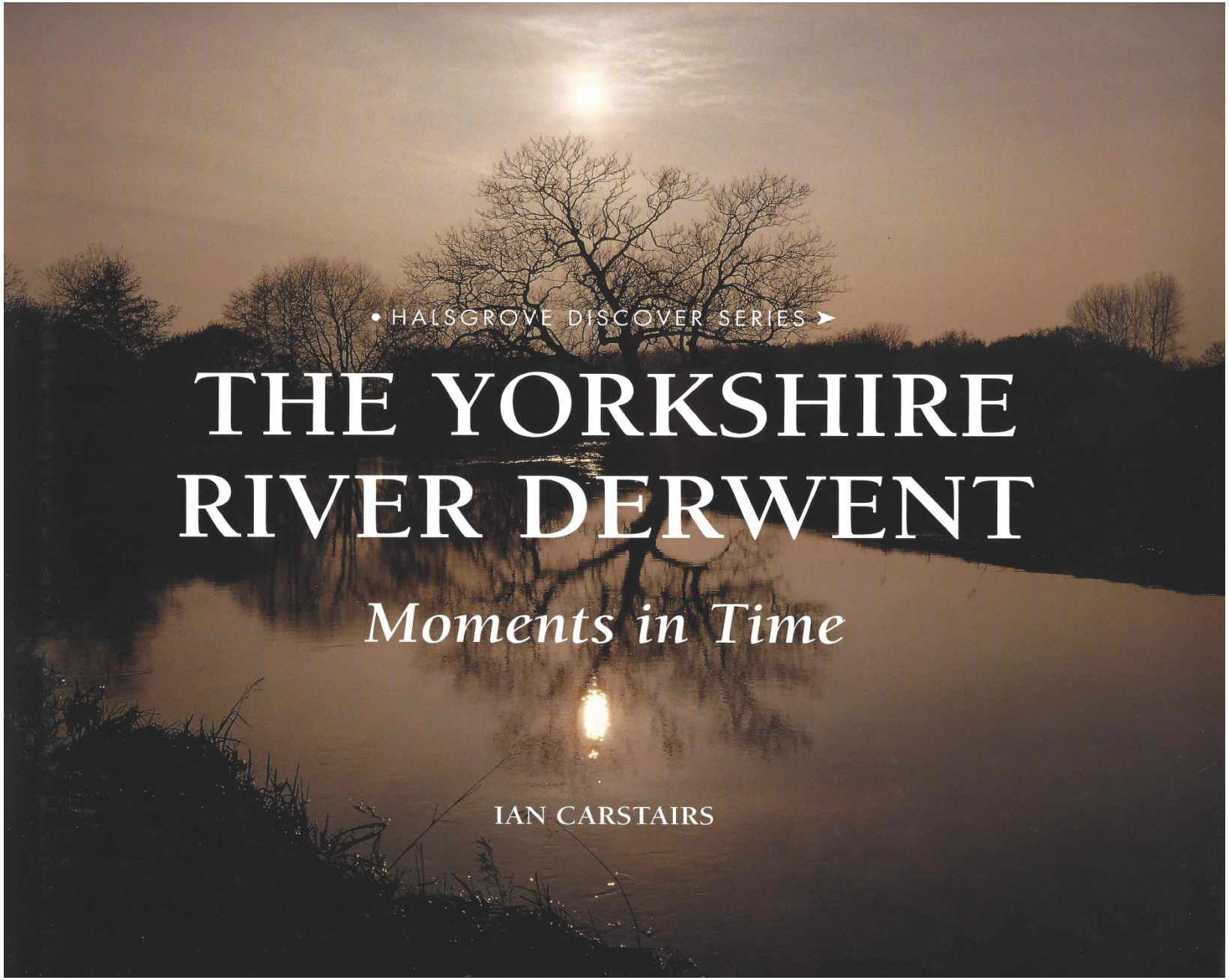
Assessing the Effect of Long-wall Mining Subsidence on Internationally Important Floodplain Grasslands in the Lower Derwent Valley, UK


• HALSGROVE DISCOVER SERIES ➤
THE YORKSHIRE RIVER DERWENT
Moments in Time
IAN CARSTAIRS

International Designations
(& legal protection)

- UNESCO Ramsar Convention Site – 1971 Wetlands – Waterfowl Habitat
- EU Special Protection Area (SPA) – 1979 EEC Birds Directive
- **EU Special Area of Conservation (SAC) – 1992 EEC Habitats & Species Directive**

LDV – UK designations & legal protection as Site(s) of Special Scientific Interest (SSSI) part is UK National Nature Reserve (NNR)

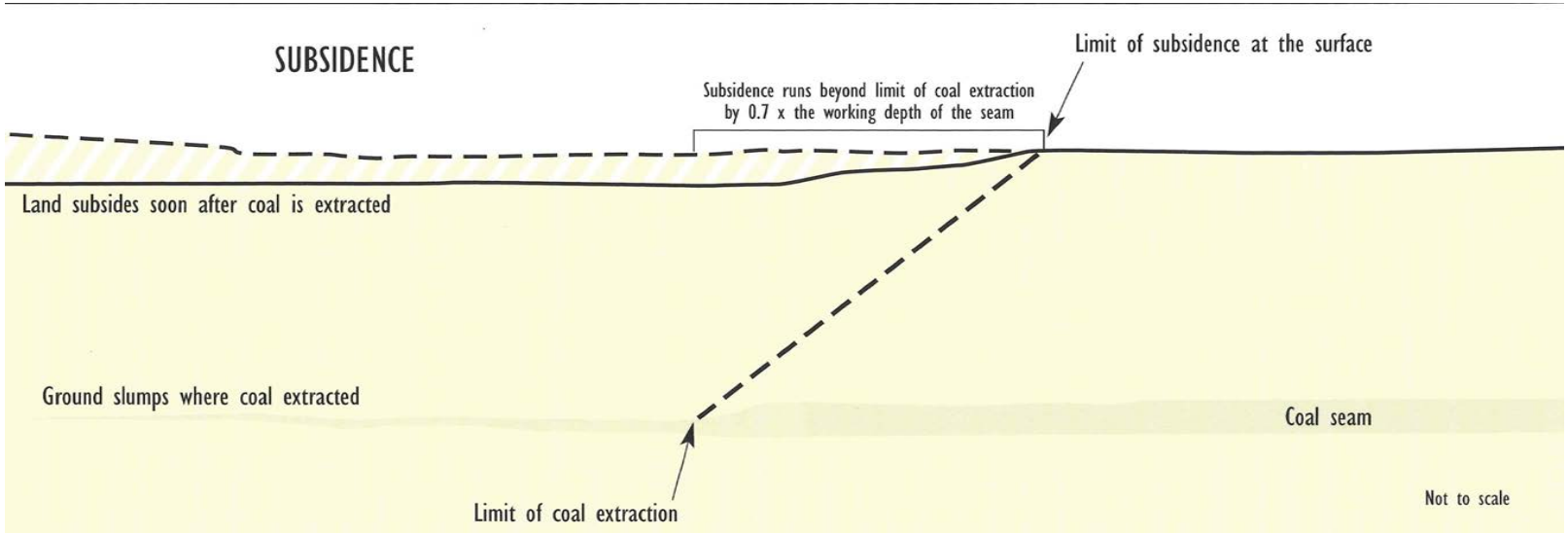
MG4 Grassland

- Rare occurrence in UK & Europe - Prime reason for EU SAC designation
- 120ha of 917ha total LDV area & most extensive of UK (>10% resource)
- Probably significantly less than 120ha because of inclusion of degraded/altered forms
- Mining potentially threatened pristine MG4 communities (areas already lost to mining)
- **EU SAC Directive – “no net loss” & “maintained in favourable condition”- otherwise development should not be allowed unless of national importance**

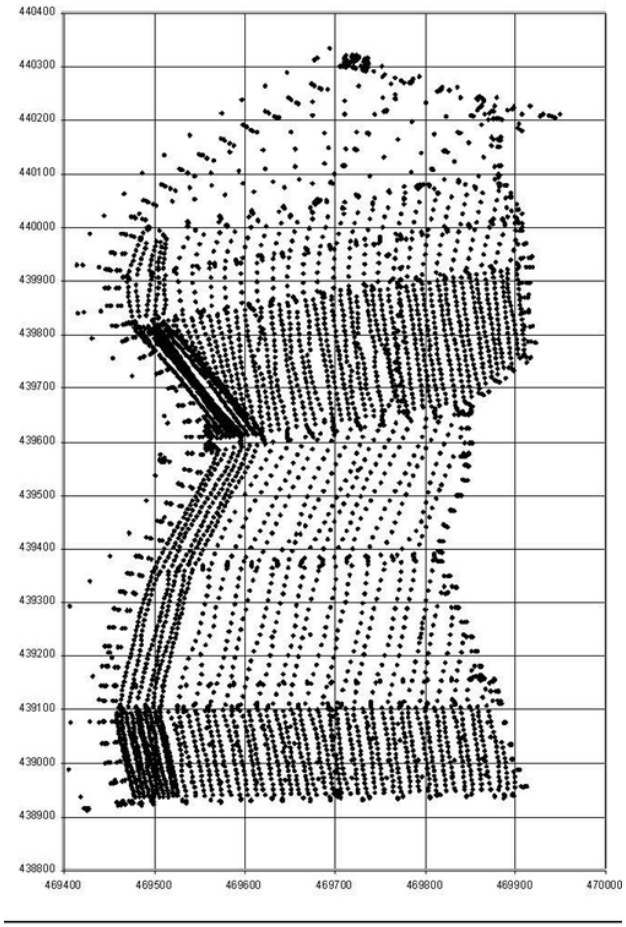
1. Topographic model for the prediction of subsidence impact on extent of MG4 grassland

Rationale:

- Topographic height and gradient will change
- Grassland community type and distribution adjust according to new wetness
- Corresponding height change in discrete community boundaries enables loss / no change / gain to be determined

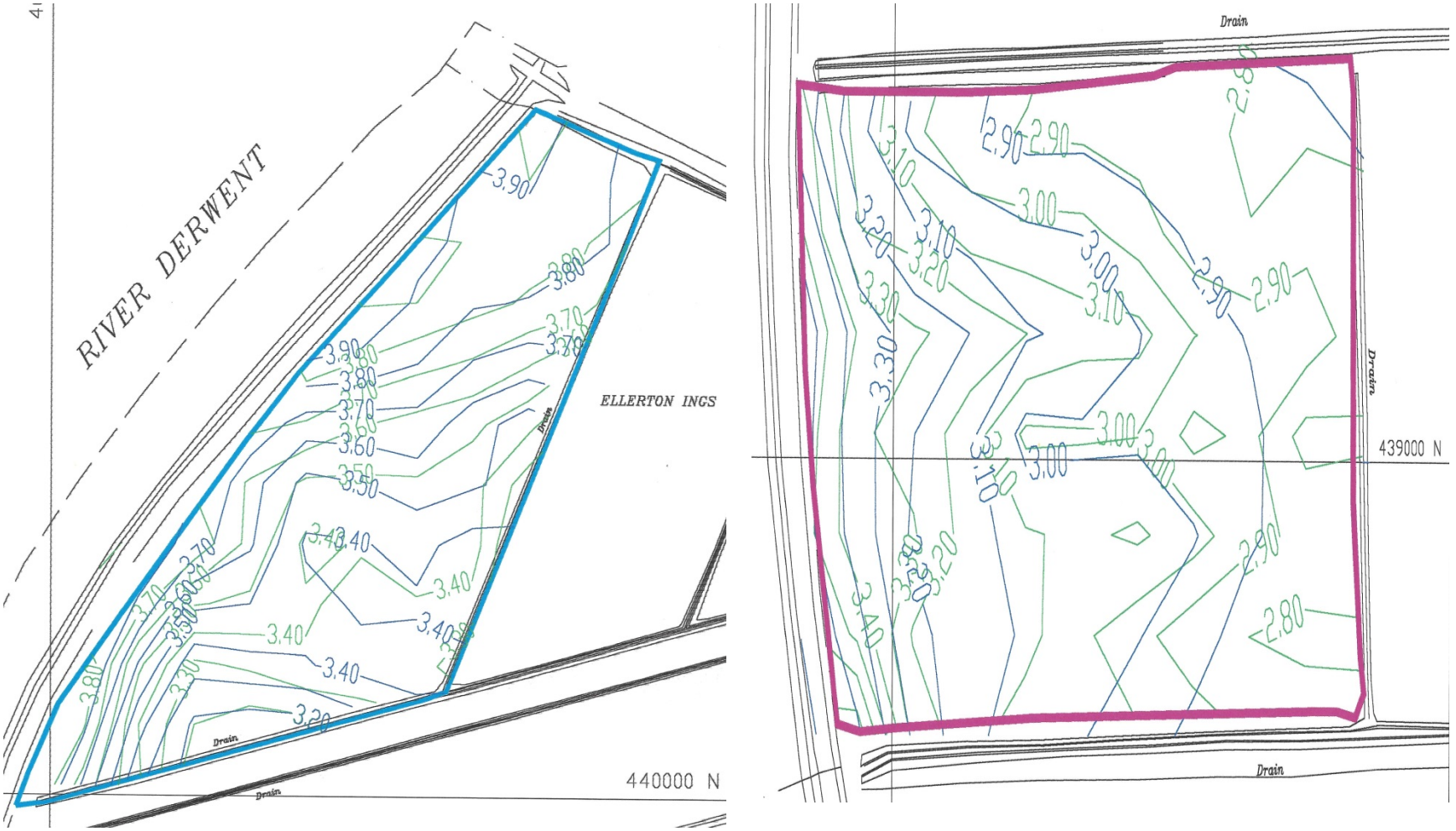


Topography & MG4 Boundaries

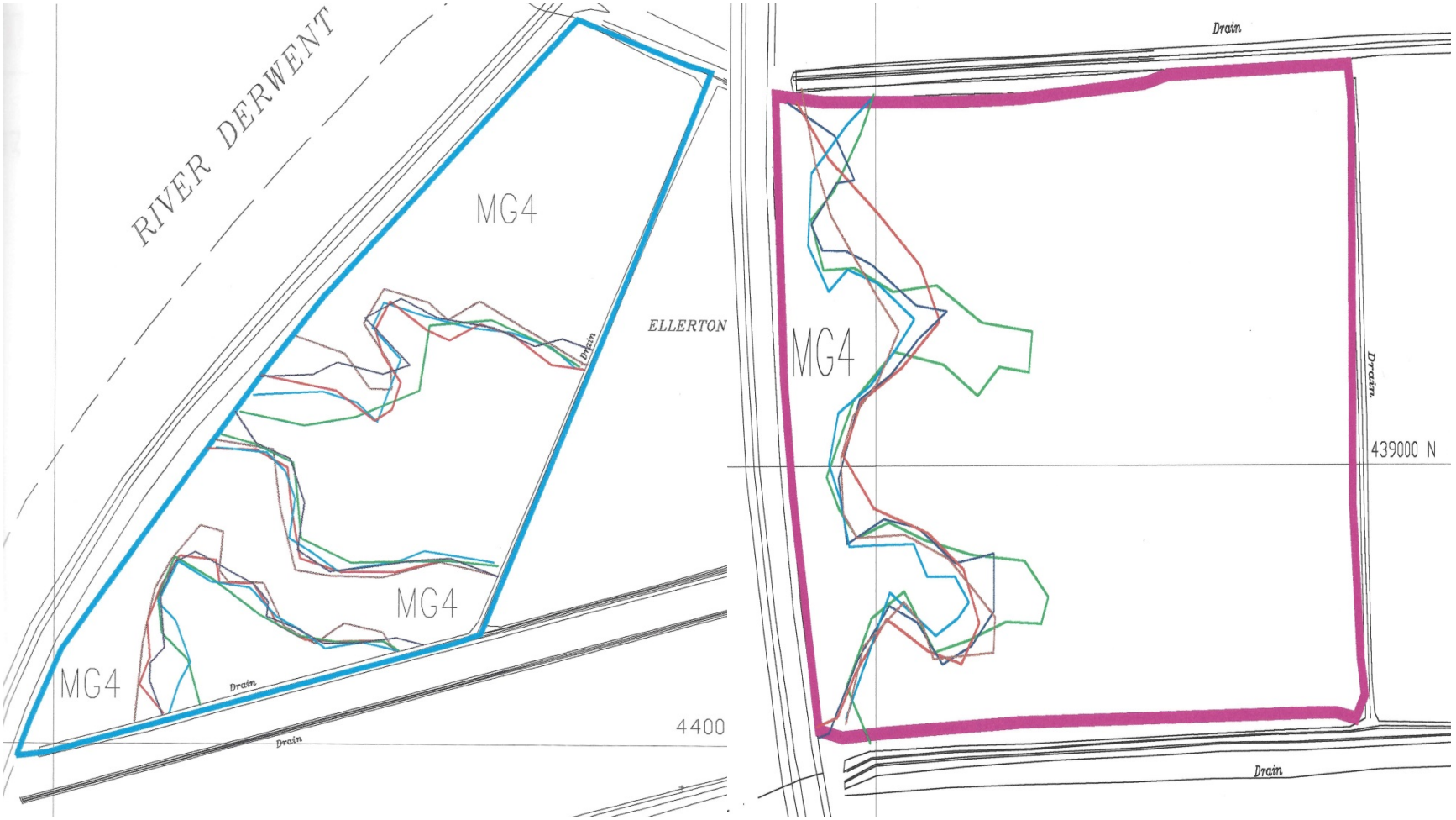


Predicted Subsidence – Whitemoor Mine Panels H634 & H635

Pre-mining Topography – Control & Affected Area



Pre- & Post-mining MG4 Boundaries

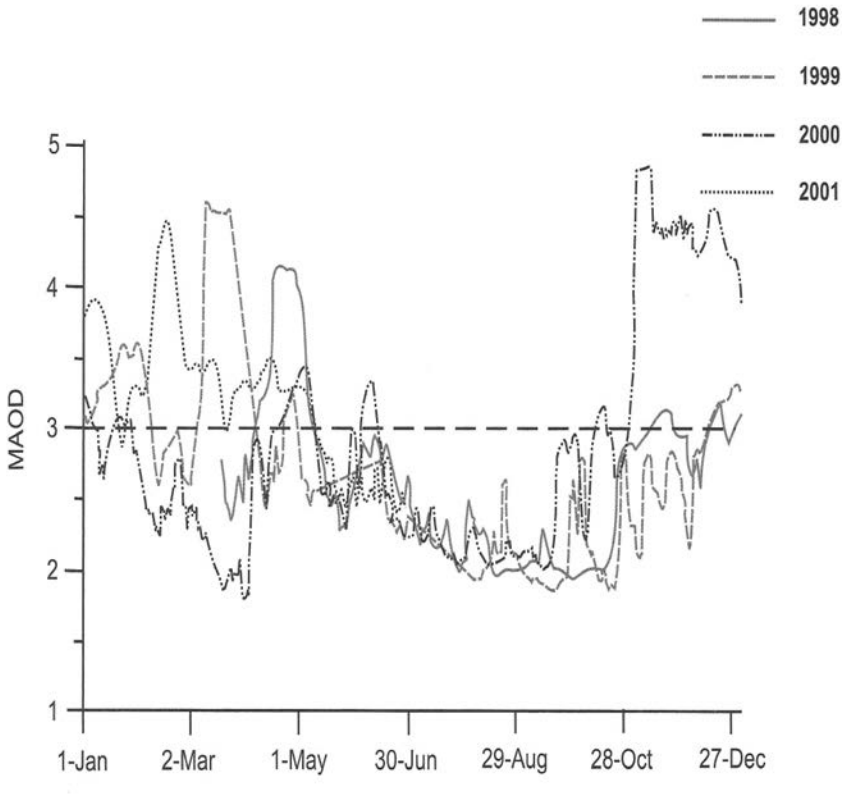


Outcome of Topographic Model

- Extent MG4 in example area before mining 0.594ha / After 0.577ha = Literal Reduction of 0.017ha
- Method at limit of detection as subsidence prediction only 5-10cm in MG4 zone, survey detection height limit 2.5cm & potential swell/shrinkage of clay soils 0-6cm
- Annual variation in MG4 boundary height as-great/greater than mine induced change
- Topographic model does not account for the annual variation in MG4 boundary and not applicable to the Derwent floodplain as deployed for the Riccal Mine
- Model useful for assessing point of zero effect (stand-offs)

2. Development of model based on ditch hydrographs

Typical ditch hydrograph – 24hour at 15min intervals



Conversion to cumulative days inundation

		North Duffield Ings				
Category	Description	1997	1998	1999	2000	2001
I	Above MG4	29	40	66	10	72
II	Between -40cm & MG4	1	10	40	49	58
III	Below -40cm	100	62	45	92	21
No Data		21	39	0	0	0

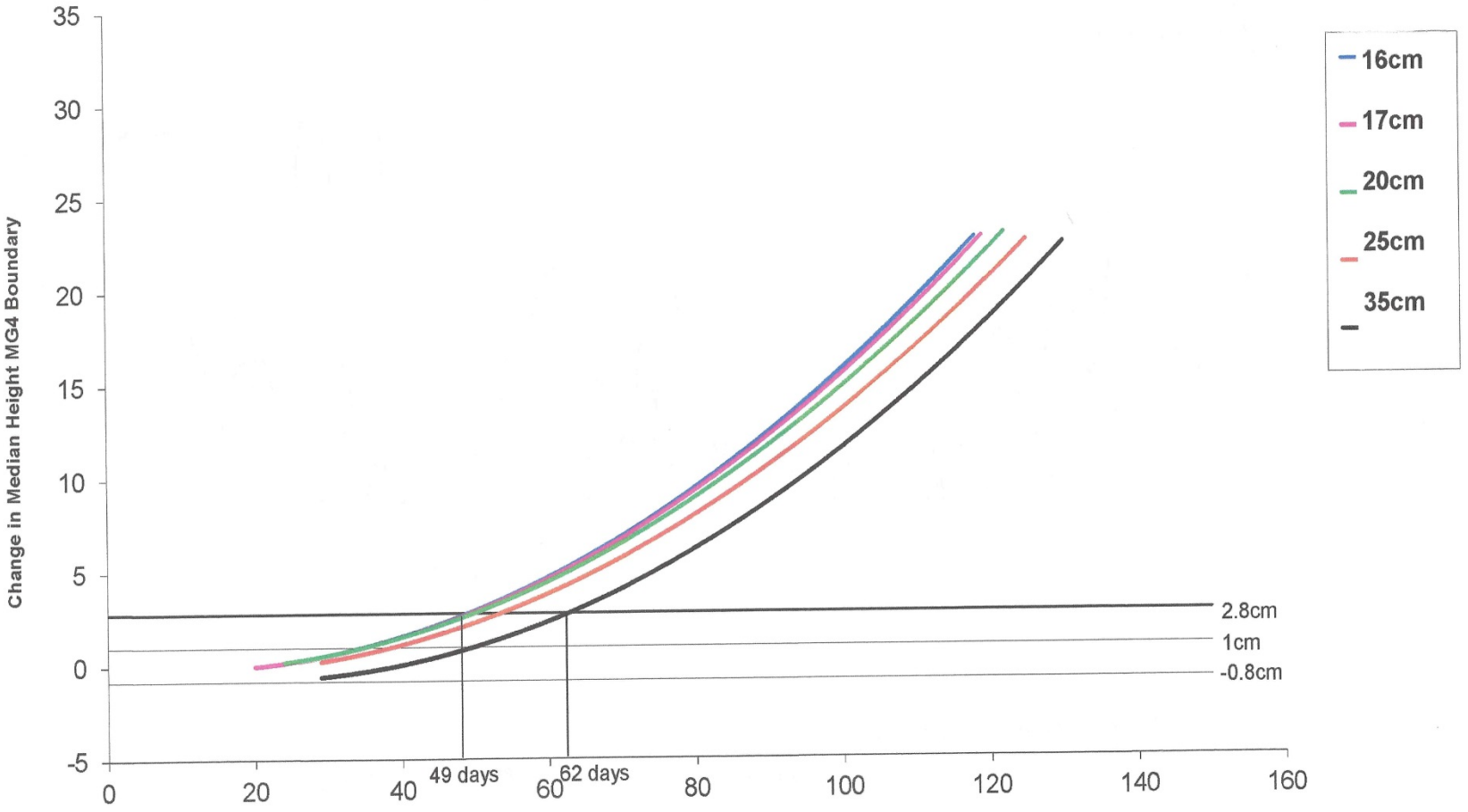
		Ellerton Ings			
Category	Description	1998	1999	2000	2001
I	Above MG4	30	66	15	109
II	Between -40cm & MG4	14	36	49	24
III	Below -40cm	31	28	87	18
No Data		76	21	0	0

Annual change in MG4 lower boundaries

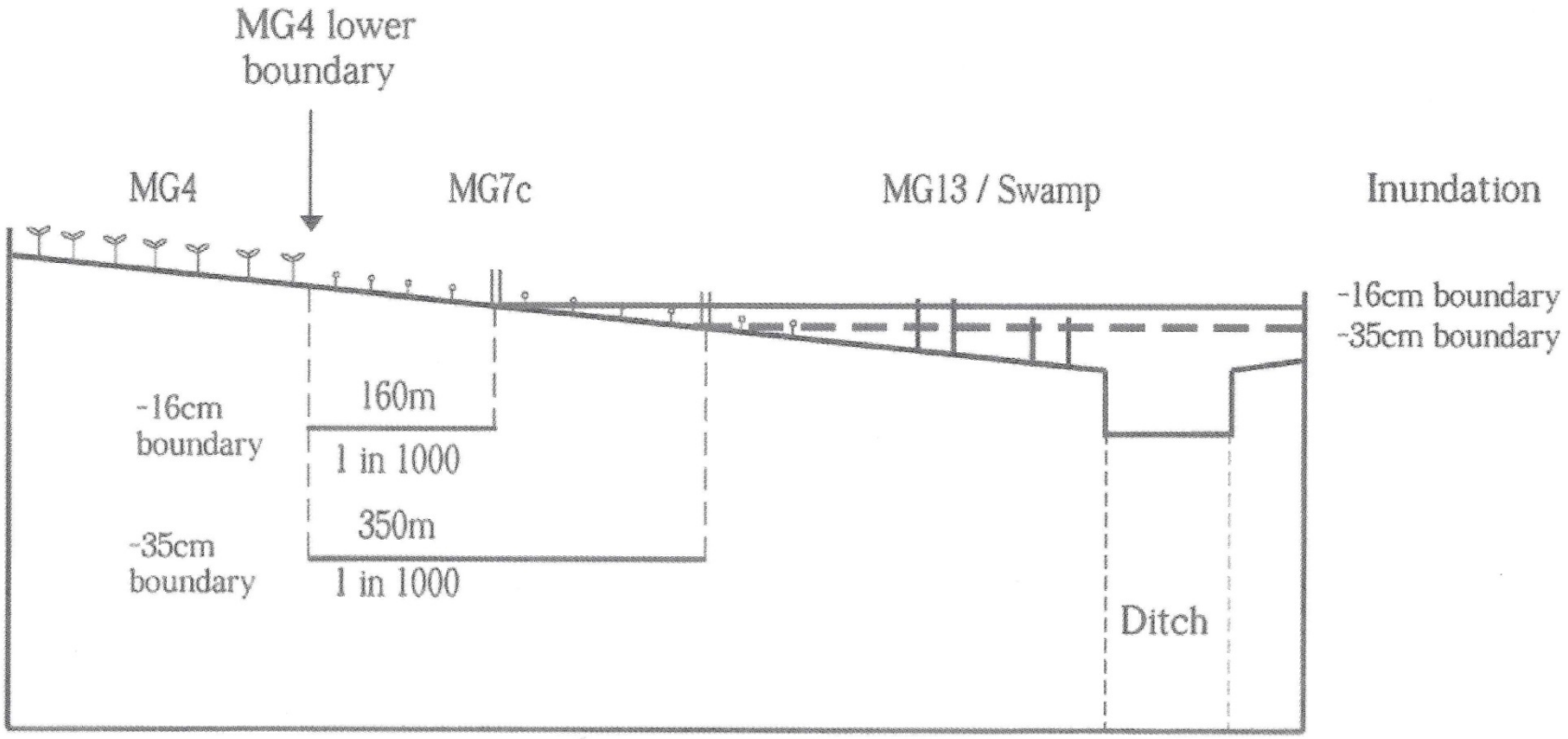
	North Duffield Ings											
	1996		1997		1998		1999		2000		2001	
Mean	2.97		2.96		2.96		3.03		3.06		3.41	
Median	2.96		2.97		2.95		3.04		3.08		3.41	
Minimum	2.85		2.78		2.84		2.95		2.89		3.01	
Maximum	3.17		3.06		3.04		3.12		3.30		3.83	
Range	2.85-3.17		2.78-3.06		2.84-3.04		2.95-3.12		2.89-3.30		3.01-3.83	
Change in mean height		1cm		0cm		9cm		4cm		33cm		
t Value & degrees of freedom		0.820	67	-0.126	68	-5.449	62	-2.121	63	-7.687	52	
Significance (90% Level)		NS		NS		*		*		*		

	Ellerton Ings									
	1997		1998		1999		2000		2001	
Mean	3.20		3.11		3.18		3.21		3.40	
Median	3.19		3.12		3.18		3.23		3.37	
Minimum	3.07		2.98		3.04		3.02		3.31	
Maximum	3.43		3.44		3.43		3.38		3.61	
Range	3.07-3.43		2.98-3.44		3.04-3.43		3.02-3.38		3.31-3.61	
Change in mean height		-9cm		6cm		5cm		14cm		
t Value & degrees of freedom		2.890	40	-3.096	55	-1.414	54	-5.971	32	
Significance (90% Level)		*		*		*		*		

Regression of decrease in MG4 boundary height and number of inundation days



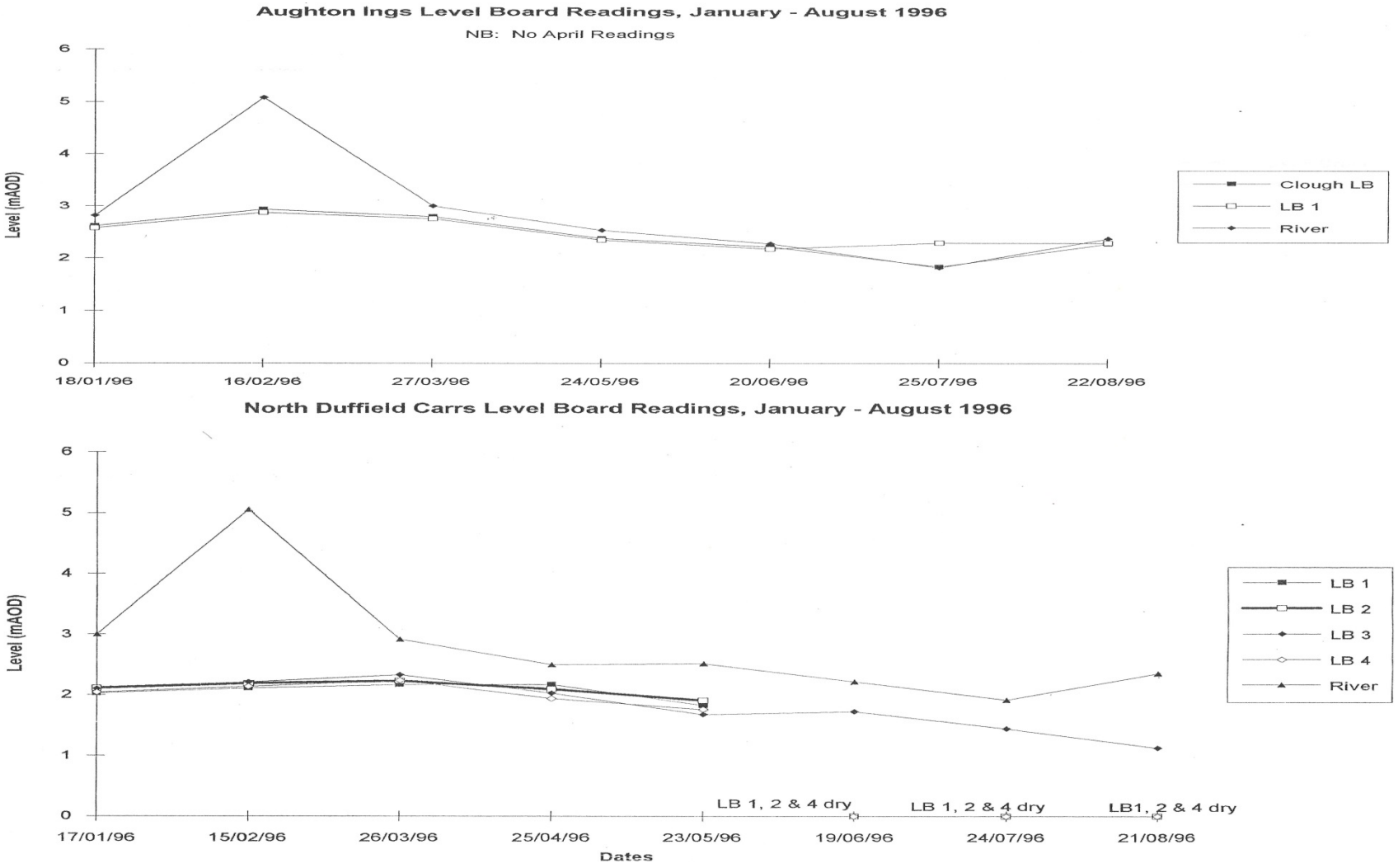
Ditch water level model



Outcome of Ditch Water Level Model

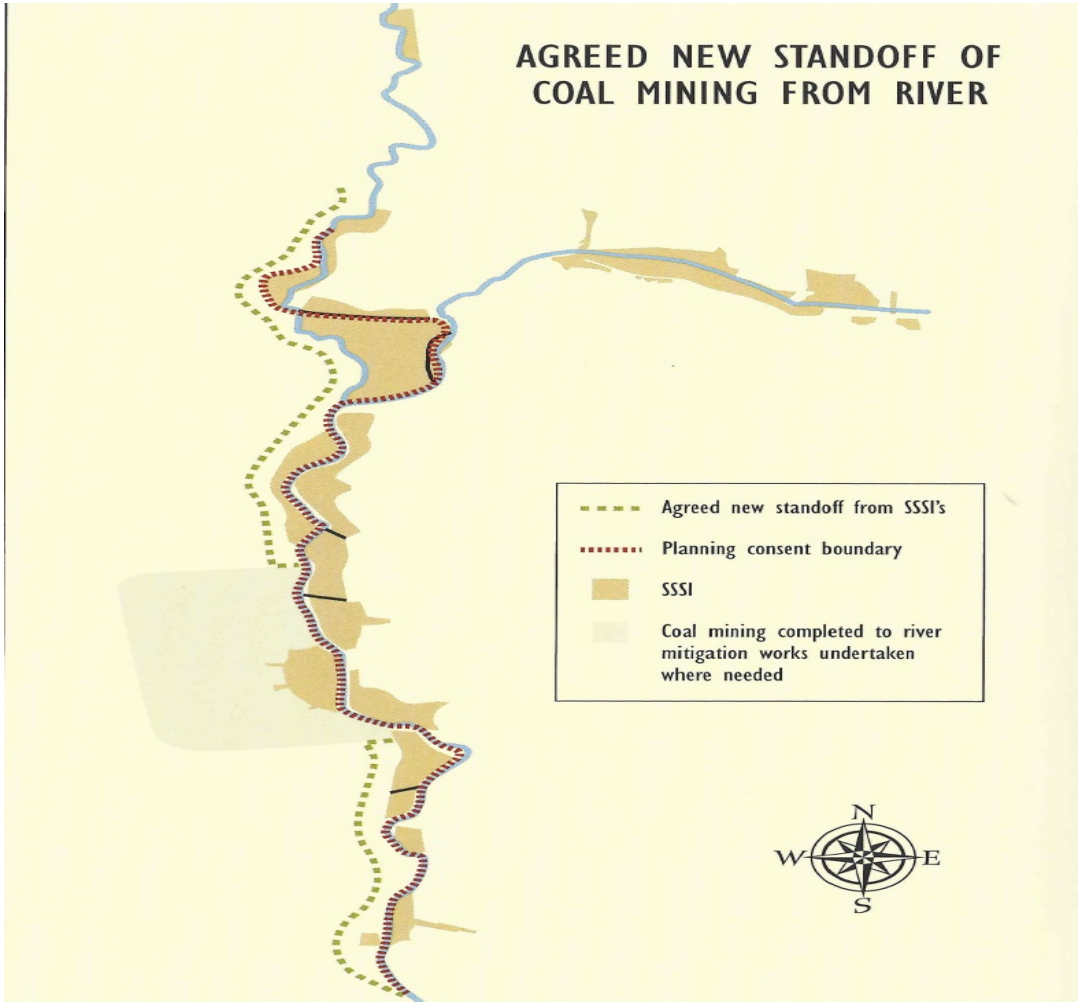
- Model explains and refines the relationship between the limit of the MG4 community and site wetness
- Model accounts for the between-years variation in site wetness and MG4 boundaries
- Practical application of the model requires the ‘control’ over ditch water levels, which are determined by the River levels and the operation of the Barmby tidal barrage

River level determine MG4 boundary by controlling ditch water level



3. Avoidance & Mitigation

- Avoidance (Stand-off) by restricting subsidence envelope overlapping with MG4 zones – eg North Duffield & Bubwith Ings
- Assume worst-case loss of MG4 zone – eg Ellerton and Aughton Ings – either on-site or off-site mitigation
- On-site mitigation by pump drainage to maintain MG4 zone (difficult to achieve in practice – eg Duffield Carrs)
- Off-site mitigation involving establishing new grasslands



Off-set mitigation

Estimated 5.6ha loss – nearby land purchased in 2000

Harvested hay crop from existing MG4 grassland

Re-spreading to establish new MG4 grassland at off-site receptor

Trails 2002/2004 – Large-scale 2005

Successful mitigation – South Grange Farm

MG4 Indicator Species	National Ref Sites	Off-set Site (2012)
Ranu acris	V	V
Trif prate	V	IV
Plan lanc	V	III
Cyno crist	V	V
Anth odor	V	V
Sang off	IV	II
Holc lanat	IV	IV
Sila silaus	III	II
Lath prate	I	II

Outcome of Off-site Mitigation Approach

- Off-site replacement for MG4 loss seems to be achievable and the most realistic mitigation option (where river level not determining site wetness)
- MG4 is not limited to floodplains and there is greater scope for mitigation and for extending the natural range of the protected grassland

Mining's Contribution to the Debate

- Construction and operation of Barmby Barrage likely to have caused degradation of MG4 grasslands and reduced their extent
- Becoming accepted with Environment Agency trials (2016-2020) to manipulate river flows and reduce duration of flooding
- Future threat - rise in sea levels likely to have consequential impact as mining subsidence

Main Cast

Humphries Rowell Associates (researchers)

– Neil Humphries, Paul Benyon, Harold Wesseman, Anna Brewis

RJB (coal mining company) – Chris Bennett, Steve Peace

English Nature (statutory governmental agency)

– Jeff Lunn, Tim Dixon

Light Owlers Trust (NGO & land owner) – Ian Carstairs

Some References

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