Balancing Hydro-ecological Needs with Sustainable Groundwater Abstraction

Anglian Region's Framework for Managing Groundwater Resources

Hydrogeology Meets Hydroecology
Geological Society, 22nd May 2008

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Objectives

- **Provide a quick overview of 9 years of work in 15 minutes!**
  - Development of a framework for managing groundwater resources making use of new distributed groundwater flow models
  - RSA and Habitats Directive Review of Consents

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Water Resources in East Anglia

- East Anglia – As a region is highly dependent upon groundwater as a potable source. Ca 45% of water comes from groundwater
- Main aquifers comprise Lincolnshire Limestone, Greensand, Crag and Chalk. Main aquifers underly 55% of the Anglian Region
- Thousands of agricultural users (spray irrigation etc) and industrial users
- The 90s was a dry decade - 2 serious droughts. Perception abstraction damaging wetlands.

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Groundwater Strategy

- The strategy established:
  - A programme to ensure a good understanding of the main groundwater systems across the region
  - The approach to be taken to groundwater investigation and modelling
  - The 'whole-life' approach to investigations and modelling, which means keeping models up to date and validated
  - A plan for maximising the use of groundwater models to directly support abstraction licensing
  - A plan for developing a distributed groundwater model framework which could provide a common management framework between the Agency and water companies

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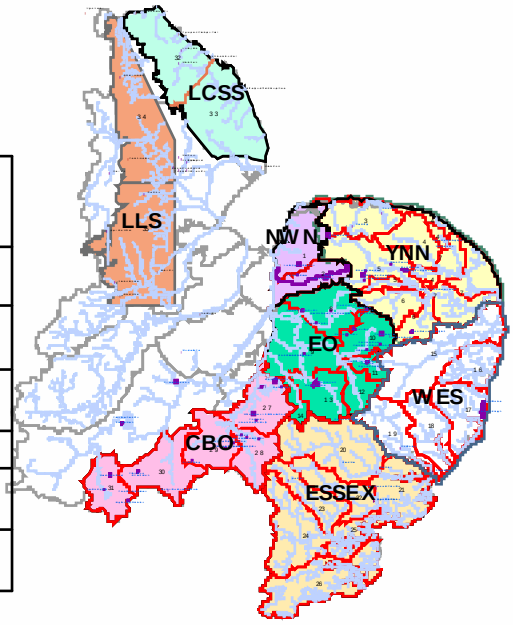
Model Areas

LCSS	Lincs Chalk and Spilsby Sandstone
LLS	Lincs Limestone
NWN	North West Norfolk
YNN	Yare and North Norfolk
EO	Ely Ouse
WES	Waveney and East Suffolk
CBO	Cam Bedford Ouse



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Model Layering – Complexity in Anglian Region

- Anglian models typically have 5 – 10 layers
- Models of the Chalk in Southern England typically have 1 or 2.
- So why have so many layers?

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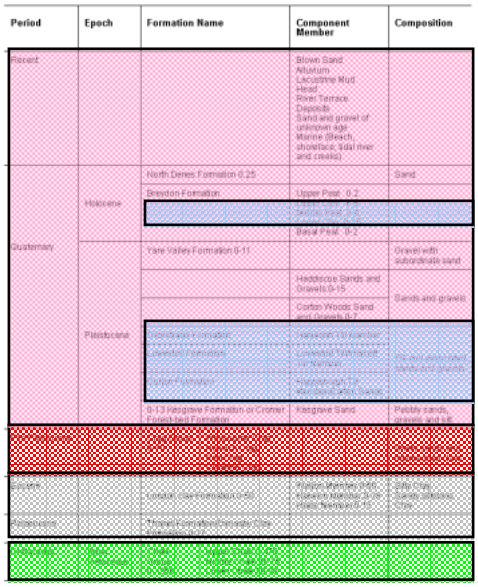
Geological Succession



Quaternary & Recent sands and gravels,..

..tills and clays

Crag

London Clay etc.

Chalk

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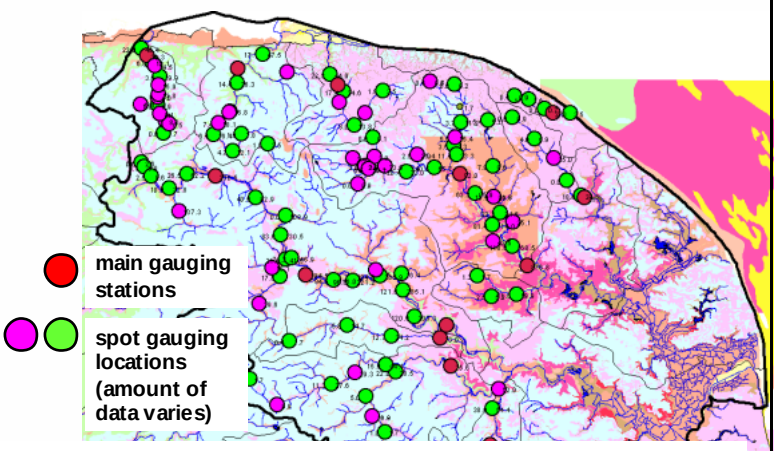
Does the drift matter?



Where is the chalk?
Flows from 'drift' covered areas are often more than 50% of flow at main gauging stations.
Supports wetlands – Majority of wetlands are within the 'drift'
Provides reservoir for Chalk 'recharge'

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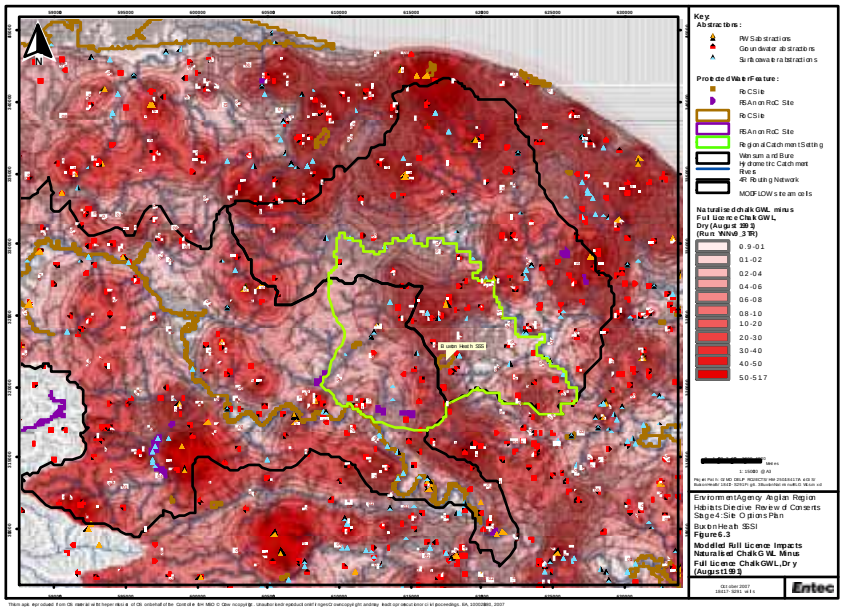
Groundwater model output



Uses of Models in Anglian Region

- **Impact assessments at wetlands, potentially leading to reductions in abstraction**
  - HD RoC
  - RSA on Non-Roc
  - Water company plans
  - AMP studies
  - Licence determinations
- **Estimation of drought impacts**
- **CAMS**
- **WFD Significant Damage**

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Restoring Sustainable Abstraction

- **RSA Programme set up by the Environment Agency in 1999 to identify and catalogue those sites which may be at risk from abstraction**
- **Main legal and policy requirements for EA**
  - Must ensure that licensed water abstractions (along with all other Environment Agency issued permissions) do not adversely affect the integrity of sites of European importance (SACs and SPAs)
  - Take action for SSSI at risk – PSA Agreement 95% in favourable condition by 2010
  - Agency has to protect BAP habitats and species
  - Take action on local issues

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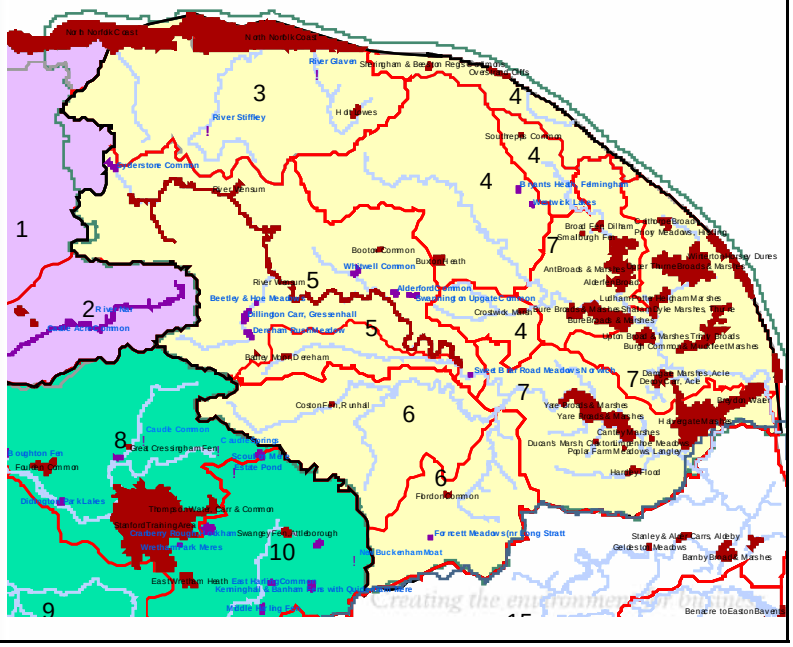
Implications for Anglian Region



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Large Range of N2k Designated Habitats and Species

- Alkaline Fen (M13)
- Calcareous Fen (S24, S25, S26, S28)
- *Molinia* meadows (M24, M25)
- Natural Eutrophic lakes (Plant communities - Ditches and Broads)
- Natural Eutrophic lakes – Plant communities of fluctuating meres
- *Chara* communities
- Transition mires (S27, M5, M9)
- Alder woodland (W5, W6, W7)
- Fen orchid
- Desmoulins whorl snail (S2, S5, S6, S7, S25)

- Lowland hay meadows (MG4)
- Wet heaths (M14, M16)
- Depressions on peat substrates (M1, M2, M21)
- Otter
- Great crested newt
- *Ranunculus* community
- Crayfish
- Lamprey
- Bullhead
- Humid dune slacks (SD16, SD17 etc)
- Saline lagoons

- plus Habitats supporting SPA species

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HD RoC Process

- **Stage 1 – Identify permissions which are relevant to the review for a European site**
- **Stage 2 – Assess which relevant permissions are likely to have a significant effect on the European site**
- **Stage 3 – Undertake an Appropriate Assessment to establish whether those permissions identified at Stage 2 are having an adverse effect upon the integrity of the European site**
- **Stage 4 – Affirm, modify or revoke permissions as appropriate following the Stage 3 conclusion**

- **First 7 years of RSA work focused solely on RoC wetlands**

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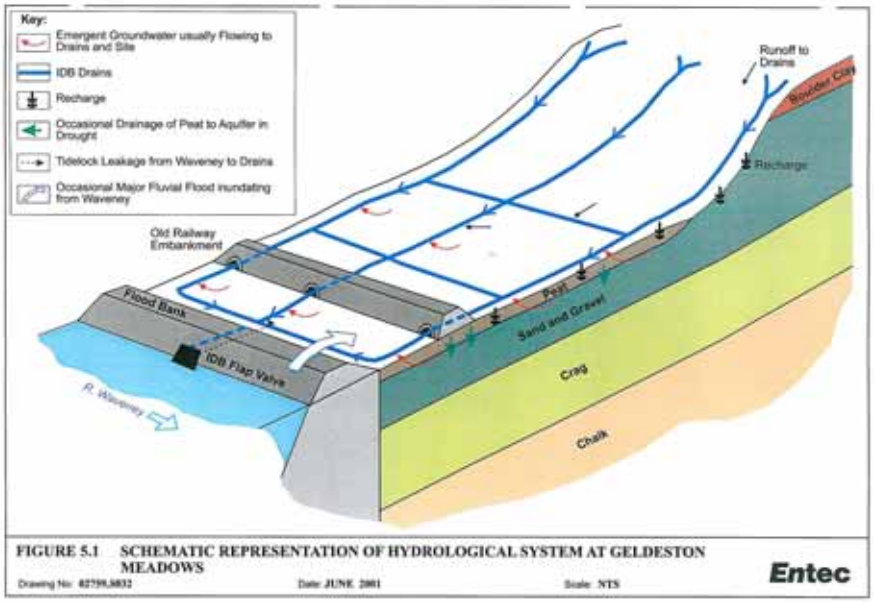
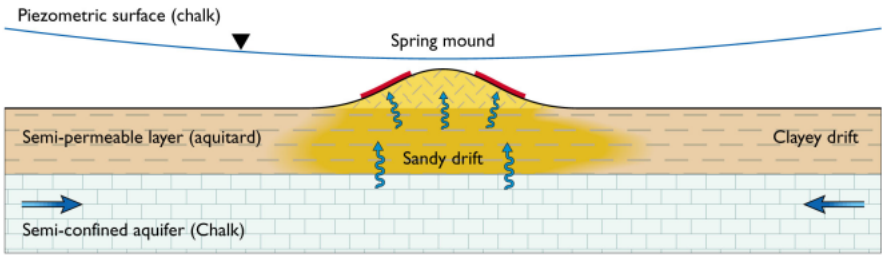
Stage 2 Site Characterisation Reports



Ecohydrological Guidelines for Lowland Wetland Plant Communities (Wheeler et al, 2004)

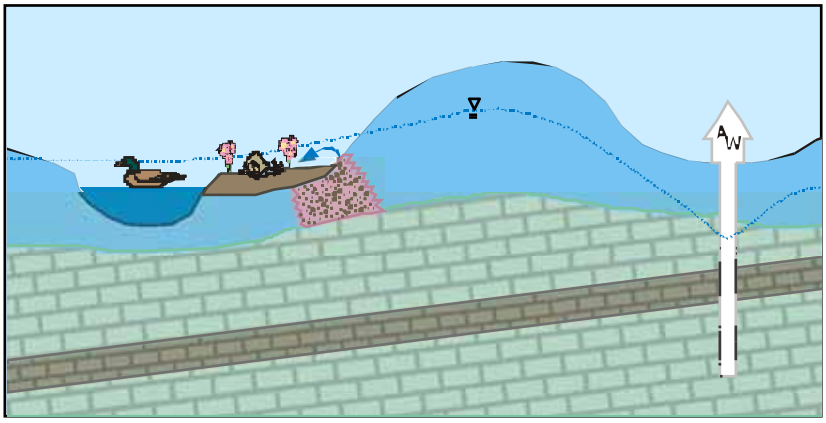
- ***What are the water needs of wetlands and how do we decide whether existing consents are having an adverse impact on European features?***

Permanent Seepage Slope (Spring Mound) with M13 (Badley Moor)



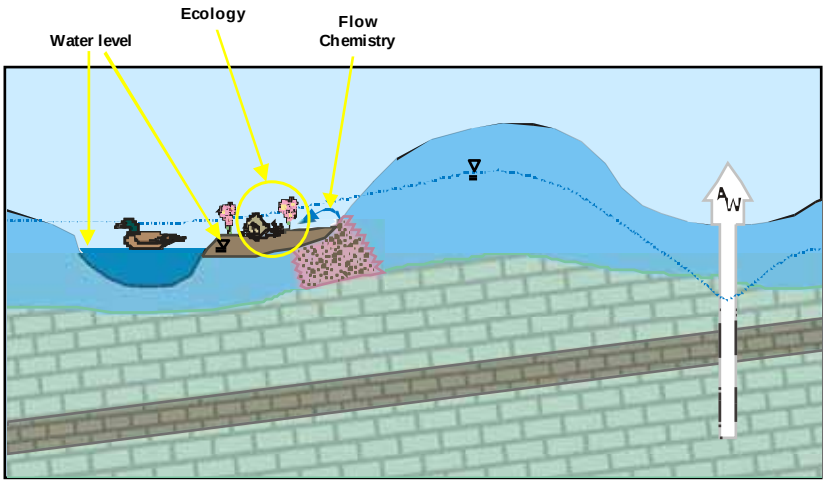
Designing Site Works - Conceptual Understanding

(source – pathway – receptor)



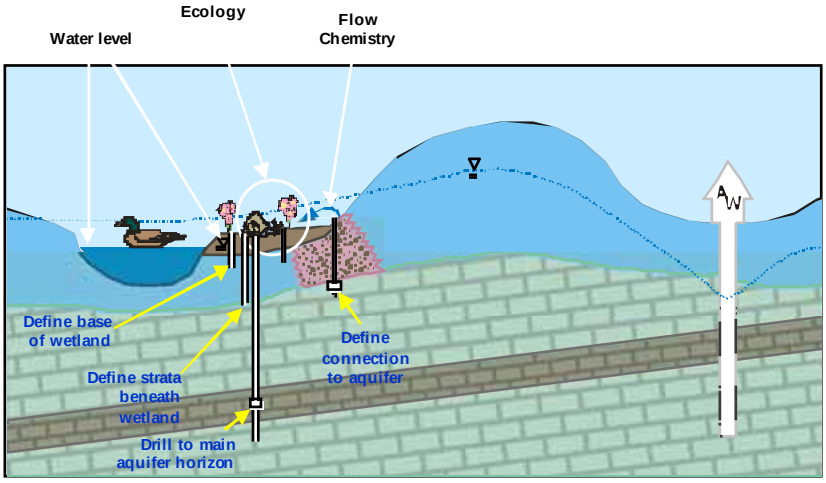
Conceptual Understanding

Ecological Vulnerability (Receptor) & Abstraction Signal (Source)



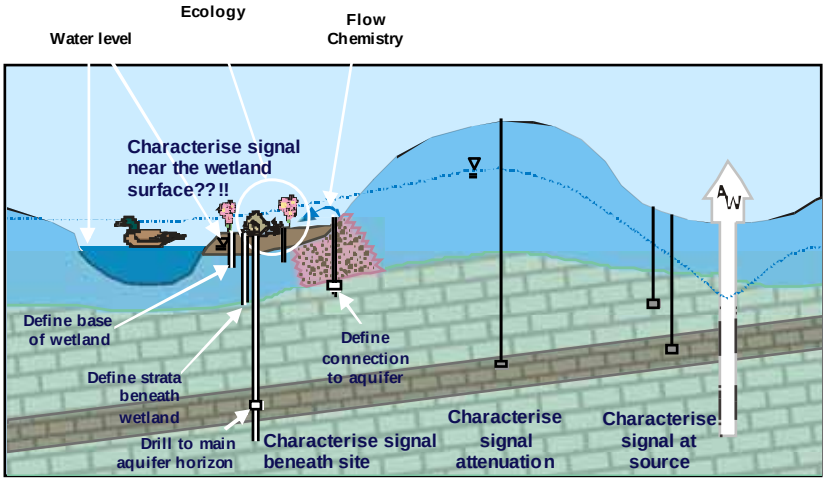
Conceptual Understanding

Nature of Pathway/connectivity with aquifer



Conceptual Understanding

Operation of Pathway – can we see any direct evidence?



Site Works Plans – Targeted Field Investigation

- Ecological baseline
- Topographic survey
  - Ecological features
  - Controls on water levels (e.g. stop gates)
  - Instrumentation
- Soil augering
- Water levels in main ecological features
- Piezometers in shallow/deep aquifers
- Stage and flow of key watercourses
- Hydrochemistry Regional observation boreholes
- Observation boreholes between abstractor and site
- Signal testing
- Monitoring for 1 year

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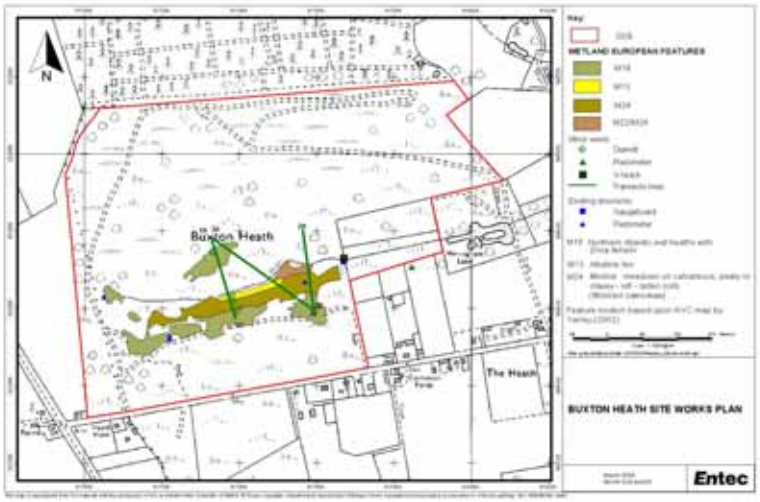
Example



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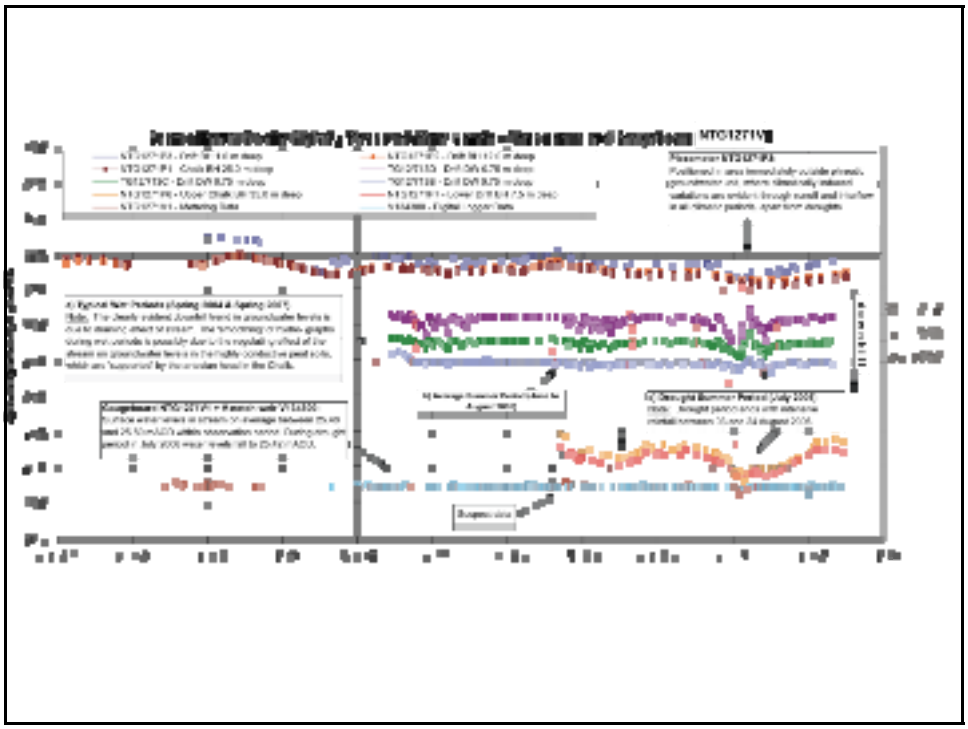

Investigations undertaken

- **To date (others to follow):**
  - Site Works Plans and Maps for 76 sites
  - Ecological studies on 15 sites
  - Auger studies on ca15 sites
  - Topographic studies on 52 (installations and/or transects)
  - Minor works (dipwells, gaugeboards) on 42
  - Drilling on 32
  - Spot flow/accretion on 34

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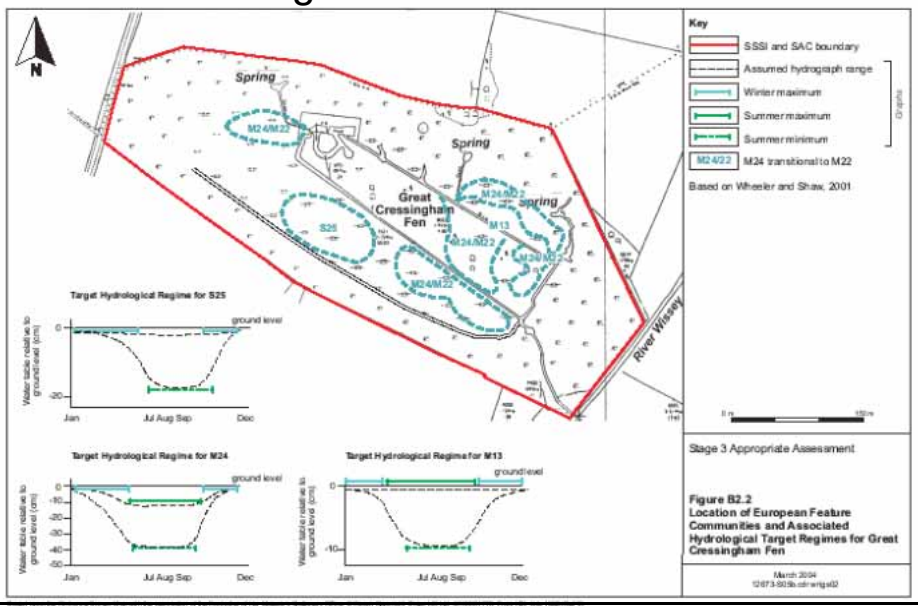
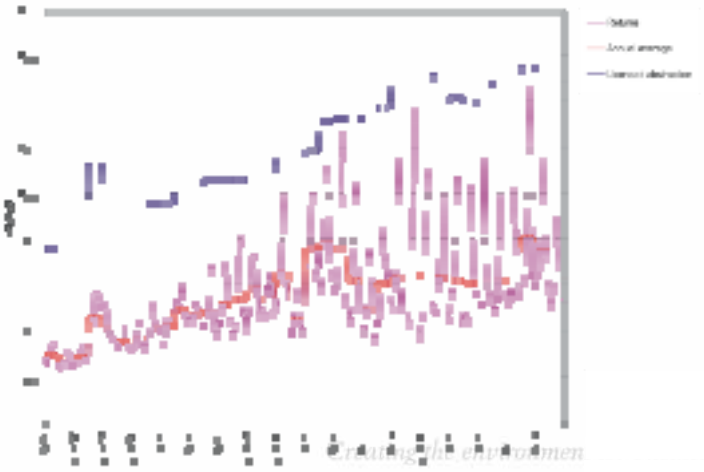
Stage 3 – Appropriate Assessment
Great Cressingham Fen



Stage 4 Site Options Plans

Site Characterisation and Conceptual Model

- Abstraction and licensing history (combined/individual)



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Ecological Features and Environmental Setting

- **European Features**
  - M13 (Alkaline fen)
  - M24 (*Molinia* meadows)
  - M16 (North Atlantic wet heaths)
  - H1, H8 (European dry heath)
- **M13 moderate - good quality, supported 16 M13 species when surveyed in 92, 18 species in 2007**
- **Site condition – 100% unfavourable declining**
- **Ecological change**
  - Differences between 1993 and 2000 surveys attributed to mapping differences, introduction of grazing rather and scrub encroachment
  - Possible species loss but more likely lack of recording than loss
  - Although concern about drying of the seepages, no long term reduction in water levels in the period 1976 to 1996

Stage 4 Site Options Plans

- **Proposed criteria for deciding acceptable levels of abstraction**
  - Surface Flows/baseflow
  - Groundwater levels (near surface)
  - Groundwater flow (vertical/lateral/net)
  - Soil moisture
- **Which to use?**
  - Select according to ecohydrological requirements of site/ecology
  - Takes into account evidence of ecological change
  - Whether NE believes a site is stressed under drought or non-drought conditions
  - Natural England – *'It is the best professional opinion of NE staff that the Site is not under apparent water stress in non-drought years (under recent abstraction levels)'*

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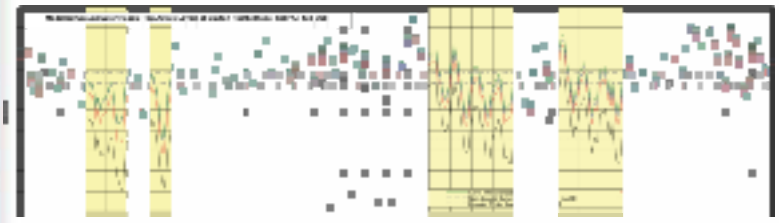
Appraisal of Scenarios – Site/Feature



Historical	**Non-drought summer – always within ooziness band,**
	Drought summer – no problem by definition
Full Licensed	**Non-drought summer – falls below ooziness band in 1 year (1975) (by 5%)**
	Drought summer – below water level threshold in 2 drought years (1974 and 1976) by up to 14 cm (in 1976) but only 2-3cm in 1974)
50% LTA	**Non-drought summer – falls below ooziness band in 10 non-drought summers**
	Drought summer – below water level threshold in 8 out of 10 drought years by up to 51cm (1974)

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Conclusions

- 7 large regional Models well on the way to completion
- Detailed investigation of over 50 sites
- Monitoring data (for some sites >10yrs)
- As a result obtained really good conceptual understanding of many sites
- Anglian region feel they are within touching distance of having a method for deciding acceptable levels of abstraction in the vicinity of wetlands – something that has eluded the Agency since the 70s
- Potential savings of hundreds of millions in compensation as a result of the work

- Overall therefore the Framework is helping the Agency make the right decisions in managing groundwater resources and balancing the hydro-ecological needs

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