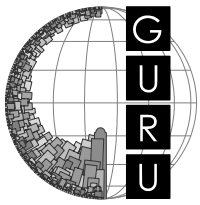

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Planning for Water:
Space, Time and the Social Organisation of Natural Resources

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ABSTRACT

Managing the provision and use of water has become increasingly controversial. This working paper seeks to provide an analysis of the wider sociotechnical issues shaping contemporary water management strategies. It draws upon in-depth interviews with water company engineers, regulators, policy-makers and developers together with a detailed survey of relevant reports and secondary literature covering recent technological, commercial, regulatory and environmental innovation shaping the British water industry. The overall aim is to highlight the ways in which approaches to water management are framed within changing temporal and spatial frameworks.

The paper firstly maps the diverse concerns which have drawn the management of water resources to public attention, illustrates the response of the newly privatised water companies to the water 'crisis' and explores the elaboration of a new vocabulary of water demand planning, Demand Side Management (DSM). Secondly, the roles of regulatory and commercial actors in shaping the control, management, provision and use of water resources in the South of England are then identified. Critically, the paper demonstrates how the dynamics of top-down regulatory push against bottom-up commercial pull creates a constant jarring of effect within inter-regional water management strategies in this area of water stress. Thirdly, the logic of DSM is illustrated through a critical examination of a proposed infrastructure project to supply a new commercial venture near Folkestone using DSM techniques. Key issues for water utilities raised by this shift in management 'logic' are then highlighted and the lessons for innovative land-use planning strategies explored. The paper concludes by reviewing the main issues raised by the emergence of a DSM logic in the British water sector.

ABBREVIATIONS

CPRE	Council for the Protection of Rural England
DoE	Department of the Environment
DSM	Demand Side Management
FDWSL	Folkestone and Dover Water Services Limited
FoE	Friends of the Earth
KCC	Kent County Council
MKWC	Mid Kent Water Company
ML/D	Million Litres/Day
NCC	National Consumers Council
NGO	Non-Governmental Organisation
NRA	National Rivers Authority
OFWAT	Office of Water Services
RH&HD	Rank Holidays and Hotel Development Limited
RWA	Regional Water Authority
RPG	Regional Planning Guidance
spz	Source Protection Zone
SWSL	Southern Water Services Limited

FIGURES

1. INTRODUCTION

Context

Managing the provision and use of water has become increasingly controversial. Questions are currently being raised around many inter-related water issues; the adequacy of existing resources to withstand drought, the environmental implications of continuing to expand supply, the re-organisation of the water industry as a commercial business and subsequent commodification of water through spiralling tariffs. This working paper gathers together many of these issues by examining the emergence of a new 'logic' of water management that emphasises the active shaping of demand in alleviating the stresses and strains placed on contemporary water infrastructure networks. This 'logic' of demand-side planning represents a striking departure from established modes of water management. Rather than leaping to expand supply capacity, through environmentally questionable infrastructure development, a new sensitivity to the efficiency of water provision and use has arisen. Driven by a range of political, regulatory, commercial and technical 'signals' privatised water companies are currently 'experimenting' with novel water management techniques. Intensive leakage control initiatives, widespread industrial and selective domestic metering, pressure reduction, real-time informatic monitoring of system operations and more accurate demand forecasting are all serving to minimise water wastage and 're-balance' the supply and demand of water.

The advent off these demand-management techniques have important implications for land-use planning strategies. The Department of the Environment (DoE) is increasingly signalling the critical importance of water management issues to the development of county, district and unitary structure plans (DoE, 1992a). DoE is particularly concerned that intensive development does not over-stretch already fully-committed regional water networks while also ensuring that lack of necessary infrastructure does not hamper local economic development. The paper will demonstrate how demand management initiatives can help satisfy these contradictory priorities. For example, the siting of water intensive commercial/industrial enterprise can be fundamentally shaped by the availability or otherwise of adequate water supplies. Mediating the impact of new business developments on local infrastructure networks through demand management strategies can make a vital difference to the feasibility of development, allowing scope for the introduction of more environmentally sustainable local economic development.

However, debates around water network management are caught within a web of opposing strategies which have their basis in fundamentally different 'ways of seeing' water resource issues. The different agencies with a role in the control, management, provision and use of water have distinctive viewpoints driven by particular spatial, temporal and cognitive priorities. Government agencies (DoE/County/District council's/OFWAT/NRA) tend to adopt a top-down view, seeking to control county/district and regional space over long periods of time. In contrast, the providers and users of water necessarily see resource issues from the bottom-up. Developers are spatially driven by local property markets in the context of short-term economic cycles, while water companies are concerned with their own bounded territories and lengthy investment strategies. Aims and approaches to water management issues therefore depend upon the way of seeing which matches the institutional location of each water actor.

Structure of Report

This working paper seeks to provide a general overview of all these issues. It draws upon in-depth interviews with water company engineers, regulators, policy-makers and developers together with a detailed survey of relevant reports and secondary literature covering recent technological, commercial, regulatory and environmental innovation shaping the British water industry. The overall aim is to highlight the ways in which approaches to water management are framed within changing temporal and spatial frameworks. The rest of the paper is structured in the following way:

Section 2 will map the diverse social, physical, technological and commercial concerns which have drawn the management of water resources to the attention of Government, social and environmental pressure groups, industry, regulators, the media and general consumers alike. Concerns over drought, environmental spoliation, spiralling investment costs and consumer prices and the evils and virtues of competitive water provision together provide the context for the emergence of the 'logic' of demand-management infrastructure strategies. The elaboration of a new vocabulary of water demand planning is explored as it surfaced in the publication of seminal reports from Government, pressure groups and water industry regulators over the last three years.

Section 3 reviews the response of the newly privatised water companies to these reports by reference to internal water industry debates and demand-management trials and initiatives. These shifts highlight the emergence of a new logic of water management as the industry focuses attention towards more demand oriented responses to economic and environmental presures.

Section 4 will identify the roles of each institutional actor shaping the control, management, provision and use of water resources. The 'way of seeing' of each of these groups will then be unpacked with particular regard to the spatial, temporal and cognitive dimensions of each 'world view'. These will be highlighted with reference to water resource management in the Southern Region, which has experienced some of the worst effects of drought and continues to experience water management problems. The tensions that exist between the demands of medium term land-use planning, environmental protection and economic regulation, and the pressures and priorities of the commercial water and development industries will be illustrated. The paper will show how the dynamics of top-down regulatory push against bottom-up commercial pull creates a constant jarring of effect within inter-regional water management strategies. Such disharmony can lead to profound supply/demand imbalances which may leave an abundance of water in some areas and serious shortages in another, exacerbating social and environmental problems.

Section 5 develops a typology of supply and demand oriented demand-management techniques and critically contrasts the established water management approach of simply facilitating infrastructure provision through the exploitation of additional sources of supply. This section illustrates the DSM 'logic's' by critically examining infrastructure management approaches with reference to the proposed siting of a commercial venture near Folkestone. The impact on local water resources the development presented difficult planning obstacles. The approach taken by the potential water customers, suppliers and local authorities is illustrative of the limits to traditional water infrastructure management approaches and the potential of demand-management planning strategies. Further key issues for water utilities raised by this shift in management 'logic' are then highlighted including; a greater sensitivity to the commercial implications of territorial governance,

a changing profile of social, environmental and commercial risk shaping technical decisions, the critical importance of micro water-demand data, the growing importance of infomatic technologies to water management strategies and a wavering connection with local, regional and national environmental policy and planning. Overall, the case study will demonstrate the efficacy of demand-management techniques in easing the impact of new, water intensive developments and will discuss the lessons for innovative land-use planning strategies.

Section 6 concludes the working paper by speculating as to the role planners can play in smoothing this discord by positively engaging in the co-ordination of the disparate aims and actions of each water actor. By revealing hitherto hidden institutional processes and engaging with the desegregated spatial, temporal and cognitive agendas of each agent some of the tensions that beset water management debates may be eased and more appropriate planning strategies adopted. The paper will finally identify the political, regulatory and economic signals pushing the water industry towards adoption of demand-management techniques and assess the likely pattern of such a shift in the logic of infrastructure planning. In conclusion, the likely consolidation of demand-management of water resources will be evaluated and the key issues for future land-use planning strategies explored.

2. THE EMERGENCE OF WATER STRESS[1]

Heroic Engineering

Water has conventionally been seen as a taken for granted, low-cost, renewable resource. Until recently, economic development has stimulated the expansion of water supply capacity in a elementary cause and effect symmetry. With water engineers anticipating water demand to rise linearly over time the eradication of 'water stress' has traditionally been viewed as a techno-managerial problem, the exploitation and distribution of new sources of supply to meet changing demand for water provision. As James Winpenny puts it:

> Faced with the evidence of future shortages of supply to meeting growing demand, the typical response has been to: commission a comprehensive study of resources; project the demand on an 'unconstrained' scenario; consider the various supply-augmentation options: recommend that which meet projected demand at the least cost; and implement the scheme through public agencies, and at a subsidised price (Winpenny, 1994, p21-2).

The roots of this techno-managerial approach to infrastructure management lie in a widely shared 'modernising' desire to massively expand infrastructure networks in order to support national economic development. From the 1920's, and gathering speed following the second world war, the ethos shared by infrastructure planners was to capacity-build utility networks to create an all embracing sweep across the country. This technical objective has been achieved as specific socio-technical problems have been gradually solved. In the early development of water infrastructure physical connection to domestic consumers to the network was of prime importance on public

[1] 'Water stress' is here meant to denote any short-fall in provision of potable water supply existing after viable economic and environmental limits to water extraction and distribution have been reached. See Winpenny,1994.

health and environmental grounds. Connection of all households to secure water supplies and waste disposal, irrespective of class, was seen as the key to radical improvements in urban living standards. Industrial and commercial consumers only become connected to the water network later, having to rely upon private supplies of water for many years. This strategy was highly successful. Britain was one of the first countries to achieve high levels of connection and early improvements in public health were closely linked to reliable and cheap provision of potable water supplies. Such success inspired the technological imagination. As with the concurrent development of a national electricity network, management of public water supplies was over-whelmingly directed by 'heroic engineering' solutions to nation-wide priorities. Management and development of the water industry was driven by "politically neutral" technologists operating in a closed world of technical expertise (Maloney and Richardson, 1994, p113). Through the 1960's and 1970's the development of water supply infrastructure increasingly followed a powerful supply oriented logic premised by forecasts of substantial increases in water demand due to rapid industrial growth and rising standards of living, through the adoption of new domestic technologies such as washing machines and dish washers. Such optimistic projections provided the rationale for massive investment in new reservoirs and treatment facilities.

The 1990's has, however, witnessed the emergence of critical debate around supply-led water management strategies. Concerns have grown over the environmental and economic costs of unrestricted infrastructure growth. Environmental groups such as Friends of the Earth (FoE) and the Council for the Protection of Rural England (CPRE) have campaigned long and hard to prevent the development of new reservoirs and further abstraction of over-stretched aquifers and rivers (FoE, 1992, CPRE, 1995). At the same time the privatisation of the water industry in 1989 signalled recognition of the impending crisis faced by a decaying infrastructure starved of vital investment, the scale of which, the Government argued, was beyond the public purse (Vickers and Yarrow, 1988)[2]. This debate around water management issues took place against the background of severe drought[3]. From 1988-92 the media was filled with stark images of barren river-beds and dried-up gardens. Hosepipe bans became common-place and the sight of public standpipes familiar, dashing the image of water as a plentiful free-good. Hitherto confined to third world imagery, the harsh realities of water stress emerged into British consciousness. Rarely a year now goes by without televised confrontations between water company representatives and consumers on the culpability for water shortages highlighting the socio-political tensions surrounding water resource management (Bannister, 1995).

Concurrent realisation of the environmental and economic costs of water provision and daily reminders of the effects of water shortages brought the inherent limitations of traditional water management strategies into sharp relief. On the one hand the standard engineering response to growing demand was to enhance supply capability. During the 1960's and 1970's crude, linear demand projections (based upon past trends extrapolated uncritically into the future) justified the development of a host of new reservoirs, the enlargement of existing reservoirs plus the construction of major inter-regional transfer networks (Water Resources Board, 1974). The

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[2] The Government estimated that £24 billion investment was required over a 10 year period to make good years of restrictions on capital spending (Kinnersley,1994,p4).

[3] The worst drought for 150 years (CPRE,1993,p4).

technical and physical efficacy of such water management approaches is illustrated by the muted impact of the 1975-6 drought, the effect of which was dramatically mitigated by the development of new supply capability (Kirby, 1984, p117). Such supply-side development of water resources clearly mitigates the effect of water stress. However, from an enviro-economic standpoint such a development intensive management style seems crude. For as Judith Rees and Sarah William's put it:

> ...the crucial issues are, first, whether such a supply oriented management approach is also sustainable in environmental, economic and social terms and, second, which amongst the range of potential supply enhancement measures are most compatible with the various sustainability dimensions (CPRE, 1993, p11).

The case of Kielder Water graphically illustrates the enviro-economic poverty of supply oriented approaches to water management. Driven by demand forecasts built upon expectations of high industrial growth a 200,000 Mega litre reservoir was planned in Northumbria. The development went ahead, despite widespread opposition to the environmental disturbance caused by the scheme, justified by the need to service the future expansion of the heavy chemical and steel industry in region. The cost was £169 million, with one and a half million trees felled to clear the site. However, the completion of the reservoir coincided with a significant collapse in industrial demand, leaving the Northumbrian Water Authority servicing a high interest debt, which it was unable to meet due to the loss of expected revenue, and necessitating the rapid conversion of Kielder from a critical infrastructural resource to a recreational water-park (Gardiner, 1986).

Such heady days of 'heroic engineering' are passing quickly. Privatisation of the water industry, together with the dramatic elevation of environmental concern, is promoting a more integrated approach to resource planning rooted in an understanding of infrastructure networks as complex systems of provision. Rather than merely focusing on technical fix-it solutions through massive supply-side investment, the efficiency of water systems form production, through distribution, supply and use is being more closely scrutinised. In particular, privatisation has signalled the emergence of more demand oriented water management strategies.

Using Water Wisely

Demand-Side Management aims to modify the intensity, amount and/or time of energy and water consumption of new development rather than simply supplying more infrastructure and services. DSM initiatives can be effectively employed across utility sectors to minimise the economic, social and environmental costs of meeting increases in demand with supply side investments (Dziegielewski and Baumann, 1992, Davison 1991, Hanson et al 1991). Measures can include a wide variety of energy and water efficiency innovations as an alternative to investing in major new power and water. Demand side management techniques first surfaced in the United States. Under pressure from consumer and interest groups, a number of US state regulatory commissions developed an alternative method of regulation aimed at actively discouraging supply side of investment in energy services. Instead, DSM energy strategies, based on a mix of energy inputs and energy efficiency were encouraged, minimising the enviro-economic costs of energy provision. In the energy sector, 43 US States now have established forms of utility regulation that employ DSM principles to meet rising demand for energy services through a wide variety of utility controlled load management initiatives and the incorporation of increased insulation, energy efficient lighting

and domestic appliances, often subsidised by low interest loans to customers for energy conservation measures (Schreuder, 1991).

Inspired by the success of DSM in the energy sector regulatory commissions throughout the states are now considering how to encourage DSM initiatives in the gas, water and transport sectors. In California, innovative local ordinances have been developed to encourage both developers and utilities to implement demand management policies to deal with the problem of regional water shortages and rising levels of demand created by new development. Such an approach was stimulated by demand profiles predicting increases between 1990 and 2010 of 24.4 gallons per capita per day (Dziegielewski and Baumann, 1992). A whole host of DSM initiatives have been implemented by the Metropolitan Water District of Southern California including; educational programmes, plumbing retrofit campaigns, conservation audits, conservation ordinances, water supply efficiency programmes and conservation-oriented pricing. In practise this means that for a new development to receive planning permission water demand from existing developments must be reduced, through retrospective water conservation measures such as more efficient plumbing, low-flow showers and toilet cisterns, by the same level that the new development will increase demand. In this way both new developments, and the existing housing stock, is made more efficient in its use of water. The overall goal of the Californian program is to save some 50,000 to 150,000 acre-feet of water year with the result that by 2010 water conservation would constitute the largest single source of additional water. Such a strategy has the clear enviro-economic benefit of ameliorating major increases in demand in areas of water stress, so lowering infrastructure investment costs. The Californian example is currently being widely replicated. For example, in Boston demand is said to have been reduced by 14% over a five-year period, avoiding the need for a new dam (McCann and Appleton, 1993, p37).

Figure 1 summarises the main changes that DSM measures bring about in the process of managing and developing infrastructure networks. The rationale for DSM measures in the United States encompasses three related objectives. First, the appropriateness of integrating considerations of demand and supply side options; second, the value of explicitly considering the social, economic and environmental impacts of different options; third, the desirability of greater public participation in the policy making and implementation processes. The overall aim is to assign values or costs to the social, economic and environmental implications of different options. Network planners can then select an option which minimises adverse economic and environmental impacts but maximises the overall socio-economic benefits to society. Of course the context of utility management in the United States is very different to that in the United Kingdom. In the US model the different interest groups are brought together by powerful state regulatory commissions who are ultimately responsible for water, energy and transport services. No comparable public agency exists in Britain where privatisation and liberalisation of utility services has transformed the utility marketplace. Nevertheless DSM initiatives are appearing in Britain across all infrastructure sectors. Again it is in the electricity sector that we find the clearest examples[4]. However, there are signs that a gradual development of comparable demand side management initiatives is concurrently emerging in the British water sector. A new logic of water planning, characterised by an enhanced sensitivity to the

[4] See Guy, S (1994) *The New Energy Managers? Regional Electricity Companies and the Logic of DSM,* Departmental Working Paper No. 47, Dept. Town and Country Planning, University of Newcastle.

dynamics of demand, appears to be surfacing, fundamentally reshaping the social, technical, spatial and commercial strategies of privatised water companies.

Figure 1 Key Features of Traditional Planning and Demand Side Planning Approaches

FEATURE	TRADITIONAL PLANNING	DEMAND SIDE PLANNING
Options	supply	demand & supply
Focus of economic analysis	internal	multiple groups
Objectives	single	multiple
Environmental requirements	meet minimum	exceed minimum
Judgement & Preferences	implicit	explicit
Role of public	passive	participants

(After Hanson et al 1991)

The emergence of debate[5] around demand-management in the United Kingdom has been stimulated by the publication of a set of 'seminal' reports on water resource management. A consultation paper from the DoE (1992b), a series of campaigning reports from the Council for the Protection of Rural England (CPRE, 1989, 1991, 1993) and the Royal Society for the Protection of Birds (Fowler, 1994), an assessment of our ability to deal with drought from the Parliamentary Office of Science and Technology (POST, 1993), a development strategy manifesto from the National Rivers Authority (1994a) and a series of discussion papers from the Office of Water Services on issues of investment costs and water pricing (OFWAT, 1991, 1992, 1993). Each of these reports has signalled the critical importance of DSM techniques to the challenge of alleviating water stress in a socially, economically and environmentally sustainable manner. Each has advocated off-setting the need for supply enhancement investment through more sustainable development pathways. Rather than simply adopting a technical fix-it approach, no matter what the circumstances, a more cautious route is commended - one which identifies a range of options, assesses their potential contribution to minimising water stress, explores the full range of costs and benefits associated with each measure. NGO's, the DoE and regulators alike seem to have found a degree of consensus in the efficacy of this strategy. Most notably the Government has tentatively backed a DSM approach to water management, with a Minister of State for the Environment and Countryside, Robert Atkins, arguing that in the Government's view, "major action on the supply-side - such as investment in new reservoirs or inter-basin transfers should not be pursued while there is still scope for demand side action" (Atkins, 1994). An earlier DoE publication, 'Using Water Wisely' (DoE, 1992b), set a new framework for debate around the management of water resources by arguing for substantial

[5] Pressure groups such as the Council for the Protection of Rural England (CPRE) have been campaigning around 'demand-management' issues for many years, while criticism of supply-side infrastructure engineering has a long history (see Hirschleifer et al, 1960).

'demand-side' intervention. Pitched in terms of Bruntland's Sustainability, and complimenting the Environment White paper 'This Common Inheritance' (HMSO, 1990), 'Using Water Wisely' aimed to stimulate debate about the "scope for reducing demand for water use as an alternative to major works to increase supply" (DoE, 1992b, p4). The consultative paper took particular issue with the techno-managerial assumption's underlying traditional water management strategies:

> We should not take it for granted...that the only answer to existing or predicted water shortage should be major increases in supply, especially when under the present charging system the extra costs of such supply would be spread across the bills of most customers according to property values and not related to the extra volume they are consuming. The better course may be action to cut waste or reduce demand (DoE, 1992b, p3).

'Using Water Wisely' identified a number of priority areas where demand-management initiatives could help alleviate zones of water stress including reducing leakage levels, saving water inside domestic, industrial and commercial sectors, water recycling, re-use and more widespread metering. The technological efficacy of these initiatives has been well documented elsewhere (Binnie, 1992). More critically, 'Using Water Wisely' asked who should be responsible for the implementation of these innovations? Whilst acknowledging that the National Rivers Authority (NRA) were the only body with a formal responsibility for environmental protection, the DoE argued that DSM required wider involvement from the Government, NRA, OFWAT, Water companies, local authorities, manufacturers and ordinary citizens alike. In particular, the document emphasised the importance of strong regulatory signals in encouraging private water companies to opt for DSM strategies in managing water resources.

Signalling DSM

Fundamental to the emergence of new approaches to water management has been the development of a regulatory framework which has transformed techno-managerial issues into questions of enviro-economic efficiency. The NRA, the licensing authority for water abstraction, have been charged with scrutinising the enviro-economic costs of supply-side investment. A firmer grip on new abstraction licenses has been quickly established with a review of individual water companies efforts to reduce leakage central to the granting of new licenses. More generally in recent reports the NRA have committed themselves to the "promotion of water efficiency" and for an ongoing review of the "feasibility, cost and environmental impact of local schemes" as compared with other "strategic options" (NRA, 1994). Drawing on an analysis of potential growth in public water supply demand to 2021 the NRA have identified 3 scenarios. A 'high' scenario, in which demand grows by 25% (expressed as a % of 1991 demand) due to high growth in consumption and negliable dsm, a 'medium' scenario in which demand grows by 10%, suggesting moderate growth in consumption and some demand management, and finally a 'low' scenario of only 2% due to increased dsm and little or no growth in consumption (NRA, 1994a, p5). This scenario analysis, with its emphasis on DSM as the key to a low future consumption growth, is now shaping NRA policy on water management. A Demand-Management Centre has been set up to promote DSM activity throughout the water industry and strategic plans for the Southern and Thames regions (which experience the most acute water stress) have been published.

Meanwhile, OFWAT encouraging water companies to manage demand more effectively - primarily through the minimisation of leakage and increased use of meters. This process began in 1993 with the publication of the consultation paper "Paying for Growth" which provided a framework for thinking about the costs of increased water and sewerage provision, encouraging water companies to think about DSM rather than merely engaging in supply-side engineering. In October/November 1991 the 31 water companies handed to OFWAT a complete set of demand-forecasts for the next 20 years together with their plans for increasing supply/managing demand. These plans will be used by OFWAT to check the progress of water companies on DSM issues. OFWAT maintain this on-going supervision by annually scrutinising the operational efficiency of water companies on a comparative basis. This results of this evaluation feed in directly to the pricing regime determining both price levy's and the degree to which water companies can pass on investment costs to customers through the 'K' component of the pricing formula[6]. Critically, this 'annual return' now focuses on 'water delivered' rather than 'water supplied'. This means that the relative efficiency of different components of water use through trunk mains, service reservoirs, distribution mains and household communication pipes has become clear. This is an important regulatory shift as hitherto any losses through the water system were hidden. OFWAT are also leading the debate about a more demand sensitive pricing regime. Again this represents a critical step for DSM initiatives as pricing by rateable value has meant relative costs of treatment, transmission and supply were masked.

Moreover, the regulatory push of both OFWAT and the NRA is proving complimentary. If water companies over-estimate potential future sales OFWAT can reduced unit costs in the price review - if they under-estimate future growth the will find it difficult to justify applications for new abstraction licenses to the NRA. In this way, the regulatory framework is strongly shaping the operational priorities and practices of water companies by encouraging a move away from technically conventional supply investment towards more integrated management approaches which aim to balance supply and demand.

The regulatory and commercial drive towards greater efficiency in the water industry has been matched by the rising profile of environmental debates surrounding water management issues. Much of the credit for this must also go to various NGO's. In particular CPRE have argued vigorously that we cannot simply "build our way out of water supply problems with new reservoirs, increased ground water abstraction and transfer schemes.." (CPRE, 1995). Together with Friends of the Earth (FoE) CPRE have been arguing that the "answer to our current crisis must lie in a package of demand management measures, which are used differently according to the nature of the problem in specific areas.." (FoE, 1992).

Each of these institutional actors is playing a part in fashioning the market-based context of water provision. Through the production of new regulatory frameworks, and stimulation of highly public socio-environmental debates, the social organisation of the water industry is being radically reshaped. Through this process the traditional supply oriented logic of water planning is being gradually displaced.

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[6] The 'K' factor is the amount water companies can charge customers over and above the rate of inflation.

To summarise, there are a broad range of social, economic, regulatory and commercial factors shaping the emerging 'logic' of demand-side water management:

- There has been a long debate about the economic costs of continuing to expand infrastructure networks. Part of the rationale for privatisation has been the strain placed on the public purse from the massive influx of capital required to both improve a a decaying water infrastructure and raise water quality to European standards

- This attention to the economic costs of supply-side infrastructure growth has been mirrored by growing awareness of the environmental costs involved in the development of new reservoir schemes and continued road network expansion. Pressure groups such as the Council for the Protection of Rural England have pointed to the environmental impact of new reservoir schemes in terms of lost land, diminishing green belt area, natural sites and buildings of scientific interest.

- Awareness of the economic/environmental costs of 'heroic engineering' initiatives has prompted widespread social resistance to new infrastructure plans. Demonstrations against proposed reservoir developments such as Broad Oak in Kent have produced high profile media coverage.

- This new climate of social and political concern over infrastructure management strategies has stimulated a transformation in the regulatory/financial framework governing utility decision-making. In the water sector the National Rivers Authority (NRA) are tightly controlling new abstraction licenses to encourage water companies to increase the efficiency of their networks, mainly through leakage reduction which can run to 25% of total water supplied. At the same time the Office of Water Regulation (OFWAT) is measuring the economic efficiency of water companies against rigorous standards of performance, judged via the comparative regional 'cost' of water delivered by each company.

3. THE NEW WATER MANAGEMENT

Changing Logics

Such changes have transformed the logic driving water planning. Hitherto local incidences of water stress would be solved within a wider supply strategy, a new reservoir or abstraction point at almost limitless enviro-economic expense. Today this makes less sense. With all major capital expenditure under review water stress is being dealt with at a more local level. Consequently a new emphasis on demand management and planning of water infrastructure is surfacing. Critically, this process of more efficiently managing the use of water resources is not driven so much by commercial competition between utility companies, as say in the electricity industry, but rather by the desire to maximise profitability in the privatised organisational environment that water companies now inhabit. Moreover, with metering still only accounting for a minority of water-usage (around 25%), and physical limitations to increased industry competition, water companies are being forced to redefine network management strategies less by competitive pressures (relating to demand) and more by regulatory signals (relating to operational efficiency) sent by both the economic and environmental regulators. While electricity suppliers experience little environmental regulation, the control of abstraction licenses by the NRA is encouraging the abandonment of supply-oriented

management strategies. Similarly, with OFWAT now examining efficiency in terms of water delivered to customers, rather than water supplied into the system, and at the same time counting the 'costs of paying for growth', the reshaping of demand through refined network management is increasingly the only viable alternative to massive infrastructure investment

The response of water companies to these social, environmental, economic and regulatory 'signals' has been highly uneven. DSM as actually practised clearly cannot be understood in the 'ideal' terms found in the various reports reviewed above. Water companies do not operate in a cultural, political or commercial vacuum. Utilities must weigh and balance the social and regulatory pressure to adopt more environmentally sensitive approaches with the need to increase profits to satisfy shareholders at the same time as gradually shifting existing practices, deeply embedded within existing organisational cultures. Nevertheless, we can tease out a variety of shifts in traditional water management strategies that exemplify the turn to DSM. To begin with water companies are seeking to differentiate between classes of customers by developing more individually focused technical demand profiles and more widespread metering. A recent NRA report showed the growth of interest by water companies in the actual dynamics of demand, with the number of detailed monitoring schemes focusing on domestic consumption growing from 5 in 1980, to 10 in 1988 and to almost 30 in 1994 (Turton, 1995, p14). Such interest suggests a new emphasis on the tailoring of water supply to actual, local demand. In particular there is a desire to detect the nature and timing of peak demands which will set limits to the sizing of water supply systems. in this way DSM programmes can be more effectively targetted. Urban and rural zones suffering high water stress can be prioritised and demand management programmes instigated through metering of domestic consumption[7] and 'beyond the meter' water management initiatives in commercial and industrial premises.

The potential for such 'beyond the meter' activity is evident in a number of reports and best practice demonstration schemes. For instance the Audit commission investigated water use within the NHS (Audit Commission, 1993). Investigating the use of water at 300 hospitals the commission estimated that water and sewerage costs could be reduced by up to 30% or £15 million/annum by developing water management strategies including: developing accurate information about where water is consumed, exploring alternative sources of water and installing water saving devices. Carrying these principles into action in the industrial sector CEST (Centre for Exploration in Science and Technology) have operationalised a water and waste management scheme with companies sited on the Aire and Calder River in Yorkshire (CEST, 1994). Eleven industries participated by investigating techniques of waste minimisation. The experience of Coca Cola was typical. By producing even a relatively small reduction in water usage from 1.4 litres to 1.3 litres per can of coke saves 100 million litres a year. Applied across Coke's 5 other sites this could save £200,000 a year (DMC, 1993).

However, such 'beyond the meter' initiatives critically depend on the existence of metering and related demand-management practices. Here, in the seemingly dull technical world of leaks and

[7] Metering is particularly effective in reducing peak demands. See NRA Demand Management Bulletin, No 6, June, 1994, p3.

pressure valves, we find an intensification of social, regulatory and commercial pressures shaping the implementation of water management strategies.

Pipes, Leaks and Meters

Metering Change

Whereas it is normal for commercial and industrial users to pay for their water use by volume only a small minority of domestic users are metered[8]. But as the concern of water stress has grown interest in water metering has surfaced. The current Conservative government are very much in favour of extending metering to the domestic sector, as are the regulators OFWAT and the NRA. Evidence from abroad seems to favour this position. In continental Europe, most water supply is metered and customers pay for their water on a volume basis (POST, 1993, p45). Studies from abroad highlight the demand management potential of metering water resources. In Denmark studies have suggested average reductions in consumption of between 20 and 50% due to metering (POST, 1993, p46). While per capita consumption in Denmark is higher than in the U.K., 190 litres/day as compared to 136 litres/day, leading to enhanced savings, the environmental benefits to be reaped by metering British water are clear.

Much of the debate over water metering in the British domestic sector has revolved around trials on the Isle of Wight. Here, a comparison over 3 years of metering in different areas occupied by different incomes groups highlighted potential savings of around 10% - 20%. However, a number of wider issues were also raised by the study which has locked the water industry into a controversial debate on the relative merits of metering for some time.

- Social - While the savings identified in the Isle of Wight study were not income related, some hardship was identified, particularly for those in the lowest rateable value housing (who therefore paid least for their water and also coincidentally represented the highest family size and highest incidence of illness)[9]. This group experienced the highest increase in charges [the richest, the biggest decreases]. These social costs of metering make water companies uneasy, providing an immediate disincentive to further implementation of domestic metering (OFWAT, 1992a). Opposition to metering on social and health grounds has been led by the National Consumer Council (NCC). The NCC argue that the Isle of Wight study was socially unrepresentative, with only 6% of households receiving income support, one-third of the national figure (NCC, 1992, p7). This suggests that if universal metering was introduced levels of hardship due to water poverty could rise dramatically over the whole country. This has prompted a growing coalition of interests opposed to mandatory metering including consumer groups, the Labour Party and local authorities (Halsall, 1995).

- Financial - The capital costs of installing meters are prohibitive - around £200 for externally sited meters, . slightly less if the meter is sited within the home (FoE, 1992, p9). The cost of

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[8] Only 4% of domestic customers where charged by volume in 1993 (OFWAT, 1993a).

[9] 3.8% of a sample of 6,429 households on the Isle of Wight were identified as having experienced social or financial 'hardship. A further 8% claimed difficuly in affording their water bills since being metered (OFWAT, 1992a, pp i-ii).

reading of meters, around £20/year including reading, billing testing, maintaining, is also a problem . The Labour Party estimate it would cost £5 billion to install water meters universally and £1/2 million to operate (Dobson, 1995a, p1). Some experimentation on remote meter reading[10] and joint metering reading with other utilities using real time infomatic systems is occurring but no satisfactory solutions have currently been found (Dawn, 1994). In order to cover these costs over a 10 year period customers would have to pay an extra £40/year (£20 reading/£20 capital cost). On an average bill of £100 this is clearly a significant outlay. As recent media debates have highlighted, leakage control and pipe replacement may prove a more cost effective use (Dobson, 1995b). There is also some evidence that measured water charges have grown quicker than unmeasured, further stoking public fears of an escalation of water charges after metering (OFWAT, 1991, p7)[11].

- Physical - The siting of the meter is critical here. On the Isle of Wight it was found that there were significant differences in demand between internally and externally metered sites - highlighting the extent of leakage in ageing customer supply pipes. Responsibility for replacing these pipes is a major issue. Siting the meter externally gives the water companies no incentive to replace supply pipes sited beyond their boundary of responsibility. Water companies argue that the capital investment of systematic pipe replacement would be too great without some clear reward. By contrast, placing the meter externally means that the customer has a clear interest in replacing their pipes. However, water users are rarely aware of leaks until they grow to a substantial level. Many customers are not even aware of their responsibility for this 'stretch' of infrastructure. The debate over internal/external metering is raging. OFWAT want internal metering because it's customer friendly (e.g. user friendly meter reading), pushing responsibility for the service pipe onto the utility. Water companies are resisting this for what they see as sound commercial reasons! Paradoxically, reducing losses would not necessarily lead to a reduction in pipe size, and therefore network capacity, as the size of the water infrastructure system is related to peak demand. Seen in this way, gardening habits have a bigger impact than distribution losses in shaping the investment profile of the water industry.

Clearly, a whole range of social, economic, technical and physical issues are shaping the implementation of metering technologies. Around the time of the metering trials there was a real momentum in the industry towards retrospective metering. Now there is much more caution and some of the previously pro-metering companies are now opposing metering. Anglian water, who were originally in favour of universal metering, are currently reviewing its policy as are Yorkshire Water[12]. In particular implementation costs have dampened the enthusiasm of many companies, although this is less onerous in new properties and many companies are fitting all new properties with meters. Further, there is the question of whether the 10% saving found on the Isle of Wight is sustainable? FoE have found in Canada that relative savings declined as customers became used to paying for water on a volume basis. In fact consumption returned to follow the pre-metering trend only 3 years after meters were installed (FoE, 1992, p.9) . Clearly, universal metering is not a short

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[10] See: 'Remote Metering Moves Closer', Water supplment in Electrical Review, Vol. 226, No. 9, p42.

[11] See: Public Utilities Access Forum (1994) Minutes: Water Issues Sub-group, 15th March.

[12] See: NRA, Demand Management Bulletin; No. 8, December 1994, p5 and No. 10, April 1995, p4.

term solution and while leakage levels remain high there is likely to be stern opposition to mandatory metering. Nevertheless, set against the background of the end of rateable valuation/charging by the end of the year 2000, a looming crisis in the water charging mechanism with 18 m properties needing to be billed, selective metering is likely to proceed.

Pressure on Pipes

DSM strategies have been increasingly divided between metering and other demand management techniques such as leakage control. For whenever water companies have been able to save 10% through leakage control at a fraction of the cost of metering, without any of the problematic social issues, they have put metering initiatives to one side. However, the recent drought has strongly focused public attention on unnecessary loss of water through leakage from ageing and damaged pipes. In particular the Labour Party has highlighted how over 826 million gallons of water are lost from water company pipes in England and Wales (Dobson, 1995a). Water companies are now being closely scrutinised about leakage reduction plans. Of course awareness of the scale of the leakage problem has long been recognised within the water industry. Arguably, it was in the nationalised period of water supply that leakage levels ran out of control due to lack of adequate investment in pipe replacement. Water engineers have been grappling with the problem ever since, experimenting with new infomatic detection systems and identifying the economic optimisation of leakage control programmes. For instance, Bristol Water took a conscious decision in 1985 to actively manage their demand through leakage control to off-set need for a new treatment facility which would cost an estimated £20m (Bessey, 1993). By spending £1.5m on leakage control they managed to reduce leakage levels in the Company area by 2 litres per property per hour, hold consumption levels at the 1983/4 level until 1990, and potentially save a total of £6 million in revenue costs over the next 20 years through reduced water losses and energy savings. In this way they were able to defer major capital expenditure by 5 years.

Rather than compulsory meter then, most water companies are striving to improve the efficiency of their ageing networks through which almost a quarter of the water put into the supply never reaches the customer. While this figure includes unaccounted for losses due to fire-fighting, street cleaning etc, it also reveals excessive losses through leakage from mains pipes, customers pipes and service reservoirs (DoE, 1992, p12-15). Interestingly, these losses were previously hidden because distribution losses were not broken down into their component parts. With the introduction of the OFWAT July return (1st in 1991) this has all changed. For the first time the performance of water companies is being assessed in a regulated environment and the efficiency of each component of the water system is evaluated separately. Previously such matters were confidential and efficiency initiatives were left to the company involved. Now released in an OFWAT publication 'the cost of water delivered', average leakage losses appear to be around 22% (OFWAT, 1992). Of course there is a problem here of accurate measurement/estimation. Huge differences exist within domestic demand. Also, with only 25% of all water delivered actually measured there is inevitably a lot of guesswork about the remaining, unmetered, 75%. However, there is now a greater desire to 'know' more about changing demand patterns (Turton, 1995) and with 22% leakage occurring there is a clear priority to identify the precise location and levels of leakage. Critical here is the state of the infrastructure system which is over 100 years old. With little political capital to be gained from water supply and sewage improvements, investment in maintenance and refurbishment has always been restricted. In this context leakage control acts as a kind of band-aid, patching together a

system and so averting a looming crisis. Again, many water companies feel that money spent on metering could be better spent on further infrastructure investment initiatives such as pipe replacement. However, the recent regulation review has seen K-factors cut back further leaving water companies crying they there is not the money around for investment. Whatever the causes it seems that, after a brief boom in 1991/2, spending on water distribution has crashed by 27% by 1993/4, while the length of water mains relined or renewed fell by 16% (Lean, 1995, p1).

Clearly leakage control must be costed against potential savings. This has been the focus of a major study which recently reported (WRc, 1995**)**. This study revealed the critical importance of spatial variations in the 'cost' of water. In Northumbria you have the massive resource of Kielder reservoir and substantial 'pure' water from upland sources. By contrast the southern regions must tackle diminishing aquifers and heavily polluted sources (eg bottom of Thames) which requires expensive treatment. For instance, in Bristol water is taken from the bottom of the river Severn before it hits the Severn estuary. This costs around £30/mlitre. It must then be pumped 20 miles to Bristol. Conversely, on the south side of Bristol there are lakes which flow by gravity to the city which require fairly minimal treatment (£11/ml). Moreover, water can cost £150/ml to deliver to customers at the top of hills. The estimation of these variable 'costs' can also include forward investment strategies, including capital expenditure on new infrastructure. These costs must then be set against labour costs. Clearly there is a diminishing return as you plug the big leaks and start searching for the smaller leaks. The water industry leakage report therefore includes a formula with which each company can assess their leakage control priorities[13].

Related to leakage is the question of pressure. Pressure can be 'natural' (i.e. gravity) but often water must be pumped. Critically, both demand and leakage levels are pressure related. Until 10 years ago all pressure control valves were linear. However, for the last 10 years water companies have been working on pressure reducing valves. The problem is that as demand goes up, losses go up through friction losses in the pipes so pressure reduces at the end-point. So pressure controlling devices have to be set to appease the last customer on the distribution system. To overcome this problem water companies are introducing flow modulating (PRV) pressure reducing valves which can be programmed (head vs flow curve) so that the valve will increase the pressure as the flow goes up and decreasing as the demand goes down. This might mean a small increase in pressure to service peak demand as the valves will let more water through than a fixed valve would, but it also minimises water supply levels at low demand. Pumping systems are now similarly controlled through variable pressure systems. These pressure controlling/leakage control technologies date from about the early 1980's and are still being refined. Bristol Water introduced wide-scale pressure control as a part of their demand-management waste action plan (Bessey, 1993). At present 25% of Bristol Waters customers enjoy direct pressure control. Many other customers still experience minimal water pressure as they are fed by a service reservoir situated at the correct height to feed them. However, as with metering there is opposition to pressure reduction DSM. The fire service have to make contingency arrangements to ensure sufficient water exists to combat major fires. Any

[13]The water industry working party tried to introduce an environmental cost into the leakage cost equation but couldn't! Only a note exists which exhorts water companies to introduce an environmental component to the equation.

marked reduction in mains pressure could well result in this pre-planning being to no avail[14]. There are also commercial interests at stake. MODUSSE, the trade association representing manufacturers of mains-fed plumbing equipment are strenuously opposing any drop in water mains pressure[15].. Mains-fed hot water supply systems operate ideally at 3 bar and above and, happily for MODUSSE members, the majority of British dwellings have a water pressure above 3 bar. Pressure control DSM threatens to diminish this market leading MODUSSE to lobby OFWAT to monitor company performance on pressure[16]. OFWAT now require regular reports on mains pressure as a priority when water suppliers provide details of their level of service.

In sum, technological innovations such as metering, leakage control and pressure reduction are playing their part in ameliorating water stress. While each of these DSM initiatives pre-date privatisation, new regulatory frameworks set by OFWAT and the NRA (see above) and the frantic search for revenue has significantly accelerated their use. For instance, leakage control has been transformed from a routine exercise in good housekeeping to a profit enhancement tool at the heart of contemporary water management strategies. But as we have seen, there is a world of difference between the imaginary worlds of demand oriented water management envisaged in the various reports on DSM by the NRA, DoE and CPRE (listed above) and the messy worlds of pipes, leaks and meters. There are clear tensions between the structural (top down), rational water management scenarios developed by the NRA, OFWAT and the DoE and the micro (bottom up) concerns of local water companies who must balance water supply and demand against a background of conflicting environmental, economic and landuse regulations and the need to satisfy shareholders hungry for dividends. There have been a number of 'splash points' where different interests have been brought into conflict over water issues. The controversy over infrastructure charges, in which spatially differential charges where introduced by newly privatised water companies for providing infrastructural links to developers, provides a useful example of the tensions between key interests involved in water supply and use. While this problem has now been resolved by OFWAT setting a standard infrastructure charge, the conflict provides useful insights into the complex interactions between regulatory, commercial and planning tensions over the implications of new forms of built development on the water system.

Within this rapidly changing sociotechnical framework decisions about the future management of water resources are highly contested. Each company, working in differently 'stressed' areas across a socially and physically uneven landscape, is attempting to develop a strategy that both satisfies the regulators while also meeting rigorous commercial priorities in an increasingly cut-throat utility marketplace. There are a whole range of contentious spatial and temporal issues worth examining in more detail.

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[14] Personal communication, G. Edwards (Chairman) Operations Technical Committee, The Chief and Assistant Chief Fire Officers Association, 10/2/95.

[15] In the United Kingdom we depend upon storage tanks whereas in the rest of Europe they operate direct heating systems leading to a much higher peak water demand at breakfast time. Therefore water pressure levels must be higher to avoid a supply shortage. This has led to European water appliances requiring a higher pressure to operate. Interestingly, the creation of a single market for water appliances is leading to a commercial struggle over water pressure levels signalled by the formation of MODDUSE a British trade association for direct European water systems.

[16] Personal communication, G. Marsh (Director), MODUSSE, 9/2/95.

4. WATER STRESS IN THE SOUTH

Competing Perspectives

Here we examine the complex regulatory, commercial, technical and environmental issues shaping debates around the provision of infrastructure in an area of potential water stress, the south-east of England[17]. In particular we focus on the tensions between competing spatial and temporal perspectives on water shortage, unpacking the social organisation of water resource management. We suggest that debates around water network management are caught within a web of opposing strategies which have their basis in fundamentally different 'ways of seeing' water resource issues. The different agencies with a role in the control, management, provision and use of water have distinctive viewpoints driven by particular spatial, temporal and cognitive priorities. Government agencies (DoE/County/District council's/OFWAT/NRA) tend to adopt a top-down view, seeking to control county/district and regional space over long periods of time. In contrast, the providers and users of water necessarily see resource issues from the bottom-up. Developers are spatially driven by local property markets in the context of short-term economic cycles, while water companies are concerned with their own bounded territories and lengthy investment strategies. Aims and approaches to water management issues therefore depend upon the way of seeing which matches the institutional location of each water actor. Such a diversity in 'views' is highlighted by the tensions that exist between the objectives of medium term land-use planning, environmental protection and economic regulation, and the pressures and priorities of the commercial water and development industries. The resulting dynamics of top-down regulatory push against bottom-up commercial pull creates a constant jarring of effect within inter-regional water management strategies. Such disharmony in the southern region is leading to profound supply/demand imbalances, creating an abundance of water in the south-west and serious shortages in the south-east.

This dis-connection between planning, regulatory and commercial endeavour is exacerbating social and environmental problems in the region. On the surface such conflict appears unnecessary. At a regional level there are sufficient water resources to meet both average and peak demands. However, these resources are not evenly distributed inter-regionally, between the water companies. Perspectives on resolving this physical unevenness in the utility landscape graphically illuminates the top-down, bottom-up divide. We start by focusing on "top-down", structural assessments of regional water resource issues prepared by the regional arms of national environmental, landuse and economic regulators for the Southern Region. The NRA have set out a strategic framework for regional self-sufficiency in water supplies, largely based on the rigorous application of demand management measures and the sharing of regional water resources between the local water companies. Further support for this approach is forthcoming from OFWAT, the regional DoE, and local and national environmental groups, who have powerfully resisted the development of major new water resource development within the region until the benefits of DSM have been exhausted. We then review the "bottom-up", micro perspective shared by water companies, examining how one particular company within the Southern Region - the Folkestone and Dover Water Company

[17] The Southern Region has experienced some of the worst effects of drought and continues to experience water management problems.

(FDWC) - is attempting to manage imbalances between water supply and demand. FDWC is already having major difficulties meeting demand and has to impose water restrictions in drought years to meet peaks. Even if future demand grows at the low scenario forecast by the NRA, which includes the rigorous application of DSM measures, the company will still have major problems meeting average demand in non-drought years. While both the NRA and OFWAT have indicated that they would like to investigate the potential for inter-company transfers, FDWC has rejected this option on commercial grounds. Consequently, there are major uncertainties as to how supply and demand will be balanced in this part of the Southern region. Tracing the roots of these tensions means mapping the interplay between different regulatory agencies and the fragmented patchwork of water companies, charting their contrasting public and commercial priorities against the differential distribution of resources across the region. Such a map will provide an illustration of the difficulties involved in managing water resources divided by conflicting temporal planning horizons, contested spatial boundaries and competing public and commercial interests.

Regulating Water Stress

Water companies in the southern region respond to the problems of water stress within social contexts and commercial frameworks shaped by a diverse set of regulatory agencies. These include the regional offices of the environmental regulator, the NRA, the commercial regulator OFWAT, regional planning guidance prepared by the DoE and the County Structure plan prepared by local planners. These regulatory bodies send signals to water companies which closely structure the contexts within which they make decisions about the future management of water resources. Specific spatial and temporal assumptions underpin the programmes and strategies promoted by these regulators. As we shall see, these spatial and temporal co-ordinates are highly contested.

Sustaining Our Resources - NRA Southern Region

In November 1994 the Southern Region of the NRA published its assessment of the most effective strategy for the future management of water resources in the southern region (NRA 1994b). The strategy is designed to provide a detailed regional interpretation of the NRAs national water resources strategy (NRA 1994a), build upon the consultations received from the previous Southern strategy (NRA 1992) and utilise information prepared by the water companies for OFWATs periodic review of companies Strategic Business Plans. The document identified three key issues for water resources in the Southern NRA Region:

- the protection of the quantity and quality of existing water resources
- the assessment of the environmental effects of new water schemes
- the promotion of demand management and water conservation

Balancing Water Demand and Supply

Figure 2 illustrates a series of demand scenarios for the Southern Region over the next 30 years[18].

[18] The Water Resources Board 1996 forecast provides a useful example of the supply oriented logic of this period where demand was expected to continue increasing in line with economic growth. Since the

Figure 2 NRA Southern Region Water Demand Scenarios

Source: (NRA 1994b p13)

During the early 1990s the NRA prepared both a high and a low demand scenario for the next 30 years[19].

- The high scenario assumes relatively high rates of domestic and non-domestic consumption and no increase in levels of metering or a reduction from current leakage levels.

- The low scenario assumes moderate growth in domestic consumption and no increase in non-domestic consumption - that industrial demand is static or declining while agriculture has very low growth. It also assumes that 30% of domestic properties are metered and that leakage is reduced to 6L/Prop/Hr.

Comparing present resources with 1992/93 demands there is a regional surplus of 25% (330Ml/d) above current demand while the peak resource surplus is over 13% (200Ml/d) over demands. Both scenarios assume that there will be an increase in future demand which could be met by expanding water supply or implementing DSM measures. The NRA argues that the low scenario is "likely to be the course that demands follow" because the water company own forecasts are close to this scenario, industrial demand is unlikely to grow and because it incorporates DSM measures which are considered "the minimum necessary in areas where resources are under stress" (1994b p.14). Rather than invest in new supplies the NRA suggest that the "best use should be made of existing resources before any new ones are developed" (1994b p15).

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economic problems of the mid 1970s, restraints on water authority expenditure and increased environmental concern about the impacts of new water resource development demand has been much hard to forecast.

[19] Assumptions about future levels of domestic demand have the greatest influence on future projects. The NRA developed the scenarios based on their own data collected from 60 domestic monitoring areas.

Focusing on DSM initiatives, the NRA has prioritised its preferred options. First, an enhanced role for leakage control. The NRA estimate that 25% (300Ml/d) of water supplied is lost in the Southern Region equating to 9l/prop/h. Reducing this to 6l/prop/hr (as set out in the low scenario) would generate substantial savings. There may, argues the NRA, be powerful economic reasons why some companies should reduce this target even further. Second, an extension of selective metering in areas of water stress. Although only 6% of domestic properties in the region are metered there are substantial variations in commitment to metering between companies. The low scenario assumes that 30% of domestic properties are metered by 2006, thereby reducing peak and average demand. A higher target would be desirable for the NRA. Finally the NRA indicate that conservation and recycling measures together with an education campaign could save further water resources. While they provide examples of the type of measures that might be implemented there is no attempt to assess the impact of such measures on water demands. Taken as a package the NRA argue that these measures would result in a "large overall regional resource surplus" (1994 p.19). Critically, the NRA assert that the Southern region can remain self-sufficient in water resources under both low and high scenarios without the development of major new water resources. There is, however, one important proviso. Surplus water resources will need to be transferred inter-regionally, between companies, in order to prevent deficits. We shall return to this point later.

Protection of Existing Water Resources

Due to the difficulties of balancing water supply and demand the Southern Region NRA have placed a strong emphasis on the protection of both the quality and quantity of existing water resources. As much of the regions water is abstracted from underground reserves the NRA are planning to provide special protection for these resources. There are two main sets of measures proposed. Firstly, the quality of water resources will be protected through the implementation of the Ground water Protection Policy (NRA 1992). A series of zones around major water sources will be determined by their catchment bands and travel time of pollutants. These zones will be given special protection to secure the resource from pollutants. While they will not have statutory status, the NRA will be able to give advice to planning authorities, land-users and developers about the measures needed to protect ground waters. Secondly, the quantity of water abstracted from the resource will be protected through a Ground water Management Policy. In the Southern region there is a presumption that further increases in abstraction from chalk aquifers is not feasible and that in areas of water stress the NRA may even seek lower levels of abstractions. Although both sets of policies are still under development they have important implications for the siting of new developments within the region and the level of resources available to local water companies.

New Water Schemes?

The NRA strategy assumes that no new water resources will be developed in the region until the demand management options have been exhausted. In the context of a regional strategy this presumes that there are sufficient water resources within the region to meet both average and peak demands. The NRA argue that existing resources need only relatively small scale enhancement in "order to satisfy projected demands for the next 27 years, provided existing sources are protected, leakage is reduced and surplus supplies are transferred to areas of deficit ...[and] for metering to be extended particularly in areas where seasonal peak demands are a problem ...before any decision is taken to develop new resources" (1994b p.2). But as we highlighted above, there are major problems of resource imbalance within the southern region. Water stocks are high in the west, but

decline towards the east. Under the low scenario this imbalance could be solved by reallocation of regional resources by the bulk transfer of water supplies *within* the region and *between* companies. On this basis it would not be necessary to increase regional abstraction, transfer water from outside the region or develop large new resource schemes in the plan period[20]. Consequently, inter-regional/company water sharing is seen by the NRA as a critical compliment to DSM options and wherever possible is encouraging water companies to adopt such a strategy.

OFWAT - Paying for Growth

While not systematically linked to the operations and strategies of the NRA there is a clear synergy between many of the policies and practices of OFWAT. OFWAT are concerned to promote 'efficiency' within the water industry which, in parallel to the environmental concerns of the NRA, means encouraging better water management. OFWAT have developed an economic framework which seeks to spur water companies into DSM initiatives. As we saw in section 2 (*Signalling DSM*), a major regulatory development governing the privatised water companies has been the Periodic Review of their strategic Business Plans by OFWAT. This review determines the limits of company price rises and expenditure on water quality, resource development and environmental improvements over the next 10 years. OFWAT have signalled that as part of a wider efficiency drive aimed at giving water consumer value for money, companies should address DSM management issues before investing in expensive supply infrastructure. The price control formula and expenditure under the periodic review are only set for 10 years. However, for the next decade it is unlikely that there will be any investment major regional resources. Therefore companies have been pressed into DSM measures. OFWAT understand that there is a problem of regional resource imbalance in the Southern Region but like the NRA see the issue in terms of regional imbalance rather than one of localised water shortage. Water companies in areas of deficit have therefore been encouraged by the Director General of OFWAT to request a bulk transfer contract from local companies with a surplus of water. OFWAT have said that if a company was unhappy with the commercial terms of the contract the company could appeal to the regulator adjudicate the quantity and price of bulk transfers. But these measures can only be initiated by a water company and although OFWAT would like to oversee bulk transfers none of the companies in the areas of water deficit have been keen to explore this option.

The DoE and Regional Planning Guidance for the South East

There is an additional layer of policy guidance provided to water companies through DoE Regional Planning Guidance. The original guidance was produced in 1991, updated in 1994 to more clearly reflect environmental concerns, and is designed to provide strategic planning guidance in the 10 year period up to 2001. A section of the RPG specifically deals with the issue of water supply and waste water disposal. This statement recognises that water stress in parts of the south east region

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[20] These options are rejected because of their high economic costs and environmental damage. The NRA argue that there is no case for a major expansion of new schemes until the DSM measures and inter company transfers have been completed. However, it is accepted that work should continue on the environmental, water resource and cost implications of some of the major new resource developments so that a quick decision can be made about a preferred option should demand suddenly increase. In conclusion it assumed that a major new development could be postponed till at least 2016 - approximately 20 years assuming inter company transfers take place.

raises important considerations for the planning system. Guidance (RPG 9) suggests that the planning system "must ensure that demand and the provision of this essential resource keep pace with each other, and the relationship is sufficiently robust to cope with the inevitable fluctuations in rainfall" (1994 para 4.33, p.14). In line with wider DoE initiatives on water (such as the document 'Using Water Wisely' - see above) the Guidance note argues that "measures to reduce demand for water, including recycling and re-use schemes, should be incorporated into development wherever practicable, particularly in areas where resources are short" (1994 para 4.34, p.14). However, although the DoE expects that in the short term "it may be necessary to adjust the rate of development to meet the limitations of the existing infrastructure", in the longer term the DoE feels potential water shortages should not be regarded as a constraint.

> "Within the South East Region there are considerable local variations in the adequacy of water supply. The rate of development across the Region should take into account the ability of the infrastructure to meet demands for water. However, *the ability of the existing water infrastructure to meet the demands should not be regarded as a long term constraint*, since the necessary infrastructure (including, if need be, inter-regional transfers) can be provided, given sufficient lead-time and plans should be based on such provision being made" (1994, para. 4.35, p.14 added emphasis)

It is not clear what time scale "long" and "short" term refer to. In terms of the spatial location of new development RPG 9 only gives the broadest of indications about the strategic link between water and location, and the necessary planning constraints required. In conclusion, RPG9 argues that planning authorities should consult with the NRA and water companies to ensure that development plan proposals "are realistic in terms of the likely availability of adequate water supply and sewerage infrastructure, and will not compromise environmental quality objectives" (1994 para 4.37, p.15). In this way DOE thinking largely reflects OFWAT and NRA advice on DSM in areas of water stress. However, the DoE have also generated new uncertainties around water planning, clouding the temporal and spatial issues linking water provision and development processes for local planning authorities and water companies alike. For instance, new development proposals could place significant extra demands on the water network, creating new doubts about the ability of water companies to balance supply and demands. Clearly the company has a statutory duty to supply and will not want to turn away commercial opportunities to supply major new development. However, estimating likely demand levels of new developments is extremely difficult. For example, Folkestone and Dover Water (FDWC) is particularly concerned about the future security of its largest user - the Magnox nuclear power station at Dungeness (due to doubts about the future of nuclear power) and the Dover and Folkestone Harbour Board (who face increased competition from the channel tunnel).

The Structure of Local Plans

Of course the channel tunnel development could create major new sources of demand. Most of the local planning authorities in the area are anxious to promote new job generating activity in an area of relatively high unemployment and assisted area status. But local planners must balance this desire for economic development against objections to new development in areas of protected environmental status and the problem of providing sufficient water supply and sewage capacity in an area of water stress.

Kent Country Council (KCC) frame the development context for local water companies through the County Structure Plan. The early development of the Kent Structure plan co-incided with the drought years of 1989-92. However, the focus of the first two drafts of the plan was on economic development. These drafts contained no individual headings on water resources and while the environment was discussed it was incorporated into chapters on the Green Belt (Ch. 5), and Countryside conservation (Ch.8), diluting its impact**.** By the third deposit draft of the plan this had all changed. Originally prompted by local political concern, the publication of the Bruntland report pushed environmental concern to the top of the agenda. Here, chapters on the Environment (Ch. 4), Natural Resources (Ch. 5) and the Green Belt (Ch. 6) preceed economic development (Ch.7). This latest deposit draft contains 20 pages on environmental issues in general, whole sections on natural resources in particular and water management specifically. Policy NR1 states "local authorities will also consult and take full account of the advice of the NRA and water and sewerage undertakers when considering proposals which are likely to have significant water or waste water implications" (Kent CC 1994 p.62). In order to facilitate new development the County will support the development or expansion of new water facilities to serve existing or proposed development provided the environmental impacts of such development can be minimised and that the water company supports DSM measures in its water resource strategy. Development will not be permitted that would have an unacceptable effect on the quality or yield of ground water resources. A 'noughts and crosses' evaluation has been developed to enable Kent's planners to assess the environmental implications of new development proposals signalling the new significance of environmental issues (Merrett, 1994).

KCC's policies reflect NRA advice on DSM measures and ground water protection and are generally supportive of the top-down DoE/NRA/OFWAT 'view' on regional water management noted above. This consensus has been developed through tri-annual liaison meetings between the Council, NRA and water companies active since 1991. Here the council has attempted to shape the management strategies of the water companies, to liase, illuminate and influence. In this way the Council hopes to convince them that water stress can, indeed should, be effectively controlled at the regional level through extensive DSM and water transfer schemes. For example, in East Kent an 'Operation Sea-Clean' is being instigated by Southern Water Service's. This scheme involves dis-charging water to the sea in Folkestone, an area of acute water stress. In line with NRA advice, Kent County Council point out that this water could be effectively re-cycled and utilised by FDWC to minimise water stress. However, commercial competition is impeding such an initiative. The Council/NRA/DoE/OFWAT nexus of interests see such opposition as 'irrational'. Viewed at a regional, top-down level there may seem little sense in such lack of co-operation. However, regional planning does not recognise that water stress varies across commercial zones which in competitive terms are rigid market boundaries to be vigorously defended. Clearly, water problems appear very different when viewed from the 'bottom-up'. While the plan does not attempt to prevent development on water grounds and water companies are keen to provide for new users, the location of location of new developments can raise acute difficulties for companies (like FDWC) in areas of water stress.

Responding to Uncertainty - the Folkestone and Dover Water Company

Here we review the problem of regional water imbalance from the local, bottom-up, perspective of the Folkestone and Dover Water Company (FDWC). As we have pointed out, while the council,

NRA, OFWAT, DoE and national environmental groups all recognise the problem of regional imbalances in water resources their proposed solution of inter-company transfers make's little commercial sense, even to water companies with scare resources. FDWC is one such company, forced to balance supply and demand in an area of extreme water stress at the same time as responding positively to the changing environmental, economic and landuse signals sent by the water regulators.

Folkestone and Dover Water Company (FDWC) was originally formed in 1848 and has since amalgamated with several other companies. The company has always been in private hands but adopted its current title when it was purchased by the worlds largest water company, the French Compagnie Generale des Eaux, in 1992. The company has an annual turnover of £10M pa., supplies more 55 million litres of water per day to 150,000 customers in an area of 420km2 which includes most of the Shepway and Dover district councils and small areas of Ashford and Canterbury. The largest customers are the Dungeness Magnox power station and Dover and Folkestone Harbour Board. Sewerage services are provided by Southern Water Services (SWS). Historically, the company has faced serious problems meeting rising demand with sufficient water resources as the supply area in the south east of Kent has an annual rainfall of only 770mm compared to the national average rainfall of 840mm. Between the 1930s and the late 1960s, a series of voluntary amalgamations of smaller water companies in the region, a process encouraged by local authorities and later central government, was promoted to develop new economies of scale, so overcoming resource constraints (FDWC 1992b). These amalgamations ended when the Regional Water Authorities were created in the early 1970s. The company then had to find new ways of meeting forecasts of increasing levels of demand likely to outstrip levels of existing supply. Initially the strategy focused on the expansion of water resources. The most significant development planned in the 1970s was the development of Broad Oak Reservoir in mid Kent. The Southern Water Authority and the Mid Kent Water company were partners in this project to provide additional water resources. Hitherto such an heroic engineering strategy was orthodox. However in the mid 1980s the Broad Oak scheme was turned down at the public inquiry because projected demand forecasts were not considered sufficiently robust and because of a lack of progress on leakage by all three companies[21]. Consequently FDWC placed renewed emphasis on the implementation of the leakage control programme begun in the early 1980s. While the abandonment of Broad Oak has not seriously affected the larger and significantly better resourced Southern water, it has left FWDC with serious problems balancing water demand and supply in the 1990s.

[21] The NRA, OFWAT, regional planning guidance and environmental pressure groups including CPRE and local groups have all rejected the development of major new resources on cost and environmental grounds. they argue that until demand management measures have been exhausted that there is now need for large new schemes. The proposed Broad Oak scheme provides a useful example of resistance to new supply oriented resources. Originally proposed in the mid 1980s by SWS, MKW and FDWC this large new reservoir development would have covered 1.75sq/km land, provided 40ML/D in at a cost of over £50M. The scheme was powerfully resisted on a series of grounds including the environmental impact on locality, increased costs to water customers and the potential for an alternative strategy based on demand management. Consequently there are powerful constraints on the development of large new water resources in the region.

FDWC's Plan for Water 1993

FDWC is already unable to meet peak demand without the imposition of drought regulations. In the drought between 1989 - 1992 rainfall was between 75% - 85% of the long term average figure. Because the company obtains its water from underground sources - aquifers - 75% from Chalk, 20% from Dungeness shingle and the remaining from Lower Green Sand - these can be depleted when there is insufficient rainfall (FDWC 1992a). In drought years the company has been forced to impose restrictions to conserve water resources. Although there are currently only serious difficulties meeting peak demands in sustained dry periods, the NRA anticipate that by the year 2010 there will even be major problems meeting average demand (NRA 1994b p25).

In the post-privatisation period there have been important changes in the development of the companies water resources strategy. The Company's 1993 document provides important insights into how the privatisation process, the new regulatory structure and the growing commodification of water resources has transformed the management of water resources. Firstly, privatisation has effectively "frozen" the imbalance of regional water resources. While the Southern Water Company has inherited sufficient abstraction capability to meet peak demands, even under the low and high NRA demand scenarios, the smaller water companies have inherited a water deficit which will widen under both NRA scenarios. The small companies have rejected the option of inter company transfers on commercial grounds, arguing with the NRA and OFWAT that there should be a re-distribution of water resources between the recently privatised water companies. Re-distribution withstanding, FDWC have been forced to look more critically at the problems involved with enhancing supply capacity. Much of the companies area is covered by chalk and therefore subject to restrictive NRA policies regarding increased levels of abstraction or the granting of new licences. The opportunities for increasing supply locally look increasingly limited. Secondly, spatial fragmentation of the water supply companies, uneven resource endowments and varying temporal urgency for new resources mean that reaching an agreement on the joint funding of a new large resource development is highly problematic. Although FDWC has revisited the potential of promoting the Broad Oak scheme, the Southern Water Company which now has a surplus of water resources, has pulled out leaving the two remaining, smaller, companies unable to fund the scheme. In any case, the NRA, OFWAT and local authorities have indicated that they would like to see all other demand side measures fully explored before supporting the scheme. Of course, FWDC are not overkeen on committing themselves to massive infrastructure investment either. There are powerful economic, regulatory, environmental and commercial reasons why the company would like to delay as long a possible such an expensive scheme. Instead, the company has developed a strategy based on small local resource developments and a renewed "emphasis on our continuing efforts to reduce leakage and widen domestic metering will allow us to defer investment in construction of the large regional scheme (for example, Broad Oak reservoir)"(1993 pp. 19-20). In 1993 FDWC argued that a new resource could be delayed until after 1999/2000[22], although there might continue to be some risk of water restrictions in drought years whilst such a programme progresses.

[22] "For the five year period from 1999/2000 to 2004/2005, early indications are that the company's capital investment will need to be approximately £50 million. The significant increase in investment for this period is principally due to the start of construction of a major regional resource" FDWC 1993 p.29.

With the difficulties of developing the Broad Oak scheme the company is now increasing investment in DSM through its leakage reduction programme and by promoting an active metering policy. This is also expensive. In 1994/5 the average water bill was £92 pa. This is likely to rise in real terms to £145 by 1999/2000 in order to fund a capital investment of approximately £28M over 5 year period up to the year 2000. There are three main elements to this programme. First a programme of leakage control. FDWC started a programme of leakage control to prevent wastage of water resources in the early 1980s. Because of the environmental and cost difficulties involved in developing further supply resources this programme has been extended. The company faces particular difficulties monitoring leakage levels because the water disappears into the chalk bedrock making leak detection problematic. New investment in telematic based monitoring systems is likely to help the company more accurately detect leakage on the network. Currently, the company targets particular areas where they refurbish the pipe work and replace service pipes where necessary. However, these activities stop at the customers boundary[23]. Secondly, a programme of compulsory domestic metering is being implemented. In 1994 less than 3% of domestic properties in FDWC were metered. However, since 1992 all new properties have been compulsory metered. It is the companies intention that metering will be extended to nearly all properties by the year 2010 with new meters installed as part of the companies leakage control programme[24]. Existing domestic customers can also request a metering installation for a set price of £130. There has been little resistance to compulsory domestic metering in the area[25]. Finally the company has also started to examine ways in which it can provide advice and education to customers about the development of water efficiency and conservation measures. These activities include a link with the Good Housekeeping Institute "to give appropriate advice on measures customers can take to use less water without undue hardship" (FDWC 1994) and discussions with South East Electricity - the local Regional Electricity Company - to promote low water use electric showers. However, FDWC rejected an approach by a company who wanted to jointly promote the use of water butts charged with grey waters to provide water for gardens. The application could have helped reduce household water consumption but the proposal was rejected by the French owners of FDWC[26].

The scale of the metering and leakage control programmes proposed by FDWC exceed the targets assumed in the NRAs low demand scenario. In 1994 FDWC stated that the measures might mean that a decision about the development of Broad Oak could be postponed until 2016[27], providing a 5-6 year period for the development of the scheme which would be available in 2021 when the NRA themselves argued that such a scheme may be necessary. By pursuing very active DSM measures

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[23] Beyond the 'boundary' the customer is responsible for any leakage in the pipe that runs along their premises.

[24] Although the meter is sited at the boundary of the customers premises so that they are responsible for leakage from their service pipe.

[25] However Southern water Services in whose area the Isle of Wight initiative was implemented have now come out against water metering because they have sufficient water resources. This could create problems for FDWC at two levels - the payment of sewerage charges to SWS based on metered water readings and the potential for resistance to metering in FDWC.

[26] The NRA's 'low' demand scenario does acknowledge the CPRE/FoE argument for domestic grey water re-use. However, the FDWC examples provides a useful insight into how water companies sometimes reject relatively simple and effective technologies due to the dangers of raising public anxiety over water stress.

[27] Interview

FDWC may be able to postpone the need for an expensive new reservoir until 2016, while also avoiding the need for inter-company transfers by saving more water than assumed in the NRA low demand scenario.

Ways of Seeing DSM

Unpacking the resonaces and dissonances between the idealised vision of public regulators and planners and the rather more grubby world of the privatised water companies means finding a way through the maze of negotiations, concessions and commercial opportunism that makes up contemporary water management strategies. Critical here is the spatial and temporal co-ordinates shaping the institutional location of these public and private actors. As we have seen, the public regulator-planners tend to view regional water problems over a time span of 10-30 years. The periodic review of OFWAT lasts 10 years, the structure plan of Kent County Council covers 20 years, while the projections of the NRA reach 30 years into the future. The solutions proffered are structural in nature and tend to be based upon assumptions of consensus between publicly spirited actors and situated within a socially, physically and commercially homogeneous landscape. But as we have further noted, the micro, 'bottom-up view' of the private water providers is necessarily shorter term, driven by a commercial logic built upon competition and cost consciousness and which is shaped by a spatial sensitivity to commercial market boundaries invisible to the regulator-planners. This means that any DSM action by water companies such as FDWC represents a negotiated response to a whole set of changing social, technical, environmental, regulatory and commercial issues. Choices as to appropriate water management strategies are motivated less by the structural, regional water planning rationalism of the NRA and associated regulatory partners and rather more by situationally specific compromises and commitments.

In order to understand the structure of the more pragmatic operational world of privatised water provision, and to more realistically assess the potential for full blown 'beyond the meter' DSM initiatives, it is instructive to unpick the debates and decisions shaping the water specification of a major new development in an area of acute water stress.

5. WATER IN DEVELOPMENT

Water and Development

Until now little attention has been paid to the provision of infrastructure within development processes (Marvin, 1992). Given the force of debates around the development industry and 'sustainability' (SPR, 1992) this seems surprising. Opportunities for shaping the intensity of water use are embedded within seemingly routine choices taken in the development process. Not that is simply a case of identifying a standardised, procedural chain of 'water' related decisions. The process is more messy. Complicated by a contradictory mix of a users idealised demands, budgetary constraints, occasional delays and organisational conflicts, the final specification of a new development is rarely a text book design. The water profiles of new developments rarely escape these pressures. While model guidelines for the planning and installation of utility supplies to new building developments exist, the reality is often different (NJUG, 1983). The internal procedures and priorities of developers, occupiers and Utilities often conflict. Co-ordination of service

provision with wider construction activities can be a fraught affair with mutual incomprehension characterising negotiations.

Privatisation of utilities has compounded this confusion, adding the uncertainty of choice to what was a fixed necessity. Moreover, changed practices do not come about without good reason. Relationships between Utilities and developers have been ordered by many years of routine interaction. While specific technical challenges may vary from project to project, negotiations and solutions have become relatively standardised. Charting the emergence of a development's water profile demands picking through an uneven set of decisions embedded within broader development processes. The aim is to detect any mutual interest, between utilities, developers and users, in the tailoring/reduction of water demand which may result in the minimisation of resource use through a review of water-related specifications.

We can usefully capture the supply logic driving traditional infrastructure management techniques by referring to the way utilities respond to the challenge of Facilitating Infrastructure Supply (FIS). The conventional, supply-led (FIS) logic of infrastructure provision is dedicated to expansion of the supply network, broadly by providing more power stations, roads or reservoirs. By stark contrast, the logic of Demand-Side Management (DSM) is aimed at balancing supply and use through active demand-management (increased energy, water and transport efficiency). For example, figure 3 illustrates how 'ideal' models of Facilitating Infrastructure Supply (FIS) and Demand-Side Management (DSM) can be assigned generalised operational characteristics.

Figure 3 Comparing FIS and DSM Approaches to Water Infrastructure Provision

FIS	DSM
maximise supply capacity	balance supply/demand
separation of utility/user by meter	Utility intervention 'beyond meter'
little concern for current demand	retrospective water-saving
little debate over new demand	water audits/advice
standardised practices	practice locally determined
compliance with building standards	building standards exceeded
no social/environmental interest	social/environmentalbenefits

This new spatial management of water networks, within tight geographical boundaries of each water company, appears to mark the end of water supply as a national, 'heroic engineering' enterprise to provide water as a virtually 'free' resource, and heralds the advent of a more integrated utility planning strategy based on water as a valuable commodity. Not that this is a seamless process. As we have seen, the technological shape of DSM initiatives varies across the water sector and is only emerging gradually. Nevertheless, it is clear that a shift in the 'logic' of infrastructure management is occurring. While echoes of traditional network management styles remain strong, DSM techniques are developing quickly. As water companies rapidly improve their inherently more 'leaky' distribution networks, the 'logic' of DSM may encourage them to follow electricity suppliers further along the network, to metering and beyond. In fact the emergence of these 'new' water management strategies critically depends upon extending traditional utility services 'beyond the meter'. Instead of merely supplying any new demand via supply enhancement investment, Utilities must begin to actively manage the development of new demand in real-time. This means anticipating and shaping new demand as it emerges through the development of the built environment. Consequently, identifying more sustainable water management strategies necessitates tracing the water networks that thread their way through 'everyday' development processes.

Reshaping of Demand - The Oasis Holiday Village

Rank Holidays and Hotel Development Limited (RH&HD) planning application for the Oasis holiday village at West Wood in Kent provides an illustration of the tensions surrounding debates and decisions involved in reshaping water demand in an area of acute water stress. The impact of this development on local water resources potentially presented severe planning obstacles. We examine in detail the key issues the developer and water company (FDWC) faced in providing relatively simple and apparently mundane infrastructure networks to meet the demands created by Oasis's water and waste disposal requirements. We argue that the negotiation process was fundamentally shaped by the "opening" and "closure" of debates around competing water management scenarios designed to address the water issues raised by the development. This dialogue took place within the context of conflicting technical, physical, regulatory, economic and environmental objectives. Before "closure" around a mutually agreeable solution could be reached different options were proposed, tested, modified, accepted and/or rejected. Nevertheless, the approach taken by the developer, engineers, water company, NRA and local authorities to mitigate the water impacts of this scheme illustrate the potential of demand management planning strategies. It is useful to summarise the key features of this process.

First, RH&HDs consultants realised at an early stage that the water issues raised by the scheme could present a serious planning obstacle to the development. The consultants presented their own assessment of the problems raised by a "conventional" holiday village on the water cycle in the West Wood area. It was demonstrated that the "normal" level of water demand and waste production expected from such a development could not be physically supported by existing local water infrastructure in a manner that would meet the environmental criteria established by the NRA. Unless an alternative could be found to the conventional supply oriented option it was considered highly unlikely that the scheme would be supported by the NRA or then obtain planning permission.

Second, the consultants then radically reshaped the scheme within a DSM context. The altered design reduced the level of water demand and waste disposal through water conservation measures and grey water recycling, whilst also recharging the local aquifer with treated waste water. This DSM oriented water management scheme was designed to address the NRAs, water companies and local planning authorities key concerns by significantly reducing the demands on the local water network below that expected from a "conventional" development. These proposals, however, still had to be tested against the criterion adopted by the NRA.

The third phase is the most complex. During this period the consultants DSM proposals were questioned by a number of different parties and tested in detail. Moreover, a local action group raised the water issue as a vehicle for resisting the development, employing their own consultant to question critical aspects of RH&HDs proposed water management scheme. More significantly the schemes consultants began to work closely with the NRA, even using the regulators computer models, to mutually re-shape and test the efficacy of their demand minimisation proposals. As the consultants modified their proposals on a number of occasions in order to "close" the issue around an agreed scheme, the NRA continued to express concern at the uncertainty, suggested by the computer modelling, of the impacts of aquifer discharge on local water supplies. Further uncertainty was created when the scheme was called to a public inquiry. Eventually the NRA and the consultants reached an outline agreement on a set of water proposals. However, because of the NRAs concern about the potential of polluting local water supplies a more conventional approach to the issue of sewage disposal emerged. To some extent the negotiations with the NRA led to a shift away from the original proposal for a 'strong' DSM oriented approach.

The fourth phase is the most uncertain. Final closure around the water management scheme is still awaited. The NRA are still testing the "agreed" proposals in the consultants last report and the outcome of the public inquiry is still unknown.

Rising Demand

The Oasis Holiday Village is designed to provide all year round, self-catering, short breaks within a high quality rural environment in West Wood, Kent. Based on 500 acres of countryside the scheme would provide a village centre, reception area, country club and sports facilities, restaurant, chapel, with over 800 villas, lodges and apartments. The buildings, roads and car parking would cover over 50 acres of the site with the remaining area landscaped with lakes, waterways, nature reserves and forest walks. The construction of the scheme would take approximately 18 months. When fully

opened the resident visitor population would be 4,500 supported by a "live-out" servicing, administrative and maintenance staff of 460 full and 240 part time employees.

RH&HD were anxious to ensure that any potential obstacles to the scheme were addressed at an early stage. The development consultants prepared a Environmental Statement to address the planning and environmental issues involved in siting such a large tourist based development in this locality. Both the local planning authorities, Kent County Council and Shepway District Council, were keen to support the scheme to ameliorate the high levels of unemployment in the area. However each council was keen to resolve any environmental issues before granting permission. Clearly, a development of this scale would place significant new demands on local services - particularly water supply and waste disposal. FDWC were keen to supply the scheme with water to increase their core business but the schemes planning consultants, Terence O'Rourke plc, and their consulting engineers, Symonds Travis Morgan, estimated that a conventional development of this type would raise serious water management issues in an area of such severe water stress. Figure 5 illustrates the impacts on the water cycle for a "normal" or "conventional" holiday village.

Figure 4 The Water Cycle for a Conventional Holiday Village

Source: (RH&HD 1994b p25 - 26).

There were three major problems with such an approach at West Wood that could constitute a major planning obstacle to the schemes development:

First, the problem of providing sufficient water to meet demand. Water supplies for the scheme were required to meet the demands for construction, washing and catering, recreational and entertainment and filling and maintenance of lakes. Ranks consultants estimated that satisfying this demand would normally require a supply of up to 1+Ml/D of potable water and 0.5+ML/D of non-potable water a day. It was likely that there would be major difficulties meeting these requirements at West Wood. The mains network was already committed while existing supplies were only

adequate to supply existing rural communities and farms in the area. Despite these problems both the local water companies, FDWC and MKW, insisted that they would be able to supply water up to 1ML/D from their existing licensed sources under normal non-drought conditions. This meant that under drought conditions both local consumers and West Wood visitors would be at risk of water restrictions more frequently than the nationally accepted criteria. So, while the water companies were anxious to service the new development such a service was "subject to investment in water supply infrastructure to augment supplies in drought conditions" (1994a p.44).With FDWC already facing severe difficulties meeting peak demands and with NRA policies preventing new or increased abstractions or the development of new water supplies, there was a real supply problem.

Second, the disposal of sewage and waste water. There were serious issues involved in the disposal of such a large quantity of waste water - estimated at 1ML/D per day - from the scheme. There is no public sewer in the vicinity of the site, while the nearest treatment works capable of taking waste was 10km south of the site. The consultants argued that construction of a link had to be rejected on the basis of high economic costs, the environmental impacts of the pipe and the loss of the treated effluent to local water resources. It was therefore unclear how sewage would be treated or disposed of.

The final issue concerned the schemes potential for contaminating local ground water resources. There was a fear that pollutants washed-off hard standing, spilt oils from machinery or a sewage spillage could enter the local ground water and contaminate local water supplies. Southern Region NRA were dedicated to protect all ground water resources through source protection zones (spz), defined according to the vulnerability of the resource to contamination. While these zones were not yet defined for the West Wood area it seemed likely that the NRA would object to this risk.

In sum, major water and waste management issues were raised by the likely demands created by a "conventional" holiday village scheme. In particular the problems focused on the implications of raising water demand, the appropriate methods of sewage treatment and disposal, and the potential for polluting ground water without a clearly defined protection zones. All these issues had to be examined by the developer in consultation and negotiation with the NRA and local water companies. Without NRA support for the scheme, local planning authorities and local pressure groups would reject or at resist the scheme on environmental grounds.

Re-Shaping Demand: Integrated Water Management

Recognising the need to resolve these issues the consultants developed a dialogue with the NRA to examine how water could be more effectively managed in this area of water stress. The initial Environmental Statement prepared by the consultants outlined a "fully integrated approach to the management of water on the site" (RH&HD 1994a p.87) that would address two key water issues - demand minimisation and the potential for local ground water contamination. Figure 5 illustrates the water cycle for the holiday village using rigorous DSM measures.

Figure 5 The Water Cycle for West Wood Holiday Village Incorporating Water Minimisation and Recycling

Source: (RH&HD 1994b p25 - 26).

Demand Minimisation

Given the water resource problems in the area, and the location of the site in relation to existing infrastructure networks, the developers proposed the "adoption of a number of measures aimed at reducing the demands on local water resources" (RH&HD 1994 p.43). Demand for potable supplies would be reduced by "the elimination of unnecessary fixtures, the installation of water efficient fixtures and fittings and the adoption of water conservation management procedures" (RH&HD 1994 p.87). These would reduce potable demand to 0.8ml/d. The recycling of treated grey waters would reduce potable demands by a further 25 - 30% - to levels of 0.6ML/d. Grey waters - from hand basins, showers and baths - would be collected, treated and then recycled via a dedicated grey water distribution network for topping up the water features and WC flushing. A separate network would collect black waters - from WC's - and treat them prior to discharge with surplus grey waters to the aquifer for recharge. The remaining sewage sludge would be collected for disposal by SWS. Another significant demand was for water features and irrigation requirements. At the initial filling stage these would be charged with collected rainwater but if there was insufficient rainfall then RH&HD would seek a license to abstract water from the local aquifer or draw on potable supplies. The water features would be topped-up with storm waters and the diversion of grey waters, while seepage losses would be kept to a minimum by the provision of impermeable lining.

Minimising Contamination of Local Ground water

Water returns to the local ground water system would be maximised by the discharge of all storm waters and both the grey and black treated sewage effluent. There was, however, the problem of potential contamination from the treated effluents and storm water discharges. Although the consultants developed a nutrient management policy "through restrictions on the nature of detergents and other nutrient sources used on site" to minimise nutrient discharge (RH&HD 1994a

p.88) they still had to agree the standard of sewage treatment. But the NRA had not yet defined the extent of the spz or the measures that would be required to protect local ground waters. The consultants attempted to identify the extent of the spz using the NRA and water companies own computer model of local ground water resources and their own computer modelling of the aquifer. At this stage the consultants modelling suggested that site proposed for the sewage treatment works and soak aways lay outside the source protection zones for the existing water resource boreholes in the area. But these initial findings had to be verified by the NRA.

The integrated water management scheme was designed to demonstrate how the scheme could be properly serviced with water supply and waste disposal networks whilst minimising the environmental impacts on the local water cycle. On paper it seemed that the rigorous application of DSM measures could significantly mitigate the schemes environmental impact. Although the demands generated by a "conventional" holiday village with "normal" water requirements would be unacceptable - the re-shaped proposals with water conservation, grey water reuse and aquifer recharge would minimise this environmental impact to acceptable levels. However, the innovative scheme for integrated water management outlined in the first ES was still subject to NRA approval.

Contesting Integrated Water Management

RH & HD took great care to present their case within the context of local and global environmental concerns and national tourism policy. By mobilising these agendas, together with more traditional job creation and economic development issues, the relevant local authorities supported the scheme. There was, however, resistance - particularly from a local action group and the neighbouring Canterbury District Council who objected to the environmental impacts caused by a scheme of this scale. Water entered into these debates as the schemes critics questioned the validity of the consultants proposals for an integrated water management strategy. The "Save Lyminge Forest Action Group", formed by local residents to resist the development, were "amazed that the local water company can suddenly come up with this extra water". Between 1989 and 1994 FDWC had imposed water restriction in the area in three years. The Group stated that "water resources are finite - there simply just is not enough water resource within the area" to support the development. At the same time they also raised uncertainty about the reliability of DSM measures and argued that the developers should demonstrate:

- the cost of separating grey and black waste.
- the reliability of demand forecasts in a holiday based complex generating higher than average water demands for bathing and washing.
- the basis on which the original consumption figure of 1ML/D and the level of grey water recycling had been estimated.

The consultants initial response to actions groups criticisms of the uncertainties of the demand minimisation measures was to argue that the site would only consume less than 0.5% of demand for the East Kent area. But in the context of water shortage in the locality it was still a major problem while a later, supplementary ES also failed to demonstrate the basis on which the demand minimisation and grey water projects had been made. But while challenging the validity of the water management proposals these objections alone did not halt the schemes development. There

were a range of powerful actors lined up in favour. FDWC had a statutory duty to supply water to the scheme and were anxious to expand their core business while the two local planning authorities had indicated that they would support the scheme provided the NRA confirmed that the environmental issues could be resolved. In this context the consultants main objective became gaining NRA approval for the water mitigation measures. Once agreed, there could be few further obstacles to the schemes development.

Initial negotiations with the NRA were "opened" on the integrated water management measures outlined in the first Environmental Statement. These proposals were subject to a complex process of testing, rejection, modification before eventual "closure" around an agreed scheme could be established. During this process the consultant produced a Supplementary Environmental Statement (1994b) which was then refined further in a final report on the water mitigation scheme for the holiday village (1994c). It became necessary to press quickly towards closure with the NRA to present an agreed scheme at a public inquiry in early 1995 in response to the Secretary of State calling in the application. Driven by the urgency of obtaining consensus during discussions with the NRA the initial integrated water management proposals were modified.

Refining Demand Minimisation

Negotiations with the NRA resulted in subtle changes in the demand minimisation proposals. The consultants now developed two different demand scenarios, an average demand of 0.75Ml/day based on an occupancy of 3500 guests and a peak demand of 0.88M/day with an occupancy rate of 95% 4250 guests. The peak figure was used for the design of the sites water network and even excluding water efficient fixtures and fittings is 0.12Ml/day below the "normal" demand expected from a "conventional" development. The extent of the grey water system was also reduced. Treated grey effluents were now to be re-used for flushing WCs and urinals in the central facilities, hotel and some 80% of the lodges and villas. It was not considered "practicable or feasible to connect all of the lodges and villas" (1984 RHHD 1994c, p.2). It was now estimated that this approach will reduce the demand for potable supplies between 0.15 and 0.20Ml/day when treated effluent is not otherwise required for topping up the lakes and irrigation (for 3 months each year). On this basis the daily potable water requirement were not expected to exceed an approximate average demand of 0.6Ml/day, or a peak of 0.7Ml/day (for some 3/4 of the year).

FDWS now confirmed that a new dedicated network would be provided from the Paddlesworth reservoir via boosters at the Ottinge pumping station, distributed through a new 3.1km water main to the edge of the site. It was also decided to include 24 hours of water storage on the site to provide a buffer for peak demands and emergencies. These were incorporated into the site design. But it was now clear that for 3 months each year, July - September, the need to utilise treated grey water in the topping up of lakes and irrigation meant that the water was not available for re-use in flushing WCs and urinals. During this period demand could rise to the peak of 0.88ml/day. Consequently further refinement of the DSM measures and the problems of meeting peak demand resulted in a scaling down of the potential efficiency of the DSM measures.

Wastewater Treatment and Disposal

The main focus of discussions with the NRA was on the type of treatment process and quality of the effluent discarded to the acquirer. No details were given in the original ES because waste disposal

were already under discussion with the NRA. The NRA in principle had no objections to treated effluent being discarded providing that:

- the water is treated to standard that satisfies the Water Quality Officer and safety methods were introduced to prevent failure.

- the recharge mound must not fall within the catchment zone of the public water supply sources within the local area.

While further detail of the treatment process to be used was given in the supplementary ES, the main focus of debate was on the results of the modelling assessment of the discharge effects on local ground water. Two different water quality models, FLOWPATH and AQUA, were used to analyse the current ground water situation and how these might be effected by the project. A number of different scenarios were established by the models. The consultants concluded that the "public water supply boreholes are not at any significant risk from emerge discharges from the West Wood development" (1994b p.29) and argued that the project "has negligible effect on the water cycle" (1994b p.29).

However, the NRA were extremely concerned about the level of uncertainty generated by the computer modelling of the impacts of contaminants on the ground water regime. Due to these concerns proposals to discharge the treated black effluent to the aquifer was rejected. Instead of treating black waters on site it was now proposed to collect all black waters from WCs and urinals together with the remaining grey waters not collected through the partial grey sewerage system. A new sewerage pipe and pump would be constructed to connect the site to SWS's existing Hythe STW where the proposed flows could be accommodated.

Further details were given in the supplementary ES and final report of the treatment methods to be utilised for removal of nutrient and grey water effluent. In the event of a failure at the treatment works the untreated grey wastewaters could be diverted to the public sewers. Standby power generation would maintain operations in the event of a power failure while RHHD could cut of water supplies and minimise sewage flows in any emergency. The modelling of the ground water regime had led the NRA to reject aquifer recharge with treated black sewage effluents. There was, however, still uncertainty about the locations of the ground water protections zones or the effects of pollutants entering the ground water. In order to secure NRA approval the consultants agreed to drill two observation boreholes on the West Wood site to monitor the effects on grey water discharge on the aquifer. The NRA will probably approve the consultants most recent design proposals for the scheme, provided they 'prove' that they can replicate the analysis in practice. The outcome of the inquiry is still awaited.

The final decision will be determined, at least in part, by the DoE's 'view' on this complex water management issue. That such a 'view' cannot simply be based upon an uncontested 'scientific' evaluation is again testament to the sociotechnical complexity of water supply. While water was only one amongst a number of issues involved in the elaborate negotiations surrounding the feasibility of this development, it created an impressive density of debate. No longer a simple, almost mundane process, the problem of adequate water provision was here mobilised and shaped by each actor in an effort to undermine or support the schemes implementation. Through a series of negotiated compromises each of the development actors have been able to fashion the schemes

design, or water/waste specifications, to reflect their own priorities. The NRA were able to powerfully reshaped the proposals, refining proposed DSM measures and making a more 'realistic' evaluation of its potential and shifting away from site based sewage treatment to physical connection with the mains network. The developers and their consultants were able to deflect public opposition to the scheme and even enhance their chances of gaining planning permission by embracing an innovative design stance. The water company (FDWC) has been able to attract a potentially lucrative customer, despite having little spare capacity on their system, and the planners have, potentially, been able to capture significant inward investment while minimising any environmental impact.

6. CONCLUSIONS

The Social Logic of Water Management

A whole host of key issues for utilities are raised by a shift in water management 'logic' from merely facilitating supply (through new reservoirs and abstraction points) to managing demand (though leakage control, metering, pressure reduction and water efficient plumbing). These include a greater sensitivity to the commercial implications of territorial governance, a changing profile of social, environmental and commercial risk shaping technical decisions such as the implementation of metering, the critical importance of micro water-demand data to future demand profiles, the growing importance of informatic technologies to water management strategies such as leakage control and remote metering, and a wavering connection with local, regional and national environmental policy and regulatory planning. Each of these technical and tactical innovations are taking place against a background of great uncertainty in the political economy of the water industry. Consequently, the emergence of systematic DSM is both hesitant and patchy. Overall, the Oasis holiday village case study has demonstrated the efficacy of demand-management techniques in easing the impact of new, water intensive developments and provided clear lessons for innovative land-use planning strategies. However, the history of the Oasis development equally demonstrates how the implementation of DSM strategies is strongly shaped by a range of non-technical factors. We will conclude by emphasising a number of key points:

Disconnected Policy

Regulatory agencies such as the NRA and DoE have increasingly targeted the planning system as an arena in which conflicts around water management should be resolved. Both the DoE and NRA have clearly signalled that the landuse planning system should be involved in the development of policies to mitigate water stress. However, despite calls for closer co-ordination it is not clear how the NRA, water companies, landuse planing and development interests can be brought together to develop mutually agreeable solutions to the problems of water stress. As Maloney and Richardson have pointed out participation in water management is increasingly complex "characterised by numerous cross-sectional linkages" (Maloney & Richardson, 1994, p112). The most recent NRA report on DSM lists about 19 public and private organisations with an interest in promoting DSM but has little to say about strategic, inter-organisational planning (NRA, 1995). Such complexity is inevitably leading to greater conflict and new institutional mechanisms of co-ordination are urgently required if the technical potential of DSM is to be harnessed. As Haughton argues, this means "integrating the different scales and boundaries of organisations providing collective

services at the local and regional scale (Haughton, 1995, p13). Such integration cannot be implemented forcibly, in a top-down show of regulatory force. Sensitivity to the heterogeneous 'ways of seeing' illustrated in this paper must inform policy strategies. In this way communities of interest may be assembled at key strategy 'moments', such as the design of the Oasis development scheme, in order to nurture DSM initiatives.

Space, Time and Knowledge

The success of DSM initiatives depends upon a clearer understanding of the micro-dynamics of water supply and use. Critically, the knowledge must embody spatial and temporal co-ordinates of water availability and demand. In this paper we have highlighted the importance of the geographical equity of natural resources to the understanding water stress and concomitant development of DSM strategies. Unfortunately, efforts to regulate the privatised water industry have so far made little distinction in terms of geographical equity. The shift towards treating water as a common economic unit has led to a view of water as geographically homogenous[28]. A litre of water is the same unit of resource in Newcastle (where water is plentiful) and Folkestone (where water is scarce). However, as Graham Haughton again suggests, more sustainable resource management "requires that we examine much more carefully than hitherto the balance of environmental benefits and costs resulting from an activity, as they occur not simply in aggregate, but as they fall in different areas" (Haughton, 1995, p13). Consequently, a finer grain understanding of water use in different sectors, across space and time, must be developed. The implementation of new infomatic technologies, for advance metering, leakage control and distribution management, is likely to enhance the development of this knowledge culture. At the same time, finer grain studies of the dynamics of domestic, industrial and commercial demand will aid the planning of DSM initiatives.

The Reconfiguration of Consumption Interests

Privatisation and liberalisation of water services has radically reconfigured consumption interests around water management issues. The controversies surrounding the whole privatisation project has brought the industry into the political spotlight and significantly raised the expectations of water consumers (Maloney & Richardson, 1994, p126). The media profile of consumer bodies such as the National Consumer Council has grown powerfully and water users themselves seem to have become much more vocal in their demands for lower prices and better services. Arguments rage about the benefits or otherwise of privatisation to consumers. While one camp decries the inequities introduced by privatisation (Ernst, 1994), another celebrates enhanced consumer benefits (Saunders and Harris, 1994). But as this paper makes clear, such totalising verdicts homogenise a spatially dynamic and contradictory social process. Closer investigation of the emergence of new styles of utility network management reveal complex patterns of social, economic and environmental change. While worries over the health implications of water poverty are highlighted by consumer groups (NCC, 1992) others point to the environmental dividends of privatised water supply (Saunders, 1994). While the media voices popular concerns over the excessive profits of water

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[28] While the 'K' component of the pricing formula (reflecting necessary capital investment to meet EC standards etc) does vary regionally, infrastructure provision charges have been standardised and the 'July returns' are compared and contrasted on an equivalent basis.

companies, a new consensus is emerging on the socio-economic virtues of managing water as an economic resources, pointing to the heightened care for conserving water prompted by charging for actual usage (Winpenny, 1994). Arguments over the efficacy of DSM is caught within these debates.

Need for New Research

All this points to the need for further research on the social logic of water management in general and of DSM in particular. There has, for instance, been little research about the relationship between the provision of water services and the development process. Instead it has routinely expected that the water industry will provide sufficient water supply and sewage capacity to meet increasing demands as a matter of course. But increasing water stress has created a serious source of tension in development processes. New linkages must therefore be found between development and infrastructure actors that enable DSM measures to be taken up as part of the development process. Unpacking the apparently mundane processes through which water is provided to new development helps make visible a whole serious of tensions, potential conflicts and emerging opportunities between institutional actors involved in development processes that shape the technical potential of DSM programmes. Uncovering the social orgainsation of contemporary water management may clear the way for more effective regulatory and policy guidance.

Thinking about Water Management

Through this paper we have demonstrated how water management and planning cannot be understood merely as an abstract science of technical and organisational efficiency. Like all policy-making processes, contemporary water management;

> ...is a constant discursive struggle over the criteria of social classification, the boundaries of problem categories, the conceptual framing of problems, and the definitions of ideas that guide the ways people create the shared meanings which motivate them to act (Fischer & Forester, 1993, p2).

As Fischer and Forester argue, "policy and planning arguments are practical productions" (Fischer & Forester, 1993, p3). That is, the production of particular technological programmes is the result of discursive and practical work. A common vocabulary and language must be developed around key priorities and an active organisational partnership forged through particular practices. In this way technical strategies are institutionalised around what Martin Hajar terms "discourse coalitions - a group of actors who share...an ensemble of ideas, concepts, and categories through which meaning is given to a phenomenon" (Hajar, 1993, p45). We have illustrated the production of just such a discourse coalition between water regulators and regional planners around the use of DSM and bulk water sharing techniques to minimise water stress. We have also pointed to the establishment of a very different position by the water companies who, while supportive of targeted DSM programmes, view water 'sharing' as commercially untenable.

Such a clash of worldviews is immediately apparent when considering FDWC's water supply problems. The negotiations and situationally specific compromises shaping the final design of the Oasis holiday village highlight the ways in which varying strategies of water provision embody different modes of sociotechnical organisation. Seen this way, understanding the shape and

direction of DSM in the water sector depends upon unpacking the different 'ways of seeing' shaping technical responses to the challenge of water stress. Most importantly, this demands spatial sensitivity to the social, technical and environmental challenges of managing and developing water networks. DSM strategies are caught within this "seamless web" of social, spatial, organisational, regulatory, political and technical processes (Hughes, 1983). British DSM is then unlikely to mimic American practices, nor is it likely to emerge in the techno-rational manner suggest by the NRA, OFWAT or the DoE. Instead DSM initiatives will surface in particular places, at commercially opportune moments in response to both the spatially and temporally contingent demands of water suppliers, the wider regulatory signals sent by the regulators and public planning bodies and the claims of socially and environmentally demanding consumers. In the case of the Oasis holiday village we have identified a number of 'narratives' framing both the 'problem' and 'solution' of water supply and use. The 'sense' or 'rationality' of these sociotechnical stories very much depends upon the institutional location of the storyteller. We have shown how the key players in the Oasis development very successfully harnessed the language and symbolism of DSM and integrated water management to strengthen support for the scheme. With the Government's follow-up document to 'Using Water Wisely', 'Water Conservation - Government Action', commending rigorous efficiency in the supply and use of water the scene seems set for the establishment of DSM as the defining logic of future water management strategies (DoE, 1995). However, water planners and policy-makers must learn to shape strategies of water management by developing a narrative around DSM which encompasess all interested parties. In this way the successful application of DSM programmes depends as much on social processes as technical fixes.

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