	(249)	0.305	(267)	9E-3
(196)	2E-3	(214)	2E-3	(232)	0.072	(250)	0.072	(268)	9E-3
(197)	0	(215)	7E-3	(233)	0.072	(251)	0.094	(269)	9E-3
(198)	2E-3	(216)	9E-3	(234)	0.038	(252)	0.038	(270)	9E-3

(271)	0.017	(289)	0.055	(307)	0.218	(325)	0.072	(343)	9.19
(272)	9E-3	(290)	0.038	(308)	0.148	(326)	0.181	(344)	10.55
(273)	9E-3	(291)	0.038	(309)	0.094	(327)	0.181	(345)	6.427
(274)	9E-3	(292)	0.054	(310)	0.054	(328)	1.035	(346)	7.858
(275)	0.054	(293)	0.046	(311)	0.054	(329)	0.471	(347)	7.278
(276)	9E-3	(294)	0.054	(312)	0.054	(330)	0.356	(348)	7.456
(277)	0.026	(295)	0.026	(313)	0.072	(331)	0.26	(349)	6.222
(278)	9E-3	(296)	0.054	(314)	0.054	(332)	0.218	(350)	6.636
(279)	0.026	(297)	0.054	(315)	0.054	(333)	0.181	(351)	6.427
(280)	0.017	(298)	0.038	(316)	0.054	(334)	0.305	(352)	4.681
(281)	0.032	(299)	0.054	(317)	0.356	(335)	0.218	(353)	3.981
(282)	0.017	(300)	0.054	(318)	0.119	(336)	0.181	(354)	3.488
(283)	0.038	(301)	0.017	(319)	0.094	(337)	0.218	(355)	3.175
(284)	0.026	(302)	0.054	(320)	0.094	(338)	0.471	(356)	2.873
(285)	0.218	(303)	7E-3	(321)	0.072	(339)	4.325	(357)	2.585
(286)	0.038	(304)	9E-3	(322)	0.072	(340)	1.34	(358)	2.446
(287)	0.054	(305)	2E-3	(323)	0.119	(341)	1.235	(359)	2.309
(288)	0.054	(306)	5E-3	(324)	0.054	(342)	1.678	(360)	2.176

River discharge data at 12-hourly intervals for Station: 14B
Period : 1

Variable: KROM2.var1 (length = 360)

(1)	1.235	(19)	0.684	(37)	0.471	(55)	0.411	(73)	0.305
(2)	1.035	(20)	0.684	(38)	0.537	(56)	0.411	(74)	1.235
(3)	1.035	(21)	0.684	(39)	0.471	(57)	0.411	(75)	0.765
(4)	0.941	(22)	0.608	(40)	0.471	(58)	0.356	(76)	0.687
(5)	0.941	(23)	0.608	(41)	0.411	(59)	0.356	(77)	1.235
(6)	0.851	(24)	0.608	(42)	0.411	(60)	0.356	(78)	10.55
(7)	0.851	(25)	0.765	(43)	0.411	(61)	0.356	(79)	4.235
(8)	0.851	(26)	0.765	(44)	0.411	(62)	0.305	(80)	2.728
(9)	1.035	(27)	0.765	(45)	0.411	(63)	0.356	(81)	2.309
(10)	0.851	(28)	0.765	(46)	0.471	(64)	0.305	(82)	1.797
(11)	0.765	(29)	0.608	(47)	0.411	(65)	0.305	(83)	1.562
(12)	0.765	(30)	0.537	(48)	0.411	(66)	0.305	(84)	1.449
(13)	0.684	(31)	0.537	(49)	0.411	(67)	0.305	(85)	1.235
(14)	0.684	(32)	0.471	(50)	0.411	(68)	0.305	(86)	1.235
(15)	0.684	(33)	0.411	(51)	0.411	(69)	0.305	(87)	1.133
(16)	0.684	(34)	0.411	(52)	0.356	(70)	0.305	(88)	1.133
(17)	0.684	(35)	0.471	(53)	0.356	(71)	0.305	(89)	1.035
(18)	0.684	(36)	0.411	(54)	0.411	(72)	0.305	(90)	1.035

(181)	0.684	(199)	0.537	(217)	1.92	(235)	1.133	(253)	0.765
(182)	0.608	(200)	0.471	(218)	4.502	(236)	1.095	(254)	0.765
(183)	0.608	(201)	0.537	(219)	3.981	(237)	1.035	(255)	0.684
(184)	0.608	(202)	0.537	(220)	2.728	(238)	1.035	(256)	0.684
(185)	0.608	(203)	0.537	(221)	2.309	(239)	1.035	(257)	0.684
(186)	0.608	(204)	0.684	(222)	2.047	(240)	1.035	(258)	0.608
(187)	0.608	(205)	0.608	(223)	2.047	(241)	0.941	(259)	0.684
(188)	0.608	(206)	0.537	(224)	1.92	(242)	0.851	(260)	0.684
(189)	0.608	(207)	0.851	(225)	1.797	(243)	0.851	(261)	0.684
(190)	0.537	(208)	1.035	(226)	1.678	(244)	0.851	(262)	0.608
(191)	0.608	(209)	1.678	(227)	1.562	(245)	0.851	(263)	0.765
(192)	0.537	(210)	3.33	(228)	1.449	(246)	0.765	(264)	0.851
(193)	0.537	(211)	4.502	(229)	1.34	(247)	0.765	(265)	0.851
(194)	0.471	(212)	2.873	(230)	1.34	(248)	0.684	(266)	0.765
(195)	0.537	(213)	4.325	(231)	1.34	(249)	0.684	(267)	0.684
(196)	0.471	(214)	2.728	(232)	1.235	(250)	0.684	(268)	0.684
(197)	0.471	(215)	2.176	(233)	1.235	(251)	0.765	(269)	0.851
(198)	0.537	(216)	1.92	(234)	1.133	(252)	0.684	(270)	2.047

(91)	0.941	(109)	1.678	(127)	0.851	(145)	1.449	(163)	0.851
(92)	0.851	(110)	1.562	(128)	0.851	(146)	1.797	(164)	0.851
(93)	0.851	(111)	1.449	(129)	0.851	(147)	2.176	(165)	0.851
(94)	0.851	(112)	1.449	(130)	0.765	(148)	8.28	(166)	0.851
(95)	0.851	(113)	1.678	(131)	0.765	(149)	2.047	(167)	0.851
(96)	0.765	(114)	1.678	(132)	0.765	(150)	1.678	(168)	0.765
(97)	0.765	(115)	1.562	(133)	0.765	(151)	1.678	(169)	0.765
(98)	0.684	(116)	1.449	(134)	0.765	(152)	1.449	(170)	0.765
(99)	0.684	(117)	1.449	(135)	0.765	(153)	1.34	(171)	0.765
(100)	0.684	(118)	1.235	(136)	0.765	(154)	1.235	(172)	0.765
(101)	1.035	(119)	1.235	(137)	0.684	(155)	1.133	(173)	0.684
(102)	1.133	(120)	1.235	(138)	0.684	(156)	1.035	(174)	0.684
(103)	1.035	(121)	1.235	(139)	0.684	(157)	1.0356	(175)	0.684
(104)	1.133	(122)	1.133	(140)	0.684	(158)	0.941	(176)	0.684
(105)	3.981	(123)	1.035	(141)	0.684	(159)	0.941	(177)	0.684
(106)	2.585	(124)	1.035	(142)	0.608	(160)	0.941	(178)	0.684
(107)	2.176	(125)	1.035	(143)	0.608	(161)	0.941	(179)	0.684
(108)	1.92	(126)	0.941	(144)	0.608	(162)	0.851	(180)	0.608

(271)	2.176	(289)	0.851	(307)	0.411	(325)	0.218	(343)	0.026
(272)	1.797	(290)	0.851	(308)	0.411	(326)	0.218	(344)	0.094
(273)	2.047	(291)	0.851	(309)	0.411	(327)	0.218	(345)	0.017
(274)	2.176	(292)	0.765	(310)	0.411	(328)	0.218	(346)	0.072
(275)	2.047	(293)	0.765	(311)	0.411	(329)	0.218	(347)	0.017
(276)	1.678	(294)	0.765	(312)	0.356	(330)	0.181	(348)	0.054
(277)	1.562	(295)	0.684	(313)	0.356	(331)	0.218	(349)	9E-3
(278)	1.449	(296)	0.608	(314)	0.305	(332)	0.181	(350)	0.026
(279)	1.34	(297)	0.608	(315)	0.305	(333)	0.218	(351)	5E-3
(280)	1.235	(298)	0.608	(316)	0.356	(334)	0.148	(352)	0.026
(281)	1.08	(299)	0.608	(317)	0.411	(335)	0.119	(353)	9E-3
(282)	1.035	(300)	0.608	(318)	0.356	(336)	0.072	(354)	0.026
(283)	1.035	(301)	0.608	(319)	0.356	(337)	0.094	(355)	0.017
(284)	1.035	(302)	0.537	(320)	0.356	(338)	0.181	(356)	9E-3
(285)	0.941	(303)	0.537	(321)	0.356	(339)	0.148	(357)	0.017
(286)	0.941	(304)	0.537	(322)	0.305	(340)	0.181	(358)	5E-3
(287)	0.941	(305)	0.471	(323)	0.26	(341)	0.054	(359)	9E-3
(288)	0.851	(306)	0.471	(324)	0.218	(342)	0.148	(360)	5E-3

River discharge data at 12-hourly intervals for Station: 14B
Period : 2

Variable: KROM3.var1 (length = 360)

(1) 0.017	(19) 1.3E-3	(37) 0.26	(55) 0.054	(73) 0.608
(2) 0.017	(20) 5E-3	(38) 0.218	(56) 0.038	(74) 0.608
(3) 0.026	(21) 0.017	(39) 0.22	(57) 0.054	(75) 0.5
(4) 0.026	(22) 5E-3	(40) 0.218	(58) 0.038	(76) 0.537
(5) 0.119	(23) 5E-3	(41) 0.22	(59) 0.119	(77) 0.471
(6) 0.094	(24) 5E-3	(42) 0.218	(60) 0.537	(78) 0.356
(7) 0.148	(25) 9E-3	(43) 0.22	(61) 0.684	(79) 0.356
(8) 0.072	(26) 5E-3	(44) 0.181	(62) 0.684	(80) 0.305
(9) 0.026	(27) 0.054	(45) 0.148	(63) 0.851	(81) 0.305
(10) 0.026	(28) 0.072	(46) 0.094	(64) 0.851	(82) 0.26
(11) 0.054	(29) 0.072	(47) 0.054	(65) 0.851	(83) 0.26
(12) 0.038	(30) 0.038	(48) 0.054	(66) 0.851	(84) 0.218
(13) 0.054	(31) 0.148	(49) 0.054	(67) 0.851	(85) 0.218
(14) 0.038	(32) 0.218	(50) 0.054	(68) 0.765	(86) 0.181
(15) 0.054	(33) 0.44	(51) 0.038	(69) 0.684	(87) 0.218
(16) 0.038	(34) 0.411	(52) 0.038	(70) 0.684	(88) 0.218
(17) 0.054	(35) 0.411	(53) 0.038	(71) 0.684	(89) 0.119
(18) 0.026	(36) 0.305	(54) 0.038	(72) 0.608	(90) 0.094

(181) 0.119	(199) 0.072	(217) 0.218	(235) 0.941	(253) 0.26
(182) 0.094	(200) 0.038	(218) 0.218	(236) 1.133	(254) 0.181
(183) 0.119	(201) 0.072	(219) 0.218	(237) 0.851	(255) 0.218
(184) 0.094	(202) 0.038	(220) 0.181	(238) 0.684	(256) 0.148
(185) 0.119	(203) 0.054	(221) 0.148	(239) 0.684	(257) 0.134
(186) 0.094	(204) 0.026	(222) 0.119	(240) 0.608	(258) 0.119
(187) 0.072	(205) 0.305	(223) 0.094	(241) 0.537	(259) 0.119
(188) 0.054	(206) 0.305	(224) 0.094	(242) 0.537	(260) 0.094
(189) 0.094	(207) 0.851	(225) 0.094	(243) 0.471	(261) 0.094
(190) 0.072	(208) 1.035	(226) 0.072	(244) 0.411	(262) 0.094
(191) 0.094	(209) 1.562	(227) 0.094	(245) 0.411	(263) 0.119
(192) 0.072	(210) 1.449	(228) 0.054	(246) 0.411	(264) 0.094
(193) 0.072	(211) 1.035	(229) 0.119	(247) 0.411	(265) 0.094
(194) 0.054	(212) 0.851	(230) 0.119	(248) 0.26	(266) 0.094
(195) 0.072	(213) 0.684	(231) 0.148	(249) 0.261	(267) 0.094
(196) 0.054	(214) 0.608	(232) 0.851	(250) 0.26	(268) 0.072
(197) 0.072	(215) 0.305	(233) 0.684	(251) 0.26	(269) 0.094
(198) 0.054	(216) 0.26	(234) 0.765	(252) 0.218	(270) 0.072

(91) 0.119	(109) 0.038	(127) 0.218	(145) 0.148	(163) 0.411
(92) 0.181	(110) 0.038	(128) 0.148	(146) 0.119	(164) 0.305
(93) 0.148	(111) 0.054	(129) 0.181	(147) 0.148	(165) 0.305
(94) 0.148	(112) 0.072	(130) 0.148	(148) 0.148	(166) 0.218
(95) 0.119	(113) 0.148	(131) 0.218	(149) 0.119	(167) 0.181
(96) 0.094	(114) 0.218	(132) 0.181	(150) 0.119	(168) 0.148
(97) 0.094	(115) 0.218	(133) 0.181	(151) 0.148	(169) 0.181
(98) 0.148	(116) 0.148	(134) 0.119	(152) 0.094	(170) 0.148
(99) 0.218	(117) 0.196	(135) 0.148	(153) 0.119	(171) 0.148
(100) 0.218	(118) 0.148	(136) 0.119	(154) 0.094	(172) 0.119
(101) 0.218	(119) 0.218	(137) 0.148	(155) 0.119	(173) 0.119
(102) 0.218	(120) 0.411	(138) 0.148	(156) 0.094	(174) 0.094
(103) 0.134	(121) 0.411	(139) 0.181	(157) 0.119	(175) 0.148
(104) 0.094	(122) 0.411	(140) 0.148	(158) 0.094	(176) 0.119
(105) 0.094	(123) 0.411	(141) 0.148	(159) 0.094	(177) 0.119
(106) 0.072	(124) 0.26	(142) 0.094	(160) 0.072	(178) 0.094
(107) 0.072	(125) 0.305	(143) 0.148	(161) 0.305	(179) 0.119
(108) 0.038	(126) 0.26	(144) 0.119	(162) 0.411	(180) 0.094

(271) 0.072	(289) 0.181	(307) 0.181	(325) 0.411	(343) 0.26
(272) 0.148	(290) 0.148	(308) 0.181	(326) 0.411	(344) 0.26
(273) 0.094	(291) 0.181	(309) 0.22	(327) 0.411	(345) 0.26
(274) 0.094	(292) 0.148	(310) 0.537	(328) 0.411	(346) 0.218
(275) 0.148	(293) 0.181	(311) 1.235	(329) 0.411	(347) 0.218
(276) 0.094	(294) 0.148	(312) 1.133	(330) 0.411	(348) 0.218
(277) 0.094	(295) 0.148	(313) 0.765	(331) 0.356	(349) 0.218
(278) 0.411	(296) 0.119	(314) 0.608	(332) 0.305	(350) 0.218
(279) 0.608	(297) 0.148	(315) 0.471	(333) 0.305	(351) 0.218
(280) 0.305	(298) 0.119	(316) 0.411	(334) 0.305	(352) 0.218
(281) 0.411	(299) 0.094	(317) 0.411	(335) 0.26	(353) 0.218
(282) 0.26	(300) 0.094	(318) 0.305	(336) 0.305	(354) 0.218
(283) 0.305	(301) 0.119	(319) 0.305	(337) 0.305	(355) 0.218
(284) 0.181	(302) 0.119	(320) 0.356	(338) 0.305	(356) 0.218
(285) 0.218	(303) 0.119	(321) 0.684	(339) 0.305	(357) 0.218
(286) 0.148	(304) 0.094	(322) 0.471	(340) 0.26	(358) 0.218
(287) 0.181	(305) 0.094	(323) 0.411	(341) 0.3	(359) 0.218
(288) 0.148	(306) 0.094	(324) 0.411	(342) 0.26	(360) 0.181

River discharge data at 12-hourly intervals for Station: 14B
Period : 3

Variable: KRDM4.var1 (length = 344)

(1)	0.218	(19)	0.537	(37)	0.356	(55)	3.488	(73)	2.176
(2)	0.181	(20)	0.684	(38)	0.411	(56)	2.728	(74)	2.176
(3)	0.181	(21)	0.941	(39)	0.411	(57)	2.446	(75)	2.047
(4)	0.218	(22)	0.851	(40)	0.411	(58)	10.55	(76)	1.92
(5)	0.218	(23)	0.608	(41)	0.356	(59)	4.681	(77)	1.92
(6)	0.181	(24)	0.608	(42)	0.356	(60)	3.488	(78)	1.562
(7)	0.218	(25)	0.537	(43)	0.356	(61)	3.022	(79)	1.34
(8)	0.684	(26)	0.537	(44)	0.356	(62)	2.446	(80)	1.235
(9)	3.022	(27)	0.471	(45)	0.356	(63)	2.176	(81)	1.235
(10)	1.92	(28)	0.411	(46)	0.356	(64)	2.047	(82)	1.235
(11)	1.34	(29)	0.411	(47)	0.356	(65)	2.728	(83)	1.235
(12)	2.176	(30)	0.411	(48)	0.356	(66)	2.585	(84)	1.133
(13)	0.851	(31)	0.411	(49)	2.047	(67)	2.446	(85)	1.133
(14)	1.797	(32)	0.411	(50)	14.32	(68)	2.309	(86)	1.035
(15)	0.684	(33)	0.356	(51)	3.981	(69)	2.176	(87)	1.035
(16)	0.608	(34)	0.356	(52)	33	(70)	2.176	(88)	1.035
(17)	0.608	(35)	0.356	(53)	6.222	(71)	2.309	(89)	0.941
(18)	0.537	(36)	0.356	(54)	4.325	(72)	2.176	(90)	0.851

(181)	1.449	(199)	1.235	(217)	0.941	(235)	1.34	(253)	0.765
(182)	1.34	(200)	1.133	(218)	0.851	(236)	1.235	(254)	0.684
(183)	1.34	(201)	1.133	(219)	0.765	(237)	1.133	(255)	0.684
(184)	1.235	(202)	1.035	(220)	0.765	(238)	1.035	(256)	0.684
(185)	1.235	(203)	1.035	(221)	0.765	(239)	0.941	(257)	0.765
(186)	1.235	(204)	1.035	(222)	0.765	(240)	0.851	(258)	1.133
(187)	1.34	(205)	0.941	(223)	0.765	(241)	0.851	(259)	0.941
(188)	1.235	(206)	0.941	(224)	0.765	(242)	0.851	(260)	0.941
(189)	1.133	(207)	0.941	(225)	0.765	(243)	0.765	(261)	0.851
(190)	1.133	(208)	0.941	(226)	0.684	(244)	0.684	(262)	0.851
(191)	1.13	(209)	0.941	(227)	0.684	(245)	0.684	(263)	0.851
(192)	1.035	(210)	0.941	(228)	0.684	(246)	0.684	(264)	0.851
(193)	1.235	(211)	0.851	(229)	0.684	(247)	0.684	(265)	0.765
(194)	1.92	(212)	0.851	(230)	0.684	(248)	0.684	(266)	0.765
(195)	1.449	(213)	0.851	(231)	0.684	(249)	1.035	(267)	0.765
(196)	1.34	(214)	0.851	(232)	0.684	(250)	0.851	(268)	0.684
(197)	1.235	(215)	0.851	(233)	1.449	(251)	0.851	(269)	0.684
(198)	1.235	(216)	0.851	(234)	1.92	(252)	0.765	(270)	0.765

(91)	0.851	(109)	5.82	(127)	1.34	(145)	0.851	(163)	2.728
(92)	0.851	(110)	3.814	(128)	1.235	(146)	0.765	(164)	2.309
(93)	0.78	(111)	3.17	(129)	1.235	(147)	0.765	(165)	2.047
(94)	0.851	(112)	2.873	(130)	1.235	(148)	0.765	(166)	1.92
(95)	0.851	(113)	2.585	(131)	1.235	(149)	0.765	(167)	3.981
(96)	0.765	(114)	2.309	(132)	1.133	(150)	0.765	(168)	3.814
(97)	6.02	(115).	2.31	(133)	1.133	(151)	1.797	(169)	3.022
(98)	11.29	(116)	2.176	(134)	1.035	(152)	1.235	(170)	2.728
(99)	4.86	(117)	2.047	(135)	1.035	(153)	1.035	(171)	2.446
(100)	3.33	(118)	1.92	(136)	1.035	(154)	2.728	(172)	2.176
(101)	2.72	(119)	1.797	(137)	1.035	(155)	2.309	(173)	1.92
(102)	2.46	(120)	1.678	(138)	1.035	(156)	1.92	(174)	1.797
(103)	9.65	(121)	1.59	(139)	1.035	(157)	1.678	(175)	1.678
(104)	4.502	(122)	1.678	(140)	0.941	(158)	1.449	(176)	1.678
(105)	3.488	(123)	1.56	(141)	0.941	(159)	1.34	(177)	1.562
(106)	3.022	(124)	1.449	(142)	0.941	(160)	1.235	(178)	1.562
(107)	2.728	(125)	1.45	(143)	0.941	(161)	2.873	(179)	1.562
(108)	5.819	(126)	1.34	(144)	0.851	(162)	3.814	(180)	1.449

(271)	0.765	(289)	0.411	(307)	0.26	(325)	0.305	(343)	0.148
(272)	0.765	(290)	0.411	(308)	0.26	(326)	0.26	(344)	0.119
(273)	0.765	(291)	0.411	(309)	0.305	(327)	0.218		
(274)	0.684	(292)	0.356	(310)	0.305	(328)	0.181		
(275)	0.608	(293)	0.305	(311)	0.305	(329)	0.181		
(276)	0.608	(294)	0.356	(312)	0.26	(330)	0.148		
(277)	0.608	(295)	0.411	(313)	0.26	(331)	0.3		
(278)	0.608	(296)	0.356	(314)	0.218	(332)	0.26		
(279)	0.608	(297)	0.411	(315)	0.26	(333)	0.26		
(280)	0.608	(298)	0.411	(316)	0.26	(334)	0.148		
(281)	0.608	(299)	0.411	(317)	0.305	(335)	0.181		
(282)	0.608	(300)	0.471	(318)	0.305	(336)	0.119		
(283)	0.608	(301)	0.537	(319)	0.305	(337)	0.148		
(284)	0.537	(302)	0.411	(320)	0.305	(338)	0.119		
(285)	0.537	(303)	0.411	(321)	0.26	(339)	0.119		
(286)	0.537	(304)	0.411	(322)	0.26	(340)	0.119		
(287)	0.539	(305)	0.411	(323)	0.305	(341)	0.148		
(288)	0.537	(306)	0.26	(324)	0.305	(342)	0.119		

River discharge data at 12-hourly intervals for Station: 14B
Period : 4

Variable: KROM5.vari   (length = 360)

(1) 0.238	(19) 0.054	(37) 0	(55) 0.054	(73) 9E-3
(2) 0.218	(20) 9E-3	(38) 2E-3	(56) 0.072	(74) 2E-3
(3) 0.181	(21) 0.015	(39) 0	(57) 0.061	(75) 9E-3
(4) 0.148	(22) 2E-3	(40) 2E-3	(58) 0.026	(76) 2E-3
(5) 0.148	(23) 0.017	(41) 9E-3	(59) 0.054	(77) 0.015
(6) 0.119	(24) 2E-3	(42) 2E-3	(60) 2E-3	(78) 9E-3
(7) 0.148	(25) 0.015	(43) 2E-3	(61) 0.015	(79) 0.017
(8) 0.148	(26) 2E-3	(44) 2E-3	(62) 2E-3	(80) 9E-3
(9) 0.181	(27) 2E-3	(45) 9E-3	(63) 0.015	(81) 0.015
(10) 0.181	(28) 2E-3	(46) 2E-3	(64) 9E-3	(82) 2E-3
(11) 0.148	(29) 9E-3	(47) 9E-3	(65) 0.015	(83) 2E-3
(12) 0.094	(30) 2E-3	(48) 2E-3	(66) 0.026	(84) 2E-3
(13) 0.119	(31) 0.015	(49) 2E-3	(67) 9E-3	(85) 0.015
(14) 0.054	(32) 2E-3	(50) 0	(68) 0.017	(86) 2E-3
(15) 0.061	(33) 2E-3	(51) 0.026	(69) 0.015	(87) 0.017
(16) 0.072	(34) 2E-3	(52) 0.038	(70) 9E-3	(88) 5E-3
(17) 0.072	(35) 0	(53) 0.072	(71) 0.012	(89) 9E-3
(18) 0.054	(36) 2E-3	(54) 0.017	(72) 9E-3	(90) 0.017

(91) 9E-3	(109) 0.026	(127) 2E-3	(145) 0.026	(163) 0.017
(92) 2E-3	(110) 9E-3	(128) 2E-3	(146) 9E-3	(164) 9E-3
(93) 0.015	(111) 0.038	(129) 2E-3	(147) 0.026	(165) 9E-3
(94) 0	(112) 0.017	(130) 2E-3	(148) 9E-3	(166) 9E-3
(95) 0.015	(113) 9E-3	(131) 2E-3	(149) 0.015	(167) 9E-3
(96) 2E-3	(114) 2E-3	(132) 2E-3	(150) 0.017	(168) 9E-3
(97) 2E-3	(115) 0.017	(133) 9E-3	(151) 9E-3	(169) 0.017
(98) 2E-3	(116) 2E-3	(134) 2E-3	(152) 9E-3	(170) 0.01
(99) 2E-3	(117) 2E-3	(135) 0.015	(153) 0.013	(171) 0.015
(100) 2E-3	(118) 2E-3	(136) 2E-3	(154) 9E-3	(172) 0.017
(101) 2E-3	(119) 2E-3	(137) 2E-3	(155) 0.015	(173) 2E-3
(102) 2E-3	(120) 2E-3	(138) 2E-3	(156) 9E-3	(174) 0.015
(103) 0.017	(121) 9E-3	(139) 0.072	(157) 9E-3	(175) 2E-3
(104) 2E-3	(122) 0.038	(140) 0.941	(158) 9E-3	(176) 2E-3
(105) 2E-3	(123) 9E-3	(141) 0.026	(159) 0.017	(177) 9E-3
(106) 0	(124) 9E-3	(142) 0.054	(160) 5E-3	(178) 2E-3
(107) 2E-3	(125) 2E-3	(143) 0.017	(161) 0.017	(179) 0.015
(108) 0.026	(126) 2E-3	(144) 0.038	(162) 9E-3	(180) 0.01

(181) 0	(199) 0	(217) 0.038	(235) 2E-3	(253) 2E-3
(182) 0.015	(200) 0	(218) 0.04	(236) 2E-3	(254) 2E-3
(183) 0	(201) 0	(219) 0.017	(237) 2E-3	(255) 0.017
(184) 0	(202) 0	(220) 0.02	(238) 2E-3	(256) 2E-3
(185) 0	(203) 0	(221) 2E-3	(239) 2E-3	(257) 0.054
(186) 0	(204) 0	(222) 2E-3	(240) 2E-3	(258) 0.017
(187) 0	(205) 0	(223) 2E-3	(241) 2E-3	(259) 0.181
(188) 0	(206) 0	(224) 2E-3	(242) 2E-3	(260) 0.054
(189) 3E-3	(207) 0	(225) 2E-3	(243) 2E-3	(261) 0.119
(190) 0	(208) 0	(226) 3E-3	(244) 2E-3	(262) 0.181
(191) 2E-3	(209) 0	(227) 2E-3	(245) 2E-3	(263) 0.094
(192) 0	(210) 0	(228) 2E-3	(246) 2E-3	(264) 0.119
(193) 0	(211) 0.017	(229) 2E-3	(247) 2E-3	(265) 0.038
(194) 0	(212) 0.018	(230) 2E-3	(248) 2E-3	(266) 0.094
(195) 0	(213) 0.017	(231) 2E-3	(249) 2E-3	(267) 0.054
(196) 0	(214) 0.015	(232) 3E-3	(250) 2E-3	(268) 0.038
(197) 0	(215) 2E-3	(233) 2E-3	(251) 2E-3	(269) 0.038
(198) 0	(216) 5E-3	(234) 2E-3	(252) 2E-3	(270) 0.054

(271) 5E-3	(289) 0.26	(307) 0	(325) 0	(343) 0
(272) 0.038	(290) 0.85	(308) 0.3	(326) 0.3	(344) 0.3
(273) 0.148	(291) 0.218	(309) 0	(327) 0	(345) 0
(274) 5E-3	(292) 0.32	(310) 0.3	(328) 0.53	(346) 0.3
(275) 0.119	(293) 0.218	(311) 0	(329) 0	(347) 0
(276) 0.148	(294) 0.25	(312) 0.258	(330) 0.2	(348) 0.3
(277) 0.054	(295) 0	(313) 0	(331) 0	(349) 0
(278) 0.119	(296) 0.25	(314) 0.3	(332) 0.6	(350) 0.3
(279) 0.094	(297) 0	(315) 0	(333) 0	(351) 0
(280) 0.055	(298) 0.3	(316) 0.3	(334) 0.6	(352) 0.3
(281) 0.094	(299) 0	(317) 0	(335) 0	(353) 0
(282) 0.098	(300) 0.3	(318) 0.3	(336) 0	(354) 0.3
(283) 0.094	(301) 0	(319) 0	(337) 0	(355) 0
(284) 0.09	(302) 0.3	(320) 0.3	(338) 0.3	(356) 0.3
(285) 0.094	(303) 0	(321) 0	(339) 0	(357) 0
(286) 0.095	(304) 0.3	(322) 0.3	(340) 0.3	(358) 0.3
(287) 0.684	(305) 0	(323) 0	(341) 0	(359) 0
(288) 0.098	(306) 0.3	(324) 0.3	(342) 0.3	(360) 0.3

River discharge data at 12-hourly intervals for Station: 14B
Period : 5

Variable: KROM6.var1 (length = 360)

(1) 0.148	(19) 2.05	(37) 0.537	(55) 1.562	(73) 0.765
(2) 0.148	(20) 1.133	(38) 0.471	(56) 0.684	(74) 1.34
(3) 0.218	(21) 1.133	(39) 0.537	(57) 1.235	(75) 1.035
(4) 0.218	(22) 1.035	(40) 0.471	(58) 2.873	(76) 1.235
(5) 0.305	(23) 0.941	(41) 0.471	(59) 1.562	(77) 1.797
(6) 0.305	(24) 0.765	(42) 0.411	(60) 1.235	(78) 3.488
(7) 0.305	(25) 0.765	(43) 0.411	(61) 1.035	(79) 1.92
(8) 0.305	(26) 0.684	(44) 0.411	(62) 1.449	(80) 1.678
(9) 0.851	(27) 0.684	(45) 0.411	(63) 1.235	(81) 1.449
(10) 0.608	(28) 0.684	(46) 0.471	(64) 1.035	(82) 1.235
(11) 1.562	(29) 0.608	(47) 0.411	(65) 0.941	(83) 1.133
(12) 1.34	(30) 0.608	(48) 0.411	(66) 0.941	(84) 1.035
(13) 1.235	(31) 0.608	(49) 0.537	(67) 0.851	(85) 1.035
(14) 0.941	(32) 0.537	(50) 2.047	(68) 0.851	(86) 0.941
(15) 1.133	(33) 0.537	(51) 0.941	(69) 0.851	(87) 2.585
(16) 0.851	(34) 0.471	(52) 0.765	(70) 0.765	(88) 1.562
(17) 0.684	(35) 0.537	(53) 1.678	(71) 0.684	(89) 1.449
(18) 2.446	(36) 0.471	(54) 0.608	(72) 0.684	(90) 1.34

(181) 0.851	(199) 1.797	(217) 1.449	(235) 1.133	(253) 0.941
(182) 2.176	(200) 1.678	(218) 1.449	(236) 1.133	(254) 0.941
(183) 3.448	(201) 1.678	(219) 1.449	(237) 1.133	(255) 0.941
(184) 5.428	(202) 2.728	(220) 1.34	(238) 1.035	(256) 0.851
(185) 5.237	(203) 5.428	(221) 1.34	(239) 0.941	(257) 0.851
(186) 5.049	(204) 4.152	(222) 1.235	(240) 0.941	(258) 1.562
(187) 5.049	(205) 3.175	(223) 1.235	(241) 0.941	(259) 2.176
(188) 3.814	(206) 2.728	(224) 1.235	(242) 0.941	(260) 2.176
(189) 2.873	(207) 2.585	(225) 1.235	(243) 0.851	(261) 1.92
(190) 2.728	(208) 2.309	(226) 1.235	(244) 0.851	(262) 1.678
(191) 2.728	(209) 2.176	(227) 1.235	(245) 0.851	(263) 1.449
(192) 2.585	(210) 2.047	(228) 1.235	(246) 0.765	(264) 1.34
(193) 2.446	(211) 2.047	(229) 1.133	(247) 0.765	(265) 1.235
(194) 2.309	(212) 1.92	(230) 1.133	(248) 0.765	(266) 1.235
(195) 2.309	(213) 1.797	(231) 1.035	(249) 0.851	(267) 1.678
(196) 2.176	(214) 1.797	(232) 1.036	(250) 0.851	(268) 2.728
(197) 2.047	(215) 1.562	(233) 1.035	(251) 0.851	(269) 2.585
(198) 1.92	(216) 1.449	(234) 1.133	(252) 1.035	(270) 2.176

(91) 1.235	(109) 0.684	(127) 0.608	(145) 2.95	(163) 1.797
(92) 1.235	(110) 0.684	(128) 0.608	(146) 2.728	(164) 1.92
(93) 2.176	(111) 0.941	(129) 0.941	(147) 3.488	(165) 1.797
(94) 2.728	(112) 1.235	(130) 1.34	(148) 3.814	(166) 1.562
(95) 2.446	(113) 1.035	(131) 1.449	(149) 3.175	(167) 1.449
(96) 2.309	(114) 0.941	(132) 1.449	(150) 2.873	(168) 1.449
(97) 2.176	(115) 1.678	(133) 1.678	(151) 2.585	(169) 1.34
(98) 1.678	(116) 1.449	(134) 1.678	(152) 2.309	(170) 1.235
(99) 1.562	(117) 1.34	(135) 1.92	(153) 2.047	(171) 1.235
(100) 1.449	(118) 1.133	(136) 1.92	(154) 1.92	(172) 1.133
(101) 1.34	(119) 1.035	(137) 2.176	(155) 1.797	(173) 1.133
(102) 1.235	(120) 1.035	(138) 2.2	(156) 1.562	(174) 1.035
(103) 1.035	(121) 0.941	(139) 2.446	(157) 0.608	(175) 1.035
(104) 0.941	(122) 0.851	(140) 2.446	(158) 1.678	(176) 1.035
(105) 0.851	(123) 0.851	(141) 3.98	(159) 1.678	(177) 1.035
(106) 0.851	(124) 0.765	(142) 3.981	(160) 1.562	(178) 0.941
(107) 0.765	(125) 0.765	(143) 2.728	(161) 1.562	(179) 0.941
(108) 0.765	(126) 0.684	(144) 2.728	(162) 1.449	(180) 0.941

(271) 1.797	(289) 0.851	(307) 0.537	(325) 0.537	(343) 0.26
(272) 1.562	(290) 0.851	(308) 0.537	(326) 0.471	(344) 0.26
(273) 1.562	(291) 0.765	(309) 0.684	(327) 0.356	(345) 0.218
(274) 1.449	(292) 0.765	(310) 0.608	(328) 0.411	(346) 0.218
(275) 1.34	(293) 0.765	(311) 0.608	(329) 0.411	(347) 0.218
(276) 1.235	(294) 0.765	(312) 0.537	(330) 0.356	(348) 0.181
(277) 1.235	(295) 0.765	(313) 0.608	(331) 0.411	(349) 0.218
(278) 1.133	(296) 0.684	(314) 0.537	(332) 0.305	(350) 0.218
(279) 1.133	(297) 0.765	(315) 0.537	(333) 0.356	(351) 0.26
(280) 1.133	(298) 0.684	(316) 0.608	(334) 0.305	(352) 0.218
(281) 1.133	(299) 0.608	(317) 0.608	(335) 0.356	(353) 0.181
(282) 1.035	(300) 0.608	(318) 0.537	(336) 0.356	(354) 0.181
(283) 1.035	(301) 0.608	(319) 0.537	(337) 0.356	(355) 0.181
(284) 1.035	(302) 0.537	(320) 0.537	(338) 0.305	(356) 0.148
(285) 0.851	(303) 0.537	(321) 0.537	(339) 0.356	(357) 0.181
(286) 0.941	(304) 0.537	(322) 0.537	(340) 0.26	(358) 0.148
(287) 0.941	(305) 0.537	(323) 0.537	(341) 0.26	(359) 0.148
(288) 0.851	(306) 0.537	(324) 0.537	(342) 0.206	(360) 0.094

A3.44

River discharge data at 12-hourly intervals for Station: 14B
Period : 6

Variable: DORING1.var1 (length = 360)

(1) 0	(19) 0	(37) 0	(55) 0	(73) 0
(2) 0	(20) 0	(38) 0	(56) 0	(74) 0
(3) 0	(21) 0	(39) 0	(57) 0	(75) 0
(4) 0	(22) 0	(40) 0	(58) 0	(76) 0
(5) 0	(23) 0	(41) 0	(59) 0	(77) 0
(6) 0	(24) 0	(42) 0	(60) 0	(78) 0
(7) 0	(25) 0	(43) 0	(61) 0	(79) 0
(8) 0	(26) 0	(44) 0	(62) 0	(80) 0
(9) 0	(27) 0	(45) 0	(63) 0	(81) 0
(10) 0	(28) 0	(46) 0	(64) 0	(82) 0
(11) 0	(29) 0	(47) 0	(65) 0	(83) 0
(12) 0	(30) 0	(48) 0	(66) 0	(84) 0
(13) 0	(31) 0	(49) 0	(67) 0	(85) 0
(14) 0	(32) 0	(50) 0	(68) 0	(86) 0
(15) 0	(33) 0	(51) 0	(69) 0	(87) 0
(16) 0	(34) 0	(52) 0	(70) 0	(88) 0
(17) 0	(35) 0	(53) 0	(71) 0	(89) 0
(18) 0	(36) 0	(54) 0	(72) 0	(90) 0

(91) 0	(109) 0	(127) 0	(145) 0	(163) 0
(92) 0	(110) 0	(128) 0	(146) 0	(164) 0
(93) 0	(111) 0	(129) 0	(147) 0	(165) 0
(94) 0	(112) 0	(130) 0	(148) 0	(166) 0
(95) 0	(113) 0	(131) 0	(149) 0	(167) 0
(96) 0	(114) 0	(132) 0	(150) 0	(168) 0
(97) 0	(115) 0	(133) 0	(151) 0	(169) 0
(98) 0	(116) 0	(134) 0	(152) 0	(170) 0
(99) 0	(117) 0	(135) 0	(153) 0	(171) 0
(100) 0	(118) 0	(136) 0	(154) 0	(172) 0
(101) 0	(119) 0	(137) 0	(155) 0	(173) 0
(102) 0	(120) 0	(138) 0	(156) 0	(174) 0
(103) 0	(121) 0	(139) 0	(157) 0	(175) 0
(104) 0	(122) 0	(140) 0	(158) 0	(176) 0
(105) 0	(123) 0	(141) 0	(159) 0	(177) 0
(106) 0	(124) 0	(142) 0	(160) 0	(178) 0
(107) 0	(125) 0	(143) 0	(161) 0	(179) 0
(108) 0	(126) 0	(144) 0	(162) 0	(180) 0

(181) 0	(199) 0	(217) 0	(235) 0	(253) 0
(182) 0	(200) 0	(218) 0	(236) 0	(254) 0
(183) 0	(201) 0	(219) 0	(237) 0	(255) 0
(184) 0	(202) 0	(220) 0	(238) 0	(256) 0
(185) 0	(203) 0	(221) 0	(239) 0	(257) 0
(186) 0	(204) 0	(222) 0	(240) 0	(258) 0
(187) 0	(205) 0	(223) 0	(241) 0	(259) 0
(188) 0	(206) 0	(224) 0	(242) 0	(260) 0
(189) 0	(207) 0	(225) 0	(243) 0	(261) 0
(190) 0	(208) 0	(226) 0	(244) 0	(262) 0
(191) 0	(209) 0	(227) 0	(245) 0	(263) 0
(192) 0	(210) 0	(228) 0	(246) 0	(264) 0
(193) 0	(211) 0	(229) 0	(247) 0	(265) 0
(194) 0	(212) 0	(230) 0	(248) 0	(266) 0
(195) 0	(213) 0	(231) 0	(249) 0	(267) 0
(196) 0	(214) 0	(232) 0	(250) 0	(268) 0
(197) 0	(215) 0	(233) 0	(251) 0	(269) 0
(198) 0	(216) 0	(234) 0	(252) 0	(270) 0

(271) 0	(289) 0	(307) 0	(325) 0.019	(343) 1.212
(272) 0	(290) 0	(308) 0	(326) 0.026	(344) 0.358
(273) 0	(291) 0	(309) 0	(327) 0.026	(345) 0.49
(274) 0	(292) 0	(310) 0	(328) 0.026	(346) 0.051
(275) 0	(293) 0	(311) 0	(329) 6E-3	(347) 1.069
(276) 0	(294) 0	(312) 0	(330) 0	(348) 2.69
(277) 0	(295) 0	(313) 0	(331) 0	(349) 1.667
(278) 0	(296) 0	(314) 0	(332) 0	(350) 1.116
(279) 0	(297) 0	(315) 0	(333) 0	(351) 1.116
(280) 0	(298) 0	(316) 0	(334) 0	(352) 0.39
(281) 0	(299) 0	(317) 0	(335) 0	(353) 0.238
(282) 0	(300) 0	(318) 0	(336) 0	(354) 0.157
(283) 0	(301) 0	(319) 0	(337) 0	(355) 0.11
(284) 0	(302) 0	(320) 0	(338) 0	(356) 0.089
(285) 0	(303) 0	(321) 0	(339) 0	(357) 0.06
(286) 0	(304) 0	(322) 0	(340) 0	(358) 0.055
(287) 0	(305) 0	(323) 0	(341) 0	(359) 0.034
(288) 0	(306) 0	(324) 0	(342) 0	(360) 0.04

River discharge data at 12-hourly intervals for Station: 15D
Period : 1

Variable: DORING2.var1 (length = 360)

(1) 0.026	(19) 0.012	(37) 0.012	(55) 0.012	(73) 0.012
(2) 0.026	(20) 0.019	(38) 0.019	(56) 0.012	(74) 0.019
(3) 0.019	(21) 0.012	(39) 0.012	(57) 0.013	(75) 0.019
(4) 0.019	(22) 0.019	(40) 0.019	(58) 0.019	(76) 0.026
(5) 0.019	(23) 0.012	(41) 0.012	(59) 0.012	(77) 0.019
(6) 0.019	(24) 0.019	(42) 0.019	(60) 0.019	(78) 0.019
(7) 0.019	(25) 0.034	(43) 0.011	(61) 0.012	(79) 0.069
(8) 0.019	(26) 0.034	(44) 0.012	(62) 0.019	(80) 0.11
(9) 0.267	(27) 0.034	(45) 0.011	(63) 0.012	(81) 0.069
(10) 0.06	(28) 0.034	(46) 0.012	(64) 0.019	(82) 0.051
(11) 0.026	(29) 0.012	(47) 0.012	(65) 0.012	(83) 0.026
(12) 0.019	(30) 0.019	(48) 0.012	(66) 0.019	(84) 0.026
(13) 0.019	(31) 0.012	(49) 0.012	(67) 0.012	(85) 0.019
(14) 0.019	(32) 0.019	(50) 0.012	(68) 0.019	(86) 0.019
(15) 0.012	(33) 0.012	(51) 0.012	(69) 0.012	(87) 0.019
(16) 0.019	(34) 0.019	(52) 0.012	(70) 0.019	(88) 0.019
(17) 0.012	(35) 0.012	(53) 0.012	(71) 0.012	(89) 0.019
(18) 0.019	(36) 0.019	(54) 0.012	(72) 0.012	(90) 0.019

(181) 0.019	(199) 0.012	(217) 0.069	(235) 0.034	(253) 0.019
(182) 0.019	(200) 0.012	(218) 0.051	(236) 0.034	(254) 0.019
(183) 0.019	(201) 0.012	(219) 0.358	(237) 0.034	(255) 0.019
(184) 0.019	(202) 0.012	(220) 0.145	(238) 0.034	(256) 0.019
(185) 0.012	(203) 0.012	(221) 0.089	(239) 0.034	(257) 0.019
(186) 0.019	(204) 0.034	(222) 0.069	(240) 0.034	(258) 0.019
(187) 0.012	(205) 0.034	(223) 0.06	(241) 0.034	(259) 0.019
(188) 0.019	(206) 0.034	(224) 0.051	(242) 0.034	(260) 0.019
(189) 0.012	(207) 0.423	(225) 0.06	(243) 0.034	(261) 0.019
(190) 0.019	(208) 1.116	(226) 0.06	(244) 0.034	(262) 0.019
(191) 0.012	(209) 0.47	(227) 0.051	(245) 0.026	(263) 0.019
(192) 0.019	(210) 1.116	(228) 0.051	(246) 0.034	(264) 0.019
(193) 0.012	(211) 1.023	(229) 0.042	(247) 0.026	(265) 0.019
(194) 0.019	(212) 0.21	(230) 0.034	(248) 0.034	(266) 0.019
(195) 0.012	(213) 1.422	(231) 0.034	(249) 0.019	(267) 0.019
(196) 0.019	(214) 0.145	(232) 0.034	(250) 0.034	(268) 0.019
(197) 0.012	(215) 0.089	(233) 0.034	(251) 0.019	(269) 0.019
(198) 0.012	(216) 0.069	(234) 0.034	(252) 0.034	(270) 1.116

(91) 0.012	(109) 0.051	(127) 0.019	(145) 0.034	(163) 0.019
(92) 0.019	(110) 0.051	(128) 0.019	(146) 0.089	(164) 0.026
(93) 0.012	(111) 0.034	(129) 0.019	(147) 0.051	(165) 0.019
(94) 0.019	(112) 0.034	(130) 0.019	(148) 0.145	(166) 0.026
(95) 0.012	(113) 0.048	(131) 0.019	(149) 0.11	(167) 0.019
(96) 0.019	(114) 0.075	(132) 0.019	(150) 0.051	(168) 0.026
(97) 0.012	(115) 0.051	(133) 0.019	(151) 0.034	(169) 0.019
(98) 0.019	(116) 0.034	(134) 0.019	(152) 0.034	(170) 0.019
(99) 0.012	(117) 0.034	(135) 0.019	(153) 0.034	(171) 0.019
(100) 0.012	(118) 0.034	(136) 0.019	(154) 0.034	(172) 0.019
(101) 0.012	(119) 0.026	(137) 0.019	(155) 0.034	(173) 0.019
(102) 0.012	(120) 0.026	(138) 0.019	(156) 0	(174) 0.019
(103) 0.069	(121) 0.019	(139) 0.019	(157) 0.034	(175) 0.019
(104) 0.051	(122) 0.019	(140) 0.019	(158) 0	(176) 0.019
(105) 0.638	(123) 0.019	(141) 0.019	(159) 0.034	(177) 0.019
(106) 0.133	(124) 0.019	(142) 0.019	(160) 0.026	(178) 0.019
(107) 0.069	(125) 0.019	(143) 0.019	(161) 0.019	(179) 0.019
(108) 0.06	(126) 0.019	(144) 0.019	(162) 0.026	(180) 0.019

(271) 0.423	(289) 0.026	(307) 0.012	(325) 6E-3	(343) 3E-3
(272) 0.133	(290) 0.026	(308) 0.012	(326) 6E-3	(344) 0
(273) 5.315	(291) 0.026	(309) 0.012	(327) 6E-3	(345) 0
(274) 0.238	(292) 0.026	(310) 0.012	(328) 6E-3	(346) 0
(275) 0.133	(293) 0.019	(311) 6E-3	(329) 6E-3	(347) 0
(276) 0.077	(294) 0.026	(312) 6E-3	(330) 6E-3	(348) 0
(277) 0.069	(295) 0.019	(313) 6E-3	(331) 6E-3	(349) 0
(278) 0.06	(296) 0.019	(314) 6E-3	(332) 6E-3	(350) 0
(279) 0.051	(297) 0.019	(315) 6E-3	(333) 6E-3	(351) 0
(280) 0.034	(298) 0.019	(316) 6E-3	(334) 6E-3	(352) 0
(281) 0.034	(299) 0.019	(317) 6E-3	(335) 6E-3	(353) 0
(282) 0.034	(300) 0.019	(318) 6E-3	(336) 6E-3	(354) 0
(283) 0.034	(301) 0.019	(319) 6E-3	(337) 5E-3	(355) 0
(284) 0.034	(302) 0.019	(320) 6E-3	(338) 6E-3	(356) 0
(285) 0.034	(303) 0.019	(321) 6E-3	(339) 3E-3	(357) 0
(286) 0.034	(304) 0.019	(322) 6E-3	(340) 6E-3	(358) 0
(287) 0.026	(305) 0.019	(323) 6E-3	(341) 3E-3	(359) 0
(288) 0.034	(306) 0.019	(324) 6E-3	(342) 3E-3	(360) 0

River discharge data at 12-hourly intervals for Station: 15D
Period : 2

Variable: DDRING3.var1 (length = 360)

(1) 0	(19) 0	(37) 0	(55) 0	(73) 0
(2) 0	(20) 0	(38) 0	(56) 0	(74) 0
(3) 0	(21) 0	(39) 0	(57) 0	(75) 0
(4) 0	(22) 0	(40) 0	(58) 0	(76) 0
(5) 0	(23) 0	(41) 0	(59) 0	(77) 0
(6) 0	(24) 0	(42) 0	(60) 0	(78) 0
(7) 0	(25) 0	(43) 0	(61) 0	(79) 0
(8) 0	(26) 0	(44) 0	(62) 0	(80) 0
(9) 0	(27) 0	(45) 0	(63) 0	(81) 0
(10) 0	(28) 0	(46) 0	(64) 0	(82) 0
(11) 0	(29) 0	(47) 0	(65) 0	(83) 0
(12) 0	(30) 0	(-48) 0	(66) 0	(84) 0
(13) 0	(31) 9	(49) 0	(67) 0	(85) 0
(14) 0	(32) 0.019	(50) 0	(68) 0	(86) 0
(15) 0	(33) 0	(51) 0	(69) 0	(87) 0
(16) 0	(34) 0	(52) 0	(70) 0	(88) 0
(17) 0	(35) 0	(53) 0	(71) 0	(89) 0
(18) 0	(36) 0	(54) 0	(72) 0	(90) 0

(181) 0	(199) 0	(217) 0	(235) 0.183	(253) 0
(182) 0	(200) 0	(218) 0	(236) 0.019	(254) 0
(183) 0	(201) 0	(219) 0	(237) 6E-3	(255) 0
(184) 0	(202) 0	(220) 0	(238) 0	(256) 0
(185) 0	(203) 0	(221) 0	(239) 0	(257) 0
(186) 0	(204) 0	(222) 0	(240) 0	(258) 0
(187) 0	(205) 0	(223) 0	(241) 0	(259) 0
(188) 0	(206) 0	(224) 0	(242) 0	(260) 0
(189) 0	(207) 0	(225) 0	(243) 0	(261) 0
(190) 0	(208) 0	(226) 0	(244) 0	(262) 0
(191) 0	(209) 0	(227) 0	(245) 0	(263) 0
(192) 0	(210) 0	(228) 0	(246) 0	(264) 0
(193) 0	(211) 0	(229) 0	(247) 0	(265) 0
(194) 0	(212) 0	(230) 0	(248) 0	(266) 0
(195) 0	(213) 0	(231) 0	(249) 0	(267) 0
(196) 0	(214) 0	(232) 0.019	(250) 0	(268) 0
(197) 0	(215) 0	(233) 6E-3	(251) 0	(269) 0
(198) 0	(216) 0	(234) 0	(252) 0	(270) 0

(91) 0	(109) 0	(127) 0	(145) 0	(163) 0
(92) 0	(110) 0	(128) 0	(146) 0	(164) 0.034
(93) 0	(111) 0	(129) 0	(147) 0	(165) 0.034
(94) 0	(112) 0	(130) 0	(148) 0	(166) 0.034
(95) 0	(113) 0	(131) 0	(149) 0	(167) 0.034
(96) 0	(114) 0	(132) 0	(150) 0	(168) 0.034
(97) 0	(115) 0	(133) 0	(151) 0	(169) 0.034
(98) 0	(116) 0	(134) 0	(152) 0	(170) 0.034
(99) 0	(117) 0	(135) 0	(153) 0	(171) 0.034
(100) 0	(118) 0	(136) 0	(154) 0	(172) 0.034
(101) 0	(119) 0	(137) 0	(155) 0	(173) 6E-3
(102) 0	(120) 0	(138) 0	(156) 0	(174) 0
(103) 0	(121) 0	(139) 0	(157) 0	(175) 0
(104) 0	(122) 0	(140) 0	(158) 0	(176) 0
(105) 0	(123) 0	(141) 0	(159) 0	(177) 0
(106) 0	(124) 0	(142) 0	(160) 0	(178) 0
(107) 0	(125) 0	(143) 0	(161) 0	(179) 0
(108) 0	(126) 0	(144) 0	(162) 0	(180) 0

(271) 0	(289) 0	(307) 0	(325) 0.012	(343) 0.019
(272) 0	(290) 0	(308) 0	(326) 0.012	(344) 0.019
(273) 0	(291) 0	(309) 0	(327) 0.019	(345) 6E-3
(274) 0	(292) 0	(310) 0	(328) 0.019	(346) 6E-3
(275) 0	(293) 0	(311) 0.599	(329) 0.019	(347) 0
(276) 0	(294) 0	(312) 0.069	(330) 0.019	(348) 0
(277) 0	(295) 0	(313) 0	(331) 0.019	(349) 0
(278) 0	(296) 0	(314) 6E-3	(332) 0.019	(350) 0
(279) 0	(297) 0	(315) 6E-3	(333) 0.019	(351) 0
(280) 0	(298) 0	(316) 6E-3	(334) 0.019	(352) 0
(281) 0	(299) 0	(317) 6E-3	(335) 0.019	(353) 0
(282) 0	(300) 0	(318) 6E-3	(336) 0.019	(354) 0
(283) 0	(301) 0	(319) 6E-3	(337) 0.019	(355) 0
(284) 0	(302) 0	(320) 6E-3	(338) 0.019	(356) 0
(285) 0	(303) 0	(321) 6E-3	(339) 0.019	(357) 0
(286) 0	(304) 0	(322) 6E-3	(340) 0.019	(358) 0
(287) 0	(305) 0	(323) 0.012	(341) 0.019	(359) 0
(288) 0	(306) 0	(324) 6E-3	(342) 0.019	(360) 0

River discharge data at 12-hourly intervals for Station: 15D
Period : 3

Variable: DORING4.var1   (length = 344)

(1) 0	(19) 0.019	(37) 6E-3	(55) 0.019	(73) 0.019
(2) 0	(20) 0.019	(38) 6E-3	(56) 0.019	(74) 0.019
(3) 0	(21) 0.019	(39) 6E-3	(57) 0.019	(75) 0.012
(4) 0	(22) 0.019	(40) 6E-3	(58) 0.561	(76) 0.012
(5) 0	(23) 0.019	(41) 3E-3	(59) 0.019	(77) 0.012
(6) 0	(24) 0.019	(42) 0	(60) 0.051	(78) 0.012
(7) 0	(25) 0.019	(43) 0	(61) 0.019	(79) 0.012
(8) 0.019	(26) 0.019	(44) 0	(62) 0.026	(80) 0.012
(9) 0.025	(27) 0.019	(45) 0	(63) 0.019	(81) 0.012
(10) 0.026	(28) 0.019	(46) 0	(64) 0.019	(82) 0.012
(11) 0.019	(29) 0.019	(47) 0	(65) 0.069	(83) 0.012
(12) 0.026	(30) 0.019	(48) 0	(66) 0.034	(84) 0.012
(13) 0.019	(31) 0.012	(49) 0	(67) 0.019	(85) 0.012
(14) 0.026	(32) 0.012	(50) 1.26	(68) 0.019	(86) 0.012
(15) 0.019	(33) 0.012	(51) 0.077	(69) 0.012	(87) 0.012
(16) 0.026	(34) 0.012	(52) 3.765	(70) 0.019	(88) 0.012
(17) 0.019	(35) 0.012	(53) 0.88	(71) 0.069	(89) 0.012
(18) 0.026	(36) 0.012	(54) 0.051	(72) 0.034	(90) 0.012

(181) 0.069	(199) 0.051	(217) 0.034	(235) 0.183	(253) 0.019
(182) 0.069	(200) 0.051	(218) 0.034	(236) 0.069	(254) 0.019
(183) 0.06	(201) 0.041	(219) 0.034	(237) 0.051	(255) 0.019
(184) 0.051	(202) 0.042	(220) 0.034	(238) 0.051	(256) 0.019
(185) 0.051	(203) 0.041	(221) 0.034	(239) 0.034	(257) 0.019
(186) 0.069	(204) 0.042	(222) 0.034	(240) 0.034	(258) 0.019
(187) 0.069	(205) 0.034	(223) 0.034	(241) 0.034	(259) 0.019
(188) 0.069	(206) 0.034	(224) 0.034	(242) 0.034	(260) 0.019
(189) 0.051	(207) 0.034	(225) 0.034	(243) 0.042	(261) 0.019
(190) 0.051	(208) 0.034	(226) 0.034	(244) 0.034	(262) 0.019
(191) 0.06	(209) 0.034	(227) 0.034	(245) 0.678	(263) 0.019
(192) 0.06	(210) 0.034	(228) 0.034	(246) 0.026	(264) 0.019
(193) 0.069	(211) 0.034	(229) 0.034	(247) 0.019	(265) 0.019
(194) 0.157	(212) 0.034	(230) 0.034	(248) 0.019	(266) 0.019
(195) 0.077	(213) 0.034	(231) 0.034	(249) 0.019	(267) 0.019
(196) 0.069	(214) 0.034	(232) 0.034	(250) 0.019	(268) 0.019
(197) 0.06	(215) 0.034	(233) 0.042	(251) 0.019	(269) 0.019
(198) 0.051	(216) 0.034	(234) 0.11	(252) 0.019	(270) 0.019

(91) 6E-3	(109) 2.257	(127) 0.051	(145) 0.034	(163) 0.133
(92) 0.019	(110) 0.678	(128) 0.051	(146) 0.034	(164) 0.121
(93) 6E-3	(111) 0.39	(129) 0.051	(147) 0.034	(165) 0.069
(94) 6E-3	(112) 0.21	(130) 0.051	(148) 0.034	(166) 0.069
(95) 6E-3	(113) 0.157	(131) 0.051	(149) 0.026	(167) 1.069
(96) 6E-3	(114) 0.133	(132) 0.051	(150) 0.026	(168) 0.358
(97) 2.257	(115) 0.11	(133) 0.034	(151) 0.845	(169) 0.25
(98) 4.257	(116) 0.11	(134) 0.034	(152) 0.11	(170) 0.157
(99) 0.327	(117) 0.089	(135) 0.034	(153) 0.069	(171) 0.133
(100) 0.157	(118) 0.089	(136) 0.034	(154) 0.889	(172) 0.11
(101) 0.077	(119) 0.069	(137) 0.034	(155) 0.327	(173) 0.1
(102) 0.051	(120) 0.069	(138) 0.034	(156) 0.157	(174) 0.11
(103) 4.427	(121) 0.069	(139) 0.034	(157) 0.11	(175) 0.11
(104) 0.423	(122) 0.069	(140) 0.034	(158) 0.089	(176) 0.089
(105) 0.267	(123) 0.069	(141) 0.034	(159) 0.069	(177) 0.069
(106) 0.099	(124) 0.069	(142) 0.034	(160) 0.069	(178) 0.069
(107) 0.12	(125) 0.06	(143) 0.034	(161) 0.157	(179) 0.069
(108) 3.613	(126) 0.06	(144) 0.034	(162) 0.253	(180) 0.069

(271) 0.019	(289) 6E-3	(307) 6E-3	(325) 6E-3	(343) 0
(272) 0.019	(290) 6E-3	(308) 6E-3	(326) 6E-3	(344) 0
(273) 0.019	(291) 6E-3	(309) 6E-3	(327) 6E-3	
(274) 0.019	(292) 6E-3	(310) 6E-3	(328) 6E-3	
(275) 0.019	(293) 6E-3	(311) 6E-3	(329) 3E-3	
(276) 0.019	(294) 6E-3	(312) 6E-3	(330) 0.069	
(277) 0.019	(295) 6E-3	(313) 6E-3	(331) 0	
(278) 0.019	(296) 6E-3	(314) 6E-3	(332) 0	
(279) 0.019	(297) 3E-3	(315) 6E-3	(333) 0	
(280) 0.019	(298) 6E-3	(316) 6E-3	(334) 0	
(281) 0.019	(299) 3E-3	(317) 6E-3	(335) 0	
(282) 0.019	(300) 6E-3	(318) 6E-3	(336) 0	
(283) 6E-3	(301) 3E-3	(319) 6E-3	(337) 0	
(284) 0.019	(302) 6E-3	(320) 6E-3	(338) 0	
(285) 6E-3	(303) 3E-3	(321) 6E-3	(339) 0	
(286) 0.019	(304) 0.069	(322) 6E-3	(340) 0	
(287) 6E-3	(305) 6E-3	(323) 6E-3	(341) 0	
(288) 0.019	(306) 6E-3	(324) 6E-3	(342) 0	

River discharge data at 12-hourly intervals for Station: 15D
Period : 4

Variable: DORINGS.var1   (length = 360)

(1) 0	(19) 0	(37) 0	(55) 0	(73) 0
(2) 0	(20) 0	(38) 0	(56) 0	(74) 0
(3) 0	(21) 0	(39) 0	(57) 0	(75) 0
(4) 0	(22) 0	(40) 0	(58) 0	(76) 0
(5) 0	(23) 0	(41) 0	(59) 0	(77) 0
(6) 0	(24) 0	(42) 0	(60) 0	(78) 0
(7) 0	(25) 0	(43) 0	(61) 0	(79) 0
(8) 0	(26) 0	(44) 0	(62) 0	(80) 0
(9) 0	(27) 0	(45) 0	(63) 0	(81) 0
(10) 0	(28) 0	(46) 0	(64) 0	(82) 0
(11) 0	(29) 0	(47) 0	(65) 0	(83) 0
(12) 0	(30) 0	(48) 0	(66) 0	(84) 0
(13) 0	(31) 0	(49) 0	(67) 0	(85) 0
(14) 0	(32) 0	(50) 0	(68) 0	(86) 0
(15) 0	(33) 0	(51) 0	(69) 0	(87) 0
(16) 0	(34) 0	(52) 0	(70) 0	(88) 0
(17) 0	(35) 0	(53) 0	(71) 0	(89) 0
(18) 0	(36) 0	(54) 0	(72) 0	(90) 0

(181) 0	(199) 0	(217) 0	(235) 0	(253) 0
(182) 0	(200) 0	(218) 0	(236) 0	(254) 0
(183) 0	(201) 0	(219) 0	(237) 0	(255) 0
(184) 0	(202) 0	(220) 0	(238) 0	(256) 0
(185) 0	(203) 0	(221) 0	(239) 0	(257) 0
(186) 0	(204) 0	(222) 0	(240) 0	(258) 0
(187) 0	(205) 0	(223) 0	(241) 0	(259) 0
(188) 0	(206) 0	(224) 0	(242) 0	(260) 0
(189) 0	(207) 0	(225) 0	(243) 0	(261) 0
(190) 0	(208) 0	(226) 0	(244) 0	(262) 0.034
(191) 0	(209) 0	(227) 0	(245) 0	(263) 0.042
(192) 0	(210) 0	(228) 0	(246) 0	(264) 0.042
(193) 0	(211) 0	(229) 0	(247) 0	(265) 0.051
(194) 0	(212) 0	(230) 0	(248) 0	(266) 0.051
(195) 0	(213) 0	(231) 0	(249) 0	(267) 0.026
(196) 0	(214) 0	(232) 0	(250) 0	(268) 0.026
(197) 0	(215) 0	(233) 0	(251) 0	(269) 0.026
(198) 0	(216) 0	(234) 0	(252) 0	(270) 0.034

(91) 0	(109) 0	(127) 0	(145) 0	(163) 0
(92) 0	(110) 0	(128) 0	(146) 0	(164) 0
(93) 0	(111) 0	(129) 0	(147) 0	(165) 0
(94) 0	(112) 0	(130) 0	(148) 0	(166) 0
(95) 0	(113) 0	(131) 0	(149) 0	(167) 0
(96) 0	(114) 0	(132) 0	(150) 0	(168) 0
(97) 0	(115) 0	(133) 0	(151) 0	(169) 0
(98) 0	(116) 0	(134) 0	(152) 0	(170) 0
(99) 0	(117) 0	(135) 0	(153) 0	(171) 0
(100) 0	(118) 0	(136) 0	(154) 0	(172) 0
(101) 0	(119) 0	(137) 0	(155) 0	(173) 0
(102) 0	(120) 0	(138) 0	(156) 0	(174) 0
(103) 0	(121) 0	(139) 0	(157) 0	(175) 0
(104) 0	(122) 0	(140) 0	(158) 0	(176) 0
(105) 0	(123) 0	(141) 0	(159) 0	(177) 0
(106) 0	(124) 0	(142) 0	(160) 0	(178) 0
(107) 0	(125) 0	(143) 0	(161) 0	(179) 0
(108) 0	(126) 0	(144) 0	(162) 0	(180) 0

(271) 0.034	(289) 0.019	(307) 0.019	(325) 0	(343) 0
(272) 0.034	(290) 0.019	(308) 0.019	(326) 0	(344) 0
(273) 0.034	(291) 0.019	(309) 0.019	(327) 0	(345) 0
(274) 0.034	(292) 0.019	(310) 0.012	(328) 0	(346) 0
(275) 0.034	(293) 0.019	(311) 0.012	(329) 0	(347) 0
(276) 0.034	(294) 0.019	(312) 6E-3	(330) 0	(348) 0
(277) 0.034	(295) 0.019	(313) 6E-3	(331) 0	(349) 0
(278) 0.034	(296) 0.019	(314) 6E-3	(332) 0	(350) 0
(279) 0.034	(297) 0.019	(315) 0	(333) 0	(351) 0
(280) 0.034	(298) 0.019	(316) 0	(334) 0	(352) 0
(281) 0.019	(299) 0.019	(317) 0	(335) 0	(353) 0
(282) 0.019	(300) 0.019	(318) 0	(336) 0	(354) 0
(283) 0.019	(301) 0.019	(319) 0	(337) 0	(355) 0
(284) 0.019	(302) 0.019	(320) 0	(338) 0	(356) 0
(285) 0.019	(303) 0.019	(321) 0	(339) 0	(357) 0
(286) 0.019	(304) 0.019	(322) 0	(340) 0	(358) 0
(287) 0.019	(305) 0.019	(323) 0	(341) 0	(359) 0
(288) 0.019	(306) 0.019	(324) 0	(342) 0	(360) 0

River discharge data at 12-hourly intervals for Station: 15D
Period : 5

Variable: DORING6.var1 (length = 360)

(1)	0	(19)	0	(37)	0	(55)	0	(73)	0
(2)	0	(20)	0	(38)	0	(56)	0	(74)	0
(3)	0	(21)	0	(39)	0	(57)	0	(75)	0
(4)	0	(22)	0	(40)	0	(58)	0	(76)	0
(5)	0	(23)	0	(41)	0	(59)	0	(77)	0
(6)	0	(24)	0	(42)	0	(60)	0	(78)	0
(7)	0	(25)	0	(43)	0	(61)	0	(79)	0
(8)	0	(26)	0	(44)	0	(62)	0	(80)	0
(9)	0	(27)	0	(45)	0	(63)	0	(81)	0
(10)	0	(28)	0	(46)	0	(64)	0	(82)	0
(11)	0	(29)	0	(47)	0	(65)	0	(83)	0
(12)	0	(30)	0	(48)	0	(66)	0	(84)	0
(13)	0	(31)	0	(49)	0	(67)	0	(85)	0
(14)	0	(32)	0	(50)	0	(68)	0	(86)	0
(15)	0	(33)	0	(51)	0	(69)	0	(87)	0
(16)	0	(34)	0	(52)	0	(70)	0	(88)	0.069
(17)	0	(35)	0	(53)	0	(71)	0	(89)	0.019
(18)	0	(36)	0	(54)	0	(72)	0	(90)	0.051

(91)	0.034	(109)	0	(127)	0	(145)	0.077	(163)	0.39
(92)	0.034	(110)	0	(128)	0.012	(146)	0.069	(164)	0.157
(93)	1.309	(111)	0	(129)	0	(147)	0.456	(165)	0.11
(94)	0.069	(112)	0.019	(130)	0.012	(148)	0.423	(166)	0.089
(95)	0.034	(113)	0.019	(131)	0	(149)	0.11	(167)	0.069
(96)	0.019	(114)	0.012	(132)	0	(150)	0.069	(168)	0.069
(97)	0.019	(115)	0.034	(133)	0	(151)	0.051	(169)	0.051
(98)	0.012	(116)	0.019	(134)	0.889	(152)	0.051	(170)	0.0517
(99)	6E-3	(117)	0	(135)	0.069	(153)	0.034	(171)	0.051
(100)	6E-3	(118)	0	(136)	0.034	(154)	0.034	(172)	0.051
(101)	6E-3	(119)	0	(137)	0.034	(155)	0.034	(173)	0.034
(102)	0.069	(120)	0	(138)	0.019	(156)	0.026	(174)	0.034
(103)	0	(121)	0	(139)	0.019	(157)	0.019	(175)	0.034
(104)	0	(122)	3E-3	(140)	0.019	(158)	1.756	(176)	0.034
(105)	0	(123)	0	(141)	3.613	(159)	0.238	(177)	0.034
(106)	0	(124)	6E-3	(142)	0.889	(160)	0.157	(178)	0.034
(107)	0	(125)	0	(143)	0.327	(161)	0.11	(179)	0.034
(108)	0	(126)	6E-3	(144)	0.157	(162)	0.089	(180)	0.034

(181)	0.034	(199)	0.11	(217)	0.089	(235)	0.089	(253)	0.051
(182)	1.667	(200)	0.099	(218)	0.085	(236)	0.069	(254)	0.051
(183)	11.7	(201)	0.089	(219)	0.077	(237)	0.069	(255)	0.034
(184)	3.926	(202)	0.21	(220)	0.077	(238)	0.06	(256)	0.051
(185)	1.164	(203)	8.372	(221)	0.069	(239)	0.051	(257)	0.034
(186)	2.69	(204)	1.212	(222)	0.069	(240)	0.051	(258)	0.49
(187)	1.023	(205)	0.523	(223)	0.069	(241)	0.051	(259)	1.422
(188)	0.561	(206)	0.358	(224)	0.069	(242)	0.051	(260)	0.224
(189)	0.39	(207)	0.297	(225)	0.069	(243)	0.051	(261)	0.133
(190)	0.297	(208)	0.224	(226)	0.069	(244)	0.051	(262)	0.099
(191)	0.238	(209)	0.183	(227)	0.069	(245)	0.051	(263)	0.089
(192)	0.183	(210)	0.157	(228)	0.069	(246)	0.051	(264)	0.257
(193)	0.157	(211)	0.157	(229)	0.051	(247)	0.051	(265)	0.11
(194)	0.157	(212)	0.133	(230)	0.051	(248)	0.051	(266)	0.069
(195)	0.157	(213)	0.11	(231)	0.051	(249)	0.051	(267)	0.069
(196)	0.133	(214)	0.11	(232)	0.051	(250)	0.051	(268)	0.069
(197)	0.133	(215)	0.099	(233)	0.069	(251)	0.051	(269)	0.11
(198)	0.11	(216)	0.085	(234)	0.133	(252)	0.051	(270)	0.069

(271)	0.051	(289)	0.026	(307)	0.019	(325)	0.019	(343)	6E-3
(272)	0.051	(290)	0.019	(308)	0.019	(326)	0.019	(344)	6E-3
(273)	0.051	(291)	0.026	(309)	0.019	(327)	0.012	(345)	6E-3
(274)	0.042	(292)	0.019	(310)	0.019	(328)	0.012	(346)	6E-3
(275)	0.034	(293)	0.026	(311)	0.019	(329)	0.012	(347)	6E-3
(276)	0.034	(294)	0.019	(312)	0.019	(330)	0.012	(348)	6E-3
(277)	0.034	(295)	0.026	(313)	0.019	(331)	0.012	(349)	6E-3
(278)	0.034	(296)	0.019	(314)	0.019	(332)	0.012	(350)	6E-3
(279)	0.034	(297)	0.026	(315)	0.019	(333)	0.012	(351)	6E-3
(280)	0.034	(298)	0.019	(316)	0.019	(334)	0.012	(352)	6E-3
(281)	0.034	(299)	0.019	(317)	0.019	(335)	0.012	(353)	6E-3
(282)	0.034	(300)	0.019	(318)	0.019	(336)	0.012	(354)	6E-3
(283)	0.034	(301)	0.019	(319)	0.019	(337)	0.012	(355)	3E-3
(284)	0.034	(302)	0.019	(320)	0.019	(338)	0.012	(356)	0
(285)	0.034	(303)	0.019	(321)	0.019	(339)	0.012	(357)	0
(286)	0.026	(304)	0.019	(322)	0.019	(340)	0.012	(358)	0
(287)	0.026	(305)	0.019	(323)	0.019	(341)	6E-3	(359)	0
(288)	0.019	(306)	0.019	(324)	0.019	(342)	0	(360)	0

River discharge data at 12-hourly intervals for Station: 15D
Period : 6

Variable: KOMPAG2.var1 (length = 360)

(1)	1.236	(19)	0.447	(37)	0.36	(55)	0.218	(73)	0.162
(2)	1.112	(20)	0.471	(38)	0.36	(56)	0.218	(74)	0.15
(3)	1.071	(21)	0.447	(39)	0.32	(57)	0.21	(75)	1.87
(4)	0.92	(22)	0.425	(40)	0.34	(58)	0.218	(76)	0.993
(5)	0.849	(23)	0.402	(41)	0.32	(59)	0.218	(77)	0.849
(6)	0.816	(24)	0.402	(42)	0.295	(60)	0.218	(78)	8.411
(7)	0.782	(25)	0.402	(43)	0.283	(61)	0.169	(79)	10.4
(8)	0.849	(26)	0.688	(44)	0.249	(62)	0.204	(80)	6.87
(9)	0.92	(27)	0.546	(45)	0.218	(63)	0.189	(81)	7.47
(10)	1.032	(28)	0.564	(46)	0.218	(64)	0.176	(82)	4.205
(11)	0.849	(29)	0.495	(47)	0.218	(65)	0.162	(83)	3.31
(12)	0.782	(30)	0.471	(48)	0.218	(66)	0.162	(84)	2.902
(13)	0.718	(31)	0.447	(49)	0.21	(67)	0.162	(85)	2.346
(14)	0.658	(32)	0.447	(50)	0.208	(68)	0.162	(86)	2.178
(15)	0.546	(33)	0.402	(51)	0.189	(69)	0.162	(87)	1.87
(16)	0.546	(34)	0.381	(52)	0.208	(70)	0.162	(88)	1.732
(17)	0.495	(35)	0.36	(53)	0.189	(71)	0.15	(89)	1.611
(18)	0.495	(36)	0.36	(54)	0.189	(72)	0.15	(90)	1.416

(181)	0.36	(199)	0.218	(217)	2.5	(235)	0.993	(253)	0.576
(182)	0.36	(200)	0.234	(218)	2.346	(236)	0.92	(254)	0.546
(183)	0.36	(201)	0.249	(219)	6.578	(237)	0.92	(255)	0.495
(184)	0.381	(202)	0.249	(220)	4.691	(238)	0.849	(256)	0.495
(185)	0.402	(203)	0.218	(221)	3.523	(239)	1.324	(257)	0.447
(186)	0.36	(204)	1.152	(222)	2.902	(240)	1.071	(258)	0.447
(187)	0.36	(205)	0.546	(223)	2.524	(241)	0.993	(259)	0.447
(188)	0.36	(206)	0.447	(224)	2.178	(242)	0.92	(260)	0.447
(189)	0.36	(207)	1.87	(225)	2.07	(243)	0.849	(261)	0.447
(190)	0.32	(208)	1.28	(226)	2.178	(244)	0.782	(262)	0.402
(191)	0.32	(209)	2.019	(227)	1.73	(245)	0.782	(263)	0.402
(192)	0.263	(210)	12.26	(228)	1.416	(246)	0.658	(264)	0.782
(193)	0.283	(211)	8.88	(229)	1.324	(247)	0.658	(265)	0.576
(194)	0.263	(212)	5.202	(230)	1.236	(248)	0.601	(266)	0.546
(195)	0.283	(213)	5.73	(231)	1.152	(249)	0.601	(267)	0.52
(196)	0.263	(214)	4.205	(232)	1.071	(250)	0.546	(268)	0.658
(197)	0.249	(215)	3.523	(233)	1.071	(251)	0.495	(269)	0.601
(198)	0.234	(216)	2.302	(234)	0.993	(252)	0.546	(270)	5.735

(91)	1.324	(109)	3.1	(127)	0.782	(145)	1.416	(163)	0.849
(92)	1.152	(110)	2.806	(128)	0.782	(146)	2.262	(164)	0.782
(93)	1.071	(111)	2.346	(129)	0.718	(147)	2.524	(165)	0.718
(94)	0.993	(112)	2.178	(130)	0.688	(148)	6.435	(166)	0.718
(95)	0.92	(113)	2.019	(131)	0.658	(149)	2.902	(167)	0.658
(96)	0.849	(114)	2.902	(132)	0.658	(150)	4.568	(168)	0.658
(97)	0.782	(115)	2.178	(133)	0.601	(151)	2.346	(169)	0.546
(98)	0.718	(116)	1.87	(134)	0.546	(152)	1.945	(170)	0.546
(99)	0.658	(117)	1.611	(135)	0.546	(153)	1.732	(171)	0.546
(100)	0.658	(118)	1.416	(136)	0.521	(154)	1.512	(172)	0.546
(101)	0.601	(119)	1.324	(137)	0.495	(155)	1.324	(173)	0.495
(102)	11.51	(120)	1.236	(138)	0.471	(156)	1.236	(174)	0.471
(103)	3.309	(121)	1.152	(139)	0.447	(157)	1.236	(175)	0.447
(104)	2.346	(122)	1.071	(140)	0.447	(158)	1.112	(176)	0.447
(105)	25	(123)	0.993	(141)	0.447	(159)	1.071	(177)	0.402
(106)	7.167	(124)	0.92	(142)	0.471	(160)	0.993	(178)	0.402
(107)	4.69	(125)	0.92	(143)	0.447	(161)	0.92	(179)	0.402
(108)	3.744	(126)	0.816	(144)	0.471	(162)	0.92	(180)	0.381

(271)	3.972	(289)	0.658	(307)	0.32	(325)	0.189	(343)	7.9
(272)	2.902	(290)	0.658	(308)	0.32	(326)	0.189	(344)	7.9
(273)	13.41	(291)	0.601	(309)	0.283	(327)	0.189	(345)	7.9
(274)	4.691	(292)	0.564	(310)	0.263	(328)	0.218	(346)	0.05
(275)	3.102	(293)	0.546	(311)	0.283	(329)	0.218	(347)	0.05
(276)	2.178	(294)	0.521	(312)	0.263	(330)	0.218	(348)	0.038
(277)	1.732	(295)	0.447	(313)	0.249	(331)	0.189	(349)	0.038
(278)	1.416	(296)	0.447	(314)	0.249	(332)	0.189	(350)	0.034
(279)	1.324	(297)	0.402	(315)	0.218	(333)	0.189	(351)	0.029
(280)	1.071	(298)	0.425	(316)	0.234	(334)	0.162	(352)	0.029
(281)	0.92	(299)	0.447	(317)	0.218	(335)	0.162	(353)	0.029
(282)	0.92	(300)	0.447	(318)	0.234	(336)	0.162	(354)	0.029
(283)	0.849	(301)	0.402	(319)	0.218	(337)	0.096	(355)	0.038
(284)	0.884	(302)	0.381	(320)	0.234	(338)	0.096	(356)	0.029
(285)	0.782	(303)	0.36	(321)	0.218	(339)	0.096	(357)	0.029
(286)	0.782	(304)	0.36	(322)	0.204	(340)	0.088	(358)	0.029
(287)	0.718	(305)	0.32	(323)	0.189	(341)	7.9	(359)	0.02
(288)	0.658	(306)	0.36	(324)	0.189	(342)	7.9	(360)	0.02

River discharge data at 12-hourly intervals for Station: 17B
Period : 2

Variable: KOMPAG3.varl (length = 360)

(1) 0.096	(19) 7E-3	(37) 7.9	(55) 0.014	(73) 0.138
(2) 0.05	(20) 0.012	(38) 0.063	(56) 0.189	(74) 0.15
(3) 0.029	(21) 9	(39) 0.063	(57) 0.014	(75) 0.116
(4) 0.025	(22) 5E-3	(40) 0.05	(58) 0.02	(76) 0.116
(5) 0.029	(23) 9	(41) 0.05	(59) 0.029	(77) 7.9
(6) 0.029	(24) 0.017	(42) 0.038	(60) 0.884	(78) 0.063
(7) 0.029	(25) 0.02	(43) 0.038	(61) 0.32	(79) 0.063
(8) 0.029	(26) 0.014	(44) 0.038	(62) 0.189	(80) 0.057
(9) 0.029	(27) 0.014	(45) 0.029	(63) 2.524	(81) 0.05
(10) 0.038	(28) 0.025	(46) 0.029	(64) 1.194	(82) 0.044
(11) 0.029	(29) 0.05	(47) 0.029	(65) 0.718	(83) 0.038
(12) 0.029	(30) 0.044	(48) 0.029	(66) 0.471	(84) 0.038
(13) 0.029	(31) 0.601	(49) 0.029	(67) 0.402	(85) 0.029
(14) 0.029	(32) 0.36	(50) 0.029	(68) 0.263	(86) 0.029
(15) 0.029	(33) 0.189	(51) 0.029	(69) 0.249	(87) 0.029
(16) 0.029	(34) 0.162	(52) 0.029	(70) 0.176	(88) 0.02
(17) 0.02	(35) 0.138	(53) 0.02	(71) 0.162	(89) 0.029
(18) 0.017	(36) 0.106	(54) 0.029	(72) 0.162	(90) 0.017

(91) 9	(109) 0.029	(127) 0.138	(145) 9	(163) 0.017
(92) 0.012	(110) 0.029	(128) 0.116	(146) 9	(164) 0.063
(93) 0.014	(111) 0.02	(129) 0.116	(147) 9	(165) 0.063
(94) 0.025	(112) 0.014	(130) 0.116	(148) 0.017	(166) 0.038
(95) 0.029	(113) 0.05	(131) 7.4	(149) 0.02	(167) 0.029
(96) 0.025	(114) 0.263	(132) 0.096	(150) 0.029	(168) 0.014
(97) 0.014	(115) 0.138	(133) 7.9	(151) 0.02	(169) 9
(98) 0.012	(116) 0.096	(134) 0.05	(152) 0.017	(170) 7E-3
(99) 0.02	(117) 7.9	(135) 0.05	(153) 0.014	(171) 9
(100) 0.32	(118) 0.071	(136) 0.038	(154) 0.014	(172) 7E-3
(101) 0.189	(119) 7.9	(137) 0.029	(155) 0.014	(173) 3E-3
(102) 0.138	(120) 0.381	(138) 0.029	(156) 0.014	(174) 5E-3
(103) 0.063	(121) 0.546	(139) 0.02	(157) 0.014	(175) 2E-3
(104) 0.063	(122) 0.36	(140) 0.014	(158) 0.014	(176) 2E-3
(105) 0.05	(123) 0.249	(141) 0.014	(159) 9	(177) 2E-3
(106) 0.05	(124) 0.218	(142) 0.014	(160) 0.012	(178) 2E-3
(107) 0.038	(125) 0.162	(143) 0.014	(161) 0.014	(179) 2E-3
(108) 0.029	(126) 0.283	(144) 0.014	(162) 0.014	(180) 2E-3

(181) 2E-3	(199) 5E-3	(217) 0.116	(235) 1.071	(253) 0.138
(182) 2E-3	(200) 5E-3	(218) 0.096	(236) 1.071	(254) 0.127
(183) 2E-3	(201) 5E-3	(219) 0.096	(237) 0.993	(255) 0.138
(184) 1E-3	(202) 5E-3	(220) 7.9	(238) 0.75	(256) 0.116
(185) 1E-3	(203) 5E-3	(221) 0.063	(239) 0.546	(257) 0.096
(186) 1E-3	(204) 5E-3	(222) 0.05	(240) 0.546	(258) 0.096
(187) 1E-3	(205) 5E-3	(223) 0.038	(241) 0.495	(259) 7.9
(188) 1E-3	(206) 9	(224) 0.038	(242) 0.425	(260) 0.071
(189) 5E-3	(207) 0.162	(225) 0.029	(243) 0.283	(261) 0.063
(190) 7E-3	(208) 0.993	(226) 0.02	(244) 0.263	(262) 0.063
(191) 9	(209) 0.658	(227) 0.02	(245) 0.249	(263) 7.9
(192) 7E-3	(210) 1.152	(228) 0.02	(246) 0.234	(264) 7.9
(193) 9	(211) 0.601	(229) 0.017	(247) 0.218	(265) 7.9
(194) 7E-3	(212) 0.447	(230) 0.017	(248) 0.218	(266) 7.9
(195) 9	(213) 0.32	(231) 0.02	(249) 0.189	(267) 7.9
(196) 7E-3	(214) 0.218	(232) 0.249	(250) 0.176	(268) 7.9
(197) 5E-3	(215) 0.138	(233) 1.236	(251) 0.162	(269) 7.9
(198) 5E-3	(216) 0.138	(234) 1.512	(252) 0.162	(270) 0.071

(271) 0.029	(289) 7.9	(307) 0.05	(325) 0.32	(343) 0.138
(272) 0.029	(290) 7.7	(308) 0.05	(326) 0.263	(344) 0.127
(273) 0.029	(291) 0.029	(309) 0.05	(327) 0.245	(345) 0.116
(274) 0.029	(292) 0.071	(310) 0.116	(328) 0.218	(346) 0.116
(275) 0.029	(293) 0.063	(311) 0.718	(329) 0.189	(347) 0.096
(276) 0.025	(294) 0.063	(312) 0.127	(330) 0.204	(348) 0.096
(277) 0.02	(295) 0.05	(313) 1.235	(331) 0.189	(349) 0.096
(278) 0.038	(296) 0.05	(314) 0.884	(332) 0.162	(350) 0.088
(279) 0.32	(297) 0.038	(315) 0.658	(333) 0.162	(351) 7.9
(280) 0.234	(298) 0.029	(316) 0.564	(334) 0.162	(352) 0.088
(281) 0.162	(299) 0.029	(317) 0.447	(335) 0.162	(353) 7.9
(282) 0.162	(300) 0.029	(318) 0.381	(336) 0.15	(354) 0.088
(283) 0.138	(301) 0.029	(319) 0.32	(337) 0.155	(355) 7.9
(284) 0.138	(302) 0.029	(320) 0.263	(338) 0.138	(356) 7.9
(285) 0.116	(303) 0.029	(321) 0.283	(339) 0.138	(357) 7.9
(286) 0.096	(304) 0.029	(322) 0.546	(340) 0.138	(358) 7.9
(287) 0.096	(305) 0.038	(323) 0.402	(341) 0.116	(359) 0.063
(288) 7.9	(306) 0.038	(324) 0.36	(342) 0.138	(360) 0.063

A3.53

River discharge data at 12-hourly intervals for Station: 17B
Period : 3

Variable: KOMPAG5.var1   (length = 360)

(1) 0.116	(19) 0.029	(37) 0	(55) 0.014	(73) 0.02
(2) 0.162	(20) 0.014	(38) 9	(56) 0.017	(74) 0.029
(3) 0.162	(21) 0.014	(39) 0.014	(57) 0.014	(75) 0.02
(4) 0.15	(22) 0.02	(40) 0.02	(58) 0.012	(76) 0.017
(5) 0.116	(23) 0.02	(41) 0.014	(59) 9	(77) 9
(6) 0.088	(24) 0.02	(42) 9	(60) 7E-3	(78) 5E-3
(7) 0.096	(25) 0.02	(43) 2E-3	(61) 5E-3	(79) 5E-3
(8) 7.9	(26) 0.02	(44) 5E-3	(62) 5E-3	(80) 5E-3
(9) 7.9	(27) 0.014	(45) 2E-3	(63) 5E-3	(81) 9
(10) 7.9	(28) 9	(46) 2E-3	(64) 0.012	(82) 9
(11) 7.9	(29) 7E-3	(47) 1E-3	(65) 0.02	(83) 5E-3
(12) 0.071	(30) 5E-3	(48) 1E-3	(66) 0.025	(84) 5E-3
(13) 0.063	(31) 5E-3	(49) 1E-3	(67) 0.03	(85) 2E-3
(14) 0.063	(32) 3E-3	(50) 1E-3	(68) 0.025	(86) 1E-3
(15) 0.063	(33) 1E-3	(51) 1E-3	(69) 0.038	(87) 2E-3
(16) 0.05	(34) 0	(52) 1E-3	(70) 0.02	(88) 1E-3
(17) 0.038	(35) 5E-3	(53) 1E-3	(71) 0.013	(89) 0
(18) 0.035	(36) 9	(54) 5E-3	(72) 0.029	(90) 0

(181) 0	(199) 0	(217) 0	(235) 0	(253) 0
(182) 0	(200) 0	(218) 0	(236) 0	(254) 0
(183) 0	(201) 0	(219) 0	(237) 0	(255) 0
(184) 0	(202) 0	(220) 0	(238) 0	(256) 0
(185) 0	(203) 0	(221) 0	(239) 0	(257) 0
(186) 0	(204) 0	(222) 0	(240) 0	(258) 0
(187) 0	(205) 0	(223) 0	(241) 0	(259) 0
(188) 0	(206) 0	(224) 0	(242) 0	(260) 0
(189) 0	(207) 0	(225) 0	(243) 0	(261) 0
(190) 0	(208) 0	(226) 0	(244) 0	(262) 0
(191) 0	(209) 0	(227) 0	(245) 0	(263) 0
(192) 0	(210) 0	(228) 0	(246) 0	(264) 0
(193) 0	(211) 0	(229) 0	(247) 0	(265) 0
(194) 0	(212) 0	(230) 0	(248) 0	(266) 0
(195) 0	(213) 0	(231) 0	(249) 0	(267) 0
(196) 0	(214) 0	(232) 0	(250) 0	(268) 0
(197) 0	(215) 0	(233) 0	(251) 0	(269) 0
(198) 0	(216) 0	(234) 0	(252) 0	(270) 0

(91) 0	(109) 0	(127) 0	(145) 0	(163) 0
(92) 0	(110) 0	(128) 0	(146) 0	(164) 0
(93) 0	(111) 0	(129) 0	(147) 0	(165) 0
(94) 0	(112) 0	(130) 0	(148) 0	(166) 0
(95) 0	(113) 0	(131) 0	(149) 0	(167) 0
(96) 0	(114) 0	(132) 0	(150) 0	(168) 0
(97) 0	(115) 0	(133) 0	(151) 0	(169) 0
(98) 0	(116) 0	(134) 0	(152) 0	(170) 0
(99) 0	(117) 0	(135) 0	(153) 0	(171) 0
(100) 0	(118) 0	(136) 0	(154) 0	(172) 0
(101) 0	(119) 0	(137) 0	(155) 0	(173) 0
(102) 0	(120) 0	(138) 0	(156) 0	(174) 0
(103) 0	(121) 0	(139) 0	(157) 0	(175) 0
(104) 0	(122) 0	(140) 0	(158) 0	(176) 0
(105) 0	(123) 0	(141) 0	(159) 0	(177) 0
(106) 0	(124) 0	(142) 0	(160) 0	(178) 0
(107) 0	(125) 0	(143) 0	(161) 0	(179) 0
(108) 0	(126) 0	(144) 0	(162) 0	(180) 0

(271) 0	(289) 1E-3	(307) 2E-3	(325) 0.249	(343) 0.063
(272) 0	(290) 0.249	(308) 2E-3	(326) 0.218	(344) 0.063
(273) 0	(291) 0.138	(309) 1E-3	(327) 1.611	(345) 0.05
(274) 0	(292) 0.106	(310) 1E-3	(328) 1.512	(346) 0.057
(275) 0	(293) 0.063	(311) 5E-3	(329) 0.849	(347) 0.05
(276) 0	(294) 0.063	(312) 5E-3	(330) 0.546	(348) 0.05
(277) 0	(295) 0.039	(313) 5E-3	(331) 0.402	(349) 0.05
(278) 0	(296) 0.034	(314) 0.012	(332) 0.32	(350) 0.05
(279) 0	(297) 0.029	(315) 5E-3	(333) 0.249	(351) 7.9
(280) 0	(298) 0.029	(316) 0.012	(334) 0.204	(352) 0.218
(281) 2E-3	(299) 0.02	(317) 5E-3	(335) 0.162	(353) 0.063
(282) 5E-3	(300) 0.017	(318) 9	(336) 0.15	(354) 0.096
(283) 5E-3	(301) 0.014	(319) 5E-3	(337) 0.116	(355) 0.063
(284) 5E-3	(302) 9	(320) 0.014	(338) 0.116	(356) 7.9
(285) 2E-3	(303) 5E-3	(321) 1.236	(339) 0.096	(357) 0.05
(286) 2E-3	(304) 5E-3	(322) 0.718	(340) 0.088	(358) 0.057
(287) 1E-3	(305) 5E-3	(323) 0.447	(341) 0.076	(359) 0.05
(288) 1E-3	(306) 5E-3	(324) 0.32	(342) 7.9	(360) 0.05

River discharge data at 12-hourly intervals for Station: 17B
Period : 5

A3.55

Variable: VIS1.vari (length = 360)

(1) 0	(19) 0	(37) 0	(55) 0	(73) 0
(2) 0	(20) 0	(38) 0	(56) 0	(74) 0
(3) 0	(21) 0	(39) 0	(57) 0	(75) 0
(4) 0	(22) 0	(40) 0	(58) 0	(76) 0
(5) 0	(23) 0	(41) 0	(59) 0	(77) 0
(6) 0	(24) 0	(42) 0	(60) 0	(78) 0
(7) 0	(25) 0	(43) 0	(61) 0	(79) 0
(8) 0	(26) 0	(44) 0	(62) 0	(80) 0
(9) 0	(27) 0	(45) 0	(63) 0	(81) 0
(10) 0	(28) 0	(46) 0	(64) 0	(82) 0
(11) 0	(29) 0	(47) 0	(65) 0	(83) 0
(12) 0	(30) 0	(48) 0	(66) 0	(84) 0
(13) 0	(31) 0	(49) 0	(67) 0	(85) 0
(14) 0	(32) 0	(50) 0	(68) 0	(86) 0
(15) 0	(33) 0	(51) 0	(69) 0	(87) 0
(16) 0	(34) 0	(52) 0	(70) 0	(88) 0
(17) 0	(35) 0	(53) 0	(71) 0	(89) 0
(18) 0	(36) 0	(54) 0	(72) 0	(90) 0

(181) 0	(199) 0	(217) 0	(235) 0	(253) 0
(182) 0	(200) 0	(218) 0	(236) 0	(254) 0
(183) 0	(201) 0	(219) 0	(237) 0	(255) 0
(184) 0	(202) 0	(220) 0	(238) 0	(256) 0
(185) 0	(203) 0	(221) 0	(239) 0	(257) 0
(186) 0	(204) 0	(222) 0	(240) 0	(258) 0
(187) 0	(205) 0	(223) 0	(241) 0	(259) 0
(188) 0	(206) 0	(224) 0	(242) 0	(260) 0
(189) 0	(207) 0	(225) 0	(243) 0	(261) 0
(190) 0	(208) 0	(226) 0	(244) 0	(262) 0
(191) 0	(209) 0	(227) 0	(245) 0	(263) 0
(192) 0	(210) 0	(228) 0	(246) 0	(264) 0
(193) 0	(211) 0	(229) 0	(247) 0	(265) 0
(194) 0	(212) 0	(230) 0	(248) 0	(266) 0
(195) 0	(213) 0	(231) 0	(249) 0	(267) 0
(196) 0	(214) 0	(232) 0	(250) 0	(268) 0
(197) 0	(215) 0	(233) 0	(251) 0	(269) 0
(198) 0	(216) 0	(234) 0	(252) 0	(270) 0

(91) 0	(109) 0	(127) 0	(145) 0	(163) 0
(92) 0	(110) 0	(128) 0	(146) 0	(164) 0
(93) 0	(111) 0	(129) 0	(147) 0	(165) 0
(94) 0	(112) 0	(130) 0	(148) 0	(166) 0
(95) 0	(113) 0	(131) 0	(149) 0	(167) 0
(96) 0	(114) 0	(132) 0	(150) 0	(168) 0
(97) 0	(115) 0	(133) 0	(151) 0	(169) 0
(98) 0	(116) 0	(134) 0	(152) 0	(170) 0
(99) 0	(117) 0	(135) 0	(153) 0	(171) 0
(100) 0	(118) 0	(136) 0	(154) 0	(172) 0
(101) 0	(119) 0	(137) 0	(155) 0	(173) 0
(102) 0	(120) 0	(138) 0	(156) 0	(174) 0
(103) 0	(121) 0	(139) 0	(157) 0	(175) 0
(104) 0	(122) 0	(140) 0	(158) 0	(176) 0
(105) 0	(123) 0	(141) 0	(159) 0	(177) 0
(106) 0	(124) 0	(142) 0	(160) 0	(178) 0
(107) 0	(125) 0	(143) 0	(161) 0	(179) 0
(108) 0	(126) 0	(144) 0	(162) 0	(180) 0

(271) 0	(289) 0	(307) 0	(325) 0	(343) 2.087
(272) 0	(290) 0	(308) 0	(326) 0.04	(344) 2.09
(273) 0	(291) 0	(309) 0	(327) 1E-3	(345) 0.518
(274) 0	(292) 0	(310) 0	(328) 0.033	(346) 0.51
(275) 0	(293) 0	(311) 0	(329) 5E-3	(347) 0.518
(276) 0	(294) 0	(312) 0	(330) 2E-3	(348) 1.87
(277) 0	(295) 0	(313) 0	(331) 1E-3	(349) 1.771
(278) 0	(296) 0	(314) 0	(332) 1E-3	(350) 1.575
(279) 0	(297) 0	(315) 0	(333) 0	(351) 1.67
(280) 0	(298) 0	(316) 0	(334) 0	(352) 1.121
(281) 0	(299) 0	(317) 0	(335) 0	(353) 0.518
(282) 0	(300) 0	(318) 0	(336) 0	(354) 0.296
(283) 0	(301) 0	(319) 0	(337) 0	(355) 0.197
(284) 0	(302) 0	(320) 0	(338) 0	(356) 0.159
(285) 0	(303) 0	(321) 0	(339) 0.376	(357) 0.121
(286) 0	(304) 0	(322) 0	(340) 0.02	(358) 0.12
(287) 0	(305) 0	(323) 0	(341) 3E-3	(359) 0.083
(288) 0	(306) 0	(324) 0	(342) 1E-3	(360) 0.07

River discharge data at 12-hourly intervals for Station: 20A
Period : 1

Variable: VISS.var1 (length = 360)

(1) 0	(19) 0	(37) 0	(55) 0	(73) 0
(2) 0	(20) 0	(38) 0	(56) 0	(74) 0
(3) 0	(21) 0	(39) 0	(57) 0	(75) 0
(4) 0	(22) 0	(40) 0	(58) 0	(76) 1E-3
(5) 0	(23) 0	(41) 0	(59) 0	(77) 9
(6) 0	(24) 0	(42) 0	(60) 0	(78) 0.015
(7) 0	(25) 0	(43) 0	(61) 1E-3	(79) 5E-3
(8) 0	(26) 0	(44) 0	(62) 1E-3	(80) 0.017
(9) 0	(27) 0	(45) 0	(63) 1E-3	(81) 3E-3
(10) 0	(28) 0	(46) 0	(64) 9	(82) 7E-3
(11) 0	(29) 0	(47) 0	(65) 5E-3	(83) 1E-3
(12) 0	(30) 0	(48) 0	(66) 5E-3	(84) 0.015
(13) 0	(31) 0	(49) 0	(67) 7E-3	(85) 0
(14) 0	(32) 0	(50) 0	(68) 1E-3	(86) 9
(15) 0	(33) 0	(51) 0	(69) 1E-3	(87) 0
(16) 0	(34) 1E-3	(52) 0	(70) 0	(88) 7E-3
(17) 0	(35) 0	(53) 0	(71) 0	(89) 0
(18) 0	(36) 1E-3	(54) 0	(72) 0	(90) 0

(91) 0	(109) 0	(127) 0	(145) 0	(163) 0
(92) 0	(110) 0	(128) 0	(146) 0	(164) 0
(93) 0	(111) 0	(129) 0	(147) 0	(165) 0
(94) 0	(112) 0	(130) 0	(148) 0	(166) 0
(95) 0	(113) 0	(131) 0	(149) 0	(167) 0
(96) 0	(114) 0	(132) 0	(150) 0	(168) 0
(97) 0	(115) 0	(133) 0	(151) 0	(169) 0
(98) 0	(116) 0	(134) 0	(152) 0	(170) 0
(99) 0	(117) 0	(135) 0	(153) 0	(171) 0
(100) 0	(118) 0	(136) 0	(154) 0	(172) 0
(101) 0	(119) 0	(137) 0	(155) 0	(173) 0
(102) 0	(120) 0	(138) 0	(156) 0	(174) 0
(103) 0	(121) 0	(139) 0	(157) 0	(175) 0
(104) 0	(122) 0	(140) 0	(158) 0	(176) 0
(105) 0	(123) 0	(141) 0	(159) 0	(177) 0
(106) 0	(124) 0	(142) 0	(160) 0	(178) 0
(107) 0	(125) 0	(143) 0	(161) 0	(179) 0
(108) 0	(126) 0	(144) 0	(162) 0	(180) 0

(181) 0	(199) 0	(217) 0	(235) 0.17	(253) 0
(182) 0	(200) 0	(218) 0	(236) 0.065	(254) 0
(183) 0	(201) 0	(219) 0	(237) 9	(255) 0
(184) 0	(202) 0	(220) 0	(238) 4E-3	(256) 0
(185) 0	(203) 0	(221) 0	(239) 1E-3	(257) 0
(186) 0	(204) 0	(222) 0	(240) 1E-3	(258) 0
(187) 0	(205) 0	(223) 0	(241) 0	(259) 0
(188) 0	(206) 0	(224) 0	(242) 1E-3	(260) 0
(189) 0	(207) 0.819	(225) 0	(243) 0	(261) 0
(190) 0	(208) 0.021	(226) 0	(244) 0	(262) 0
(191) 0	(209) 3E-3	(227) 0	(245) 0	(263) 0
(192) 0	(210) 1E-3	(228) 0	(246) 0	(264) 0
(193) 0	(211) 1E-3	(229) 0	(247) 0	(265) 0
(194) 0	(212) 2E-3	(230) 0	(248) 0	(266) 0
(195) 0	(213) 0	(231) 0.296	(249) 0	(267) 0
(196) 0	(214) 0	(232) 0.52	(250) 0	(268) 0
(197) 0	(215) 0	(233) 0.121	(251) 0	(269) 0
(198) 0	(216) 0	(234) 0.296	(252) 0	(270) 0

(271) 0	(289) 0	(307) 0	(325) 0	(343) 0.042
(272) 0	(290) 0	(308) 0	(326) 1E-3	(344) 0.03
(273) 0	(291) 0	(309) 0	(327) 0	(345) 5E-3
(274) 0	(292) 0	(310) 0.015	(328) 6E-3	(346) 3E-3
(275) 0	(293) 0	(311) 5E-3	(329) 0	(347) 1E-3
(276) 0	(294) 0	(312) 0.052	(330) 6E-3	(348) 1E-3
(277) 0.021	(295) 0	(313) 1E-3	(331) 9	(349) 0
(278) 0.021	(296) 0	(314) 1E-3	(332) 9	(350) 1E-3
(279) 5E-3	(297) 0	(315) 0	(333) 9	(351) 0
(280) 5E-3	(298) 0	(316) 1E-3	(334) 5E-3	(352) 1E-3
(281) 1E-3	(299) 0	(317) 0	(335) 5E-3	(353) 0
(282) 2E-3	(300) 0	(318) 1E-3	(336) 5E-3	(354) 1E-3
(283) 0	(301) 0	(319) 0	(337) 5E-3	(355) 0
(284) 2E-3	(302) 0	(320) 1E-3	(338) 5E-3	(356) 0
(285) 0	(303) 0	(321) 0	(339) 0.03	(357) 0.04
(286) 0	(304) 0	(322) 1E-3	(340) 0.052	(358) 0.034
(287) 0	(305) 0	(323) 0	(341) 0.083	(359) 0.04
(288) 0	(306) 0	(324) 1E-3	(342) 0.083	(360) 0.034

River discharge data at 12-hourly intervals for Station: 20A
Period : 3

A3.59

Variable: VIS5.vari (length = 360)

(1) 0	(19) 0	(37) 0	(55) 0	(73) 0	(91) 0
(2) 0	(20) 0	(38) 0	(56) 0	(74) 0	(92) 0
(3) 0	(21) 0	(39) 0	(57) 0	(75) 0	(93) 0
(4) 0	(22) 0	(40) 0	(58) 0	(76) 0	(94) 0
(5) 0	(23) 0	(41) 0	(59) 0	(77) 0	(95) 0
(6) 0	(24) 0	(42) 0	(60) 0	(78) 0	(96) 0
(7) 0	(25) 0	(43) 0	(61) 0	(79) 0	(97) 0
(8) 0	(26) 0	(44) 0	(62) 0	(80) 0	(98) 0
(9) 0	(27) 0	(45) 0	(63) 0	(81) 0	(99) 0
(10) 0	(28) 0	(46) 0	(64) 0	(82) 0	(100) 0
(11) 0	(29) 0	(47) 0	(65) 0	(83) 0	(101) 0
(12) 0	(30) 0	(48) 0	(66) 0	(84) 0	(102) 0
(13) 0	(31) 0	(49) 0	(67) 0	(85) 0	(103) 0
(14) 0	(32) 0	(50) 0	(68) 0	(86) 0	(104) 0
(15) 0	(33) 0	(51) 0	(69) 0	(87) 0	(105) 0
(16) 0	(34) 0	(52) 5E-3	(70) 0	(88) 0	(106) 0
(17) 0	(35) 0	(53) 0	(71) 0	(89) 0	(107) 0
(18) 0	(36) 0	(54) 0	(72) 0	(90) 0	(108) 0

(109) 0	(127) 0	(145) 0	(163) 0	(181) 0	(199) 0
(110) 0	(128) 0	(146) 0	(164) 0	(182) 0	(200) 0
(111) 0	(129) 0	(147) 0	(165) 0	(183) 0	(201) 0
(112) 0	(130) 0	(148) 0	(166) 0	(184) 0	(202) 0
(113) 0	(131) 0	(149) 0	(167) 0	(185) 0	(203) 0
(114) 0	(132) 0	(150) 0	(168) 0	(186) 0	(204) 0
(115) 0	(133) 0	(151) 0	(169) 0	(187) 0	(205) 0
(116) 0	(134) 0	(152) 0	(170) 0	(188) 0	(206) 0
(117) 0	(135) 0	(153) 0	(171) 0	(189) 0	(207) 0
(118) 0	(136) 0	(154) 0	(172) 0	(190) 0	(208) 0
(119) 0	(137) 0	(155) 0	(173) 0	(191) 0	(209) 0
(120) 0	(138) 0	(156) 0	(174) 0	(192) 0	(210) 0
(121) 0	(139) 0	(157) 0	(175) 0	(193) 0	(211) 0
(122) 0	(140) 0	(158) 0	(176) 0	(194) 0	(212) 0
(123) 0	(141) 0	(159) 0	(177) 0	(195) 0	(213) 0
(124) 0	(142) 0	(160) 0	(178) 0	(196) 0	(214) 0
(125) 0	(143) 0	(161) 0	(179) 0	(197) 0	(215) 0
(126) 0	(144) 0	(162) 0	(180) 0	(198) 0	(216) 0

(217) 0	(235) 0	(253) 0	(271) 0	(289) 0	(307) 0
(218) 0	(236) 0	(254) 0	(272) 0	(290) 0	(308) 0
(219) 0	(237) 0	(255) 0	(273) 0	(291) 0	(309) 0
(220) 0	(238) 0	(256) 0	(274) 0	(292) 0	(310) 0
(221) 0	(239) 0	(257) 0	(275) 0	(293) 0	(311) 0
(222) 0	(240) 0	(258) 0	(276) 0	(294) 0	(312) 0
(223) 0	(241) 0	(259) 0	(277) 0	(295) 0	(313) 0
(224) 0	(242) 0	(260) 0	(278) 0	(296) 0	(314) 0
(225) 0	(243) 0	(261) 0	(279) 0	(297) 0	(315) 0
(226) 0	(244) 0	(262) 0	(280) 0	(298) 0	(316) 0
(227) 0	(245) 0	(263) 0	(281) 0	(299) 0	(317) 0
(228) 0	(246) 0	(264) 0	(282) 0	(300) 0	(318) 0
(229) 0	(247) 0	(265) 0	(283) 0	(301) 0	(319) 0
(230) 0	(248) 0	(266) 0	(284) 0	(302) 0	(320) 0
(231) 0	(249) 0	(267) 0	(285) 0	(303) 0	(321) 0
(232) 0	(250) 0	(268) 0	(286) 0	(304) 0	(322) 0
(233) 0	(251) 0	(269) 0	(287) 0	(305) 0	(323) 0
(234) 0	(252) 0	(270) 0	(288) 0	(306) 0	(324) 0

(325) 0	(343) 0
(326) 0	(344) 0
(327) 0	(345) 0
(328) 0	(346) 0
(329) 0	(347) 0
(330) 0	(348) 0
(331) 0	(349) 0
(332) 0	(350) 0
(333) 0	(351) 0
(334) 0	(352) 0
(335) 0	(353) 0
(336) 0	(354) 0
(337) 0	(355) 0
(338) 0	(356) 0
(339) 0	(357) 0
(340) 0	(358) 0
(341) 0	(359) 0
(342) 0	(360) 0

River discharge data at 12-hourly intervals for Station: 20A
Period : 5

Variable: VUELVL1.var1 (length = 360)

(1) 0.64	(19) 0.64	(37) 0.4	(55) 0.4	(73) 0.16
(2) 0.64	(20) 0.64	(38) 0.4	(56) 0.4	(74) 0.16
(3) 0.64	(21) 0.64	(39) 0.4	(57) 0.16	(75) 0.16
(4) 0.64	(22) 0.64	(40) 0.4	(58) 0.16	(76) 0.16
(5) 0.64	(23) 0.64	(41) 0.4	(59) 0.16	(77) 0.16
(6) 0.64	(24) 0.64	(42) 0.4	(60) 0.16	(78) 0.16
(7) 0.64	(25) 0.64	(43) 0.4	(61) 0.16	(79) 0.16
(8) 0.64	(26) 0.64	(44) 0.4	(62) 0.16	(80) 0.16
(9) 0.64	(27) 0.64	(45) 0.4	(63) 0.16	(81) 0.16
(10) 0.64	(28) 0.64	(46) 0.4	(64) 0.16	(82) 0.16
(11) 0.64	(29) 0.4	(47) 0.4	(65) 0.16	(83) 0.07
(12) 0.64	(30) 0.4	(48) 0.4	(66) 0.16	(84) 0.07
(13) 0.64	(31) 0.4	(49) 0.4	(67) 0.16	(85) 0.07
(14) 0.64	(32) 0.4	(50) 0.4	(68) 0.16	(86) 0.07
(15) 0.64	(33) 0.4	(51) 0.4	(69) 0.16	(87) 0.07
(16) 0.64	(34) 0.4	(52) 0.4	(70) 0.16	(88) 0.07
(17) 0.64	(35) 0.4	(53) 0.4	(71) 0.16	(89) 0.07
(18) 0.64	(36) 0.4	(54) 0.4	(72) 0.16	(90) 0.07

(181) 0.05	(199) 0.34	(217) 0.43	(235) 0.19	(253) 0.073
(182) 0.05	(200) 0.34	(218) 0.43	(236) 0.19	(254) 0.073
(183) 0.05	(201) 0.43	(219) 0.43	(237) 0.19	(255) 0.07
(184) 0.05	(202) 0.43	(220) 0.43	(238) 0.19	(256) 0.07
(185) 0.05	(203) 0.43	(221) 0.43	(239) 0.19	(257) 0.07
(186) 0.05	(204) 0.43	(222) 0.43	(240) 0.19	(258) 0.07
(187) 0.05	(205) 0.43	(223) 0.43	(241) 0.19	(259) 0.07
(188) 0.05	(206) 0.43	(224) 0.43	(242) 0.19	(260) 0.07
(189) 0.05	(207) 0.43	(225) 0.19	(243) 0.19	(261) 0.07
(190) 0.05	(208) 0.43	(226) 0.19	(244) 0.19	(262) 0.07
(191) 0.05	(209) 0.43	(227) 0.19	(245) 0.19	(263) 0.07
(192) 0.05	(210) 0.43	(228) 0.19	(246) 0.19	(264) 0.07
(193) 0.05	(211) 0.43	(229) 0.19	(247) 0.19	(265) 0.07
(194) 0.05	(212) 0.43	(230) 0.19	(248) 0.19	(266) 0.07
(195) 0.05	(213) 0.43	(231) 0.19	(249) 0.19	(267) 0.07
(196) 0.05	(214) 0.43	(232) 0.19	(250) 0.19	(268) 0.07
(197) 0.432	(215) 0.43	(233) 0.19	(251) 0.19	(269) 0.07
(198) 0.432	(216) 0.43	(234) 0.19	(252) 0.19	(270) 0.07

(91) 0.07	(109) 0.07	(127) 0.34	(145) 0.32	(163) 0.32
(92) 0.07	(110) 0.07	(128) 0.34	(146) 0.32	(164) 0.32
(93) 0.07	(111) 0.07	(129) 0.34	(147) 0.32	(165) 0.32
(94) 0.07	(112) 0.07	(130) 0.34	(148) 0.32	(166) 0.32
(95) 0.07	(113) 0.34	(131) 0.34	(149) 0.32	(167) 0.32
(96) 0.07	(114) 0.34	(132) 0.34	(150) 0.32	(168) 0.32
(97) 0.07	(115) 0.34	(133) 0.34	(151) 0.32	(169) 0.32
(98) 0.07	(116) 0.34	(134) 0.34	(152) 0.32	(170) 0.32
(99) 0.07	(117) 0.34	(135) 0.34	(153) 0.32	(171) 0.32
(100) 0.07	(118) 0.34	(136) 0.34	(154) 0.32	(172) 0.32
(101) 0.07	(119) 0.34	(137) 0.34	(155) 0.32	(173) 0.05
(102) 0.07	(120) 0.34	(138) 0.34	(156) 0.32	(174) 0.05
(103) 0.07	(121) 0.34	(139) 0.34	(157) 0.232	(175) 0.05
(104) 0.07	(122) 0.34	(140) 0.34	(158) 0.232	(176) 0.05
(105) 0.07	(123) 0.34	(141) 0.32	(159) 0.32	(177) 0.05
(106) 0.07	(124) 0.34	(142) 0.32	(160) 0.32	(178) 0.05
(107) 0.07	(125) 0.34	(143) 0.32	(161) 0.32	(179) 0.05
(108) 0.07	(126) 0.34	(144) 0.32	(162) 0.32	(180) 0.05

(271) 0.07	(289) 0.05	(307) 0.05	(325) 0.16	(343) 1.156
(272) 0.07	(290) 0.05	(308) 0.05	(326) 0.16	(344) 1.156
(273) 0.07	(291) 0.05	(309) 0.16	(327) 0.16	(345) 1.156
(274) 0.07	(292) 0.05	(310) 0.16	(328) 0.16	(346) 1.156
(275) 0.07	(293) 0.05	(311) 0.16	(329) 0.16	(347) 1.156
(276) 0.07	(294) 0.05	(312) 0.16	(330) 0.16	(348) 1.156
(277) 0.07	(295) 0.05	(313) 0.16	(331) 0.16	(349) 1.156
(278) 0.07	(296) 0.05	(314) 0.16	(332) 0.16	(350) 1.156
(279) 0.08	(297) 0.05	(315) 0.16	(333) 0.16	(351) 1.156
(280) 0.08	(298) 0.05	(316) 0.16	(334) 0.16	(352) 1.156
(281) 0.08	(299) 0.05	(317) 0.16	(335) 0.16	(353) 1.156
(282) 0.08	(300) 0.05	(318) 0.16	(336) 0.16	(354) 1.156
(283) 0.08	(301) 0.05	(319) 0.16	(337) 1.156	(355) 1.156
(284) 0.08	(302) 0.05	(320) 0.16	(338) 1.156	(356) 1.156
(285) 0.08	(303) 0.05	(321) 0.16	(339) 1.156	(357) 1.16
(286) 0.08	(304) 0.05	(322) 0.16	(340) 1.156	(358) 1.16
(287) 0.08	(305) 0.05	(323) 0.16	(341) 1.156	(359) 1.1
(288) 0.08	(306) 0.05	(324) 0.16	(342) 1.156	(360) 1.1

River discharge data at 12-hourly intervals for Station: 21D
Period : 1

A3.63

Variable: VUELVL3.var1 (length = 360)

(1) 0.64	(19) 0.64	(37) 0.4	(55) 0.4	(73) 0.16
(2) 0.64	(20) 0.64	(38) 0.4	(56) 0.4	(74) 0.16
(3) 0.64	(21) 0.64	(39) 0.4	(57) 0.16	(75) 0.16
(4) 0.64	(22) 0.64	(40) 0.4	(58) 0.16	(76) 0.16
(5) 0.64	(23) 0.64	(41) 0.4	(59) 0.16	(77) 0.16
(6) 0.64	(24) 0.64	(42) 0.4	(60) 0.16	(78) 0.16
(7) 0.64	(25) 0.64	(43) 0.4	(61) 0.16	(79) 0.16
(8) 0.64	(26) 0.64	(44) 0.4	(62) 0.16	(80) 0.16
(9) 0.64	(27) 0.64	(45) 0.4	(63) 0.16	(81) 0.16
(10) 0.64	(28) 0.64	(46) 0.4	(64) 0.16	(82) 0.16
(11) 0.64	(29) 0.4	(47) 0.4	(65) 0.16	(83) 0.07
(12) 0.64	(30) 0.4	(48) 0.4	(66) 0.16	(84) 0.07
(13) 0.64	(31) 0.4	(49) 0.4	(67) 0.16	(85) 0.07
(14) 0.64	(32) 0.4	(50) 0.4	(68) 0.16	(86) 0.07
(15) 0.64	(33) 0.4	(51) 0.4	(69) 0.16	(87) 0.07
(16) 0.64	(34) 0.4	(52) 0.4	(70) 0.16	(88) 0.07
(17) 0.64	(35) 0.4	(53) 0.4	(71) 0.16	(89) 0.07
(18) 0.64	(36) 0.4	(54) 0.4	(72) 0.16	(90) 0.07

(181) 0.05	(199) 0.34	(217) 0.43	(235) 0.19	(253) 0.073
(182) 0.05	(200) 0.34	(218) 0.43	(236) 0.19	(254) 0.073
(183) 0.05	(201) 0.43	(219) 0.43	(237) 0.19	(255) 0.07
(184) 0.05	(202) 0.43	(220) 0.43	(238) 0.19	(256) 0.07
(185) 0.05	(203) 0.43	(221) 0.43	(239) 0.19	(257) 0.07
(186) 0.05	(204) 0.43	(222) 0.43	(240) 0.19	(258) 0.07
(187) 0.05	(205) 0.43	(223) 0.43	(241) 0.19	(259) 0.07
(188) 0.05	(206) 0.43	(224) 0.43	(242) 0.19	(260) 0.07
(189) 0.05	(207) 0.43	(225) 0.19	(243) 0.19	(261) 0.07
(190) 0.05	(208) 0.43	(226) 0.19	(244) 0.19	(262) 0.07
(191) 0.05	(209) 0.43	(227) 0.19	(245) 0.19	(263) 0.07
(192) 0.05	(210) 0.43	(228) 0.19	(246) 0.19	(264) 0.07
(193) 0.05	(211) 0.43	(229) 0.19	(247) 0.19	(265) 0.07
(194) 0.05	(212) 0.43	(230) 0.19	(248) 0.19	(266) 0.07
(195) 0.05	(213) 0.43	(231) 0.19	(249) 0.19	(267) 0.07
(196) 0.05	(214) 0.43	(232) 0.19	(250) 0.19	(268) 0.07
(197) 0.432	(215) 0.43	(233) 0.19	(251) 0.19	(269) 0.07
(198) 0.432	(216) 0.43	(234) 0.19	(252) 0.19	(270) 0.07

(91) 0.07	(109) 0.07	(127) 0.34	(145) 0.32	(163) 0.32
(92) 0.07	(110) 0.07	(128) 0.34	(146) 0.32	(164) 0.32
(93) 0.07	(111) 0.07	(129) 0.34	(147) 0.32	(165) 0.32
(94) 0.07	(112) 0.07	(130) 0.34	(148) 0.32	(166) 0.32
(95) 0.07	(113) 0.34	(131) 0.34	(149) 0.32	(167) 0.32
(96) 0.07	(114) 0.34	(132) 0.34	(150) 0.32	(168) 0.32
(97) 0.07	(115) 0.34	(133) 0.34	(151) 0.32	(169) 0.32
(98) 0.07	(116) 0.34	(134) 0.34	(152) 0.32	(170) 0.32
(99) 0.07	(117) 0.34	(135) 0.34	(153) 0.32	(171) 0.32
(100) 0.07	(118) 0.34	(136) 0.34	(154) 0.32	(172) 0.32
(101) 0.07	(119) 0.34	(137) 0.34	(155) 0.32	(173) 0.05
(102) 0.07	(120) 0.34	(138) 0.34	(156) 0.32	(174) 0.05
(103) 0.07	(121) 0.34	(139) 0.34	(157) 0.232	(175) 0.05
(104) 0.07	(122) 0.34	(140) 0.34	(158) 0.232	(176) 0.05
(105) 0.07	(123) 0.34	(141) 0.32	(159) 0.32	(177) 0.05
(106) 0.07	(124) 0.34	(142) 0.32	(160) 0.32	(178) 0.05
(107) 0.07	(125) 0.34	(143) 0.32	(161) 0.32	(179) 0.05
(108) 0.07	(126) 0.34	(144) 0.32	(162) 0.32	(180) 0.05

(271) 0.07	(289) 0.05	(307) 0.05	(325) 0.16	(343) 1.156
(272) 0.07	(290) 0.05	(308) 0.05	(326) 0.16	(344) 1.156
(273) 0.07	(291) 0.05	(309) 0.16	(327) 0.16	(345) 1.156
(274) 0.07	(292) 0.05	(310) 0.16	(328) 0.16	(346) 1.156
(275) 0.07	(293) 0.05	(311) 0.16	(329) 0.16	(347) 1.156
(276) 0.07	(294) 0.05	(312) 0.16	(330) 0.16	(348) 1.156
(277) 0.07	(295) 0.05	(313) 0.16	(331) 0.16	(349) 1.156
(278) 0.07	(296) 0.05	(314) 0.16	(332) 0.16	(350) 1.156
(279) 0.08	(297) 0.05	(315) 0.16	(333) 0.16	(351) 1.156
(280) 0.08	(298) 0.05	(316) 0.16	(334) 0.16	(352) 1.156
(281) 0.08	(299) 0.05	(317) 0.16	(335) 0.16	(353) 1.156
(282) 0.08	(300) 0.05	(318) 0.16	(336) 0.16	(354) 1.156
(283) 0.08	(301) 0.05	(319) 0.16	(337) 1.156	(355) 1.156
(284) 0.08	(302) 0.05	(320) 0.16	(338) 1.156	(356) 1.156
(285) 0.08	(303) 0.05	(321) 0.16	(339) 1.156	(357) 1.16
(286) 0.08	(304) 0.05	(322) 0.16	(340) 1.156	(358) 1.16
(287) 0.08	(305) 0.05	(323) 0.16	(341) 1.156	(359) 1.1
(288) 0.08	(306) 0.05	(324) 0.16	(342) 1.156	(360) 1.1

River discharge data at 12-hourly intervals for Station: 21D
Period : 3

Variable: VUELVL5.var1 (length = 360)

(1)	0.403	(19)	0.4	(37)	0.4	(55)	0.28	(73)	0.6
(2)	0.403	(20)	0.4	(38)	0.4	(56)	0.28	(74)	0.6
(3)	0.403	(21)	0.4	(39)	0.4	(57)	0.28	(75)	0.6
(4)	0.403	(22)	0.4	(40)	0.4	(58)	0.28	(76)	0.6
(5)	0.406	(23)	0.41	(41)	0.4	(59)	0.28	(77)	0.6
(6)	0.406	(24)	0.41	(42)	0.4	(60)	0.28	(78)	0.6
(7)	0.4	(25)	0.4	(43)	0.28	(61)	0.28	(79)	0.6
(8)	0.4	(26)	0.4	(44)	0.28	(62)	0.28	(80)	0.6
(9)	0.4	(27)	0.4	(45)	0.28	(63)	0.28	(81)	0.6
(10)	0.4	(28)	0.4	(46)	0.28	(64)	0.28	(82)	0.6
(11)	0.4	(29)	0.4	(47)	0.28	(65)	0.28	(83)	0.6
(12)	0.4	(30)	0.4	(48)	0.28	(66)	0.28	(84)	0.6
(13)	0.4	(31)	0.4	(49)	0.28	(67)	0.28	(85)	0.6
(14)	0.4	(32)	0.4	(50)	0.28	(68)	0.28	(86)	0.6
(15)	0.4	(33)	0.4	(51)	0.28	(69)	0.28	(87)	0.6
(16)	0.4	(34)	0.4	(52)	0.28	(70)	0.28	(88)	0.6
(17)	0.4	(35)	0.4	(53)	0.28	(71)	0.28	(89)	0.6
(18)	0.4	(36)	0.4	(54)	0.28	(72)	0.28	(90)	0.6

(181)	0.96	(199)	0.96	(217)	0.96	(235)	0.96	(253)	0.96
(182)	0.96	(200)	0.96	(218)	0.96	(236)	0.96	(254)	0.96
(183)	0.96	(201)	0.96	(219)	0.96	(237)	0.96	(255)	0.96
(184)	0.96	(202)	0.96	(220)	0.96	(238)	0.96	(256)	0.96
(185)	0.96	(203)	0.96	(221)	0.96	(239)	0.96	(257)	0.96
(186)	0.96	(204)	0.96	(222)	0.96	(240)	0.96	(258)	0.96
(187)	0.96	(205)	0.96	(223)	0.96	(241)	0.96	(259)	0.96
(188)	0.96	(206)	0.96	(224)	0.96	(242)	0.96	(260)	0.96
(189)	0.96	(207)	0.96	(225)	0.96	(243)	0.96	(261)	0.96
(190)	0.96	(208)	0.96	(226)	0.96	(244)	0.96	(262)	0.96
(191)	0.96	(209)	0.96	(227)	0.96	(245)	0.96	(263)	0.96
(192)	0.96	(210)	0.96	(228)	0.96	(246)	0.96	(264)	0.96
(193)	0.96	(211)	0.96	(229)	0.96	(247)	0.96	(265)	0.96
(194)	0.96	(212)	0.96	(230)	0.96	(248)	0.96	(266)	0.96
(195)	0.96	(213)	0.96	(231)	0.96	(249)	0.96	(267)	0.96
(196)	0.96	(214)	0.96	(232)	0.96	(250)	0.96	(268)	0.96
(197)	0.96	(215)	0.96	(233)	0.96	(251)	0.96	(269)	0.96
(198)	0.96	(216)	0.96	(234)	0.96	(252)	0.96	(270)	0.96

(91)	0.6	(109)	0.6	(127)	0.7	(145)	0.7	(163)	0.78
(92)	0.6	(110)	0.6	(128)	0.7	(146)	0.7	(164)	0.78
(93)	0.6	(111)	0.7	(129)	0.7	(147)	0.7	(165)	0.78
(94)	0.6	(112)	0.7	(130)	0.7	(148)	0.7	(166)	0.78
(95)	0.6	(113)	0.7	(131)	0.7	(149)	0.7	(167)	0.78
(96)	0.6	(114)	0.7	(132)	0.7	(150)	0.7	(168)	0.78
(97)	0.6	(115)	0.7	(133)	0.7	(151)	0.7	(169)	0.78
(98)	0.6	(116)	0.7	(134)	0.7	(152)	0.7	(170)	0.78
(99)	0.6	(117)	0.7	(135)	0.7	(153)	0.78	(171)	0.78
(100)	0.6	(118)	0.7	(136)	0.7	(154)	0.78	(172)	0.78
(101)	0.6	(119)	0.7	(137)	0.7	(155)	0.78	(173)	0.78
(102)	0.6	(120)	0.7	(138)	0.7	(156)	0.78	(174)	0.78
(103)	0.6	(121)	0.7	(139)	0.7	(157)	0.78	(175)	0.78
(104)	0.6	(122)	0.7	(140)	0.7	(158)	0.78	(176)	0.78
(105)	0.6	(123)	0.7	(141)	0.7	(159)	0.78	(177)	0.78
(106)	0.6	(124)	0.7	(142)	0.7	(160)	0.78	(178)	0.78
(107)	0.6	(125)	0.7	(143)	0.7	(161)	0.78	(179)	0.96
(108)	0.6	(126)	0.7	(144)	0.7	(162)	0.78	(180)	0.96

(271)	0.96	(289)	0.43	(307)	0.126	(325)	0.126	(343)	0.27
(272)	0.96	(290)	0.43	(308)	0.126	(326)	0.126	(344)	0.27
(273)	0.96	(291)	0.43	(309)	0.126	(327)	0.126	(345)	0.27
(274)	0.96	(292)	0.43	(310)	0.126	(328)	0.126	(346)	0.27
(275)	0.96	(293)	0.43	(311)	0.1269	(329)	0.27	(347)	0.27
(276)	0.96	(294)	0.43	(312)	0.1269	(330)	0.27	(348)	0.27
(277)	0.96	(295)	0.43	(313)	0.126	(331)	0.27	(349)	0.27
(278)	0.96	(296)	0.43	(314)	0.126	(332)	0.27	(350)	0.27
(279)	0.96	(297)	0.43	(315)	0.126	(333)	0.27	(351)	0.27
(280)	0.96	(298)	0.43	(316)	0.126	(334)	0.27	(352)	0.27
(281)	0.43	(299)	0.43	(317)	0.122	(335)	0.27	(353)	0.27
(282)	0.43	(300)	0.43	(318)	0.122	(336)	0.27	(354)	0.27
(283)	0.43	(301)	0.43	(319)	0.126	(337)	0.27	(355)	0.27
(284)	0.43	(302)	0.43	(320)	0.126	(338)	0.27	(356)	0.27
(285)	0.43	(303)	0.43	(321)	0.126	(339)	0.27	(357)	0.27
(286)	0.43	(304)	0.43	(322)	0.126	(340)	0.27	(358)	0.27
(287)	0.43	(305)	0.126	(323)	0.126	(341)	0.27	(359)	0.27
(288)	0.43	(306)	0.126	(324)	0.126	(342)	0.27	(360)	0.27

River discharge data at 12-hourly intervals for Station: 21D
Period : 5

Variable: FLEIN1.var1 (length = 360)

(1)	0.522	(19)	0.108	(37)	0.108	(55)	0.108
(2)	0.607	(20)	0.096	(38)	0.054	(56)	0.085
(3)	0.385	(21)	0.108	(39)	0.085	(57)	0.12
(4)	0.319	(22)	0.096	(40)	0.036	(58)	0.096
(5)	0.607	(23)	0.096	(41)	0.0742	(59)	0.108
(6)	0.255	(24)	0.036	(42)	0.0449	(60)	0.074
(7)	0.607	(25)	0.0742	(43)	0.085	(61)	0.1445
(8)	0.225	(26)	0.028	(44)	0.064	(62)	0.1445
(9)	0.197	(27)	0.0742	(45)	0.108	(63)	0.1573
(10)	0.1704	(28)	0.036	(46)	0.1704	(64)	0.1445
(11)	0.1836	(29)	0.085	(47)	0.906	(65)	0.1573
(12)	0.1321	(30)	0.054	(48)	0.2401	(66)	0.096
(13)	0.132	(31)	0.085	(49)	0.3365	(67)	0.12
(14)	0.108	(32)	0.036	(50)	0.225	(68)	0.054
(15)	0.12	(33)	0.108	(51)	0.197	(69)	0.074
(16)	0.074	(34)	0.074	(52)	0.1836	(70)	0.045
(17)	0.108	(35)	0.12	(53)	0.1704	(71)	0.0964
(18)	0.096	(36)	0.12	(54)	0.1321	(72)	0.054

(145)	2.5E-3	(163)	0.0138	(181)	0	(199)	2.5E-3
(146)	0	(164)	8E-3	(182)	0	(200)	0.021
(147)	0	(165)	0	(183)	0	(201)	0.054
(148)	0	(166)	0	(184)	8E-3	(202)	0.045
(149)	0	(167)	0	(185)	0	(203)	0.0362
(150)	0	(168)	0	(186)	8E-3	(204)	0.021
(151)	0	(169)	0	(187)	0	(205)	0.0208
(152)	0	(170)	0	(188)	8E-3	(206)	0
(153)	0	(171)	0	(189)	0	(207)	0
(154)	0	(172)	8E-3	(190)	3E-3	(208)	0
(155)	0	(173)	0	(191)	0	(209)	0
(156)	7E-3	(174)	0.021	(192)	0	(210)	2E-3
(157)	0	(175)	0	(193)	0	(211)	0.0449
(158)	2E-3	(176)	0.021	(194)	2E-3	(212)	2E-3
(159)	0	(177)	0	(195)	2.5E-3	(213)	0
(160)	2E-3	(178)	0	(196)	2E-3	(214)	0
(161)	2.5E-3	(179)	0	(197)	0	(215)	0.0362
(162)	0.028	(180)	0	(198)	8E-3	(216)	0.096

(73)	0.085	(91)	0.085	(109)	0.0138	(127)	0.0138
(74)	0.045	(92)	0.033	(110)	8E-3	(128)	0.014
(75)	0.085	(93)	0.085	(111)	7.8E-3	(129)	0.0136
(76)	0.096	(94)	0.036	(112)	8E-3	(130)	0.014
(77)	0.1321	(95)	0.054	(113)	7.8E-3	(131)	0.0138
(78)	0.1445	(96)	0.036	(114)	8E-3	(132)	0.014
(79)	0.12	(97)	0.0281	(115)	7.8E-3	(133)	0.0638
(80)	0.085	(98)	0.0281	(116)	8E-3	(134)	0.054
(81)	0.085	(99)	0.108	(117)	7.8E-3	(135)	0.054
(82)	0.045	(100)	0.054	(118)	8E-3	(136)	0.036
(83)	0.064	(101)	0.054	(119)	7.8E-3	(137)	7.8E-3
(84)	0.036	(102)	0.036	(120)	0.0742	(138)	2E-3
(85)	0.085	(103)	0.054	(121)	0.0742	(139)	2.5E-3
(86)	0.054	(104)	0.064	(122)	0.036	(140)	2E-3
(87)	0.0638	(105)	0.0964	(123)	0.0208	(141)	2.5E-3
(88)	0.036	(106)	0.074	(124)	0.021	(142)	0
(89)	0.0449	(107)	0.064	(125)	0.0138	(143)	2.5E-3
(90)	0.054	(108)	0.0281	(126)	0.014	(144)	0

(217)	0.197	(235)	0.12	(253)	0.2102	(271)	0.108
(218)	4.521	(236)	0.108	(254)	0.197	(272)	0.12
(219)	0.7	(237)	0.108	(255)	0.1573	(273)	0.1445
(220)	0.445	(238)	0.064	(256)	0.1445	(274)	0.157
(221)	0.522	(239)	0.12	(257)	0.1445	(275)	0.1445
(222)	0.32	(240)	0.074	(258)	0.1445	(276)	0.096
(223)	0.2712	(241)	0.108	(259)	0.1321	(277)	0.1321
(224)	0.225	(242)	0.085	(260)	0.132	(278)	0.108
(225)	0.2102	(243)	0.108	(261)	0.12	(279)	0.0964
(226)	0.197	(244)	0.132	(262)	0.064	(280)	0.096
(227)	0.1704	(245)	0.12	(263)	0.0964	(281)	0.1321
(228)	0.157	(246)	0.197	(264)	0.085	(282)	0.108
(229)	0.1704	(247)	1.822	(265)	0.0964	(283)	0.1445
(230)	0.157	(248)	1.822	(266)	0.074	(284)	0.12
(231)	0.1445	(249)	0.906	(267)	0.0964	(285)	0.1445
(232)	0.1445	(250)	0.445	(268)	0.085	(286)	0.157
(233)	0.1445	(251)	0.3365	(269)	0.0742	(287)	0.1704
(234)	0.096	(252)	0.2712	(270)	0.085	(288)	0.184

River discharge data at 12-hourly intervals for Station: 23A
Period : 1

Variable: KLEIN2.var1 (length = 360)

(1)	6.203	(19)	0.594	(37)	0.511	(55)	0.8895	(73)	0.522
(2)	5.95	(20)	0.522	(38)	1.02	(56)	0.906	(74)	0.799
(3)	5.601	(21)	0.434	(39)	0.686	(57)	0.784	(75)	2.771
(4)	4.8	(22)	0.445	(40)	1.02	(58)	0.799	(76)	2.771
(5)	4.227	(23)	0.376	(41)	1.002	(59)	0.784	(77)	2.124
(6)	4.02	(24)	0.353	(42)	1.02	(60)	0.799	(78)	5.077
(7)	3.501	(25)	0.354	(43)	1.002	(61)	0.686	(79)	12.75
(8)	3.11	(26)	0.353	(44)	1.02	(62)	0.7	(80)	37.4
(9)	2.746	(27)	0.345	(45)	0.8896	(63)	0.594	(81)	16.64
(10)	2.605	(28)	0.353	(46)	0.906	(64)	0.607	(82)	10
(11)	2.261	(29)	0.354	(47)	0.8896	(65)	0.594	(83)	8.22
(12)	1.972	(30)	1.264	(48)	0.906	(66)	0.607	(84)	6.57
(13)	1.655	(31)	0.376	(49)	0.784	(67)	0.594	(85)	5.361
(14)	1.396	(32)	1.14	(50)	0.799	(68)	0.607	(86)	4.8
(15)	1.119	(33)	0.376	(51)	0.784	(69)	0.445	(87)	4.53
(16)	0.906	(34)	1.02	(52)	0.799	(70)	0.445	(88)	4.02
(17)	0.784	(35)	0.434	(53)	0.784	(71)	0.445	(89)	3.77
(18)	0.7	(36)	1.02	(54)	0.799	(72)	0.607	(90)	3.54

(91)	3.314	(109)	5.953	(127)	2.442	(145)	1.972	(163)	2.771
(92)	3.11	(110)	5.077	(128)	2.44	(146)	8.22	(164)	2.61
(93)	2.94	(111)	4.531	(129)	2.442	(147)	6.89	(165)	2.605
(94)	2.771	(112)	4.02	(130)	2.44	(148)	5.65	(166)	2.442
(95)	2.771	(113)	4.018	(131)	2.442	(149)	16.64	(167)	2.281
(96)	2.605	(114)	5.077	(132)	2.28	(150)	9.26	(168)	2.281
(97)	2.442	(115)	4.801	(133)	2.281	(151)	6.572	(169)	2.124
(98)	2.442	(116)	4.02	(134)	2.124	(152)	5.65	(170)	2.124
(99)	2.442	(117)	3.773	(135)	2.124	(153)	4.531	(171)	2.124
(100)	2.281	(118)	3.54	(136)	2.124	(154)	4.27	(172)	1.972
(101)	2.124	(119)	3.773	(137)	1.972	(155)	3.773	(173)	1.972
(102)	5.38	(120)	3.11	(138)	1.822	(156)	3.54	(174)	1.972
(103)	4.531	(121)	3.114	(139)	1.822	(157)	3.314	(175)	1.972
(104)	3.54	(122)	2.94	(140)	1.972	(158)	3.11	(176)	1.972
(105)	40.42	(123)	2.771	(141)	1.972	(159)	3.114	(177)	1.822
(106)	15.3	(124)	2.77	(142)	1.972	(160)	2.94	(178)	1.822
(107)	8.91	(125)	2.605	(143)	1.972	(161)	2.94	(179)	1.822
(108)	6.89	(126)	2.61	(144)	1.972	(162)	2.77	(180)	1.676

(181)	1.676	(199)	1.264	(217)	10	(235)	3.538	(253)	2.442
(182)	1.972	(200)	1.138	(218)	8.91	(236)	3.54	(254)	2.442
(183)	1.972	(201)	1.138	(219)	15.72	(237)	3.538	(255)	2.442
(184)	1.972	(202)	1.019	(220)	11.94	(238)	3.314	(256)	2.281
(185)	1.676	(203)	1.138	(221)	8.91	(239)	3.114	(257)	2.124
(186)	1.972	(204)	2.281	(222)	7.87	(240)	3.11	(258)	2.124
(187)	1.534	(205)	2.281	(223)	6.89	(241)	3.114	(259)	2.124
(188)	1.822	(206)	1.822	(224)	6.26	(242)	3.11	(260)	1.972
(189)	1.534	(207)	1.676	(225)	5.95	(243)	3.114	(261)	1.972
(190)	1.822	(208)	10.8	(226)	6.26	(244)	2.94	(262)	1.822
(191)	1.534	(209)	16.02	(227)	5.65	(245)	2.771	(263)	1.822
(192)	1.822	(210)	70	(228)	4.8	(246)	2.771	(264)	2.124
(193)	1.396	(211)	43.42	(229)	4.53	(247)	2.605	(265)	2.124
(194)	1.676	(212)	21.4	(230)	4.27	(248)	2.605	(266)	1.972
(195)	1.264	(213)	34.4	(231)	4.018	(249)	2.442	(267)	1.972
(196)	1.264	(214)	25.5	(232)	3.77	(250)	2.442	(268)	1.972
(197)	1.264	(215)	14.87	(233)	3.773	(251)	2.281	(269)	2.124
(198)	1.264	(216)	11.94	(234)	3.77	(252)	2.442	(270)	13.16

(271)	11.15	(289)	3.314	(307)	1.972	(325)	1.264	(343)	0.353
(272)	11.15	(290)	3.11	(308)	1.822	(326)	1.138	(344)	0.353
(273)	34.99	(291)	3.114	(309)	1.822	(327)	1.138	(345)	0.385
(274)	21.89	(292)	2.77	(310)	1.676	(328)	1.02	(346)	0.385
(275)	11.94	(293)	2.771	(311)	1.822	(329)	1.138	(347)	0.445
(276)	8.56	(294)	2.442	(312)	1.534	(330)	1.14	(348)	0.353
(277)	6.89	(295)	2.442	(313)	1.534	(331)	1.138	(349)	0.522
(278)	5.95	(296)	2.28	(314)	1.534	(332)	1.02	(350)	0.385
(279)	5.381	(297)	2.281	(315)	1.676	(333)	1.019	(351)	0.522
(280)	4.53	(298)	2.28	(316)	1.534	(334)	0.906	(352)	0.353
(281)	4.531	(299)	2.281	(317)	1.534	(335)	0.799	(353)	0.445
(282)	5.08	(300)	2.28	(318)	1.676	(336)	0.607	(354)	0.271
(283)	4.27	(301)	2.124	(319)	1.676	(337)	0.522	(355)	0.385
(284)	4.02	(302)	1.972	(320)	1.534	(338)	0.445	(356)	0.32
(285)	4.018	(303)	1.972	(321)	1.534	(339)	0.445	(357)	0.385
(286)	3.77	(304)	1.822	(322)	1.396	(340)	0.353	(358)	0.336
(287)	4.018	(305)	1.822	(323)	1.396	(341)	0.3365	(359)	0.385
(288)	3.54	(306)	1.676	(324)	1.264	(342)	0.303	(360)	0.336

River discharge data at 12-hourly intervals for Station: 23A
Period : 2

A3.71

Variable: KLEIN4.var1 (length = 344)

(1)	0.607	(19)	1.26	(37)	1.4	(55)	11.94	(73)	5.95
(2)	0.607	(20)	1.264	(38)	1.396	(56)	9.63	(74)	5.38
(3)	0.607	(21)	7.2	(39)	1.4	(57)	7.87	(75)	4.801
(4)	0.7	(22)	4.27	(40)	1.396	(58)	13.58	(76)	4.53
(5)	0.7	(23)	3.1	(41)	1.4	(59)	14.01	(77)	4.53
(6)	0.7	(24)	2.442	(42)	1.396	(60)	9.26	(78)	4.27
(7)	0.52	(25)	2.28	(43)	1.4	(61)	7.54	(79)	4.27
(8)	0.799	(26)	1.972	(44)	1.396	(62)	6.572	(80)	4.018
(9)	10.76	(27)	1.82	(45)	1.26	(63)	5.65	(81)	3.77
(10)	10.38	(28)	1.676	(46)	1.396	(64)	5.753	(82)	3.54
(11)	5.65	(29)	1.676	(47)	1.14	(65)	8.22	(83)	3.114
(12)	3.114	(30)	1.534	(48)	1.264	(66)	6.89	(84)	3.114
(13)	2.442	(31)	1.534	(49)	1.14	(67)	5.95	(85)	3.114
(14)	1.676	(32)	1.534	(50)	45	(68)	5.077	(86)	2.94
(15)	1.676	(33)	1.396	(51)	14.87	(69)	4.53	(87)	2.771
(16)	1.534	(34)	1.676	(52)	100	(70)	5.077	(88)	2.771
(17)	1.39	(35)	1.4	(53)	34.4	(71)	9.63	(89)	2.771
(18)	1.264	(36)	1.396	(54)	18.02	(72)	7.213	(90)	2.605

(91)	2.442	(109)	50	(127)	5.077	(145)	3.114	(163)	33.2
(92)	2.442	(110)	21.9	(128)	5.077	(146)	3.11	(164)	19.44
(93)	2.442	(111)	16.2	(129)	5.077	(147)	2.94	(165)	14.87
(94)	2.442	(112)	15.2	(130)	4.8	(148)	2.94	(166)	11.94
(95)	2.442	(113)	14.01	(131)	4.53	(149)	2.94	(167)	42
(96)	2.442	(114)	14.01	(132)	4.53	(150)	2.94	(168)	38.6
(97)	2.605	(115)	10	(133)	4.02	(151)	5.65	(169)	24.44
(98)	55	(116)	11.94	(134)	3.77	(152)	7.21	(170)	19.44
(99)	50	(117)	8.2	(135)	3.77	(153)	4.801	(171)	17.1
(100)	23.92	(118)	8.22	(136)	3.77	(154)	18.02	(172)	14.87
(101)	11.9	(119)	7.54	(137)	3.77	(155)	14.43	(173)	11.9
(102)	16.19	(120)	7.21	(138)	3.77	(156)	9.26	(174)	8.22
(103)	8.2	(121)	6.89	(139)	3.77	(157)	7.213	(175)	7.87
(104)	15.3	(122)	6.57	(140)	3.77	(158)	5.95	(176)	7.54
(105)	14.43	(123)	6.28	(141)	3.77	(159)	5.381	(177)	7.21
(106)	11.15	(124)	5.95	(142)	3.54	(160)	4.8	(178)	6.89
(107)	9.26	(125)	5.65	(143)	3.54	(161)	23.41	(179)	6.57
(108)	60	(126)	5.38	(144)	3.31	(162)	150	(180)	6.259

(181)	5.95	(199)	4.53	(217)	2.771	(235)	10	(253)	2.442
(182)	5.65	(200)	4.27	(218)	2.94	(236)	7.87	(254)	2.442
(183)	5.65	(201)	4.02	(219)	2.771	(237)	6.259	(255)	2.281
(184)	5.08	(202)	4.02	(220)	2.605	(238)	4.801	(256)	2.124
(185)	5.077	(203)	3.77	(221)	2.442	(239)	4.27	(257)	2.124
(186)	5.08	(204)	3.77	(222)	2.605	(240)	3.773	(258)	2.442
(187)	5.077	(205)	3.54	(223)	2.281	(241)	3.54	(259)	3.114
(188)	4.801	(206)	3.54	(224)	2.28	(242)	3.114	(260)	6.89
(189)	4.27	(207)	3.31	(225)	2.94	(243)	3.114	(261)	4.801
(190)	4.27	(208)	3.114	(226)	2.28	(244)	2.94	(262)	4.018
(191)	4.018	(209)	3.114	(227)	2.281	(245)	2.771	(263)	3.538
(192)	4.02	(210)	3.114	(228)	2.442	(246)	2.771	(264)	2.94
(193)	4.27	(211)	3.114	(229)	2.281	(247)	2.605	(265)	2.94
(194)	11.15	(212)	2.94	(230)	2.124	(248)	2.605	(266)	2.771
(195)	7.54	(213)	2.94	(231)	2.124	(249)	2.605	(267)	2.605
(196)	5.65	(214)	2.771	(232)	1.972	(250)	4.02	(268)	2.442
(197)	5.077	(215)	2.771	(233)	2.281	(251)	3.114	(269)	2.442
(198)	5.08	(216)	2.771	(234)	10.38	(252)	2.605	(270)	2.442

(271)	3.114	(289)	1.676	(307)	0.905	(325)	0.607	(343)	0.385
(272)	2.771	(290)	1.534	(308)	0.799	(326)	0.7	(344)	0.353
(273)	2.605	(291)	1.534	(309)	0.799	(327)	0.701		
(274)	2.442	(292)	1.264	(310)	0.799	(328)	0.522		
(275)	2.442	(293)	1.264	(311)	0.799	(329)	0.522		
(276)	2.28	(294)	1.138	(312)	0.799	(330)	0.522		
(277)	2.281	(295)	1.138	(313)	0.799	(331)	0.607		
(278)	2.124	(296)	1.138	(314)	0.7	(332)	0.522		
(279)	2.124	(297)	1.019	(315)	0.7	(333)	0.607		
(280)	2.124	(298)	1.138	(316)	0.7	(334)	0.445		
(281)	2.124	(299)	1.138	(317)	0.607	(335)	0.445		
(282)	1.972	(300)	1.138	(318)	0.607	(336)	0.445		
(283)	1.972	(301)	1.138	(319)	0.7	(337)	0.445		
(284)	1.972	(302)	1.138	(320)	0.607	(338)	0.522		
(285)	1.972	(303)	1.318	(321)	0.522	(339)	0.607		
(286)	1.822	(304)	1.138	(322)	0.522	(340)	0.522		
(287)	1.822	(305)	1.138	(323)	0.522	(341)	0.445		
(288)	1.676	(306)	1.02	(324)	0.522	(342)	0.353		

River discharge data at 12-hourly intervals for Station: 23A
Period : 4

Variable: KLEIN6.var1 (length = 360)

(1)	0.271	(19)	9.63	(37)	0.607	(55)	0.8	(73)	0.7
(2)	0.271	(20)	4.02	(38)	0.607	(56)	0.7	(74)	0.906
(3)	0.271	(21)	2.771	(39)	0.607	(57)	0.8	(75)	1.396
(4)	0.271	(22)	3.314	(40)	0.607	(58)	4.801	(76)	1.254
(5)	0.271	(23)	2.442	(41)	0.607	(59)	4.02	(77)	1.14
(6)	0.271	(24)	1.972	(42)	0.522	(60)	3.114	(78)	1.019
(7)	0.287	(25)	1.676	(43)	0.522	(61)	2.124	(79)	4.02
(8)	0.287	(26)	1.396	(44)	0.522	(62)	1.579	(80)	2.442
(9)	0.35	(27)	1.264	(45)	0.522	(63)	1.53	(81)	1.97
(10)	6.572	(28)	1.13	(46)	0.522	(64)	1.534	(82)	1.534
(11)	5.65	(29)	1.02	(47)	0.445	(65)	1.264	(83)	1.39
(12)	5.381	(30)	0.906	(48)	0.607	(66)	1.138	(84)	1.264
(13)	5.95	(31)	0.8	(49)	0.7	(67)	1.02	(85)	1.02
(14)	3.54	(32)	0.799	(50)	0.799	(68)	0.906	(86)	1.02
(15)	4.53	(33)	0.7	(51)	2.442	(69)	0.906	(87)	3.114
(16)	4.02	(34)	0.7	(52)	1.396	(70)	0.799	(88)	7.213
(17)	2.605	(35)	0.7	(53)	1.02	(71)	0.8	(89)	4.53
(18)	1.97	(36)	0.607	(54)	0.906	(72)	0.799	(90)	3.114

(181)	1.822	(199)	5.65	(217)	5.65	(235)	4.27	(253)	3.54
(182)	2.28	(200)	5.38	(218)	5.38	(236)	4.8	(254)	2.94
(183)	11.94	(201)	5.077	(219)	5.08	(237)	4.02	(255)	2.77
(184)	78	(202)	5.08	(220)	5.06	(238)	3.77	(256)	2.771
(185)	51	(203)	18.02	(221)	4.8	(239)	3.54	(257)	2.605
(186)	49	(204)	58	(222)	4.53	(240)	3.11	(258)	3.114
(187)	40.4	(205)	19.44	(223)	4.53	(241)	2.94	(259)	9.63
(188)	23.4	(206)	13.6	(224)	4.27	(242)	2.94	(260)	14.43
(189)	17.5	(207)	11.15	(225)	4.02	(243)	2.94	(261)	9.63
(190)	14.43	(208)	12.2	(226)	4.02	(244)	2.77	(262)	6.259
(191)	11.94	(209)	10	(227)	3.77	(245)	2.77	(263)	5.381
(192)	10.76	(210)	8.55	(228)	4.02	(246)	2.61	(264)	4.531
(193)	9.63	(211)	7.54	(229)	3.77	(247)	2.442	(265)	4.27
(194)	8.91	(212)	7.21	(230)	3.54	(248)	2.442	(266)	4.018
(195)	8.55	(213)	6.89	(231)	3.31	(249)	2.94	(267)	4.27
(196)	7.87	(214)	6.57	(232)	3.11	(250)	2.94	(268)	5.653
(197)	7.54	(215)	6.25	(233)	3.114	(251)	2.77	(269)	6.572
(198)	6.57	(216)	5.95	(234)	4.27	(252)	2.77	(270)	5.077

(91)	2.442	(109)	1.676	(127)	1.97	(145)	7.54	(163)	3.53
(92)	2.124	(110)	1.676	(128)	1.97	(146)	6.57	(164)	4.53
(93)	2.124	(111)	2.442	(129)	1.97	(147)	7.54	(165)	4.02
(94)	14.43	(112)	2.771	(130)	2.124	(148)	6.89	(166)	3.54
(95)	7.541	(113)	2.77	(131)	2.124	(149)	8.91	(167)	3.31
(96)	4.801	(114)	2.442	(132)	1.97	(150)	6.25	(168)	3.11
(97)	3.77	(115)	2.605	(133)	1.822	(151)	5.95	(169)	2.94
(98)	3.114	(116)	6.89	(134)	1.97	(152)	4.801	(170)	2.77
(99)	2.77	(117)	5.08	(135)	10.8	(153)	4.53	(171)	2.44
(100)	2.605	(118)	4.02	(136)	5.08	(154)	4.02	(172)	2.28
(101)	2.442	(119)	3.314	(137)	3.77	(155)	3.77	(173)	2.28
(102)	2.281	(120)	2.94	(138)	3.114	(156)	3.77	(174)	2.124
(103)	2.28	(121)	3.114	(139)	2.77	(157)	3.11	(175)	2.124
(104)	2.124	(122)	2.605	(140)	2.605	(158)	5.65	(176)	1.97
(105)	1.97	(123)	2.442	(141)	2.77	(159)	5.95	(177)	1.97
(106)	1.822	(124)	2.28	(142)	58	(160)	4.53	(178)	1.822
(107)	1.822	(125)	2.124	(143)	20.9	(161)	4.02	(179)	1.822
(108)	1.822	(126)	1.97	(144)	10	(162)	3.77	(180)	1.822

(271)	4.53	(289)	2.442	(307)	1.822	(325)	1.396	(343)	0.7
(272)	4.018	(290)	2.442	(308)	2.281	(326)	1.264	(344)	0.607
(273)	3.773	(291)	2.442	(309)	3.114	(327)	1.264	(345)	0.522
(274)	3.538	(292)	2.281	(310)	2.442	(328)	1.019	(346)	0.522
(275)	3.314	(293)	2.281	(311)	1.972	(329)	1.019	(347)	0.522
(276)	3.114	(294)	2.281	(312)	1.822	(330)	1.019	(348)	0.522
(277)	3.114	(295)	2.281	(313)	1.822	(331)	1.019	(349)	0.607
(278)	2.94	(296)	2.124	(314)	1.676	(332)	0.906	(350)	0.607
(279)	2.94	(297)	1.972	(315)	1.676	(333)	0.906	(351)	0.522
(280)	2.771	(298)	1.822	(316)	1.534	(334)	0.906	(352)	0.445
(281)	3.538	(299)	1.822	(317)	1.396	(335)	0.906	(353)	0.522
(282)	3.114	(300)	1.922	(318)	1.396	(336)	0.906	(354)	0.522
(283)	2.94	(301)	1.822	(319)	1.396	(337)	0.906	(355)	0.522
(284)	2.771	(302)	1.822	(320)	1.264	(338)	0.799	(356)	0.353
(285)	2.771	(303)	1.676	(321)	1.264	(339)	0.799	(357)	0.353
(286)	2.771	(304)	1.676	(322)	1.264	(340)	0.7	(358)	0.445
(287)	2.605	(305)	1.676	(323)	1.396	(341)	0.7	(359)	0.445
(288)	2.442	(306)	1.676	(324)	1.396	(342)	0.607	(360)	0.445

River discharge data at 12-hourly intervals for Station: 23A
Period : 6

Variable: SAND2.var1 (length = 360)

(1) 0.361	(19) 0.19	(37) 0.064	(55) 0.029	(73) 0.029
(2) 0.361	(20) 0.163	(38) 0.05	(56) 0.029	(74) 0.029
(3) 0.285	(21) 0.163	(39) 0.05	(57) 0.029	(75) 0.029
(4) 0.322	(22) 0.163	(40) 0.05	(58) 0.039	(76) 0.361
(5) 0.285	(23) 0.163	(41) 0.05	(59) 0.039	(77) 0.19
(6) 0.322	(24) 0.139	(42) 0.05	(60) 0.039	(78) 0.19
(7) 0.285	(25) 0.117	(43) 0.039	(61) 0.039	(79) 0.285
(8) 0.285	(26) 0.117	(44) 0.039	(62) 0.029	(80) 3.001
(9) 0.285	(27) 0.17	(45) 0.029	(63) 0.029	(81) 0.786
(10) 0.285	(28) 0.139	(46) 0.029	(64) 0.029	(82) 0.361
(11) 0.285	(29) 0.117	(47) 0.029	(65) 0.029	(83) 0.19
(12) 0.25	(30) 0.097	(48) 0.021	(66) 0.029	(84) 0.163
(13) 0.219	(31) 0.079	(49) 0.021	(67) 0.029	(85) 0.139
(14) 0.219	(32) 0.079	(50) 0.021	(68) 0.029	(86) 0.117
(15) 0.219	(33) 0.064	(51) 0.021	(69) 0.039	(87) 0.117
(16) 0.19	(34) 0.064	(52) 0.021	(70) 0.029	(88) 0.117
(17) 0.19	(35) 0.064	(53) 0.021	(71) 0.029	(89) 0.097
(18) 0.19	(36) 0.064	(54) 0.021	(72) 0.029	(90) 0.097

(91) 0.097	(109) 0.163	(127) 0.064	(145) 0.097	(163) 0.079
(92) 0.097	(110) 0.19	(128) 0.05	(146) 1.421	(164) 0.079
(93) 0.079	(111) 0.117	(129) 0.05	(147) 0.449	(165) 0.079
(94) 0.079	(112) 0.117	(130) 0.05	(148) 0.404	(166) 0.079
(95) 0.079	(113) 0.117	(131) 0.05	(149) 1.72	(167) 0.064
(96) 0.079	(114) 0.117	(132) 0.05	(150) 0.604	(168) 0.064
(97) 0.056	(115) 0.404	(133) 0.05	(151) 0.361	(169) 0.064
(98) 0.05	(116) 0.219	(134) 0.05	(152) 0.25	(170) 0.05
(99) 0.05	(117) 0.139	(135) 0.039	(153) 0.19	(171) 0.05
(100) 0.05	(118) 0.117	(136) 0.039	(154) 0.163	(172) 0.079
(101) 0.05	(119) 0.117	(137) 0.029	(155) 0.163	(173) 0.079
(102) 0.079	(120) 0.097	(138) 0.029	(156) 0.139	(174) 0.064
(103) 0.079	(121) 0.079	(139) 0.029	(157) 0.139	(175) 0.064
(104) 0.163	(122) 0.079	(140) 0.029	(158) 0.117	(176) 0.05
(105) 0.604	(123) 0.079	(141) 0.029	(159) 0.117	(177) 0.05
(106) 0.998	(124) 0.079	(142) 0.029	(160) 0.097	(178) 0.05
(107) 0.361	(125) 0.064	(143) 0.05	(161) 0.097	(179) 0.039
(108) 0.19	(126) 0.064	(144) 0.039	(162) 0.097	(180) 0.039

(181) 0.029	(199) 0.014	(217) 0.285	(235) 0.064	(253) 0.029
(182) 0.039	(200) 0.014	(218) 0.19	(236) 0.064	(254) 0.029
(183) 0.039	(201) 0.014	(219) 0.219	(237) 0.055	(255) 0.029
(184) 0.029	(202) 0.014	(220) 0.998	(238) 0.05	(256) 0.029
(185) 0.029	(203) 0.014	(221) 0.604	(239) 0.064	(257) 0.029
(186) 0.029	(204) 0.029	(222) 0.322	(240) 0.05	(258) 0.029
(187) 0.029	(205) 0.029	(223) 0.25	(241) 0.05	(259) 0.029
(188) 0.029	(206) 0.021	(224) 0.19	(242) 0.05	(260) 0.029
(189) 0.029	(207) 0.029	(225) 0.19	(243) 0.05	(261) 0.029
(190) 0.029	(208) 0.117	(226) 0.163	(244) 0.05	(262) 0.029
(191) 0.029	(209) 0.549	(227) 0.139	(245) 0.039	(263) 0.029
(192) 0.029	(210) 8.07	(228) 0.139	(246) 0.029	(264) 0.029
(193) 0.021	(211) 1.329	(229) 0.117	(247) 0.029	(265) 0.029
(194) 0.021	(212) 1.156	(230) 0.097	(248) 0.029	(266) 0.029
(195) 0.021	(213) 0.661	(231) 0.097	(249) 0.029	(267) 0.029
(196) 0.014	(214) 1.329	(232) 0.079	(250) 0.021	(268) 0.064
(197) 0.014	(215) 0.449	(233) 0.079	(251) 0.029	(269) 0.064
(198) 0.014	(216) 0.322	(234) 0.079	(252) 0.029	(270) 1.72

(271) 1.329	(289) 0.05	(307) 5E-3	(325) 0	(343) 0
(272) 0.661	(290) 0.039	(308) 5E-3	(326) 0	(344) 0
(273) 0.478	(291) 0.039	(309) 2E-3	(327) 0	(345) 0
(274) 2.173	(292) 0.029	(310) 5E-3	(328) 0	(346) 0
(275) 0.786	(293) 0.039	(311) 2E-3	(329) 0	(347) 0
(276) 0.404	(294) 0.029	(312) 5E-3	(330) 0	(348) 0
(277) 0.285	(295) 0.029	(313) 1E-3	(331) 0	(349) 0
(278) 0.19	(296) 0.029	(314) 5E-3	(332) 0	(350) 0
(279) 0.139	(297) 0.029	(315) 1E-3	(333) 0	(351) 0
(280) 0.117	(298) 0.029	(316) 2E-3	(334) 0	(352) 0
(281) 0.117	(299) 0.021	(317) 0	(335) 0	(353) 0
(282) 0.097	(300) 0.014	(318) 2E-3	(336) 0	(354) 0
(283) 0.079	(301) 0.014	(319) 0	(337) 0	(355) 0
(284) 0.064	(302) 0.014	(320) 1E-3	(338) 0	(356) 0
(285) 0.064	(303) 9E-3	(321) 0	(339) 0	(357) 0
(286) 0.064	(304) 0.014	(322) 0	(340) 0	(358) 0
(287) 0.064	(305) 9E-3	(323) 0	(341) 0	(359) 0
(288) 0.05	(306) 5E-3	(324) 0	(342) 0	(360) 0

River discharge data at 12-hourly intervals for Station: 23B
Period : 2

Variable: SAHD4.var1 (length = 344)

(1)	0	(19)	0	(37)	1E-3	(55)	0.449	(73)	0.219
(2)	0	(20)	0	(38)	1E-3	(56)	0.322	(74)	0.139
(3)	0	(21)	0	(39)	1E-3	(57)	0.25	(75)	0.117
(4)	0	(22)	0	(40)	1E-3	(58)	1.617	(76)	0.117
(5)	0	(23)	1E-3	(41)	1E-3	(59)	2.053	(77)	0.088
(6)	0	(24)	5E-3	(42)	1E-3	(60)	0.786	(78)	0.079
(7)	0	(25)	1E-3	(43)	1E-3	(61)	0.404	(79)	0.079
(8)	0	(26)	2E-3	(44)	1E-3	(62)	0.285	(80)	0.079
(9)	0	(27)	1E-3	(45)	1E-3	(63)	0.219	(81)	0.079
(10)	0	(28)	1E-3	(46)	1E-3	(64)	0.219	(82)	0.064
(11)	0	(29)	1E-3	(47)	1E-3	(65)	0.191	(83)	0.064
(12)	0	(30)	1E-3	(48)	1E-3	(66)	0.498	(84)	0.064
(13)	0	(31)	1E-3	(49)	2E-3	(67)	0.285	(85)	0.064
(14)	0	(32)	1E-3	(50)	12.54	(68)	0.19	(86)	0.064
(15)	0	(33)	1E-3	(51)	1.617	(69)	0.163	(87)	0.064
(16)	0	(34)	1E-3	(52)	1.241	(70)	0.285	(88)	0.064
(17)	0	(35)	1E-3	(53)	4.037	(71)	0.219	(89)	0.05
(18)	0	(36)	1E-3	(54)	0.924	(72)	0.361	(90)	0.05

(181)	0.285	(199)	0.25	(217)	0.098	(235)	0.139	(253)	0.064
(182)	0.285	(200)	0.19	(218)	0.097	(236)	0.604	(254)	0.05
(183)	0.25	(201)	0.163	(219)	0.117	(237)	0.361	(255)	0.05
(184)	0.25	(202)	0.163	(220)	0.117	(238)	0.219	(256)	0.039
(185)	0.25	(203)	0.163	(221)	0.079	(239)	0.163	(257)	0.039
(186)	0.219	(204)	0.163	(222)	0.097	(240)	0.139	(258)	0.05
(187)	0.25	(205)	0.163	(223)	0.079	(241)	0.097	(259)	0.05
(188)	0.361	(206)	0.163	(224)	0.079	(242)	0.097	(260)	0.05
(189)	0.25	(207)	0.139	(225)	0.064	(243)	0.079	(261)	0.05
(190)	0.219	(208)	0.139	(226)	0.064	(244)	0.079	(262)	0.05
(191)	0.219	(209)	0.117	(227)	0.064	(245)	0.079	(263)	0.064
(192)	0.19	(210)	0.117	(228)	0.064	(246)	0.064	(264)	0.064
(193)	0.25	(211)	0.117	(229)	0.064	(247)	0.05	(265)	0.064
(194)	0.285	(212)	0.117	(230)	0.05	(248)	0.05	(266)	0.05
(195)	0.722	(213)	0.117	(231)	0.064	(249)	0.05	(267)	0.05
(196)	0.361	(214)	0.117	(232)	0.064	(250)	0.05	(268)	0.05
(197)	0.285	(215)	0.117	(233)	0.064	(251)	0.05	(269)	0.039
(198)	0.219	(216)	0.117	(234)	0.079	(252)	0.039	(270)	0.039

(91)	0.039	(109)	2.835	(127)	0.25	(145)	0.163	(163)	1.075
(92)	0.039	(110)	1.617	(128)	0.25	(146)	0.139	(164)	1.421
(93)	0.039	(111)	1.359	(129)	0.219	(147)	0.14	(165)	5.588
(94)	0.039	(112)	1.075	(130)	0.219	(148)	0.139	(166)	0.924
(95)	0.039	(113)	0.998	(131)	0.219	(149)	0.139	(167)	1.241
(96)	0.039	(114)	0.924	(132)	0.219	(150)	0.117	(168)	1.939
(97)	5.039	(115)	0.853	(133)	0.19	(151)	0.322	(169)	0.924
(98)	9.1	(116)	0.786	(134)	0.19	(152)	0.722	(170)	1.075
(99)	9.82	(117)	0.661	(135)	0.18	(153)	0.322	(171)	0.722
(100)	1.827	(118)	0.604	(136)	0.17	(154)	8.07	(172)	0.853
(101)	1.075	(119)	0.404	(137)	0.163	(155)	1.517	(173)	0.449
(102)	0.924	(120)	0.361	(138)	0.163	(156)	0.924	(174)	0.661
(103)	8.4	(121)	0.361	(139)	0.163	(157)	0.604	(175)	0.404
(104)	2.297	(122)	0.322	(140)	0.163	(158)	0.404	(176)	0.449
(105)	0.924	(123)	0.322	(141)	0.163	(159)	0.361	(177)	0.322
(106)	0.604	(124)	0.285	(142)	0.219	(160)	0.361	(178)	0.361
(107)	2.835	(125)	0.285	(143)	0.163	(161)	1.827	(179)	0.322
(108)	3.809	(126)	0.285	(144)	0.163	(162)	13.37	(180)	0.322

(271)	0.039	(289)	0.014	(307)	1E-3	(325)	0	(343)	0
(272)	0.039	(290)	9E-3	(308)	1E-3	(326)	0	(344)	0
(273)	0.029	(291)	9E-3	(309)	1E-3	(327)	0		
(274)	0.039	(292)	9E-3	(310)	1E-3	(328)	0		
(275)	0.029	(293)	9E-3	(311)	1E-3	(329)	0		
(276)	0.039	(294)	5E-3	(312)	1E-3	(330)	0		
(277)	0.029	(295)	5E-3	(313)	1E-3	(331)	0		
(278)	0.039	(296)	5E-3	(314)	1E-3	(332)	0		
(279)	0.029	(297)	5E-3	(315)	1E-3	(333)	0		
(280)	0.039	(298)	2E-3	(316)	0	(334)	0		
(281)	0.029	(299)	2E-3	(317)	1E-3	(335)	0		
(282)	0.021	(300)	5E-3	(318)	1E-3	(336)	0		
(283)	0.021	(301)	2E-3	(319)	1E-3	(337)	0		
(284)	0.021	(302)	2E-3	(320)	0	(338)	0		
(285)	0.021	(303)	2E-3	(321)	0	(339)	0		
(286)	0.014	(304)	2E-3	(322)	0	(340)	0		
(287)	0.02	(305)	2E-3	(323)	0	(341)	0		
(288)	0.014	(306)	2E-3	(324)	0	(342)	0		

River discharge data at 12-hourly intervals for Station: 23B
Period : 4

A3.80

Variable: SAND6.var1 (length = 360)

(1) 0	(19) 2E-3	(37) 1E-3	(55) 2E-3	(73) 2E-3
(2) 0	(20) 2E-3	(38) 1E-3	(56) 1E-3	(74) 5E-3
(3) 0	(21) 2E-3	(39) 1E-3	(57) 5E-3	(75) 2E-3
(4) 0	(22) 2E-3	(40) 1E-3	(58) 2E-3	(76) 2E-3
(5) 0	(23) 1E-3	(41) 1E-3	(59) 2E-3	(77) 1E-3
(6) 0	(24) 2E-3	(42) 1E-3	(60) 2E-3	(78) 2E-3
(7) 0	(25) 1E-3	(43) 1E-3	(61) 2E-3	(79) 2E-3
(8) 0	(26) 2E-3	(44) 1E-3	(62) 2E-3	(80) 2E-3
(9) 0	(27) 1E-3	(45) 1E-3	(63) 2E-3	(81) 2E-3
(10) 2E-3	(28) 2E-3	(46) 1E-3	(64) 1E-3	(82) 2E-3
(11) 2E-3	(29) 1E-3	(47) 1E-3	(65) 1E-3	(83) 2E-3
(12) 2E-3	(30) 2E-3	(48) 1E-3	(66) 1E-3	(84) 2E-3
(13) 2E-3	(31) 1E-3	(49) 1E-3	(67) 1E-3	(85) 1E-3
(14) 5E-3	(32) 1E-3	(50) 5E-3	(68) 1E-3	(86) 2E-3
(15) 2E-3	(33) 1E-3	(51) 2E-3	(69) 1E-3	(87) 5E-3
(16) 2E-3	(34) 1E-3	(52) 2E-3	(70) 1E-3	(88) 2E-3
(17) 2E-3	(35) 1E-3	(53) 2E-3	(71) 1E-3	(89) 2E-3
(18) 5E-3	(36) 1E-3	(54) 1E-3	(72) 1E-3	(90) 2E-3

(181) 0.021	(199) 0.139	(217) 0.163	(235) 0.097	(253) 0.05
(182) 0.029	(200) 0.139	(218) 0.163	(236) 0.219	(254) 0.05
(183) 0.05	(201) 0.17	(219) 0.139	(237) 0.139	(255) 0.05
(184) 5.009	(202) 0.139	(220) 0.139	(238) 0.139	(256) 0.05
(185) 3.184	(203) 0.504	(221) 0.117	(239) 0.097	(257) 0.05
(186) 1.421	(204) 6.772	(222) 0.17	(240) 0.097	(258) 0.05
(187) 3.809	(205) 1.241	(223) 0.117	(241) 0.07	(259) 0.097
(188) 0.766	(206) 0.661	(224) 0.117	(242) 0.079	(260) 0.285
(189) 0.722	(207) 0.498	(225) 0.117	(243) 0.064	(261) 0.322
(190) 0.361	(208) 1.156	(226) 0.117	(244) 0.064	(262) 0.25
(191) 0.285	(209) 0.549	(227) 0.097	(245) 0.064	(263) 0.163
(192) 0.219	(210) 0.404	(228) 0.097	(246) 0.064	(264) 0.117
(193) 0.19	(211) 0.322	(229) 0.097	(247) 0.05	(265) 0.097
(194) 0.163	(212) 0.285	(230) 0.097	(248) 0.05	(266) 0.079
(195) 0.139	(213) 0.25	(231) 0.097	(249) 0.05	(267) 0.079
(196) 0.219	(214) 0.25	(232) 0.079	(250) 0.05	(268) 0.079
(197) 0.219	(215) 0.19	(233) 0.079	(251) 0.05	(269) 0.064
(198) 0.163	(216) 0.19	(234) 0.079	(252) 0.05	(270) 0.06

(91) 2E-3	(109) 1E-3	(127) 2E-3	(145) 0.163	(163) 0.117
(92) 2E-3	(110) 1E-3	(128) 2E-3	(146) 0.097	(164) 0.079
(93) 2E-3	(111) 5E-3	(129) 2E-3	(147) 0.219	(165) 0.079
(94) 5E-3	(112) 2E-3	(130) 2E-3	(148) 0.235	(166) 0.139
(95) 0.029	(113) 2E-3	(131) 2E-3	(149) 0.251	(167) 0.139
(96) 0.014	(114) 2E-3	(132) 2E-3	(150) 0.285	(168) 0.079
(97) 0.05	(115) 5E-3	(133) 2E-3	(151) 0.139	(169) 0.064
(98) 5E-3	(116) 5E-3	(134) 0.021	(152) 0.097	(170) 0.05
(99) 5E-3	(117) 9E-3	(135) 0.498	(153) 0.079	(171) 0.039
(100) 2E-3	(118) 5E-3	(136) 0.163	(154) 0.064	(172) 0.039
(101) 2E-3	(119) 5E-3	(137) 0.079	(155) 0.05	(173) 0.039
(102) 2E-3	(120) 5E-3	(138) 0.064	(156) 0.05	(174) 0.029
(103) 2E-3	(121) 5E-3	(139) 0.039	(157) 0.039	(175) 0.029
(104) 2E-3	(122) 2E-3	(140) 0.029	(158) 0.361	(176) 0.029
(105) 2E-3	(123) 2E-3	(141) 0.029	(159) 0.322	(177) 0.029
(106) 2E-3	(124) 2E-3	(142) 0.998	(160) 0.322	(178) 0.029
(107) 2E-3	(125) 2E-3	(143) 0.19	(161) 0.322	(179) 0.021
(108) 1E-3	(126) 2E-3	(144) 0.139	(162) 0.117	(180) 0.021

(271) 0.079	(289) 5E-3	(307) 1E-3	(325) 1E-3	(343) 0
(272) 0.08	(290) 5E-3	(308) 1E-3	(326) 1E-3	(344) 1E-3
(273) 0.064	(291) 5E-3	(309) 1E-3	(327) 1E-3	(345) 0
(274) 0.05	(292) 5E-3	(310) 1E-3	(328) 1E-3	(346) 0
(275) 0.039	(293) 5E-3	(311) 1E-3	(329) 1E-3	(347) 0
(276) 0.039	(294) 5E-3	(312) 2E-3	(330) 1E-3	(348) 0
(277) 0.029	(295) 5E-3	(313) 1E-3	(331) 1E-3	(349) 0
(278) 0.029	(296) 5E-3	(314) 1E-3	(332) 2E-3	(350) 0
(279) 0.029	(297) 5E-3	(315) 1E-3	(333) 2E-3	(351) 0
(280) 0.021	(298) 2E-3	(316) 1E-3	(334) 1E-3	(352) 0
(281) 0.021	(299) 1E-3	(317) 1E-3	(335) 1E-3	(353) 0
(282) 0.021	(300) 1E-3	(318) 1E-3	(336) 1E-3	(354) 0
(283) 0.017	(301) 1E-3	(319) 1E-3	(337) 1E-3	(355) 0
(284) 0.014	(302) 1E-3	(320) 1E-3	(338) 1E-3	(356) 0
(285) 0.014	(303) 1E-3	(321) 1E-3	(339) 1E-3	(357) 0
(286) 0.014	(304) 1E-3	(322) 1E-3	(340) 1E-3	(358) 0
(287) 9E-3	(305) 1E-3	(323) 1E-3	(341) 0	(359) 0
(288) 9E-3	(306) 1E-3	(324) 1E-3	(342) 1E-3	(360) 0

River discharge data at 12-hourly intervals for Station: 23B
Period : 6

Variable: DRIE2.vart (length = 360)

(1)	33.9	(19)	12.7	(37)	9.8	(55)	6.9	(73)	5.97
(2)	29.8	(20)	11.9	(38)	9.1	(56)	6.7	(74)	6
(3)	27.1	(21)	11.9	(39)	9.1	(57)	6.4	(75)	5.54
(4)	25.2	(22)	11.1	(40)	8.5	(58)	6.4	(76)	6
(5)	23.3	(23)	11.1	(41)	8.5	(59)	6.4	(77)	6.4
(6)	22.7	(24)	10.4	(42)	8	(60)	6.4	(78)	6.9
(7)	21.5	(25)	10.4	(43)	8	(61)	6.4	(79)	8
(8)	20.4	(26)	10.4	(44)	8	(62)	6.4	(80)	27.8
(9)	18.2	(27)	10.4	(45)	8	(63)	6.4	(81)	135
(10)	18.2	(28)	9.8	(46)	8	(64)	6.4	(82)	146
(11)	18.2	(29)	9.8	(47)	7.4	(65)	6.4	(83)	187
(12)	17.1	(30)	9.8	(48)	7.4	(66)	6.4	(84)	167
(13)	18.2	(31)	11.1	(49)	7.4	(67)	6.4	(85)	124
(14)	18.2	(32)	11.1	(50)	7.4	(68)	6	(86)	76.2
(15)	17.1	(33)	11.9	(51)	7.4	(69)	6.4	(87)	49
(16)	16.2	(34)	11.9	(52)	6.9	(70)	6	(88)	36
(17)	15.2	(35)	11.1	(53)	6.9	(71)	6.4	(89)	29.8
(18)	13.5	(36)	10.4	(54)	6.9	(72)	6	(90)	27.8

(91)	27.1	(109)	180	(127)	25.2	(145)	14.3	(163)	24
(92)	25.8	(110)	171	(128)	24	(146)	13.5	(164)	23.3
(93)	25.8	(111)	104	(129)	24	(147)	21.5	(165)	22.7
(94)	25.2	(112)	53.15	(130)	23.3	(148)	25.2	(166)	22.1
(95)	23.2	(113)	45	(131)	22.7	(149)	24.6	(167)	22.1
(96)	22.1	(114)	38.2	(132)	22.1	(150)	112	(168)	24
(97)	20.4	(115)	34.6	(133)	22.1	(151)	105.7	(169)	22.7
(98)	18.2	(116)	33.9	(134)	21.5	(152)	120	(170)	22.1
(99)	18.2	(117)	33.9	(135)	20.4	(153)	147	(171)	22.1
(100)	16.2	(118)	44	(136)	20.4	(154)	97	(172)	21.5
(101)	15.2	(119)	50.6	(137)	19.2	(155)	62.5	(173)	20.4
(102)	14.3	(120)	44	(138)	19.2	(156)	47.4	(174)	19.2
(103)	14.3	(121)	36.7	(139)	18.2	(157)	38.2	(175)	18.2
(104)	14.3	(122)	32.5	(140)	17.1	(158)	32.5	(176)	17.1
(105)	23.3	(123)	30.4	(141)	17.1	(159)	29.1	(177)	17.1
(106)	31.8	(124)	29.1	(142)	16.2	(160)	27.8	(178)	16.2
(107)	147	(125)	27.8	(143)	16.2	(161)	25.8	(179)	16.2
(108)	143	(126)	27.1	(144)	15.2	(162)	25.2	(180)	15.2

(181)	15.2	(199)	9.8	(217)	139	(235)	29.8	(253)	13.5
(182)	13.6	(200)	9.1	(218)	143	(236)	28.4	(254)	12.7
(183)	13.5	(201)	9.1	(219)	147	(237)	26.5	(255)	12.7
(184)	13.5	(202)	8.5	(220)	178	(238)	24.6	(256)	12.7
(185)	13.5	(203)	8.5	(221)	163	(239)	22.7	(257)	12.7
(186)	12.7	(204)	8.5	(222)	147	(240)	22.1	(258)	12.7
(187)	12.7	(205)	9.1	(223)	167	(241)	21.5	(259)	12.7
(188)	12.7	(206)	9.8	(224)	137	(242)	20.4	(260)	11.7
(189)	12.7	(207)	9.8	(225)	105.2	(243)	22.1	(261)	11.7
(190)	11.9	(208)	11.1	(226)	77.1	(244)	23.3	(262)	11.1
(191)	11.9	(209)	19.2	(227)	62.5	(245)	23.3	(263)	11.1
(192)	11.9	(210)	22.9	(228)	55.6	(246)	22.1	(264)	11.1
(193)	11.9	(211)	129	(229)	50.6	(247)	20.4	(265)	11.1
(194)	11.7	(212)	205	(230)	48.2	(248)	18.2	(266)	11.1
(195)	11.1	(213)	153	(231)	42.7	(249)	17.1	(267)	11.1
(196)	10.7	(214)	146	(232)	35.3	(250)	16.2	(268)	11.9
(197)	10.4	(215)	232	(233)	33.2	(251)	15.2	(269)	12.7
(198)	10.4	(216)	176	(234)	36.7	(252)	14.3	(270)	12.7

(271)	14.3	(289)	25.2	(307)	11.1	(325)	7.4	(343)	3.22
(272)	52.2	(290)	24.6	(308)	10.4	(326)	7.4	(344)	3.4
(273)	59	(291)	23.3	(309)	9.8	(327)	7.4	(345)	3.15
(274)	108	(292)	22.7	(310)	9.1	(328)	6.9	(346)	2.94
(275)	235	(293)	23.3	(311)	9.1	(329)	6.9	(347)	2.74
(276)	181	(294)	22.1	(312)	8.5	(330)	6.4	(348)	2.74
(277)	153	(295)	20.4	(313)	8.5	(331)	6.4	(349)	2.74
(278)	147	(296)	17.1	(314)	8	(332)	6.4	(350)	2.55
(279)	112.9	(297)	16.2	(315)	8	(333)	6.4	(351)	2.55
(280)	77.1	(298)	14.3	(316)	7.4	(334)	6.4	(352)	2.55
(281)	57.3	(299)	12.7	(317)	8	(335)	6.4	(353)	2.55
(282)	49	(300)	12.7	(318)	7.4	(336)	5.54	(354)	2.55
(283)	42.7	(301)	12.7	(319)	7.4	(337)	5.54	(355)	2.37
(284)	41.2	(302)	11.9	(320)	7.3	(338)	5.54	(356)	2.1
(285)	33.2	(303)	11.1	(321)	8	(339)	5.13	(357)	1.95
(286)	27.8	(304)	11.1	(322)	8	(340)	4.74	(358)	1.8
(287)	26.5	(305)	11.1	(323)	8	(341)	4.38	(359)	1.73
(288)	25.8	(306)	11.1	(324)	8	(342)	4.04	(360)	1.66

River discharge data at 12-hourly intervals for Station: 23D
Period : 2

Variable: DRIE4.var1 (length = 344)

(1)	4.04	(19)	19.2	(37)	10.4	(55)	276	(73)	54.7
(2)	3.9	(20)	16.5	(38)	10.4	(56)	244	(74)	53.9
(3)	3.72	(21)	16.2	(39)	9.8	(57)	292	(75)	67.8
(4)	3.9	(22)	27.8	(40)	11.1	(58)	273	(76)	67.8
(5)	3.72	(23)	28.4	(41)	11.1	(59)	171	(77)	52.2
(6)	3.9	(24)	16.2	(42)	11.1	(60)	167	(78)	44.2
(7)	4.04	(25)	14.3	(43)	10.4	(61)	125	(79)	38.2
(8)	4.04	(26)	17.1	(44)	9.8	(62)	129	(80)	35.3
(9)	4.38	(27)	18.2	(45)	9.8	(63)	153	(81)	35.3
(10)	4.74	(28)	16.2	(46)	9.8	(64)	120	(82)	33.9
(11)	63.4	(29)	14.3	(47)	9.8	(65)	89.8	(83)	33.2
(12)	33.9	(30)	12.7	(48)	9.1	(66)	72.4	(84)	31.1
(13)	27.8	(31)	11.9	(49)	9.1	(67)	62.5	(85)	29.8
(14)	45.8	(32)	11.1	(50)	9.1	(68)	57.3	(86)	28.4
(15)	50.6	(33)	10.4	(51)	59	(69)	70.6	(87)	28.4
(16)	36	(34)	10.4	(52)	129.7	(70)	72.4	(88)	28.4
(17)	26.5	(35)	9.3	(53)	72.4	(71)	60.7	(89)	27.8
(18)	22.1	(36)	10.4	(54)	336	(72)	54.7	(90)	26.5

(91)	25.2	(109)	198	(127)	26	(145)	22.1	(163)	307
(92)	24.6	(110)	356	(128)	35.3	(146)	22.1	(164)	389
(93)	23.3	(111)	254	(129)	33.2	(147)	22.1	(165)	247
(94)	22.7	(112)	232	(130)	31.8	(148)	22.1	(166)	239.3
(95)	22.1	(113)	232	(131)	31.1	(149)	21.5	(167)	204
(96)	21.5	(114)	191	(132)	29.1	(150)	18.2	(168)	254
(97)	20.4	(115)	147	(133)	28.4	(151)	18.2	(169)	247
(98)	45.8	(116)	118	(134)	28.1	(152)	19.2	(170)	211
(99)	135	(117)	172	(135)	27.8	(153)	22.7	(171)	239
(100)	479	(118)	82	(136)	26.5	(154)	28.4	(172)	218
(101)	284	(119)	202	(137)	26.5	(155)	40.4	(173)	158
(102)	232	(120)	61.6	(138)	25.2	(156)	101	(174)	112
(103)	292	(121)	57.3	(139)	24.6	(157)	83.9	(175)	90.8
(104)	339	(122)	50.6	(140)	23.3	(158)	96.9	(176)	75
(105)	372	(123)	49	(141)	23.3	(159)	104.3	(177)	63.4
(106)	194	(124)	42.7	(142)	23.3	(160)	77.1	(178)	53.9
(107)	211	(125)	41.2	(143)	23.3	(161)	86.4	(179)	48.2
(108)	232	(126)	38.9	(144)	22.7	(162)	81.9	(180)	44.2

(181)	40.4	(199)	35.3	(217)	18.2	(235)	14.3	(253)	13.2
(182)	40.4	(200)	29.8	(218)	17.1	(236)	35.2	(254)	19.2
(183)	33.2	(201)	29.1	(219)	17.1	(237)	33.9	(255)	19.2
(184)	36.7	(202)	28.4	(220)	17.1	(238)	40.4	(256)	18.2
(185)	35.3	(203)	26.5	(221)	17.1	(239)	40.4	(257)	16.2
(186)	33.9	(204)	24.9	(222)	17.1	(240)	35.3	(258)	16.2
(187)	31.8	(205)	24.6	(223)	16.2	(241)	29.1	(259)	15.2
(188)	30.4	(206)	23.3	(224)	16.2	(242)	26.5	(260)	16.65
(189)	29.8	(207)	22.7	(225)	15.2	(243)	24	(261)	14
(190)	29.4	(208)	22.1	(226)	14.3	(244)	22.1	(262)	18.7
(191)	28.4	(209)	22.1	(227)	14.3	(245)	21.5	(263)	13
(192)	27.8	(210)	21.5	(228)	14.3	(246)	18.7	(264)	19.2
(193)	26.5	(211)	20.4	(229)	14.3	(247)	17.1	(265)	12
(194)	25.8	(212)	20.4	(230)	14.3	(248)	17.1	(266)	19.2
(195)	28.4	(213)	20.4	(231)	13.5	(249)	17.1	(267)	11
(196)	39.7	(214)	19.2	(232)	13.5	(250)	16.2	(268)	19.2
(197)	33.2	(215)	18.2	(233)	13.5	(251)	15.2	(269)	11
(198)	35.3	(216)	18.2	(234)	13.5	(252)	19.2	(270)	19.2

(271)	10.8	(289)	12.7	(307)	11.9	(325)	4.38	(343)	4.74
(272)	19.2	(290)	12.7	(308)	10.4	(326)	4.38	(344)	4.56
(273)	20.4	(291)	11.9	(309)	8.5	(327)	4.38		
(274)	20.95	(292)	11.9	(310)	7.4	(328)	4.38		
(275)	20.4	(293)	11.1	(311)	6.9	(329)	4.38		
(276)	20.4	(294)	11.9	(312)	6.4	(330)	4.38		
(277)	19.2	(295)	10.4	(313)	6.4	(331)	4.38		
(278)	18.2	(296)	9.8	(314)	5.97	(332)	4.04		
(279)	18.2	(297)	8.5	(315)	5.97	(333)	4.04		
(280)	13.9	(298)	8.5	(316)	5.54	(334)	3.42		
(281)	15.2	(299)	8.5	(317)	5.54	(335)	3.15		
(282)	16.2	(300)	8.5	(318)	5.13	(336)	3.42		
(283)	15.2	(301)	8.5	(319)	5.13	(337)	6.4		
(284)	15.2	(302)	8	(320)	4.74	(338)	7.4		
(285)	14.3	(303)	8	(321)	4.38	(339)	6.9		
(286)	14.3	(304)	8	(322)	4.38	(340)	6.4		
(287)	14.3	(305)	8.5	(323)	4.38	(341)	5.54		
(288)	13.5	(306)	10.4	(324)	4.38	(342)	5.13		

A3.86

River discharge data at 12-hourly intervals for Station: 23D
Period : 4

Variable: DRIE6.b_23dq12_6 (length = 360)

(1)	3.72	(19)	21.5	(37)	6.4	(55)	22.1	(73)	10.4
(2)	3.42	(20)	21.5	(38)	5.77	(56)	17.1	(74)	10.4
(3)	3.15	(21)	16.2	(39)	5.97	(57)	13.5	(75)	9.8
(4)	2.94	(22)	22.1	(40)	5.97	(58)	17.1	(76)	9.8
(5)	2.94	(23)	24.6	(41)	5.54	(59)	25.8	(77)	10.4
(6)	2.74	(24)	22.1	(42)	5.54	(60)	20.4	(78)	11.9
(7)	2.55	(25)	19.2	(43)	5.54	(61)	32.5	(79)	14.3
(8)	2.55	(26)	17.1	(44)	5.13	(62)	46.6	(80)	22.7
(9)	2.55	(27)	14.3	(45)	4.74	(63)	44.2	(81)	40.4
(10)	4.38	(28)	12.7	(46)	4.74	(64)	32.5	(82)	66
(11)	11.9	(29)	11.1	(47)	4.74	(65)	25.8	(83)	57.3
(12)	7.4	(30)	9.8	(48)	4.74	(66)	23.3	(84)	40.4
(13)	15.2	(31)	8.5	(49)	4.38	(67)	22.1	(85)	31.1
(14)	24	(32)	8	(50)	4.74	(68)	19.2	(86)	27.8
(15)	27.1	(33)	8	(51)	4.74	(69)	16.2	(87)	25.2
(16)	30.4	(34)	7.4	(52)	4.74	(70)	14.3	(88)	34
(17)	27.8	(35)	6.9	(53)	5.13	(71)	12.7	(89)	24.6
(18)	23.3	(36)	6.9	(54)	22.7	(72)	11.1	(90)	27.1

(181)	18.2	(199)	71.5	(217)	45.8	(235)	30.4	(253)	26.5
(182)	18.2	(200)	71.5	(218)	42.7	(236)	42.7	(254)	27.5
(183)	21.3	(201)	64.2	(219)	41.2	(237)	78.1	(255)	28.4
(184)	261	(202)	53.1	(220)	38.9	(238)	80.9	(256)	29.1
(185)	424	(203)	56.4	(221)	36.7	(239)	58.1	(257)	27.8
(186)	412	(204)	372	(222)	34.6	(240)	43.5	(258)	26.5
(187)	394	(205)	239.8	(223)	33.9	(241)	33.6	(259)	25.8
(188)	400	(206)	213	(224)	32.5	(242)	29.1	(260)	62.5
(189)	398	(207)	258	(225)	31.8	(243)	28.4	(261)	69.6
(190)	351	(208)	218	(226)	31.1	(244)	29.8	(262)	65.1
(191)	261	(209)	153	(227)	29.8	(245)	29.1	(263)	75.2
(192)	178	(210)	112	(228)	29.8	(246)	27.5	(264)	59.6
(193)	135	(211)	90.8	(229)	29.8	(247)	26.5	(265)	52.2
(194)	108	(212)	76.2	(230)	29.1	(248)	25.8	(266)	40.4
(195)	91.8	(213)	64.2	(231)	29.1	(249)	25.2	(267)	35.3
(196)	83.9	(214)	58.1	(232)	29.8	(250)	25.2	(268)	40.4
(197)	76.2	(215)	53.1	(233)	29.1	(251)	25.2	(269)	48.2
(198)	76.2	(216)	49	(234)	29.8	(252)	25.2	(270)	57.3

(91)	35.3	(109)	20.4	(127)	24	(145)	53.9	(163)	39.7
(92)	38.2	(110)	20.4	(128)	23.3	(146)	68.7	(164)	35.3
(93)	34.6	(111)	20.4	(129)	22.1	(147)	116	(165)	35.3
(94)	67.8	(112)	20.4	(130)	21.8	(148)	109.5	(166)	40.4
(95)	72.4	(113)	19.2	(131)	21.5	(149)	101	(167)	45
(96)	43.5	(114)	24	(132)	24	(150)	82.9	(168)	40.4
(97)	63.4	(115)	32.5	(133)	32.5	(151)	92.8	(169)	34.6
(98)	77.1	(116)	33.2	(134)	37.5	(152)	111.8	(170)	31.8
(99)	57.3	(117)	30.4	(135)	50.6	(153)	105	(171)	29.8
(100)	40.4	(118)	36	(136)	90.6	(154)	80	(172)	28.4
(101)	31.1	(119)	41.9	(137)	77.1	(155)	60.7	(173)	27.8
(102)	28.4	(120)	36	(138)	144.9	(156)	49.8	(174)	26.5
(103)	26.5	(121)	30.4	(139)	122.8	(157)	42.7	(175)	24.6
(104)	25.2	(122)	28.4	(140)	79	(158)	42.7	(176)	23.3
(105)	24	(123)	27.1	(141)	53.9	(159)	52.2	(177)	23.3
(106)	22.7	(124)	26.5	(142)	67.8	(160)	59.9	(178)	22.1
(107)	22.1	(125)	-25.2	(143)	173	(161)	59	(179)	20.4
(108)	21.5	(126)	24.6	(144)	83.9	(162)	49.8	(180)	19.2

(271)	95.9	(289)	21.5	(307)	19.2	(325)	8	(343)	5.13
(272)	122.8	(290)	20.4	(308)	10.4	(326)	8	(344)	5.13
(273)	96.9	(291)	19.2	(309)	19.2	(327)	8	(345)	4.74
(274)	65	(292)	18.2	(310)	11.1	(328)	7.4	(346)	4.74
(275)	50.6	(293)	18.2	(311)	11.1	(329)	7.4	(347)	4.38
(276)	41.9	(294)	17.1	(312)	11.1	(330)	7.4	(348)	4.04
(277)	36	(295)	17.1	(313)	11.1	(331)	6.9	(349)	4.04
(278)	33.2	(296)	16.2	(314)	11.1	(332)	6.9	(350)	4.04
(279)	30.4	(297)	16.2	(315)	11.1	(333)	6.4	(351)	4.04
(280)	29.8	(298)	15.2	(316)	10.4	(334)	6.4	(352)	4.04
(281)	29.1	(299)	14.3	(317)	9.8	(335)	6.4	(353)	4.04
(282)	29.1	(300)	14.3	(318)	9.1	(336)	6.4	(354)	4.04
(283)	29.1	(301)	13.5	(319)	9.1	(337)	6.4	(355)	4.04
(284)	29.1	(302)	11.9	(320)	9.1	(338)	6.4	(356)	4.04
(285)	27.1	(303)	11.1	(321)	8.5	(339)	6.4	(357)	3.42
(286)	24.6	(304)	11.1	(322)	8.5	(340)	5.54	(358)	3.42
(287)	22.7	(305)	11.1	(323)	8.5	(341)	5.54	(359)	2.94
(288)	22.1	(306)	10.4	(324)	8	(342)	5.54	(360)	2.74

River discharge data at 12-hourly intervals for Station: 23D
Period : 6

Variable: KOMPAG1.var1 (length = 360)

(1)	0.15	(19)	?	(37)	2E-3	(55)	9	(73)	0
(2)	0.116	(20)	0.014	(38)	2E-3	(56)	9	(74)	0
(3)	0.071	(21)	9	(39)	0.014	(57)	0.069	(75)	0
(4)	0.05	(22)	5E-3	(40)	0.025	(58)	5E-3	(76)	0
(5)	0.044	(23)	2E-3	(41)	0.014	(59)	3E-3	(77)	0
(6)	0.029	(24)	2E-3	(42)	0.025	(60)	2E-3	(78)	0
(7)	0.02	(25)	0.014	(43)	0.024	(61)	1E-3	(79)	0
(8)	0.017	(26)	0.014	(44)	0.02	(62)	1E-3	(80)	0
(9)	9	(27)	0.014	(45)	0.05	(63)	1E-3	(81)	0
(10)	9	(28)	0.014	(46)	0.32	(64)	0	(82)	0
(11)	9	(29)	0.029	(47)	0.162	(65)	0	(83)	0
(12)	9	(30)	0.017	(48)	0.106	(66)	0	(84)	0
(13)	9	(31)	0.029	(49)	0.05	(67)	0	(85)	0
(14)	9	(32)	0.029	(50)	0.038	(68)	0	(86)	0
(15)	5E-3	(33)	0.029	(51)	0.05	(69)	0	(87)	0
(16)	0.014	(34)	0.02	(52)	0.05	(70)	0	(88)	0
(17)	0.014	(35)	5E-3	(53)	0.029	(71)	0	(89)	0
(18)	9	(36)	5E-3	(54)	0.014	(72)	0	(90)	0

(181)	0.017	(199)	0.02	(217)	4.205	(235)	0.02	(253)	0.034
(182)	9	(200)	0.029	(218)	0.816	(236)	0.029	(254)	0.029
(183)	0.02	(201)	0.02	(219)	0.249	(237)	0.029	(255)	0.02
(184)	0.025	(202)	0.014	(220)	0.116	(238)	0.017	(256)	0.02
(185)	0.02	(203)	7E-3	(221)	7.9	(239)	0.017	(257)	0.014
(186)	0.034	(204)	5E-3	(222)	0.05	(240)	0.02	(258)	0.014
(187)	0.02	(205)	2E-3	(223)	0.038	(241)	0.017	(259)	9
(188)	0.017	(206)	2E-3	(224)	0.034	(242)	0.02	(260)	9
(189)	0.017	(207)	5E-3	(225)	0.02	(243)	0.02	(261)	9
(190)	0.014	(208)	0.014	(226)	0.05	(244)	0.014	(262)	7E-3
(191)	0.014	(209)	0.014	(227)	0.05	(245)	7E-3	(263)	0.017
(192)	0.025	(210)	0.014	(228)	0.029	(246)	7E-3	(264)	0.02
(193)	0.014	(211)	9	(229)	0.038	(247)	0.3	(265)	0.014
(194)	0.012	(212)	9	(230)	0.029	(248)	0.218	(266)	0.014
(195)	0.015	(213)	0.014	(231)	0.02	(249)	0.106	(267)	0.014
(196)	0.014	(214)	0.014	(232)	0.014	(250)	7.9	(268)	0.014
(197)	0.014	(215)	0.02	(233)	0.014	(251)	0.045	(269)	0.014
(198)	0.017	(216)	0.029	(234)	9	(252)	0.038	(270)	0.014

(91)	0	(109)	0	(127)	0.017	(145)	9	(163)	1E-3
(92)	0	(110)	7E-3	(128)	0.02	(146)	9	(164)	1E-3
(93)	0	(111)	0.014	(129)	0.014	(147)	9	(165)	3E-3
(94)	0	(112)	0.014	(130)	0.02	(148)	0.012	(166)	5E-3
(95)	0	(113)	0.011	(131)	0.02	(149)	9	(167)	5E-3
(96)	0	(114)	0.014	(132)	0.02	(150)	0.012	(168)	5E-3
(97)	0	(115)	0.014	(133)	9	(151)	9	(169)	5E-3
(98)	0	(116)	0.014	(134)	5E-3	(152)	9	(170)	5E-3
(99)	0	(117)	0.014	(135)	9	(153)	9	(171)	9
(100)	0	(118)	0.014	(136)	0.014	(154)	9	(172)	0.012
(101)	0	(119)	0.014	(137)	0.014	(155)	9	(173)	5E-3
(102)	0	(120)	0.02	(138)	0.017	(156)	9	(174)	5E-3
(103)	0	(121)	0.02	(139)	0.014	(157)	9	(175)	3E-3
(104)	0	(122)	0.017	(140)	0.014	(158)	9	(176)	5E-3
(105)	0	(123)	9	(141)	9	(159)	0.014	(177)	3E-3
(106)	0	(124)	5E-3	(142)	7E-3	(160)	9	(178)	9
(107)	0	(125)	5E-3	(143)	9	(161)	7E-3	(179)	9
(108)	0	(126)	0.025	(144)	0.014	(162)	3E-3	(180)	0.012

(271)	5E-3	(289)	5E-3	(307)	0.017	(325)	0.05	(343)	18.6
(272)	5E-3	(290)	0.014	(308)	0.017	(326)	0.038	(344)	15.85
(273)	5E-3	(291)	0.014	(309)	0.116	(327)	0.038	(345)	15.85
(274)	5E-3	(292)	0.014	(310)	0.096	(328)	0.263	(346)	14.61
(275)	5E-3	(293)	9	(311)	7.9	(329)	0.447	(347)	16
(276)	5E-3	(294)	0.014	(312)	0.044	(330)	0.34	(348)	14.81
(277)	0.014	(295)	0.014	(313)	0.029	(331)	0.249	(349)	11.15
(278)	0.014	(296)	0.014	(314)	0.025	(332)	0.204	(350)	11.32
(279)	0.017	(297)	0.014	(315)	0.02	(333)	0.138	(351)	11.15
(280)	0.02	(298)	9	(316)	0.025	(334)	0.138	(352)	8.092
(281)	0.014	(299)	5E-3	(317)	0.029	(335)	0.116	(353)	5.202
(282)	0.014	(300)	5E-3	(318)	0.029	(336)	0.096	(354)	3.972
(283)	0.02	(301)	2E-3	(319)	0.063	(337)	7.9	(355)	3.309
(284)	0.017	(302)	2E-3	(320)	0.063	(338)	7.9	(356)	2.617
(285)	0.02	(303)	1E-3	(321)	0.038	(339)	0.32	(357)	2.178
(286)	0.029	(304)	1E-3	(322)	0.038	(340)	1.324	(358)	2.2
(287)	0.014	(305)	1E-3	(323)	0.038	(341)	0.718	(359)	1.611
(288)	0.012	(306)	1E-3	(324)	0.05	(342)	1.732	(360)	1.65

River discharge data at 12-hourly intervals for Station: 17B
Period : 1

Variable: KOMPAG2.vari (length = 360)

(1)	1.236	(19)	0.447	(37)	0.36	(55)	0.218	(73)	0.162
(2)	1.112	(20)	0.471	(38)	0.36	(56)	0.218	(74)	0.15
(3)	1.071	(21)	0.447	(39)	0.32	(57)	0.21	(75)	1.87
(4)	0.92	(22)	0.425	(40)	0.34	(58)	0.218	(76)	0.993
(5)	0.849	(23)	0.402	(41)	0.32	(59)	0.218	(77)	0.849
(6)	0.816	(24)	0.402	(42)	0.295	(60)	0.218	(78)	8.411
(7)	0.782	(25)	0.402	(43)	0.283	(61)	0.189	(79)	10.4
(8)	0.849	(26)	0.688	(44)	0.249	(62)	0.204	(80)	6.87
(9)	0.92	(27)	0.546	(45)	0.218	(63)	0.189	(81)	7.47
(10)	1.032	(28)	0.564	(46)	0.218	(64)	0.176	(82)	4.205
(11)	0.849	(29)	0.495	(47)	0.218	(65)	0.162	(83)	3.31
(12)	0.782	(30)	0.471	(48)	0.218	(66)	0.162	(84)	2.902
(13)	0.718	(31)	0.447	(49)	0.21	(67)	0.162	(85)	2.346
(14)	0.658	(32)	0.447	(50)	0.208	(68)	0.162	(86)	2.178
(15)	0.546	(33)	0.402	(51)	0.189	(69)	0.162	(87)	1.87
(16)	0.546	(34)	0.381	(52)	0.208	(70)	0.162	(88)	1.732
(17)	0.495	(35)	0.36	(53)	0.189	(71)	0.15	(89)	1.611
(18)	0.495	(36)	0.36	(54)	0.189	(72)	0.15	(90)	1.416

(181)	0.36	(199)	0.218	(217)	2.6	(235)	0.993	(253)	0.576
(182)	0.36	(200)	0.234	(218)	2.346	(236)	0.92	(254)	0.546
(183)	0.36	(201)	0.249	(219)	6.578	(237)	0.92	(255)	0.495
(184)	0.381	(202)	0.249	(220)	4.691	(238)	0.849	(256)	0.495
(185)	0.402	(203)	0.218	(221)	3.523	(239)	1.324	(257)	0.447
(186)	0.36	(204)	1.152	(222)	2.902	(240)	1.071	(258)	0.447
(187)	0.36	(205)	0.546	(223)	2.524	(241)	0.993	(259)	0.447
(188)	0.36	(206)	0.447	(224)	2.178	(242)	0.92	(260)	0.447
(189)	0.36	(207)	1.87	(225)	2.07	(243)	0.849	(261)	0.447
(190)	0.32	(208)	1.28	(226)	2.178	(244)	0.782	(262)	0.402
(191)	0.32	(209)	2.019	(227)	1.73	(245)	0.782	(263)	0.402
(192)	0.263	(210)	12.26	(228)	1.416	(246)	0.658	(264)	0.782
(193)	0.283	(211)	8.88	(229)	1.324	(247)	0.658	(265)	0.576
(194)	0.263	(212)	5.202	(230)	1.236	(248)	0.601	(266)	0.546
(195)	0.283	(213)	5.73	(231)	1.152	(249)	0.601	(267)	0.52
(196)	0.263	(214)	4.205	(232)	1.071	(250)	0.546	(268)	0.658
(197)	0.249	(215)	3.523	(233)	1.071	(251)	0.495	(269)	0.601
(198)	0.234	(216)	2.302	(234)	0.993	(252)	0.546	(270)	5.735

(91)	1.324	(109)	3.1	(127)	0.782	(145)	1.416	(163)	0.849
(92)	1.152	(110)	2.806	(128)	0.782	(146)	2.262	(164)	0.782
(93)	1.071	(111)	2.346	(129)	0.719	(147)	2.524	(165)	0.718
(94)	0.993	(112)	2.178	(130)	0.688	(148)	6.435	(166)	0.718
(95)	0.92	(113)	2.019	(131)	0.658	(149)	2.902	(167)	0.658
(96)	0.849	(114)	2.902	(132)	0.658	(150)	4.568	(168)	0.658
(97)	0.782	(115)	2.178	(133)	0.601	(151)	2.346	(169)	0.546
(98)	0.718	(116)	1.87	(134)	0.546	(152)	1.945	(170)	0.546
(99)	0.658	(117)	1.611	(135)	0.546	(153)	1.732	(171)	0.546
(100)	0.658	(118)	1.416	(136)	0.521	(154)	1.512	(172)	0.546
(101)	0.601	(119)	1.324	(137)	0.495	(155)	1.324	(173)	0.495
(102)	11.51	(120)	1.236	(138)	0.471	(156)	1.236	(174)	0.471
(103)	3.309	(121)	1.152	(139)	0.447	(157)	1.236	(175)	0.447
(104)	2.346	(122)	1.071	(140)	0.447	(158)	1.112	(176)	0.447
(105)	25	(123)	0.993	(141)	0.447	(159)	1.071	(177)	0.402
(106)	7.167	(124)	0.92	(142)	0.471	(160)	0.993	(178)	0.402
(107)	4.69	(125)	0.92	(143)	0.447	(161)	0.92	(179)	0.402
(108)	3.744	(126)	0.816	(144)	0.471	(162)	0.92	(180)	0.381

(271)	3.972	(289)	0.658	(307)	0.32	(325)	0.189	(343)	7.9
(272)	2.902	(290)	0.658	(308)	0.32	(326)	0.189	(344)	7.9
(273)	13.41	(291)	0.601	(309)	0.283	(327)	0.189	(345)	7.9
(274)	4.691	(292)	0.564	(310)	0.263	(328)	0.218	(346)	0.05
(275)	3.102	(293)	0.546	(311)	0.283	(329)	0.218	(347)	0.05
(276)	2.178	(294)	0.521	(312)	0.263	(330)	0.218	(348)	0.038
(277)	1.732	(295)	0.447	(313)	0.249	(331)	0.189	(349)	0.038
(278)	1.416	(296)	0.447	(314)	0.249	(332)	0.189	(350)	0.034
(279)	1.324	(297)	0.402	(315)	0.218	(333)	0.189	(351)	0.029
(280)	1.071	(298)	0.425	(316)	0.234	(334)	0.162	(352)	0.029
(281)	0.92	(299)	0.447	(317)	0.218	(335)	0.162	(353)	0.029
(282)	0.92	(300)	0.447	(318)	0.234	(336)	0.162	(354)	0.029
(283)	0.849	(301)	0.402	(319)	0.218	(337)	0.096	(355)	0.038
(284)	0.884	(302)	0.381	(320)	0.234	(338)	0.096	(356)	0.029
(285)	0.782	(303)	0.36	(321)	0.218	(339)	0.096	(357)	0.029
(286)	0.782	(304)	0.36	(322)	0.204	(340)	0.088	(358)	0.029
(287)	0.718	(305)	0.32	(323)	0.189	(341)	7.9	(359)	0.02
(288)	0.658	(306)	0.36	(324)	0.189	(342)	7.9	(360)	0.02

River discharge data at 12-hourly intervals for Station: 17B
Period : 2

Variable: KOMPAG3.var1 (length = 360)

(1)	0.096	(19)	7E-3	(37)	7.9	(55)	0.014	(73)	0.138
(2)	0.05	(20)	0.012	(38)	0.063	(56)	0.189	(74)	0.15
(3)	0.029	(21)	9	(39)	0.063	(57)	0.014	(75)	0.116
(4)	0.025	(22)	5E-3	(40)	0.05	(58)	0.02	(76)	0.116
(5)	0.029	(23)	9	(41)	0.05	(59)	0.029	(77)	7.9
(6)	0.029	(24)	0.017	(42)	0.038	(60)	0.884	(78)	0.063
(7)	0.029	(25)	0.02	(43)	0.038	(61)	0.32	(79)	0.063
(8)	0.029	(26)	0.014	(44)	0.038	(62)	0.189	(80)	0.057
(9)	0.029	(27)	0.014	(45)	0.029	(63)	2.524	(81)	0.05
(10)	0.038	(28)	0.025	(46)	0.029	(64)	1.194	(82)	0.044
(11)	0.029	(29)	0.05	(47)	0.029	(65)	0.718	(83)	0.038
(12)	0.029	(30)	0.044	(48)	0.029	(66)	0.471	(84)	0.038
(13)	0.029	(31)	0.601	(49)	0.029	(67)	0.402	(85)	0.029
(14)	0.029	(32)	0.36	(50)	0.029	(68)	0.263	(86)	0.029
(15)	0.029	(33)	0.189	(51)	0.029	(69)	0.249	(87)	0.029
(16)	0.029	(34)	0.162	(52)	0.029	(70)	0.176	(88)	0.02
(17)	0.02	(35)	0.138	(53)	0.02	(71)	0.162	(89)	0.029
(18)	0.017	(36)	0.106	(54)	0.029	(72)	0.162	(90)	0.017

(91)	9	(109)	0.029	(127)	0.138	(145)	9	(163)	0.017
(92)	0.012	(110)	0.029	(128)	0.116	(146)	9	(164)	0.063
(93)	0.014	(111)	0.02	(129)	0.116	(147)	9	(165)	0.063
(94)	0.025	(112)	0.014	(130)	0.116	(148)	0.017	(166)	0.038
(95)	0.029	(113)	0.05	(131)	9.4	(149)	0.02	(167)	0.029
(96)	0.025	(114)	0.263	(132)	0.096	(150)	0.029	(168)	0.014
(97)	0.014	(115)	0.138	(133)	7.9	(151)	0.02	(169)	9
(98)	0.012	(116)	0.096	(134)	0.05	(152)	0.017	(170)	7E-3
(99)	0.02	(117)	7.9	(135)	0.05	(153)	0.014	(171)	9
(100)	0.32	(118)	0.071	(136)	0.038	(154)	0.014	(172)	7E-3
(101)	0.189	(119)	7.9	(137)	0.029	(155)	0.014	(173)	3E-3
(102)	0.138	(120)	0.381	(138)	0.029	(156)	0.014	(174)	5E-3
(103)	0.063	(121)	0.546	(139)	0.02	(157)	0.014	(175)	2E-3
(104)	0.063	(122)	0.36	(140)	0.014	(158)	0.014	(176)	2E-3
(105)	0.05	(123)	0.249	(141)	0.014	(159)	9	(177)	2E-3
(106)	0.05	(124)	0.218	(142)	0.014	(160)	0.012	(178)	2E-3
(107)	0.038	(125)	0.162	(143)	0.014	(161)	0.014	(179)	2E-3
(108)	0.029	(126)	0.283	(144)	0.014	(162)	0.014	(180)	2E-3

(181)	2E-3	(199)	5E-3	(217)	0.116	(235)	1.071	(253)	0.138
(182)	2E-3	(200)	5E-3	(218)	0.096	(236)	1.071	(254)	0.127
(183)	2E-3	(201)	5E-3	(219)	0.096	(237)	0.993	(255)	0.138
(184)	1E-3	(202)	5E-3	(220)	7.9	(238)	0.75	(256)	0.116
(185)	1E-3	(203)	5E-3	(221)	0.063	(239)	0.546	(257)	0.096
(186)	1E-3	(204)	5E-3	(222)	0.05	(240)	0.546	(258)	0.096
(187)	1E-3	(205)	5E-3	(223)	0.038	(241)	0.495	(259)	7.9
(188)	1E-3	(206)	9	(224)	0.038	(242)	0.425	(260)	0.071
(189)	5E-3	(207)	0.162	(225)	0.029	(243)	0.283	(261)	0.063
(190)	7E-3	(208)	0.993	(226)	0.02	(244)	0.263	(262)	0.063
(191)	9	(209)	0.658	(227)	0.02	(245)	0.249	(263)	7.9
(192)	7E-3	(210)	1.152	(228)	0.02	(246)	0.234	(264)	7.9
(193)	9	(211)	0.601	(229)	0.017	(247)	0.218	(265)	7.9
(194)	7E-3	(212)	0.447	(230)	0.017	(248)	0.218	(266)	7.9
(195)	9	(213)	0.32	(231)	0.02	(249)	0.189	(267)	7.9
(196)	7E-3	(214)	0.218	(232)	0.249	(250)	0.176	(268)	7.9
(197)	5E-3	(215)	0.138	(233)	1.236	(251)	0.162	(269)	7.9
(198)	5E-3	(216)	0.138	(234)	1.512	(252)	0.162	(270)	0.071

(271)	0.029	(289)	7.9	(307)	0.05	(325)	0.32	(343)	0.138
(272)	0.029	(290)	7.9	(308)	0.05	(326)	0.263	(344)	0.127
(273)	0.029	(291)	0.029	(309)	0.05	(327)	0.245	(345)	0.116
(274)	0.029	(292)	0.071	(310)	0.116	(328)	0.218	(346)	0.116
(275)	0.029	(293)	0.063	(311)	0.718	(329)	0.189	(347)	0.096
(276)	0.025	(294)	0.063	(312)	0.127	(330)	0.204	(348)	0.096
(277)	0.02	(295)	0.05	(313)	1.235	(331)	0.189	(349)	0.096
(278)	0.038	(296)	0.05	(314)	0.884	(332)	0.162	(350)	0.088
(279)	0.32	(297)	0.038	(315)	0.658	(333)	0.162	(351)	7.9
(280)	0.234	(298)	0.029	(316)	0.564	(334)	0.162	(352)	0.088
(281)	0.162	(299)	0.029	(317)	0.447	(335)	0.162	(353)	7.9
(282)	0.162	(300)	0.029	(318)	0.381	(336)	0.15	(354)	0.088
(283)	0.138	(301)	0.029	(319)	0.32	(337)	0.155	(355)	7.9
(284)	0.138	(302)	0.029	(320)	0.263	(338)	0.138	(356)	7.9
(285)	0.116	(303)	0.029	(321)	0.283	(339)	0.138	(357)	7.9
(286)	0.096	(304)	0.029	(322)	0.546	(340)	0.138	(358)	7.9
(287)	0.096	(305)	0.038	(323)	0.402	(341)	0.116	(359)	0.063
(288)	7.9	(306)	0.038	(324)	0.36	(342)	0.138	(360)	0.063

River discharge data at 12-hourly intervals for Station: 17B
Period : 3

Variable: KOMPAG4.var1 (length = 344)

(1)	0.072	(19)	0.447	(37)	0.249	(55)	4.445	(73)	2.346
(2)	0.063	(20)	0.495	(38)	0.234	(56)	3.523	(74)	1.87
(3)	0.063	(21)	1.236	(39)	0.249	(57)	2.902	(75)	1.611
(4)	0.063	(22)	0.849	(40)	0.234	(58)	14.61	(76)	1.562
(5)	0.063	(23)	0.67	(41)	0.218	(59)	8.092	(77)	1.416
(6)	0.071	(24)	0.631	(42)	0.218	(60)	4.818	(78)	1.324
(7)	0.063	(25)	0.546	(43)	0.189	(61)	3.744	(79)	1.152
(8)	0.106	(26)	0.546	(44)	0.204	(62)	3.102	(80)	1.071
(9)	2.524	(27)	0.495	(45)	0.189	(63)	2.709	(81)	0.993
(10)	4.205	(28)	0.447	(46)	0.176	(64)	2.346	(82)	0.92
(11)	2.019	(29)	0.402	(47)	0.162	(65)	3.309	(83)	0.92
(12)	1.512	(30)	0.36	(48)	0.162	(66)	2.524	(84)	0.92
(13)	1.152	(31)	0.36	(49)	0.162	(67)	2.178	(85)	0.782
(14)	0.92	(32)	0.34	(50)	35	(68)	1.87	(86)	0.782
(15)	0.782	(33)	0.32	(51)	6.87	(69)	1.611	(87)	0.718
(16)	0.658	(34)	0.292	(52)	24	(70)	3.102	(88)	0.781
(17)	0.546	(35)	0.283	(53)	10.43	(71)	3.972	(89)	0.658
(18)	0.495	(36)	0.263	(54)	6.291	(72)	2.7909	(90)	0.658

(181)	1.324	(199)	1.152	(217)	0.66	(235)	2.019	(253)	0.495
(182)	1.236	(200)	1.032	(218)	0.718	(236)	1.87	(254)	0.447
(183)	1.15	(201)	0.993	(219)	0.62	(237)	1.324	(255)	0.447
(184)	1.071	(202)	0.92	(220)	0.601	(238)	1.071	(256)	0.447
(185)	0.993	(203)	0.949	(221)	0.6	(239)	0.993	(257)	0.447
(186)	1.112	(204)	0.849	(222)	0.601	(240)	0.849	(258)	0.601
(187)	1.152	(205)	0.78	(223)	0.546	(241)	0.782	(259)	0.92
(188)	1.071	(206)	0.782	(224)	0.546	(242)	0.688	(260)	1.032
(189)	0.993	(207)	0.78	(225)	0.495	(243)	0.658	(261)	0.9
(190)	0.957	(208)	0.75	(226)	0.447	(244)	0.631	(262)	0.884
(191)	0.92	(209)	0.78	(227)	0.495	(245)	0.6	(263)	0.78
(192)	0.849	(210)	0.688	(228)	0.47	(246)	0.546	(264)	0.658
(193)	0.92	(211)	0.66	(229)	0.447	(247)	0.495	(265)	0.601
(194)	3.309	(212)	0.658	(230)	0.495	(248)	0.495	(266)	0.546
(195)	1.87	(213)	0.601	(231)	0.495	(249)	0.546	(267)	0.546
(196)	1.512	(214)	0.631	(232)	0.495	(250)	0.816	(268)	0.521
(197)	1.512	(215)	0.601	(233)	0.49	(251)	0.658	(269)	0.495
(198)	1.324	(216)	0.688	(234)	1.464	(252)	0.546	(270)	0.521

(91)	0.601	(109)	17.57	(127)	1.236	(145)	0.658	(163)	4.94
(92)	0.601	(110)	10.08	(128)	1.194	(146)	0.631	(164)	3.972
(93)	0.546	(111)	6.291	(129)	1.15	(147)	0.601	(165)	3.31
(94)	0.546	(112)	4.691	(130)	1.071	(148)	0.631	(166)	2.806
(95)	0.546	(113)	3.972	(131)	1.07	(149)	0.546	(167)	15.43
(96)	0.546	(114)	3.523	(132)	1.071	(150)	0.564	(168)	7.019
(97)	5.735	(115)	3.102	(133)	0.99	(151)	9.74	(169)	4.94
(98)	28	(116)	2.806	(134)	0.92	(152)	2.709	(170)	3.744
(99)	15.43	(117)	2.524	(135)	0.78	(153)	1.87	(171)	3.309
(100)	6.87	(118)	2.262	(136)	0.782	(154)	5.878	(172)	2.902
(101)	4.691	(119)	2.019	(137)	0.78	(155)	4.69	(173)	2.524
(102)	3.744	(120)	1.87	(138)	0.75	(156)	3.206	(174)	2.346
(103)	21	(121)	1.65	(139)	0.99	(157)	2.524	(175)	2.178
(104)	8.73	(122)	1.611	(140)	0.849	(158)	2.019	(176)	1.945
(105)	5.46	(123)	1.512	(141)	0.78	(159)	1.73	(177)	1.732
(106)	4.205	(124)	1.416	(142)	0.718	(160)	1.611	(178)	1.611
(107)	3.52	(125)	1.324	(143)	0.658	(161)	12.26	(179)	1.512
(108)	13.41	(126)	1.28	(144)	0:658	(162)	8.73	(180)	1.416

(271)	0.601	(289)	0.249	(307)	0.218	(325)	0.096	(343)	0.116
(272)	0.546	(290)	0.249	(308)	0.234	(326)	0.096	(344)	0.106
(273)	0.495	(291)	0.218	(309)	0.189	(327)	0.096		
(274)	0.495	(292)	0.109	(310)	0.176	(328)	7.9		
(275)	0.447	(293)	0.162	(311)	0.162	(329)	0.076		
(276)	0.447	(294)	0.138	(312)	0.162	(330)	0.096		
(277)	0.402	(295)	0.138	(313)	0.162	(331)	7.9		
(278)	0.425	(296)	0.234	(314)	0.162	(332)	0.138		
(279)	0.402	(297)	0.218	(315)	0.138	(333)	0.116		
(280)	0.402	(298)	0.189	(316)	0.162	(334)	0.096		
(281)	0.36	(299)	0.162	(317)	0.116	(335)	0.096		
(282)	0.36	(300)	0.204	(318)	0.138	(336)	7.9		
(283)	0.32	(301)	0.447	(319)	0.138	(337)	7.9		
(284)	0.263	(302)	0.425	(320)	0.138	(338)	7.9		
(285)	0.283	(303)	0.36	(321)	0.116	(339)	7.9		
(286)	0.263	(304)	0.292	(322)	0.116	(340)	7.9		
(287)	0.283	(305)	0.283	(323)	0.116	(341)	7.9		
(288)	0.263	(306)	0.249	(324)	0.116	(342)	0.088		

River discharge data at 12-hourly intervals for Station: 17B
Period : 4

A3.54

Variable: KOMPAG5.var1 (length = 360)

(1)	0.116	(19)	0.029	(37)	9	(55)	0.014	(73)	0.02
(2)	0.162	(20)	0.014	(38)	9	(56)	0.017	(74)	0.029
(3)	0.162	(21)	0.014	(39)	0.014	(57)	0.014	(75)	0.02
(4)	0.15	(22)	0.02	(40)	0.02	(58)	0.012	(76)	0.017
(5)	0.116	(23)	0.02	(41)	0.014	(59)	9	(77)	9
(6)	0.088	(24)	0.02	(42)	9	(60)	7E-3	(78)	5E-3
(7)	0.096	(25)	0.02	(43)	7E-3	(61)	5E-3	(79)	5E-3
(8)	7.9	(26)	0.02	(44)	5E-3	(62)	5E-3	(80)	5E-3
(9)	7.9	(27)	0.014	(45)	2E-3	(63)	5E-3	(81)	9
(10)	7.9	(28)	9	(46)	2E-3	(64)	0.012	(82)	9
(11)	7.9	(29)	7E-3	(47)	1E-3	(65)	0.02	(83)	5E-3
(12)	0.071	(30)	5E-3	(48)	1E-3	(66)	0.025	(84)	5E-3
(13)	0.063	(31)	5E-3	(49)	1E-3	(67)	0.03	(85)	2E-3
(14)	0.063	(32)	3E-3	(50)	1E-3	(68)	0.025	(86)	1E-3
(15)	0.063	(33)	1E-3	(51)	1E-3	(69)	0.038	(87)	2E-3
(16)	0.05	(34)	0	(52)	1E-3	(70)	0.02	(88)	1E-3
(17)	0.038	(35)	5E-3	(53)	1E-3	(71)	0.013	(89)	0
(18)	0.035	(36)	9	(54)	5E-3	(72)	0.029	(90)	0

(91)	0	(109)	0	(127)	0	(145)	0	(163)	0
(92)	0	(110)	0	(128)	0	(146)	0	(164)	0
(93)	0	(111)	0	(129)	0	(147)	0	(165)	0
(94)	0	(112)	0	(130)	0	(148)	0	(166)	0
(95)	0	(113)	0	(131)	0	(149)	0	(167)	0
(96)	0	(114)	0	(132)	0	(150)	0	(168)	0
(97)	0	(115)	0	(133)	0	(151)	0	(169)	0
(98)	0	(116)	0	(134)	0	(152)	0	(170)	0
(99)	0	(117)	0	(135)	0	(153)	0	(171)	0
(100)	0	(118)	0	(136)	0	(154)	0	(172)	0
(101)	0	(119)	0	(137)	0	(155)	0	(173)	0
(102)	0	(120)	0	(138)	0	(156)	0	(174)	0
(103)	0	(121)	0	(139)	0	(157)	0	(175)	0
(104)	0	(122)	0	(140)	0	(158)	0	(176)	0
(105)	0	(123)	0	(141)	0	(159)	0	(177)	0
(106)	0	(124)	0	(142)	0	(160)	0	(178)	0
(107)	0	(125)	0	(143)	0	(161)	0	(179)	0
(108)	0	(126)	0	(144)	0	(162)	0	(180)	0

(181)	0	(199)	0	(217)	0	(235)	0	(253)	0
(182)	0	(200)	0	(218)	0	(236)	0	(254)	0
(183)	0	(201)	0	(219)	0	(237)	0	(255)	0
(184)	0	(202)	0	(220)	0	(238)	0	(256)	0
(185)	0	(203)	0	(221)	0	(239)	0	(257)	0
(186)	0	(204)	0	(222)	0	(240)	0	(258)	0
(187)	0	(205)	0	(223)	0	(241)	0	(259)	0
(188)	0	(206)	0	(224)	0	(242)	0	(260)	0
(189)	0	(207)	0	(225)	0	(243)	0	(261)	0
(190)	0	(208)	0	(226)	0	(244)	0	(262)	0
(191)	0	(209)	0	(227)	0	(245)	0	(263)	0
(192)	0	(210)	0	(228)	0	(246)	0	(264)	0
(193)	0	(211)	0	(229)	0	(247)	0	(265)	0
(194)	0	(212)	0	(230)	0	(248)	0	(266)	0
(195)	0	(213)	0	(231)	0	(249)	0	(267)	0
(196)	0	(214)	0	(232)	0	(250)	0	(268)	0
(197)	0	(215)	0	(233)	0	(251)	0	(269)	0
(198)	0	(216)	0	(234)	0	(252)	0	(270)	0

(271)	0	(289)	1E-3	(307)	2E-3	(325)	0.249	(343)	0.063
(272)	0	(290)	0.249	(308)	2E-3	(326)	0.218	(344)	0.063
(273)	0	(291)	0.138	(309)	1E-3	(327)	1.611	(345)	0.05
(274)	0	(292)	0.106	(310)	1E-3	(328)	1.512	(346)	0.057
(275)	0	(293)	0.063	(311)	5E-3	(329)	0.849	(347)	0.05
(276)	0	(294)	0.063	(312)	5E-3	(330)	0.546	(348)	0.05
(277)	0	(295)	0.039	(313)	5E-3	(331)	0.402	(349)	0.05
(278)	0	(296)	0.034	(314)	0.012	(332)	0.32	(350)	0.05
(279)	0	(297)	0.029	(315)	5E-3	(333)	0.249	(351)	7.9
(280)	0	(298)	0.029	(316)	0.012	(334)	0.204	(352)	0.218
(281)	2E-3	(299)	0.02	(317)	5E-3	(335)	0.162	(353)	0.063
(282)	5E-3	(300)	0.017	(318)	9	(336)	0.15	(354)	0.096
(283)	5E-3	(301)	0.014	(319)	5E-3	(337)	0.116	(355)	0.063
(284)	5E-3	(302)	9	(320)	0.014	(338)	0.116	(356)	7.9
(285)	2E-3	(303)	5E-3	(321)	1.236	(339)	0.096	(357)	0.05
(286)	2E-3	(304)	5E-3	(322)	0.718	(340)	0.088	(358)	0.057
(287)	1E-3	(305)	5E-3	(323)	0.447	(341)	0.076	(359)	0.05
(288)	1E-3	(306)	5E-3	(324)	0.32	(342)	7.9	(360)	0.05

River discharge data at 12-hourly intervals for Station: 17B
Period : 5

Variable: VISI.varl (length = 360)

(1) 0	(19) 0	(37) 0	(55) 0	(73) 0
(2) 0	(20) 0	(38) 0	(56) 0	(74) 0
(3) 0	(21) 0	(39) 0	(57) 0	(75) 0
(4) 0	(22) 0	(40) 0	(58) 0	(76) 0
(5) 0	(23) 0	(41) 0	(59) 0	(77) 0
(6) 0	(24) 0	(42) 0	(60) 0	(78) 0
(7) 0	(25) 0	(43) 0	(61) 0	(79) 0
(8) 0	(26) 0	(44) 0	(62) 0	(80) 0
(9) 0	(27) 0	(45) 0	(63) 0	(81) 0
(10) 0	(28) 0	(46) 0	(64) 0	(82) 0
(11) 0	(29) 0	(47) 0	(65) 0	(83) 0
(12) 0	(30) 0	(48) 0	(66) 0	(84) 0
(13) 0	(31) 0	(49) 0	(67) 0	(85) 0
(14) 0	(32) 0	(50) 0	(68) 0	(86) 0
(15) 0	(33) 0	(51) 0	(69) 0	(87) 0
(16) 0	(34) 0	(52) 0	(70) 0	(88) 0
(17) 0	(35) 0	(53) 0	(71) 0	(89) 0
(18) 0	(36) 0	(54) 0	(72) 0	(90) 0

(91) 0	(109) 0	(127) 0	(145) 0	(163) 0
(92) 0	(110) 0	(128) 0	(146) 0	(164) 0
(93) 0	(111) 0	(129) 0	(147) 0	(165) 0
(94) 0	(112) 0	(130) 0	(148) 0	(166) 0
(95) 0	(113) 0	(131) 0	(149) 0	(167) 0
(96) 0	(114) 0	(132) 0	(150) 0	(168) 0
(97) 0	(115) 0	(133) 0	(151) 0	(169) 0
(98) 0	(116) 0	(134) 0	(152) 0	(170) 0
(99) 0	(117) 0	(135) 0	(153) 0	(171) 0
(100) 0	(118) 0	(136) 0	(154) 0	(172) 0
(101) 0	(119) 0	(137) 0	(155) 0	(173) 0
(102) 0	(120) 0	(138) 0	(156) 0	(174) 0
(103) 0	(121) 0	(139) 0	(157) 0	(175) 0
(104) 0	(122) 0	(140) 0	(158) 0	(176) 0
(105) 0	(123) 0	(141) 0	(159) 0	(177) 0
(106) 0	(124) 0	(142) 0	(160) 0	(178) 0
(107) 0	(125) 0	(143) 0	(161) 0	(179) 0
(108) 0	(126) 0	(144) 0	(162) 0	(180) 0

(181) 0	(199) 0	(217) 0	(235) 0	(253) 0
(182) 0	(200) 0	(218) 0	(236) 0	(254) 0
(183) 0	(201) 0	(219) 0	(237) 0	(255) 0
(184) 0	(202) 0	(220) 0	(238) 0	(256) 0
(185) 0	(203) 0	(221) 0	(239) 0	(257) 0
(186) 0	(204) 0	(222) 0	(240) 0	(258) 0
(187) 0	(205) 0	(223) 0	(241) 0	(259) 0
(188) 0	(206) 0	(224) 0	(242) 0	(260) 0
(189) 0	(207) 0	(225) 0	(243) 0	(261) 0
(190) 0	(208) 0	(226) 0	(244) 0	(262) 0
(191) 0	(209) 0	(227) 0	(245) 0	(263) 0
(192) 0	(210) 0	(228) 0	(246) 0	(264) 0
(193) 0	(211) 0	(229) 0	(247) 0	(265) 0
(194) 0	(212) 0	(230) 0	(248) 0	(266) 0
(195) 0	(213) 0	(231) 0	(249) 0	(267) 0
(196) 0	(214) 0	(232) 0	(250) 0	(268) 0
(197) 0	(215) 0	(233) 0	(251) 0	(269) 0
(198) 0	(216) 0	(234) 0	(252) 0	(270) 0

(271) 0	(289) 0	(307) 0	(325) 0	(343) 2.087
(272) 0	(290) 0	(308) 0	(326) 0.04	(344) 2.09
(273) 0	(291) 0	(309) 0	(327) 1E-3	(345) 0.518
(274) 0	(292) 0	(310) 0	(328) 0.083	(346) 0.51
(275) 0	(293) 0	(311) 0	(329) 5E-3	(347) 0.518
(276) 0	(294) 0	(312) 0	(330) 2E-3	(348) 1.87
(277) 0	(295) 0	(313) 0	(331) 1E-3	(349) 1.771
(278) 0	(296) 0	(314) 0	(332) 1E-3	(350) 1.675
(279) 0	(297) 0	(315) 0	(333) 0	(351) 1.67
(280) 0	(298) 0	(316) 0	(334) 0	(352) 1.121
(281) 0	(299) 0	(317) 0	(335) 0	(353) 0.518
(282) 0	(300) 0	(318) 0	(336) 0	(354) 0.296
(283) 0	(301) 0	(319) 0	(337) 0	(355) 0.197
(284) 0	(302) 0	(320) 0	(338) 0	(356) 0.159
(285) 0	(303) 0	(321) 0	(339) 0.376	(357) 0.121
(286) 0	(304) 0	(322) 0	(340) 0.02	(358) 0.12
(287) 0	(305) 0	(323) 0	(341) 3E-3	(359) 0.083
(288) 0	(306) 0	(324) 0	(342) 1E-3	(360) 0.07

River discharge data at 12-hourly intervals for Station: 20A
Period : 1

Variable: KOMFAG6.var1 (length = 360)

(1)	0.038	(19)	2.346	(37)	0.189	(55)	0.063	(73)	0.218
(2)	0.034	(20)	1.416	(38)	0.189	(56)	0.293	(74)	0.249
(3)	0.038	(21)	1.324	(39)	0.162	(57)	0.849	(75)	0.631
(4)	0.038	(22)	1.071	(40)	0.162	(58)	0.92	(76)	0.631
(5)	0.038	(23)	0.884	(41)	0.138	(59)	1.071	(77)	0.546
(6)	0.044	(24)	0.718	(42)	0.138	(60)	0.78	(78)	3.309
(7)	0.044	(25)	0.631	(43)	0.116	(61)	0.601	(79)	1.611
(8)	0.044	(26)	0.546	(44)	0.116	(62)	0.546	(80)	1.28
(9)	0.044	(27)	0.471	(45)	0.116	(63)	0.782	(81)	1.071
(10)	1.152	(28)	0.425	(46)	0.106	(64)	0.601	(82)	0.849
(11)	1.236	(29)	0.36	(47)	0.106	(65)	0.495	(83)	0.688
(12)	1.87	(30)	0.32	(48)	0.076	(66)	0.447	(84)	0.564
(13)	2.709	(31)	0.283	(49)	0.096	(67)	0.36	(85)	0.521
(14)	1.672	(32)	0.253	(50)	0.162	(68)	0.34	(86)	0.447
(15)	2.019	(33)	0.218	(51)	0.92	(69)	0.292	(87)	3.206
(16)	1.236	(34)	0.218	(52)	0.601	(70)	0.283	(88)	1.732
(17)	0.993	(35)	0.218	(53)	1.071	(71)	0.249	(89)	1.152
(18)	0.816	(36)	0.218	(54)	0.381	(72)	0.234	(90)	0.993

(181)	0.782	(199)	1.732	(217)	1.732	(235)	3.309	(253)	0.92
(182)	0.92	(200)	1.611	(218)	1.512	(236)	1.945	(254)	0.816
(183)	7.47	(201)	1.611	(219)	1.416	(237)	1.562	(255)	0.782
(184)	13.8	(202)	2.346	(220)	1.324	(238)	1.324	(256)	0.688
(185)	11.15	(203)	28	(221)	1.28	(239)	1.236	(257)	0.658
(186)	20.5	(204)	16.7	(222)	1.236	(240)	1.032	(258)	0.92
(187)	16.27	(205)	8.73	(223)	1.194	(241)	0.993	(259)	6.87
(188)	9.74	(206)	6.291	(224)	1.071	(242)	0.884	(260)	3.309
(189)	6.87	(207)	4.944	(225)	1.071	(243)	0.849	(261)	2.524
(190)	4.944	(208)	4.325	(226)	1.071	(244)	0.782	(262)	2.178
(191)	3.972	(209)	3.624	(227)	1.071	(245)	0.782	(263)	1.87
(192)	3.309	(210)	3.102	(228)	1.071	(246)	0.718	(264)	1.562
(193)	2.902	(211)	2.806	(229)	0.757	(247)	0.718	(265)	1.464
(194)	2.524	(212)	2.524	(230)	0.884	(248)	0.718	(266)	1.37
(195)	2.806	(213)	2.346	(231)	0.849	(249)	0.75	(267)	1.512
(196)	2.262	(214)	2.178	(232)	0.782	(250)	0.718	(268)	2.524
(197)	2.178	(215)	2.019	(233)	0.92	(251)	0.688	(269)	3.102
(198)	1.87	(216)	1.801	(234)	1.512	(252)	0.957	(270)	2.435

(91)	0.849	(109)	0.36	(127)	0.471	(145)	4.691	(163)	6.291
(92)	0.782	(110)	0.36	(128)	0.471	(146)	3.858	(164)	3.972
(93)	0.849	(111)	0.4447	(129)	0.495	(147)	13.9	(165)	2.902
(94)	3.102	(112)	0.884	(130)	1.071	(148)	8.092	(166)	2.435
(95)	1.672	(113)	0.688	(131)	0.782	(149)	5.202	(167)	2.178
(96)	1.28	(114)	0.601	(132)	0.718	(150)	3.744	(168)	1.87
(97)	1.071	(115)	4.205	(133)	0.658	(151)	3.309	(169)	1.732
(98)	0.957	(116)	1.945	(134)	12.26	(152)	2.902	(170)	1.562
(99)	0.849	(117)	1.512	(135)	5.202	(153)	2.524	(171)	1.416
(100)	0.782	(118)	1.236	(136)	3.206	(154)	2.178	(172)	1.324
(101)	0.658	(119)	0.993	(137)	2.435	(155)	2.019	(173)	1.236
(102)	0.631	(120)	0.957	(138)	1.945	(156)	1.801	(174)	1.152
(103)	0.546	(121)	0.816	(139)	1.87	(157)	1.611	(175)	1.071
(104)	0.495	(122)	0.718	(140)	1.611	(158)	17.13	(176)	0.993
(105)	0.447	(123)	0.658	(141)	9.4	(159)	4.818	(177)	0.92
(106)	0.447	(124)	0.564	(142)	20.5	(160)	3.309	(178)	0.884
(107)	0.402	(125)	0.546	(143)	9.74	(161)	2.709	(179)	0.849
(108)	0.381	(126)	0.495	(144)	6.15	(162)	2.262	(180)	0.782

(271)	2.019	(289)	0.658	(307)	0.36	(325)	0.218	(343)	0.138
(272)	1.732	(290)	0.601	(308)	0.658	(326)	0.218	(344)	0.162
(273)	1.512	(291)	0.546	(309)	0.495	(327)	0.218	(345)	0.162
(274)	1.324	(292)	0.546	(310)	0.447	(328)	0.218	(346)	0.138
(275)	1.324	(293)	0.546	(311)	0.402	(329)	0.189	(347)	0.116
(276)	1.152	(294)	0.546	(312)	0.36	(330)	0.189	(348)	0.096
(277)	1.152	(295)	0.546	(313)	0.36	(331)	0.189	(349)	0.096
(278)	0.993	(296)	0.495	(314)	0.32	(332)	0.189	(350)	0.116
(279)	0.993	(297)	0.495	(315)	0.32	(333)	0.162	(351)	0.116
(280)	0.92	(298)	0.495	(316)	0.32	(334)	0.189	(352)	0.116
(281)	1.071	(299)	0.447	(317)	0.32	(335)	0.162	(353)	0.116
(282)	0.92	(300)	0.447	(318)	0.32	(336)	0.189	(354)	0.116
(283)	0.92	(301)	0.402	(319)	0.283	(337)	0.162	(355)	0.096
(284)	0.849	(302)	0.402	(320)	0.283	(338)	0.162	(356)	0.096
(285)	0.782	(303)	0.36	(321)	0.283	(339)	0.162	(357)	0.096
(286)	0.782	(304)	0.36	(322)	0.283	(340)	0.162	(358)	0.096
(287)	0.718	(305)	0.36	(323)	0.283	(341)	0.162	(359)	0.096
(288)	0.658	(306)	0.36	(324)	0.283	(342)	0.162	(360)	0.096

River discharge data at 12-hourly intervals for Station: 17B
Period : 6

Variable: VIS2.var1 (length = 360)

(1)	0.052	(19)	9	(37)	0.015	(55)	5E-3	(73)	4E-3
(2)	0.052	(20)	7E-3	(38)	0.014	(56)	5E-3	(74)	0.121
(3)	0.052	(21)	9	(39)	9	(57)	5E-3	(75)	0.03
(4)	0.035	(22)	7E-3	(40)	9	(58)	5E-3	(76)	0.018
(5)	0.03	(23)	9	(41)	9	(59)	5E-3	(77)	0.015
(6)	0.03	(24)	7E-3	(42)	8	(60)	5E-3	(78)	0.69
(7)	0.021	(25)	0.052	(43)	5E-3	(61)	5E-3	(79)	0.468
(8)	0.023	(26)	0.015	(44)	5E-3	(62)	5E-3	(80)	0.24
(9)	0.021	(27)	0.052	(45)	5E-3	(63)	5E-3	(81)	0.17
(10)	0.021	(28)	0.026	(46)	5E-3	(64)	5E-3	(82)	0.083
(11)	0.021	(29)	0.021	(47)	5E-3	(65)	5E-3	(83)	0.052
(12)	0.02	(30)	0.021	(48)	5E-3	(66)	5E-3	(84)	0.05
(13)	0.015	(31)	0.015	(49)	5E-3	(67)	5E-3	(85)	0.035
(14)	0.015	(32)	0.016	(50)	5E-3	(68)	5E-3	(86)	0.035
(15)	0.015	(33)	0.015	(51)	5E-3	(69)	5E-3	(87)	0.03
(16)	0.012	(34)	0.015	(52)	4E-3	(70)	5E-3	(88)	0.035
(17)	9	(35)	0.015	(53)	8	(71)	5E-3	(89)	0.03
(18)	9	(36)	0.015	(54)	5E-3	(72)	5E-3	(90)	0.035

(91)	0.03	(109)	0.066	(127)	0.03	(145)	1.04	(163)	0.03
(92)	0.03	(110)	0.059	(128)	0.03	(146)	0.33	(164)	0.032
(93)	0.03	(111)	0.066	(129)	0.03	(147)	0.228	(165)	0.03
(94)	0.026	(112)	0.059	(130)	0.03	(148)	2.31	(166)	0.03
(95)	0.021	(113)	0.121	(131)	0.03	(149)	1.383	(167)	0.03
(96)	0.021	(114)	0.228	(132)	0.03	(150)	0.63	(168)	0.028
(97)	0.021	(115)	0.101	(133)	0.021	(151)	0.376	(169)	0.021
(98)	0.022	(116)	0.066	(134)	0.025	(152)	0.27	(170)	0.026
(99)	0.021	(117)	0.052	(135)	0.021	(153)	0.228	(171)	0.021
(100)	0.015	(118)	0.04	(136)	0.018	(154)	0.18	(172)	0.022
(101)	0.021	(119)	0.04	(137)	0.015	(155)	0.066	(173)	0.021
(102)	0.083	(120)	0.03	(138)	0.016	(156)	0.05	(174)	0.018
(103)	0.144	(121)	0.03	(139)	0.015	(157)	0.052	(175)	0.015
(104)	0.046	(122)	0.03	(140)	0.015	(158)	0.05	(176)	0.015
(105)	1.293	(123)	0.03	(141)	0.015	(159)	0.052	(177)	0.015
(106)	0.197	(124)	0.026	(142)	0.015	(160)	0.0406	(178)	0.015
(107)	0.121	(125)	0.021	(143)	0.015	(161)	0.04	(179)	0.015
(108)	0.083	(126)	0.018	(144)	0.015	(162)	0.034	(180)	0.015

(181)	0.015	(199)	5E-3	(217)	0.819	(235)	0.144	(253)	0.021
(182)	0.015	(200)	5E-3	(218)	0.98	(236)	0.17	(254)	0.021
(183)	0.015	(201)	5E-3	(219)	0.572	(237)	0.121	(255)	0.021
(184)	0.015	(202)	5E-3	(220)	1.121	(238)	0.17	(256)	0.018
(185)	0.015	(203)	5E-3	(221)	0.296	(239)	0.066	(257)	0.015
(186)	0.015	(204)	5E-3	(222)	1.121	(240)	0.06	(258)	0.015
(187)	0.015	(205)	5E-3	(223)	0.261	(241)	0.04	(259)	0.015
(188)	0.014	(206)	5E-3	(224)	1.121	(242)	0.03	(260)	0.015
(189)	0.015	(207)	5E-3	(225)	0.228	(243)	0.03	(261)	0.015
(190)	0.012	(208)	0.012	(226)	0.228	(244)	0.03	(262)	0.015
(191)	9	(209)	0.021	(227)	0.228	(245)	0.03	(263)	0.015
(192)	0.012	(210)	0.083	(228)	0.228	(246)	0.03	(264)	0.018
(193)	9	(211)	0.819	(229)	0.228	(247)	0.021	(265)	0.021
(194)	0.01	(212)	0.82	(230)	0.228	(248)	0.021	(266)	0.021
(195)	9	(213)	0.963	(231)	0.197	(249)	0.021	(267)	0.021
(196)	0.01	(214)	0.98	(232)	0.213	(250)	0.018	(268)	0.021
(197)	7E-3	(215)	1.04	(233)	0.17	(251)	0.021	(269)	0.04
(198)	7E-3	(216)	0.98	(234)	0.197	(252)	0.018	(270)	1.874

(271)	0.629	(289)	0.04	(307)	9	(325)	1E-3	(343)	0
(272)	0.421	(290)	0.034	(308)	7E-3	(326)	1E-3	(344)	0
(273)	2.403	(291)	0.03	(309)	5E-3	(327)	0	(345)	0
(274)	0.82	(292)	0.121	(310)	4E-3	(328)	1E-3	(346)	0
(275)	0.468	(293)	0.03	(311)	3E-3	(329)	0	(347)	0
(276)	0.26	(294)	0.026	(312)	4E-3	(330)	0	(348)	0
(277)	0.144	(295)	0.021	(313)	3E-3	(331)	0	(349)	0
(278)	0.195	(296)	0.018	(314)	3E-3	(332)	0	(350)	0
(279)	0.17	(297)	0.015	(315)	3E-3	(333)	0	(351)	0
(280)	0.17	(298)	0.015	(316)	3E-3	(334)	0	(352)	0
(281)	0.121	(299)	0.015	(317)	3E-3	(335)	0	(353)	0
(282)	0.08	(300)	0.015	(318)	3E-3	(336)	0	(354)	0
(283)	0.066	(301)	0.015	(319)	3E-3	(337)	0	(355)	0
(284)	0.059	(302)	0.015	(320)	3E-3	(338)	0	(356)	0
(285)	0.052	(303)	9	(321)	1E-3	(339)	0	(357)	0
(286)	0.052	(304)	0.012	(322)	1E-3	(340)	0	(358)	0
(287)	0.04	(305)	9	(323)	1E-3	(341)	0	(359)	0
(288)	0.04	(306)	9	(324)	1E-3	(342)	0	(360)	0

River discharge data at 12-hourly intervals for Station: 20A
Period : 2

Variable: VIS3.var1 (length = 360)

(1) 0	(19) 0	(37) 0	(55) 0	(73) 0
(2) 0	(20) 0	(38) 0	(56) 0	(74) 0
(3) 0	(21) 0	(39) 0	(57) 0	(75) 0
(4) 0	(22) 0	(40) 0	(58) 0	(76) 1E-3
(5) 0	(23) 0	(41) 0	(59) 0	(77) 9
(6) 0	(24) 0	(42) 0	(60) 0	(78) 0.015
(7) 0	(25) 0	(43) 0	(61) 1E-3	(79) 5E-3
(8) 0	(26) 0	(44) 0	(62) 1E-3	(80) 0.017
(9) 0	(27) 0	(45) 0	(63) 1E-3	(81) 3E-3
(10) 0	(28) 0	(46) 0	(64) 9	(82) 7E-3
(11) 0	(29) 0	(47) 0	(65) 5E-3	(83) 1E-3
(12) 0	(30) 0	(48) 0	(66) 5E-3	(84) 0.015
(13) 0	(31) 0	(49) 0	(67) 2E-3	(85) 0
(14) 0	(32) 0	(50) 0	(68) 1E-3	(86) 9
(15) 0	(33) 0	(51) 0	(69) 1E-3	(87) 0
(16) 0	(34) 1E-3	(52) 0	(70) 0	(88) 7E-3
(17) 0	(35) 0	(53) 0	(71) 0	(89) 0
(18) 0	(36) 1E-3	(54) 0	(72) 0	(90) 0

(181) 0	(199) 0	(217) 0	(235) 0.17	(253) 0
(182) 0	(200) 0	(218) 0	(236) 0.065	(254) 0
(183) 0	(201) 0	(219) 0	(237) 9	(255) 0
(184) 0	(202) 0	(220) 0	(238) 4E-3	(256) 0
(185) 0	(203) 0	(221) 0	(239) 1E-3	(257) 0
(186) 0	(204) 0	(222) 0	(240) 1E-3	(258) 0
(187) 0	(205) 0	(223) 0	(241) 0	(259) 0
(188) 0	(206) 0	(224) 0	(242) 1E-3	(260) 0
(189) 0	(207) 0.819	(225) 0	(243) 0	(261) 0
(190) 0	(208) 0.021	(226) 0	(244) 0	(262) 0
(191) 0	(209) 3E-3	(227) 0	(245) 0	(263) 0
(192) 0	(210) 1E-3	(228) 0	(246) 0	(264) 0
(193) 0	(211) 1E-3	(229) 0	(247) 0	(265) 0
(194) 0	(212) 2E-3	(230) 0	(248) 0	(266) 0
(195) 0	(213) 0	(231) 0.296	(249) 0	(267) 0
(196) 0	(214) 0	(232) 0.52	(250) 0	(268) 0
(197) 0	(215) 0	(233) 0.121	(251) 0	(269) 0
(198) 0	(216) 0	(234) 0.296	(252) 0	(270) 0

(91) 0	(109) 0	(127) 0	(145) 0	(163) 0
(92) 0	(110) 0	(128) 0	(146) 0	(164) 0
(93) 0	(111) 0	(129) 0	(147) 0	(165) 0
(94) 0	(112) 0	(130) 0	(148) 0	(166) 0
(95) 0	(113) 0	(131) 0	(149) 0	(167) 0
(96) 0	(114) 0	(132) 0	(150) 0	(168) 0
(97) 0	(115) 0	(133) 0	(151) 0	(169) 0
(98) 0	(116) 0	(134) 0	(152) 0	(170) 0
(99) 0	(117) 0	(135) 0	(153) 0	(171) 0
(100) 0	(118) 0	(136) 0	(154) 0	(172) 0
(101) 0	(119) 0	(137) 0	(155) 0	(173) 0
(102) 0	(120) 0	(138) 0	(156) 0	(174) 0
(103) 0	(121) 0	(139) 0	(157) 0	(175) 0
(104) 0	(122) 0	(140) 0	(158) 0	(176) 0
(105) 0	(123) 0	(141) 0	(159) 0	(177) 0
(106) 0	(124) 0	(142) 0	(160) 0	(178) 0
(107) 0	(125) 0	(143) 0	(161) 0	(179) 0
(108) 0	(126) 0	(144) 0	(162) 0	(180) 0

(271) 0	(289) 0	(307) 0	(325) 0	(343) 0.083
(272) 0	(290) 0	(308) 0	(326) 1E-3	(344) 0.03
(273) 0	(291) 0	(309) 0	(327) 0	(345) 5E-3
(274) 0	(292) 0	(310) 0.015	(328) 6E-3	(346) 5E-3
(275) 0	(293) 0	(311) 5E-3	(329) 0	(347) 1E-3
(276) 0	(294) 0	(312) 0.052	(330) 6E-3	(348) 1E-3
(277) 0.021	(295) 0	(313) 1E-3	(331) 9	(349) 0
(278) 0.021	(296) 0	(314) 1E-3	(332) 9	(350) 1E-3
(279) 5E-3	(297) 0	(315) 0	(333) 9	(351) 0
(280) 5E-3	(298) 0	(316) 1E-3	(334) 5E-3	(352) 1E-3
(281) 1E-3	(299) 0	(317) 0	(335) 5E-3	(353) 0
(282) 2E-3	(300) 0	(318) 1E-3	(336) 5E-3	(354) 1E-3
(283) 0	(301) 0	(319) 0	(337) 5E-3	(355) 0
(284) 2E-3	(302) 0	(320) 1E-3	(338) 5E-3	(356) 0
(285) 0	(303) 0	(321) 0	(339) 0.03	(357) 0.04
(286) 0	(304) 0	(322) 1E-3	(340) 0.052	(358) 0.034
(287) 0	(305) 0	(323) 0	(341) 0.083	(359) 0.04
(288) 0	(306) 0	(324) 1E-3	(342) 0.083	(360) 0.034

River discharge data at 12-hourly intervals for Station: 20A
Period : 3

Variable: VIS4.var1 (length = 344)

(1) 0.03	(19) 1E-3	(37) 0	(55) 0.197	(73) 0.083
(2) 0.015	(20) 1E-3	(38) 1E-3	(56) 0.23	(74) 0.067
(3) 3E-3	(21) 9	(39) 0	(57) 0.197	(75) 0.066
(4) 1E-3	(22) 9	(40) 1E-3	(58) 2.13	(76) 0.052
(5) 0	(23) 3E-3	(41) 0	(59) 0.629	(77) 0.052
(6) 0	(24) 1E-3	(42) 1E-3	(60) 0.296	(78) 0.052
(7) 0	(25) 1E-3	(43) 0	(61) 0.197	(79) 0.046
(8) 1E-3	(26) 1E-3	(44) 1E-3	(62) 0.228	(80) 0.05
(9) 0.052	(27) 1E-3	(45) 0	(63) 0.101	(81) 0.04
(10) 0.03	(28) 1E-3	(46) 0	(64) 0.197	(82) 0.036
(11) 3E-3	(29) 1E-3	(47) 0	(65) 0.518	(83) 0.03
(12) 3E-3	(30) 1E-3	(48) 0	(66) 0.21	(84) 0.035
(13) 1E-3	(31) 1E-3	(49) 2E-3	(67) 0.144	(85) 0.03
(14) 1E-3	(32) 1E-3	(50) 2.31	(68) 0.121	(86) 0.03
(15) 1E-3	(33) 1E-3	(51) 0.376	(69) 0.083	(87) 0.03
(16) 1E-3	(34) 1E-3	(52) 4.37	(70) 0.376	(88) 0.03
(17) 1E-3	(35) 0	(53) 0.963	(71) 0.197	(89) 0.03
(18) 1E-3	(36) 1E-3	(54) 0.35	(72) 0.121	(90) 0.026

(91) 0.018	(109) 3.411	(127) 0.121	(145) 0.066	(163) 0.819
(92) 0.018	(110) 1.476	(128) 0.121	(146) 0.06	(164) 0.52
(93) 0.015	(111) 0.963	(129) 0.101	(147) 0.059	(165) 0.421
(94) 0.018	(112) 0.689	(130) 0.101	(148) 0.052	(166) 0.296
(95) 0.015	(113) 0.572	(131) 9	(149) 0.052	(167) 2.779
(96) 0.016	(114) 0.52	(132) 0.083	(150) 0.052	(168) 1.04
(97) 3.543	(115) 0.468	(133) 0.083	(151) 0.752	(169) 0.659
(98) 0.012	(116) 0.421	(134) 0.083	(152) 0.335	(170) 0.57
(99) 1.383	(117) 0.376	(135) 0.066	(153) 0.261	(171) 0.518
(100) 0.689	(118) 0.261	(136) 0.066	(154) 0.82	(172) 0.468
(101) 0.518	(119) 0.197	(137) 0.066	(155) 0.689	(173) 0.296
(102) 0.468	(120) 0.197	(138) 0.066	(156) 0.44	(174) 0.17
(103) 4.812	(121) 0.197	(139) 0.066	(157) 0.335	(175) 0.21
(104) 1.16	(122) 0.17	(140) 0.066	(158) 0.17	(176) 0.23
(105) 0.629	(123) 0.17	(141) 0.066	(159) 0.144	(177) 0.17
(106) 0.518	(124) 0.159	(142) 0.066	(160) 0.083	(178) 0.17
(107) 0.468	(125) 0.121	(143) 0.066	(161) 3.411	(179) 0.17
(108) 4.96	(126) 0.121	(144) 0.06	(162) 1.57	(180) 0.121

(181) 0.121	(199) 0.083	(217) 0.052	(235) 0.296	(253) 0.021
(182) 0.121	(200) 0.08	(218) 0.052	(236) 0.214	(254) 0.021
(183) 0.101	(201) 0.066	(219) 0.052	(237) 0.101	(255) 0.021
(184) 9	(202) 0.07	(220) 0.046	(238) 0.066	(256) 0.021
(185) 0.083	(203) 0.052	(221) 0.04	(239) 0.052	(257) 0.021
(186) 0.1	(204) 0.07	(222) 0.04	(240) 0.052	(258) 0.017
(187) 0.101	(205) 0.052	(223) 0.04	(241) 0.052	(259) 0.03
(188) 0.17	(206) 6.8	(224) 0.04	(242) 0.04	(260) 0.03
(189) 0.197	(207) 0.052	(225) 0.04	(243) 0.04	(261) 0.03
(190) 0.197	(208) 0.159	(226) 0.04	(244) 0.04	(262) 0.03
(191) 0.197	(209) 0.144	(227) 0.03	(245) 0.03	(263) 0.03
(192) 9	(210) 0.163	(228) 0.036	(246) 0.03	(264) 0.03
(193) 0.197	(211) 0.17	(229) 0.03	(247) 0.03	(265) 0.03
(194) 0.296	(212) 0.052	(230) 0.036	(248) 0.026	(266) 0.03
(195) 0.197	(213) 0.052	(231) 0.03	(249) 0.052	(267) 0.021
(196) 0.121	(214) 0.052	(232) 0.034	(250) 0.04	(268) 0.03
(197) 0.121	(215) 0.052	(233) 0.04	(251) 0.04	(269) 0.021
(198) 9	(216) 0.083	(234) 0.144	(252) 0.03	(270) 0.03

(271) 0.021	(289) 5E-3	(307) 0	(325) 0	(343) 0
(272) 0.03	(290) 5E-3	(308) 0	(326) 0	(344) 0
(273) 0.018	(291) 5E-3	(309) 0	(327) 0	
(274) 0.017	(292) 5E-3	(310) 0	(328) 0	
(275) 0.015	(293) 3E-3	(311) 0	(329) 0	
(276) 0.017	(294) 4E-3	(312) 0	(330) 0	
(277) 0.015	(295) 3E-3	(313) 0	(331) 0	
(278) 0.017	(296) 3E-3	(314) 0	(332) 0	
(279) 0.021	(297) 3E-3	(315) 0	(333) 0	
(280) 0.021	(298) 3E-3	(316) 0	(334) 0	
(281) 0.021	(299) 5E-3	(317) 0	(335) 0	
(282) 0.021	(300) 3E-3	(318) 0	(336) 0	
(283) 0.015	(301) 5E-3	(319) 0	(337) 0	
(284) 0	(302) 0	(320) 0	(338) 0	
(285) 0.015	(303) 3E-3	(321) 0	(339) 0	
(286) 0.015	(304) 0	(322) 0	(340) 0	
(287) 5E-3	(305) 1E-3	(323) 0	(341) 0	
(288) 0.015	(306) 0	(324) 0	(342) 0	

River discharge data at 12-hourly intervals for Station: 20A
Period : 4

Variable: VIS5.var1 (length = 360)

(1) 0	(19) 0	(37) 0	(55) 0	(73) 0	(91) 0
(2) 0	(20) 0	(38) 0	(56) 0	(74) 0	(92) 0
(3) 0	(21) 0	(39) 0	(57) 0	(75) 0	(93) 0
(4) 0	(22) 0	(40) 0	(58) 0	(76) 0	(94) 0
(5) 0	(23) 0	(41) 0	(59) 0	(77) 0	(95) 0
(6) 0	(24) 0	(42) 0	(60) 0	(78) 0	(96) 0
(7) 0	(25) 0	(43) 0	(61) 0	(79) 0	(97) 0
(8) 0	(26) 0	(44) 0	(62) 0	(80) 0	(98) 0
(9) 0	(27) 0	(45) 0	(63) 0	(81) 0	(99) 0
(10) 0	(28) 0	(46) 0	(64) 0	(82) 0	(100) 0
(11) 0	(29) 0	(47) 0	(65) 0	(83) 0	(101) 0
(12) 0	(30) 0	(48) 0	(66) 0	(84) 0	(102) 0
(13) 0	(31) 0	(49) 0	(67) 0	(85) 0	(103) 0
(14) 0	(32) 0	(50) 0	(68) 0	(86) 0	(104) 0
(15) 0	(33) 0	(51) 0	(69) 0	(87) 0	(105) 0
(16) 0	(34) 0	(52) 5E-3	(70) 0	(88) 0	(106) 0
(17) 0	(35) 0	(53) 0	(71) 0	(89) 0	(107) 0
(18) 0	(36) 0	(54) 0	(72) 0	(90) 0	(108) 0

(217) 0	(235) 0	(253) 0	(271) 0	(289) 0	(307) 0
(218) 0	(236) 0	(254) 0	(272) 0	(290) 0	(308) 0
(219) 0	(237) 0	(255) 0	(273) 0	(291) 0	(309) 0
(220) 0	(238) 0	(256) 0	(274) 0	(292) 0	(310) 0
(221) 0	(239) 0	(257) 0	(275) 0	(293) 0	(311) 0
(222) 0	(240) 0	(258) 0	(276) 0	(294) 0	(312) 0
(223) 0	(241) 0	(259) 0	(277) 0	(295) 0	(313) 0
(224) 0	(242) 0	(260) 0	(278) 0	(296) 0	(314) 0
(225) 0	(243) 0	(261) 0	(279) 0	(297) 0	(315) 0
(226) 0	(244) 0	(262) 0	(280) 0	(298) 0	(316) 0
(227) 0	(245) 0	(263) 0	(281) 0	(299) 0	(317) 0
(228) 0	(246) 0	(264) 0	(282) 0	(300) 0	(318) 0
(229) 0	(247) 0	(265) 0	(283) 0	(301) 0	(319) 0
(230) 0	(248) 0	(266) 0	(284) 0	(302) 0	(320) 0
(231) 0	(249) 0	(267) 0	(285) 0	(303) 0	(321) 0
(232) 0	(250) 0	(268) 0	(286) 0	(304) 0	(322) 0
(233) 0	(251) 0	(269) 0	(287) 0	(305) 0	(323) 0
(234) 0	(252) 0	(270) 0	(288) 0	(306) 0	(324) 0

(109) 0	(127) 0	(145) 0	(163) 0	(181) 0	(199) 0
(110) 0	(128) 0	(146) 0	(164) 0	(182) 0	(200) 0
(111) 0	(129) 0	(147) 0	(165) 0	(183) 0	(201) 0
(112) 0	(130) 0	(148) 0	(166) 0	(184) 0	(202) 0
(113) 0	(131) 0	(149) 0	(167) 0	(185) 0	(203) 0
(114) 0	(132) 0	(150) 0	(168) 0	(186) 0	(204) 0
(115) 0	(133) 0	(151) 0	(169) 0	(187) 0	(205) 0
(116) 0	(134) 0	(152) 0	(170) 0	(188) 0	(206) 0
(117) 0	(135) 0	(153) 0	(171) 0	(189) 0	(207) 0
(118) 0	(136) 0	(154) 0	(172) 0	(190) 0	(208) 0
(119) 0	(137) 0	(155) 0	(173) 0	(191) 0	(209) 0
(120) 0	(138) 0	(156) 0	(174) 0	(192) 0	(210) 0
(121) 0	(139) 0	(157) 0	(175) 0	(193) 0	(211) 0
(122) 0	(140) 0	(158) 0	(176) 0	(194) 0	(212) 0
(123) 0	(141) 0	(159) 0	(177) 0	(195) 0	(213) 0
(124) 0	(142) 0	(160) 0	(178) 0	(196) 0	(214) 0
(125) 0	(143) 0	(161) 0	(179) 0	(197) 0	(215) 0
(126) 0	(144) 0	(162) 0	(180) 0	(198) 0	(216) 0

(325) 0	(343) 0
(326) 0	(344) 0
(327) 0	(345) 0
(328) 0	(346) 0
(329) 0	(347) 0
(330) 0	(348) 0
(331) 0	(349) 0
(332) 0	(350) 0
(333) 0	(351) 0
(334) 0	(352) 0
(335) 0	(353) 0
(336) 0	(354) 0
(337) 0	(355) 0
(338) 0	(356) 0
(339) 0	(357) 0
(340) 0	(358) 0
(341) 0	(359) 0
(342) 0	(360) 0

River discharge data at 12-hourly intervals for Station: 20A
Period : 5

Variable: VIS6.varl (length = 360)

(1)	0	(19)	1E-3	(37)	0	(55)	0	(73)	0
(2)	0	(20)	1E-3	(38)	0	(56)	0	(74)	0
(3)	0	(21)	0	(39)	0	(57)	0	(75)	0
(4)	0	(22)	0	(40)	0	(58)	0	(76)	0
(5)	0	(23)	0	(41)	0	(59)	1E-3	(77)	0
(6)	0	(24)	0	(42)	0	(60)	1E-3	(78)	0
(7)	0	(25)	0	(43)	0	(61)	1E-3	(79)	0
(8)	0	(26)	0	(44)	0	(62)	1E-3	(80)	0
(9)	0	(27)	0	(45)	0	(63)	1E-3	(81)	0
(10)	0	(28)	0	(46)	0	(64)	0	(82)	0
(11)	0	(29)	0	(47)	0	(65)	0	(83)	0
(12)	0.04	(30)	0	(48)	0	(66)	0	(84)	0
(13)	0.052	(31)	0	(49)	0	(67)	0	(85)	0
(14)	0.021	(32)	0	(50)	0	(68)	0	(86)	0
(15)	5E-3	(33)	0	(51)	0	(69)	0	(87)	9
(16)	1E-3	(34)	0	(52)	0	(70)	0	(88)	0.03
(17)	1E-3	(35)	0	(53)	0	(71)	0	(89)	4E-3
(18)	1E-3	(36)	0	(54)	0	(72)	0	(90)	1E-3

(91)	1E-3	(109)	0	(127)	5E-3	(145)	0.121	(163)	0.57
(92)	1E-3	(110)	0	(128)	4E-3	(146)	0.131	(164)	0.23
(93)	5E-3	(111)	5E-3	(129)	7E-3	(147)	0.963	(165)	0.14
(94)	0.121	(112)	0.03	(130)	0.021	(148)	1.125	(166)	0.101
(95)	0.03	(113)	7E-3	(131)	0.012	(149)	0.376	(167)	0.08
(96)	9	(114)	3E-3	(132)	9	(150)	0.185	(168)	0.066
(97)	5E-3	(115)	0.24	(133)	0	(151)	0.125	(169)	0.05
(98)	3E-3	(116)	0.067	(134)	3.677	(152)	0.101	(170)	0.052
(99)	1E-3	(117)	0.04	(135)	0.52	(153)	0.083	(171)	0.04
(100)	1E-3	(118)	0.04	(136)	0.24	(154)	0.067	(172)	0.03
(101)	1E-3	(119)	0.03	(137)	0.156	(155)	0.058	(173)	0.03
(102)	0	(120)	0.03	(138)	0.101	(156)	0.052	(174)	0.03
(103)	0	(121)	0.018	(139)	0.083	(157)	0.04	(175)	0.03
(104)	0	(122)	0.015	(140)	0.066	(158)	1.21	(176)	0.03
(105)	0	(123)	0.012	(141)	0.82	(159)	0.335	(177)	0.03
(106)	0	(124)	9	(142)	0.54	(160)	0.197	(178)	0.03
(107)	0	(125)	5E-3	(143)	0.468	(161)	0.144	(179)	0.03
(108)	0	(126)	5E-3	(144)	0.26	(162)	0.101	(180)	0.03

(181)	0.03	(199)	0.066	(217)	0.111	(235)	0.083	(253)	0.052
(182)	0.03	(200)	0.066	(218)	9	(236)	0.066	(254)	0.052
(183)	0.05	(201)	0.065	(219)	0.083	(237)	0.067	(255)	0.052
(184)	2.48	(202)	0.28	(220)	0.083	(238)	0.066	(256)	0.03
(185)	0.121	(203)	5.265	(221)	0.083	(239)	0.066	(257)	0.03
(186)	0.819	(204)	1.476	(222)	0.076	(240)	0.066	(258)	0.03
(187)	1.04	(205)	0.752	(223)	0.083	(241)	0.065	(259)	0.228
(188)	0.572	(206)	0.572	(224)	0.076	(242)	0.066	(260)	0.39
(189)	0.336	(207)	0.468	(225)	0.07	(243)	0.054	(261)	0.296
(190)	0.228	(208)	0.425	(226)	0.083	(244)	0.052	(262)	0.17
(191)	0.17	(209)	0.335	(227)	0.07	(245)	0.052	(263)	0.159
(192)	0.12	(210)	0.26	(228)	0.052	(246)	0.052	(264)	0.144
(193)	0.121	(211)	0.332	(229)	0.052	(247)	0.052	(265)	0.13
(194)	0.12	(212)	0.228	(230)	0.052	(248)	0.052	(266)	0.12
(195)	0.144	(213)	0.197	(231)	0.052	(249)	0.052	(267)	0.13
(196)	0.12	(214)	0.24	(232)	0.052	(250)	0.052	(268)	0.17
(197)	0.08	(215)	0.228	(233)	0.052	(251)	0.052	(269)	0.17
(198)	0.076	(216)	0.17	(234)	0.083	(252)	0.052	(270)	0.066

(271)	0.066	(289)	9	(307)	1E-3	(325)	1E-3	(343)	0
(272)	0.066	(290)	9	(308)	1E-3	(326)	1E-3	(344)	0
(273)	0.052	(291)	9	(309)	1E-3	(327)	0	(345)	0
(274)	0.052	(292)	9	(310)	1E-3	(328)	0	(346)	0
(275)	0.04	(293)	9	(311)	1E-3	(329)	0	(347)	0
(276)	0.04	(294)	5E-3	(312)	2E-3	(330)	0	(348)	0
(277)	0.04	(295)	5E-3	(313)	1E-3	(331)	0	(349)	0
(278)	0.03	(296)	5E-3	(314)	1E-3	(332)	0	(350)	0
(279)	0.03	(297)	5E-3	(315)	1E-3	(333)	0	(351)	0
(280)	0.03	(298)	5E-3	(316)	1E-3	(334)	0	(352)	0
(281)	0.021	(299)	3E-3	(317)	1E-3	(335)	0	(353)	0
(282)	0.021	(300)	3E-3	(318)	1E-3	(336)	0	(354)	0
(283)	0.015	(301)	3E-3	(319)	1E-3	(337)	0	(355)	0
(284)	0.015	(302)	3E-3	(320)	1E-3	(338)	0	(356)	0
(285)	0.015	(303)	1E-3	(321)	1E-3	(339)	0	(357)	0
(286)	0.015	(304)	1E-3	(322)	1E-3	(340)	0	(358)	0
(287)	0.015	(305)	1E-3	(323)	1E-3	(341)	0	(359)	0
(288)	0.015	(306)	1E-3	(324)	1E-3	(342)	0	(360)	0

A3.62

River discharge data at 12-hourly intervals for Station: 20A
Period : 6

Variable: VOELVL1.var1 (length = 360)

(1) 0.64	(19) 0.64	(37) 0.4	(55) 0.4	(73) 0.16
(2) 0.64	(20) 0.64	(38) 0.4	(56) 0.4	(74) 0.16
(3) 0.64	(21) 0.64	(39) 0.4	(57) 0.16	(75) 0.16
(4) 0.64	(22) 0.64	(40) 0.4	(58) 0.16	(76) 0.16
(5) 0.64	(23) 0.64	(41) 0.4	(59) 0.16	(77) 0.16
(6) 0.64	(24) 0.64	(42) 0.4	(60) 0.16	(78) 0.16
(7) 0.64	(25) 0.64	(43) 0.4	(61) 0.16	(79) 0.16
(8) 0.64	(26) 0.64	(44) 0.4	(62) 0.16	(80) 0.16
(9) 0.64	(27) 0.64	(45) 0.4	(63) 0.16	(81) 0.16
(10) 0.64	(28) 0.64	(46) 0.4	(64) 0.16	(82) 0.16
(11) 0.64	(29) 0.4	(47) 0.4	(65) 0.16	(83) 0.07
(12) 0.64	(30) 0.4	(48) 0.4	(66) 0.16	(84) 0.07
(13) 0.64	(31) 0.4	(49) 0.4	(67) 0.16	(85) 0.07
(14) 0.64	(32) 0.4	(50) 0.4	(68) 0.16	(86) 0.07
(15) 0.64	(33) 0.4	(51) 0.4	(69) 0.16	(87) 0.07
(16) 0.64	(34) 0.4	(52) 0.4	(70) 0.16	(88) 0.07
(17) 0.64	(35) 0.4	(53) 0.4	(71) 0.16	(89) 0.07
(18) 0.64	(36) 0.4	(54) 0.4	(72) 0.16	(90) 0.07

(91) 0.07	(109) 0.07	(127) 0.34	(145) 0.32	(163) 0.32
(92) 0.07	(110) 0.07	(128) 0.34	(146) 0.32	(164) 0.32
(93) 0.07	(111) 0.07	(129) 0.34	(147) 0.32	(165) 0.32
(94) 0.07	(112) 0.07	(130) 0.34	(148) 0.32	(166) 0.32
(95) 0.07	(113) 0.34	(131) 0.34	(149) 0.32	(167) 0.32
(96) 0.07	(114) 0.34	(132) 0.34	(150) 0.32	(168) 0.32
(97) 0.07	(115) 0.34	(133) 0.34	(151) 0.32	(169) 0.32
(98) 0.07	(116) 0.34	(134) 0.34	(152) 0.32	(170) 0.32
(99) 0.07	(117) 0.34	(135) 0.34	(153) 0.32	(171) 0.32
(100) 0.07	(118) 0.34	(136) 0.34	(154) 0.32	(172) 0.32
(101) 0.07	(119) 0.34	(137) 0.34	(155) 0.32	(173) 0.05
(102) 0.07	(120) 0.34	(138) 0.34	(156) 0.32	(174) 0.05
(103) 0.07	(121) 0.34	(139) 0.34	(157) 0.232	(175) 0.05
(104) 0.07	(122) 0.34	(140) 0.34	(158) 0.232	(176) 0.05
(105) 0.07	(123) 0.34	(141) 0.32	(159) 0.32	(177) 0.05
(106) 0.07	(124) 0.34	(142) 0.32	(160) 0.32	(178) 0.05
(107) 0.07	(125) 0.34	(143) 0.32	(161) 0.32	(179) 0.05
(108) 0.07	(126) 0.34	(144) 0.32	(162) 0.32	(180) 0.05

(181) 0.05	(199) 0.34	(217) 0.43	(235) 0.19	(253) 0.073
(182) 0.05	(200) 0.34	(218) 0.43	(236) 0.19	(254) 0.073
(183) 0.05	(201) 0.43	(219) 0.43	(237) 0.19	(255) 0.07
(184) 0.05	(202) 0.43	(220) 0.43	(238) 0.19	(256) 0.07
(185) 0.05	(203) 0.43	(221) 0.43	(239) 0.19	(257) 0.07
(186) 0.05	(204) 0.43	(222) 0.43	(240) 0.19	(258) 0.07
(187) 0.05	(205) 0.43	(223) 0.43	(241) 0.19	(259) 0.07
(188) 0.05	(206) 0.43	(224) 0.43	(242) 0.19	(260) 0.07
(189) 0.05	(207) 0.43	(225) 0.19	(243) 0.19	(261) 0.07
(190) 0.05	(208) 0.43	(226) 0.19	(244) 0.19	(262) 0.07
(191) 0.05	(209) 0.43	(227) 0.19	(245) 0.19	(263) 0.07
(192) 0.05	(210) 0.43	(228) 0.19	(246) 0.19	(264) 0.07
(193) 0.05	(211) 0.43	(229) 0.19	(247) 0.19	(265) 0.07
(194) 0.05	(212) 0.43	(230) 0.19	(248) 0.19	(266) 0.07
(195) 0.05	(213) 0.43	(231) 0.19	(249) 0.19	(267) 0.07
(196) 0.05	(214) 0.43	(232) 0.19	(250) 0.19	(268) 0.07
(197) 0.432	(215) 0.43	(233) 0.19	(251) 0.19	(269) 0.07
(198) 0.432	(216) 0.43	(234) 0.19	(252) 0.19	(270) 0.07

(271) 0.07	(289) 0.05	(307) 0.05	(325) 0.16	(343) 1.156
(272) 0.07	(290) 0.05	(308) 0.05	(326) 0.16	(344) 1.156
(273) 0.07	(291) 0.05	(309) 0.16	(327) 0.16	(345) 1.156
(274) 0.07	(292) 0.05	(310) 0.16	(328) 0.16	(346) 1.156
(275) 0.07	(293) 0.05	(311) 0.16	(329) 0.16	(347) 1.156
(276) 0.07	(294) 0.05	(312) 0.16	(330) 0.16	(348) 1.156
(277) 0.07	(295) 0.05	(313) 0.16	(331) 0.16	(349) 1.156
(278) 0.07	(296) 0.05	(314) 0.16	(332) 0.16	(350) 1.156
(279) 0.08	(297) 0.05	(315) 0.16	(333) 0.16	(351) 1.156
(280) 0.08	(298) 0.05	(316) 0.16	(334) 0.16	(352) 1.156
(281) 0.08	(299) 0.05	(317) 0.16	(335) 0.16	(353) 1.156
(282) 0.08	(300) 0.05	(318) 0.16	(336) 0.16	(354) 1.156
(283) 0.08	(301) 0.05	(319) 0.16	(337) 1.156	(355) 1.156
(284) 0.08	(302) 0.05	(320) 0.16	(338) 1.156	(356) 1.156
(285) 0.08	(303) 0.05	(321) 0.16	(339) 1.156	(357) 1.16
(286) 0.08	(304) 0.05	(322) 0.16	(340) 1.156	(358) 1.16
(287) 0.08	(305) 0.05	(323) 0.16	(341) 1.156	(359) 1.1
(288) 0.08	(306) 0.05	(324) 0.16	(342) 1.156	(360) 1.1

River discharge data at 12-hourly intervals for Station: 21D
Period : 1

Variable: VOELVL2.var1 (length = 360)

(1)	0.9	(19)	0.9	(37)	0.29	(55)	0.9	(73)	0.9
(2)	0.9	(20)	0.9	(38)	0.29	(56)	0.9	(74)	0.9
(3)	0.9	(21)	0.9	(39)	0.9	(57)	0.9	(75)	0.9
(4)	0.9	(22)	0.9	(40)	0.9	(58)	0.9	(76)	0.9
(5)	0.9	(23)	0.9	(41)	0.9	(59)	0.9	(77)	0.9
(6)	0.9	(24)	0.9	(42)	0.9	(60)	0.9	(78)	0.9
(7)	0.9	(25)	0.9	(43)	0.9	(61)	0.9	(79)	0.9
(8)	0.9	(26)	0.9	(44)	0.9	(62)	0.9	(80)	0.9
(9)	0.9	(27)	0.9	(45)	0.9	(63)	0.9	(81)	0.9
(10)	0.9	(28)	0.9	(46)	0.9	(64)	0.9	(82)	0.9
(11)	0.9	(29)	0.9	(47)	0.9	(65)	0.9	(83)	0.9
(12)	0.9	(30)	0.9	(48)	0.9	(66)	0.9	(84)	0.9
(13)	0.9	(31)	0.9	(49)	0.9	(67)	0.9	(85)	0.9
(14)	0.9	(32)	0.9	(50)	0.9	(68)	0.9	(86)	0.9
(15)	0.9	(33)	0.9	(51)	0.9	(69)	0.9	(87)	0.9
(16)	0.9	(34)	0.9	(52)	0.9	(70)	0.9	(88)	0.9
(17)	0.9	(35)	0.9	(53)	0.9	(71)	0.9	(89)	0.9
(18)	0.9	(36)	0.9	(54)	0.9	(72)	0.9	(90)	0.9

(181)	0.9	(199)	0.9	(217)	9.3	(235)	4	(253)	4
(182)	0.9	(200)	0.9	(218)	9.3	(236)	4	(254)	4
(183)	0.9	(201)	0.9	(219)	5	(237)	4	(255)	4
(184)	0.9	(202)	0.9	(220)	5	(238)	4	(256)	4
(185)	0.9	(203)	0.9	(221)	6	(239)	4	(257)	4
(186)	0.9	(204)	0.9	(222)	6	(240)	4	(258)	4
(187)	0.9	(205)	0.9	(223)	5	(241)	4	(259)	4
(188)	0.9	(206)	0.9	(224)	5	(242)	4	(260)	4
(189)	0.9	(207)	0.9	(225)	4	(243)	4	(261)	4
(190)	0.9	(208)	0.9	(226)	4	(244)	4	(262)	4
(191)	0.9	(209)	1.5	(227)	4	(245)	4	(263)	4
(192)	0.9	(210)	1.5	(228)	4	(246)	4	(264)	4
(193)	0.9	(211)	2	(229)	3	(247)	4	(265)	4
(194)	0.9	(212)	2	(230)	3	(248)	4	(266)	4
(195)	0.9	(213)	3	(231)	4	(249)	4	(267)	4
(196)	0.9	(214)	3	(232)	4	(250)	4	(268)	4
(197)	0.9	(215)	4	(233)	4	(251)	4	(269)	4
(198)	0.9	(216)	4	(234)	4	(252)	4	(270)	4

(91)	0.9	(109)	0.9	(127)	0.9	(145)	0.9	(163)	0.9
(92)	0.9	(110)	0.9	(128)	0.9	(146)	0.9	(164)	0.9
(93)	0.9	(111)	0.9	(129)	0.9	(147)	0.9	(165)	0.9
(94)	0.9	(112)	0.9	(130)	0.9	(148)	0.9	(166)	0.9
(95)	0.9	(113)	0.9	(131)	0.9	(149)	0.9	(167)	0.9
(96)	0.9	(114)	0.9	(132)	0.9	(150)	0.9	(168)	0.9
(97)	0.9	(115)	0.9	(133)	0.9	(151)	0.9	(169)	0.9
(98)	0.9	(116)	0.9	(134)	0.9	(152)	0.9	(170)	0.9
(99)	0.9	(117)	0.9	(135)	0.9	(153)	0.9	(171)	0.9
(100)	0.9	(118)	0.9	(136)	0.9	(154)	0.9	(172)	0.9
(101)	0.9	(119)	0.9	(137)	0.9	(155)	0.9	(173)	0.9
(102)	0.9	(120)	0.9	(138)	0.9	(156)	0.9	(174)	0.9
(103)	0.9	(121)	0.9	(139)	0.9	(157)	0.9	(175)	0.9
(104)	0.9	(122)	0.9	(140)	0.9	(158)	0.9	(176)	0.9
(105)	0.9	(123)	0.9	(141)	0.9	(159)	0.9	(177)	0.9
(106)	0.9	(124)	0.9	(142)	0.9	(160)	0.9	(178)	0.9
(107)	0.9	(125)	0.9	(143)	0.9	(161)	0.9	(179)	0.9
(108)	0.9	(126)	0.9	(144)	0.9	(162)	0.9	(180)	0.9

(271)	3.6	(289)	3	(307)	0.7	(325)	0.6	(343)	0.5
(272)	3.6	(290)	3	(308)	0.7	(326)	0.6	(344)	0.5
(273)	3.6	(291)	32	(309)	0.7	(327)	0.6	(345)	0.5
(274)	3.6	(292)	32	(310)	0.7	(328)	0.6	(346)	0.5
(275)	3.6	(293)	2	(311)	0.7	(329)	0.6	(347)	0.5
(276)	3.6	(294)	2	(312)	0.7	(330)	0.6	(348)	0.5
(277)	3.6	(295)	2	(313)	0.7	(331)	0.6	(349)	0.5
(278)	3.6	(296)	2	(314)	0.7	(332)	0.6	(350)	0.5
(279)	3	(297)	1	(315)	0.7	(333)	0.6	(351)	0.5
(280)	3	(298)	1	(316)	0.7	(334)	0.6	(352)	0.5
(281)	3	(299)	0.73	(317)	0.6	(335)	0.5	(353)	0.5
(282)	3	(300)	0.73	(318)	0.6	(336)	0.5	(354)	0.5
(283)	3	(301)	0.7	(319)	0.6	(337)	0.5	(355)	0.5
(284)	3	(302)	0.7	(320)	0.6	(338)	0.5	(356)	0.5
(285)	3	(303)	0.7	(321)	0.6	(339)	0.5	(357)	0.5
(286)	3	(304)	0.7	(322)	0.6	(340)	0.5	(358)	0.5
(287)	3	(305)	0.7	(323)	0.6	(341)	0.5	(359)	0.56
(288)	3	(306)	0.7	(324)	0.6	(342)	0.5	(360)	0.56

River discharge data at 12-hourly intervals for Station: 21D
Period : 2

Variable: VOELVL3.var1 (length = 360)

(1) 0.64	(19) 0.64	(37) 0.4	(55) 0.4	(73) 0.16
(2) 0.64	(20) 0.64	(38) 0.4	(56) 0.4	(74) 0.16
(3) 0.64	(21) 0.64	(39) 0.4	(57) 0.16	(75) 0.16
(4) 0.64	(22) 0.64	(40) 0.4	(58) 0.16	(76) 0.16
(5) 0.64	(23) 0.64	(41) 0.4	(59) 0.16	(77) 0.16
(6) 0.64	(24) 0.64	(42) 0.4	(60) 0.16	(78) 0.16
(7) 0.64	(25) 0.64	(43) 0.4	(61) 0.16	(79) 0.16
(8) 0.64	(26) 0.64	(44) 0.4	(62) 0.16	(80) 0.16
(9) 0.64	(27) 0.64	(45) 0.4	(63) 0.16	(81) 0.16
(10) 0.64	(28) 0.64	(46) 0.4	(64) 0.16	(82) 0.16
(11) 0.64	(29) 0.4	(47) 0.4	(65) 0.16	(83) 0.07
(12) 0.64	(30) 0.4	(48) 0.4	(66) 0.16	(84) 0.07
(13) 0.64	(31) 0.4	(49) 0.4	(67) 0.16	(85) 0.07
(14) 0.64	(32) 0.4	(50) 0.4	(68) 0.16	(86) 0.07
(15) 0.64	(33) 0.4	(51) 0.4	(69) 0.16	(87) 0.07
(16) 0.64	(34) 0.4	(52) 0.4	(70) 0.16	(88) 0.07
(17) 0.64	(35) 0.4	(53) 0.4	(71) 0.16	(89) 0.07
(18) 0.64	(36) 0.4	(54) 0.4	(72) 0.16	(90) 0.07

(91) 0.07	(109) 0.07	(127) 0.34	(145) 0.32	(163) 0.32
(92) 0.07	(110) 0.07	(128) 0.34	(146) 0.32	(164) 0.32
(93) 0.07	(111) 0.07	(129) 0.34	(147) 0.32	(165) 0.32
(94) 0.07	(112) 0.07	(130) 0.34	(148) 0.32	(166) 0.32
(95) 0.07	(113) 0.34	(131) 0.34	(149) 0.32	(167) 0.32
(96) 0.07	(114) 0.34	(132) 0.34	(150) 0.32	(168) 0.32
(97) 0.07	(115) 0.34	(133) 0.34	(151) 0.32	(169) 0.32
(98) 0.07	(116) 0.34	(134) 0.34	(152) 0.32	(170) 0.32
(99) 0.07	(117) 0.34	(135) 0.34	(153) 0.32	(171) 0.32
(100) 0.07	(118) 0.34	(136) 0.34	(154) 0.32	(172) 0.32
(101) 0.07	(119) 0.34	(137) 0.34	(155) 0.32	(173) 0.05
(102) 0.07	(120) 0.34	(138) 0.34	(156) 0.32	(174) 0.05
(103) 0.07	(121) 0.34	(139) 0.34	(157) 0.232	(175) 0.05
(104) 0.07	(122) 0.34	(140) 0.34	(158) 0.232	(176) 0.05
(105) 0.07	(123) 0.34	(141) 0.32	(159) 0.32	(177) 0.05
(106) 0.07	(124) 0.34	(142) 0.32	(160) 0.32	(178) 0.05
(107) 0.07	(125) 0.34	(143) 0.32	(161) 0.32	(179) 0.05
(108) 0.07	(126) 0.34	(144) 0.32	(162) 0.32	(180) 0.05

(181) 0.05	(199) 0.34	(217) 0.43	(235) 0.19	(253) 0.073
(182) 0.05	(200) 0.34	(218) 0.43	(236) 0.19	(254) 0.073
(183) 0.05	(201) 0.43	(219) 0.43	(237) 0.19	(255) 0.07
(184) 0.05	(202) 0.43	(220) 0.43	(238) 0.19	(256) 0.07
(185) 0.05	(203) 0.43	(221) 0.43	(239) 0.19	(257) 0.07
(186) 0.05	(204) 0.43	(222) 0.43	(240) 0.19	(258) 0.07
(187) 0.05	(205) 0.43	(223) 0.43	(241) 0.19	(259) 0.07
(188) 0.05	(206) 0.43	(224) 0.43	(242) 0.19	(260) 0.07
(189) 0.05	(207) 0.43	(225) 0.19	(243) 0.19	(261) 0.07
(190) 0.05	(208) 0.43	(226) 0.19	(244) 0.19	(262) 0.07
(191) 0.05	(209) 0.43	(227) 0.19	(245) 0.19	(263) 0.07
(192) 0.05	(210) 0.43	(228) 0.19	(246) 0.19	(264) 0.07
(193) 0.05	(211) 0.43	(229) 0.19	(247) 0.19	(265) 0.07
(194) 0.05	(212) 0.43	(230) 0.19	(248) 0.19	(266) 0.07
(195) 0.05	(213) 0.43	(231) 0.19	(249) 0.19	(267) 0.07
(196) 0.05	(214) 0.43	(232) 0.19	(250) 0.19	(268) 0.07
(197) 0.432	(215) 0.43	(233) 0.19	(251) 0.19	(269) 0.07
(198) 0.432	(216) 0.43	(234) 0.19	(252) 0.19	(270) 0.07

(271) 0.07	(289) 0.05	(307) 0.05	(325) 0.16	(343) 1.156
(272) 0.07	(290) 0.05	(308) 0.05	(326) 0.16	(344) 1.156
(273) 0.07	(291) 0.05	(309) 0.16	(327) 0.16	(345) 1.156
(274) 0.07	(292) 0.05	(310) 0.16	(328) 0.16	(346) 1.156
(275) 0.07	(293) 0.05	(311) 0.16	(329) 0.16	(347) 1.156
(276) 0.07	(294) 0.05	(312) 0.16	(330) 0.16	(348) 1.156
(277) 0.07	(295) 0.05	(313) 0.16	(331) 0.16	(349) 1.156
(278) 0.07	(296) 0.05	(314) 0.16	(332) 0.16	(350) 1.156
(279) 0.08	(297) 0.05	(315) 0.16	(333) 0.16	(351) 1.156
(280) 0.08	(298) 0.05	(316) 0.16	(334) 0.16	(352) 1.156
(281) 0.08	(299) 0.05	(317) 0.16	(335) 0.16	(353) 1.156
(282) 0.08	(300) 0.05	(318) 0.16	(336) 0.16	(354) 1.156
(283) 0.08	(301) 0.05	(319) 0.16	(337) 1.156	(355) 1.156
(284) 0.08	(302) 0.05	(320) 0.16	(338) 1.156	(356) 1.156
(285) 0.08	(303) 0.05	(321) 0.16	(339) 1.156	(357) 1.16
(286) 0.08	(304) 0.05	(322) 0.16	(340) 1.156	(358) 1.16
(287) 0.08	(305) 0.05	(323) 0.16	(341) 1.156	(359) 1.1
(288) 0.08	(306) 0.05	(324) 0.16	(342) 1.156	(360) 1.1

River discharge data at 12-hourly intervals for Station: 21D
Period : 3

Variable: VOELVL4.var1 (length = 344)

(1) 3.404	(19) 3.4	(37) 3.4	(55) 3.4	(73) 5
(2) 3.404	(20) 3.4	(38) 3.4	(56) 3.4	(74) 5
(3) 3.4	(21) 3.4	(39) 3.4	(57) 3.4	(75) 5
(4) 3.4	(22) 3.4	(40) 3.4	(58) 3.4	(76) 5
(5) 3.4	(23) 3.4	(41) 3.4	(59) 3.4	(77) 5
(6) 3.4	(24) 3.4	(42) 3.4	(60) 3.4	(78) 5
(7) 3.4	(25) 3.4	(43) 3.4	(61) 3.4	(79) 5
(8) 3.4	(26) 3.4	(44) 3.4	(62) 3.4	(80) 5
(9) 3.4	(27) 3.4	(45) 3.4	(63) 3.4	(81) 5
(10) 3.4	(28) 3.4	(46) 3.4	(64) 3.4	(82) 5
(11) 3.4	(29) 3.4	(47) 3.4	(65) 3.4	(83) 5
(12) 3.4	(30) 3.4	(48) 3.4	(66) 3.4	(84) 5
(13) 3.4	(31) 3.4	(49) 3.4	(67) 3.4	(85) 5
(14) 3.4	(32) 3.4	(50) 3.4	(68) 3.4	(86) 5
(15) 3.4	(33) 3.4	(51) 3.4	(69) 3.4	(87) 5
(16) 3.4	(34) 3.4	(52) 3.4	(70) 3.4	(88) 5
(17) 3.4	(35) 3.4	(53) 3.4	(71) 5	(89) 5
(18) 3.4	(36) 3.4	(54) 3.4	(72) 5	(90) 5

(181) 4.8	(199) 0.9	(217) 0.9	(235) 0.8	(253) 2.5
(182) 4.8	(200) 0.9	(218) 0.9	(236) 0.8	(254) 2.5
(183) 4.8	(201) 0.9	(219) 0.8	(237) 0.8	(255) 2.74
(184) 4.8	(202) 0.9	(220) 0.8	(238) 0.8	(256) 2.74
(185) 4.8	(203) 0.9	(221) 0.8	(239) 0.8	(257) 2.74
(186) 4.8	(204) 0.9	(222) 0.8	(240) 0.8	(258) 2.74
(187) 4.8	(205) 0.9	(223) 0.8	(241) 0.8	(259) 2.74
(188) 4.8	(206) 0.9	(224) 0.8	(242) 0.8	(260) 2.74
(189) 4.8	(207) 0.9	(225) 0.8	(243) 2.74	(261) 2.5
(190) 4.8	(208) 0.9	(226) 0.8	(244) 2.74	(262) 2.5
(191) 0.9	(209) 0.9	(227) 0.8	(245) 2.74	(263) 2.5
(192) 0.9	(210) 0.9	(228) 0.8	(246) 2.74	(264) 2.5
(193) 0.9	(211) 0.9	(229) 0.8	(247) 2.74	(265) 2.74
(194) 0.9	(212) 0.9	(230) 0.8	(248) 2.74	(266) 2.74
(195) 0.9	(213) 0.9	(231) 0.8	(249) 2.74	(267) 2.74
(196) 0.9	(214) 0.9	(232) 0.8	(250) 2.74	(268) 2.74
(197) 0.9	(215) 0.9	(233) 0.8	(251) 2.74	(269) 2.74
(198) 0.9	(216) 0.9	(234) 0.8	(252) 2.74	(270) 2.74

(91) 5	(109) 5	(127) 5	(145) 3.1	(163) 4.8
(92) 5	(110) 5	(128) 5	(146) 3.1	(164) 4.8
(93) 5	(111) 5	(129) 5	(147) 3.1	(165) 4.8
(94) 5	(112) 5	(130) 5	(148) 3.1	(166) 4.8
(95) 5	(113) 5	(131) 5	(149) 3.1	(167) 4.8
(96) 5	(114) 5	(132) 5	(150) 3.1	(168) 4.8
(97) 5	(115) 5	(133) 5	(151) 3.1	(169) 4.8
(98) 5	(116) 5	(134) 5	(152) 3.1	(170) 4.8
(99) 5	(117) 5	(135) 5	(153) 3.1	(171) 4.8
(100) 5	(118) 5	(136) 5	(154) 3.1	(172) 4.8
(101) 5	(119) 5	(137) 3.1	(155) 3.1	(173) 4.8
(102) 5	(120) 5	(138) 3.1	(156) 3.1	(174) 4.8
(103) 5	(121) 5	(139) 3.1	(157) 3.1	(175) 4.8
(104) 5	(122) 5	(140) 3.1	(158) 3.1	(176) 4.8
(105) 5	(123) 5	(141) 3.1	(159) 3.1	(177) 4.8
(106) 5	(124) 5	(142) 3.1	(160) 3.1	(178) 4.8
(107) 5	(125) 5	(143) 3.1	(161) 3.1	(179) 4.8
(108) 5	(126) 5	(144) 3.1	(162) 3.1	(180) 4.8

(271) 2.74	(289) 2.6	(307) 0.9	(325) 0.9	(343) 0.43
(272) 2.74	(290) 2.6	(308) 0.9	(326) 0.9	(344) 0.43
(273) 2.74	(291) 2.6	(309) 0.9	(327) 0.9	
(274) 2.74	(292) 2.6	(310) 0.9	(328) 0.9	
(275) 2.74	(293) 2.6	(311) 0.9	(329) 0.43	
(276) 2.74	(294) 2.6	(312) 0.9	(330) 0.43	
(277) 2.5	(295) 2.6	(313) 0.9	(331) 0.43	
(278) 2.5	(296) 2.6	(314) 0.9	(332) 0.43	
(279) 2.5	(297) 2.6	(315) 0.9	(333) 0.43	
(280) 2.5	(298) 2.6	(316) 0.9	(334) 0.43	
(281) 2.6	(299) 0.9	(317) 0.9	(335) 0.43	
(282) 2.6	(300) 0.9	(318) 0.9	(336) 0.43	
(283) 2.6	(301) 0.9	(319) 0.9	(337) 0.45	
(284) 2.6	(302) 0.9	(320) 0.9	(338) 0.45	
(285) 2.6	(303) 0.9	(321) 0.9	(339) 0.43	
(286) 2.6	(304) 0.9	(322) 0.9	(340) 0.43	
(287) 2.6	(305) 0.9	(323) 0.9	(341) 0.43	
(288) 2.6	(306) 0.9	(324) 0.9	(342) 0.43	

River discharge data at 12-hourly intervals for Station: 21D
Period : 4

Variable: VOELVL5.var1 (length = 360)

(1) 0.403	(19) 0.4	(37) 0.4	(55) 0.28	(73) 0.6
(2) 0.403	(20) 0.4	(38) 0.4	(56) 0.28	(74) 0.6
(3) 0.403	(21) 0.4	(39) 0.4	(57) 0.28	(75) 0.6
(4) 0.403	(22) 0.4	(40) 0.4	(58) 0.28	(76) 0.6
(5) 0.406	(23) 0.41	(41) 0.4	(59) 0.28	(77) 0.6
(6) 0.406	(24) 0.41	(42) 0.4	(60) 0.28	(78) 0.6
(7) 0.4	(25) 0.4	(43) 0.28	(61) 0.28	(79) 0.6
(8) 0.4	(26) 0.4	(44) 0.28	(62) 0.28	(80) 0.6
(9) 0.4	(27) 0.4	(45) 0.28	(63) 0.28	(81) 0.6
(10) 0.4	(28) 0.4	(46) 0.28	(64) 0.28	(82) 0.6
(11) 0.4	(29) 0.4	(47) 0.28	(65) 0.28	(83) 0.6
(12) 0.4	(30) 0.4	(48) 0.28	(66) 0.28	(84) 0.6
(13) 0.4	(31) 0.4	(49) 0.28	(67) 0.28	(85) 0.6
(14) 0.4	(32) 0.4	(50) 0.28	(68) 0.28	(86) 0.6
(15) 0.4	(33) 0.4	(51) 0.28	(69) 0.28	(87) 0.6
(16) 0.4	(34) 0.4	(52) 0.28	(70) 0.28	(88) 0.6
(17) 0.4	(35) 0.4	(53) 0.28	(71) 0.28	(89) 0.6
(18) 0.4	(36) 0.4	(54) 0.28	(72) 0.28	(90) 0.6

(181) 0.96	(199) 0.96	(217) 0.96	(235) 0.96	(253) 0.96
(182) 0.96	(200) 0.96	(218) 0.96	(236) 0.96	(254) 0.96
(183) 0.96	(201) 0.96	(219) 0.96	(237) 0.96	(255) 0.96
(184) 0.96	(202) 0.96	(220) 0.96	(238) 0.96	(256) 0.96
(185) 0.96	(203) 0.96	(221) 0.96	(239) 0.96	(257) 0.96
(186) 0.96	(204) 0.96	(222) 0.96	(240) 0.96	(258) 0.96
(187) 0.96	(205) 0.96	(223) 0.96	(241) 0.96	(259) 0.96
(188) 0.96	(206) 0.96	(224) 0.96	(242) 0.96	(260) 0.96
(189) 0.96	(207) 0.96	(225) 0.96	(243) 0.96	(261) 0.96
(190) 0.96	(208) 0.96	(226) 0.96	(244) 0.96	(262) 0.96
(191) 0.96	(209) 0.96	(227) 0.96	(245) 0.96	(263) 0.96
(192) 0.96	(210) 0.96	(228) 0.96	(246) 0.96	(264) 0.96
(193) 0.96	(211) 0.96	(229) 0.96	(247) 0.96	(265) 0.96
(194) 0.96	(212) 0.96	(230) 0.96	(248) 0.96	(266) 0.96
(195) 0.96	(213) 0.96	(231) 0.96	(249) 0.96	(267) 0.96
(196) 0.96	(214) 0.96	(232) 0.96	(250) 0.96	(268) 0.96
(197) 0.96	(215) 0.96	(233) 0.96	(251) 0.96	(269) 0.96
(198) 0.96	(216) 0.96	(234) 0.96	(252) 0.96	(270) 0.96

(91) 0.6	(109) 0.6	(127) 0.7	(145) 0.7	(163) 0.78
(92) 0.6	(110) 0.6	(128) 0.7	(146) 0.7	(164) 0.78
(93) 0.6	(111) 0.7	(129) 0.7	(147) 0.7	(165) 0.78
(94) 0.6	(112) 0.7	(130) 0.7	(148) 0.7	(166) 0.78
(95) 0.6	(113) 0.7	(131) 0.7	(149) 0.7	(167) 0.78
(96) 0.6	(114) 0.7	(132) 0.7	(150) 0.7	(168) 0.78
(97) 0.6	(115) 0.7	(133) 0.7	(151) 0.7	(169) 0.78
(98) 0.6	(116) 0.7	(134) 0.7	(152) 0.7	(170) 0.78
(99) 0.6	(117) 0.7	(135) 0.7	(153) 0.78	(171) 0.78
(100) 0.6	(118) 0.7	(136) 0.7	(154) 0.78	(172) 0.78
(101) 0.6	(119) 0.7	(137) 0.7	(155) 0.78	(173) 0.78
(102) 0.6	(120) 0.7	(138) 0.7	(156) 0.78	(174) 0.78
(103) 0.6	(121) 0.7	(139) 0.7	(157) 0.78	(175) 0.78
(104) 0.6	(122) 0.7	(140) 0.7	(158) 0.78	(176) 0.78
(105) 0.6	(123) 0.7	(141) 0.7	(159) 0.78	(177) 0.78
(106) 0.6	(124) 0.7	(142) 0.7	(160) 0.78	(178) 0.78
(107) 0.6	(125) 0.7	(143) 0.7	(161) 0.78	(179) 0.96
(108) 0.6	(126) 0.7	(144) 0.7	(162) 0.78	(180) 0.96

(271) 0.96	(289) 0.43	(307) 0.126	(325) 0.126	(343) 0.27
(272) 0.96	(290) 0.43	(308) 0.126	(326) 0.126	(344) 0.27
(273) 0.96	(291) 0.43	(309) 0.126	(327) 0.126	(345) 0.27
(274) 0.96	(292) 0.43	(310) 0.126	(328) 0.126	(346) 0.27
(275) 0.96	(293) 0.43	(311) 0.1269	(329) 0.27	(347) 0.27
(276) 0.96	(294) 0.43	(312) 0.1269	(330) 0.27	(348) 0.27
(277) 0.96	(295) 0.43	(313) 0.126	(331) 0.27	(349) 0.27
(278) 0.96	(296) 0.43	(314) 0.126	(332) 0.27	(350) 0.27
(279) 0.96	(297) 0.43	(315) 0.126	(333) 0.27	(351) 0.27
(280) 0.96	(298) 0.43	(316) 0.126	(334) 0.27	(352) 0.27
(281) 0.43	(299) 0.43	(317) 0.122	(335) 0.27	(353) 0.27
(282) 0.43	(300) 0.43	(318) 0.122	(336) 0.27	(354) 0.27
(283) 0.43	(301) 0.43	(319) 0.126	(337) 0.27	(355) 0.27
(284) 0.43	(302) 0.43	(320) 0.126	(338) 0.27	(356) 0.27
(285) 0.43	(303) 0.43	(321) 0.126	(339) 0.27	(357) 0.27
(286) 0.43	(304) 0.43	(322) 0.126	(340) 0.27	(358) 0.27
(287) 0.43	(305) 0.126	(323) 0.126	(341) 0.27	(359) 0.27
(288) 0.43	(306) 0.126	(324) 0.126	(342) 0.27	(360) 0.27

River discharge data at 12-hourly intervals for Station: 21D
Period : 5

Variable: VOELVL6.var1 (length = 360)

(1) 0.156	(19) 0.098	(37) 0.098	(55) 0.098	(73) 0.098
(2) 0.156	(20) 0.098	(38) 0.098	(56) 0.098	(74) 0.098
(3) 0.156	(21) 0.098	(39) 0.098	(57) 0.073	(75) 0.098
(4) 0.156	(22) 0.098	(40) 0.098	(58) 0.073	(76) 0.098
(5) 0.156	(23) 0.098	(41) 0.098	(59) 0.073	(77) 0.098
(6) 0.156	(24) 0.098	(42) 0.098	(60) 0.073	(78) 0.098
(7) 0.156	(25) 0.098	(43) 0.098	(61) 0.073	(79) 0.098
(8) 0.156	(26) 0.098	(44) 0.098	(62) 0.073	(80) 0.098
(9) 0.156	(27) 0.098	(45) 0.098	(63) 0.073	(81) 0.098
(10) 0.156	(28) 0.098	(46) 0.098	(64) 0.073	(82) 0.098
(11) 0.156	(29) 0.098	(47) 0.098	(65) 0.073	(83) 0.098
(12) 0.156	(30) 0.098	(48) 0.098	(66) 0.073	(84) 0.098
(13) 0.156	(31) 0.098	(49) 0.098	(67) 0.073	(85) 0.073
(14) 0.156	(32) 0.098	(50) 0.098	(68) 0.073	(86) 0.073
(15) 0.098	(33) 0.098	(51) 0.098	(69) 0.073	(87) 0.073
(16) 0.098	(34) 0.098	(52) 0.098	(70) 0.073	(88) 0.073
(17) 0.098	(35) 0.098	(53) 0.098	(71) 0.098	(89) 0.073
(18) 0.098	(36) 0.098	(54) 0.098	(72) 0.098	(90) 0.073

(181) 0.098	(199) 2.469	(217) 4.447	(235) 6.573	(253) 4.78
(182) 0.098	(200) 2.469	(218) 4.447	(236) 6.573	(254) 4.78
(183) 0.098	(201) 2.469	(219) 4.447	(237) 6.573	(255) 4.78
(184) 0.078	(202) 2.469	(220) 4.447	(238) 6.573	(256) 4.78
(185) 0.098	(203) 2.469	(221) 4.447	(239) 5.324	(257) 4.78
(186) 0.098	(204) 2.469	(222) 4.447	(240) 6.324	(258) 4.78
(187) 0.098	(205) 2.469	(223) 4.447	(241) 6.234	(259) 4.78
(188) 0.098	(206) 2.469	(224) 4.447	(242) 6.234	(260) 4.78
(189) 0.098	(207) 2.469	(225) 6.573	(243) 6.234	(261) 4.78
(190) 0.098	(208) 2.469	(226) 6.573	(244) 6.234	(262) 4.78
(191) 0.098	(209) 2.469	(227) 6.573	(245) 6.234	(263) 4.78
(192) 0.098	(210) 2.469	(228) 6.573	(246) 6.234	(264) 4.78
(193) 2.469	(211) 4.447	(229) 6.573	(247) 6.234	(265) 4.78
(194) 2.469	(212) 4.447	(230) 6.573	(248) 6.234	(266) 4.78
(195) 2.469	(213) 4.447	(231) 6.573	(249) 6.234	(267) 4.78
(196) 2.469	(214) 4.447	(232) 6.573	(250) 6.234	(268) 4.78
(197) 2.469	(215) 4.447	(233) 6.573	(251) 6.234	(269) 1.652
(198) 2.469	(216) 4.447	(234) 6.573	(252) 6.234	(270) 1.652

(91) 0.073	(109) 0.073	(127) 0.223	(145) 0.223	(163) 0.223
(92) 0.073	(110) 0.073	(128) 0.223	(146) 0.223	(164) 0.223
(93) 0.073	(111) 0.073	(129) 0.223	(147) 0.223	(165) 0.223
(94) 0.073	(112) 0.073	(130) 0.223	(148) 0.223	(166) 0.223
(95) 0.073	(113) 0.073	(131) 0.223	(149) 0.223	(167) 0.223
(96) 0.073	(114) 0.073	(132) 0.223	(150) 0.223	(168) 0.223
(97) 0.073	(115) 0.073	(133) 0.223	(151) 0.223	(169) 0.098
(98) 0.073	(116) 0.073	(134) 0.223	(152) 0.223	(170) 0.098
(99) 0.073	(117) 0.073	(135) 0.223	(153) 0.223	(171) 0.098
(100) 0.073	(118) 0.073	(136) 0.223	(154) 0.223	(172) 0.098
(101) 0.073	(119) 0.073	(137) 0.223	(155) 0.223	(173) 0.098
(102) 0.073	(120) 0.073	(138) 0.223	(156) 0.223	(174) 0.098
(103) 0.073	(121) 0.073	(139) 0.223	(157) 0.223	(175) 0.098
(104) 0.073	(122) 0.073	(140) 0.223	(158) 0.223	(176) 0.098
(105) 0.073	(123) 0.073	(141) 0.223	(159) 0.223	(177) 0.098
(106) 0.073	(124) 0.073	(142) 0.223	(160) 0.223	(178) 0.098
(107) 0.073	(125) 0.073	(143) 0.223	(161) 0.223	(179) 0.098
(108) 0.073	(126) 0.073	(144) 0.223	(162) 0.223	(180) 0.098

(271) 1.652	(289) 2.128	(307) 2.21	(325) 0.223	(343) 0.223
(272) 1.652	(290) 2.128	(308) 2.21	(326) 0.223	(344) 0.223
(273) 1.652	(291) 2.128	(309) 2.128	(327) 0.223	(345) 0.223
(274) 1.652	(292) 2.128	(310) 2.128	(328) 0.223	(346) 0.223
(275) 1.652	(293) 2.128	(311) 2.128	(329) 0.223	(347) 0.223
(276) 1.652	(294) 2.128	(312) 2.128	(330) 0.223	(348) 0.223
(277) 1.652	(295) 2.21	(313) 2.128	(331) 0.223	(349) 0.223
(278) 1.652	(296) 2.21	(314) 2.128	(332) 0.223	(350) 0.223
(279) 1.652	(297) 2.21	(315) 2.128	(333) 0.223	(351) 0.26
(280) 1.652	(298) 2.21	(316) 2.128	(334) 0.223	(352) 0.26
(281) 2.128	(299) 2.21	(317) 2.128	(335) 0.223	(353) 0.26
(282) 2.128	(300) 2.21	(318) 2.128	(336) 0.223	(354) 0.26
(283) 2.128	(301) 2.21	(319) 2.128	(337) 0.223	(355) 0.26
(284) 2.128	(302) 2.21	(320) 2.128	(338) 0.223	(356) 0.26
(285) 2.128	(303) 2.21	(321) 2.128	(339) 0.223	(357) 0.26
(286) 2.128	(304) 2.21	(322) 2.128	(340) 0.223	(358) 0.26
(287) 2.128	(305) 2.21	(323) 0.223	(341) 0.223	(359) 0.26
(288) 2.128	(306) 2.21	(324) 0.223	(342) 0.223	(360) 0.26

River discharge data at 12-hourly intervals for Station: 21D
Period : 6

Variable: KLEIN1.var1 (length = 360)

(1)	0.522	(19)	0.108	(37)	0.108	(55)	0.108
(2)	0.607	(20)	0.096	(38)	0.054	(56)	0.085
(3)	0.385	(21)	0.108	(39)	0.085	(57)	0.12
(4)	0.319	(22)	0.096	(40)	0.036	(58)	0.096
(5)	0.607	(23)	0.096	(41)	0.0742	(59)	0.108
(6)	0.255	(24)	0.036	(42)	0.0449	(60)	0.074
(7)	0.607	(25)	0.0742	(43)	0.085	(61)	0.1445
(8)	0.225	(26)	0.028	(44)	0.064	(62)	0.1445
(9)	0.197	(27)	0.0742	(45)	0.108	(63)	0.1573
(10)	0.1704	(28)	0.036	(46)	0.1704	(64)	0.1445
(11)	0.1836	(29)	0.085	(47)	0.906	(65)	0.1573
(12)	0.1321	(30)	0.054	(48)	0.2401	(66)	0.096
(13)	0.132	(31)	0.085	(49)	0.3365	(67)	0.12
(14)	0.108	(32)	0.036	(50)	0.225	(68)	0.054
(15)	0.12	(33)	0.108	(51)	0.197	(69)	0.074
(16)	0.074	(34)	0.074	(52)	0.1836	(70)	0.045
(17)	0.108	(35)	0.12	(53)	0.1704	(71)	0.0964
(18)	0.096	(36)	0.12	(54)	0.1321	(72)	0.054
(73)	0.085	(91)	0.085	(109)	0.0138	(127)	0.0138
(74)	0.045	(92)	0.085	(110)	8E-3	(128)	0.014
(75)	0.085	(93)	0.085	(111)	7.8E-3	(129)	0.0138
(76)	0.096	(94)	0.036	(112)	8E-3	(130)	0.014
(77)	0.1321	(95)	0.054	(113)	7.8E-3	(131)	0.0138
(78)	0.1445	(96)	0.036	(114)	8E-3	(132)	0.014
(79)	0.12	(97)	0.0281	(115)	7.8E-3	(133)	0.0638
(80)	0.085	(98)	0.0281	(116)	8E-3	(134)	0.054
(81)	0.085	(99)	0.108	(117)	7.8E-3	(135)	0.054
(82)	0.045	(100)	0.054	(118)	8E-3	(136)	0.036
(83)	0.064	(101)	0.054	(119)	7.8E-3	(137)	7.8E-3
(84)	0.036	(102)	0.036	(120)	0.0742	(138)	2E-3
(85)	0.085	(103)	0.054	(121)	0.0742	(139)	2.5E-3
(86)	0.054	(104)	0.064	(122)	0.036	(140)	2E-3
(87)	0.0638	(105)	0.0964	(123)	0.0208	(141)	2.5E-3
(88)	0.036	(106)	0.074	(124)	0.021	(142)	0
(89)	0.0449	(107)	0.064	(125)	0.0138	(143)	2.5E-3
(90)	0.054	(108)	0.0281	(126)	0.014	(144)	0

(145)	2.5E-3	(163)	0.0138	(181)	0	(199)	2.5E-3
(146)	0	(164)	8E-3	(182)	0	(200)	0.021
(147)	0	(165)	0	(183)	0	(201)	0.054
(148)	0	(166)	0	(184)	8E-3	(202)	0.045
(149)	0	(167)	0	(185)	0	(203)	0.0362
(150)	0	(168)	0	(186)	8E-3	(204)	0.021
(151)	0	(169)	0	(187)	0	(205)	0.0208
(152)	0	(170)	0	(188)	8E-3	(206)	0
(153)	0	(171)	0	(189)	0	(207)	0
(154)	0	(172)	8E-3	(190)	3E-3	(208)	0
(155)	0	(173)	0	(191)	0	(209)	0
(156)	7E-3	(174)	0.021	(192)	0	(210)	2E-3
(157)	0	(175)	0	(193)	0	(211)	0.0449
(158)	2E-3	(176)	0.021	(194)	2E-3	(212)	2E-3
(159)	0	(177)	0	(195)	2.5E-3	(213)	0
(160)	2E-3	(178)	0	(196)	2E-3	(214)	0
(161)	2.5E-3	(179)	0	(197)	0	(215)	0.0362
(162)	0.028	(180)	0	(198)	8E-3	(216)	0.096
(217)	0.197	(235)	0.12	(253)	0.2102	(271)	0.108
(218)	4.531	(236)	0.108	(254)	0.197	(272)	0.12
(219)	0.7	(237)	0.108	(255)	0.1573	(273)	0.1445
(220)	0.445	(238)	0.064	(256)	0.1445	(274)	0.157
(221)	0.522	(239)	0.12	(257)	0.1445	(275)	0.1445
(222)	0.32	(240)	0.074	(258)	0.1445	(276)	0.096
(223)	0.2712	(241)	0.108	(259)	0.1321	(277)	0.1321
(224)	0.225	(242)	0.085	(260)	0.132	(278)	0.108
(225)	0.2102	(243)	0.108	(261)	0.12	(279)	0.0964
(226)	0.197	(244)	0.132	(262)	0.064	(280)	0.096
(227)	0.1704	(245)	0.12	(263)	0.0964	(281)	0.1321
(228)	0.157	(246)	0.197	(264)	0.085	(282)	0.108
(229)	0.1704	(247)	1.822	(265)	0.0964	(283)	0.1445
(230)	0.157	(248)	1.822	(266)	0.074	(284)	0.12
(231)	0.1445	(249)	0.906	(267)	0.0964	(285)	0.1445
(232)	0.1445	(250)	0.445	(268)	0.085	(286)	0.157
(233)	0.1445	(251)	0.3365	(269)	0.0742	(287)	0.1704
(234)	0.096	(252)	0.2712	(270)	0.085	(288)	0.184

River discharge data at 12-hourly intervals for Station: 23A
Period : 1

(289)	0.1836	(307)	0.1573	(325)	0.2555	(343)	31.52
(290)	0.132	(308)	4.018	(326)	0.799	(344)	60
(291)	0.1704	(309)	0.445	(327)	1.534	(345)	34.4
(292)	0.157	(310)	0.7	(328)	11.9	(346)	13.58
(293)	0.1836	(311)	1.396	(329)	5.077	(347)	109.2
(294)	0.184	(312)	0.445	(330)	2.281	(348)	60
(295)	0.1836	(313)	0.607	(331)	1.822	(349)	48
(296)	0.1445	(314)	0.385	(332)	1.264	(350)	43
(297)	0.1704	(315)	0.445	(333)	0.91	(351)	24.4
(298)	0.12	(316)	0.197	(334)	0.906	(352)	27.6
(299)	0.12	(317)	0.2871	(335)	0.799	(353)	17.4
(300)	0.12	(318)	0.1321	(336)	0.7	(354)	20.4
(301)	0.1704	(319)	0.1704	(337)	0.607	(355)	14.32
(302)	0.1704	(320)	0.074	(338)	0.607	(356)	18.02
(303)	0.1573	(321)	0.0964	(339)	1.822	(357)	9.55
(304)	0.157	(322)	0.074	(340)	3.773	(358)	15.74
(305)	0.1573	(323)	0.0742	(341)	2.94	(359)	6.83
(306)	0.1704	(324)	0.2102	(342)	2.94	(360)	6.84

Variable: KLEIN2.var1 (length = 360)

(1)	6.203	(19)	0.594	(37)	0.511	(55)	0.8895	(73)	0.522
(2)	5.95	(20)	0.522	(38)	1.02	(56)	0.906	(74)	0.799
(3)	5.601	(21)	0.434	(39)	0.686	(57)	0.784	(75)	2.771
(4)	4.8	(22)	0.445	(40)	1.02	(58)	0.799	(76)	2.771
(5)	4.227	(23)	0.376	(41)	1.002	(59)	0.784	(77)	2.124
(6)	4.02	(24)	0.353	(42)	1.02	(60)	0.799	(78)	5.077
(7)	3.501	(25)	0.354	(43)	1.002	(61)	0.686	(79)	12.75
(8)	3.11	(26)	0.353	(44)	1.02	(62)	0.7	(80)	37.4
(9)	2.746	(27)	0.345	(45)	0.8896	(63)	0.594	(81)	16.64
(10)	2.605	(28)	0.353	(46)	0.906	(64)	0.607	(82)	10
(11)	2.261	(29)	0.354	(47)	0.8896	(65)	0.594	(83)	8.22
(12)	1.972	(30)	1.264	(48)	0.906	(66)	0.607	(84)	6.57
(13)	1.655	(31)	0.376	(49)	0.784	(67)	0.594	(85)	5.361
(14)	1.396	(32)	1.14	(50)	0.799	(68)	0.607	(86)	4.8
(15)	1.119	(33)	0.376	(51)	0.784	(69)	0.445	(87)	4.53
(16)	0.906	(34)	1.02	(52)	0.799	(70)	0.445	(88)	4.02
(17)	0.784	(35)	0.434	(53)	0.784	(71)	0.445	(89)	3.77
(18)	0.7	(36)	1.02	(54)	0.799	(72)	0.607	(90)	3.54

(91)	3.314	(109)	5.953	(127)	2.442	(145)	1.972	(163)	2.771
(92)	3.11	(110)	5.077	(128)	2.44	(146)	8.22	(164)	2.61
(93)	2.94	(111)	4.531	(129)	2.442	(147)	6.89	(165)	2.605
(94)	2.771	(112)	4.02	(130)	2.44	(148)	5.65	(166)	2.442
(95)	2.771	(113)	4.018	(131)	2.442	(149)	16.64	(167)	2.281
(96)	2.605	(114)	5.077	(132)	2.28	(150)	9.26	(168)	2.281
(97)	2.442	(115)	4.901	(133)	2.281	(151)	6.572	(169)	2.124
(98)	2.442	(116)	4.02	(134)	2.124	(152)	5.65	(170)	2.124
(99)	2.442	(117)	3.773	(135)	2.124	(153)	4.531	(171)	2.124
(100)	2.281	(118)	3.54	(136)	2.124	(154)	4.27	(172)	1.972
(101)	2.124	(119)	3.773	(137)	1.972	(155)	3.773	(173)	1.972
(102)	5.38	(120)	3.11	(138)	1.822	(156)	3.54	(174)	1.972
(103)	4.531	(121)	3.114	(139)	1.822	(157)	3.314	(175)	1.972
(104)	3.54	(122)	2.94	(140)	1.972	(158)	3.11	(176)	1.972
(105)	40.42	(123)	2.771	(141)	1.972	(159)	3.114	(177)	1.822
(106)	15.3	(124)	2.77	(142)	1.972	(160)	2.94	(178)	1.822
(107)	8.91	(125)	2.605	(143)	1.972	(161)	2.94	(179)	1.822
(108)	6.89	(126)	2.61	(144)	1.972	(162)	2.77	(180)	1.676

(181)	1.676	(199)	1.264	(217)	10	(235)	3.538	(253)	2.442
(182)	1.972	(200)	1.138	(218)	8.91	(236)	3.54	(254)	2.442
(183)	1.972	(201)	1.138	(219)	15.72	(237)	3.538	(255)	2.442
(184)	1.972	(202)	1.019	(220)	11.94	(238)	3.314	(256)	2.281
(185)	1.676	(203)	1.138	(221)	8.91	(239)	3.314	(257)	2.124
(186)	1.972	(204)	2.281	(222)	7.37	(240)	3.11	(258)	2.124
(187)	1.534	(205)	2.281	(223)	6.89	(241)	3.114	(259)	2.124
(188)	1.822	(206)	1.822	(224)	6.26	(242)	3.11	(260)	1.972
(189)	1.534	(207)	1.676	(225)	5.95	(243)	3.114	(261)	1.972
(190)	1.822	(208)	10.8	(226)	6.26	(244)	2.94	(262)	1.822
(191)	1.534	(209)	18.02	(227)	5.65	(245)	2.771	(263)	1.822
(192)	1.822	(210)	70	(228)	4.8	(246)	2.771	(264)	2.124
(193)	1.396	(211)	43.42	(229)	4.53	(247)	2.605	(265)	2.124
(194)	1.676	(212)	21.4	(230)	4.27	(248)	2.605	(266)	1.972
(195)	1.264	(213)	34.4	(231)	4.018	(249)	2.442	(267)	1.972
(196)	1.264	(214)	25.5	(232)	3.77	(250)	2.442	(268)	1.972
(197)	1.264	(215)	14.87	(233)	3.773	(251)	2.281	(269)	2.124
(198)	1.264	(216)	11.94	(234)	3.77	(252)	2.442	(270)	13.16

(271)	11.15	(289)	3.314	(307)	1.972	(325)	1.264	(343)	0.353
(272)	11.15	(290)	3.11	(308)	1.822	(326)	1.138	(344)	0.353
(273)	34.97	(291)	3.114	(309)	1.822	(327)	1.138	(345)	0.385
(274)	21.89	(292)	2.77	(310)	1.676	(328)	1.02	(346)	0.385
(275)	11.94	(293)	2.771	(311)	1.822	(329)	1.138	(347)	0.445
(276)	8.56	(294)	2.442	(312)	1.534	(330)	1.14	(348)	0.353
(277)	6.89	(295)	2.442	(313)	1.534	(331)	1.138	(349)	0.522
(278)	5.95	(296)	2.28	(314)	1.534	(332)	1.02	(350)	0.385
(279)	5.381	(297)	2.281	(315)	1.676	(333)	1.019	(351)	0.522
(280)	4.53	(298)	2.28	(316)	1.534	(334)	0.906	(352)	0.353
(281)	4.531	(299)	2.281	(317)	1.534	(335)	0.799	(353)	0.445
(282)	5.08	(300)	2.28	(318)	1.676	(336)	0.607	(354)	0.271
(283)	4.27	(301)	2.124	(319)	1.676	(337)	0.522	(355)	0.385
(284)	4.02	(302)	1.972	(320)	1.534	(338)	0.445	(356)	0.32
(285)	4.018	(303)	1.972	(321)	1.534	(339)	0.445	(357)	0.385
(286)	3.77	(304)	1.822	(322)	1.396	(340)	0.353	(358)	0.336
(287)	4.018	(305)	1.822	(323)	1.396	(341)	0.3365	(359)	0.385
(288)	3.54	(306)	1.676	(324)	1.264	(342)	0.303	(360)	0.336

A3.71

River discharge data at 12-hourly intervals for Station: 23A
Period : 2

Variable: KLEIN3.varl (length = 360)

(1)	0.3198	(19)	0.1573	(37)	0.799	(55)	0.225	(73)	0.607
(2)	0.32	(20)	0.132	(38)	0.607	(56)	0.21	(74)	0.607
(3)	0.3198	(21)	0.1573	(39)	0.607	(57)	0.225	(75)	0.607
(4)	0.21	(22)	0.12	(40)	0.522	(58)	0.145	(76)	0.445
(5)	0.3198	(23)	0.1445	(41)	0.445	(59)	0.1704	(77)	0.445
(6)	0.27	(24)	0.12	(42)	0.445	(60)	3.77	(78)	0.287
(7)	0.3198	(25)	0.1445	(43)	0.445	(61)	2.124	(79)	0.2871
(8)	0.225	(26)	0.17	(44)	0.353	(62)	1.264	(80)	0.255
(9)	0.2871	(27)	0.225	(45)	0.445	(63)	1.019	(81)	0.2871
(10)	0.225	(28)	0.287	(46)	0.255	(64)	2.124	(82)	0.255
(11)	0.353	(29)	0.255	(47)	0.2712	(65)	2.771	(83)	0.2871
(12)	0.24	(30)	0.21	(48)	0.184	(66)	1.534	(84)	0.287
(13)	0.255	(31)	0.3365	(49)	0.2712	(67)	1.138	(85)	0.2712
(14)	0.256	(32)	2.442	(50)	0.17	(68)	0.799	(86)	0.184
(15)	0.2401	(33)	1.676	(51)	0.1573	(69)	0.799	(87)	0.225
(16)	0.145	(34)	1.264	(52)	0.108	(70)	0.607	(88)	0.24
(17)	0.1704	(35)	1.138	(53)	0.1573	(71)	0.607	(89)	0.1704
(18)	0.145	(36)	0.799	(54)	0.197	(72)	0.607	(90)	0.132

(181)	0.1321	(199)	0.12	(217)	0.7	(235)	4.53	(253)	1.138
(182)	0.12	(200)	0.064	(218)	0.445	(236)	5.381	(254)	1.019
(183)	0.1321	(201)	0.12	(219)	0.522	(237)	4.53	(255)	0.906
(184)	0.108	(202)	0.054	(220)	0.353	(238)	2.771	(256)	0.906
(185)	0.0964	(203)	0.12	(221)	0.353	(239)	2.281	(257)	0.906
(186)	0.074	(204)	0.074	(222)	0.255	(240)	2.124	(258)	0.906
(187)	0.085	(205)	0.1573	(223)	0.2871	(241)	1.972	(259)	1.018
(188)	0.074	(206)	0.21	(224)	0.197	(242)	1.676	(260)	0.906
(189)	0.096	(207)	1.676	(225)	0.197	(243)	1.534	(261)	0.906
(190)	0.045	(208)	8.56	(226)	0.108	(244)	1.534	(262)	0.799
(191)	0.1321	(209)	4.018	(227)	0.108	(245)	1.534	(263)	0.906
(192)	0.074	(210)	7.541	(228)	0.12	(246)	1.534	(264)	0.906
(193)	0.1573	(211)	3.538	(229)	0.12	(247)	1.676	(265)	0.906
(194)	0.145	(212)	1.9	(230)	0.085	(248)	1.534	(266)	0.799
(195)	0.1704	(213)	1.534	(231)	0.108	(249)	1.396	(267)	0.799
(196)	0.17	(214)	1.138	(232)	1.019	(250)	1.264	(268)	0.799
(197)	0.1573	(215)	1.019	(233)	0.12	(251)	1.264	(269)	0.799
(198)	0.096	(216)	0.799	(234)	8.22	(252)	1.138	(270)	0.799

(91)	0.1321	(109)	0.197	(127)	0.799	(145)	0.2712	(163)	0.445
(92)	0.17	(110)	0.157	(128)	0.7	(146)	0.24	(164)	0.385
(93)	0.1704	(111)	0.1704	(129)	0.607	(147)	0.2401	(165)	0.3365
(94)	0.132	(112)	0.24	(130)	0.607	(148)	0.21	(166)	0.32
(95)	0.2102	(113)	0.445	(131)	0.522	(149)	0.197	(167)	0.3033
(96)	0.197	(114)	5.381	(132)	0.445	(150)	0.197	(168)	0.271
(97)	0.225	(115)	6.87	(133)	0.445	(151)	0.255	(169)	0.255
(98)	0.225	(116)	2.442	(134)	0.385	(152)	0.24	(170)	0.24
(99)	0.228	(117)	1.676	(135)	0.385	(153)	0.2401	(171)	0.225
(100)	0.607	(118)	1.138	(136)	0.337	(154)	0.24	(172)	0.197
(101)	0.607	(119)	1.019	(137)	0.385	(155)	0.2102	(173)	0.197
(102)	0.353	(120)	1.138	(138)	0.353	(156)	0.197	(174)	0.17
(103)	0.255	(121)	2.442	(139)	0.353	(157)	0.197	(175)	0.1836
(104)	0.225	(122)	2.605	(140)	0.353	(158)	0.145	(176)	0.145
(105)	0.2102	(123)	1.676	(141)	0.353	(159)	0.1445	(177)	0.1321
(106)	0.17	(124)	1.264	(142)	0.271	(160)	0.17	(178)	0.096
(107)	0.1573	(125)	1.019	(143)	0.2555	(161)	0.2712	(179)	0.1321
(108)	0.132	(126)	0.906	(144)	0.24	(162)	0.7	(180)	0.132

(271)	0.799	(289)	0.799	(307)	0.607	(325)	1.138	(343)	0.607
(272)	0.7	(290)	0.799	(308)	0.522	(326)	1.02	(344)	0.607
(273)	0.799	(291)	0.799	(309)	0.7	(327)	0.906	(345)	0.52
(274)	0.7	(292)	0.799	(310)	1.02	(328)	0.906	(346)	0.445
(275)	0.7	(293)	0.799	(311)	2.94	(329)	0.906	(347)	0.607
(276)	0.799	(294)	0.799	(312)	6.57	(330)	0.906	(348)	0.607
(277)	10.19	(295)	0.799	(313)	2.94	(331)	0.799	(349)	0.607
(278)	4.018	(296)	0.799	(314)	2.44	(332)	0.799	(350)	0.607
(279)	5.077	(297)	0.799	(315)	1.972	(333)	0.799	(351)	0.7
(280)	2.771	(298)	0.7	(316)	1.534	(334)	0.799	(352)	0.607
(281)	2.771	(299)	0.7	(317)	1.264	(335)	0.799	(353)	0.7
(282)	1.972	(300)	0.7	(318)	1.14	(336)	0.799	(354)	0.7
(283)	1.534	(301)	0.7	(319)	1.019	(337)	0.799	(355)	0.7
(284)	1.396	(302)	0.607	(320)	0.906	(338)	0.7	(356)	0.7
(285)	1.264	(303)	0.607	(321)	0.906	(339)	0.7	(357)	0.607
(286)	1.019	(304)	0.607	(322)	1.02	(340)	0.7	(358)	0.607
(287)	1.019	(305)	0.607	(323)	1.534	(341)	0.7	(359)	0.607
(288)	0.906	(306)	0.522	(324)	1.14	(342)	0.607	(360)	0.607

River discharge data at 12-hourly intervals for Station: 23A
Period : 3

Variable: KLEIN4.var1 (length = 344)

(1)	0.607	(19)	1.26	(37)	1.4	(55)	11.94	(73)	5.95
(2)	0.607	(20)	1.264	(38)	1.396	(56)	9.63	(74)	5.38
(3)	0.607	(21)	7.2	(39)	1.4	(57)	7.87	(75)	4.801
(4)	0.7	(22)	4.27	(40)	1.396	(58)	13.58	(76)	4.53
(5)	0.7	(23)	3.1	(41)	1.4	(59)	14.01	(77)	4.53
(6)	0.7	(24)	2.442	(42)	1.396	(60)	9.26	(78)	4.27
(7)	0.52	(25)	2.28	(43)	1.4	(61)	7.54	(79)	4.27
(8)	0.799	(26)	1.972	(44)	1.396	(62)	6.572	(80)	4.018
(9)	10.76	(27)	1.82	(45)	1.26	(63)	5.65	(81)	3.77
(10)	10.38	(28)	1.676	(46)	1.396	(64)	5.953	(82)	3.54
(11)	5.65	(29)	1.676	(47)	1.14	(65)	8.22	(83)	3.114
(12)	3.114	(30)	1.534	(48)	1.264	(66)	6.89	(84)	3.114
(13)	2.442	(31)	1.534	(49)	1.14	(67)	5.95	(85)	3.114
(14)	1.676	(32)	1.534	(50)	45	(68)	5.077	(86)	2.94
(15)	1.676	(33)	1.396	(51)	14.87	(69)	4.53	(87)	2.771
(16)	1.534	(34)	1.676	(52)	100	(70)	5.077	(88)	2.771
(17)	1.39	(35)	1.4	(53)	34.4	(71)	9.63	(89)	2.771
(18)	1.264	(36)	1.396	(54)	18.02	(72)	7.213	(90)	2.605

(181)	5.95	(199)	4.53	(217)	2.771	(235)	10	(253)	2.442
(182)	5.65	(200)	4.27	(218)	2.94	(236)	7.87	(254)	2.442
(183)	5.65	(201)	4.02	(219)	2.771	(237)	6.259	(255)	2.281
(184)	5.08	(202)	4.02	(220)	2.605	(238)	4.801	(256)	2.124
(185)	5.077	(203)	3.77	(221)	2.442	(239)	4.27	(257)	2.124
(186)	5.08	(204)	3.77	(222)	2.605	(240)	3.773	(258)	2.442
(187)	5.077	(205)	3.54	(223)	2.281	(241)	3.54	(259)	3.114
(188)	4.801	(206)	3.54	(224)	2.28	(242)	3.114	(260)	6.89
(189)	4.27	(207)	3.31	(225)	2.94	(243)	3.114	(261)	4.801
(190)	4.27	(208)	3.114	(226)	2.28	(244)	2.94	(262)	4.018
(191)	4.018	(209)	3.114	(227)	2.281	(245)	2.771	(263)	3.538
(192)	4.02	(210)	3.114	(228)	2.442	(246)	2.771	(264)	2.94
(193)	4.27	(211)	3.114	(229)	2.281	(247)	2.605	(265)	2.94
(194)	11.15	(212)	2.94	(230)	2.124	(248)	2.605	(266)	2.771
(195)	7.54	(213)	2.94	(231)	2.124	(249)	2.605	(267)	2.605
(196)	5.65	(214)	2.771	(232)	1.972	(250)	4.02	(268)	2.442
(197)	5.077	(215)	2.771	(233)	2.281	(251)	3.114	(269)	2.442
(198)	5.08	(216)	2.771	(234)	10.38	(252)	2.605	(270)	2.442

(91)	2.442	(109)	50	(127)	5.077	(145)	3.114	(163)	33.2
(92)	2.442	(110)	21.9	(128)	5.077	(146)	3.11	(164)	19.44
(93)	2.442	(111)	16.2	(129)	5.077	(147)	2.94	(165)	14.87
(94)	2.442	(112)	16.2	(130)	4.8	(148)	2.94	(166)	11.94
(95)	2.442	(113)	14.01	(131)	4.53	(149)	2.94	(167)	42
(96)	2.442	(114)	14.01	(132)	4.53	(150)	2.94	(168)	38.6
(97)	2.605	(115)	10	(133)	4.02	(151)	5.65	(169)	24.44
(98)	55	(116)	11.94	(134)	3.77	(152)	7.21	(170)	19.44
(99)	50	(117)	8.2	(135)	3.77	(153)	4.801	(171)	17.1
(100)	23.92	(118)	8.22	(136)	3.77	(154)	18.02	(172)	14.87
(101)	11.9	(119)	7.54	(137)	3.77	(155)	14.43	(173)	11.9
(102)	16.19	(120)	7.21	(138)	3.77	(156)	9.26	(174)	8.22
(103)	8.2	(121)	6.89	(139)	3.77	(157)	7.213	(175)	7.87
(104)	15.3	(122)	6.57	(140)	3.77	(158)	5.95	(176)	7.54
(105)	14.43	(123)	6.28	(141)	3.77	(159)	5.381	(177)	7.21
(106)	11.15	(124)	5.95	(142)	3.54	(160)	4.8	(178)	6.89
(107)	9.26	(125)	5.65	(143)	3.54	(161)	23.41	(179)	6.57
(108)	60	(126)	5.38	(144)	3.31	(162)	150	(180)	6.259

(271)	3.114	(289)	1.676	(307)	0.906	(325)	0.607	(343)	0.385
(272)	2.771	(290)	1.534	(308)	0.799	(326)	0.7	(344)	0.353
(273)	2.605	(291)	1.534	(309)	0.799	(327)	0.701		
(274)	2.442	(292)	1.264	(310)	0.799	(328)	0.522		
(275)	2.442	(293)	1.264	(311)	0.799	(329)	0.522		
(276)	2.28	(294)	1.138	(312)	0.799	(330)	0.522		
(277)	2.281	(295)	1.138	(313)	0.799	(331)	0.607		
(278)	2.124	(296)	1.138	(314)	0.7	(332)	0.522		
(279)	2.124	(297)	1.019	(315)	0.7	(333)	0.607		
(280)	2.124	(298)	1.138	(316)	0.7	(334)	0.445		
(281)	2.124	(299)	1.138	(317)	0.607	(335)	0.445		
(282)	1.972	(300)	1.138	(318)	0.607	(336)	0.445		
(283)	1.972	(301)	1.138	(319)	0.7	(337)	0.445		
(284)	1.972	(302)	1.138	(320)	0.607	(338)	0.522		
(285)	1.972	(303)	1.319	(321)	0.522	(339)	0.607		
(286)	1.822	(304)	1.138	(322)	0.522	(340)	0.522		
(287)	1.822	(305)	1.138	(323)	0.522	(341)	0.445		
(288)	1.676	(306)	1.02	(324)	0.522	(342)	0.353		

River discharge data at 12-hourly intervals for Station: 23A
Period : 4

Variable: KLEIN5.var1 (length = 360)

(1) 0.395	(19) 0.17	(37) 0.157	(55) 0.353	(73) 0.157
(2) 0.385	(20) 0.145	(38) 0.17	(56) 0.303	(74) 0.096
(3) 0.445	(21) 0.21	(39) 0.184	(57) 0.255	(75) 0.13
(4) 0.385	(22) 0.17	(40) 0.096	(58) 0.21	(76) 0.064
(5) 0.385	(23) 0.255	(41) 0.12	(59) 0.21	(77) 0.13
(6) 0.319	(24) 0.21	(42) 0.045	(60) 0.21	(78) 0.096
(7) 0.353	(25) 0.17	(43) 0.085	(61) 0.197	(79) 0.157
(8) 0.353	(26) 0.17	(44) 0.064	(62) 0.157	(80) 0.157
(9) 0.353	(27) 0.1573	(45) 0.14	(63) 0.182	(81) 0.1445
(10) 0.353	(28) 0.108	(46) 0.074	(64) 0.17	(82) 0.045
(11) 0.32	(29) 0.17	(47) 0.109	(65) 0.197	(83) 0.13
(12) 0.256	(30) 0.132	(48) 0.054	(66) 0.21	(84) 0.045
(13) 0.287	(31) 0.1573	(49) 0.132	(67) 0.197	(85) 0.096
(14) 0.157	(32) 0.108	(50) 0.132	(68) 0.145	(86) 0.036
(15) 0.287	(33) 0.1573	(51) 0.183	(69) 0.17	(87) 0.085
(16) 0.197	(34) 0.132	(52) 0.799	(70) 0.132	(88) 0.064
(17) 0.197	(35) 0.184	(53) 0.799	(71) 0.1836	(89) 0.085
(18) 0.184	(36) 0.12	(54) 0.337	(72) 0.096	(90) 0.085

(181) 0.085	(199) 0.021	(217) 0.184	(235) 0.132	(253) 0.085
(182) 0.036	(200) 0.028	(218) 0.184	(236) 0.085	(254) 0.045
(183) 0.064	(201) 0.04	(219) 0.17	(237) 0.108	(255) 0.132
(184) 0.036	(202) 0.028	(220) 0.184	(238) 0.108	(256) 0.096
(185) 0.085	(203) 0.096	(221) 0.184	(239) 0.1445	(257) 0.12
(186) 0.045	(204) 0.074	(222) 0.145	(240) 0.074	(258) 0.054
(187) 0.074	(205) 0.085	(223) 0.184	(241) 0.12	(259) 0.1445
(188) 0.054	(206) 0.096	(224) 0.12	(242) 0.074	(260) 0.157
(189) 0.132	(207) 0.096	(225) 0.132	(243) 0.085	(261) 0.197
(190) 0.132	(208) 0.036	(226) 0.096	(244) 0.045	(262) 0.184
(191) 0.132	(209) 0.054	(227) 0.12	(245) 0.074	(263) 0.17
(192) 0.145	(210) 0.045	(228) 0.085	(246) 0.108	(264) 0.17
(193) 0.12	(211) 0.064	(229) 0.12	(247) 0.12	(265) 0.157
(194) 0.045	(212) 0.045	(230) 0.085	(248) 0.108	(266) 0.157
(195) 0.074	(213) 0.1445	(231) 0.1445	(249) 0.108	(267) 0.1445
(196) 0.045	(214) 0.157	(232) 0.132	(250) 0.036	(268) 0.108
(197) 0.085	(215) 0.184	(233) 0.132	(251) 0.064	(269) 0.108
(198) 0.028	(216) 0.157	(234) 0.132	(252) 0.036	(270) 0.12

(91) 0.12	(109) 0.225	(127) 0.085	(145) 0.12	(163) 0.12
(92) 0.12	(110) 0.157	(128) 0.036	(146) 0.054	(164) 0.108
(93) 0.126	(111) 0.17	(129) 0.06	(147) 0.12	(165) 0.096
(94) 0.132	(112) 0.132	(130) 0.028	(148) 0.12	(166) 0.132
(95) 0.126	(113) 0.157	(131) 0.05	(149) 0.132	(167) 0.074
(96) 0.064	(114) 0.145	(132) 0.021	(150) 0.12	(168) 0.054
(97) 0.054	(115) 0.13	(133) 0.045	(151) 0.108	(169) 0.085
(98) 0.074	(116) 0.096	(134) 0.074	(152) 0.074	(170) 0.054
(99) 0.108	(117) 0.13	(135) 0.12	(153) 0.132	(171) 0.085
(100) 0.108	(118) 0.036	(136) 0.145	(154) 0.036	(172) 0.074
(101) 0.108	(119) 0.096	(137) 0.108	(155) 0.074	(173) 0.085
(102) 0.054	(120) 0.085	(138) 0.028	(156) 0.054	(174) 0.045
(103) 0.085	(121) 0.12	(139) 0.036	(157) 0.074	(175) 0.096
(104) 0.054	(122) 0.132	(140) 0.045	(158) 0.054	(176) 0.085
(105) 0.064	(123) 0.108	(141) 0.255	(159) 0.085	(177) 0.108
(106) 0.045	(124) 0.045	(142) 0.197	(160) 0.045	(178) 0.12
(107) 0.114	(125) 0.074	(143) 0.21	(161) 0.085	(179) 0.132
(108) 0.17	(126) 0.045	(144) 0.132	(162) 0.074	(180) 0.085

(271) 0.108	(289) 0.2401	(307) 0.197	(325) 1.019	(343) 0.385
(272) 0.108	(290) 1.972	(308) 0.21	(326) 0.906	(344) 0.353
(273) 0.1321	(291) 1.019	(309) 0.255	(327) 0.799	(345) 0.353
(274) 0.184	(292) 0.7	(310) 0.337	(328) 5.93	(346) 0.337
(275) 0.2555	(293) 0.522	(311) 0.607	(329) 2.94	(347) 0.3198
(276) 0.7	(294) 0.385	(312) 0.522	(330) 1.97	(348) 0.319
(277) 0.607	(295) 0.3033	(313) 0.445	(331) 1.396	(349) 0.3198
(278) 0.337	(296) 0.271	(314) 0.35	(332) 1.02	(350) 0.303
(279) 0.2712	(297) 0.2401	(315) 0.3365	(333) 0.906	(351) 0.445
(280) 0.24	(298) 0.24	(316) 0.319	(334) 0.799	(352) 0.607
(281) 0.225	(299) 0.225	(317) 0.2871	(335) 0.65	(353) 0.607
(282) 0.21	(300) 0.225	(318) 0.287	(336) 0.607	(354) 0.522
(283) 0.197	(301) 0.225	(319) 0.2871	(337) 0.522	(355) 0.445
(284) 0.184	(302) 0.21	(320) 0.385	(338) 0.445	(356) 0.445
(285) 0.1704	(303) 0.2102	(321) 7.213	(339) 0.445	(357) 0.385
(286) 0.197	(304) 0.197	(322) 2.94	(340) 0.445	(358) 0.337
(287) 0.1836	(305) 0.197	(323) 1.972	(341) 0.445	(359) 0.3198
(288) 0.17	(306) 0.184	(324) 1.39	(342) 0.385	(360) 0.303

River discharge data

intervals for Station: 23A
Period : 5

A3.74

Variable: KLEIN6.var1 (length = 360)

(1)	0.271	(19)	9.63	(37)	0.607	(55)	0.8	(73)	0.7
(2)	0.271	(20)	4.02	(38)	0.607	(56)	0.7	(74)	0.906
(3)	0.271	(21)	2.771	(39)	0.607	(57)	0.8	(75)	1.396
(4)	0.271	(22)	3.314	(40)	0.607	(58)	4.801	(76)	1.264
(5)	0.271	(23)	2.442	(41)	0.607	(59)	4.02	(77)	1.14
(6)	0.271	(24)	1.972	(42)	0.522	(60)	3.114	(78)	1.019
(7)	0.287	(25)	1.676	(43)	0.522	(61)	2.124	(79)	4.02
(8)	0.287	(26)	1.396	(44)	0.522	(62)	1.676	(80)	2.442
(9)	0.35	(27)	1.264	(45)	0.522	(63)	1.53	(81)	1.97
(10)	6.572	(28)	1.13	(46)	0.522	(64)	1.534	(82)	1.534
(11)	5.65	(29)	1.02	(47)	0.445	(65)	1.264	(83)	1.39
(12)	5.381	(30)	0.906	(48)	0.607	(66)	1.138	(84)	1.264
(13)	5.95	(31)	0.8	(49)	0.7	(67)	1.02	(85)	1.02
(14)	3.54	(32)	0.799	(50)	0.799	(68)	0.706	(86)	1.02
(15)	4.53	(33)	0.7	(51)	2.442	(69)	0.906	(87)	3.114
(16)	4.02	(34)	0.7	(52)	1.396	(70)	0.799	(88)	7.213
(17)	2.605	(35)	0.7	(53)	1.02	(71)	0.8	(89)	4.53
(18)	1.97	(36)	0.607	(54)	0.906	(72)	0.799	(90)	3.114

(91)	2.442	(109)	1.676	(127)	1.97	(145)	7.54	(163)	3.53
(92)	2.124	(110)	1.676	(128)	1.97	(146)	6.57	(164)	4.53
(93)	2.124	(111)	2.442	(129)	1.97	(147)	7.54	(165)	4.02
(94)	14.43	(112)	2.771	(130)	2.124	(148)	6.89	(166)	3.54
(95)	7.541	(113)	2.77	(131)	2.124	(149)	8.91	(167)	3.31
(96)	4.801	(114)	2.442	(132)	1.97	(150)	6.25	(168)	3.11
(97)	3.77	(115)	2.605	(133)	1.822	(151)	5.38	(169)	2.94
(98)	3.114	(116)	6.89	(134)	1.97	(152)	4.801	(170)	2.77
(99)	2.77	(117)	5.08	(135)	10.8	(153)	4.53	(171)	2.44
(100)	2.605	(118)	4.02	(136)	5.08	(154)	4.02	(172)	2.28
(101)	2.442	(119)	3.314	(137)	3.77	(155)	3.77	(173)	2.28
(102)	2.281	(120)	2.94	(138)	3.114	(156)	3.77	(174)	2.124
(103)	2.28	(121)	3.114	(139)	2.77	(157)	3.11	(175)	2.124
(104)	2.124	(122)	2.605	(140)	2.605	(158)	5.65	(176)	1.97
(105)	1.97	(123)	2.442	(141)	2.77	(159)	5.95	(177)	1.97
(106)	1.822	(124)	2.28	(142)	58	(160)	4.53	(178)	1.822
(107)	1.822	(125)	2.124	(143)	20.9	(161)	4.02	(179)	1.822
(108)	1.822	(126)	1.97	(144)	10	(162)	3.77	(180)	1.822

(181)	1.822	(199)	5.63	(217)	5.65	(235)	4.27	(253)	3.54
(182)	2.28	(200)	5.38	(218)	5.38	(236)	4.8	(254)	2.94
(183)	11.94	(201)	5.077	(219)	5.08	(237)	4.02	(255)	2.77
(184)	78	(202)	5.08	(220)	5.08	(238)	3.77	(256)	2.771
(185)	51	(203)	18.02	(221)	4.8	(239)	3.54	(257)	2.605
(186)	49	(204)	58	(222)	4.53	(240)	3.11	(258)	3.114
(187)	40.4	(205)	19.44	(223)	4.53	(241)	2.94	(259)	9.63
(188)	23.4	(206)	13.6	(224)	4.27	(242)	2.94	(260)	14.43
(189)	17.6	(207)	11.15	(225)	4.02	(243)	2.94	(261)	9.63
(190)	14.43	(208)	12.3	(226)	4.02	(244)	2.77	(262)	6.259
(191)	11.94	(209)	10	(227)	3.77	(245)	2.77	(263)	5.361
(192)	10.76	(210)	8.56	(228)	4.02	(246)	2.61	(264)	4.531
(193)	9.63	(211)	7.54	(229)	3.77	(247)	2.442	(265)	4.27
(194)	8.91	(212)	7.21	(230)	3.54	(248)	2.442	(266)	4.018
(195)	8.56	(213)	6.89	(231)	3.31	(249)	2.94	(267)	4.27
(196)	7.87	(214)	6.57	(232)	3.11	(250)	2.94	(268)	5.653
(197)	7.54	(215)	6.25	(233)	3.114	(251)	2.77	(269)	6.572
(198)	6.57	(216)	5.95	(234)	4.27	(252)	2.77	(270)	5.077

(271)	4.53	(289)	2.442	(307)	1.822	(325)	1.396	(343)	0.7
(272)	4.018	(290)	2.442	(308)	2.281	(326)	1.264	(344)	0.607
(273)	3.773	(291)	2.442	(309)	3.114	(327)	1.264	(345)	0.522
(274)	3.538	(292)	2.281	(310)	2.442	(328)	1.019	(346)	0.522
(275)	3.314	(293)	2.281	(311)	1.972	(329)	1.019	(347)	0.522
(276)	3.114	(294)	2.281	(312)	1.822	(330)	1.019	(348)	0.522
(277)	3.114	(295)	2.281	(313)	1.822	(331)	1.019	(349)	0.607
(278)	2.94	(296)	2.124	(314)	1.676	(332)	0.906	(350)	0.607
(279)	2.94	(297)	1.972	(315)	1.676	(333)	0.706	(351)	0.522
(280)	2.771	(298)	1.822	(316)	1.534	(334)	0.906	(352)	0.445
(281)	3.538	(299)	1.822	(317)	1.396	(335)	0.906	(353)	0.522
(282)	3.114	(300)	1.822	(318)	1.396	(336)	0.906	(354)	0.522
(283)	2.94	(301)	1.822	(319)	1.396	(337)	0.906	(355)	0.522
(284)	2.771	(302)	1.822	(320)	1.264	(338)	0.799	(356)	0.353
(285)	2.771	(303)	1.676	(321)	1.264	(339)	0.799	(357)	0.353
(286)	2.771	(304)	1.676	(322)	1.264	(340)	0.7	(358)	0.445
(287)	2.605	(305)	1.676	(323)	1.396	(341)	0.7	(359)	0.445
(288)	2.442	(306)	1.676	(324)	1.396	(342)	0.607	(360)	0.445

River discharge data at 12-hourly intervals for Station: 23A
Period : 6

Variable: SAND1.var1 (length = 360)

(1)	0	(19)	0	(37)	0	(55)	0	(73)	0
(2)	0	(20)	0	(38)	0	(56)	0	(74)	0
(3)	0	(21)	0	(39)	0	(57)	0	(75)	0
(4)	0	(22)	0	(40)	0	(58)	0	(76)	0
(5)	0	(23)	0	(41)	0	(59)	0	(77)	0
(6)	0	(24)	0	(42)	0	(60)	0	(78)	0
(7)	0	(25)	0	(43)	0	(61)	0	(79)	0
(8)	0	(26)	0	(44)	0	(62)	0	(80)	0
(9)	0	(27)	0	(45)	0	(63)	0	(81)	0
(10)	0	(28)	0	(46)	0	(64)	0	(82)	0
(11)	0	(29)	0	(47)	0	(65)	0	(83)	0
(12)	0	(30)	0	(48)	0	(66)	0	(84)	0
(13)	0	(31)	0	(49)	0	(67)	0	(85)	0
(14)	0	(32)	0	(50)	0	(68)	0	(86)	0
(15)	0	(33)	0	(51)	0	(69)	0	(87)	0
(16)	0	(34)	0	(52)	0	(70)	0	(88)	0
(17)	0	(35)	0	(53)	0	(71)	0	(89)	0
(18)	0	(36)	0	(54)	0	(72)	0	(90)	0

(181)	0	(199)	0	(217)	0	(235)	0	(253)	0
(182)	0	(200)	0	(218)	0	(236)	0	(254)	0
(183)	0	(201)	0	(219)	0	(237)	0	(255)	0
(184)	0	(202)	0	(220)	0.117	(238)	0	(256)	0
(185)	0	(203)	0	(221)	0.029	(239)	0	(257)	0
(186)	0	(204)	0	(222)	9E-3	(240)	0	(258)	0
(187)	0	(205)	0	(223)	5E-3	(241)	0	(259)	0
(188)	0	(206)	0	(224)	2E-3	(242)	0	(260)	0
(189)	0	(207)	0	(225)	2E-3	(243)	0	(261)	0
(190)	0	(208)	0	(226)	1E-3	(244)	0	(262)	0
(191)	0	(209)	0	(227)	1E-3	(245)	0	(263)	0
(192)	0	(210)	0	(228)	1E-3	(246)	0	(264)	0
(193)	0	(211)	0	(229)	1E-3	(247)	0	(265)	0
(194)	0	(212)	0	(230)	0	(248)	0	(266)	0
(195)	0	(213)	0	(231)	0	(249)	0	(267)	0
(196)	0	(214)	0	(232)	0	(250)	0	(268)	0
(197)	0	(215)	0	(233)	0	(251)	0	(269)	0
(198)	0	(216)	0	(234)	0	(252)	0	(270)	0

(91)	0	(109)	0	(127)	0	(145)	0	(163)	0
(92)	0	(110)	0	(128)	0	(146)	0	(164)	0
(93)	0	(111)	0	(129)	0	(147)	0	(165)	0
(94)	0	(112)	0	(130)	0	(148)	0	(166)	0
(95)	0	(113)	0	(131)	0	(149)	0	(167)	0
(96)	0	(114)	0	(132)	0	(150)	0	(168)	0
(97)	0	(115)	0	(133)	0	(151)	0	(169)	0
(98)	0	(116)	0	(134)	0	(152)	0	(170)	0
(99)	0	(117)	0	(135)	0	(153)	0	(171)	0
(100)	0	(118)	0	(136)	0	(154)	0	(172)	0
(101)	0	(119)	0	(137)	0	(155)	0	(173)	0
(102)	0	(120)	0	(138)	0	(156)	0	(174)	0
(103)	0	(121)	0	(139)	0	(157)	0	(175)	0
(104)	0	(122)	0	(140)	0	(158)	0	(176)	0
(105)	0	(123)	0	(141)	0	(159)	0	(177)	0
(106)	0	(124)	0	(142)	0	(160)	0	(178)	0
(107)	0	(125)	0	(143)	0	(161)	0	(179)	0
(108)	0	(126)	0	(144)	0	(162)	0	(180)	0

(271)	0	(289)	0	(307)	0	(325)	0	(343)	0.786
(272)	0	(290)	0	(308)	0	(326)	0	(344)	11.74
(273)	0	(291)	0	(309)	0	(327)	0	(345)	0.853
(274)	0	(292)	0	(310)	0	(328)	0	(346)	0.498
(275)	0	(293)	0	(311)	0	(329)	0	(347)	47
(276)	0	(294)	0	(312)	0	(330)	0	(348)	5.873
(277)	0	(295)	0	(313)	0	(331)	0.039	(349)	3.001
(278)	0	(296)	0	(314)	0	(332)	0.021	(350)	4.037
(279)	0	(297)	0	(315)	0	(333)	9E-3	(351)	3.001
(280)	0	(298)	0	(316)	0	(334)	5E-3	(352)	1.827
(281)	0	(299)	0	(317)	0	(335)	5E-3	(353)	1.156
(282)	0	(300)	0	(318)	0	(336)	2E-3	(354)	0.998
(283)	0	(301)	0	(319)	0	(337)	2E-3	(355)	0.786
(284)	0	(302)	0	(320)	0	(338)	2E-3	(356)	0.661
(285)	0	(303)	0	(321)	0	(339)	2E-3	(357)	0.604
(286)	0	(304)	0	(322)	0	(340)	5E-3	(358)	0.498
(287)	0	(305)	0	(323)	0	(341)	5E-3	(359)	0.449
(288)	0	(306)	0	(324)	0	(342)	2E-3	(360)	0.361

River discharge data at 12-hourly intervals for Station: 23B
Period : 1

Variable: SAND2.var1 (length = 360)

(1) 0.361	(19) 0.19	(37) 0.064	(55) 0.029	(73) 0.025
(2) 0.361	(20) 0.163	(38) 0.05	(56) 0.029	(74) 0.029
(3) 0.285	(21) 0.163	(39) 0.05	(57) 0.029	(75) 0.039
(4) 0.322	(22) 0.163	(40) 0.05	(58) 0.039	(76) 0.361
(5) 0.285	(23) 0.163	(41) 0.05	(59) 0.039	(77) 0.19
(6) 0.322	(24) 0.139	(42) 0.05	(60) 0.039	(78) 0.19
(7) 0.285	(25) 0.117	(43) 0.039	(61) 0.039	(79) 0.285
(8) 0.285	(26) 0.117	(44) 0.039	(62) 0.029	(80) 3.001
(9) 0.285	(27) 0.17	(45) 0.029	(63) 0.029	(81) 0.786
(10) 0.285	(28) 0.139	(46) 0.029	(64) 0.029	(82) 0.361
(11) 0.285	(29) 0.117	(47) 0.029	(65) 0.029	(83) 0.19
(12) 0.25	(30) 0.097	(48) 0.021	(66) 0.029	(84) 0.163
(13) 0.219	(31) 0.079	(49) 0.021	(67) 0.029	(85) 0.139
(14) 0.219	(32) 0.079	(50) 0.021	(68) 0.029	(86) 0.117
(15) 0.219	(33) 0.064	(51) 0.021	(69) 0.034	(87) 0.117
(16) 0.19	(34) 0.064	(52) 0.021	(70) 0.029	(88) 0.117
(17) 0.19	(35) 0.064	(53) 0.021	(71) 0.029	(89) 0.097
(18) 0.19	(36) 0.064	(54) 0.021	(72) 0.029	(90) 0.097

(91) 0.097	(109) 0.163	(127) 0.064	(145) 0.097	(163) 0.079
(92) 0.097	(110) 0.19	(128) 0.05	(146) 1.421	(164) 0.079
(93) 0.079	(111) 0.117	(129) 0.05	(147) 0.449	(165) 0.079
(94) 0.079	(112) 0.117	(130) 0.05	(148) 0.404	(166) 0.079
(95) 0.079	(113) 0.117	(131) 0.05	(149) 1.72	(167) 0.064
(96) 0.079	(114) 0.117	(132) 0.05	(150) 0.604	(168) 0.064
(97) 0.056	(115) 0.404	(133) 0.05	(151) 0.361	(169) 0.064
(98) 0.05	(116) 0.219	(134) 0.05	(152) 0.25	(170) 0.05
(99) 0.05	(117) 0.139	(135) 0.039	(153) 0.19	(171) 0.05
(100) 0.05	(118) 0.117	(136) 0.039	(154) 0.163	(172) 0.079
(101) 0.05	(119) 0.117	(137) 0.029	(155) 0.163	(173) 0.079
(102) 0.079	(120) 0.097	(138) 0.029	(156) 0.139	(174) 0.064
(103) 0.079	(121) 0.079	(139) 0.029	(157) 0.139	(175) 0.064
(104) 0.163	(122) 0.079	(140) 0.029	(158) 0.117	(176) 0.05
(105) 0.604	(123) 0.079	(141) 0.029	(159) 0.117	(177) 0.05
(106) 0.998	(124) 0.079	(142) 0.029	(160) 0.097	(178) 0.05
(107) 0.361	(125) 0.064	(143) 0.05	(161) 0.097	(179) 0.039
(108) 0.19	(126) 0.064	(144) 0.039	(162) 0.097	(180) 0.039

(181) 0.037	(199) 0.014	(217) 0.285	(235) 0.064	(253) 0.029
(182) 0.039	(200) 0.014	(218) 0.19	(236) 0.064	(254) 0.029
(183) 0.039	(201) 0.014	(219) 0.219	(237) 0.055	(255) 0.029
(184) 0.029	(202) 0.014	(220) 0.998	(238) 0.05	(256) 0.029
(185) 0.029	(203) 0.014	(221) 0.604	(239) 0.064	(257) 0.029
(186) 0.029	(204) 0.029	(222) 0.322	(240) 0.05	(258) 0.029
(187) 0.029	(205) 0.029	(223) 0.25	(241) 0.05	(259) 0.029
(188) 0.029	(206) 0.021	(224) 0.19	(242) 0.05	(260) 0.029
(189) 0.029	(207) 0.029	(225) 0.19	(243) 0.05	(261) 0.029
(190) 0.029	(208) 0.117	(226) 0.163	(244) 0.05	(262) 0.029
(191) 0.029	(209) 0.549	(227) 0.139	(245) 0.039	(263) 0.029
(192) 0.029	(210) 8.07	(228) 0.139	(246) 0.029	(264) 0.029
(193) 0.021	(211) 1.329	(229) 0.117	(247) 0.029	(265) 0.029
(194) 0.021	(212) 1.156	(230) 0.097	(248) 0.029	(266) 0.029
(195) 0.021	(213) 0.661	(231) 0.097	(249) 0.029	(267) 0.029
(196) 0.014	(214) 1.329	(232) 0.079	(250) 0.021	(268) 0.064
(197) 0.014	(215) 0.449	(233) 0.079	(251) 0.029	(269) 0.064
(198) 0.014	(216) 0.322	(234) 0.079	(252) 0.029	(270) 1.72

(271) 1.329	(289) 0.05	(307) 5E-3	(325) 0	(343) 0
(272) 0.561	(290) 0.039	(308) 5E-3	(326) 0	(344) 0
(273) 0.478	(291) 0.039	(309) 2E-3	(327) 0	(345) 0
(274) 2.173	(292) 0.029	(310) 5E-3	(328) 0	(346) 0
(275) 0.786	(293) 0.039	(311) 2E-3	(329) 0	(347) 0
(276) 0.404	(294) 0.029	(312) 5E-3	(330) 0	(348) 0
(277) 0.285	(295) 0.029	(313) 1E-3	(331) 0	(349) 0
(278) 0.19	(296) 0.029	(314) 5E-3	(332) 0	(350) 0
(279) 0.139	(297) 0.029	(315) 1E-3	(333) 0	(351) 0
(280) 0.117	(298) 0.029	(316) 2E-3	(334) 0	(352) 0
(281) 0.117	(299) 0.021	(317) 0	(335) 0	(353) 0
(282) 0.097	(300) 0.014	(318) 2E-3	(336) 0	(354) 0
(283) 0.079	(301) 0.014	(319) 0	(337) 0	(355) 0
(284) 0.064	(302) 0.014	(320) 1E-3	(338) 0	(356) 0
(285) 0.064	(303) 9E-3	(321) 0	(339) 0	(357) 0
(286) 0.064	(304) 0.014	(322) 0	(340) 0	(358) 0
(287) 0.064	(305) 9E-3	(323) 0	(341) 0	(359) 0
(288) 0.05	(306) 5E-3	(324) 0	(342) 0	(360) 0

River discharge data at 12-hourly intervals for Station: 23B
Period : 2

Variable: SAND3.var1 (length = 360)

(1) 0	(19) 0	(37) 0	(55) 0	(73) 0	(91) 0	(109) 0	(127) 0
(2) 0	(20) 0	(38) 0	(56) 0	(74) 0	(92) 0	(110) 0	(128) 0
(3) 0	(21) 0	(39) 0	(57) 0	(75) 0	(93) 0	(111) 0	(129) 0
(4) 0	(22) 0	(40) 0	(58) 0	(76) 0	(94) 0	(112) 0	(130) 0
(5) 0	(23) 0	(41) 0	(59) 0	(77) 0	(95) 0	(113) 0	(131) 0
(6) 0	(24) 0	(42) 0	(60) 0	(78) 0	(96) 0	(114) 0	(132) 0
(7) 0	(25) 0	(43) 0	(61) 0	(79) 0	(97) 0	(115) 0	(133) 0
(8) 0	(26) 0	(44) 0	(62) 0	(80) 0	(98) 0	(116) 0	(134) 0
(9) 0	(27) 0	(45) 0	(63) 0	(81) 0	(99) 0	(117) 0	(135) 0
(10) 0	(28) 0	(46) 0	(64) 0	(82) 0	(100) 0	(118) 0	(136) 0
(11) 0	(29) 0	(47) 0	(65) 0	(83) 0	(101) 0	(119) 0	(137) 0
(12) 0	(30) 0	(48) 0	(66) 0	(84) 0	(102) 0	(120) 0	(138) 0
(13) 0	(31) 0	(49) 0	(67) 0	(85) 0	(103) 0	(121) 0	(139) 0
(14) 0	(32) 0	(50) 0	(68) 0	(86) 0	(104) 0	(122) 0	(140) 0
(15) 0	(33) 0	(51) 0	(69) 0	(87) 0	(105) 0	(123) 0	(141) 0
(16) 0	(34) 0	(52) 0	(70) 0	(88) 0	(106) 0	(124) 0	(142) 0
(17) 0	(35) 0	(53) 0	(71) 0	(89) 0	(107) 0	(125) 0	(143) 0
(18) 0	(36) 0	(54) 0	(72) 0	(90) 0	(108) 0	(126) 0	(144) 0

(289) 0	(307) 0	(325) 0	(343) 0
(290) 0	(308) 0	(326) 0	(344) 0
(291) 0	(309) 0	(327) 0	(345) 0
(292) 0	(310) 0	(328) 0	(346) 0
(293) 0	(311) 0	(329) 0	(347) 0
(294) 0	(312) 0	(330) 0	(348) 0
(295) 0	(313) 0	(331) 0	(349) 0
(296) 0	(314) 0	(332) 0	(350) 0
(297) 0	(315) 0	(333) 0	(351) 0
(298) 0	(316) 0	(334) 0	(352) 0
(299) 0	(317) 0	(335) 0	(353) 0
(300) 0	(318) 0	(336) 0	(354) 0
(301) 0	(319) 0	(337) 0	(355) 0
(302) 0	(320) 0	(338) 0	(356) 0
(303) 0	(321) 0	(339) 0	(357) 0
(304) 0	(322) 0	(340) 0	(358) 0
(305) 0	(323) 0	(341) 0	(359) 0
(306) 0	(324) 0	(342) 0	(360) 0

(145) 0	(163) 0	(181) 0	(199) 0	(217) 0	(235) 0	(253) 0	(271) 0
(146) 0	(164) 0	(182) 0	(200) 0	(218) 0	(236) 0	(254) 0	(272) 0
(147) 0	(165) 0	(183) 0	(201) 0	(219) 0	(237) 0	(255) 0	(273) 0
(148) 0	(166) 0	(184) 0	(202) 0	(220) 0	(238) 0	(256) 0	(274) 0
(149) 0	(167) 0	(185) 0	(203) 0	(221) 0	(239) 0	(257) 0	(275) 0
(150) 0	(168) 0	(186) 0	(204) 0	(222) 0	(240) 0	(258) 0	(276) 0
(151) 0	(169) 0	(187) 0	(205) 0	(223) 0	(241) 0	(259) 0	(277) 0
(152) 0	(170) 0	(188) 0	(206) 0	(224) 0	(242) 0	(260) 0	(278) 0
(153) 0	(171) 0	(189) 0	(207) 0	(225) 0	(243) 0	(261) 0	(279) 0
(154) 0	(172) 0	(190) 0	(208) 0	(226) 0	(244) 0	(262) 0	(280) 0
(155) 0	(173) 0	(191) 0	(209) 0	(227) 0	(245) 0	(263) 0	(281) 0
(156) 0	(174) 0	(192) 0	(210) 0	(228) 0	(246) 0	(264) 0	(282) 0
(157) 0	(175) 0	(193) 0	(211) 0	(229) 0	(247) 0	(265) 0	(283) 0
(158) 0	(176) 0	(194) 0	(212) 0	(230) 0	(248) 0	(266) 0	(284) 0
(159) 0	(177) 0	(195) 0	(213) 0	(231) 0	(249) 0	(267) 0	(285) 0
(160) 0	(178) 0	(196) 0	(214) 0	(232) 0	(250) 0	(268) 0	(286) 0
(161) 0	(179) 0	(197) 0	(215) 0	(233) 0	(251) 0	(269) 0	(287) 0
(162) 0	(180) 0	(198) 0	(216) 0	(234) 0	(252) 0	(270) 0	(288) 0

River discharge data at 12-hourly intervals for Station: 23B
Period : 3

Variable: SAND4.var1 (length = 344)

(1)	0	(19)	0	(37)	1E-3	(55)	0.449	(73)	0.219
(2)	0	(20)	0	(38)	1E-3	(56)	0.322	(74)	0.139
(3)	0	(21)	0	(39)	1E-3	(57)	0.25	(75)	0.117
(4)	0	(22)	0	(40)	1E-3	(58)	1.617	(76)	0.117
(5)	0	(23)	1E-3	(41)	1E-3	(59)	2.853	(77)	0.088
(6)	0	(24)	5E-3	(42)	1E-3	(60)	0.786	(78)	0.079
(7)	0	(25)	1E-3	(43)	1E-3	(61)	0.404	(79)	0.079
(8)	0	(26)	2E-3	(44)	1E-3	(62)	0.285	(80)	0.079
(9)	0	(27)	1E-3	(45)	1E-3	(63)	0.219	(81)	0.079
(10)	0	(28)	1E-3	(46)	1E-3	(64)	0.219	(82)	0.064
(11)	0	(29)	1E-3	(47)	1E-3	(65)	0.191	(83)	0.064
(12)	0	(30)	1E-3	(48)	1E-3	(66)	0.498	(84)	0.064
(13)	0	(31)	1E-3	(49)	2E-3	(67)	0.285	(85)	0.064
(14)	0	(32)	1E-3	(50)	12.54	(68)	0.19	(86)	0.064
(15)	0	(33)	1E-3	(51)	1.617	(69)	0.163	(87)	0.064
(16)	0	(34)	1E-3	(52)	1.241	(70)	0.285	(88)	0.064
(17)	0	(35)	1E-3	(53)	4.037	(71)	0.219	(89)	0.05
(18)	0	(36)	1E-3	(54)	0.924	(72)	0.361	(90)	0.05

(181)	0.285	(199)	0.25	(217)	0.098	(235)	0.139	(253)	0.064
(182)	0.285	(200)	0.19	(218)	0.097	(236)	0.604	(254)	0.05
(183)	0.25	(201)	0.163	(219)	0.117	(237)	0.361	(255)	0.05
(184)	0.25	(202)	0.163	(220)	0.117	(238)	0.219	(256)	0.039
(185)	0.25	(203)	0.163	(221)	0.099	(239)	0.163	(257)	0.039
(186)	0.219	(204)	0.163	(222)	0.097	(240)	0.139	(258)	0.05
(187)	0.25	(205)	0.163	(223)	0.079	(241)	0.097	(259)	0.05
(188)	0.361	(206)	0.163	(224)	0.079	(242)	0.097	(260)	0.05
(189)	0.25	(207)	0.139	(225)	0.064	(243)	0.079	(261)	0.05
(190)	0.219	(208)	0.139	(226)	0.064	(244)	0.079	(262)	0.05
(191)	0.219	(209)	0.117	(227)	0.064	(245)	0.079	(263)	0.064
(192)	0.19	(210)	0.117	(228)	0.064	(246)	0.064	(264)	0.064
(193)	0.25	(211)	0.117	(229)	0.064	(247)	0.05	(265)	0.064
(194)	0.285	(212)	0.117	(230)	0.05	(248)	0.05	(266)	0.05
(195)	0.722	(213)	0.117	(231)	0.064	(249)	0.05	(267)	0.05
(196)	0.361	(214)	0.117	(232)	0.064	(250)	0.05	(268)	0.05
(197)	0.285	(215)	0.117	(233)	0.064	(251)	0.05	(269)	0.039
(198)	0.219	(216)	0.117	(234)	0.079	(252)	0.039	(270)	0.039

(91)	0.039	(109)	2.835	(127)	0.25	(145)	0.163	(163)	1.075
(92)	0.039	(110)	1.617	(128)	0.25	(146)	0.139	(164)	1.421
(93)	0.039	(111)	1.329	(129)	0.219	(147)	0.14	(165)	5.588
(94)	0.039	(112)	1.075	(130)	0.219	(148)	0.139	(166)	0.924
(95)	0.039	(113)	0.998	(131)	0.219	(149)	0.139	(167)	1.241
(96)	0.039	(114)	0.924	(132)	0.219	(150)	0.117	(168)	1.939
(97)	5.039	(115)	0.853	(133)	0.19	(151)	0.322	(169)	0.924
(98)	9.1	(116)	0.786	(134)	0.19	(152)	0.722	(170)	1.075
(99)	9.82	(117)	0.661	(135)	0.18	(153)	0.322	(171)	0.722
(100)	1.827	(118)	0.604	(136)	0.17	(154)	8.07	(172)	0.853
(101)	1.075	(119)	0.404	(137)	0.163	(155)	1.517	(173)	0.449
(102)	0.924	(120)	0.361	(138)	0.163	(156)	0.924	(174)	0.661
(103)	8.4	(121)	0.361	(139)	0.163	(157)	0.604	(175)	0.404
(104)	2.297	(122)	0.322	(140)	0.163	(158)	0.404	(176)	0.449
(105)	0.924	(123)	0.322	(141)	0.163	(159)	0.361	(177)	0.322
(106)	0.604	(124)	0.285	(142)	0.219	(160)	0.361	(178)	0.361
(107)	2.835	(125)	0.285	(143)	0.163	(161)	1.827	(179)	0.322
(108)	3.809	(126)	0.285	(144)	0.163	(162)	13.37	(180)	0.322

(271)	0.039	(289)	0.014	(307)	1E-3	(325)	0	(343)	0
(272)	0.039	(290)	9E-3	(308)	1E-3	(326)	0	(344)	0
(273)	0.029	(291)	9E-3	(309)	1E-3	(327)	0		
(274)	0.039	(292)	9E-3	(310)	1E-3	(328)	0		
(275)	0.029	(293)	9E-3	(311)	1E-3	(329)	0		
(276)	0.039	(294)	5E-3	(312)	1E-3	(330)	0		
(277)	0.029	(295)	5E-3	(313)	1E-3	(331)	0		
(278)	0.039	(296)	5E-3	(314)	1E-3	(332)	0		
(279)	0.029	(297)	5E-3	(315)	1E-3	(333)	0		
(280)	0.039	(298)	2E-3	(316)	0	(334)	0		
(281)	0.029	(299)	2E-3	(317)	1E-3	(335)	0		
(282)	0.021	(300)	5E-3	(318)	1E-3	(336)	0		
(283)	0.021	(301)	2E-3	(319)	1E-3	(337)	0		
(284)	0.021	(302)	2E-3	(320)	0	(338)	0		
(285)	0.021	(303)	2E-3	(321)	0	(339)	0		
(286)	0.014	(304)	2E-3	(322)	0	(340)	0		
(287)	0.02	(305)	2E-3	(323)	0	(341)	0		
(288)	0.014	(306)	2E-3	(324)	0	(342)	0		

River discharge data at 12-hourly intervals for Station: 23B
Period : 4

Variable: SAND5.var1 (length = 360)

(1) 0	(19) 0	(37) 0	(55) 0	(73) 0	(91) 0	(109) 0	(127) 0
(2) 0	(20) 0	(38) 0	(56) 0	(74) 0	(92) 0	(110) 0	(128) 0
(3) 0	(21) 0	(39) 0	(57) 0	(75) 0	(93) 0	(111) 0	(129) 0
(4) 0	(22) 0	(40) 0	(58) 0	(76) 0	(94) 0	(112) 0	(130) 0
(5) 0	(23) 0	(41) 0	(59) 0	(77) 0	(95) 0	(113) 0	(131) 0
(6) 0	(24) 0	(42) 0	(60) 0	(78) 0	(96) 0	(114) 0	(132) 0
(7) 0	(25) 0	(43) 0	(61) 0	(79) 0	(97) 0	(115) 0	(133) 0
(8) 0	(26) 0	(44) 0	(62) 0	(80) 0	(98) 0	(116) 0	(134) 0
(9) 0	(27) 0	(45) 0	(63) 0	(81) 0	(99) 0	(117) 0	(135) 0
(10) 0	(28) 0	(46) 0	(64) 0	(82) 0	(100) 0	(118) 0	(136) 0
(11) 0	(29) 0	(47) 0	(65) 0	(83) 0	(101) 0	(119) 0	(137) 0
(12) 0	(30) 0	(48) 0	(66) 0	(84) 0	(102) 0	(120) 0	(138) 0
(13) 0	(31) 0	(49) 0	(67) 0	(85) 0	(103) 0	(121) 0	(139) 0
(14) 0	(32) 0	(50) 0	(68) 0	(86) 0	(104) 0	(122) 0	(140) 0
(15) 0	(33) 0	(51) 0	(69) 0	(87) 0	(105) 0	(123) 0	(141) 0
(16) 0	(34) 0	(52) 0	(70) 0	(88) 0	(106) 0	(124) 0	(142) 0
(17) 0	(35) 0	(53) 0	(71) 0	(89) 0	(107) 0	(125) 0	(143) 0
(18) 0	(36) 0	(54) 0	(72) 0	(90) 0	(108) 0	(126) 0	(144) 0

(145) 0	(163) 0	(181) 0	(199) 0	(217) 0	(235) 0	(253) 0	(271) 0
(146) 0	(164) 0	(182) 0	(200) 0	(218) 0	(236) 0	(254) 0	(272) 0
(147) 0	(165) 0	(183) 0	(201) 0	(219) 0	(237) 0	(255) 0	(273) 0
(148) 0	(166) 0	(184) 0	(202) 0	(220) 0	(238) 0	(256) 0	(274) 0
(149) 0	(167) 0	(185) 0	(203) 0	(221) 0	(239) 0	(257) 0	(275) 0
(150) 0	(168) 0	(186) 0	(204) 0	(222) 0	(240) 0	(258) 0	(276) 0
(151) 0	(169) 0	(187) 0	(205) 0	(223) 0	(241) 0	(259) 0	(277) 0
(152) 0	(170) 0	(188) 0	(206) 0	(224) 0	(242) 0	(260) 0	(278) 0
(153) 0	(171) 0	(189) 0	(207) 0	(225) 0	(243) 0	(261) 0	(279) 0
(154) 0	(172) 0	(190) 0	(208) 0	(226) 0	(244) 0	(262) 0	(280) 0
(155) 0	(173) 0	(191) 0	(209) 0	(227) 0	(245) 0	(263) 0	(281) 0
(156) 0	(174) 0	(192) 0	(210) 0	(228) 0	(246) 0	(264) 0	(282) 0
(157) 0	(175) 0	(193) 0	(211) 0	(229) 0	(247) 0	(265) 0	(283) 0
(158) 0	(176) 0	(194) 0	(212) 0	(230) 0	(248) 0	(266) 0	(284) 0
(159) 0	(177) 0	(195) 0	(213) 0	(231) 0	(249) 0	(267) 0	(285) 0
(160) 0	(178) 0	(196) 0	(214) 0	(232) 0	(250) 0	(268) 0	(286) 0
(161) 0	(179) 0	(197) 0	(215) 0	(233) 0	(251) 0	(269) 0	(287) 0
(162) 0	(180) 0	(198) 0	(216) 0	(234) 0	(252) 0	(270) 0	(288) 0

(289) 0	(307) 0	(325) 0	(343) 0
(290) 0	(308) 0	(326) 0	(344) 0
(291) 0	(309) 0	(327) 0	(345) 0
(292) 0	(310) 0	(328) 0	(346) 0
(293) 0	(311) 0	(329) 0	(347) 0
(294) 0	(312) 0	(330) 0	(348) 0
(295) 0	(313) 0	(331) 0	(349) 0
(296) 0	(314) 0	(332) 0	(350) 0
(297) 0	(315) 0	(333) 0	(351) 0
(298) 0	(316) 0	(334) 0	(352) 0
(299) 0	(317) 0	(335) 0	(353) 0
(300) 0	(318) 0	(336) 0	(354) 0
(301) 0	(319) 0	(337) 0	(355) 0
(302) 0	(320) 0	(338) 0	(356) 0
(303) 0	(321) 0	(339) 0	(357) 0
(304) 0	(322) 0	(340) 0	(358) 0
(305) 0	(323) 0	(341) 0	(359) 0
(306) 0	(324) 0	(342) 0	(360) 0

River discharge data at 12-hourly intervals for Station: 23B
Period : 5

Variable: SAND6.var1 (length = 360)

(1)	0	(19)	2E-3	(37)	1E-3	(55)	2E-3	(73)	2E-3
(2)	0	(20)	2E-3	(38)	1E-3	(56)	1E-3	(74)	5E-3
(3)	0	(21)	2E-3	(39)	1E-3	(57)	5E-3	(75)	2E-3
(4)	0	(22)	2E-3	(40)	1E-3	(58)	2E-3	(76)	2E-3
(5)	0	(23)	1E-3	(41)	1E-3	(59)	2E-3	(77)	1E-3
(6)	0	(24)	2E-3	(42)	1E-3	(60)	2E-3	(78)	2E-3
(7)	0	(25)	1E-3	(43)	1E-3	(61)	2E-3	(79)	2E-3
(8)	0	(26)	2E-3	(44)	1E-3	(62)	2E-3	(80)	2E-3
(9)	0	(27)	1E-3	(45)	1E-3	(63)	2E-3	(81)	2E-3
(10)	2E-3	(28)	2E-3	(46)	1E-3	(64)	1E-3	(82)	2E-3
(11)	2E-3	(29)	1E-3	(47)	1E-3	(65)	1E-3	(83)	2E-3
(12)	2E-3	(30)	2E-3	(48)	1E-3	(66)	1E-3	(84)	2E-3
(13)	2E-3	(31)	1E-3	(49)	1E-3	(67)	1E-3	(85)	1E-3
(14)	5E-3	(32)	1E-3	(50)	5E-3	(68)	1E-3	(86)	2E-3
(15)	2E-3	(33)	1E-3	(51)	2E-3	(69)	1E-3	(87)	5E-3
(16)	2E-3	(34)	1E-3	(52)	2E-3	(70)	1E-3	(88)	2E-3
(17)	2E-3	(35)	1E-3	(53)	2E-3	(71)	1E-3	(89)	2E-3
(18)	5E-3	(36)	1E-3	(54)	1E-3	(72)	1E-3	(90)	2E-3

(181)	0.021	(199)	0.139	(217)	0.163	(235)	0.097	(253)	0.05
(182)	0.029	(200)	0.139	(218)	0.163	(236)	0.219	(254)	0.05
(183)	0.05	(201)	0.17	(219)	0.139	(237)	0.139	(255)	0.05
(184)	5.039	(202)	0.139	(220)	0.139	(238)	0.139	(256)	0.05
(185)	3.184	(203)	0.604	(221)	0.117	(239)	0.097	(257)	0.05
(186)	1.421	(204)	6.772	(222)	0.17	(240)	0.097	(258)	0.05
(187)	3.809	(205)	1.241	(223)	0.117	(241)	0.07	(259)	0.097
(188)	0.786	(206)	0.661	(224)	0.117	(242)	0.079	(260)	0.285
(189)	0.722	(207)	0.498	(225)	0.117	(243)	0.064	(261)	0.322
(190)	0.361	(208)	1.156	(226)	0.117	(244)	0.064	(262)	0.25
(191)	0.285	(209)	0.549	(227)	0.097	(245)	0.064	(263)	0.163
(192)	0.219	(210)	0.404	(228)	0.097	(246)	0.064	(264)	0.117
(193)	0.19	(211)	0.322	(229)	0.097	(247)	0.05	(265)	0.097
(194)	0.163	(212)	0.285	(230)	0.097	(248)	0.05	(266)	0.079
(195)	0.139	(213)	0.25	(231)	0.097	(249)	0.05	(267)	0.079
(196)	0.219	(214)	0.25	(232)	0.079	(250)	0.05	(268)	0.079
(197)	0.219	(215)	0.19	(233)	0.079	(251)	0.05	(269)	0.064
(198)	0.163	(216)	0.19	(234)	0.079	(252)	0.05	(270)	0.06

(91)	2E-3	(109)	1E-3	(127)	2E-3	(145)	0.163	(163)	0.117
(92)	2E-3	(110)	1E-3	(128)	2E-3	(146)	0.097	(164)	0.079
(93)	2E-3	(111)	5E-3	(129)	2E-3	(147)	0.219	(165)	0.079
(94)	5E-3	(112)	2E-3	(130)	2E-3	(148)	0.235	(166)	0.139
(95)	0.029	(113)	2E-3	(131)	2E-3	(149)	0.361	(167)	0.139
(96)	0.014	(114)	2E-3	(132)	2E-3	(150)	0.285	(168)	0.079
(97)	0.05	(115)	5E-3	(133)	2E-3	(151)	0.139	(169)	0.064
(98)	5E-3	(116)	5E-3	(134)	0.021	(152)	0.097	(170)	0.05
(99)	5E-3	(117)	9E-3	(135)	0.498	(153)	0.079	(171)	0.039
(100)	2E-3	(118)	5E-3	(136)	0.163	(154)	0.064	(172)	0.039
(101)	2E-3	(119)	5E-3	(137)	0.079	(155)	0.05	(173)	0.039
(102)	2E-3	(120)	5E-3	(138)	0.064	(156)	0.05	(174)	0.029
(103)	2E-3	(121)	5E-3	(139)	0.039	(157)	0.039	(175)	0.029
(104)	2E-3	(122)	2E-3	(140)	0.029	(158)	0.361	(176)	0.029
(105)	2E-3	(123)	2E-3	(141)	0.029	(159)	0.322	(177)	0.029
(106)	2E-3	(124)	2E-3	(142)	0.998	(160)	0.322	(178)	0.029
(107)	2E-3	(125)	2E-3	(143)	0.19	(161)	0.322	(179)	0.021
(108)	1E-3	(126)	2E-3	(144)	0.139	(162)	0.117	(180)	0.021

(271)	0.079	(289)	5E-3	(307)	1E-3	(325)	1E-3	(343)	0
(272)	0.08	(290)	5E-3	(308)	1E-3	(326)	1E-3	(344)	1E-3
(273)	0.064	(291)	5E-3	(309)	1E-3	(327)	1E-3	(345)	0
(274)	0.05	(292)	5E-3	(310)	1E-3	(328)	1E-3	(346)	0
(275)	0.039	(293)	5E-3	(311)	1E-3	(329)	1E-3	(347)	0
(276)	0.039	(294)	5E-3	(312)	2E-3	(330)	1E-3	(348)	0
(277)	0.029	(295)	5E-3	(313)	1E-3	(331)	1E-3	(349)	0
(278)	0.029	(296)	5E-3	(314)	1E-3	(332)	2E-3	(350)	0
(279)	0.029	(297)	5E-3	(315)	1E-3	(333)	2E-3	(351)	0
(280)	0.021	(298)	2E-3	(316)	1E-3	(334)	1E-3	(352)	0
(281)	0.021	(299)	1E-3	(317)	1E-3	(335)	1E-3	(353)	0
(282)	0.021	(300)	1E-3	(318)	1E-3	(336)	1E-3	(354)	0
(283)	0.017	(301)	1E-3	(319)	1E-3	(337)	1E-3	(355)	0
(284)	0.014	(302)	1E-3	(320)	1E-3	(338)	1E-3	(356)	0
(285)	0.014	(303)	1E-3	(321)	1E-3	(339)	1E-3	(357)	0
(286)	0.014	(304)	1E-3	(322)	1E-3	(340)	1E-3	(358)	0
(287)	9E-3	(305)	1E-3	(323)	1E-3	(341)	0	(359)	0
(288)	9E-3	(306)	1E-3	(324)	1E-3	(342)	1E-3	(360)	0

River discharge data at 12-hourly intervals for Station: 23B
Period : 6

Variable: DRIE1.var1 (length = 360)

(1)	1.95	(19)	0.512	(37)	2.21	(55)	2.94	(73)	1.26
(2)	1.97	(20)	0.6	(38)	2.37	(56)	3.7	(74)	1.1
(3)	1.73	(21)	0.427	(39)	2.1	(57)	2.02	(75)	0.96
(4)	2.02	(22)	0.469	(40)	2.28	(58)	2.6	(76)	0.96
(5)	1.73	(23)	0.348	(41)	2.74	(59)	1.46	(77)	1.02
(6)	1.66	(24)	0.427	(42)	2.55	(60)	1.8	(78)	1.02
(7)	2.55	(25)	0.311	(43)	2.37	(61)	1.2	(79)	0.96
(8)	2.1	(26)	0.36	(44)	2.74	(62)	1.33	(80)	0.96
(9)	2.55	(27)	0.209	(45)	1.87	(63)	1.2	(81)	0.85
(10)	2.55	(28)	0.275	(46)	2.06	(64)	1.2	(82)	0.85
(11)	1.95	(29)	0.96	(47)	1.46	(65)	1.14	(83)	0.75
(12)	2.21	(30)	0.22	(48)	1.66	(66)	1.2	(84)	0.85
(13)	1.46	(31)	1.39	(49)	1.33	(67)	1.14	(85)	0.91
(14)	1.73	(32)	1.33	(50)	1.39	(68)	1.38	(86)	0.88
(15)	0.96	(33)	1.59	(51)	4.74	(69)	1.66	(87)	0.75
(16)	1.33	(34)	1.49	(52)	1.33	(70)	1.75	(88)	0.85
(17)	0.7	(35)	2.21	(53)	4.04	(71)	1.59	(89)	0.56
(18)	0.85	(36)	1.8	(54)	4.5	(72)	1.5	(90)	0.56

(91)	0.469	(109)	1.93	(127)	1.46	(145)	1.8	(163)	1.08
(92)	0.48	(110)	1.8	(128)	1.42	(146)	1.84	(164)	0.99
(93)	0.469	(111)	1.59	(129)	1.26	(147)	1.87	(165)	0.85
(94)	0.52	(112)	1.46	(130)	1.26	(148)	1.95	(166)	0.77
(95)	0.469	(113)	1.14	(131)	1.2	(149)	1.87	(167)	0.512
(96)	0.47	(114)	1.02	(132)	1.49	(150)	1.95	(168)	0.44
(97)	0.512	(115)	0.8	(133)	1.73	(151)	1.95	(169)	0.311
(98)	0.51	(116)	0.77	(134)	1.74	(152)	2.1	(170)	0.311
(99)	0.56	(117)	0.65	(135)	1.73	(153)	2.21	(171)	0.209
(100)	0.56	(118)	0.67	(136)	1.87	(154)	2.37	(172)	0.311
(101)	0.56	(119)	0.7	(137)	2.02	(155)	2.37	(173)	0.242
(102)	0.53	(120)	0.82	(138)	2.15	(156)	2.37	(174)	0.275
(103)	0.469	(121)	1.08	(139)	2.1	(157)	2.02	(175)	0.275
(104)	0.56	(122)	1.2	(140)	2.21	(158)	1.8	(176)	0.179
(105)	1.39	(123)	1.33	(141)	2.1	(159)	1.46	(177)	0.151
(106)	2.37	(124)	1.42	(142)	2.1	(160)	1.46	(178)	0.22
(107)	2.55	(125)	1.52	(143)	1.95	(161)	1.33	(179)	0.209
(108)	2.2	(126)	1.55	(144)	1.95	(162)	1.23	(180)	0.24

(181)	0.242	(199)	1.46	(217)	1.66	(235)	0.8	(253)	2.94
(182)	0.35	(200)	1.52	(218)	1.73	(236)	0.75	(254)	3
(183)	0.427	(201)	1.59	(219)	4.04	(237)	0.6	(255)	2.94
(184)	0.512	(202)	1.66	(220)	6.4	(238)	0.56	(256)	2.94
(185)	0.56	(203)	1.66	(221)	5.4	(239)	0.512	(257)	2.21
(186)	0.65	(204)	1.72	(222)	5.9	(240)	0.47	(258)	2.06
(187)	0.75	(205)	1.8	(223)	4.38	(241)	0.427	(259)	1.8
(188)	0.8	(206)	2.08	(224)	3.42	(242)	0.427	(260)	1.73
(189)	0.85	(207)	2.02	(225)	2.74	(243)	0.6	(261	1.59
(190)	0.93	(208)	2.02	(226)	2.38	(244)	0.87	(262)	1.55
(191)	0.96	(209)	1.59	(227)	2.02	(245)	1.2	(263)	1.52
(192)	1.02	(210)	1.59	(228)	1.83	(246)	1.26	(264)	1.49
(193)	0.91	(211)	1.46	(229)	1.52	(247)	1.33	(265)	1.33
(194)	1	(212)	1.46	(230)	1.46	(248)	1.46	(266)	1.33
(195)	1.2	(213)	1.33	(231)	1.35	(249)	1.59	(267)	1.26
(196)	1.36	(214)	1.35	(232)	1.2	(250)	1.58	(268)	1.26
(197)	1.39	(215)	1.39	(233)	1.02	(251)	1.95	(269)	1.2
(198)	1.46	(216)	1.47	(234)	1.02	(252)	2.22	(270)	1.23

(271)	1.2	(289)	1.08	(307)	1.26	(325)	2.74	(343)	232
(272)	1.23	(290)	1.14	(308)	1.39	(326)	2.37	(344)	23.3
(273)	1.39	(291)	1.14	(309)	1.2	(327)	2.55	(345)	232
(274)	1.46	(292)	1.2	(310)	1.2	(328)	2.74	(346)	172
(275)	1.46	(293)	1.14	(311)	1.14	(329)	5.13	(347)	424
(276)	1.46	(294)	1.1	(312)	1.2	(330)	10.4	(348)	500
(277)	1.66	(295)	1.08	(313)	1.52	(331)	16.2	(349)	424
(278)	1.8	(296)	1.2	(314)	1.14	(332)	3.3	(350)	442
(279)	1.39	(297)	1.73	(315)	5.13	(333)	16.2	(351)	232
(280)	1.2	(298)	1.85	(316)	5.13	(334)	22.7	(352)	323
(281)	0.85	(299)	1.8	(317)	4.38	(335)	8.5	(353)	166
(282)	0.82	(300)	1.74	(318)	4.5	(336)	11.9	(354)	192
(283)	0.65	(301)	1.66	(319)	3.15	(337)	6.9	(355)	83.9
(284)	0.6	(302)	1.59	(320)	3.7	(338)	7.4	(356)	120.6
(285)	0.6	(303)	1.52	(321)	2.74	(339)	6.4	(357)	46.6
(286)	0.6	(304)	1.46	(322)	2.94	(340)	6.4	(358)	60
(287)	0.65	(305)	1.39	(323)	2.55	(341)	6.4	(359)	33.9
(288)	0.85	(306)	1.39	(324)	2.55	(342)	8.25	(360)	37.7

River discharge data at 12-hourly intervals for Station: 23D
Period : 1

Variable: DRIE2.vari (length = 360)

(1)	33.9	(19)	12.7	(37)	9.8	(55)	6.9	(73)	5.97
(2)	29.8	(20)	11.9	(38)	9.1	(56)	6.7	(74)	6
(3)	27.1	(21)	11.9	(39)	9.1	(57)	6.4	(75)	5.54
(4)	25.2	(22)	11.1	(40)	8.5	(58)	6.4	(76)	6
(5)	23.3	(23)	11.1	(41)	8.5	(59)	6.4	(77)	6.4
(6)	22.7	(24)	10.4	(42)	8	(60)	6.4	(78)	6.9
(7)	21.5	(25)	10.4	(43)	8	(61)	6.4	(79)	8
(8)	20.4	(26)	10.4	(44)	8	(62)	6.4	(80)	27.8
(9)	18.2	(27)	10.4	(45)	8	(63)	6.4	(81)	135
(10)	18.2	(28)	9.8	(46)	8	(64)	6.4	(82)	146
(11)	18.2	(29)	9.8	(47)	7.4	(65)	6.4	(83)	187
(12)	17.1	(30)	9.8	(48)	7.4	(66)	6.4	(84)	167
(13)	18.2	(31)	11.1	(49)	7.4	(67)	6.4	(85)	124
(14)	18.2	(32)	11.1	(50)	7.4	(68)	6	(86)	76.2
(15)	17.1	(33)	11.9	(51)	7.4	(69)	6.4	(87)	49
(16)	16.2	(34)	11.9	(52)	6.9	(70)	6	(88)	36
(17)	15.2	(35)	11.1	(53)	6.9	(71)	6.4	(89)	29.8
(18)	13.5	(36)	10.4	(54)	6.9	(72)	6	(90)	27.8

(91)	27.1	(109)	180	(127)	25.2	(145)	14.3	(163)	24
(92)	25.8	(110)	171	(128)	24	(146)	13.5	(164)	23.3
(93)	25.8	(111)	104	(129)	24	(147)	21.5	(165)	22.7
(94)	25.2	(112)	55.15	(130)	23.3	(148)	25.2	(166)	22.1
(95)	23.2	(113)	45	(131)	22.7	(149)	24.6	(167)	22.1
(96)	22.1	(114)	38.2	(132)	22.1	(150)	112	(168)	24
(97)	20.4	(115)	34.6	(133)	22.1	(151)	105.3	(169)	22.7
(98)	18.2	(116)	35.9	(134)	21.5	(152)	120	(170)	22.1
(99)	18.2	(117)	33.9	(135)	20.4	(153)	147	(171)	22.1
(100)	16.2	(118)	44	(136)	20.4	(154)	97	(172)	21.5
(101)	15.2	(119)	50.6	(137)	19.2	(155)	62.5	(173)	20.4
(102)	14.3	(120)	44	(138)	19.2	(156)	47.4	(174)	19.2
(103)	14.3	(121)	36.7	(139)	18.2	(157)	38.2	(175)	18.2
(104)	14.3	(122)	32.5	(140)	17.1	(158)	32.5	(176)	17.1
(105)	23.3	(123)	30.4	(141)	17.1	(159)	29.1	(177)	17.1
(106)	31.8	(124)	29.1	(142)	16.2	(160)	27.8	(178)	16.2
(107)	147	(125)	27.8	(143)	16.2	(161)	25.8	(179)	16.2
(108)	143	(126)	27.1	(144)	15.2	(162)	25.2	(180)	15.2

(181)	15.2	(199)	9.8	(217)	139	(235)	29.8	(253)	13.5
(182)	13.6	(200)	9.1	(218)	143	(236)	28.4	(254)	12.7
(183)	13.5	(201)	9.1	(219)	147	(237)	26.5	(255)	12.7
(184)	13.5	(202)	8.5	(220)	178	(238)	24.6	(256)	12.7
(185)	13.5	(203)	8.5	(221)	163	(239)	22.7	(257)	12.7
(186)	12.7	(204)	8.5	(222)	147	(240)	22.1	(258)	12.7
(187)	12.7	(205)	9.1	(223)	167	(241)	21.5	(259)	12.7
(188)	12.7	(206)	9.8	(224)	137	(242)	20.4	(260)	11.9
(189)	12.7	(207)	9.8	(225)	105.2	(243)	22.1	(261)	11.9
(190)	11.9	(208)	11.1	(226)	77.1	(244)	23.3	(262)	11.1
(191)	11.9	(209)	19.2	(227)	62.5	(245)	23.3	(263)	11.1
(192)	11.9	(210)	22.9	(228)	55.6	(246)	22.1	(264)	11.1
(193)	11.9	(211)	129	(229)	50.6	(247)	20.4	(265)	11.1
(194)	11.7	(212)	205	(230)	48.2	(248)	18.2	(266)	11.1
(195)	11.1	(213)	153	(231)	42.7	(249)	17.1	(267)	11.1
(196)	10.7	(214)	146	(232)	35.3	(250)	16.2	(268)	11.9
(197)	10.4	(215)	232	(233)	33.2	(251)	15.2	(269)	12.7
(198)	10.4	(216)	176	(234)	36.7	(252)	14.3	(270)	12.7

(271)	14.3	(289)	25.2	(307)	11.1	(325)	7.4	(343)	3.72
(272)	52.2	(290)	24.6	(308)	10.4	(326)	7.4	(344)	3.4
(273)	59	(291)	23.3	(309)	9.8	(327)	7.4	(345)	3.15
(274)	108	(292)	22.7	(310)	9.1	(328)	6.9	(346)	2.94
(275)	235	(293)	23.3	(311)	9.1	(329)	6.9	(347)	2.94
(276)	181	(294)	22.1	(312)	8.5	(330)	6.4	(348)	2.74
(277)	153	(295)	20.4	(313)	8.5	(331)	6.4	(349)	2.74
(278)	147	(296)	17.1	(314)	8	(332)	6.4	(350)	2.55
(279)	112.9	(297)	16.2	(315)	8	(333)	6.4	(351)	2.55
(280)	77.1	(298)	14.3	(316)	7.4	(334)	6.4	(352)	2.55
(281)	57.3	(299)	12.7	(317)	8	(335)	6.4	(353)	2.55
(282)	49	(300)	12.7	(318)	7.4	(336)	5.54	(354)	2.55
(283)	42.7	(301)	12.7	(319)	7.4	(337)	5.54	(355)	2.37
(284)	41.2	(302)	11.9	(320)	7.3	(338)	5.54	(356)	2.1
(285)	33.2	(303)	11.1	(321)	8	(339)	5.13	(357)	1.95
(286)	27.8	(304)	11.1	(322)	8	(340)	4.74	(358)	1.8
(287)	26.5	(305)	11.1	(323)	8	(341)	4.38	(359)	1.73
(288)	25.8	(306)	11.1	(324)	8	(342)	4.04	(360)	1.66

River discharge data at 12-hourly intervals for Station: 23D
Period : 2

Variable: DRIE3.var1 (length = 360)

(1)	1.59	(19)	1.87	(37)	10.4	(55)	1.46	(73)	8.5
(2)	1.52	(20)	1.95	(38)	10.4	(56)	1.59	(74)	7.4
(3)	1.43	(21)	1.8	(39)	8.5	(57)	1.66	(75)	6.4
(4)	1.33	(22)	1.52	(40)	6.9	(58)	1.73	(76)	6.4
(5)	1.26	(23)	1.33	(41)	6	(59)	2.15	(77)	6
(6)	1.26	(24)	1.08	(42)	5.54	(60)	2.74	(78)	5.54
(7)	1.37	(25)	0.96	(43)	5.13	(61)	6.9	(79)	5.5
(8)	1.33	(26)	0.85	(44)	4.74	(62)	6.4	(80)	5.13
(9)	1.26	(27)	0.85	(45)	3.72	(63)	5.13	(81)	4.7
(10)	1.14	(28)	1.02	(46)	3.42	(64)	6.9	(82)	4.38
(11)	1.08	(29)	1.2	(47)	2.94	(65)	14.3	(83)	4.04
(12)	1.02	(30)	1.26	(48)	2.74	(66)	12.7	(84)	3.42
(13)	1.08	(31)	1.52	(49)	2.21	(67)	26.5	(85)	3.2
(14)	1.08	(32)	1.8	(50)	1.87	(68)	28.4	(86)	2.94
(15)	1.14	(33)	4.04	(51)	1.59	(69)	22.7	(87)	2.9
(16)	1.39	(34)	4.74	(52)	1.33	(70)	16.2	(88)	2.74
(17)	1.52	(35)	5.13	(53)	1.29	(71)	11.9	(89)	2.55
(18)	1.59	(36)	8	(54)	1.33	(72)	9.8	(90)	2.21

(181)	1.39	(199)	0.7	(217)	11.9	(235)	24.6	(253)	7.4
(182)	1.2	(200)	0.65	(218)	9.8	(236)	22.1	(254)	7.4
(183)	1.14	(201)	0.65	(219)	8	(237)	24.6	(255)	6.9
(184)	1.08	(202)	0.6	(220)	6.9	(238)	26.5	(256)	6.4
(185)	1.05	(203)	0.65	(221)	6.9	(239)	28.4	(257)	6.4
(186)	0.96	(204)	0.65	(222)	6.9	(240)	25.8	(258)	5.97
(187)	0.8	(205)	0.75	(223)	6.4	(241)	22	(259)	5.5
(188)	0.7	(206)	0.75	(224)	5.97	(242)	18.2	(260)	5.54
(189)	0.56	(207)	0.91	(225)	5.5	(243)	15.2	(261)	5.13
(190)	0.56	(208)	1.2	(226)	5.13	(244)	12.7	(262)	4.74
(191)	0.56	(209)	17.1	(227)	4.74	(245)	10.4	(263)	3.7
(192)	0.512	(210)	16.2	(228)	4.74	(246)	9.1	(264)	3.42
(193)	0.47	(211)	23.3	(229)	4.04	(247)	8.5	(265)	3.15
(194)	0.512	(212)	32.5	(230)	3.72	(248)	7.4	(266)	2.94
(195)	0.512	(213)	35.3	(231)	3.15	(249)	8	(267)	2.94
(196)	0.6	(214)	31.1	(232)	3.42	(250)	8	(268)	2.94
(197)	0.625	(215)	24.6	(233)	4.04	(251)	8	(269)	2.94
(198)	0.65	(216)	17.1	(234)	5.13	(252)	8	(270)	3.42

(91)	1.87	(109)	1.87	(127)	6.9	(145)	1.2	(163)	1.2
(92)	1.59	(110)	1.46	(128)	5.97	(146)	1.33	(164)	1.2
(93)	1.33	(111)	1.26	(129)	5.13	(147)	1.33	(165)	1.14
(94)	1.14	(112)	1.14	(130)	4.74	(148)	1.2	(166)	1.08
(95)	0.96	(113)	1.26	(131)	3.7	(149)	1.2	(167)	1.02
(96)	0.96	(114)	2.55	(132)	3.15	(150)	1.08	(168)	6.4
(97)	0.91	(115)	2.55	(133)	2.55	(151)	0.96	(169)	8
(98)	1.2	(116)	4.04	(134)	2.21	(152)	0.85	(170)	13.5
(99)	1.87	(117)	4.4	(135)	1.87	(153)	0.8	(171)	10.1
(100)	2.94	(118)	4.04	(136)	1.59	(154)	0.75	(172)	8.5
(101)	2.94	(119)	4.04	(137)	1.46	(155)	0.65	(173)	6.9
(102)	3.15	(120)	4.04	(138)	1.33	(156)	0.65	(174)	5.54
(103)	3.15	(121)	3.72	(139)	1.26	(157)	0.65	(175)	4.4
(104)	3.42	(122)	3.72	(140)	1.26	(158)	0.65	(176)	3.42
(105)	3.72	(123)	4.04	(141)	1.33	(159)	0.6	(177)	2.74
(106)	3.15	(124)	4.04	(142)	1.33	(160)	0.7	(178)	2.21
(107)	2.74	(125)	6	(143)	1.26	(161)	0.96	(179)	1.95
(108)	2.21	(126)	7.4	(144)	1.2	(162)	1.14	(180)	1.59

(271)	3.42	(289)	6.4	(307)	3.72	(325)	8.5	(343)	4.74
(272)	3.42	(290)	5.97	(308)	4.04	(326)	9.1	(344)	4.74
(273)	3.15	(291)	5.54	(309)	4.04	(327)	9.1	(345)	4.74
(274)	2.94	(292)	5.54	(310)	4.74	(328)	8.5	(346)	5.13
(275)	2.74	(293)	5.26	(311)	6.4	(329)	8	(347)	5.13
(276)	2.74	(294)	5.13	(312)	8.5	(330)	7.4	(348)	5.13
(277)	2.94	(295)	4.74	(313)	10.4	(331)	7.4	(349)	4.74
(278)	3.42	(296)	4.74	(314)	9.1	(332)	6.9	(350)	4.74
(279)	8.5	(297)	4.74	(315)	24	(333)	6.4	(351)	4.74
(280)	9.1	(298)	4.74	(316)	27.1	(334)	6.4	(352)	4.74
(281)	6.4	(299)	4.38	(317)	24	(335)	5.97	(353)	4.74
(282)	6.4	(300)	4.04	(318)	20.4	(336)	5.97	(354)	4.74
(283)	8.5	(301)	4.04	(319)	17.1	(337)	5.54	(355)	4.74
(284)	9.8	(302)	4.04	(320)	14.3	(338)	5.54	(356)	4.74
(285)	9.1	(303)	4.04	(321)	11.9	(339)	5.26	(357)	4.38
(286)	8.5	(304)	4.04	(322)	10.4	(340)	5.13	(358)	4.38
(287)	6.9	(305)	3.72	(323)	9.1	(341)	5.13	(359)	4.04
(288)	6.9	(306)	3.72	(324)	8.5	(342)	5.13	(360)	4.04

River discharge data at 12-hourly intervals for Station: 23D
Period : 3

Variable: DRIE4.var1 (length = 344)

(1)	4.04	(19)	19.2	(37)	10.4	(55)	276	(73)	54.7
(2)	3.9	(20)	16.6	(38)	10.4	(56)	244	(74)	53.9
(3)	3.72	(21)	16.2	(39)	9.8	(57)	292	(75)	67.8
(4)	3.9	(22)	27.8	(40)	11.1	(58)	273	(76)	67.8
(5)	3.72	(23)	28.4	(41)	11.1	(59)	191	(77)	52.2
(6)	3.9	(24)	16.2	(42)	11.1	(60)	169	(78)	44.2
(7)	4.04	(25)	14.3	(43)	10.4	(61)	135	(79)	38.2
(8)	4.04	(26)	17.1	(44)	9.8	(62)	129	(80)	35.3
(9)	4.38	(27)	18.2	(45)	9.8	(63)	153	(81)	35.3
(10)	4.74	(28)	16.2	(46)	9.8	(64)	120	(82)	33.9
(11)	63.4	(29)	14.3	(47)	9.8	(65)	89.8	(83)	33.2
(12)	33.9	(30)	12.7	(48)	9.1	(66)	72.4	(84)	31.1
(13)	27.8	(31)	11.9	(49)	9.1	(67)	62.5	(85)	29.8
(14)	45.8	(32)	11.1	(50)	9.1	(68)	57.3	(86)	28.4
(15)	50.6	(33)	10.4	(51)	59	(69)	70.6	(87)	28.4
(16)	36	(34)	10.4	(52)	129.7	(70)	72.4	(88)	28.4
(17)	26.5	(35)	9.8	(53)	72.4	(71)	60.7	(89)	27.8
(18)	22.1	(36)	10.4	(54)	336	(72)	54.7	(90)	26.5

(91)	25.2	(109)	198	(127)	26	(145)	22.1	(163)	307
(92)	24.6	(110)	356	(128)	35.3	(146)	22.1	(164)	389
(93)	23.3	(111)	254	(129)	33.2	(147)	22.1	(165)	247
(94)	22.7	(112)	232	(130)	31.8	(148)	22.1	(166)	239.3
(95)	22.1	(113)	232	(131)	31.1	(149)	21.5	(167)	204
(96)	21.5	(114)	191	(132)	29.1	(150)	18.2	(168)	254
(97)	20.4	(115)	147	(133)	28.4	(151)	18.2	(169)	247
(98)	45.8	(116)	118	(134)	28.1	(152)	19.2	(170)	211
(99)	135	(117)	172	(135)	27.8	(153)	22.7	(171)	239
(100)	479	(118)	82	(136)	26.5	(154)	28.4	(172)	218
(101)	284	(119)	202	(137)	26.5	(155)	40.4	(173)	158
(102)	232	(120)	61.6	(138)	25.2	(156)	101	(174)	112
(103)	292	(121)	57.3	(139)	24.6	(157)	83.9	(175)	90.8
(104)	339	(122)	50.6	(140)	23.3	(158)	96.9	(176)	75
(105)	372	(123)	49	(141)	23.3	(159)	104.3	(177)	63.4
(106)	194	(124)	42.7	(142)	23.3	(160)	77.1	(178)	53.9
(107)	211	(125)	41.2	(143)	23.3	(161)	86.4	(179)	48.2
(108)	232	(126)	38.9	(144)	22.7	(162)	81.9	(180)	44.2

(181)	40.4	(199)	35.3	(217)	18.2	(235)	14.3	(253)	18.2
(182)	40.4	(200)	29.8	(218)	17.1	(236)	35.3	(254)	19.2
(183)	38.2	(201)	29.1	(219)	17.1	(237)	33.9	(255)	19.2
(184)	36.7	(202)	28.4	(220)	17.1	(238)	40.4	(256)	18.2
(185)	35.3	(203)	26.5	(221)	17.1	(239)	40.4	(257)	16.2
(186)	33.9	(204)	24.9	(222)	17.1	(240)	35.3	(258)	16.2
(187)	31.8	(205)	24.6	(223)	16.2	(241)	29.1	(259)	15.2
(188)	30.4	(206)	23.3	(224)	16.2	(242)	26.5	(260)	16.65
(189)	29.8	(207)	22.7	(225)	15.2	(243)	24	(261)	14
(190)	29.4	(208)	22.1	(226)	14.3	(244)	22.1	(262)	18.7
(191)	28.4	(209)	22.1	(227)	14.3	(245)	21.5	(263)	12
(192)	27.8	(210)	21.5	(228)	14.3	(246)	18.7	(264)	19.2
(193)	26.5	(211)	20.4	(229)	14.3	(247)	17.1	(265)	12
(194)	25.8	(212)	20.4	(230)	14.3	(248)	17.1	(266)	19.2
(195)	28.4	(213)	20.4	(231)	13.5	(249)	17.1	(267)	11
(196)	39.7	(214)	19.2	(232)	13.5	(250)	16.2	(268)	19.2
(197)	33.2	(215)	18.2	(233)	13.5	(251)	16.2	(269)	11
(198)	35.3	(216)	18.2	(234)	13.5	(252)	19.2	(270)	19.2

(271)	10.8	(289)	12.7	(307)	11.9	(325)	4.38	(343)	4.74
(272)	19.2	(290)	12.7	(308)	10.4	(326)	4.38	(344)	4.56
(273)	20.4	(291)	11.9	(309)	8.5	(327)	4.38		
(274)	20.95	(292)	11.9	(310)	7.4	(328)	4.38		
(275)	20.4	(293)	11.1	(311)	6.9	(329)	4.38		
(276)	20.4	(294)	11.9	(312)	6.4	(330)	4.38		
(277)	19.2	(295)	10.4	(313)	6.4	(331)	4.38		
(278)	18.2	(296)	9.8	(314)	5.97	(332)	4.04		
(279)	18.2	(297)	8.5	(315)	5.97	(333)	4.04		
(280)	13.9	(298)	8.5	(316)	5.54	(334)	3.42		
(281)	16.2	(299)	8.5	(317)	5.54	(335)	3.15		
(282)	16.2	(300)	8.5	(318)	5.13	(336)	3.42		
(283)	15.2	(301)	8.5	(319)	5.13	(337)	6.4		
(284)	15.2	(302)	8	(320)	4.74	(338)	7.4		
(285)	14.3	(303)	8	(321)	4.38	(339)	6.9		
(286)	14.3	(304)	8	(322)	4.38	(340)	6.4		
(287)	14.3	(305)	8.5	(323)	4.38	(341)	5.54		
(288)	13.5	(306)	10.4	(324)	4.38	(342)	5.13		

River discharge data at 12-hourly intervals for Station: 23D
Period : 4

Variable: DRIES.var1 (length = 360)

(1)	4.56	(19)	1.87	(37)	0.56	(55)	2.1	(73)	1.46
(2)	4.38	(20)	1.59	(38)	0.56	(56)	1	(74)	1.39
(3)	3.7	(21)	1.46	(39)	0.512	(57)	2	(75)	1.2
(4)	3.42	(22)	1.33	(40)	0.512	(58)	1	(76)	0.96
(5)	3.15	(23)	1.2	(41)	0.512	(59)	2	(77)	0.85
(6)	3.42	(24)	1.2	(42)	0.469	(60)	1	(78)	0.75
(7)	3.42	(25)	1.1	(43)	0.469	(61)	2	(79)	0.73
(8)	4.04	(26)	1.02	(44)	0.427	(62)	1	(80)	0.75
(9)	4.04	(27)	0.91	(45)	0.512	(63)	2	(81)	0.7
(10)	3.72	(28)	0.75	(46)	0.56	(64)	1	(82)	0.8
(11)	3.7	(29)	0.7	(47)	0.6	(65)	2	(83)	0.91
(12)	4.04	(30)	0.56	(48)	0.469	(66)	1	(84)	1.2
(13)	4.38	(31)	0.512	(49)	0.387	(67)	2	(85)	1.52
(14)	4.04	(32)	0.427	(50)	0.348	(68)	1	(86)	1.59
(15)	3.72	(33)	0.387	(51)	0.311	(69)	1.14	(87)	1.46
(16)	3.15	(34)	0.387	(52)	0.311	(70)	1.08	(88)	1.33
(17)	2.74	(35)	0.512	(53)	0.275	(71)	0.96	(89)	1.39
(18)	2.21	(36)	0.56	(54)	1.02	(72)	1.14	(90)	1.26

(91)	1.26	(109)	1.7	(127)	0.96	(145)	1.59	(163)	0.96
(92)	1.14	(110)	1.8	(128)	0.85	(146)	1.59	(164)	1.02
(93)	1.14	(111)	2.37	(129)	0.825	(147)	2.1	(165)	0.91
(94)	1.14	(112)	2.02	(130)	0.91	(148)	2.55	(166)	0.8
(95)	1.26	(113)	2.74	(131)	0.96	(149)	2.37	(167)	0.8
(96)	1.39	(114)	2.74	(132)	0.85	(150)	1.95	(168)	0.7
(97)	1.66	(115)	2.74	(133)	0.75	(151)	1.73	(169)	0.7
(98)	1.95	(116)	2.74	(134)	0.65	(152)	1.52	(170)	0.6
(99)	2.21	(117)	2.1	(135)	0.6	(153)	1.33	(171)	0.6
(100)	2.21	(118)	2.37	(136)	0.6	(154)	1.2	(172)	0.512
(101)	2.1	(119)	1.73	(137)	0.56	(155)	1.26	(173)	0.51
(102)	1.95	(120)	1.95	(138)	0.512	(156)	1.33	(174)	0.56
(103)	1.8	(121)	1.52	(139)	0.6	(157)	1.39	(175)	0.7
(104)	1.73	(122)	1.59	(140)	0.6	(158)	1.33	(176)	1.2
(105)	1.59	(123)	1.3	(141)	0.7	(159)	1.2	(177)	1.8
(106)	1.59	(124)	1.39	(142)	1.14	(160)	1.08	(178)	1.87
(107)	1.8	(125)	1.26	(143)	1.59	(161)	0.96	(179)	1.73
(108)	1.95	(126)	1.14	(144)	1.66	(162)	0.96	(180)	1.8

(181)	1.8	(199)	2.1	(217)	1.59	(235)	1.08	(253)	0.7
(182)	1.73	(200)	1.8	(218)	1.52	(236)	1.02	(254)	0.65
(183)	1.73	(201)	1.52	(219)	1.59	(237)	0.96	(255)	0.7
(184)	1.73	(202)	1.46	(220)	1.73	(238)	0.91	(256)	0.85
(185)	1.66	(203)	1.33	(221)	1.87	(239)	0.91	(257)	0.96
(186)	1.52	(204)	1.26	(222)	1.87	(240)	0.96	(258)	0.96
(187)	1.39	(205)	1.26	(223)	2.21	(241)	1.14	(259)	0.85
(188)	1.2	(206)	1.33	(224)	2.74	(242)	1.14	(260)	0.7
(189)	1.08	(207)	1.33	(225)	2.94	(243)	1.14	(261)	0.7
(190)	0.96	(208)	1.33	(226)	3.15	(244)	1.02	(262)	0.65
(191)	0.96	(209)	1.49	(227)	2.94	(245)	0.91	(263)	0.6
(192)	1.33	(210)	1.59	(228)	2.55	(246)	0.9	(264)	0.56
(193)	1.66	(211)	1.73	(229)	2.02	(247)	0.8	(265)	0.58
(194)	1.66	(212)	1.73	(230)	1.66	(248)	0.8	(266)	0.65
(195)	1.91	(213)	1.83	(231)	1.42	(249)	0.75	(267)	0.7
(196)	2.02	(214)	1.66	(232)	1.26	(250)	0.7	(268)	0.91
(197)	2.21	(215)	1.59	(233)	1.2	(251)	0.7	(269)	1.46
(198)	2.21	(216)	1.59	(234)	1.14	(252)	0.65	(270)	1.59

(271)	1.52	(289)	1.73	(307)	1.8	(325)	13.5	(343)	4.38
(272)	1.39	(290)	1.73	(308)	1.73	(326)	16.2	(344)	4.38
(273)	1.33	(291)	1.73	(309)	1.66	(327)	13.5	(345)	4.04
(274)	1.26	(292)	1.8	(310)	1.66	(328)	10.4	(346)	4.04
(275)	1.26	(293)	1.8	(311)	1.66	(329)	8.5	(347)	3.72
(276)	1.2	(294)	5.54	(312)	1.66	(330)	8.5	(348)	3.42
(277)	1.33	(295)	8	(313)	1.66	(331)	22.7	(349)	3.42
(278)	1.39	(296)	6.9	(314)	1.59	(332)	24	(350)	3.42
(279)	1.36	(297)	5.97	(315)	1.52	(333)	18.2	(351)	3.42
(280)	1.26	(298)	5.13	(316)	1.95	(334)	13.5	(352)	3.42
(281)	1.14	(299)	4.38	(317)	4.04	(335)	9.8	(353)	3.42
(282)	1.52	(300)	3.42	(318)	4.38	(336)	8.5	(354)	3.15
(283)	2.74	(301)	3.15	(319)	4.04	(337)	7.4	(355)	3.15
(284)	2.94	(302)	2.74	(320)	4.04	(338)	6.4	(356)	4.04
(285)	2.74	(303)	2.37	(321)	3.72	(339)	5.97	(357)	5.13
(286)	2.21	(304)	2.1	(322)	3.72	(340)	5.54	(358)	5.13
(287)	1.95	(305)	1.95	(323)	3.72	(341)	5.13	(359)	4.74
(288)	1.73	(306)	1.87	(324)	4.38	(342)	4.74	(360)	4.38

River discharge data at 12-hourly intervals for Station: 23D
Period : 5

Variable: DRIE6.b_23dq12_6 (length = 360)

(1)	3.72	(19)	21.5	(37)	6.4	(55)	22.1	(73)	10.4
(2)	3.42	(20)	21.5	(38)	5.77	(56)	17.1	(74)	10.4
(3)	3.15	(21)	16.2	(39)	5.97	(57)	13.5	(75)	9.8
(4)	2.94	(22)	22.1	(40)	5.97	(58)	17.1	(76)	9.8
(5)	2.94	(23)	24.6	(41)	5.54	(59)	25.8	(77)	10.4
(6)	2.74	(24)	22.1	(42)	5.54	(60)	20.4	(78)	11.9
(7)	2.55	(25)	19.2	(43)	5.54	(61)	32.5	(79)	14.3
(8)	2.55	(26)	17.1	(44)	5.13	(62)	46.6	(80)	22.7
(9)	2.55	(27)	14.3	(45)	4.74	(63)	44.2	(81)	40.4
(10)	4.38	(28)	12.7	(46)	4.74	(64)	32.5	(82)	66
(11)	11.9	(29)	11.1	(47)	4.74	(65)	25.8	(83)	57.3
(12)	7.4	(30)	9.8	(48)	4.74	(66)	23.3	(84)	40.4
(13)	15.2	(31)	8.5	(49)	4.38	(67)	22.1	(85)	31.1
(14)	24	(32)	8	(50)	4.74	(68)	19.2	(86)	27.8
(15)	27.1	(33)	8	(51)	4.74	(69)	16.2	(87)	25.2
(16)	30.4	(34)	7.4	(52)	4.74	(70)	14.3	(88)	24
(17)	27.8	(35)	6.9	(53)	5.13	(71)	12.7	(89)	24.6
(18)	23.3	(36)	6.9	(54)	22.7	(72)	11.1	(90)	27.1

(181)	18.2	(199)	71.5	(217)	45.8	(235)	30.4	(253)	26.5
(182)	18.2	(200)	71.5	(218)	42.7	(236)	42.7	(254)	27.5
(183)	21.5	(201)	64.2	(219)	41.2	(237)	78.1	(255)	28.4
(184)	261	(202)	53.1	(220)	38.9	(238)	80.9	(256)	29.1
(185)	424	(203)	56.4	(221)	36.7	(239)	58.1	(257)	27.8
(186)	412	(204)	372	(222)	34.6	(240)	43.5	(258)	26.5
(187)	394	(205)	239.8	(223)	33.9	(241)	33.6	(259)	25.8
(188)	400	(206)	213	(224)	32.5	(242)	29.1	(260)	62.5
(189)	398	(207)	258	(225)	31.8	(243)	28.4	(261)	69.6
(190)	351	(208)	218	(226)	31.1	(244)	29.8	(262)	65.1
(191)	261	(209)	153	(227)	29.8	(245)	29.1	(263)	76.2
(192)	178	(210)	112	(228)	29.8	(246)	27.5	(264)	69.6
(193)	135	(211)	90.8	(229)	29.8	(247)	26.5	(265)	52.2
(194)	108	(212)	76.2	(230)	29.1	(248)	25.8	(266)	40.4
(195)	91.8	(213)	64.2	(231)	29.1	(249)	25.2	(267)	35.3
(196)	83.9	(214)	58.1	(232)	29.8	(250)	25.2	(268)	40.4
(197)	76.2	(215)	53.1	(233)	29.1	(251)	25.2	(269)	48.2
(198)	76.2	(216)	49	(234)	29.8	(252)	25.2	(270)	57.3

(91)	35.3	(109)	20.4	(127)	24	(145)	53.9	(163)	39.7
(92)	38.2	(110)	20.4	(128)	23.3	(146)	68.7	(164)	35.3
(93)	34.6	(111)	20.4	(129)	22.1	(147)	116	(165)	35.3
(94)	67.9	(112)	20.4	(130)	21.5	(148)	108.5	(166)	40.4
(95)	72.4	(113)	19.2	(131)	21.5	(149)	101	(167)	45
(96)	43.5	(114)	24	(132)	24	(150)	82.9	(168)	40.4
(97)	63.4	(115)	32.5	(133)	32.5	(151)	92.8	(169)	34.6
(98)	77.1	(116)	33.2	(134)	37.5	(152)	111.8	(170)	31.8
(99)	57.3	(117)	30.4	(135)	50.6	(153)	105	(171)	29.8
(100)	40.4	(118)	36	(136)	50.6	(154)	80	(172)	28.4
(101)	31.1	(119)	41.9	(137)	77.1	(155)	60.7	(173)	27.8
(102)	28.4	(120)	36	(138)	144.9	(156)	49.8	(174)	26.5
(103)	26.5	(121)	30.4	(139)	122.8	(157)	42.7	(175)	24.6
(104)	25.2	(122)	28.4	(140)	79	(158)	42.7	(176)	23.3
(105)	24	(123)	27.1	(141)	53.9	(159)	52.2	(177)	23.3
(106)	22.7	(124)	26.5	(142)	67.8	(160)	59.9	(178)	22.1
(107)	22.1	(125)	25.2	(143)	173	(161)	59	(179)	20.4
(108)	21.5	(126)	24.6	(144)	83.9	(162)	49.8	(180)	19.2

(271)	96.9	(289)	21.5	(307)	19.2	(325)	8	(343)	5.13
(272)	122.8	(290)	20.4	(308)	10.4	(326)	8	(344)	5.13
(273)	96.9	(291)	19.2	(309)	19.2	(327)	8	(345)	4.74
(274)	65	(292)	18.2	(310)	11.1	(328)	7.4	(346)	4.74
(275)	50.6	(293)	18.2	(311)	11.1	(329)	7.4	(347)	4.38
(276)	41.9	(294)	17.1	(312)	11.1	(330)	7.4	(348)	4.04
(277)	36	(295)	17.1	(313)	11.1	(331)	6.9	(349)	4.04
(278)	33.2	(296)	16.2	(314)	11.1	(332)	6.9	(350)	4.04
(279)	30.4	(297)	16.2	(315)	11.1	(333)	6.4	(351)	4.04
(280)	29.8	(298)	15.2	(316)	10.4	(334)	6.4	(352)	4.04
(281)	29.1	(299)	14.3	(317)	9.8	(335)	6.4	(353)	4.04
(282)	29.1	(300)	14.3	(318)	9.1	(336)	6.4	(354)	4.04
(283)	29.1	(301)	13.5	(319)	9.1	(337)	6.4	(355)	4.04
(284)	29.1	(302)	11.9	(320)	9.1	(338)	6.4	(356)	4.04
(285)	27.1	(303)	11.1	(321)	8.5	(339)	6.4	(357)	3.42
(286)	24.6	(304)	11.1	(322)	8.5	(340)	5.54	(358)	3.42
(287)	22.7	(305)	11.1	(323)	8.5	(341)	5.54	(359)	2.94
(288)	22.1	(306)	10.4	(324)	8	(342)	5.54	(360)	2.74

River discharge data at 12-hourly intervals for Station: 23D
Period : 6