LOW FLOW VERIFICATION

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Definition of Low Flow Verification

My definition of this practice is - " The verification of a model so that it reasonably simulates measured low flows." i.e. those flows which occur during periods when no rain has fallen for some time.

In the past very little attention was paid to this aspect of Verification simply because there was little need for it.

There were two main reasons for this :-

1. The instrumentation available was not accurate enough at low flows for us to have very much confidence in the results.

2. The main problems with which we had to deal were due mostly to flooding and to serious hydraulic overload problems where the base dry weather flows were scarcely relevant.

Reasons for Low Flow Verification

It is likely that now or in the very near future, we will have to look at and model the operation of a very large number of Storm Sewer Overflows (S.S.O's). The performance of these overflows will very likely be judged by their compliance with a laid down standard which will involve the use of time series rainfall.

A large number of these S.S.O's will incorporate low sided weirs and of course their accurate simulation is heavily dependant on the level of the base flow which the design or time series storms are superimposed on. The effect of this is shown in Fig 1 where the effect of increasing the base flow on the amount spilled from a hypothetical catchment is shown. It is clear that the model is very sensitive to small changes in base flow over part of the range and that the effect of small errors in either direction could be critical to compliance.

One problem which will need to be resolved is the definition of which low flow should be used in a simulation. Up to the present the normal criterion has been the Average Dry Weather Flow (DWF), but this is a value which in practice only occurs instantaneously twice a day (Fig 2). The value which has the highest probability of occurrence is the average value between 7 a.m. and 2 p.m. This is the value that Model Solutions Group refer to as High Dry Weather Flow (HDWF) and use to determine compliance and our other criteria. In practice a level of up to 3 times D.W.F. can occur for 8 to 10 hours each day and during this period rainfall has only to reach 3 D.W.F. to overtop an overflow setting of 6 D.W.F.

Using HDWF also has the virtue of being both high in value and thus more accurately measured and occurring at a time when many sites will be visited to retrieve data and so can be easily subject to check measurements.

Improved methods of Low Flow Measurement

The main problem in measuring low flows is that Doppler meters do not function accurately in this regime although the depth measurement transducer is usually much more accurate.

Our hydrometric measurement group Total Flow Surveys have as a matter of routine, always checked the operation and accuracy of their Doppler meters at low flows using a different type of meter such as a small turbine Ottmeter or an electro-magnetic meter. The check is carried out every time data is retrieved and this enables an accurate stage discharge relationship (fig 3) to be built up over the weeks.

A scatter diagram of all the readings for the whole survey is produced (fig 4) and this is used to decide the range for which the Doppler readings were valid. Below that the measured depth and the stage discharge relation are used to determine the flow.

Instruments are improving in accuracy all the time as technology improves and low flow measurement should become easier and more reliable.

The Methodology of Low Flow Verification

The method is very straightforward , all PRN files contain the allocation of D.W.F. to each node which WASSP believes is the most reasonable distribution or where specific values are assigned to particular nodes then these are allocated first and the balance is distributed by WASSP.

At the nodes where flow measurements have been taken, the flows are compared with the model predictions and any discrepancies are resolved by normal verification methods i.e. by checking the assumptions used to build up the model.

We then have a model verified for low flow .

The other advantages of Low Flow Verification

Low flow verification highlights those sewers where excessive inflow and infiltration takes place and this may offer alternative solutions to overflow problems. This again will relate to overflow compliance. An allied study which is well worth carrying out is to determine the way that the minimum night time flows vary with an increasing period without rainfall. This can help to indicate the source of the inflow.

Low flow verification can also be of great assistance when trying to verify catchments where the measured performance of a series of overflows is seriously at variance with the modelled performance. It can lead to an understanding of how the system balances when the overflows are not operating , even allowing for instrument accuracy , and can be extremely valuable in solving these relatively common problems.

A further advantage of using verified low flow values, which we in the Model Solutions Group have used for some years, is to be able to remove base flows from storm events. I described the process in a paper which I gave to a WaPUG meeting in Glasgow some years ago. The effect of doing this is shown by figs 5,6 and 7, it removes a source of uncertainty showing only the effect of the storm on the flow in the sewer.

Although large events are still needed to see how the system reacts to large flows the method allows smaller events to be used in the verification process. The advantage is gained by being able to look at more events during a survey,enabling a consensus to be arrived at from events which vary a good deal in their effect on the system.

Verification in the Future

This is a purely personal view but I feel that our industry, should in the very near future, set up a group of experienced practitioners to address a number of problems which I see looming on the horizon. The foremost one is standardisation, WRC have made a good start on this but I think it must be developed.

The increasing importance of sewer modelling to the Water Industry will demand a move into the field of Quality Assurance, a move which we must be ready for.

The greatly increased workload which is coming and the shortage of experienced practitioners will necessitate firm and well thought out guidelines to help the new practitioners coming into this field.

One the areas which would be very fruitful would be the final standardisation of the data formats provided by flow survey contractors. This would allow groups such as H.R. and W.R.C. to provide a great variety of software which would significantly increase the throughput of work and remove most of the tedious tasks from verification, releasing the experts to concentrate on problem solving.

As I have already indicated Model Solutions Group have gone a long way down this road. We have further developed our software to mechanise most of the tedious tasks although I am not sure how standard our data formats are. Events are automatically extracted and PCD or RED files set up, long sections with surcharge and flooding are produced and modelled and measured data graphed together comparison measures produced.

Another area which must be re-examined is the size and number of events which should be used in a verification, a problem highlighted by the weather this summer. Much more data is now available to the industry and a more practical set of guidelines drawn up.

I hope that this paper will encourage a fresh look at certain aspects of verification which I believe will become increasingly important in the next few years.

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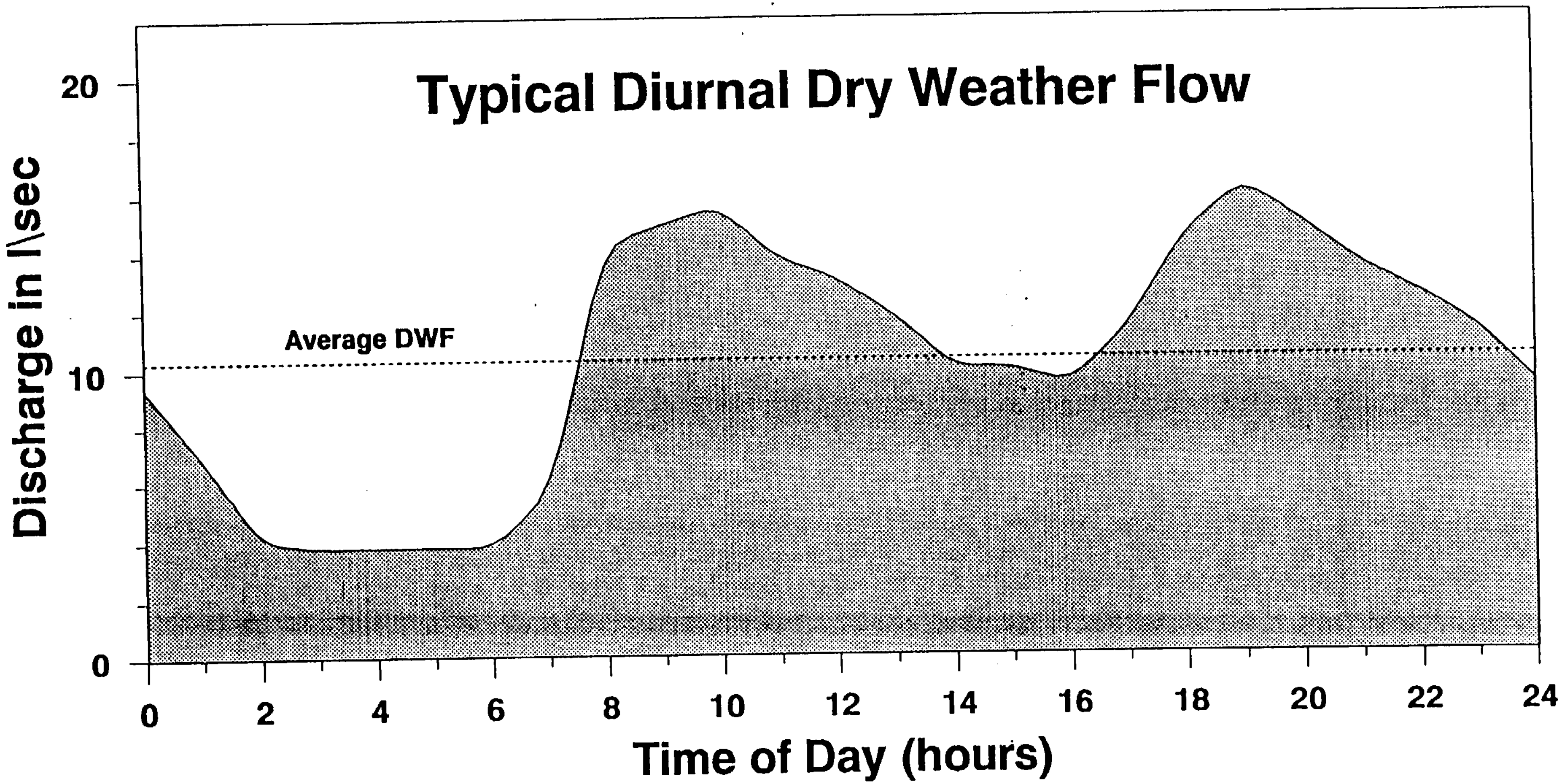

Engineering Quality Solutions

FIG. 1

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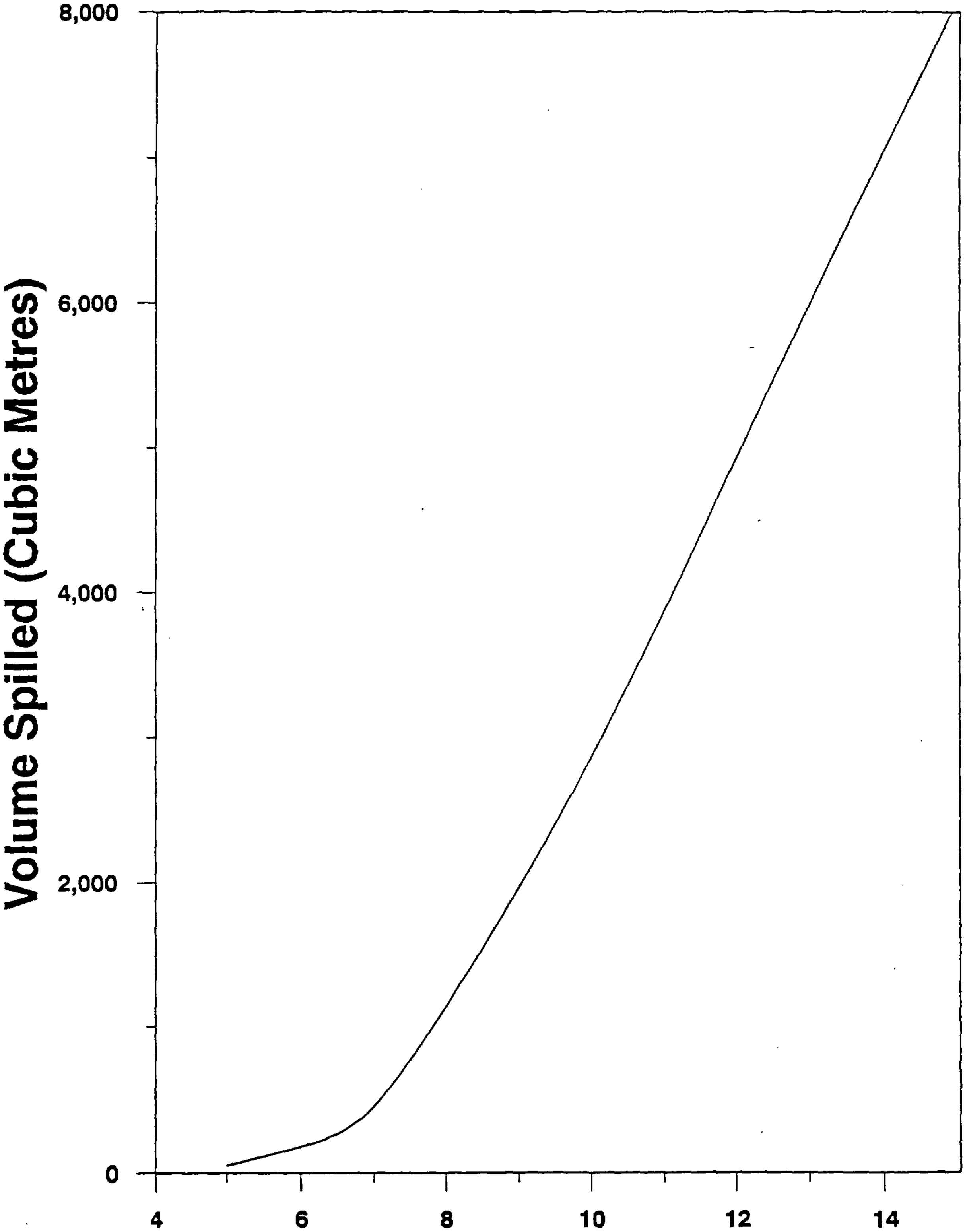

FIG. 2

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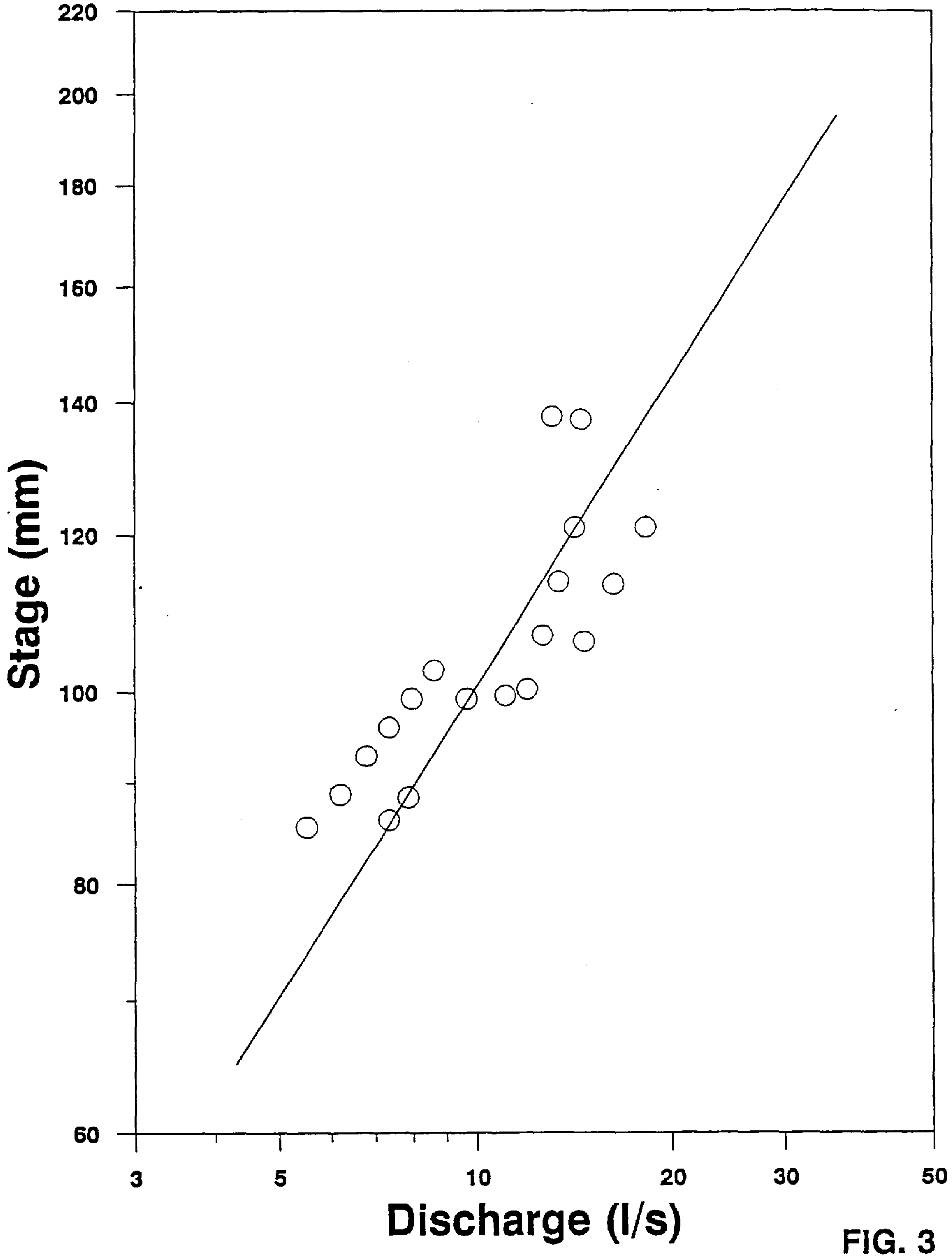

FIG. 3

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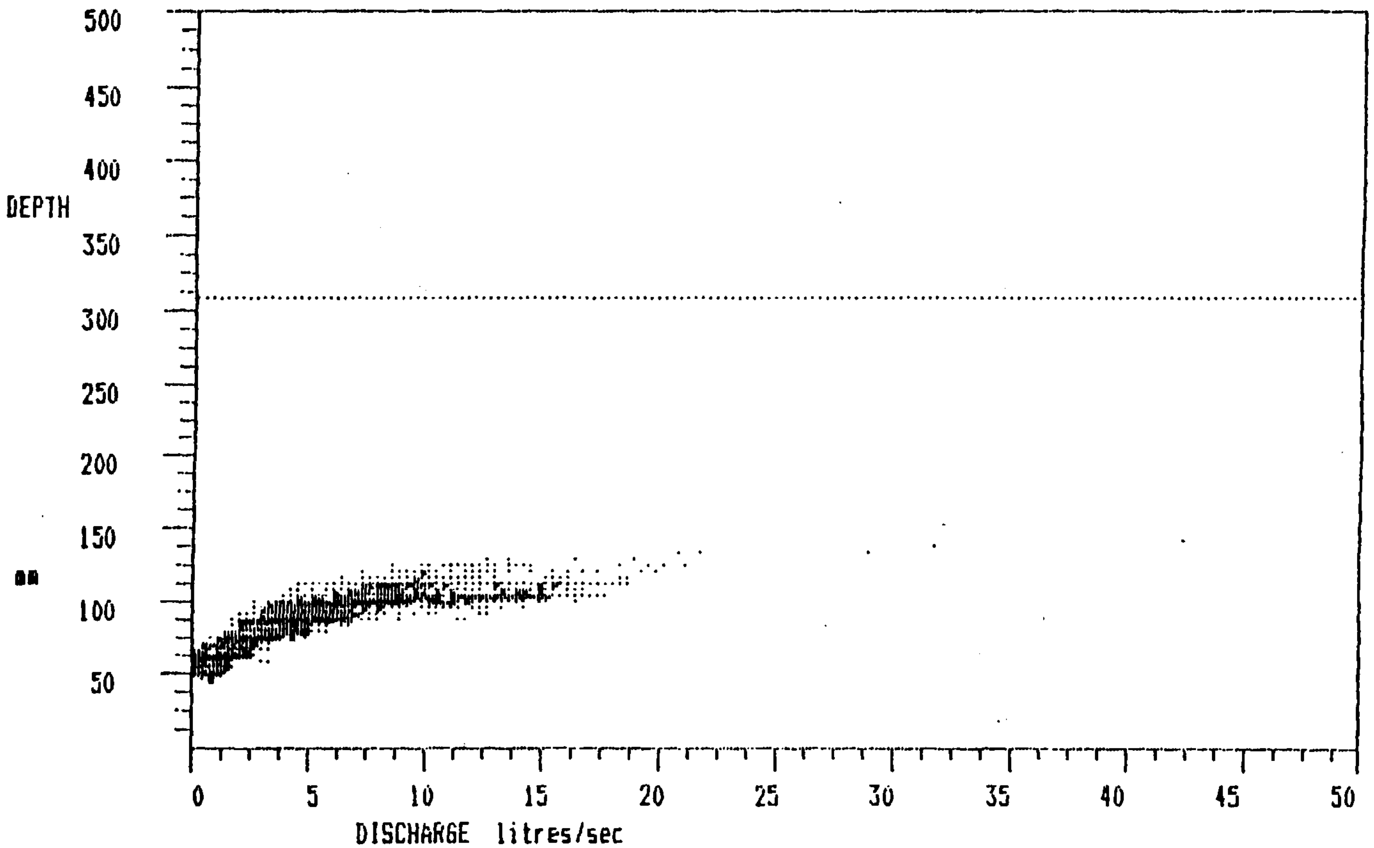

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FIG. 4

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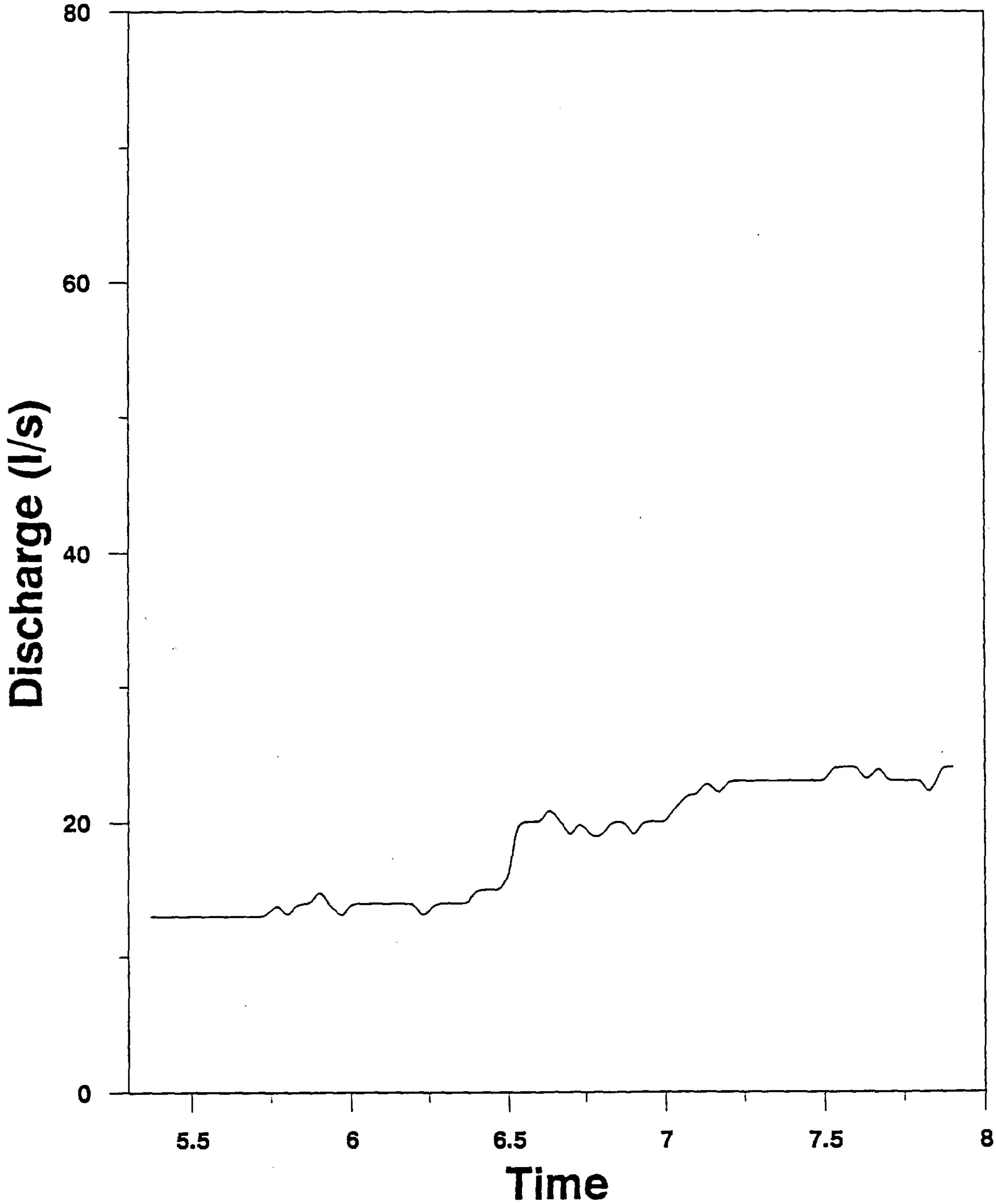

Base Discharge

FIG. 5

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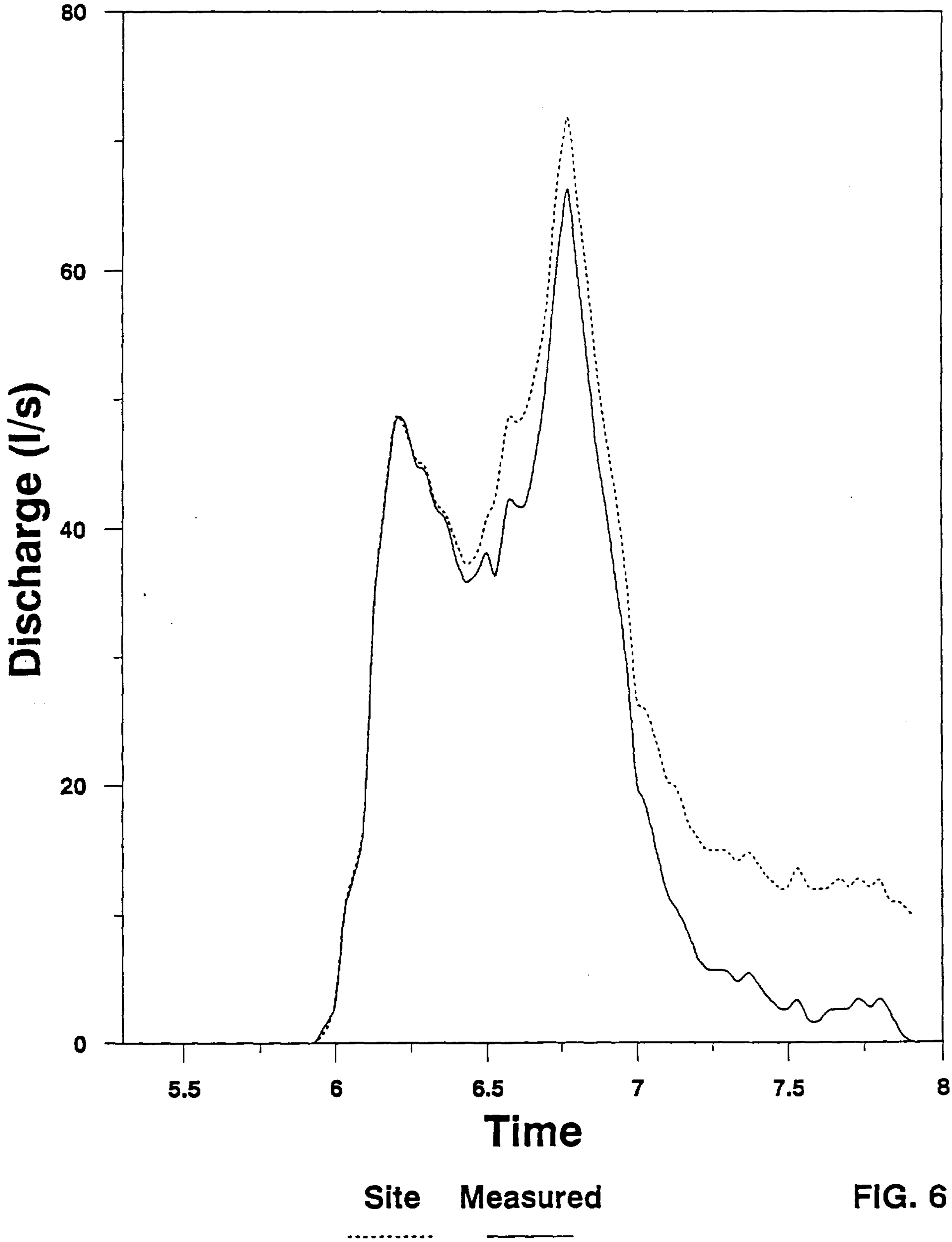

FIG. 6

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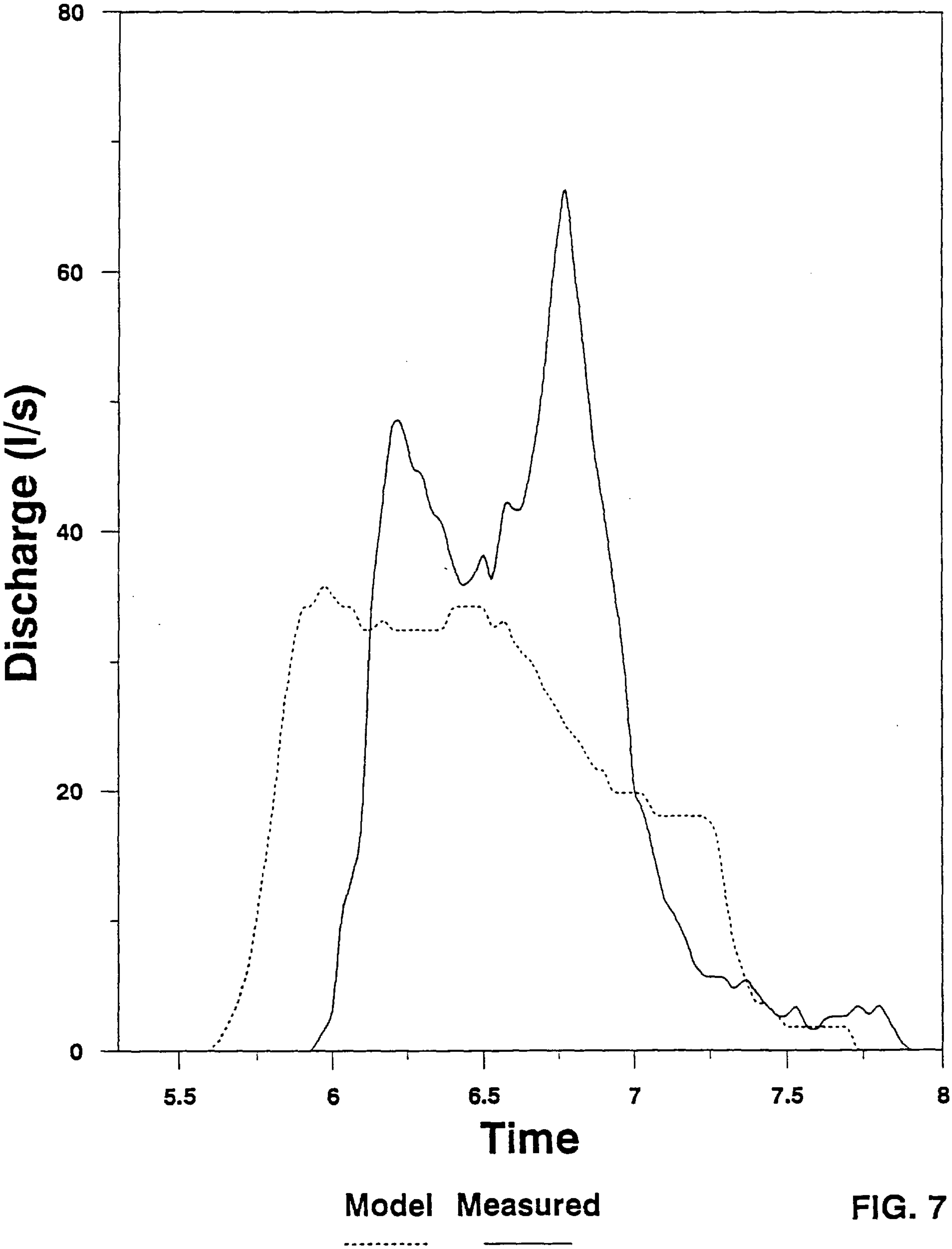

FIG. 7

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