NRA Southern 102

WS Atkins

NRA Southern Region Box 2.

WS ATKINS

Client:	NRA Southern Region 21.61
Project:	Abstraction Licence Determination in the Medway and Rother Catchments
Title:	Review of the Findings of the Prescribed Flow at the Wallers Haven
Date:	June 1995

Job No: K1813 ***Copy No:*** 00 Master
01 File Copy
02 NRA Southern
03 NRA Southern
04 NRA Southern

Document Reference: K1813/61/DG/010

1-D1	Draft for Client						Client
Revision	Purpose Description	Originated	Checked	Reviewed	Authorised	Date	
		WS ATKINS					

CONTENTS

EXECUTIVE SUMMARY

The purpose of this study was to review (i) the prescribed flow setting and (ii) the catchment hydrology and water balance of the Wallers Haven and Pevensey Levels.

South East Water abstract from the Wallers Haven at Hazards Green. The abstraction is controlled by a prescribed flow setting of 3.41Ml/day. This setting is required to ensure sufficient resources for the gravity feeds to the Pevensey Levels over the summer period, maintaining water levels in the ditches.

The prescribed flow cannot be measured conventionally at Hazards Green and the licence states that the flow should be taken as the sum of the gauged flows for the four upstream catchments. South East Water actually apply factors to those flows in order to account for additional inflows to the Haven, downstream of the gauges. NRA data collected in the summers of 1989 and 1993 indicate that South East Water's approach over estimates the flow and reduces, in effect, the prescribed flow by between 1 and 3Ml/d. South East Water also operate six augmentation boreholes. The entire yield from three of these boreholes and 65 per cent of the yield from the other three, is also permitted to be removed from the Haven at Hazards Green. There is no evidence that the augmentation systems are efficient enough to justify this.

In summary, it would appear that the prescribed flow in the Wallers Haven is not being adequately protected in the summer. This is supported by NRA observations.

Previous water balances for the Levels have assumed that transpiration losses from the grass cover are entirely at the expense of the ditches. In fact, summer transpiration losses will be at least part sourced from water storage in the peat. Transpiration is by far the largest loss from the levels so an accurate understanding of the relative contribution from the ditches to this loss is essential to the production of an accurate water balance.

We produced an initial, balance based on limited data, which indicated that the prescribed flow was adequate to meet the direct evaporation losses from the ditches. The outstanding issue is therefore the contribution of the ditches to transpiration from the grass cover.

The Levels can be divided into two areas. The eastern part is fed by the Wallers Haven and is prone to water shortages. The western part is fed by sewage works discharges, where the water resources are sufficient but nutrient enrichment is a problem in the summer.

Recommendations are made to progress with the electromagnetic gauging of the Wallers Haven as a priority. Further work should also be undertaken on the water balance, following completion of the ongoing project by NRA and English Nature.

1.0 INTRODUCTION

In February 1995 NRA Southern Region commissioned WS Atkins (WSA) to carry out six items of work in support of abstraction licence determinations to be made by the NRA. Separate reports are being prepared for each of these items. This report presents our findings with respect to item 4, "Review of the findings of the prescribed flow at the Wallers Haven in East Sussex".

In October 1991 Eastbourne Water Company (now part of South East Water) applied for a variation to their existing surface water abstraction licence from the Wallers Haven at Hazards Green. The application was to increase the annual abstraction from 4500Ml to 8200Ml and the peak daily abstraction from 17Ml to 39Ml. The application was determined by the NRA in September 1994 and refused on the grounds that insufficient resources are available in the river to support the scheme and other water needs. South East Water lodged an appeal against this determination although this appeal has been subsequently withdrawn.

Abstraction from the Wallers Haven is controlled by a prescribed flow, set when a licence was first granted at the site in 1947. The prescribed flow setting is intended to protect the summer transfers from the Wallers Haven into the Pevensey Levels, used to support water levels in the extensive network of ditches.

In November 1993 the NRA produced a report defining the water balance for the Pevensey Levels and this was used in the licence determination. The NRA are currently working on a Water Level Management Strategy for the Levels.

The NRA Project Brief required this report to review:

(a) the prescribed flow setting

(b) catchment hydrology and water balance

As part of this review we have studied the following documents:

- Pevensey Levels Draft Strategy - Consultation Document (NRA leaflet)
- Abstraction of water from Wallers Haven by Bexhill Corporation - Engineers Report (1947)
- Abstraction of water from Wallers Haven by Bexhill Corporation - Engineers Report (1952)
- Flow of Wallers Haven (Oct 12 to Nov 7 1989)
- Water resource balance for the Pevensey Levels catchment (NRA 1993)

- Abstraction licences for the Wallers Haven (see Appendix A)

In addition we have toured the study area and discussed its characteristics with the technical staff at the NRA.

2.0 BACKGROUND

The Wallers Haven and associated Pevensey Levels catchment are shown on Figure 2.1, which also shows the old Southern Water Authority catchment numbering system. The area can be subdivided into three as below:

(i) The Upper Catchment

This comprises four main tributaries of the Wallers Haven, known as Nunningham Stream (1221), Hugletts Stream (1222), Ash Bourne (1223) and Kitchenham Stream (1224). The streams are fed by surface runoff and baseflow from the underlying Ashdown Sands aquifer. These catchments, along with catchment 1220, provide the main inflow to the Wallers Haven.

South East Water abstract from the Wallers Haven at Hazards Green intake, as shown on Figure 2.1. This abstraction is controlled by a prescribed flow condition of 3.41 Ml/day. Six augmentation boreholes, also shown on Figure 2.1, are available in the summer to provide additional stream support to this abstraction from the underlying Ashdown Sands aquifer.

(ii) Pevensey Rim Catchments

These are the small local catchments to the Pevensey Levels, numbered 1210 to 1214, 1310 to 1317 and 1410 to 1412. These catchments provide local runoff to the Levels during the winter. A network of small gauges was installed by the NRA during a recent monitoring exercise and these indicated that the catchments provide minimal water resources to the Levels during the summer months.

A major contribution to the Levels during the summer is provided by the Hailsham North and Hailsham South sewage treatment works which serve the town and the surrounding area and are licensed to discharge a combined dry weather flow of 11.3 Ml/day. These outfalls feed into the western edge of the Levels and provide an additional high nutrient resource.

(iii) Pevensey Levels

The Pevensey Levels cover an area of 21.9 km^2 on both sides of the Wallers Haven. The Levels are used largely for stock grazing and are drained by an extensive network of channels, under the control of the NRA as the IDB for the area.

The Levels are an internationally important wetland supporting many rare plants and animals. The entire Levels are designated as a SSSI and contain local and national nature reserves. The control of water levels in the summer months is an important factor in retaining the character of the wetland.

Until around 20 years ago the Levels used to flood extensively each winter. At this time pumps were installed to drain the wetlands to the Wallers Haven and Pevensey Haven and outfall to the sea.

In the summer water is fed, by gravity, from the Wallers and Pevensey Haven into the Levels to retain water levels as wet fencing for stock control. The NRA control levels by operating this system of pumps, along with an extensive network of stops and gates, in response to requests from the local farming community and English Nature. The sea outfalls are closed, although weir structures allow continued outflows above a certain level.

The requirements of the farmers are to have low water levels in the winter principally to ensure year round use for livestock and controlled water levels in the summer to retain the wet fencing.

The requirements of English Nature are to flood the Levels in the winter, to soften the clay soil sufficiently for birds to feed through the spring, and to retain water in the ditches through the summer to support the wetland flora.

The NRA are undertaking a project, with support from EN and MAFF, to develop a management strategy for the Levels which satisfies both interested parties.

The next two sections of this report review the prescribed flow setting and the water balance for the Levels in more detail.

3.0 WALLERS HAVEN ABSTRACTION AND THE PRESCRIBED FLOW SETTING

3.1 The History of Abstraction Licensing

The Engineer's report of April 1947 presents a review of the proposals of Bexhill Corporation to abstract a maximum of 15000 gallons per hour from the Wallers Haven at Hazards Green. This translates to only 1.6 Ml/day, compared to the present maximum licensed abstraction of 17 Ml/day. In addition, the Corporation originally applied for the licence for a period of two years only with the intention of supplanting this surface source with abstraction from the Ashdown Sands aquifer. This 1947 report provides an assessment of the water balance for the marshes but does not specify the controls on an abstraction licence.

A further report is available from April 1952. This notes that an extensive investigation was made into the requirements of the marsh and, following this, the surplus stream water available for abstraction was agreed between the Corporation and the Inland Drainage Board. This was set into a temporary licence which operated up until 1952. This report proposes that a permanent licence is set for the Hazards Green intake with the following conditions:

(i) the abstraction is of not more than 1080000 gallons per day (4.9 Ml/day)

(ii) the abstraction operates subject to a prescribed flow of 750000 gallons per day (3.4 Ml/day) over a seven day period in the river

(iii) the river flow may be augmented by support boreholes which pump from the Ashdown Sands into Hugletts and Ashbourne tributaries. Abstraction may equal the yield of these boreholes regardless of the stream flow.

(iv) the flow at the Hazards Green intake, controlling the prescribed flow condition, shall be considered as the sum of the flows at the gauging stations on the three main tributaries

(v) if circumstances should arise whereby the prescribed flow of 750000 gallons per day was insufficient for the needs of the Board, then the Board were to give notice to the Corporation specifying the higher rate required

The prescribed flow condition was set to meet the requirements for wet fencing and not, at least explicitly, the ecological needs of the Levels. The means by which the prescribed flow rate was defined are not presented in the report.

There are no additional data or reports available for the intervening period between the 1952 report and October 1983, when the current licences were issued for (i) surface water abstraction from the Wallers Haven at Hazards Green and (ii)

groundwater abstraction for stream support from the Ashdown Sands. The previous prescribed flow condition was retained in this licence.

It would appear that the abstraction proposed in 1952 became disused prior to 1963 as there is no licence of right for this source. The current licences, granted in 1983, are considered in more detail below.

3.2 The Current Abstraction Licences

i) **Abstraction licence 10/41/120302** was issued to Eastbourne Waterworks Co on 3 October 1983 and controls abstraction from the Wallers Haven at Hazards Green. The licence is now operated by South East Water. Two amendments have been issued subsequently for the licence. The licence and amendments are enclosed in Appendix A and the main conditions of the original licence and these amendments are presented below:

Original licence

licensed to abstract 4200 Ml/year and 15 Ml/day

abstraction shall not reduce the flow at Wallers Haven below 3.41 Ml/day (condition i (a))

below a flow of 18.41 Ml/day in Wallers Haven, abstraction shall not exceed the total augmentation from Boreholes 1, 3 and 4 plus 65% of the total from Boreholes 6, 8 and 11. Condition i (b)

The flow at Wallers Haven shall be ascertained by aggregating the measured rates of flow in the Nunningham, Hugletts, Ash Bourne and Kitchenham Streams together with the total quantity of water discharged to the streams by the augmentation boreholes (condition iii).

Note: The flow could not be measured directly at Hazards Green due to the very low flow velocities in the summer.

Licence amendment no. 1 (March 1987)

licensed abstraction increased to 4500 Ml/year and 17 Ml/day

Additional augmentation provided by Cowbeech supply borehole

Licence amendment no. 2 (July 1992)

Augmentation from Cowbeech removed from the licence.

Note: The licensed abstraction increased when Cowbeech was added to the augmentation system, was not reduced when Cowbeech was removed.

ii) **Abstraction licence no. 10/41/122001.** This licence was also issued on 3 October 1983 and controls the operation of the six augmentation boreholes. This licence is also enclosed in Appendix A and the main conditions are provided below:

combined maximum annual licence is 2200 Ml

combined maximum daily licence is 14.5 Ml

iii) **Compliance with licence conditions**

South East Water do not comply with the licence condition specifying the means of ascertaining the flow at Wallers Haven. They have devised the following means of ascertaining the flow:

the flow measured at Coombe Hill on the Kitchenham Stream is multiplied by 1.5

the combined stream flow, including the factored flow above, is multiplied by 1.12

The basis of this equation and its history are not known and there is no correspondence available in NRA to support its use, although South East Water may hold some.

3.3 Review of Abstraction Licence Conditions

This section reviews the conditions detailed above and identifies where these may not be satisfactory.

(i) Prescribed flow setting

The original prescribed flow setting was made as 3.41 Ml/day in 1952 to protect the water transfers to the Levels for wet fencing. It is unlikely that the environmental requirements of the Levels were considered at this time. Nevertheless, a clause in the licence allowed the prescribed flow to be increased if required.

The setting in the 1983 licence was retained as 3.41 Ml/day, but did not provide a clause allowing any increase.

The water requirements of the marshes have never been fully examined, and the validity of the 3.41 Ml/day setting is not known. This issue is considered

further in Section 4 of this report where the water balance for the Levels is reviewed.

(ii) Measurement of the prescribed flow

The summer flow in the Wallers Haven at Hazards Green is at too low a velocity for conventional gauging. In 1952 the flow was calculated by simply combining the flow records from the four upstream gauges. This is still the method specified in the 1983 licence. South East Water operate a more complex equation, however, as detailed above.

In 1989, NRA installed temporary gauging stations on the Wallers Haven and measured the flow on a daily basis over the low flow period from 12 October to 7 November. The actual gauged flows are compared in Figure 3.1 with (a) the calculated flows on the basis of the South East Water equation, and (b) the simple combined flows at the upstream gauges. This shows that

(a) the actual measured flow was an average of 1.4 Ml/day lower than that calculated by the flow equation and 1.0 Ml/day higher than the combined flow.

(b) between 12 and 24 October the difference between the actual and calculated flows, of around 3Ml/d was approximately the same as the prescribed flow (3.41Ml/d). Under these conditions, the actual flow available to the Pevensey Levels would have been essentially zero.

A second set of data were collected for April to September 1993 and presented in the NRA's 1993 water balance report. The data are reproduced as Figures 3.2 to 3.7. These data show a similar story to that in 1989, except that in this case the actual flows were often significantly lower than the prescribed flow.

It would appear therefore that the South East Water flow calculation method tends to overestimate the flow during the lowest flow periods. The NRA are currently investigating the potential for installing an electromagnetic gauging system, capable of measuring very low flow velocities, on the Wallers Haven at Hazards Green intake. In the meantime it may be appropriate to review the current operating rules used by South East Water.

(iii) Incorporation of the stream support flows

The stream support boreholes are licensed to provide up to 14 Ml/day into the Wallers Haven. The Wallers Haven licence allows the additional yield provided by these stream support boreholes to be abstracted at Hazards Green.

The operation of the stream support boreholes will tend to reduce the natural baseflow to the catchment and the borehole yield will not be 100 per cent effective. The nett additional yield is specified in the licence as the total yield from Boreholes 1, 3 and 4 and 65 per cent of the yield from Boreholes 6, 8 and 11.

The basis for this assessment of nett additional yield is not known by NRA. The general concensus is that this may overestimate the effectiveness of the boreholes. It would be possible to interrogate the flow and abstraction data to assess the actual effectiveness of the boreholes but this has not been done to date.

The analysis above indicates that the operating rules used to assess (a) the flow rate and (b) the stream support rate may both lead to the actual flow being reduced below the prescribed flow. This assessment is supported by the observations of NRA personnel during low flow periods, who recorded that

(i) there was often less than the prescribed flow available to release into the Levels and

(ii) the Wallers Haven contains a very large water storage volume; water levels generally fall significantly over the summer months, indicating that supplies are being taken from storage.

The implications of these findings are considered further in Section 4 below.

4.0 THE WATER BALANCE

The components of the water balance for Pevensey Levels are considered in turn below:

Storage

(i) **open water storage in the drainage channels.** There are 150 km of channels in the Levels. The 1947 report recorded a channel width of between 2.5 and 5 metres and a total open water area of 105 hectares. Water depth varies between 0.3 and 1.7m giving an average storage volume of around $1Mm^3$. The storage volume retained in the Levels at the start of summer is controlled by a system of stops and gates.

Farmers will tend to install the water retaining structures later, to minimise the risk of flooding, whereas environmentalists will install structures earlier to maximise water levels.

Storage is depleted in the summer by evaporation and stock watering, and replenished by marsh feeding from the Wallers Haven and inputs from the sewage works.

(ii) **storage in the clays and peat.** Auger holes installed in the Levels, as part of the recent NRA/EN investigation, reveal around a metre of clay, underlain by 1 to 2 metres of peat. The grass cover of the Levels has very long root systems, which penetrate the clays and tap water from the peat in the summer.

Water storage in the clays is depleted by evaporation in the summer and replenished by rainfall in the winter.

Historically, the clays would have been fully saturated each winter by extensive flooding. Folllowing the installation of a pumped drainage system in the Levels this no longer occurs. This change appears to have significantly reduced the saturation of the clays in the spring, often resulting in a hard pan layer which forms a barrier to wildfowl feeding. Reduced access to this food resource to nesting birds in the spring is a major current concern to English Nature.

Water storage in the peat, and the means of replenishment, are not well understood at present. The issue of storage, and storage losses in the peat is considered further in the section on transpiration losses.

Inputs

(i) **Transfers from Wallers Haven.** The transfers are by gravity inflow and are not measured. The transfers feed the eastern half of the Levels directly, as far west as Hurst Haven. As noted in Section 3, a minimum of 3.4 Ml/day should be available for transfer, but recent measurements and analysis indicate that the actual available flow may be significantly lower during low flow periods.

(ii) **Sewage works inflows.** Discharges from Hailsham North and Hailsham South sewage works inflow to small streams directly feeding the Levels, as shown on Figure 2.1. The combined dry weather inflow from the works is 11.3 Ml/day. The actual flows are gauged by Southern Water but not collected by NRA. Nevertheless, NRA consider that the actual summer outflows from the works may be somewhat lower than the dry weather flow.

The discharges feed the western half of the Levels up to around the Hurst Haven. The NRA deliberately try to keep the feeds from the Wallers Haven and the sewage works separate due to the large differences in water quality. NRA and English Nature are concerned as to the impact of the high nutrient waters from the sewage works on the ecology of the Levels.

(iii) **Local runoff.** There are a large number of small catchments around the Levels, as shown in Figure 2.1. Temporary gauges were installed on some of these by the NRA and the recorded summer inflows were minimal.

Outflows

(i) **Evaporation from the open channels.** The nett evaporation loss is the open water evaporation minus the rainfall input. Evaporation exceeds rainfall over much of the summer and, given the large open water area (105 hectares), evaporation losses can be significant.

(ii) **Transpiration from the Levels.** Water storage in the peat, and the means of replenishment, are not well understood at present and are being investigated in a joint NRA/English Nature project. The grass cover to the levels is very old, with extensive root systems which penetrate the clays and tap water from the peat. Transpiration levels from the peat by these grasses are by far the largest outflow from the Levels. The means of replenishing these losses are therefore of fundamental importance to the water balance. There are two basic means available as below:

a) Vertical infiltration through the clays in response to winter rainfall and flooding.

b) Lateral inflow from the drainage ditches in both summer and winter.

Average nett transpiration losses over the summer of 1993 were 35Ml/day for example, compared to direct evaporation losses from the ditches of 1 to 2 Ml/day. Consequently, the division of summer transpiration losses between water storage loss from the peat and lateral transfer from the ditches is the most critical element of the water balance.

Both the water balances produced to date have assumed that the entire transpiration loss is at the expense of the ditches. This is not believed to be correct however, as (i) storage losses (from our basic conceptual understanding), must provide some of the resource and (ii) there is no clear mechanism for the rapid lateral transfer of resources through the low permeability peat.

The ongoing study by NRA and English Nature is investigating this issue in more detail. NRA reported that the work to date indicated that the contribution of the ditches was relatively low. Clearly, the water balance cannot be completed with any degree of confidence until the contribution of the ditches to summer transpiration losses is understood.

(iii) **Stock watering.** The drainage channels are used by the livestock for watering in the summer. The losses due to watering were assessed, in 1952 as, 0.47 Ml/day. On the basis of a unit consumption of around 25l/h/day this corresponds to around 20,000 head. Stock watering losses were not included in the 1993 report.

(iv) **Water level controls.** A complex system of stops and gates retains the water in the summer and releases flows to various parts of the system. The operation of this system is outside the scope of this and previous studies. However, NRA reported that there was scope for improvement in the operation of the initial summer closures and the water retention levels so as to optimise the use of the available resources.

The 1993 NRA report attempts to produce a water balance for the Pevensey Levels on the basis of flow data recorded between April and September 1993. As noted above, the balance is considered to be incorrect as it includes the full transpiration losses being sourced from the Levels. Base data are presented in the report for the sewage inflow and surface water abstraction from the system and these are reproduced below (all data in Ml/day):

	Apr	May	Jun	Jul	Aug	Sep
Effluent Input	10.5	8.2	8.8	8.4	7.5	9.5
Abstraction from Hazards Green	8.6	10.4	10.5	9.5	9.7	8.9
Difference	+1.9	-2.2	-1.7	-1.1	-2.2	+0.6

This water balance indicates that the system is not, in overall terms, that different from the natural flow system. This is because the surface water abstractions at Hazards Green are largely counterbalanced by the sewage works discharges. As noted above however, the inflows from the sewage works are retained in the western part of the Levels due to water quality concerns. Consequently, the water balance for the Levels should be considered in two parts as below:

(i) the eastern part, where inflows are reduced by the upstream Hazards Green abstraction, and resources are limited

(ii) the western part, where resources are generally adequate due to the inflow from the sewage works, and the high nutrient concentrations are the major issue

Evaporation and rainfall data are not available from the NRA report. The data from the 1947 report (taken from the year 1945) provide an indication of the total water losses direct from the drainage channels and are reproduced below (all data in Ml/day:

	Apr	May	Jun	Jul	Aug	Sep
Evaporation - rainfall	-1.0	-0.3	-1.8	0.0	-0.6	+0.9
Stock watering	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Total losses	-1.5	-0.8	-2.3	-0.5	-1.1	+0.4

The total water losses from the open water system, as calculated above, would have been a maximum of 2.3 Ml/day. This is a lower order of magnitude than the transpiration losses (average of around 35Ml/day) and this emphasises the importance of understanding the contribution of the ditches to summer transpiration.

A proper water balance evaluation should be undertaken on completion of the detailed Pevensey Levels investigation, when the relationship between the ditches and the marginal peats is better understood.

The water balance should also be considered in two parts. A conventional water balance is required for the eastern part of the Levels and the balance for the western part should focus on the nutrient concentrations.

5.0 SUMMARY

1 Abstraction at Hazards Green commenced in the late 1940's at a rate of 4.9Ml/day. The prescribed flow setting of 3.4Ml/day was defined at this time. The prescribed flow was set based on the requirement to maintain water levels in the ditches for wet fencing.

2 Abstraction was discontinued, and restarted again in 1983. The current licensed abstraction rates are 4500Ml/year and 17Ml/day. The prescribed flow of 3.4Ml/day was retained.

3 The flow rate at Hazards Green cannot be measured conventionally at present. The licence states that the flow rate will be taken as the sum of the flows in the upstream catchments. South East Water are using a more complex equation, intended to account for downstream inflows. Measurements in 1989 and 1993 indicate that this overestimates low flows by 1 to 3 Ml/day.

4 Augmentation flows are provided by six boreholes in the upper reaches. The effectiveness of these boreholes is specified in the licence and used to control the abstraction from Hazards Green during low flows. The effectiveness is specified as 100 per cent for three boreholes and 65 per cent for the other three. There are no data to indicate whether this is an accurate assessment of the effectiveness of the stream support and the first impression is that it may be an overestimate.

5 Points 3 and 4 both indicate that the prescribed flow is not maintained during low flow conditions. NRA report that water levels fall in the Wallers Haven in the summer, indicating losses from storage, and that there is insufficient water to support the Levels during low flow periods.

6 The NRA produced a water level balance for the Levels in 1993. The balance assumed that transpiration from the Levels is entirely at the expense of water stored in the ditches. Further work currently being undertaken by NRA and English Nature indicates that this, in general, is incorrect. Transpiration losses are the major outflow from the levels in the summer. Understanding the relative contributions of peat water storage and the ditches is an essential pre-requisite of producing a reasonable water balance.

7 A partial water balance has been undertaken in this report, using limited data. This indicates that the direct losses from the ditches are of the same order as the prescribed flow, suggesting that this prescribed flow is adequate for this purpose. A full water balance is required on completion of the NRA/English Nature study.

8 The Levels can be divided into two, approximately along the line of the Hurst Haven. Sewage works discharges feed the Levels to the west, resulting in sufficient water resources but water quality problems caused by high nutrient loadings. The

Levels to the east have limited water resources due to the reduced feed from the Wallers Haven.

9 A major environmental issue concerning English Nature is the hardening of the clay cover to the Levels, impeding the feeding of water fowl. This is related to the winter pump drainage of the Levels and not summer feeding. The main purpose of summer feeding would still appear to be the retention of wet fencing, (and possibly transfer to the peat) although the value to marginal flora may also be of importance.

10 In summary, the current prescribed flow appears to be entirely adequate to meet the direct losses from the ditch system. The water balance is incomplete however pending an improved understanding of the sources of water for transpiration losses. The operation of the surface abstraction and (possibly) the augmentation boreholes by South East Water, appears to compromise the prescribed flow condition during low flows. The nutrient input to the western part of the Levels is a separate, but potentially equally important issue.

6 RECOMMENDATIONS

1. The electromagnetic flow gauging at Hazards Green should be progressed as a priority.

2. The operation of the licence by South East Water and the value of the augmentation boreholes should be investigated with a view to ensuring that the 3.4 Ml/day prescribed flow is achieved.

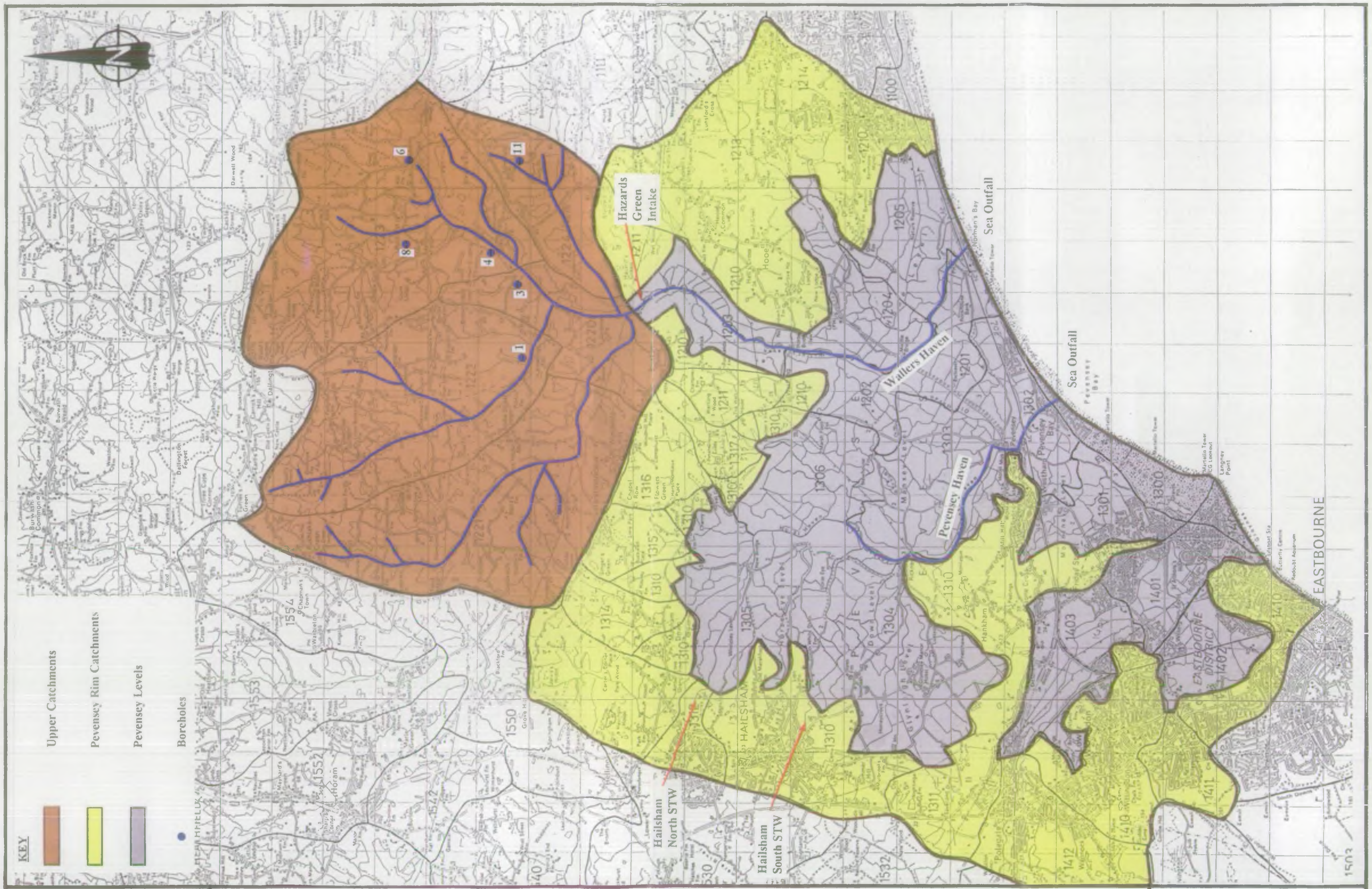
3. The relative contribution of peatwater storage and the ditches to summer water losses needs to be evaluated. The water balance should be re-calculated following completion of the NRA/English Nature investigation to confirm the adequacy of the prescribed flow.

   A survey of the ditches should be undertaken to determine the volume of storage in the levels. Water levels recorded at strategic points within the Levels would determine changes in storage through the summer. Records of operation of stops, gates, weirs etc within the Levels should be kept during the measurement period. This would allow water losses from the open water system to be quantified.

4. The impact of the high nutrient inputs to the western Levels should be evaluated.

5. The potential for the re-introduction of seasonal flooding to the levels should be investigated. This work may be largely included in the Brief for the ongoing NRA/EN project.

6. The detailed operation and control levels of stops and gates within the Levels could be reviewed, as there is considered to be potential for improved use of the available resource. This follos on from 3 above.

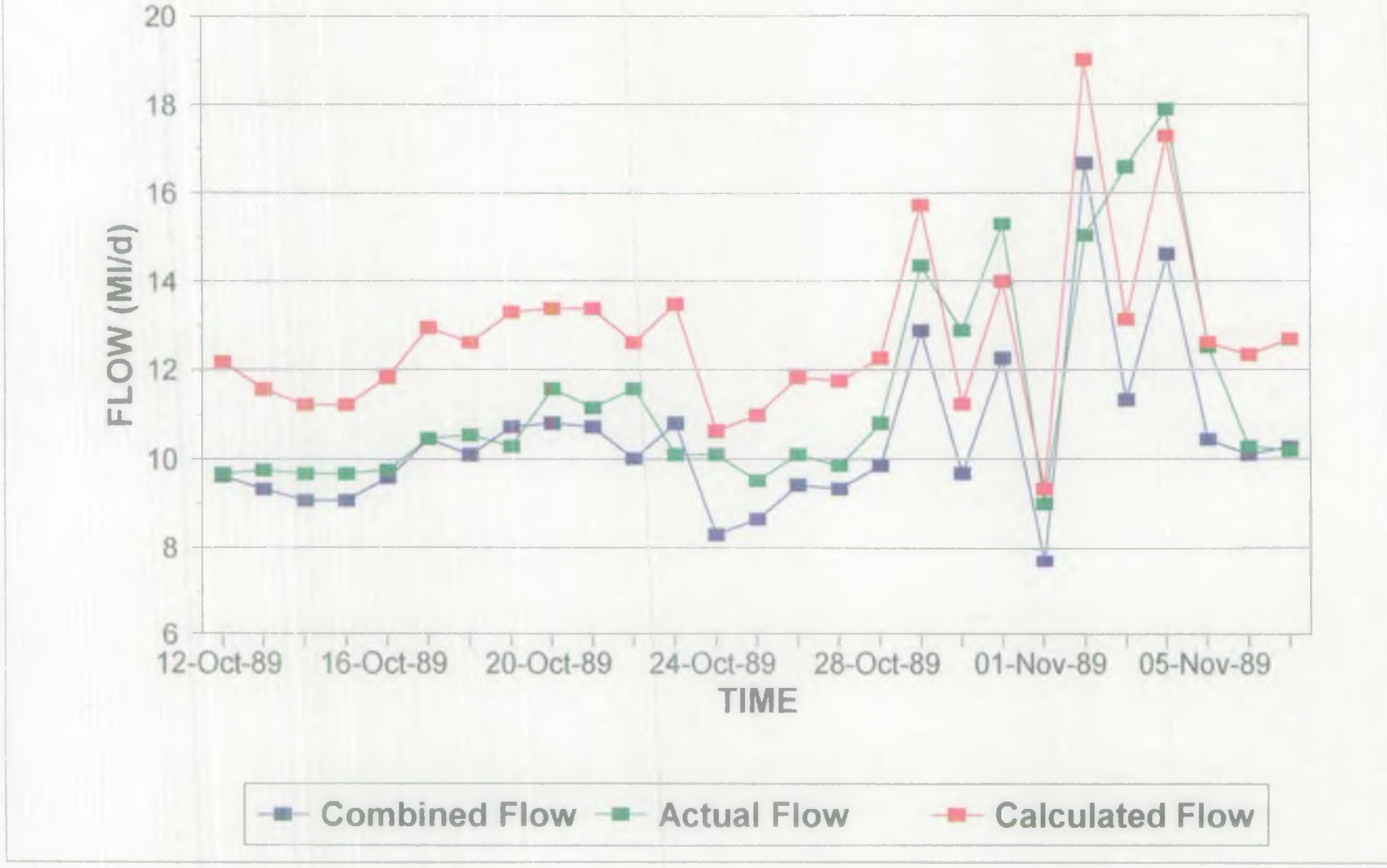


WS/Atkins

STUDY AREA

Figure 2.1

Figure 3.1 Flow data for the Wallers Haven in 1989



WALLERS HAVEN FLOW
Gauged & Calculated Flow

April 1993

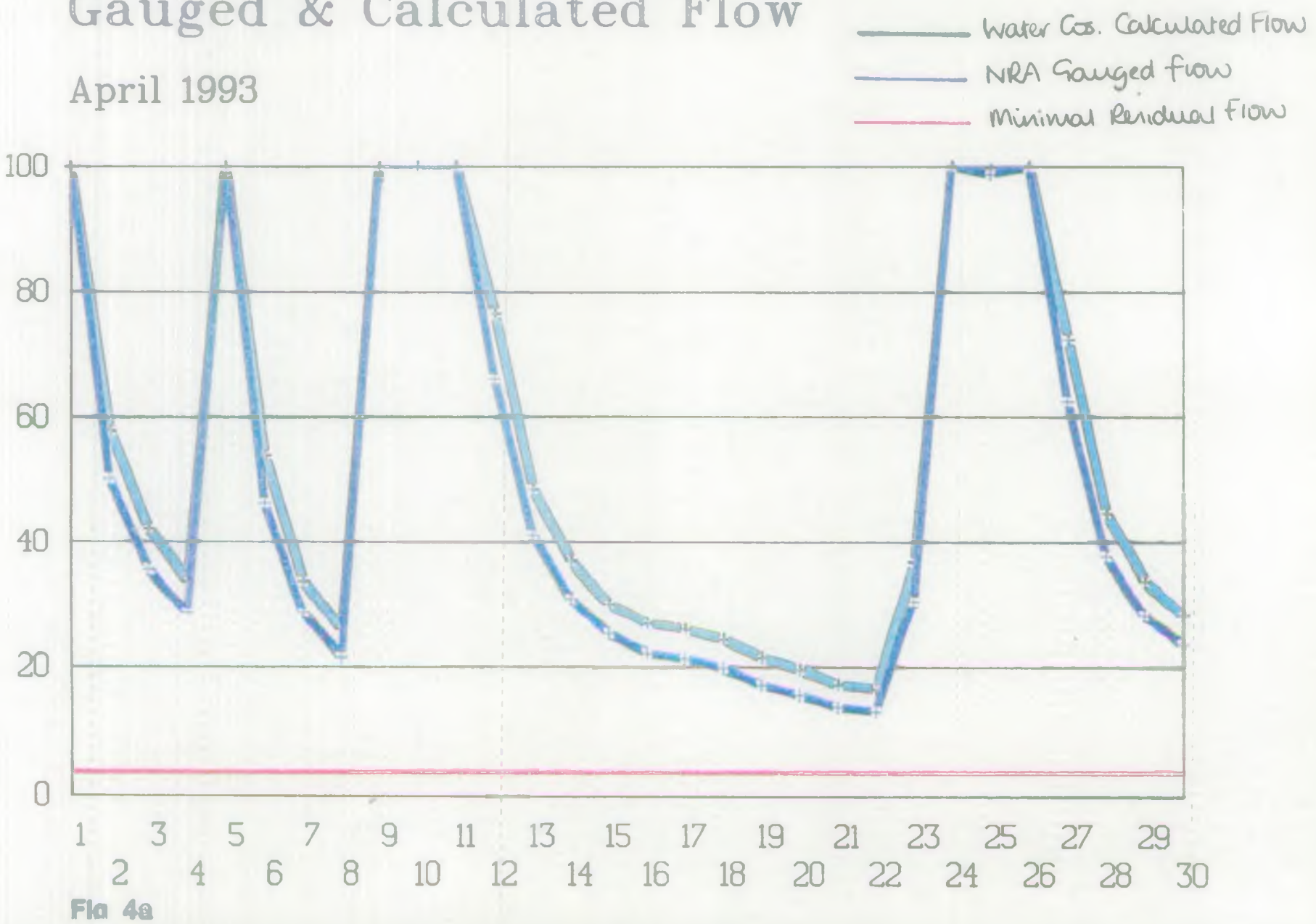


Figure 3.2

Wallers Haven Flow
Gauged & Calculated Flow

May 1993

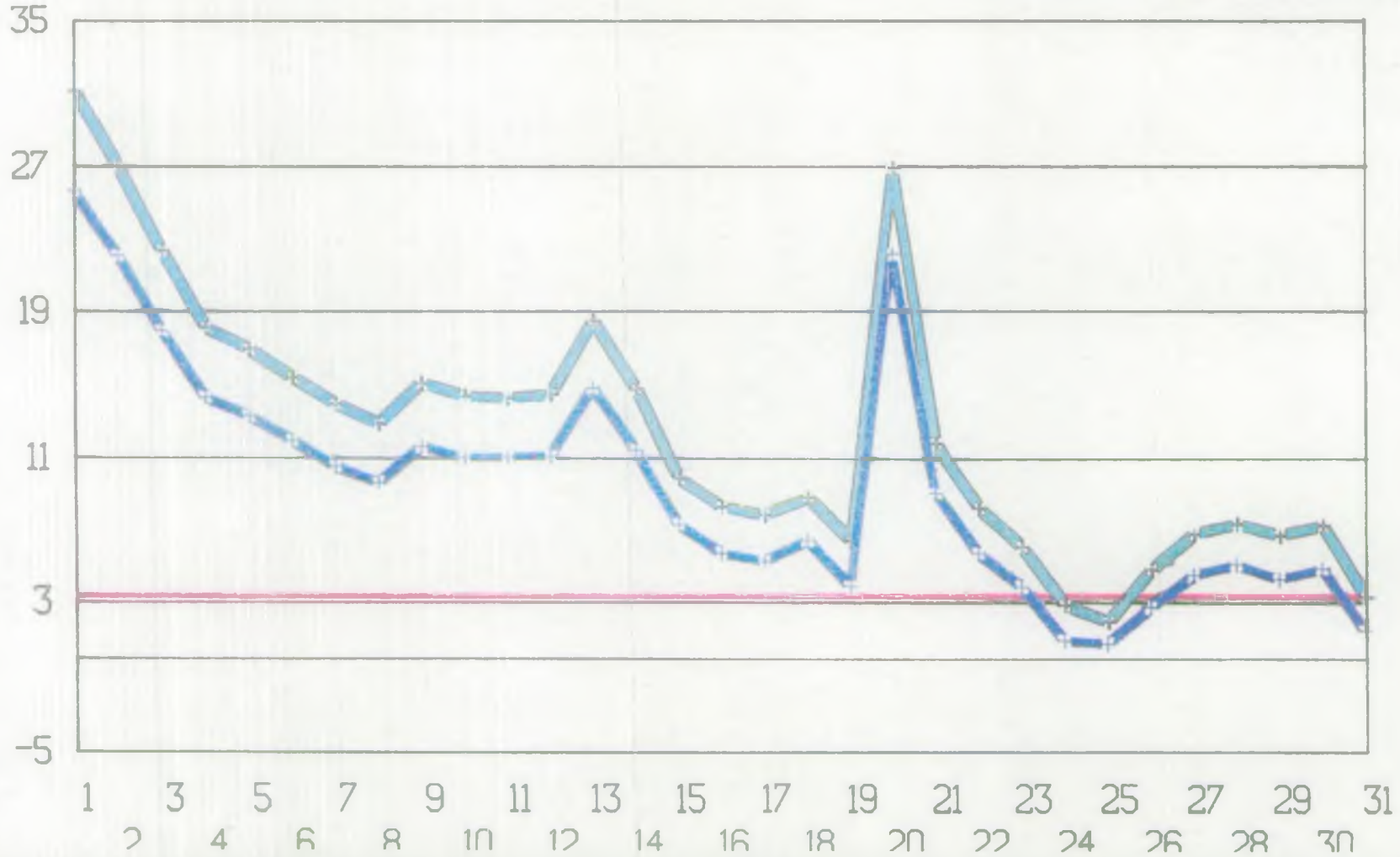


Figure 3.

Wallers Haven Flow
Gauged & Calculated Flow

June 1993

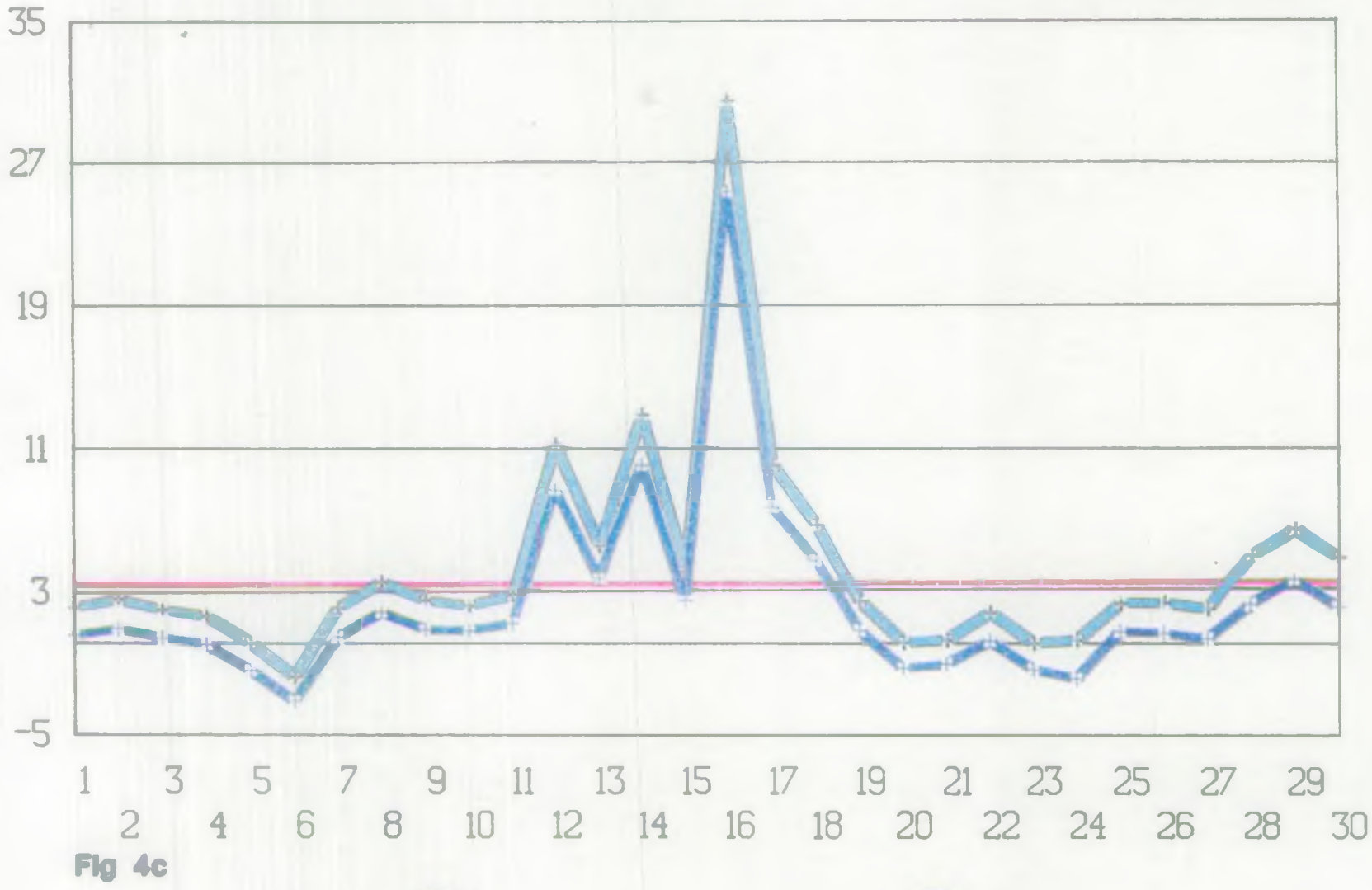


Fig 4c

Figure 3.

Wallers Haven Flow
Gauged & Calculated Flow

July 1993

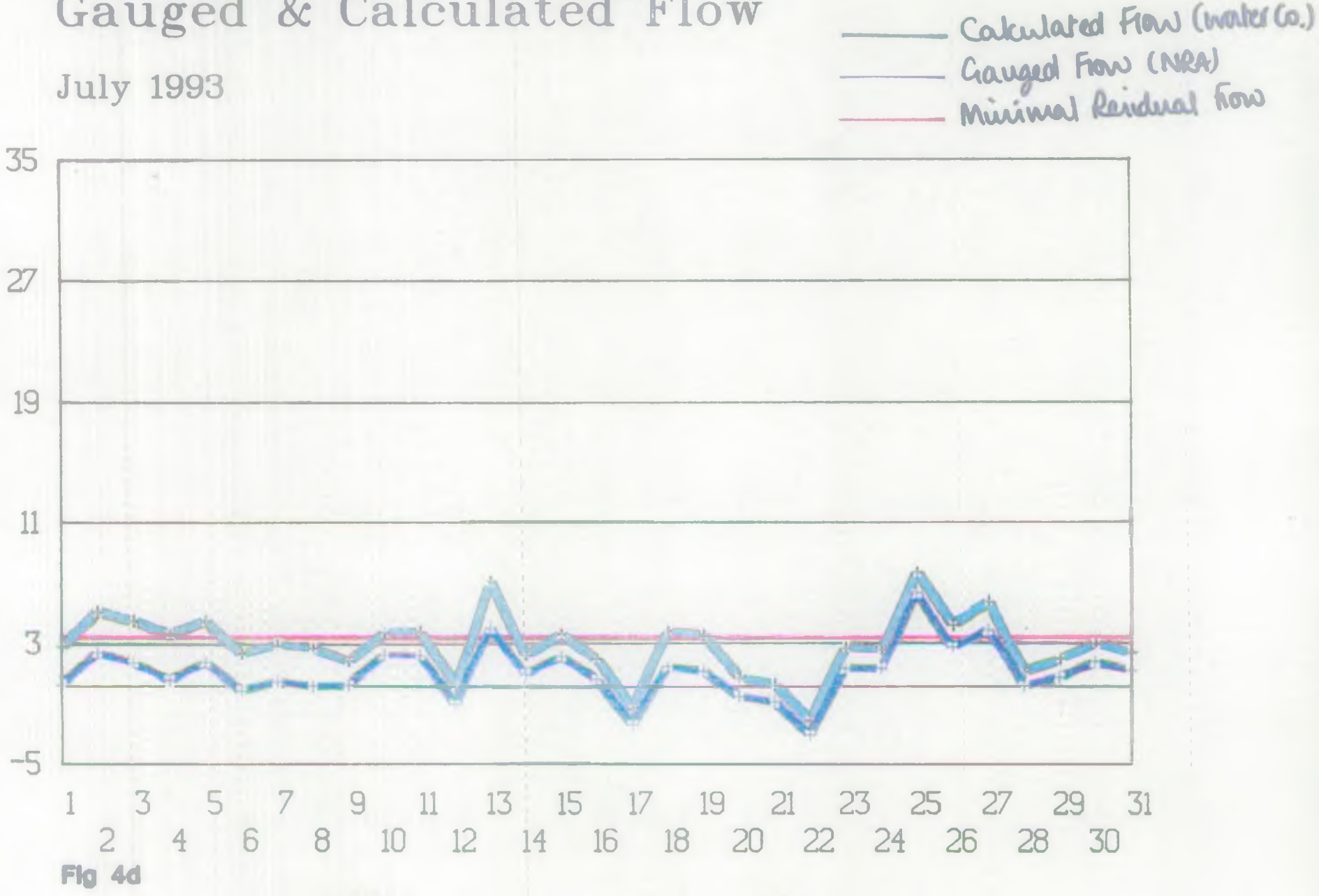


Fig 4d

Figure 3.5

Wallers Haven Flow
Gauged & Calculated Flow

August 1993

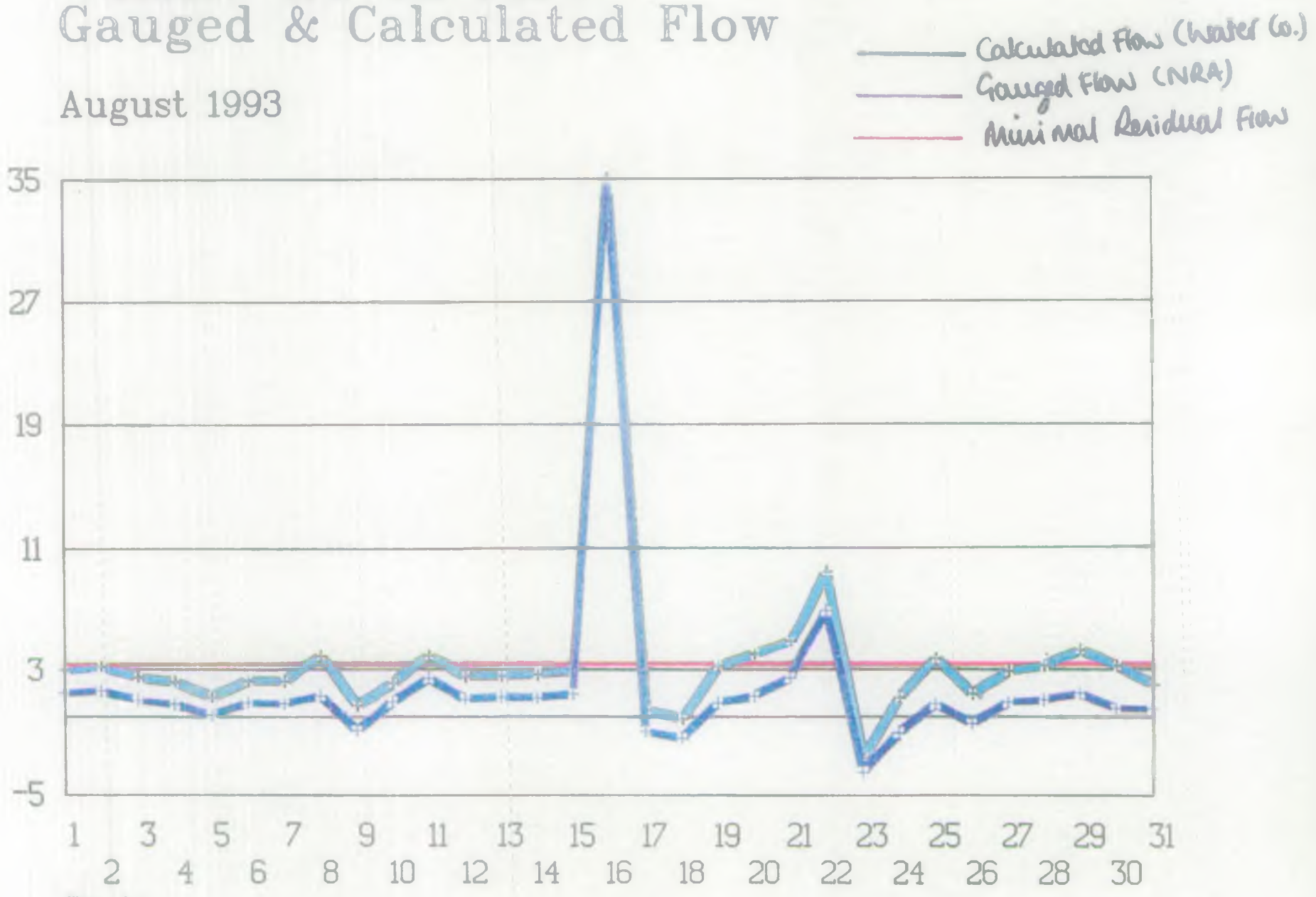


Fig 4e

Figure 3.(

Wallers Haven Flow
Gauged & Calculated Flow

September 1993

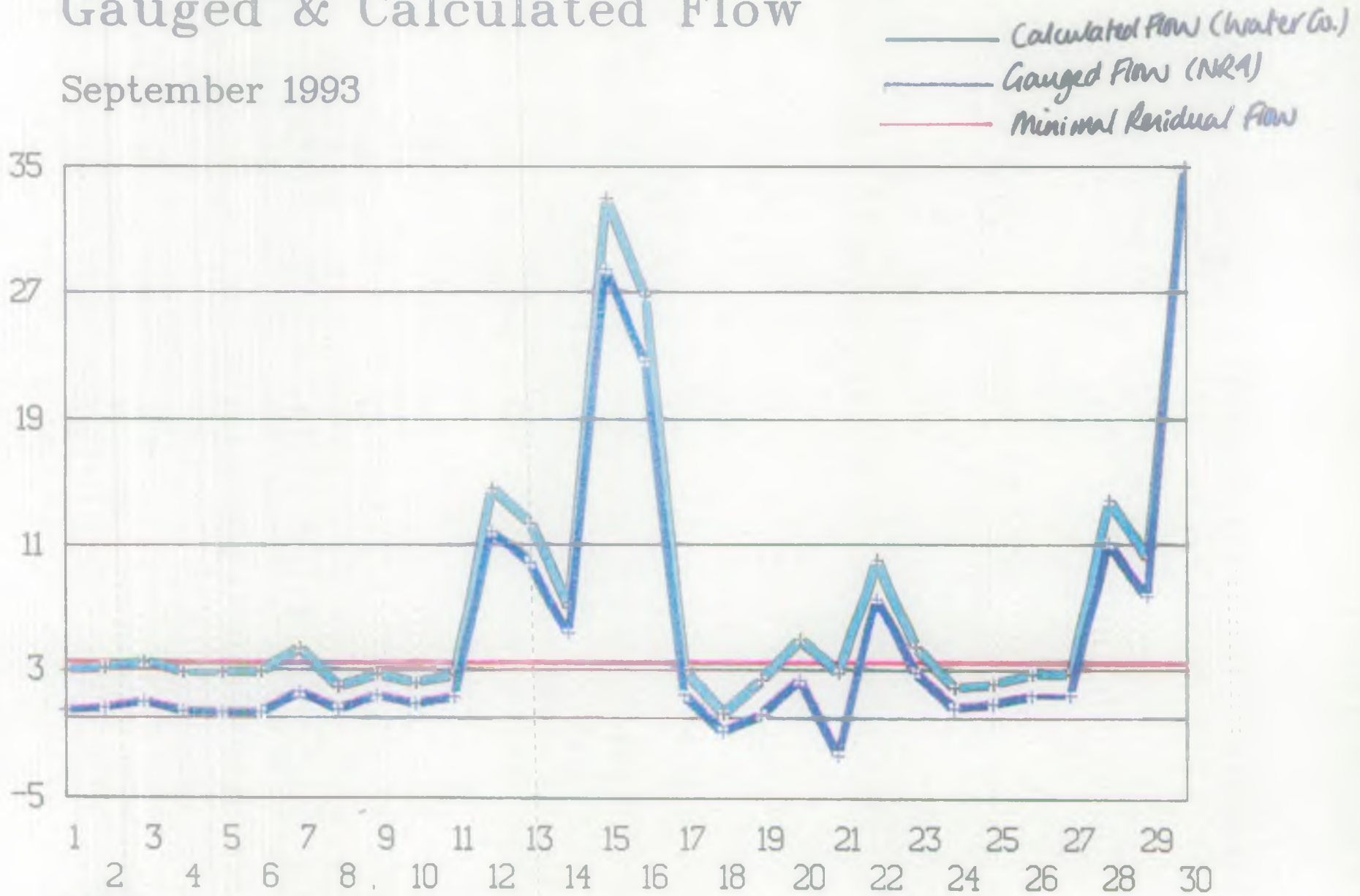


Fig 4f

Figure 3.'

APPENDIX A

Licence No. **10/41/122001**

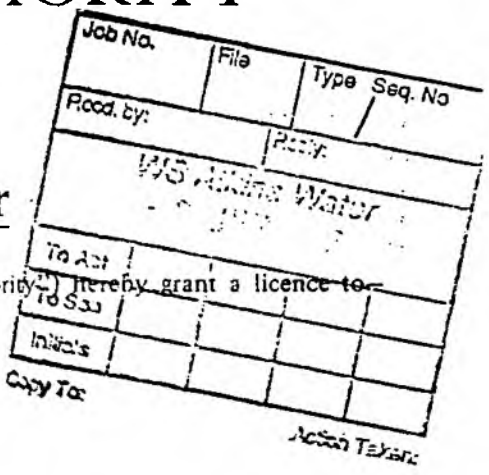
(WALLERS HAVEN AUGMENTATION)

SOUTHERN WATER AUTHORITY

Water Resources Act 1963

Water Resources (Licences) Regulations 1965

Licence to Abstract Water



THE SOUTHERN WATER AUTHORITY (hereinafter referred to as "the Authority") hereby grant a licence to—

EASTBOURNE WATERWORKS COMPANY

of **14 UPPERTON ROAD**
EASTBOURNE
EAST SUSSEX
BN21 1EP

(hereinafter referred to as "the licence holder") to abstract water from the source of supply described in the Schedule hereto, subject to the provisions specified in such Schedule.

This licence shall remain in force until revoked.

Dated this **3** day of **October** 19**83**

Chief Solicitor

NOTES.

1. Charges
Charges may be payable pursuant to Part V of the Act in respect of water authorised to be abstracted under this licence.

2. Reasons for Conditions
Reasons for the imposition of conditions and for any material departure from the proposals in the application are set forth on page 4 hereof

3. Right of Appeal
If the applicant is dissatisfied with the decision of the Water Authority on his application, he may, by notice served within one month from the date of receipt of this notice, appeal to the Secretary of State for the Environment in accordance with Section 39 of the Water Resources Act 1963 and the Water Resources (Licences) Regulations 1965 (S.I. 1965 No. 534). The Secretary of State has power to allow a longer period for the giving of a notice of appeal.

4. Offences
Attention is drawn to the following offences under the Act. It is an offence—
(1) to fail to comply with a condition or requirement of a licence—penalty, a fine (not exceeding £100 in the case of summary conviction) (Section 49);
(2) to construct or extend any well, borehole or other work whereby water may be abstracted from underground strata, or instal or modify any machinery or apparatus whereby additional quantities of water may be abstracted from underground strata, unless the abstraction of the water, or additional quantities of water, is authorised by licence under the Act and the well, borehole or other work as constructed or extended, or the machinery or apparatus as installed or modified, complies with the requirements of the licence—penalty as in (1) above (Sections 23(2) and 49);
(3) wilfully to alter or to interfere with a measuring device required by a licence to be used, so as to prevent it from measuring correctly —penalty, imprisonment, or a fine, or both (Section 115).

5. Important Notice to a Successor to this Licence
If you have become the holder of this licence, in accordance with Section 32(1), or Regulations made under Section 32(3), of the Water Resources Act 1963, by succeeding to the previous licence holder's occupation of land specified in the licence as land on which water abstracted in pursuance of the licence is to be used, you should note that, by virtue of Section 32(2) of the above Act (or corresponding provisions in the regulations under Section 32(3)), you will cease to be the holder of the licence at the end of a period of one month from the date on which you became the occupier of the land in question unless before the end of that period you have given the Water Authority notice of the change in the occupation of the land.

SCHEDULE

PROVISIONS OF LICENCE

SOURCE OF SUPPLY AND AUTHORISED PLACE(S) OF ABSTRACTION

The source of supply from which water may be abstracted in pursuance of this Licence is underground strata at Ashburnham Penhurst and Catsfield all in East Sussex and the authorised points of abstraction are the positions marked No. 1, 3, 4, 6, 8 and 11 on the map annexed to and bearing the serial number of this Licence. (Grid References TQ 666 141 TQ 683 143 TQ 687 146 TQ 705 164 TQ 692 162 and TQ 705 144 respectively)

LAND(S) ON WHICH WATER IS AUTHORISED TO BE USED

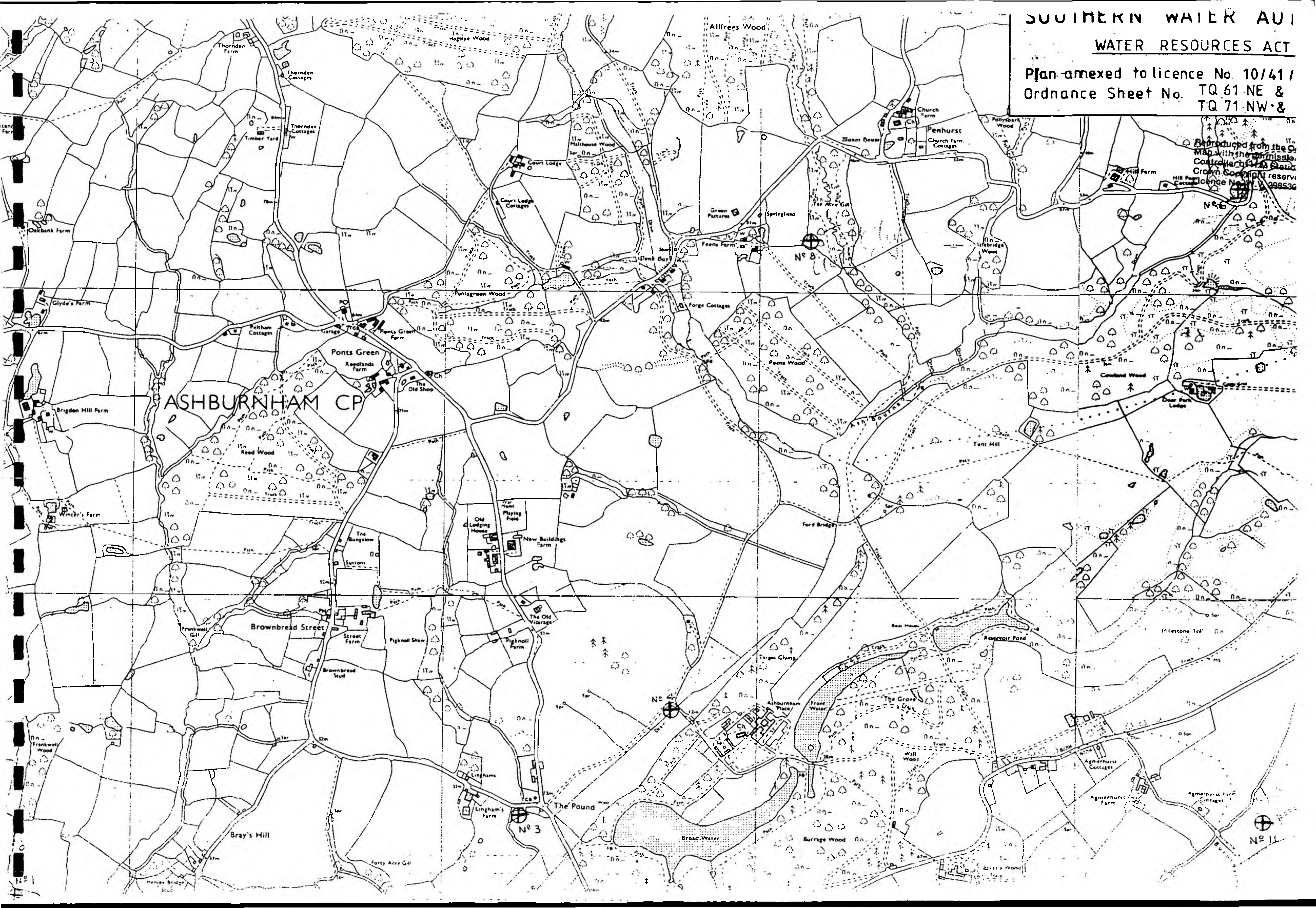
PURPOSE(S) FOR WHICH WATER IS AUTHORISED TO BE USED

The water abstracted shall be discharged to the Hugletts Stream, Ash Bourne and Pitchenham Stream as required to permit abstraction from the River Wallers Haven under Licence No. 10/41/120302

QUANTITY(IES) OF WATER AUTHORISED TO BE ABSTRACTED DURING A PERIOD OR PERIODS SPECIFIED

The quantities of water authorised to be abstracted in pursuance of this Licence shall be limited as follows:-

	per calendar year Megalitres (gallons)	per day of 24 hours Megalitres (gallons)
No. 1	150 (33 million)	1.5 (330,000)
No. 3	)	(1.5 (330,000)
No. 4	)	(1.5 (330,000)
No. 6	) in aggregate	(4.5 (990,000)
No. 8	) 1600 (352 million)	(1.7 (370,000)
No.11	450 (99 million)	3.8 (840,000)
TOTAL :	2,200 (484 million)	14.5 (3,190,000)


SOUTHERN WATER AUT
WATER RESOURCES ACT
Plan annexed to licence No. 10/41/
Ordnance Sheet No. TQ 61 NE &
TQ 71 NW &
ASHBURNHAM CP
Thornden Farm
Thornden Cottages
Timber Yard
Hogtye Wood
Allfrees Wood
Malthouse Wood
Court Lodge
Court Lodge Cottages
Church Farm
Penhurst
Manor House
Church Farm Cottages
Pollyspark Wood
Hill Farm
Ten Acre Gill
Green Pastures
Springfield
Feens Farm
Nº 8
Nº 6
Oakbank Farm
Glyde's Farm
Peltham Cottages
Garage
Ponts Green Farm
Pontsgreen Wood
Forge Cottages
Ponts Green
Reedlands Farm
The Old Shop
Peens Wood
Cowland Wood
Deer Park Lodge
Brigden Hill Farm
Reed Wood
Tent Hill
Ford Bridge
Winter's Farm
The Bungalow
Suttons
Old Lodging House
Playing Field
New Buildings Farm
Brownbread Street
Street Farm
Picknoll Shaw
Picknoll Farm
The Old Vicarage
Frankwell Gill
Brownbread Stud
Reservoir Pond
Milestone Toll
Target Clump
Ashburnham Place
Front Water
The Grove
Wall Woos
Agmerhurst Cottages
Agmerhurst Farm
Agmerhurst Farm Cottages
Frankwell Wood
Linghams
Lingham's Farm
Nº 3
The Pound
Bray's Hill
Broad Water
Burrage Wood
Forty Acre Gill
Nº 11
Nº 1

AUTHORISED MEANS OF ABSTRACTION

The abstraction shall be by means of pumps details of which shall be notified to the Authority.

MEANS TO BE USED FOR MEASURING OR ASSESSING QUANTITIES OF WATER AUTHORISED BY THIS LICENCE TO BE ABSTRACTED

The quantity of water abstracted shall be measured by a meter of a type to be approved by the Authority.

The licence holder shall record the meter readings in a log daily and annually so that the quantity of water abstracted may be ascertained therefrom.

PROVISIONS FOR DETERMINING, BY MEASUREMENT OR ASSESSMENT, THE QUANTITY(IES) OF WATER TAKEN TO HAVE BEEN ABSTRACTED DURING THE PERIOD(S) SPECIFIED

The licence holder shall forward to the Authority annually at a date to be specified by the Authority a copy of the log referred to in the last preceding condition.

A duly authorised officer of the Authority shall be entitled to inspect or transcribe the said log at all reasonable times.

OTHER CONDITIONS SUBJECT TO WHICH ABSTRACTION IS AUTHORISED

The Authority does not guarantee that the quality of water in the source of supply is suitable for the purpose for which it is authorised to be used by this licence and will not accept any liability in respect thereof. It shall at all times be the responsibility of the licence holder to ensure that the quality of the abstracted water is satisfactory before it is used.

REASONS FOR CONDITIONS OF THIS LICENCE AND FOR ANY MATERIAL DEPARTURE FROM THE PROPOSALS IN THE APPLICATION

The reason for imposing the foregoing conditions is to secure the proper use of water resources in the area.

Licence No. 10/41/120302
(WALLERS HAVEN ABSTRACTI

SOUTHERN WATER AUTHORITY

Water Resources Act 1963

Water Resources (Licences) Regulations 1965

Licence to Abstract Water

THE SOUTHERN WATER AUTHORITY (hereinafter referred to as "the Authority") hereby grant a licence to—

EASTBOURNE WATERWORKS COMPANY

of

14 UPPERTON ROAD
EASTBOURNE
EAST SUSSEX
BN21 1EP

(hereinafter referred to as "the licence holder") to abstract water from the source of supply described in the Schedule hereto, subject to the provisions specified in such Schedule.

This licence shall remain in force until revoked.

~~expire on the day of~~

Dated this **3** day of **October** 19 **83** .

Chief Solicitor

NOTES.

1. Charges
Charges may be payable pursuant to Part V of the Act in respect of water authorised to be abstracted under this licence.

2. Reasons for Conditions
Reasons for the imposition of conditions and for any material departure from the proposals in the application are set forth on page 4 hereof.

3. Right of Appeal
If the applicant is dissatisfied with the decision of the Water Authority on his application, he may, by notice served within one month from the date of receipt of this notice, appeal to the Secretary of State for the Environment in accordance with Section 39 of the Water Resources Act 1963 and the Water Resources (Licences) Regulations 1965 (S.I. 1965 No. 534). The Secretary of State has power to allow a longer period for the giving of a notice of appeal.

4. Offences
Attention is drawn to the following offences under the Act. It is an offence—
(1) to fail to comply with a condition or requirement of a licence—penalty, a fine (not exceeding £100 in the case of summary conviction) (Section 49);
(2) to construct or extend any well, borehole or other work whereby water may be abstracted from underground strata, or instal or modify any machinery or apparatus whereby additional quantities of water may be abstracted from underground strata, unless the abstraction of the water, or additional quantities of water, is authorised by licence under the Act and the well, borehole or other work as constructed or extended, or the machinery or apparatus as installed or modified, complies with the requirements of the licence—penalty as in (1) above (Sections 23(2) and 49);
(3) wilfully to alter or to interfere with a measuring device required by a licence to be used, so as to prevent it from measuring correctly —penalty, imprisonment, or a fine, or both (Section 115).

5. Important Notice to a Successor to this Licence
If you have become the holder of this licence, in accordance with Section 32(1), or Regulations made under Section 32(3), of the Water Resources Act 1963, by succeeding to the previous licence holder's occupation of land specified in the licence as land on which water abstracted in pursuance of the licence is to be used, you should note that, by virtue of Section 32(2) of the above Act (or corresponding provisions in the regulations under Section 32(3)), you will cease to be the holder of the licence at the end of a period of one month from the date on which you became the occupier of the land in question unless before the end of that period you have given the Water Authority notice of the change in the occupation of the land.

SCHEDULE

PROVISIONS OF LICENCE

SOURCE OF SUPPLY AND AUTHORISED PLACE(S) OF ABSTRACTION

The source of supply from which water may be abstracted in pursuance of this Licence is the River Wallers Haven at Hazards Green in East Sussex and the authorised point of abstraction is the position marked A on the map annexed to and bearing the serial number of this Licence. (Grid Reference TQ 678 118)

LAND(S) ON WHICH WATER IS AUTHORISED TO BE USED

PURPOSE(S) FOR WHICH WATER IS AUTHORISED TO BE USED

The water abstracted shall be used for public water supply.

QUANTITY(IES) OF WATER AUTHORISED TO BE ABSTRACTED DURING A PERIOD OR PERIODS SPECIFIED

The quantities of water authorised to be abstracted in pursuance of this Licence shall be limited as follows:-

(i) 4,500 ~~4,269~~ Megalitres (990 ~~924~~ million gallons) per calendar year

(ii) 17 ~~15~~ Megalitres (3.7 ~~3.3~~ million gallons) per day of 24 hours

(Amended 3.3.87)

S O U T H E R N   W A T E R   A U T H O R I T Y

WATER RESOURCES ACT 1963

THE EASTBOURNE WATERWORKS CO
14 UPPERTON ROAD
EASTBOURNE   EAST SUSSEX
BN21 1EP

Licence No: 10/41/120302

Amendment No: 1.

This licence to abstract water is hereby varied by the substitution of the following provisions for the provisions in the Schedule to the Licence :-

SCHEDULE TO LICENCE NUMBER : 10/41/120302

MAXIMUM QUANTITIES - EACH YEAR

990,000,000	gallons in total	(4,500 Megalitres)
3,700,000	gallons per day	(17 Megalitres)

SPECIAL CONDITIONS

(i) (b) The total quantity from Sites 1, 3, and 4 plus 65% of the total quantity from Sites 6, 8 and 11 discharged on a daily basis in accordance with Licence Number 10/41/122001 ~~and 65% of the total quantity discharged from site 16 on a daily basis in accordance with Licence Number 10/41/155001~~. xxx

DATED THIS 9 DAY OF MARCH 1987

[signature]

CHIEF SOLICITOR

SOUTHERN WATER AUTHORITY
GUILDBOURNE HOUSE
CHATSWORTH ROAD
WORTHING   WEST SUSSEX
BN11 1LD

xxx See amend't No 2 07/92 which effectively drops site 16 (Cowbeech) from the list as that site reverts to Public Water Supply — as opposed to [illegible]

[signature] 5/8/92

BCD1/85/LS

7120

NATIONAL RIVERS AUTHORITY

SOUTHERN REGION

WATER RESOURCES ACT 1991

TO: Eastbourne Water Company
14 Upperton Road
Eastbourne
East Sussex BN21 1EP

Licence No: 10/41/120302

Amendment No: 2

This licence to abstract water is hereby varied as follows by the substitution of the following provisions for the provisions in the Schedule to the licence:-

SCHEDULE TO LICENCE NUMBER: 10/41/120302

SPECIAL CONDITIONS

By the addition of the following conditions:-

(1) (B) The total quantity from sites 1, 3 and 4 plus 65% of the total quantity from 6, 8 and 11 discharged on a daily basis in accordance with licence number 10/41/122001.

DATED THIS 24 DAY OF JULY 1992

P. W. Hubertson

.....

RESOURCES MANAGER

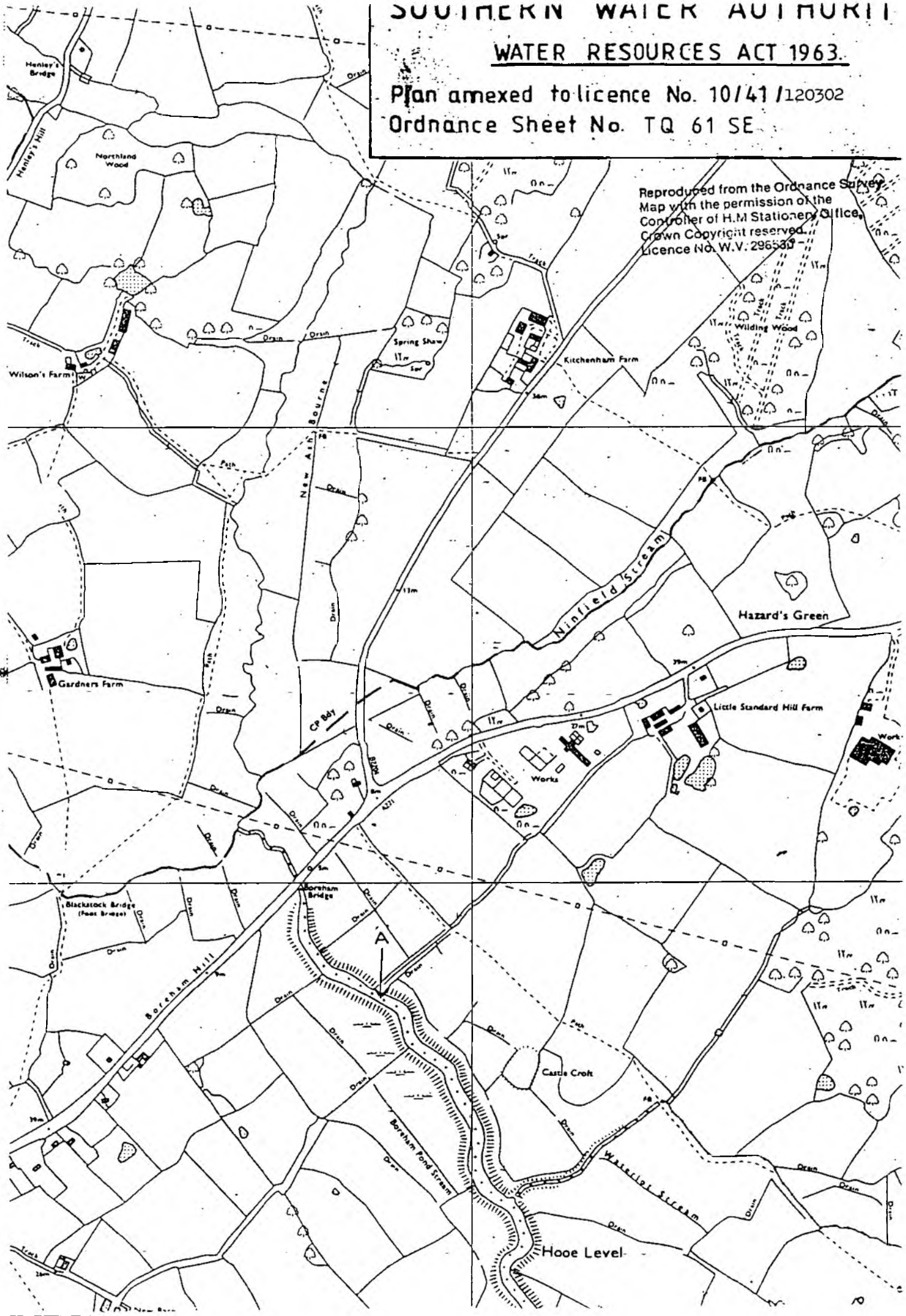
National Rivers Authority,
Southern Region,
Guildbourne House,
Chatsworth Road,
Worthing, West Sussex,
BN11 1LD.

SOUTHERN WATER AUTHORITY

WATER RESOURCES ACT 1963.

Plan annexed to licence No. 10/41/120302

Ordnance Sheet No. TQ 61 SE



OTHER CONDITIONS SUBJECT TO WHICH ABSTRACTION IS AUTHORISED

(i) when the rate of flow of water in the Wallers Haven is equal to or less than 18.41 Ml/d, the rate of abstraction shall not exceed a rate equal to either :-

(a) the difference between the rate of flow in the Wallers Haven and 3.41 Ml/d, or

(b) the total quantity from Sites 1 3 and 4 plus 65% of the total quantity from Sites 6 8 and 11 discharged on a daily basis in accordance with Licence No. 10/41/122001, -- (see amendment)

whichever is greater

(ii) no abstraction shall take place when the rate of flow in the Wallers Haven is equal to or less than 3.41 Ml/d

(iii) for the purposes of the preceding conditions, the rate of flow of water in the Wallers Haven shall be ascertained by aggregating the measured rates of flow of the Nunningham, Hugletts, Ash Bourne and Kitchenham Streams together with the total quantity of water discharged to the said streams on a daily basis in accordance with Licence No. 10/41/122001.

(iv) The Authority does not guarantee that the quality of water in the source of supply is suitable for the purpose for which it is authorised to be used by this licene and will not accept any liability in respect thereof. It shall at all times be the responsibility of the licence holder to ensure that the quality of the abstracted water is satisfactory before it is used.

AUTHORISED MEANS OF ABSTRACTION

The abstraction shall be by means of a river intake to the requirements of the Authority and a pump or pumps details of which shall be notified to the Authority.

MEANS TO BE USED FOR MEASURING OR ASSESSING QUANTITIES OF WATER AUTHORISED BY THIS LICENCE TO BE ABSTRACTED

The quantity of water abstracted shall be measured by a meter of a type to be approved by the Authority.

The licence holder shall record the meter readings in a log daily and annually so that the quantity of water abstracted may be ascertained therefrom.

PROVISIONS FOR DETERMINING, BY MEASUREMENT OR ASSESSMENT, THE QUANTITY(IES) OF WATER TAKEN TO HAVE BEEN ABSTRACTED DURING THE PERIOD(S) SPECIFIED

The licence holder shall forward to the Authority annually at a date to be specified by the Authority a copy of the log referred to in the last preceding condition.

A duly authorised officer of the Authority shall be entitled to inspect or transcribe the said log at all reasonable times.

OTHER CONDITIONS SUBJECT TO WHICH ABSTRACTION IS AUTHORISED

SEE ATTACHED

REASONS FOR CONDITIONS OF THIS LICENCE AND FOR ANY MATERIAL DEPARTURE FROM THE PROPOSALS IN THE APPLICATION

The reason for imposing the foregoing conditions is to secure the proper use of water resources in the area.

WS Atkins