

Entec 2006 *East Hampshire and Chichester Chalk Groundwater Conceptualisation Project. Phase 1 Data Synthesis, Conceptual Model and Water Balance Final Report*. EA Southern Region

Chapter 1 Introduction gives background to drivers for the study. Outlines that abstractions do have stresses on the watercourses and on discharges to the harbour. As usual in such locations, there are hydrogeological complexities affecting flows. The EA commissioned the work because it is required to understand the relationships between groundwater resources, abstraction and river/spring flows. A key driver was to provide information for the Chichester Harbour RoC (Habitats Regs). The other is CAMS- the Ems and Lavant are within the *East Hants and Arun and Western Streams* CAMS area. In the 2003 CAMS the area has been assessed as 'Over Abstracted' (EA 2003).

To be fair in relation to this project, a key objective was not to determine impacts of abstraction on flows in the Ems and Lavant, but more the Harbour.

Chapter 2 covers the database and GIS description whilst **Chapter 3** provides information on topography and geology

Chapter 4 is a literature review, and should be used for anyone interested in more detailed info on geology, hydrogeology etc. This included nearly 50 references, including all relevant modelling studies.

It quotes the national hydrogeological review of the south downs (BGS report of 1999). A point from this was repeated... *The Chichester Syncline is of prime importance in understanding the regional groundwater flow regime. It blocks groundwater flow and diverts it to the east, and also limits the saline intrusion.*

As part of PWCo's AMP3 work, Mott MacDonald (ref 31) did pump tests to investigate the impacts of the Fishbourne abstraction. The tests indicated high transmissivity, with significant impact on high level spring flows but with low level springs little affected. Atkins did further work because of these concerns (ref 45) and concluded some impacts to Desmoulins Whorl Snail could have resulted. **There appears little in relation to pump tests regarding quantifying, or even getting a better qualitative handle on the potential impacts on flow.**

They reported there was much high quality work in the late 1970s and 1980s that revealed much about the regional hydrogeology. This was subsequently summarized and extended into the conceptualisation and numerical modelling by the SWA Chichester Block Water Resource report (ref 12). There are many references to Mott MacDonald and Halcrow studies for the area (see the refs in the doc)

Chapter 5 covers Climate, Land-use and Soils.

Information on rainfall data is given. It concluded that 'The current state of the rainfall and PE data and the parameterisation of the Recharge Model using soil and land use data should not be considered final. Further refinement is possible and encouraged.....as this would allow the recharge estimates to be better tested. **I would support this as a recommendation in my report as being very helpful, and more in-depth investigations made regarding GW, rainfall and available flow data.**

Land-use is based on CEH 25m gridded 'Land Cover Map of GB' (2000 dataset). Shows significant arable in both catchments (where are these data for other people to use and compare??)

Chapter 6 deals with abstractions, discharges and other artificial influences

Refers to urbanisation, abs and discharges.

Abstraction information primarily has come from the Arun and Western Streams CAMS ledger (**ref CAMS doc**). It is this ledger that ‘contains all of the essential abstraction details, including licencee, point locations, use description, source type and annual, daily and hourly (where available) licence quantities. They also provide an indication of the recent actual abstraction rate’. Entec also used ‘Sussex abstraction returns for PWS from 1970-2004 and non-PWS from 1990-2003. The Halcrow modelling files also contain daily abstraction data for the PWS sources in the Chichester Block from 1993-2003. **Disappointed nothing on 1970-1989 for target area – these really needed in relation to reported flows from other sources (e.g. Rudkin for the Ems).**

Figure 6.2 (PC) shows the location of all surface and groundwater abstractions, and abstractions amounts in Table 6.2 (PC). This shows the Walderton abs to be the fourth largest (27.3MI/d) average and the Lavant (20.9ML/d) the 6th. **Note Lavant combined with Brickkiln. Need to know influence (if any) of other abstractions in chalk block potentially affecting flows in the Ems and Lavant.** Other abstraction on the Ems is Woodmancote – Max 4.5MI/d with average 3.7MI/d. All 3 (4) PWS are by Portsmouth WC.

Non-PWS such as agriculture in the modelled area are described as ‘numerous’, but the ‘vast majority are small (<1MI/d)’. None in the Ems or Lavant exceed 1MI/d. No watercress beds are cited. **Files subsequently revealed concerns and derogations when Walderton licence granted as several cress-beds in this catchment.**

Extent of trickle irrigation not really known – where known they do not exceed 0.3MI/d in the target catchment. **Is it considered of any significance? I suspect not.**

Trends in abstraction in Chichester block: Brickkiln has increased to about 4MI/d, about 2/3 of licensed rate. Lavant has increased slightly...figures match the table. Fishbourne has fallen from 6 to 3 MI/d since 2000 due to environmental concerns. ‘Overall, suspected the PWS abstraction has decreased over the study period, the increase in brickkiln and Lavant failing to match the decline in Walderton and Fishbourne’...**but need very accurate figures for all – ideally a simple excel table with amounts represented as daily means on a monthly basis from the start.**

Entec feel they have a good understanding of abstractions/discharges for the post 1970 period. They say there ‘appears to have been a trend of generally lower abstractions in the’... Chichester block – **either there is a trend or there isn’t, surely, if they have a good understanding!! By having the data above we could be clearer on this.**

Figs –

6.3 – Daily averages per month? 6.3b shows Walderton & Woodmancote abstractions from 1990 only..**need all pre 1990 data**...shows Walderton at 15-25 in early 1990s dropping to 10-15 in early 2000s – but odd big monthly peak and real returns higher than modelled in 2004.

Discharge data – data on location, magnitude and nature of STW discharges came from the EA – the CAMS ledger (for all discharges not just STWs) within the ‘Un/AssocDischarges’ worksheet. Maximum consented flows DWFs and assessment of average DWF where available. They also used info from water companies on locations and volumetric information.

For the Lavant there is gauged STW data from 2004.

Fig 6.2 shows locations – Lavant works at 8837007930 has DWF listed as 1.7MI/d and average actual as 0.4MI/d. Chichester STW discharges to Harbour (DWF 7.7MI/d) but nothing for Ems – **exported out of catchment.**

What has changed in terms of discharges to rivers in past say 50 years? Have effluents from Singleton etc. gone to Lavant works and been discharged to the same location for many decades, and does this pre-date any abstraction?

Watercress beds – no mention is made for either the Lavant or the Ems re discharges. Logical if none now operating – have there been in the past, and is info for this on file?

NOTE: report says flood relief channel takes more or less old route of Lavant – course through Chichester ‘was diverted to its current route when the Romans settled at Chichester’. **I agree.**

Chapter 7 – Groundwater Levels

The chapter aims to identify some of the factors influencing groundwater storage and flow through the system.

I don't understand most of this!! Don't think too much to be concerned about though!

Figure 7.20 does not appear to match text describing the Lavant system as a type 7 (constant minima – showing little climatic response - i.e. they are the same in wet and drought years)!! Chilgrove is 4 (large response – diametric opposite?? Ems is Gp 1 for Compton (no response) and Walderton area – Gp 4!!

Regional groundwater flow is predominantly in the direction of the dip- i.e. south and south-west. At times of high groundwater level, there is convergent groundwater flow along the Arun, Lavant, Ems, Meon Itchen, ‘implying the occurrence of baseflow into these rivers’... **significance?**

They have derived groundwater catchments based on ground water level contouring – Fig 7.26 (combining the Ems and Lavant) that have subsequently been used to examine abstraction trends and water balance assessments.

Chapter 8 River Flows

Highlights importance of understanding the relationship of river flows to the aquifer.

Used flow data from the EA's WISKI database as daily mean flows for the period of record. Fig 8.1 shows the locations of the gauging station on the Lavant at Graylingwell, and on the Ems at Westbourne. Both reported to have been gauged since 1974, with gaps in data reported only for the Lavant due to prolonged periods of no flow. The Figure also shows numerous spot gauging locations on both catchments, with this information from EA sources, including their ‘Biber database for West Sussex’. For both rivers data for potential assessment of accretion profiles – Ems had 3 sites monitored 7 times in 1993!! And Lavant 3-8 sites monitored regularly in 1993 and again in 2002, ‘otherwise data sparse’. **This is too limited for quantitative appraisal of potential abstraction impacts?? NOTE: confirmed by discussions with Alec 24/11/06**

Figure 8.2 shows the hydrograph rainfall responses for the two sites for 1991-3. ‘Runoff does not appear to significantly contribute to flows at Graylingwell, and groundwater baseflow into the R Lavant only occurs intermittently’. For the Ems the hydrograph is described as smooth, but with some discernible influence of run-off from the tertiaries.

For the Ems, due to few data 'only limited conclusions can be drawn'says gradual gain to Walderton, but says W PWS abstraction 'causes a loss in flow between Walderton Bridge and Racton'. There are then consistent gains to Westbourne, the limit of gauged data – does not think much gain would occur d/s. **Concern people may read into this that the abstraction does not affect flows here (know not what it is saying) – the fact that it gains flows does not mean it is not gaining as much as it used to, or needs to support the ecology it might once have done!!**

For the Lavant see p 95....says accretion to Singleton – where the Littlewood Syncline and Singleton Anticline result in convergence of groundwater flow from the middle chalk. Below West Dean Farm the river loses flow as it crosses the Upper Chalk. The Lavant PWS abstraction 'causes a loss in river flow'. Says beyond this towards East Lavant flows accrete again, with evidence of high water table and springs (SU857087). **Same point as above for accretion.** Below East Lavant there is a decline – thinks may be being lost to Chichester Harbour via Fishbourne Springs!! Also considerable flow through the gravels...**The small flow from the Lavant STW maintaining flow in low-flow periods is amazing!! There must be amazing bed sealing – perhaps due to the alluvium, but for a flow of such a small amount to last so long, bed sealing must be the answer? NOTE: discussions with Alec 24/11/06 more or less in agreement.**

P96 and 97 discuss groundwater levels and river flows in the Ems and Lavant, and possible reasons why Ems has more reliable flow in lower reaches. Photocopied.

9. Data Synthesis & Conceptual Model

Concludes the Chichester Syncline is critical in understanding GW flow and interaction with river flows. The gravels provide a pathway for flows from the chalk in the north to discharge to Chichester Harbour.

Re the Chichester Harbour Catchment Conceptualisation, the report states that the whole catchment is determined by 'assumed groundwater divides', but the lack of perennially flowing rivers on the chalk means that the groundwater catchments are indistinct. It starts there are factors that affect groundwater/surface water interactions in the Ems and Lavant. Pump test information suggests transmissivity is poor at Brickkiln on the edge of the main chalk outcrop, and high at the Lavant PWS location in the Lavant valley (2,400 – 9,100 m²/d).

P 112 gives details of abstractions in the catchment. Refers to flows at Westbourne being frequently low, but consistently above zero; and the augmentation 'taken from Walderton' that has 'a net benefit to environmental flows to the Emsworth Channel' – **benefit cf if not there, but surely less beneficial than the mitigation for abstracted water at Walderton.**

Notes that the flow regimes of the Lavant and Ems may appear to be similar, but important differences exist (p 113).

- low elevation, high transmissivity corridor above Fishbourne Springs depress groundwater levels under the Lavant, hence the typically losing reach between E Lavant and Graylingwell – **could effect of abstraction not have some influence? What is the depth of the water table and the cone of depression during low-GW conditions from the Lavant abstraction – what data are there to help determine this (any pump tests)?**
- The Littlewood Syncline, at times of low GW conditions, 'results in flows being channelled away from the top of the R Lavant past Chilgrove and towards the Ems near Walderton'.

10. Recharge Estimation

The section describes how spatial distributions of hydrologically effective rainfall, runoff and recharge have been calculated for 250m² grids for 1970-2004. These data are then used in chapter 11 for water balance calculations.

11. Water Balance Calculations

Due to ToR, the focus has been to model flows reaching the harbours rather than down each river reach/section. On p 148/9 states that recharge model was able to reasonably approximate recharge and modelled flow outputs were 'comparable to observed flows'. On p146 (Fig 11.11) says for the Chichester Harbour catchment the model over-estimated flow *cf* gauged data. **A key need is to understand better from the model the effect on flows in the rivers...this is not anywhere in the report as far as I can see?** NOTE: confirmed by discussions with Alec 24/11/06

In 11.5.3, when discussing outflow under fully licensed PWS abstraction they note such a move 'could induce a change in the groundwater catchment boundaries'!! **Not sure I think Fig 11.14 is very re-assuring!! The total gauged flows consistently are lower, and for much longer, than any of the scenarios during low flow periods.** NOTE: discussions with Alec 24/11/06 confirms the flows reaching the Harbour are likely to be greater than the combined flows of the Lavant and Ems due to flows under drift deposits (clear in report).

'Hands-off flow limits for abstraction based on local river flows are a typical method of limiting abstraction during low-flow periods, but the highly seasonal nature of the R Ems, Lavant (and Wallington) currently prevent this approach being exercised'. For flows to Chichester Harbour to remain in an extreme drought, it is ESTIMATED there would need to be a 29% reduction in abstraction in the combined abstractions with the area!! **(Lots of caution and uncertainties, but interesting that model suggests this...what would be the flows to the estuary with no abstractions?)**

12. Numerical Modelling

Provides draft recommendations on further numerical modelling of the EHCC area. Objectives did include better understanding impacts of abstractions on flows in the Ems & Lavant!! It concludes only the EA can determine if a distributed groundwater model is needed.

13. Recommendations for Further work

Environment Agency (2003WR) RAM Assessment for Arun and Western Streams. EA, Worthing.

Halcrow, Motts, Atkins and SWA all cited and number referenced, but not in references – do not understand their referencing!! Is there anything else I should refer to?

I have reviewed Halcrow – contained some good historical info.

Need to have!:

Dates of start of abstractions at present locations

Monthly means for abstraction amounts from the start

Info on what other sources were used/replaced prior to these

Confirm there are no pre-abstraction flow gauging info for either rivers

Get better handle on what has been done on modelling present impacts of abstraction on river flows
NOTE: confirmed by discussions with Alec 24/11/06 data are limited in this area to allow this to be meaningfully done at present

Determine what could be done easily re hydrograph outputs with existing systems/data – i.e. Flow duration curves for various locations down the rivers (say three each), and mean daily flows at each location with present abstractions, and without abstractions.

What would be needed to get a confident picture NOTE: discussions with Alec 24/11/06 that this is a subject of current phases of work and EA in process of trying to determine this

Paul Sansby a good contact for additional info I want direct from PWCo – as guided by EA?

ADDITIONAL NOTES (in light blue made 24/11/06 following discussions with Alec Irving)

Phase II of the project is doing numerical modelling of abstractions on flow in Hants – in Sussex data are not comprehensive enough to allow this.

Cannot at present numerically assess Ems and Lavant flows in relation to abstraction. Can make explanations of possible effects. In three years time perhaps in Sussex area will have necessary data and tools.

Do not have good abstraction data either beyond 1989. Post 1989 is both accessible and quality assured. Need to get the pre-data, and intend to in next few months – not easily got, but will be retrieved. Gavin will be contact for me for this.

I also told Alec about two spring sources in Chichester. One, to the east of the car park provides perennial flow to a part of the southern channel in Chichester (dries by Waitrose though). The other one is north of the College (this one comes from two pipes but appears to be groundwater) – above it on the bank is a green hut – was it a previous borehole that is now defunct and the spring flows now discharge to the river? From here I think the flow is perennial all the way to Appledram.