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WASTE MANAGEMENT IN WALES: ITS PROBLEMS AND POLICY IMPLICATIONS

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This thesis is dedicated to my parents

for their constant support.

ABSTRACT.

The Local Government Act, 1972, treated Wales separately from England with respect to waste disposal. Consequently, responsibility for waste disposal in Wales, is placed with the thirty-seven District Councils, whilst in England, the County Councils are the Waste Disposal Authorities.

An appraisal of the efficacy of waste management in the Principality, is restricted by the inadequate data base. Few authorities utilise weighbridges to record accurate weight data. In addition, no single organisation, including central government, collates information regularly on an all-Wales basis. Data are thus inconsistent, inaccurate and often, incompatible. The ability of both central and local government to adequately assess the impact of their respective policies is, therefore, questioned. At District level, the inadequate data base, is found to be manifest in the inappropriate selection of landfill sites and occasionally, in a shortage of disposal capacity.

The inadequate data base inhibits policy appraisal in terms of change in environmental quality, but does permit the assessment of procedural change. Some authorities are found to be in contravention of the Control of Pollution Act, 1974, with respect to basic administrative procedures. The Act, also fails to have any discernable impact upon landfill site selection; both pre- and post-1974 sites record pollution problems. Consultation procedures are misused by some authorities, allowing consultees insufficient time to report.

Notwithstanding the data inadequacies, analysis reveals spatial patterns in waste production and disposal. Waste Disposal Authorities are shown to exhibit similar characteristics on a regional basis. Three regions are identified, namely, North, Mid and South Wales. No trends in waste arisings are discernable for the seven year study period; these fluctuate widely and present difficulties for day to day waste management and long term prediction.

Given the financial constraints imposed upon Local Government, no improvement in the monitoring of waste, is foreseen. In light of the importance of accurate data for waste management and prediction, the development of a practical, predictive model, is undertaken with a view to making a positive contribution. The model utilises the relationship, at various scales, between waste arisings and population, households and in particular, socio-economic groups. It is based upon two principles: first, that accurate weight data are available for a small number of authorities and secondly, that authorities within regional groups, exhibit similar characteristics. Thus, the use of authorities with 'good' data as a template, upon which to build general rules for waste prediction applicable to other authorities, is investigated. Although, the findings are inconclusive for most individual socio-economic categories at sub-District level, the methodology developed is shown to have potential, particularly for further development by central government.

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LIST OF ABBREVIATIONS

ACORN	:	A Classification of Residential Neighbourhoods.
AONB	:	Area of Outstanding Natural Beauty.
COPA	:	Control of Pollution Act, 1974.
DOE	:	Department of the Environment.
EEC	:	European Economic Community.
NCC	:	Nature Conservancy Council.
OPCS	:	Office of Population Censuses and Surveys.
OS	:	Ordnance Survey.
RCV	:	Refuse Collection Vehicle.
SAS	:	Small Area Statistics.
SP	:	Super Profile.
SPG	:	Super Profile Group.
SSSI	:	Site of Special Scientific Interest.
WCA	:	Waste Collection Authority.
WDA	:	Waste Disposal Authority.
WO	:	Welsh Office.
WWA	:	Welsh Water Authority.

PREFACE

Although Wales is frequently subjected to 'blanket legislation' by central government, waste management is one area, where it has been treated differently from England. As such, it warrants investigation in it's own right, with a view to assessing whether this decision is justified. The appraisal of administrative responsibility, must inevitably, focus upon the efficiency of the current Waste Disposal Authorities to adequately fulfil their statutory duties. The Principality contains a large sample of physical and socio-economic environments for analysis. Thus, providing the opportunity to assess the efficacy of individual Waste Disposal Authorities to cope under very different circumstances.

The appraisal of both local authority and central government policy, necessitates an adequate data base upon which to make an assessment. Trend data are required, commencing prior to the introduction of a new policy and continuing throughout implementation. Thus, the impact upon selected variables may be monitored and in this way, the effectiveness of the policy and, in the case of new legislation, compliance with statutory requirements, may be assessed. The appraisal of waste management in Wales, therefore, requires trend data for individual authorities, enabling comparison through time and over space.

Waste production and disposal are well-suited to geographical analysis, being the products of man's domestic and industrial activities. Thus, spatial patterns in population density and industrial intensity, are closely mirrored by waste arisings and disposal requirements. At the micro scale, the relationship between socio-economic groups within a population and waste arisings, may be discerned. A further issue of geographical interest and concern, is the environmental impact of waste disposal. The mismanagement of waste has serious environmental consequences in terms of the inappropriate selection of landfill sites and inadequate provision of disposal capacity. Waste disposal in Wales is dominated by landfill disposal; over 90% of waste is disposed of direct to landfill without prior treatment. Landfill site selection is, therefore, vital and yet, varies considerably throughout the Principality. The selection of landfill sites is a complex procedure, involving locational decisions, cost-benefit analysis and environmental impact assessments. It is surprising, therefore, that to date, virtually no geographical investigations have focused attention on the issue of waste production and management.

Two studies have investigated waste management in Wales:-

a) First, the Association of District Councils has investigated the situation for the year, 1977/78, (ADC, 1979). However, the study failed to investigate individual authorities and omitted the analysis of trends and spatial patterns in waste production and disposal, landfill site selection and management, and waste prediction. The report comprised a self-analysis and failed to adequately review the situation,

and b) A research project funded by the Environmental Directorate of the EEC, has been undertaken jointly by the University of

Aberystwyth and Clwyd County Council, (Wathern, 1983). The project attempted to appraise the impact of the EEC's Environmental Directives on the Welsh environment; waste management was just one of the environmental issues analysed. The author of this study was a member of the team and had sole responsibility for the appraisal of the EEC's waste directives. The investigation identified some of the problems facing waste management in Wales and the potential for further analysis, was revealed. Consequently, the findings of that investigation are the author's own work[1], under the guidance of Dr. Peter Wathern, and are referred to in this study.[2]

This research follows three main lines of inquiry:-

i). A geography of waste in Wales - an investigation into the current situation regarding waste management in Wales, in particular, the adequacy of the data available for identifying spatial patterns and trends and hence, the effectiveness of current policy and legislation;

ii). An investigation of the data requirements for good waste management, in particular, for strategic planning and policy appraisal. The possibilities for using surrogate data for authorities with poor waste data and also, the relationships between waste arisings, population, domestic hereditaments and socio-economic groups, are investigated, with a view to establishing a methodology for waste prediction,

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[1]. EEC Report to be provided at examination if requested.

[2]. I testify that this is my own work, unless otherwise stated.

and iii). The methodological development of a predictive model based upon relationships between waste arisings and other variables, at the grass roots level. The investigation utilises a selected case study and attempts to establish a method of waste prediction, with general applicability to all Waste Disposal Authorities.

Finally, the definition of waste used throughout this research is taken as that laid down in the Control of Pollution Act, 1974, Part I, Section 30. Thus, waste includes:-

'a). any substance which constitutes a scrap material or an effluent or other unwanted surplus substance arising from the application of any process; and

b). any substance or article which requires to be disposed of as being broken, worn out, contaminated or otherwise spoiled, but does not include a substance which is an explosive within the meaning of the Explosives Act, 1875;
and for the purposes of this Part of the Act any thing which is discarded or otherwise dealt with as if it were waste shall be presumed to be waste unless the contrary is proved' (Control of Pollution Act, 1974, Chapter 40).

The following wastes, however, are excluded from this study:-
mine and quarry waste, radio-active waste, farm waste or medical, surgical and veterinary waste.

PART I A GEOGRAPHY OF WASTE IN WALES

CHAPTER 1

1. INTRODUCTION

The geographical investigation of waste management in Wales must, necessarily, be based upon an analysis of spatial patterns and trends through time. The objective of such analysis, being the identification of the underlying causal factors at work and, in particular, the effectiveness of current policy and legislation on waste. Emphasis will be placed upon an appraisal of the impact of the Control of Pollution Act, 1974, Part I, Waste on Land.

Such an investigation requires the availability of accurate quantitative and qualitative data, that is, information on selected variables, covering as long a period as possible and at all levels. Ideally, policy appraisal requires the monitoring of, and data for, selected variables prior to, during, and after the implementation of a policy. Consequently, any impact should be more easily detected. Part I, therefore, incorporates an analysis of data adequacy for each aspect of waste management investigated, along with the examination of spatial patterns and trends; in some instances, the latter study may be restricted by the poor quality of the data available.

Three scales of investigation are included in the analysis, these are Wales, the three regions of North, Mid and South Wales, and the thirty-seven Welsh Waste Disposal Authorities, (WDAs). In addition, the various aspects of waste management are dealt with separately in order to aid investigation. Thus, Part I comprises the following sub-sections:-

i). Administrative and Legislative Background;

ii). Data Sources;

iii). Waste Arisings in Wales: Changing Patterns and Trends;

iv). Waste Disposal in Wales: Changing Patterns and Trends;

v). Landfill Site Selection: A Geographical Analysis,

and vi). Data Inadequacies.

CHAPTER 2

2. ADMINISTRATIVE AND LEGISLATIVE BACKGROUND

2.1 Legislative Background

Britain has a long legislative history concerning various aspects of waste management. Indeed, waste disposal has been a local authority function since the last century; for example, through the Public Health Acts, 1875 and 1897. During the intervening period, a wide range of legislation which impinges on the problems of waste management has been implemented. Some of the more important provisions prior to 1972 were included in Acts such as The Alkali and Works Regulation Act, 1906, The Public Health Act, 1936, The Civic Amenities Act, 1967, The Town and Country Planning Acts of 1947 and 1971 and The Litter Act, 1958, (the relevant legislation is listed in Appendix 2.1). The principal Act prior to 1972 was the Public Health Act, 1936, which empowered public health authorities to collect refuse, but with the exception of inner London, this was not a statutory duty.

Apart from minor provisions, the law underwent little change until 1972 and the introduction of the Local Government Act. This led to the distinction between England and Wales in terms of the location of responsibility for waste disposal. In the same year, the introduction of the Deposit of Poisonous Waste Act, 1972, was the first piece of legislation to be implemented which dealt solely with waste disposal. Prior to this, only certain aspects of waste disposal had been incorporated into other pieces of legislation. For example, the requirement of planning permission for any new development including waste disposal sites and plants, was introduced by the Town and Country Planning Act, 1947, but as only one of the many types of developments requiring planning permission under the Act.

A major legislative breakthrough in waste management has been made with the introduction of the Control of Pollution Act, 1974, (COPA). Part I of the Act, entitled 'Waste on Land', deals specifically with waste disposal. Parts II, III and IV of the Act cover water pollution, noise pollution and air pollution respectively. Part I consists of thirty sections dealing with various aspects of waste collection and disposal. Most, though not all, sections have been brought into force at some point in time, but the Act is still not fully operative; Sections 1, 12 to 14, and 24, were still not operative by 1st May, 1987.

In some cases, a particular aspect of waste management is controlled through a combination of Acts. The requirement for all private waste disposal site operators to obtain a waste disposal licence is such an example. The Public Health Act, 1936, empowered local authorities to licence the disposal of waste by private operators. These licences, however, can be issued only in respect of sites that have received planning permission under the Town and Country Planning Acts. Sites in existence prior to 1947, that is before the introduction of the Planning Acts, are exempt from these licensing provisions. The recent Control of Pollution Act, Part I , Sections 3 to 11, brought in further, stricter site licensing provisions which were implemented in 1976. These gave local authorities their first powers of control over all waste disposal. Section 17 of COPA introduced provisions covering dangerous or intractable waste, referred to as 'special waste'. Under this section, the Control of Pollution (Special Waste) Regulations were brought into force in March 1981. The regulations make it the duty of disposal authorities to control the movement and disposal of special waste within their administrative area.

2.2 Administration

2.2.1 Location of Administrative Responsibility

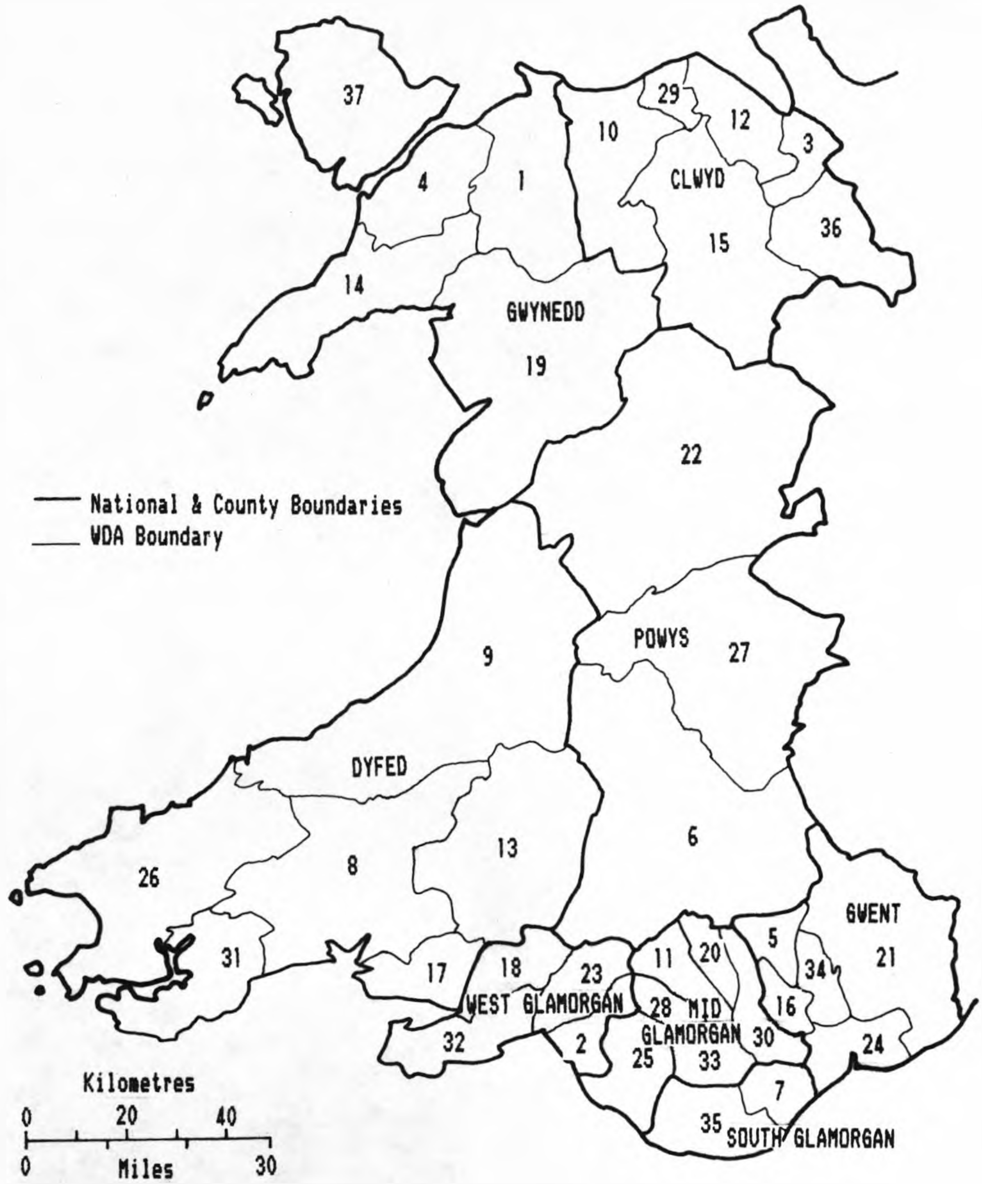
Responsibility for waste collection and disposal in Wales rests with the thirty-seven District Councils[1], (Figure 2.1). Thus, the Districts have a dual role as both Waste Collection Authority (WCA) and Waste Disposal Authority (WDA). This is in contrast to the situation in England, where the County Councils are the WDAs, whilst collection is undertaken by the District Councils.[2] The difference in administrative structure between England and Wales is a statutory difference created by the Local Government Act, 1972, in which the two countries were treated differently.

The ability of the Welsh District Councils to fulfil their duty as WDA has been questioned over recent years by central government and

[1].The name 'Afan' Borough Council is used in this study, however, this authority was renamed 'Port Talbot', on January 1st, 1986.

[2].Responsibility for waste disposal in the former Metropolitan County Councils, varies from area to area. For example, a Waste Regulation Authority has been established for the control of special waste and waste licensing in the area of the former Greater London Council, whilst South Yorkshire is administered by Borough and District Councils.

Figure 2.1. The Welsh Waste Disposal Authorities.



The Disposal Authorities

1. ABERCONWY	10. COLWYN	19. MEIRIONNYDD	28. RHONDDA
2. AFAN	11. CYNON VALLEY	20. MERTHYR TYDFIL	29. RHUDDLAN
3. ALYN & DEESIDE	12. DELYN	21. MONMOUTH	30. RHYMNEY VALLEY
4. ARFON	13. DINEFWR	22. MONTGOMERY	31. SOUTH PEMBROKESHIRE
5. BLAENAU GWENT	14. DWYFOR	23. NEATH	32. SWANSEA
6. BRECKNOCK	15. GLYNDWR	24. NEWPORT	33. TAFF-ELY
7. CARDIFF	16. ISLWYN	25. OGWR	34. TORFAEN
8. CARMARTHEN	17. LLANELLI	26. PRESELI	35. VALE OF GLAMORGAN
9. CEREDIGION	18. LLIW VALLEY	27. RADNOR	36. WREXHAM
			37. YNYS MON

others, (Welsh Office, 1982, House of Lords', 1981, Wathern et al., 1983). A consultation paper reviewing the administration of waste disposal in Wales and proposing four alternative options, was circulated to all relevant organisations by the Welsh Office during 1982, (Welsh Office, 1982). On February 24th, 1984, the Secretary of State for Wales announced that responsibility for waste disposal would be left with the District Councils. Three main considerations weighed in favour of responsibility for waste remaining with the Districts:-

> 'The first was that the county councils did not possess the relevant expertise either. Secondly, there were no statutory powers to effect an immediate change and new legislation would be required. This would take time - the third most important consideration. We found that we would not be able to effect a change much before the end of 1985. We clearly could not afford to wait almost 2 years during which very little improvement to the Waste Disposal Service could be achieved.' (Welsh Office, 1984).

This decision was, however, conditional on the Districts being able to demonstrate their ability to deal efficiently with all aspects of waste disposal. In particular, emphasis was placed on the completion by each WDA, of a waste disposal plan; a statutory requirement under Part I, Section 2, of the Control of Pollution Act, 1974 (COPA). Although, this Section was implemented in December, 1977, seven years later (1984), only thirteen plans were available or nearing completion, (Wathern et al., 1983). Consequent upon the Sectretary of State's warning, the majority (thirty-three), were complete by December, 1985; Neath, Rhondda, Taff-Ely and Wrexham Maelor, being the last to comply, during 1986.

The power of central government to control various aspects of waste collection and disposal through legislation, is in reality, far from absolute. Loopholes in the legislation and differences in the interpretation of legislation by District Councils to suit their individual circumstances, have weakened these 'apparent' controls. One prime example, being the requirement to produce waste disposal plans. No completion date was set by COPA, and subesquently, local authorities delayed compliance for as long as possible.

The Secretary of State does, however, have decision making powers over contentious planning applications for waste disposal sites, but these powers are limited to the specific applications before him. He cannot, for example, compel a WDA to introduce a particular policy such as waste reclamation or to select only derelict sites such as disused quarries for landfill sites. Local authority policy on aspects such as these, can only be influenced by central government in its advisory capacity.

The newly created (August 1983), Hazardous Waste Inspectorate for Wales, based within the Welsh Office, is an example of an advisory body established by central government to give guidance to the local authorities. Guidance which may be accepted or ignored. Within Wales, the Hazardous Waste Inspectorate consists solely of the Hazardous Waste Inspector, who has responsibility for the whole of the Principality. He is also responsible for non-hazardous waste.

At present, therefore, each District has effective control, within the broad confines of legislation, over the collection, disposal and monitoring of waste in its own administrative area. This situation combined with the great variation in the physical and economical resources of these small administrative authorities has resulted in a concomitant variation in waste management practice and policy.

2.2.2 Staffing Levels and Technical Expertise

A simplistic, yet informative example of the current diversity of administrative practices is provided by a study of the personnel involved in waste management. Table 2.1 lists the official designation of officers responsible for waste disposal in twenty-seven Districts. The situation in the remaining ten Districts is not known. The variation in the titles reflects a very real difference in the background training of personnel and the consequent variation in expertise has inevitably resulted in differences in management practices. In addition, placing responsibility for waste disposal in the hands of technical officers, environmental health officers and engineers, rather than appointing a separate waste disposal officer indicates a number of failings in current management practice:-

i) First, the low priority accorded waste disposal by most authorities in the present economic climate;

ii) Secondly, a lack of understanding of the expertise and

Table 2.1 Officers Responsible for Waste Disposal in Twenty-Seven Waste Disposal Authorities

Title of Designated Officer	No. of Districts
Environmental Health Officer	8
Director of Technical Services/Technical Officer	6
Director of Works	1
Chief Cleansing and Transport Officer	1
Engineer;-	4
a) Director of Engineering and Building Services	
b) Borough Engineer and Surveyor	
c) Principal Engineering Assistant	
d) Engineer	
Borough Surveyor	1
Joint responsibility between 2 officers;-	
a) Director of Works/Director of Housing & Environmental Health	1
b) Director of Technical Services/Director of Public Health & Housing	1
c) Assistant Chief Technical Officer/Chief Environmental Health Officer	1
d) Chief Engineer/Chief Environmental Health Officer	1
e) Chief Environmental Health Officer/Director of Technical Services	1
f) Director of Technical Services/Director of Housing & Environment	1

Source; Wathern, 1983.

training required for a Waste Disposal Officer having to deal with the complexities of modern wastes and their disposal. A fact acknowledged by the Welsh Office, (Welsh Office, 1984),

and iii) Finally, the lack of standardisation which is necessary if efficiency is to be improved and equality of disposal facilities available througout the Principality achieved.

Further evidence of inadequate resource allocation for waste management, particularly in the area of expertise, is presented in Table 2.2. This provides data on the number of technical and administrative staff employed by the WDAs. During the six year period, a total of twenty-two Districts (59%), employed four or less technical and administrative staff. The reliability of the data is questionable, however, given that eight Districts registered no technical or administrative staff for at least one year during this period. In some instances there are dubious fluctuations in staff numbers, such as those recorded for Alyn and Deeside, Blaenau Gwent and Taff-Ely. Other Districts, such as Brecknock, Cynon Valley, Swansea and Wrexham have experienced sudden, large, decreases in staff numbers, often by as much as 50% or more.

Table 2.3 indicates trends in total staff numbers employed in waste collection by the Districts. The reliability of the data provided by some authorities is again questionable given the fluctuations in staff. The data provided by Arfon, Lliw Valley, Monmouth, Rhondda and Taff-Ely give cause for concern. Sudden decreases in collection staff numbers might possibly be explained by a transfer of the

Table 2.2 Number of Technical and Administrative Staff Employed in Waste Disposal

District	1978/9	1979/0	1980/1	1981/2	1982/3	1983/4	1984/5	1985/6
ABERCONWY	4	6	6	6	4	4	4	4
AFAN	ND	ND	ND	ND	3	2	1	1
ALYN & DEE	5	5	8	ND	3	4	4	4
ARFON	6	6	6	5	-	2	2	2
BLAENAU G.	5	ND	ND	4	7	-	-	4
BRECKNOCK	12	ND	2	1	2	2	2	2
CARDIFF	16	16	17	17	19	19	19	19
CARMARTHEN	2	2	2	3	2	2	1	1
CEREDIGION	2	2	3	3	3	2	2	2
COLWYN	3	3	3	3	3	3	ND	3
CYNON VALL.	7	ND	3	3	3	3	3	1
DELYN	2	2	2	2	4	2	1	3
DINEFWR	ND	ND	2	2	ND	ND	1	1
DWYFOR	2	2	3	3	3	1	1	1
GLYNDWR	-	ND	-	-	-	1	1	-
ISLWYN	8	7	7	7	7	4	4	4
LLANELLI	4	ND	4	-	ND	4	4	ND
LLIW VALLEY	-	2	2	2	2	2	2	2
MEIRIONNYDD	2	2	2	2	2	ND	2	2
MERTHYR TYD	4	4	4	4	4	4	4	4
MONMOUTH	1	1	1	1	3	3	2	2
MONTGOMERY	ND	-	-	2	-	ND	*	*
NEATH	2	2	2	2	2	2	1	1
NEWPORT	6	6	ND	6	5	5	4	3
OGWR	6	5	5	5	5	6	7	4
PRESELI	3	ND	3	3	3	3	ND	ND
RADNOR	1	2	2	2	2	ND	2	2
RHONDDA	-	-	-	ND	3	3	3	3
RHUDDLAN	3	2	2	2	2	2	2	2
RHYMNEY VAL	4	4	4	4	ND	5	5	5
SOUTH PEMB	ND	ND	ND	1	1	1	1	1
SWANSEA	13	13	13	ND	7	7	6	6
TAFF-ELY	ND	8	-	ND	2	ND	2	2
TORFAEN	2	2	3	ND	3	3	ND	1
V.OF GLAM	1	3	3	3	2	1	1	1
WREXHAM	13	13	13	7	7	6	6	6
YNYS MON	3	3	3	3	3	3	3	3

ND= No data
- = zero
* = amount too small to register

Source: CIPFA Waste Collection Statistics Reports (Actuals).

Table 2.3 Total Staff Employed on Waste Collection

District	1978/9	1979/80	1980/1	1981/2	1982/3	1983/4	1984/5	1985/6
ABERCONWY	93	100	100	100	64	65	65	54
AFAN	ND	ND	ND	ND	18	15	16	16
ALYN & DEE	59	58	65	ND	51	46	46	41
ARFON	51	51	48	47	11	46	46	45
BLAENAU G.	73	ND	ND	35	41	31	31	37
BRECKNOCK	41	ND	34	33	29	29	30	29
CARDIFF	189	164	158	159	161	161	161	161
CARMARTHEN	26	27	27	27	26*	26	26	26
CEREDIGION	39	39	41	45	45	40	40	40
COLWYN	40	40	39	35	33	33	ND	33
CYNON VALL	73	ND	49	52	40	38	38	40
DELYN	52	52	52	52	53	46	46	39
DINEFWR	ND	ND	25	25	ND	ND	26	25
DWYFOR	36	31*	31	31	31	29	29	29
GLYNDWR	44	ND	34	27*	29	30	29	27
ISLWYN	56	51	51	45	45	36	36	40
LLANELLI	74	ND	74	47	ND	40	38	ND
LLIW VALLE	38	40	47	34	33	33	33	33
MEIRIONNYD	27	27	25	24	26	ND	25	26
MERTHYR TY	50	51	49	49	35	35	35	35
MONMOUTH	48	47	46	40	47	37	35	35
MONTGOMERY	ND	24	24	24	22	22	22	22
NEATH	33	31	31	32	33	33	30	40
NEWPORT	85	79	ND	79	78	74	69	59
OGWR	90	84	84	81	81	83	84	81
PRESELI	41	ND	40	39	39	39	ND	ND
RADNOR	15	16	16	17	17	ND	17	14
RHONDDA	88	92	51	ND	64	69	55	55
RHUDDLAN	65	61	61	61	61	42	42	39
RHYMNEY VA	64	64	61	61	ND	46	51	51
SOUTH PEMB	ND	ND	ND	28	26	26	24	26
SWANSEA	247	204	148	ND	121	108	104	104
TAFF-ELY	ND	78	38	ND	50	ND	41	46
TORFAEN	64	64	56	ND	51	47	ND	41
V.OF GLAM	49	51	51	49	48	46	38	37
WREXHAM	110	111	111	101	101	97	96	96
YNYS MON	59	61	55	56	56	56	56	56

ND = No data
* The fall in staff numbers from the previous year may have been due to privatisation of waste collection.

Source of data: CIPFA Waste Collection Statistics (Actuals) waste collection function from the public to the private sector. An investigation of changes in the percentage of waste collection undertaken by private contractors, does not, however, reveal this as a causal factor in these cases.

2.2.3 Administrative Practices Introduced by COPA

The Control of Pollution Act, 1974, introduced a number of administrative practices, some of which were not employed previously. Thus, compliance with these statutory requirements is easily monitored. In particular, three new practices were required:-

i) The preparation of a waste disposal plan (COPA, Section 2);

ii) The issuing of waste disposal licences, (COPA, Sections 3 to 11),

and iii) The requirement to 'maintain a register containing prescribed particulars of all disposal licences issued by the authority which are for the time being in force,' (COPA, Section 6.4a)

Compliance with Section 2, on waste disposal plans, has been shown to be 'leisurely', (2.1.1).

The site licensing provisions, (Sections 3 to 11), were brought into force in June, 1976. These give the WDAs control over the disposal of all waste within their administrative area, in that, all waste disposal sites require a site licence, in which the conditions of operation are laid down by the WDA. There are two exceptions to this:

i) Sites in operation prior to 1947 are not covered, because licences are required solely for sites granted planning permission under the 1947 and 1971 Town and Country Planning Acts,

ii) Secondly, the WDA is not required to issue a licence for its own sites. Instead, it is required to prepare a statement of conditions, refer this for consultation to the Water Authority and other interested parties, and finally, pass a resolution through its Council.

A survey of the Welsh WDAs, (Wathern, 1983), has provided data on both the number of licences issued and the numbers of private and WDA operated sites, within each authority. Comparison of these figures revealed that only 40% of authorities had appeared to issue the correct number of licences. The discrepancies were:-

i) The number of licences issued, exceeded the number of private sites, in seven WDAs. In some cases, the excess matched the number of WDA operated sites and, therefore, the authorities had incorrectly issued themselves with one or more disposal licences;

ii) Four authorities issued more licences, than the total number of disposal facilities claimed to be in use by both the authority and private operators, and iii) In three authorities, the number of privately operated sites exceeded the number of licences issued.

The survey also asked authorities whether or not they maintained a register of waste disposal licences, (Wathern, 1983). Twenty-seven WDAs replied, of which four acknowledged that no register was kept; a direct contravention of COPA.

In summary, it appears that implementation of the most basic administrative procedures required by COPA, has proved difficult for some authorities. A number have been shown to be in breach of their statutory duties. The ability of the current administrative structure to cope adequately with its responsibilites, is therefore, questionable. Basic information such as total staff numbers appears in some cases to be unreliable and is, perhaps, symptomatic of the current uncoördinated approach to waste administration in Wales.

In spite of these deficiencies, many of which are acknowledged by central government, responsibility for waste management is to remain with the District Councils for the foreseeable future. Yet, the need for change and the implementation of a more organised administrative structure through legislative controls, remains. There appears, however, to be little motivation within central government to alter the current situation. Evidence for this is shown by the second consideration which weighed in favour of responsibility for waste management remaining with the Districts, (<u>op. cit.</u>,).

CHAPTER 3

3. DATA AND DATA SOURCES

3.1 Data Collection

The ultimate source of all data relating to waste collection and disposal is the District Councils. However, local authorities are not in the habit of publishing data, unless specifically requested. Furthermore, the Welsh Office does not appear to collate information on this topic; certainly none are published. The collection of data from all thirty-seven authorities is, therefore, a necessary and somewhat difficult task. Techniques for data collection, are briefly examined in Appendix 6.1.

Most of the data used in this research, whether from published material or collected specifically, have been obtained through the use of a questionnaire. This particular technique of data collection has been necessary given the nature of the situation, in that only the District Councils have the data and access to it is gained solely with their consent. A copy of the questionnaire used in the collection of data for the Waste Disposal Statistics 1984/85 Actuals report, produced by CIPFA, is appended, (Appendix 3.1). Whilst, the postal questionnaire used specifically to collect data on landfill sites for this study, is shown in Appendix 6.1.

There are a number of difficulties inherent in the use of questionnaires:-

i) First, that not all Districts will choose to respond or that they may only provide a partial response;

ii) Secondly, the questionnaire has to be designed carefully so as to obtain essential data, whilst being brief and simple enough to encourage a response. Thus, the quantity of data requested must necessarily be limited to bare essentials,

iii) Finally, questions must be carefully worded so as to avoid misinterpretation or confusion and thus obtain the data in a particular format ready for analysis.

3.2 Published Data

The three main sources of published data have all been based upon questionnaire responses. These are the reports of the Chartered Institute of Public Finance and Accountancy (CIPFA), The Association of District Councils (ADC), and the House of Lords' Select Committee on Science and Technology (The Gregson Report).

CIPFA produces three annual reports on waste collection and disposal. These provide the most readily available source of data on waste in Wales. The three reports - Waste Disposal Statistics (Actuals), Waste Collection Statistics (Actuals) and Waste Disposal Statistics (Estimates), contain records of waste disposal and collection during the preceeding year and waste disposal estimates for the following year, respectively. Statistics for English Counties and Districts, as well as for each of the thirty-seven District Councils in Wales, are covered in the reports. The data are obtained, by three separate postal questionnaires; only a sample of the questionnaire for the Waste Disposal Statistics 1984/85 (Actuals) report, has been included, (Appendix 3.1).

Although, CIPFA Reports are readily accessible, they only commenced publication in the late seventies. Table 3.1 shows the number of reports that have been produced since 1976/77 and thus, indicates the maximum period for which trend data are available. Separate refuse collection statistics are available for the period 1976/77, whilst the main reports on waste collection and disposal, which contain data on Wales, were not published until 1978/79. Thus, continuous trend data cover a maximum period of seven years, to 1984/85.

A more detailed analysis of the CIPFA reports, Table 3.1, indicates that trend data over the whole seven year period, are available for very few WDAs. This is because most have, at some stage, provided only a partial response to the questionnaire and in some instances have not responded at all. The Table shows the number of responses obtained for each report, including those which were only partial replies; answers to some questions may be incomplete or totally lacking. The Waste Disposal Statistics (Estimates) Reports have been omitted from the Table. These commenced in 1980/81 and contain estimates only. They are of little value in ascertaining the current state of waste management practice.

Table 3.1 <u>Waste Disposal Authority Returns to CIPFA Questionnaires</u>

	Disp, Actuals								Collect, Actuals								
District	78 79	79 80	80 81	81 82	82 83	83 84	84 85	SET	76 77	78 79	79 80	80 81	81 82	82 83	83 84	84 85	SET
ABERCONWY								C	(X)								c*
AFAN				X					(X)	X	X	X	X				
ALYN & DEE		P						P					X				
ARFON					P				(X)								c
BLAENAU G.		X	X						(X)		X	X					
BRECKNOCK				X					(X)		X						
CARDIFF								C									C*
CARMARTHEN						P		P									C
CEREDIGION								C							P		P
COLWYN								C								X	
CYNON VALL.		P						P			X						
DELYN								C									C*
DINEFWR					X	X			(X)	X	X			X	X		
DWYFOR								C	(X)								c*
GLYNDWR								C	(X)		X						
ISLWYN								C									C*
LLANELLI		X			P	X	X		(X)		P			P	P	P	
LLIW VALLEY								C					P				P
MEIRIONNYDD							X								X		
MERTHYR TYD								C									C*
MONMOUTH								C	(X)								c*
MONTGOMERY								C		X					P		
NEATH								C									C*
NEWPORT						P		P				X					
OGWR								C	(X)						P		p
PRESELI							X		(X)		X					X	
RADNOR								C							X		
RHONDDA						P	P	P				X					
RHUDDLAN								C	(X)								c*
RHYMNEY VAL								C						P			P
SOUTH PEMB								C	(X)	X	X	X					
SWANSEA		X			P	P							X				
TAFF-ELY				X		P	P			X			X		X		
TORFAEN			X	X			X						X			X	
V.OF GLAM								C	(X)								c*
WREXHAM								C	(X)							P	p
YNYS MON								C									C*
TOTAL	37	34	35	33	36	35	33	26	21	32	29	33	31	36	33	34	10
P only	0	2	0	0	3	4	2	5	0	0	1	0	1	2	4	2	3
Adjusted																	18
Total																	6

X = No reply   P = Partial reply   C = Complete set of trend data
* = Both sets of trend data are complete
c and p = complete or partial set, if the 1976/77 data are excluded
Totals = number of replies received
Adjusted = Totals, excluding 1976/77

Source: Based on the Annual Reports, Published by CIPFA

The response rates shown in Table 3.1, indicate that a greater response is obtained from questionnaires on waste disposal, than those on waste collection. This suggests that authorities are more likely to record data on waste disposal than on waste collection.

A second source of Welsh data, is the report of the Working Party on Waste Disposal in Wales, which was established by the Committee for Wales of the Association of District Councils, (ADC), in 1978. The Committee believed that:

> '..it would be helpful for a multi-disciplinary working party to examine the requirements for implementing the sections of the Control of Pollution Act not yet brought into force and future waste disposal arrangements in Wales.' (Association of District Councils, 1979).

The report, first published in August 1979, touches on many aspects of waste management including waste arisings, disposal methods, toxic waste, landfill, recycling, planning and costs. The data contained in the report covers only a one year period, 1977/78, and no topic is dealt with to any great depth. It is, however, the only report found which attempts to investigate the situation regarding waste disposal in Wales. The ADC questionnaire, which was compiled with the help of the statistical section of the Welsh Office, obtained a complete response from the thirty-seven Districts. Even so, the report admits that:

' the ADC's returns cannot be said to be in every respect satisfactory, despite supplementary questions being issued.' (ADC, 1979, p6).

The ADC Report correctly identifies the uncoordinated approach to waste management in the Principality as an obstacle to data collection:

'The problem in obtaining replies to the questionnaire showed that administrative arrangements differed widely between districts in that in some waste disposal was split between different departments, in others technical services or environmental health, were wholly responsible and still others had separate cleansing departments. It did appear that some districts might review their arrangements with advantage so as to ensure that overall control and responsibility for policy was concentrated in one department.'(ADC, 1979, p6).

The third source of published data for Wales is the report of the House of Lords' Select Committee on Science and Technology under the chairmanship of Lord Gregson, 'The Gregson Report', (House of Lords' Select Committee, 1981). The request for information on hazardous waste disposal from the Gregson Committee to the Districts received a 100% response. The terms of reference of the Committee were:-

' to review the organisation and methods of hazardous waste disposal, and to consider what national policy for such disposal should be.' (House of Lords' Select Committee, 1981).

The findings of the enquiry were reported in 1981, together with the detailed submissions made to the Committee by those involved in the disposal of hazardous waste. Appendix 3 of the report includes numerical data on hazardous waste in Wales, giving the total amount of waste dealt with, the main disposal agencies, the major disposal methods and the number of landfill sites for each Waste Disposal Authority. These data, however, only cover a single year, thus no trends in hazardous waste disposal can be determined from this data source.

Other published material is confined to journal articles on various aspects of waste management in Wales. These tend to be accounts of specific problems at a particular site or reviews of the experience of an individual District Council. Most are 'one off' studies lacking any trend data, many contain a minimal amount of data. Thus, in many cases they are of limited value.

3.3 Unpublished Data

The small amount of published material encountered on waste in the Principality, reflects the fact that coverage of Wales in the literature is poor and also that very little work has been undertaken in this field. Consequently, the collection of unpublished data is essential in order to compensate for this serious deficiency.

An investigation into the quality of Welsh environmental data, including data on waste, has been carried out by a research team on behalf of the Directorate General for the Environment, Consumer Protection and Nuclear Safety, Commission of the European Communities, (Wathern, 1983). The establishment of a Welsh environmental data base was viewed as a necessary foundation on which to carry out a policy appraisal study of the impact of EEC environmental legislation in Wales. The data collected on waste during the EEC research were obtained through the use of a postal questionnaire, circulated to WDAs during February 1983. An attempt was made to obtain information on a number of aspects, including trend data for special (toxic), waste disposal. Access to the data collected, has been granted for use in this study.

Information on landfill sites, has been collected through a postal questionnaire sent to the District Councils in August 1984. Two further letters were sent during October and November 1984, until all thirty-seven Districts had supplied information. The questionnaire (Appendix 6.1), was formulated to provide information which is not available from published sources, and to supplement the information on landfill sites collected during the EEC research project. Consequently, a record of the main landfill sites in operation throughout Wales during 1983 and 1984, has been obtained.

3.4 Weight Data for Waste

Finally, all aspects of waste management, in particular, those which involve decision-making, are dependent upon accurate weight data. The detailed investigation of waste arisings and disposal, Chapters 4 and 5, is based upon weight data and includes an analysis of the accuracy and adequacy of the data available. However, it is necessary to precede the investigation, by an analysis of the ability of local authorities to weigh their waste arisings accurately.

It must be stressed, that accurate weight data can only be obtained through the use of a weighbridge, together with the maintenance of adequate records. Whilst, local authorities must rely upon the accuracy of the tonnages claimed to be produced and/or disposed by private operators, they are responsible for recording the waste which they collect and all wastes disposed at their own disposal sites.

Data provided by CIPFA on the number of authorities weighing waste and the percentage of total waste weighed, are presented in Tables 3.2 and 3.3. These cover a seven year period, from 1978-79 to 1984/85, and reveal a number of facts:-

i) The total number of authorities which have weighed the waste collected, are 7, 4, 6, 6, 7, 14 and 15 for each of the seven years respectively. For these Districts, the average percentage of total waste weighed was a low of 28.9% in 1978/79 and a maximum of 80.7% in 1982/83;

ii) Similarly, low levels are recorded for the amount of waste which is weighed prior to disposal, with 10, 10, 8, 11, 12, 15 and 17, authorities respectively, weighing waste. The

Table 3.2 Estimated Percentage of Waste Collected Weighed

District	1978/9	1979/0	1980/1	1981/2	1982/3	1983/4	1984/5
Aberconwy	-	-	-	-	-	-	-
Afan	ND	ND	ND	ND	-	5,0	-
Alyn & Deeside	-	-	96,0	ND	98,0	96,0	100,0
Arfon	-	-	-	-	-	-	-
Blaenau Gwent	-	ND	ND	50,0	-	22,0	5,0
Brecknock	15,0	ND	-	-	-	-	-
Cardiff	53,0	82,0	100,0	90,0	90,0	99,0	94,0
Carmarthen	-	-	1,0	-	-	80,0	75,0
Ceredigion	-	-	-	-	-	-	-
Colwyn	-	-	-	-	-	5,0	ND
Cynon Valley	45,0	ND	-	-	-	100,0	100,0
Delyn	-	-	-	-	-	100,0	100,0
Dinefwr	ND	ND	-	-	ND	ND	-
Dwyfor	-	-	-	-	-	-	-
Glyndwr	-	ND	-	-	1,0	4,0	4,0
Islwyn	-	-	-	-	-	-	-
Llanelli	3,0	ND	-	-	ND	-	-
Lliw Valley	-	-	-	-	-	-	-
Meirionnydd	-	-	-	-	-	ND	-
Merthyr Tydfil	1,0	-	-	-	-	-	4,0
Monmouth	-	60,0	58,0	60,0	100,0	100,0	100,0
Montgomery	ND	-	-	5,0	-	-	8,0
Neath	-	-	-	1,0	-	-	-
Newport	10,0	-	ND	-	-	-	-
Ogwr	-	-	-	-	-	-	-
Preseli	-	ND	-	-	-	-	ND
Radnor	-	2,0	2,0	-	-	ND	1,0
Rhondda	75,0	80,0	80,0	ND	100,0	100,0	100,0
Rhuddlan	-	-	-	-	-	-	-
Rhymney Valley	-	-	-	-	ND	-	-
South Pemb.	ND	ND	ND	-	-	-	-
Swansea	-	-	-	ND	95,0	95,0	80,0
Taff-Ely	ND	-	-	ND	-	ND	-
Torfaen	-	-	-	ND	-	-	ND
Vale of Gl.	-	-	-	4,0	81,0	100,0	100,0
Wrexham	-	-	-	-	-	5,0	2,0
Ynys Mon	-	-	-	-	-	-	-
Total WCAs	7	4	6	6	7	14	15
Average % weighed	28.9	56.0	56.2	35.0	80.7	65.1	58.2

ND = No Data
- = No waste weighed
WCA = Waste Collection Authority

Source of data; CIPFA Waste Collection Statistics Reports (Actuals)

Table 3.3 Estimated Percentage of Waste Disposed Weighed

District	1978/9	1979/0	1980/1	1981/2	1982/3	1983/4	1984/5
Aberconwy	-	-	-	-	-	-	-
Afan	-	-	-	ND	-	5,0	2,0
Alyn & Deeside	-	81,0	96,0	96,0	95,0	96,0	95,0
Arfon	3,2	-	-	-	ND	-	-
Blaenau Gwent	-	ND	ND	50,0	-	10,0	20,0
Brecknock	14,9	15,0	15,0	ND	10,0	-	-
Cardiff	82,4	82,0	98,0	96,0	96,0	99,0	96,0
Carmarthen	-	-	-	-	-	82,0	75,0
Ceredigion	-	1,0	1,0	1,0	1,0	-	-
Colwyn	0,4	-	-	-	-	-	2,0
Cynon Valley	45,0	45,0	-	-	-	100,0	100,0
Delyn	-	-	-	-	83,0	100,0	100,0
Dinefwr	-	-	-	-	ND	ND	-
Dwyfor	-	-	-	-	-	-	-
Glyndwr	-	-	-	-	1,0	4,0	4,0
Islwyn	-	-	-	-	-	-	-
Llanelli	-	ND	-	-	ND	ND	ND
Lliw Valley	-	-	-	-	-	-	-
Meirionnydd	-	-	-	-	-	-	ND
Merthyr Tydfil	1,4	-	-	-	-	-	2,0
Monmouth	-	76,0	60,0	70,0	100,0	100,0	100,0
Montgomery	-	-	-	5,0	-	5,0	8,0
Neath	-	-	-	-	-	-	-
Newport	-	-	-	-	-	-	-
Ogwr	-	-	-	-	-	-	-
Preseli	-	-	-	-	-	-	ND
Radnor	-	1,0	2,0	2,0	-	-	-
Rhondda	13,5	23,0	20,0	15,0	30,0	26,0	21,0
Rhuddlan	-	-	-	-	-	-	3,0
Rhymney Valley	-	-	-	-	-	-	-
South Pemb.	0,3	1,0	-	-	-	-	-
Swansea	-	ND	-	80,0	95,0	90,0	80,0
Taff-Ely	13,2	-	-	ND	-	-	-
Torfaen	-	-	ND	ND	4,0	4,0	ND
Vale of Gl.	1,5	-	-	4,0	60,0	94,0	91,0
Wrexham	-	40,0	46,0	46,0	20,0	20,0	2,0
Ynys Mon	-	-	-	-	-	-	-
Total WDAs	10	10	8	11	12	15	17
Average % weighed	17.6	36.5	42.2	41.9	49.6	55.7	47.1

ND = No Data
\- = No waste weighed
WDA = Waste Disposal Authority

Source of data: CIPFA Waste Disposal Statistics Reports (Actuals)

average percentages for the amount weighed, range from 17.6% in 1978-79 to 55.7% in 1983-84;

iii) Some authorities which weigh their waste, weigh only a very small percentage. In approximately 20% of cases, the percentage of waste weighed is less than 5%; an inadequate sample from which to draw conclusions about total tonnages;

iv) A small number of authorities have been consistently good at weighing waste, in particular, Alyn and Deeside, Cardiff, Monmouth and Rhondda;

v) Some authorities exhibit an irregular pattern of weighing. Records for this latter group often reveal a small amount of waste weighed for one year only. The remaining data for these, must be viewed with caution, as no reasonable explanation can be found as to why the facilities for weighing waste were present one year, but not in previous or subsequent years;

vi) A third group of authorities have consistently failed to weigh any waste. These number thirteen for both waste collection and disposal, including those which have failed to provide data for one or more years. One might reasonably expect the thirteen authorities to be the same for both collection and disposal, however, this is not the case. Surprisingly, only nine correspond,

vii) A number of other inconsistencies are revealed when the two sets of data are compared. These relate to the percentages of waste claimed to be weighed in the two sets of data. It is difficult to explain such discrepancies. District Councils are both the Collection and Disposal Authorities and therefore, if weighing facilities are present, records should be available for both waste weighed during collection and prior to disposal.

This analysis indicates that quantitative data on the waste collected and disposed of by the authorities, must be viewed in the majority of cases as rough estimates. The inability of authorities to consistently weigh a large proportion of waste, has meant a reliance on other methods such as counting collection vehicles. Such techniques are primitive, producing unreliable data which must be used with caution. The implications for waste management are immense, particularly for strategic planning and policy appraisal at District level, and for the appraisal of administrative responsibility, policy and legislation at the national level.

The following analyses of waste production and disposal in Wales, are, therefore, based upon data of questionable accuracy. No alternative data are available and any conclusions drawn are done so, tentatively.

CHAPTER 4

4. WASTE ARISINGS IN WALES: CHANGING PATTERNS AND TRENDS

4.1 Introduction

Waste production is not static, but changes through time and over space as a result of variations in numerous socio-economic factors, such as population and industrial intensity. Local authority policy on waste management, has only a limited impact on actual waste production. This is restricted to certain types of industrial wastes requiring specialist disposal techniques. In such cases, if the authority refuses to provide or grant permission for the required disposal facilities, industries producing the waste concerned may choose to locate elsewhere. Thus, some authorities may, indirectly, severely restrict the production of some industrial wastes within their administrative area. Commercial and domestic waste, however, remain unaffected.

Investigation of both temporal and spatial change in waste arisings within Wales is important, in that, it lays the foundations for the analysis of current waste disposal practice and subsequently, for strategic planning. The planning of waste disposal facilities, now a statutory requirement based upon the production of a waste disposal plan, is dependent upon accurate quantitative and qualitative data, in order to be effective. In particular, the availability of adequate trend data, and the ability to correlate this with associated factors such as population, is important in the prediction of future waste arisings and hence, disposal requirements.

The analysis of waste arisings is divided into the following components:-

i).Total Waste Arisings

ii).Different Types of Waste Arising

iii).Special Waste Arisings

4.2 <u>Total Waste Arisings</u>

4.2.1 Trends in Total Waste Arisings

Total waste arisings, by definition, represent domestic, commercial and industrial wastes, collectively. Data on total waste arisings for Wales over a seven year period are shown in Table 4.1.; these are the only data available for Wales as a whole and are based on a variable number of replies. The 'adjusted totals' include values[1] for the missing data. Even so, there is still considerable room for error and the totals must be viewed as estimates only. Total arisings vary and no trend can be discerned within either the recorded or the adjusted figures. These fluctuations, however, are only small. In the last six

[1] These were calculated using the mean of the values for the years preceeding and following the missing figure, for the WDAs concerned.

Table 4.1 Total Waste Arisings for Wales (tonnes)

Year	Amount (tonnes)	No. of WDA Replies	Adjusted Totals	% of 1978/79 Level
1978-79	2,328,350	37	2,328,350	100.0
1979-80	1,975,083	34	2,276,776	97.8
1980-81	2,062,966	35	2,272,110	97.6
1981-82	2,127,660	33	2,356,726	101.2
1982-83	2,283,683	34	2,399,661	103.1
1983-84	2,242,942	35	2,310,482	99.2
1984-85	2,183,836	33	2,353,931	101.1

Source of data; CIPFA Disposal Statistics years, total waste arisings have varied by only 3% above or below the 1978-79 level. There are two possible explanations for this:-

i) First, the economic recession may have restricted industrial expansion and consequently, industrial waste arisings,

and ii) Secondly, the level of population has remained fairly static. Over the seven year period, the highest estimated population level was 2,809,563 in 1982/83, only 1.5% higher than the lowest level of 2,767,900, for 1978/79.

It is at District Council level, however, that the impact of changes in arisings are experienced. Districts are responsible for the provision of adequate waste disposal facilities within their areas. Substantial fluctuations in arisings, particularly if unexpected and unexplained, can in the short term, create problems for resource allocation, such as machinery, manpower and even landfill capacity. In the long term, the inadequate and inaccurate planning of disposal facilities, may emerge.

Total waste arisings for individual District Councils are shown in Table 4.2. A number of facts are revealed:-

i) Eleven authorities have provided incomplete data sets;

ii) Trends in arisings for individual Districts vary. No District exhibits a continuous upward or downward trend in waste arisings over the seven year period. Three authorities, Aberconwy, Rhymney Valley and Wrexham, exhibit general trends,

Table 4.2 Total Waste Arisings for WDAs, 1978/79 to 1984/85 (Tonnes)

WDA	1978/9	1979/0	1980/1	1981/2	1982/3	1983/4	1984/5	Range
ABER	24,500	29,592	29,592	44,000	44,000	44,624	44,683	20,183
AFAN	61,232	61,100	61,100	ND	58,000	55,734	55,734	5,498
ALYN	30,100	31,000	50,700	44,682	51,000	47,520	47,500	20,900
ARFO	36,196	35,166	36,000	37,000	ND	59,876	54,650	24,710
BLAE	98,504	ND	ND	158,255	95,595	88,000	134,960	70,255
BREC	14,732	14,600	14,600	ND	12,900	17,530	13,000	4,630
CARD	260,032	373,443	328,461	380,634	447,703	312,752	215,056	232,647*
CARM	24,461	21,000	29,000	30,000	30,000	23,530	21,469	9,000
CERE	24,900	23,000	23,000	23,000	23,000	29,000	42,000	19,000
COLW	32,500	32,300	32,500	29,000	32,000	28,780	32,000	3,720
CYNO	23,582	24,000	50,000	24,500	24,500	48,345	44,717	26,418*
DELY	36,862	42,000	35,000	41,000	19,495	25,000	21,192	22,505*
DINE	18,540	18,750	23,500	30,000	ND	ND	27,500	11,460
DWYF	16,586	16,270	16,500	16,600	16,605	16,950	18,350	2,080
GLYN	18,200	18,000	18,000	22,000	19,725	27,200	27,200	9,200
ISLW	77,345	77,700	77,700	77,700	78,700	71,000	71,000	7,700
LLAN	75,590	ND	35,540	37,540	ND	ND	ND	40,050*
LLIW	39,000	27,325	41,500	44,000	55,000	44,500	42,000	27,675*
MEIR	14,000	14,000	14,200	14,250	14,500	15,000	ND	1,000
MERT	88,305	88,180	88,180	88,180	98,080	98,930	97,800	10,750
MONM	20,200	19,450	27,497	27,414	29,900	30,222	46,832	27,382*
MONT	26,114	26,158	36,158	18,200	38,000	39,600	25,450	21,400*
NEAT	58,600	52,000	45,850	47,080	56,528	98,073	97,648	52,223*
NEWP	66,150	82,355	125,000	140,000	120,000	120,000	165,000	98,850*
OGWR	275,781	147,000	124,000	113,000	105,000	127,500	117,500	170,781*
PRES	34,600	35,000	36,500	36,500	36,000	37,800	ND	3,200
RADN	11,541	9,540	10,000	10,000	16,800	9,000	10,000	7,800
RHON	138,770	110,000	105,000	97,000	100,000	94,500	94,000	44,770
RHUD	31,200	34,000	32,000	33,000	29,000	30,000	33,000	5,000
RHYM	176,100	176,100	144,000	144,000	125,000	118,016	96,100	80,000
S.PE	59,500	61,500	30,000	30,000	32,000	20,000	20,500	41,500*
SWAN	126,500	ND	109,000	122,000	121,000	94,084	96,132	32,416
TAFF	46,222	58,760	62,500	ND	89,500	69,500	145,537	99,315*
TORF	65,000	68,000	ND	ND	93,533	79,755	ND	28,533
V.GL	41,005	41,389	40,690	41,285	36,979	38,201	40,426	4,410
WREX	47,000	49,460	50,500	51,640	51,640	102,920	104,900	57,900*
YNYS	88,900	56,945	80,915	74,200	82,000	79,500	80,000	31,955

* = Range is greater than the lowest level of arisings recorded

Source of data; CIPFA Waste Disposal Statistics (Actuals) but with waste arisings remaining static for one or two years during the period analysed. The longest continuous 'trend', is an increase over five years, recorded by Dwyfor. Meirionnydd and Ogwr show a continuous increase and decrease, respectively, over a four year period. Analysis of the remaining thirty-one authorities, is either inhibited by missing data, or reveals fluctuations from year to year.

These findings have two implications for waste management, both on a day to day basis and in terms of strategic planning:-

i) First, that for some authorities, there appears to be a lack of the most basic data; this information may be recorded and has simply not been made available. The consequences, however, are that analysis of these authorities is severely restricted,

ii) Secondly, that recorded total arisings fluctuate greatly and appear to be unpredictable. To what extent these reflect changes in the 'guesstimates' made by those authorities without weighbridges, as opposed to actual change in arisings, is unclear.

The difference between the highest and lowest annual arisings, the 'range', is shown in Table 4.2. For thirteen authorities, the range was reportedly greater than the lowest level of arisings recorded, that is, the highest figure was more than double that of the lowest. This suggests that these Districts had to cater for the disposal of waste which varied in amount by more than 100% during the seven years studied.

Further investigation, reveals that the highest and lowest arisings occurred in consecutive years in four Districts. Three of these, Islwyn, Radnor and Ynys Mon, experienced decreases in arisings of 10%, 46% and 36% respectively. An increase of 36% for Brecknock, however, has more serious implications for available disposal capacity. A further six Districts experienced only a one year interval between the occurrence of their highest and lowest annual waste arisings; five of these recorded increases. An increase of 43% for Carmarthen and 12% for Merthyr Tydfil, are easily surpassed by the increases of 83%, 112% and 118% for Ceredigion, Cynon Valley and Montgomery, respectively.

The relatively 'sudden' and significant increase in waste arisings which appears to have been experienced by some authorities, is of particular concern given the implications for disposal, resource allocation and the planning of future requirements. The actual impact, would depend upon individual circumstances and in particular, the availability of adequate disposal capacity. In view of the unreliable nature of the data, it is probable that increases of this size are more apparent than real. However, in the event of substantial, actual increases, the ability to predict such changes would avert any major disposal problems, giving Districts time to make suitable arrangements. Accurate prediction must, of necessity, be based upon a thorough understanding of causal factors.

4.2.2 Spatial Patterns for Total Waste Arisings

An examination of the geographical distribution of waste arisings gives some insight into the possibilities for prediction. The existence of spatial patterns suggests similarities in the characteristics and forces at play within Districts on a regional basis.

Total waste arisings for the first and last years of the seven year study period, have been mapped out, Figure 4.1. These exhibit distinct spatial 'tendencies'. It is noticeable that Districts in South Wales generally have the highest waste arisings, most being over 75,000 tonnes. Districts in Mid Wales rarely exceed 50,000 tonnes, whilst those in the North fall between the two extremes of the South and Mid Wales regions. A detailed investigation of the relationships between waste production and various causal factors, including the causes of regional characteristics, will form the basis of Chapter 9.

4.3 Different Types of Waste Arising

4.3.1 The Classification of Waste

The recording of data by waste type is dependent upon the use of a uniform system of waste classification throughout Wales, both by WDAs and data collection agencies. Unfortunately, this has not been achieved. The major sources of published data employ different waste classifications, Figure 4.2.

CIPFA categorises waste according to source and not according to type, such as, toxic or industrial waste. Reclaimed wastes, for example ferrous metals and glass, are the only specific wastes identified, (CIPFA, 1978 to 1985). The CIPFA classification is

Figure 4.1. Total Waste Arisings. 1978/79 and 1984/85.

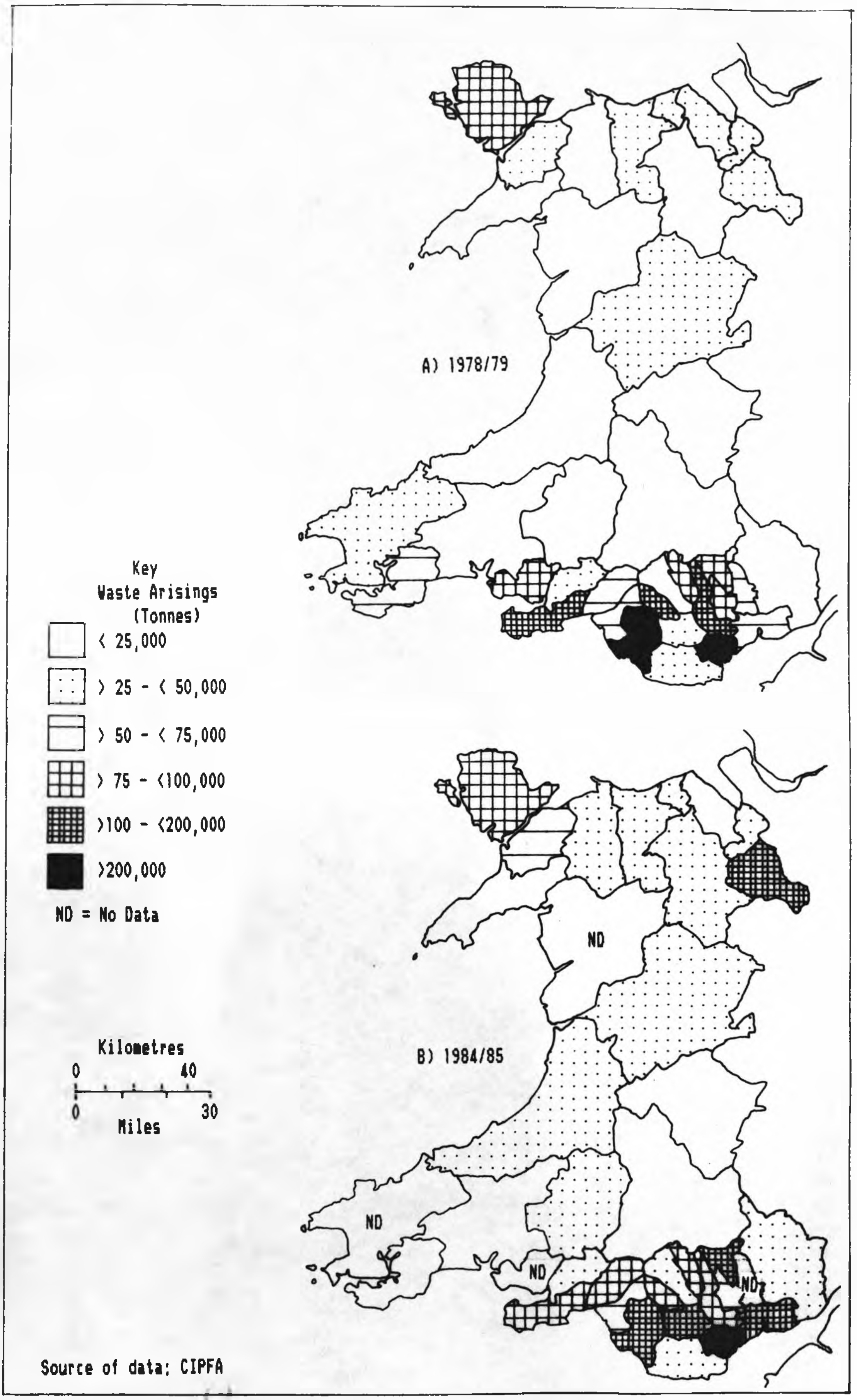
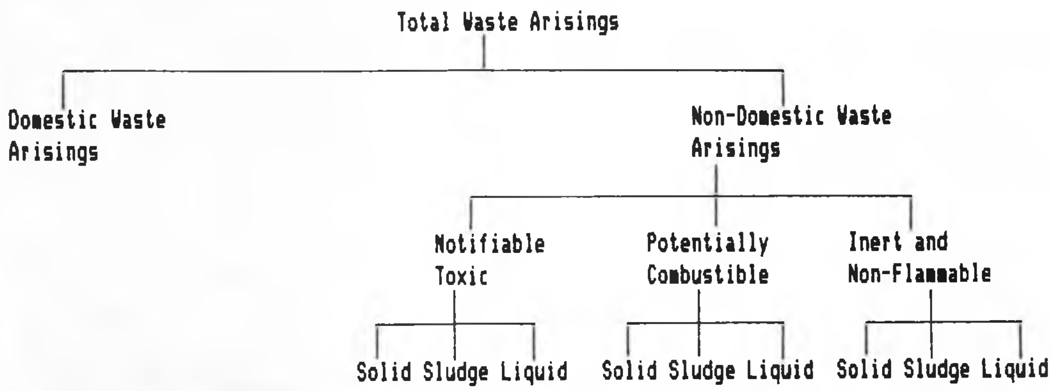
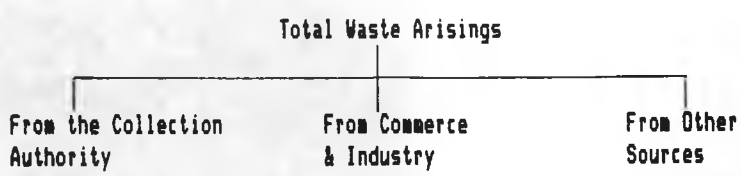


Figure 4.2. Comparison of the Waste Classifications Used By the ADC and CIPFA.

1. Waste Classification Used for Data Collection By the ADC:



2. Waste Classification Used for Data Collection By CIPFA:



Source: 1. ADC Report, 1979.
2. CIPFA Reports.

devised purely for accounting purposes and thus, the emphasis is on which organisations collect or dispose of waste and the costs incurred, rather than the types of waste arising.

The ADC report contains a comprehensive and practical classification, based on the physical characteristics of waste, (ADC, 1979). Wastes are initially classified into domestic and non-domestic, with non-domestic waste subdivided into potentially combustible, notifiable toxic, inert and non-flammable wastes. Each of these sub-classes is further divided into liquid, sludge and solid wastes. Thus, the amount of waste being produced with similar physical properties and hence handling requirements, can be easily assessed.

The use of different classifications in the monitoring and recording of waste, has implications for analysis and in particular, data compatibility. These are assessed in the following sections.

4.3.2 Domestic and Non-Domestic Waste: Spatial Patterns

Data for domestic and non-domestic waste arisings, contained in the ADC report, span a twelve month period only; 1977/78, (Appendix 4.1). Domestic waste arisings range from 5,500 tonnes in Radnor to 71,018 tonnes in Cardiff, with Neath the only South Wales WDA to have arisings of less than 20,000 tonnes.

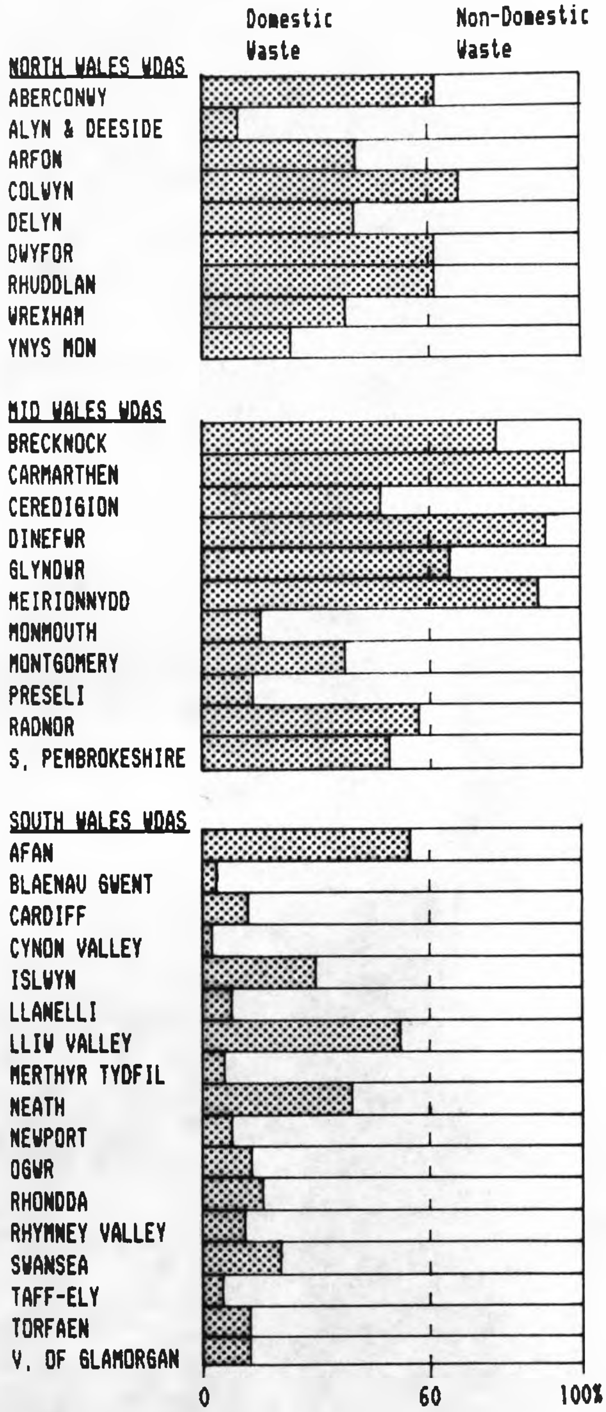
Non-domestic waste arisings show a far greater range, with a low of 1,040 tonnes in Carmarthen, to 911,634 tonnes in Blaenau Gwent. A total of fifteen Districts produce non-domestic waste arisings in excess of 100,000 tonnes; thirteen of these are located in South Wales. Seven Districts produce less than 10,000 tonnes, six of these are located in Mid Wales and one in North Wales.

The data imply definite spatial trends in both domestic and non-domestic waste arisings, but perhaps, particularly so in the latter. Regional variations in both types of arising are further evidenced in percentage terms. Figure 4.3 shows the respective percentage of domestic and non-domestic waste arisings which comprise the total waste produced within each District.

Total waste arisings for the whole of Wales comprises 14.6% domestic waste and 85.4% non-domestic waste. The ratio of domestic to non-domestic waste arisings does, however, vary considerably for individual Districts. The 'Welsh' pattern of small domestic waste arisings and large non-domestic arisings, is only representative of WDAs in South Wales. In the industrial South, fourteen out of a total of seventeen Districts have a ratio of less than 30% domestic waste to more than 70% non-domestic waste. Six of these have less than 10% domestic waste arisings and more than 90% non-domestic arisings.

This pattern does not hold true for the majority of Districts in Mid Wales, or for most WDAs in North Wales. Five Districts in Mid and four in North Wales have domestic waste arisings of more than 60%; in the South, Afan has the highest ratio of domestic to non-domestic waste, with 53.9% and 46.1% respectively. Calculated on a regional basis, the average figures for domestic and non-domestic waste are

Figure 4.3. Domestic and Non-Domestic Waste Arisings, As Percentages of Total Waste Arisings.



respectively 44.9% and 55.1% in North Wales, 57.9% and 42.1% in Mid Wales and 19.0% and 81.0% in South Wales.

The regional characteristics, evident in the composition of waste arisings, are very much as expected. Rural Mid Wales with its agricultural base and absence of any major industrial conurbations, has the lowest levels of industrial waste arisings. At the other extreme, the highly populated and industrialised valleys of South Wales produce vast quantities of non-domestic waste. North Wales, combines both agricultural and industrial features and reflects this in its waste arisings; it lies between the two extremes.

4.3.3 Domestic and Non-Domestic Waste: Surrogate Data

It is unfortunate that the valuable study undertaken by the ADC in 1977/8, was not continued to produce trend data for the various categories of waste arising. In the circumstances, data collated by CIPFA, may be adapted as a surrogate source of information. A comparison between the two data sources, may also demonstrate the potential for data substitution between them. First, any definitional differences in the terms 'domestic' and 'household' waste, used by the two sources, will undoubtedly affect analysis. In the CIPFA classification,

> '(the distinction between household, commercial and industrial waste follows the relevant provision of the Control of Pollution Act 1974,)', (CIPFA, 1978 to 1985).

The ADC report, however, contains no definition. It is not known, therefore, whether or not any definitional differences occur between the two data sets. For the purposes of this study, 'domestic' and 'household' waste are viewed as synonymous.

The method used to convert CIPFA data into domestic and non-domestic waste arisings, is explained in Appendix 4.2. The resultant data have been compared with those of the ADC, (Appendix 4.3), and are summarised in Tables 4.3 and 4.4. The main findings are:-

i) First, analysis of compatibility is inhibited by the time gap between the two data sets. CIPFA commenced data collection in 1978/79, the year after that of the ADC;

ii) Differences in the figures for domestic waste arisings are on the whole fairly small, the majority being an increase or decrease of less than 5,000 tonnes, (Table 4.3). In only three Districts, Cardiff, Swansea and Torfaen, were differences in excess of 10,000 tonnes revealed;

iii) Percentage differences are high and indicate the degree of flexibility required in planning waste disposal facilities;

iv) Differences both in tonnage and percentage change, are higher between the two sets of data for non-domestic waste arisings, than for domestic waste, (Tables 4.3 and 4.4). Apparent changes in excess of 10,000 tonnes were experienced by twenty authorities within a one year period.

Table 4.3 Summary of Differences in Domestic Waste Arisings Data

Difference (tonnes)	No. of WDAs	Percentage Difference	No. of WDAs
< 1,000	5	<10%	11
> 1,000 and <5,000	17	>10 and <20%	10
> 5,000 and <10,000	7	>20 and <40%	7
>10,000	3	>40%	4
No data	5	No data	5

Source: Based on Appendix 4.3

Table 4.4 Summary of Differences in Non-Domestic Waste Arisings Data

Difference (tonnes)	No. of WDAs	Percentage Difference	No. of WDAs
< 1,000	4	<10%	5
> 1,000 and <5,000	5	>10 and <20%	1
> 5,000 and <10,000	3	>20 and <40%	5
>10,000	20	>40%	21
No data	5	No data	5

Source: Based on Appendix 4.3

These findings, in particular, the differences recorded for non-domestic waste arisings, cast doubt on the degree of compatibility between the two sets. To what extent these discrepancies represent definitional differences, is unclear, but this is the most practical explanation.

Comparison of other data sets obtained from the two data sources, provides further evidence of their incompatibility. Appendix 4.4 compares the percentages of total waste arisings comprising domestic and non-domestic waste respectively. Given the twelve month difference between the data sets, one could reasonably allow variations in the data of up to 20%. In sixteen cases the variation was in excess of this level; seven exhibited a difference of 50% or more.

It appears unlikely, that these substantial percentage changes actually occurred. Trend data produced by CIPFA on the relative percentages of household and non-household waste collected, (Appendix 4.5), provide an indication of the size of the annual change normally experienced. The annual changes revealed, are much lower than those recorded between the 1977/78 ADC data and 1978/79 CIPFA data, (Appendix 4.4). There are some exceptions, such as the change of 65% in both Islwyn and Rhondda and 76% in the Vale of Glamorgan. However, these can be identified as errors in the data, occurring when figures have been placed in the wrong order, (Appendix 4.5).

The investigation has shown, therefore, that data produced by CIPFA are not compatible with those of the ADC, thus, data substitution is not possible. District Councils are the ultimate source of both sets of data, it is, therefore, difficult to explain why the data are not compatible, or at least are not capable of adaptation so as to be compatible. Consequently, the only trend data for the categories domestic and non-domestic waste arisings, are those adapted from CIPFA data.

4.3.4 Trends in Calculated Domestic Waste Arisings

Table 4.5 contains the calculated values for domestic waste arisings based upon CIPFA data. These have been calculated using the method previously described, (Appendix 4.2). The figures for the relative percentages of domestic and non-domestic waste arisings, used in the calculations, are estimates only. Thus, the calculated values for domestic waste arisings are, at best, rough estimates.

Analysis of the trends in arisings over the seven year period, is hampered by incomplete data sets for many Districts. Only sixteen have provided complete data sets; of these, Wrexham Maelor exhibits a continuous trend, recording an annual increase for five consecutive years. The remaining fifteen Districts, record fluctuations in their arisings. A further eleven authorities have provided data for a five year period; these show no trend in arisings, whilst the remaining ten authorities have provided data for four years or less, and consequently, analysis is not possible.

Tables 4.6 and 4.7 summarise the changes identified in the calculated domestic waste arisings, both in terms of tonnage and percentage change. These serve to indicate the national situation.

Table 4.5 Calculated Domestic Waste Arisings (Tonnes)

WDA	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
ABER	22,050	24,561	24,561	24,900	28,665	17,850	17,850
AFAN	ND	ND	ND	ND	26,130	15,129	13,642
ALYN	22,140	ND	31,050	ND	28,475	8,914*	15,667
ARFO	17,374	17,903	17,250	17,416	ND	20,000	22,640
BLAE	54,090	ND	ND	27,605	30,115	27,520	34,412
BREC	11,049	ND	8,400	ND	6,895	10,871*	8,050
CARD	115,207	79,144	98,163	103,148	95,938	98,615	101,431
CARM	20,385	14,896	15,040	14,288	10,850	12,023	11,071
CERE	20,169	18,860	20,700	20,700	20,700	22,140	16,500
COLW	24,960	24,000	24,240	22,080	20,000	9,581*	ND
CYNO	22,639	ND	23,400	21,375	21,375	17,068	19,226
DELY	29,247	26,892	27,300	29,750	12,321*	19,465	16,047
DINE	ND	ND	15,750	15,050	ND	ND	12,225
DWYF	9,727	10,088	7,236	7,303	7,524	7,590	9,975
GLYN	10,370	ND	13,600	14,080	11,096	14,794	14,775
ISLW	30,280	30,600	5,100*	27,200	26,950	17,850	17,850
LLAN	30,844	ND	21,099	29,281	ND	ND	ND
LLIW	31,450	23,226	32,725	ND	33,150	17,850	20,400
MEIR	11,039	11,035	11,197	11,226	11,624	ND	ND
MERT	21,297	21,218	21,218	21,218	30,993	22,648	22,275
MONM	15,352	14,782	21,998	19,060	22,720	14,208	14,756
MONT	ND	21,711	30,011	10,400*	11,200	10,920	11,585
NEAT	18,800	18,800	20,852	19,646	24,415	29,403	24,750
NEWP	39,512	45,295	ND	42,250	42,250	39,000	40,950
OGWR	34,349	36,000	33,600	36,800	38,400	38,675	41,710
PRES	21,120	ND	28,670	28,670	33,840	35,532	ND
RADN	6,375	4,836	4,875	4,875	11,550*	ND	6,300
RHON	17,500	28,000	2,000*	ND	36,000	24,000	14,400
RHUD	18,480	20,160	19,320	19,320	19,320	17,640	14,280
RHYM	45,182	45,182	36,040	36,040	ND	23,265	35,109
SPEM	ND	ND	ND	16,000	19,200	12,320	12,000
SWAN	86,700	ND	26,400	ND	23,836	21,154	33,459*
TAFF	ND	52,884	50,000	ND	80,550	ND	39,280
TORF	18,357	24,480	ND	ND	35,380	29,514	ND
VOGL	27,754	26,298	1,367*	27,748	28,342	29,509	30,074
WREX	30,800	32,877	33,880	35,763	36,080	61,398*	62,656
YNYS	23,630	23,885	24,327	24,820	24,650	25,075	27,000

ND = No data
 * = Large Scale Change

Source of data: Calculated from Appendices 4.6 and 4.5

Table 4.6 Summary of Changes in Calculated Domestic Waste Arisings: Tonnes

Change Tonnes	1978/9 to 1979/0	1979/0 to 1980/1	1980/1 to 1981/2	1981/2 to 1982/3	1982/3 to 1983/4	1983/4 to 1984/5	Total
	Number of Waste Disposal Authorities						
No change	2	2	6	4	0	2	16
< 1,000	+4 -4	+6 -2	+6 -2	+5 -2	+3 -1	+3 -4	42
> 1,000 & < 5,000	+4 -5	+3 -3	+4 -4	+6 -3	+8 -5	+9 -5	59
> 5,000 & <10,000	+2 -1	+3 -1	+1	+3 -1	+1 -5	+2 -2	22
>10,000 & <20,000	+1	+1	-1	-1	-6	+2	12
>20,000	-1	-3	+2		+1		7
No Data	13	13	11	12	7	8	64
Increase	+11	+13	+13	+14	+13	+16	+80
Decrease	-11	- 9	- 7	- 7	-17	-11	-62
NC	2	2	6	4	0	2	16

+ = Increase - = Decrease NC = No change
Source of data: Based on Table 4.5

Table 4.7 Summary of Changes in Calculated Domestic Waste Arisings: Percentage Change

Change Percentage	1978/9 to 1979/0	1979/0 to 1980/1	1980/1 to 1981/2	1981/2 to 1982/3	1982/3 to 1983/4	1983/4 to 1984/5	Total
	Number of Waste Disposal Authorities						
No change	3	2	6	4	0	3	18
< 10	+7 -6	+8 -4	+10 -5	+8 -3	+7 -4	+8 -4	74
>10 & <20	+2	+1	-1	+3	+1 -2	+3 -3	16
>20 & <30	-3	+1 -2		+2 -2	+1 -2	+1 -2	16
>30 & <40	+1 -1	+1	+1		+1 -5	+1	11
>40 & <50		+2		+1	-2	-1	6
>50 & <100	+1	-3	-1	+1 -1	+3 -2	+3	15
>100			+2				2
No Data	13	13	11	12	7	8	64
Increase	+11	+13	+13	+15	+13	+16	+81
Decrease	-10	- 9	- 7	- 6	-17	-10	-59
NC	3	2	6	4	0	3	18

+ = Increase - = Decrease NC = No change
Source of data: Based on Table 4.5

No trend can be discerned nationally; changes in annual arisings are fairly evenly split between increases and decreases. The impact of missing data on the analysis of annual change and trends nationally, is clearly shown.

The absence of trends in arisings, both for individual WDAs and nationally, must inevitably make prediction of future levels difficult. However, one positive outcome of the analysis, is that annual changes, whether increases or decreases, are usually low. Out of 158 instances where there were sufficient data to observe annual change, sixteen showed no change and in 101, changes in tonnage were by less than 5,000 tonnes. In percentage terms, no change was recorded in eighteen cases, whilst changes of less than 10% occurred in a further seventy-four cases.

Investigation of those Districts which experience apparently anomalous, large scale changes in arisings, may prove more valuable. Eleven instances of change in excess of 50% have been highlighted in Table 4.5. For two authorities, the Vale of Glamorgan and Rhondda, these can be explained by cross reference with Appendix 4.5. This reveals that the percentages for household and non-household waste, have been placed in the wrong columns and hence, when used to calculate domestic waste arisings have produced spurious results. The irregular figures for these two Districts are, therefore, errors and do not represent real changes in arisings. This is also the case for Islwyn. Changes in the percentage figures for houshold and non-household waste was a contributory factor in the cases of Alyn and Deeside, Colwyn, Montgomery, Radnor and Swansea. Analysis of the data, (Appendices 4.5 and 4.6), suggests that changes have occurred in real terms, with respect to Brecknock, Delyn and Wrexham.

4.3.5 Spatial Patterns in Calculated Domestic Waste Arisings

Spatial patterns produced by mapping the distribution of domestic waste arisings are shown in Figure 4.4. Highest arisings tend to occur in South Wales and to a lesser extent in Districts along the North Wales coast, particularly North East Wales. Cardiff, not surprisingly, records the highest annual arisings; these are far greater than for any other District. Taff-Ely, Newport, Rhymney Valley, Ogwr, Swansea and Wrexham record arisings which are constantly above average.

At the other extreme, lowest arisings have occurred in Radnor for four years (five years if the erroneous data for Rhondda and Vale of Glamorgan are omitted), and in Brecknock and Dwyfor for one year each. Consistently low arisings have been produced in Dwyfor, Radnor, Meirionnydd, Glyndwr, Brecknock and Dinefwr, all of which lie in Mid Wales.

4.3.6 Trends in Calculated Non-Domestic Waste Arisings

Non-domestic waste arisings can be obtained by subtracting the 'calculated' domestic waste arisings, (Table 4.5), from the actual total waste arisings, (Table 4.2). The resultant data are, for reasons previously stated, 'rough' estimates, (Table 4.8). Again,

Figure 4.4. Calculated Domestic Waste Arisings.

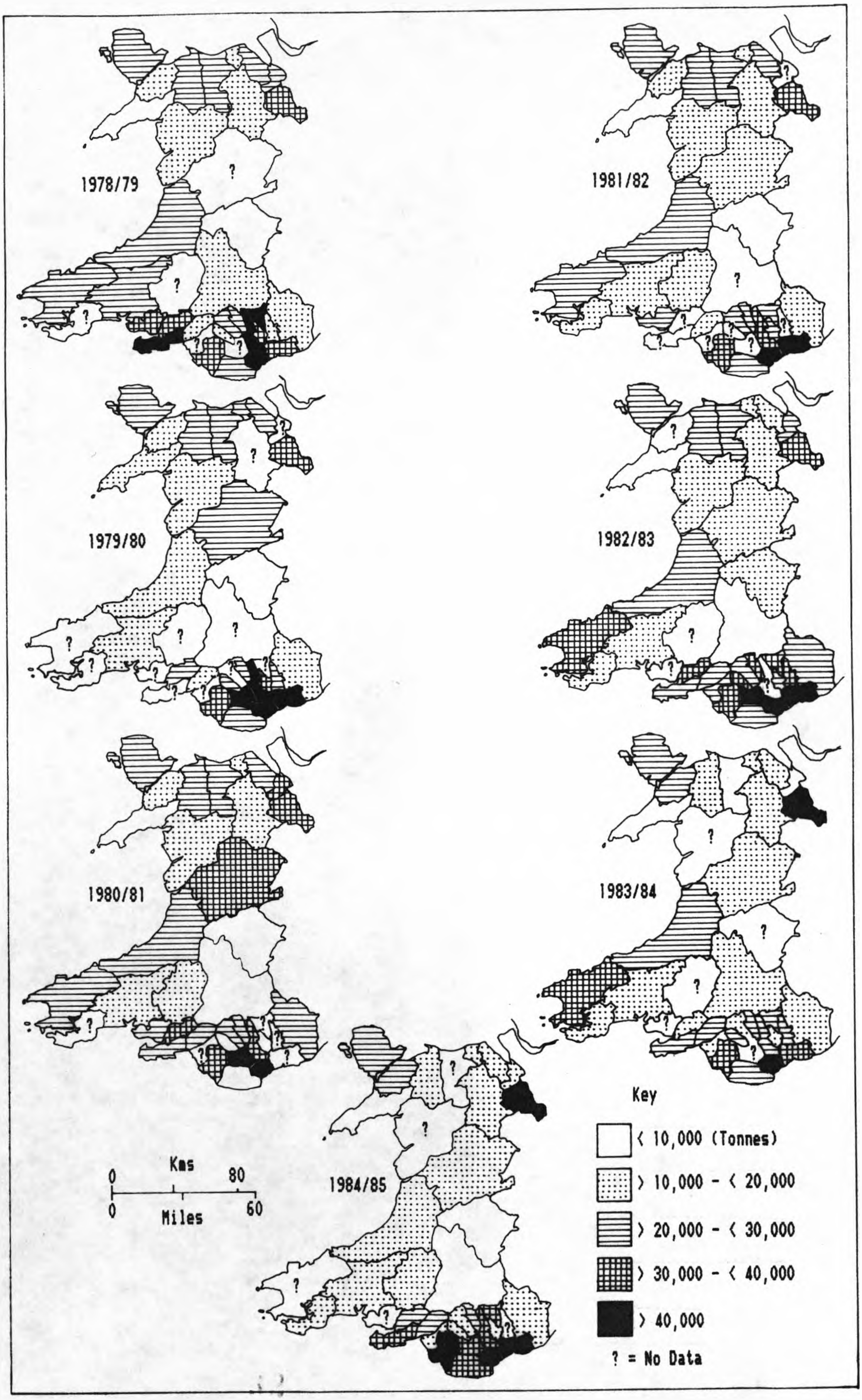


Table 4.8 Calculated Non-Domestic Waste Arisings (Tonnes)

WDA	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
ABER	2,450	5,031	5,031	19,100	15,335	26,774	26,833
AFAN	ND	ND	ND	ND	31,870	40,605	42,092
ALYN	7,960	ND	19,650	ND	22,525	38,606	31,833
ARFO	18,822	17,263	18,750	19,584	ND	39,876	32,010
BLAE	44,414	ND	ND	130,650	65,480	60,480	100,548
BREC	3,683	ND	6,200	ND	6,005	6,659	4,950
CARD	144,825	294,299	230,298	277,486	351,765	214,137	113,625
CARM	4,076	6,104	13,960	15,712	19,150	11,507	10,398
CERE	4,731	4,140	2,300	2,300	2,300	6,860	25,500
COLW	7,540	8,300	8,260	6,920	12,000	19,199	ND
CYNO	943	ND	26,600	3,125	3,125	31,277	25,491
DELY	7,615	15,108	7,700	11,250	7,174	5,535	5,145
DINE	ND	ND	7,750	14,950	ND	ND	15,275
DWYF	6,859	6,182	9,264	9,297	9,081	9,360	8,375
GLYN	7,830	ND	4,400	7,920	8,629	12,406	12,425
ISLW	47,065	47,100	72,600*	50,500	51,750	53,150	53,150
LLAN	44,746	ND	14,441	8,259	ND	ND	ND
LLIW	7,550	4,099	8,775	ND	21,850	26,650	21,600
MEIR	2,961	2,965	3,003	3,024	2,876	ND	ND
MERT	67,008	66,962	66,962	66,962	67,087	76,282	75,525
MONM	4,848	4,668	5,499	8,354	7,180	16,014	32,076
MONT	ND	4,447	6,147	7,800	26,800	28,680	13,865
NEAT	39,800	33,200	24,998	27,434	32,113	68,670	72,898
NEWP	26,638	37,060	ND	97,750	77,750	81,000	124,050
OGWR	241,432	111,000	90,400	76,200	66,600	88,825	75,790
PRES	13,480	ND	7,830	7,830	2,160	2,268	ND
RADN	5,166	4,704	5,125	5,125	5,250	ND	3,700
RHON	121,270	82,000	103,000*	ND	64,000	70,500	79,600
RHUD	12,720	13,840	12,680	13,680	9,680	12,360	18,720
RHYM	130,918	130,918	197,960	107,960	ND	94,751	60,991
SPEM	ND	ND	ND	14,000	12,800	7,680	8,500
SWAN	39,800	ND	82,600	ND	97,164	72,930	62,673
TAFF	ND	5,876	12,500	ND	8,950	ND	106,257
TORF	46,643	43,520	ND	ND	58,153	50,241	ND
VOGL	13,251	15,091	39,323*	13,537	8,637	8,692	10,352
WREX	16,200	16,583	16,620	15,877	15,560	41,522	42,244
YNYS	65,270	33,060	56,588	49,380	57,350	54,425	53,000

* = Erroneous Data
D = No data

Source of data: Based on Tables 4.2 and 4.5

analysis is made difficult by missing data, with only sixteen Districts having complete data sets. However, a number of points arise:-

i) No District experienced either a continual trend upwards or downwards in their arisings over the whole period;

ii) The longest trends recorded span four consecutive years; Carmarthen, Glyndwr, Montgomery and Neath had continual increases and Ogwr, a continual decrease, in arisings. In all other Districts, arisings fluctuate and no overall trend can be discerned;

iii) Most changes recorded are in the order of 10,000 tonnes or less, (Table 4.9);

iv) Percentage change provides a clearer indication of the difficulties created by changes in actual tonnage. For example, of 137 changes recorded, seventy-three were by more than 20%,

and v) 1983/84 was an unusual year, with more Districts experiencing increases in non-domestic waste arisings than in previous years. No explanation is readily apparent.

Non-Domestic waste arisings exhibit many more large scale changes than domestic waste arisings. In effect, the calculated values for non-domestic waste represent waste arising from commerce and industry, and from 'other sources', (Figure 4.2), together with waste arisings from the Collection Authority which remain after the

Table 4.9 <u>Summary of Changes in Calculated Non-Domestic Waste Arisings (Tonnes)</u>

Change Tonnes	1978/9 to 1979/0	1979/0 to 1980/1	1980/1 to 1981/2	1981/2 to 1982/3	1982/3 to 1983/4	1983/4 to 1984/5	Total
No Change	1	2	5	2	0	1	11
<10,000	+9 -9	+10 -5	+11 -4	+8 -11	+16 -6	+9 -10	108
>10,000 & >30,000	+1	+4 -2	+1 -4	+1 -1	+5 -1	+2 -3	25
>30,000 & <50,000	-2		+1		+1	+2 -1	7
>50,000 & >100,000		-1		+1 -1			3
>100,000	+1 -1				-1	-1	4
No Data	13	13	11	12	7	8	64
Increase	+11	+14	+13	+10	+22	+13	+83
Decrease	-12	- 8	- 8	-13	- 8	-15	-64
NC	1	2	5	2	0	1	11

+ = Increase - = Decrease NC = No change

Source: Based on Table 4.8

Table 4.10 <u>Summary of Percentage Changes in Calculated Non-Domestic Waste Arisings</u>

Change Percentage	1978/9 to 1979/0	1979/0 to 1980/1	1980/1 to 1981/2	1981/2 to 1982/3	1982/3 to 1983/4	1983/4 to 1984/5	Total
No change	4	4	6	3	0	3	20
<10%	+2 -4	+3 -1	+3 -1	+3 -4	+6 -2	+4 -2	35
>10 & <20	+2 -3	+1 -2	+2 -3	+1 -3	+3	+3 -7	30
>20 & <30		+1 -2	+2	+2 -3	+3 -2	-2	17
>30 & <40	+1 -1	+1	-1	-2	+1 -1	-1	9
>40 & <50	-2	-2	+1 -1		+1 -2	-1	10
>50 & <100	+2 -1	+3	+3 -2	+1 -2	+3 -1	+3 -1	22
>100	+2	+4	+1	+1	+5	+2	15
No Data	13	13	11	12	7	8	64
Increase	+9	+13	+12	+8	+22	+12	+76
Decrease	-11	-7	-8	-14	-8	-14	-62
NC	4	4	6	3	0	3	20

+ = Increase - = Decrease NC = No change

Source: Based on Table 4.8

calculated domestic waste arisings have been subtracted. Thus, the data can be broken down into these component parts, in order to analyse why some of the annual changes are abnormally high:-

i)The greatest changes, in excess of 100,000 tonnes, occurred in Ogwr, 1979/80, and Cardiff, 1979/80 and 1983/84. For the most part, these can be explained by changes in the waste arisings from 'other sources', (Appendix 4.7) and therefore, represent real changes in tonnage;

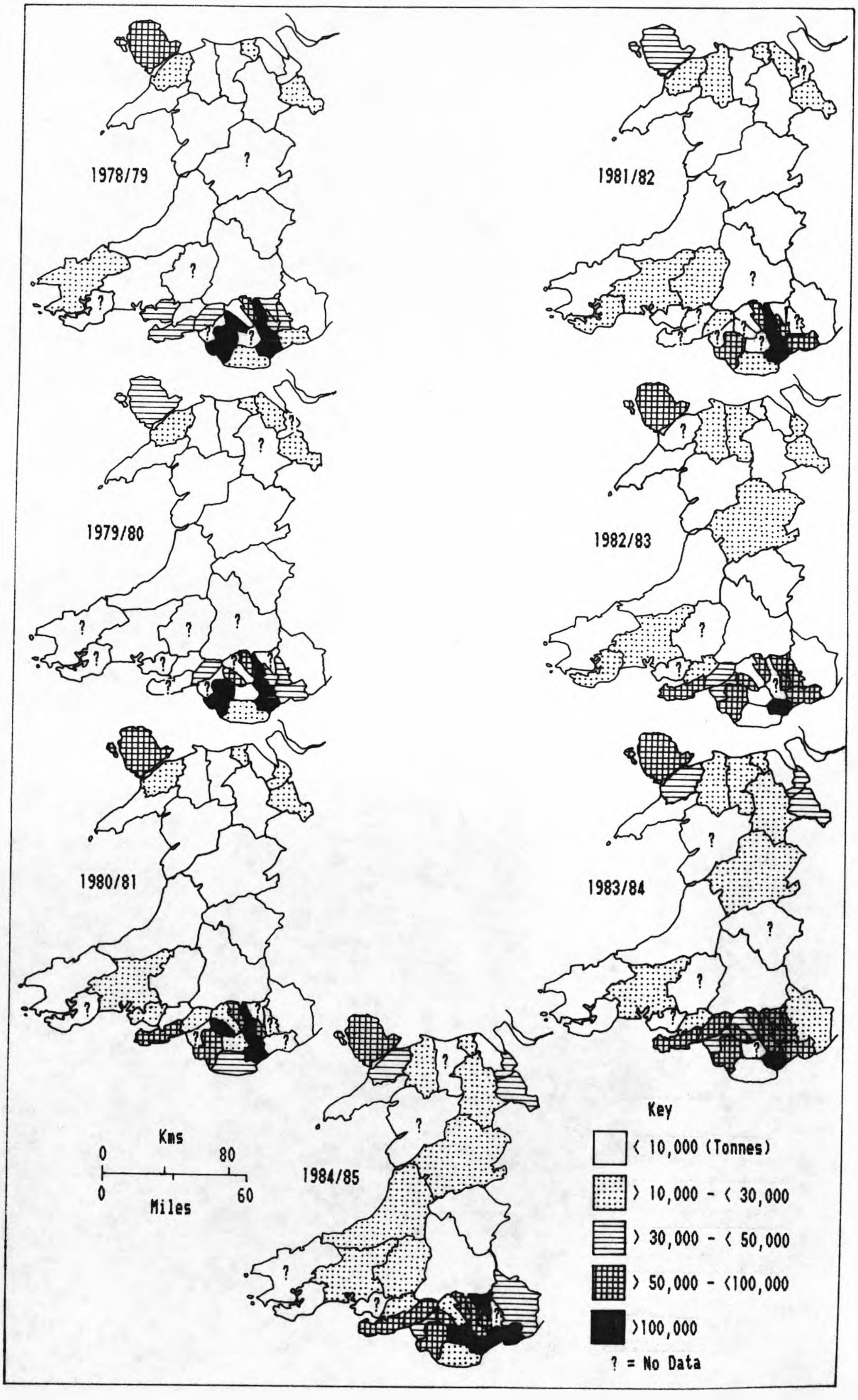
ii) Changes ranging from 50,000 and 100,000 tonnes occurred in Cardiff, 1980/81 and 1982/83, and in Blaenau Gwent, 1982/83. These may also be explained in terms of 'actual' changes in arisings from 'other sources'. In the case of Cardiff, changes in waste arising from commerce and industry, (Appendix 4.8), have also contributed,

iii) Some changes are attributable to erroneous data. These occur where non-domestic waste arisings have been calculated using erroneous data on the percentage of waste comprising domestic and non-domestic waste, (Appendix 4.5). The scale of these changes is, therefore, questionable and they have been highlighted in Table 4.8.

4.3.7 Spatial Patterns in Calculated Non-Domestic Waste Arisings

Regional differences in non-domestic waste arisings are more pronounced than those for domestic waste, (Figures 4.4 and 4.5). The distinctive tripartite division of the Principality into North, Mid

Figure 4.5. Calculated Non-Domestic Waste Arisings.



and South, is most apparent for non-domestic waste arisings during the first four years, (Figure 4.5). All WDAs in South Wales, with the exception of Vale of Glamorgan, Taff-Ely and Lliw Valley, have had arisings of over 30,000 tonnes at some point during the seven year period. In the majority of cases, this has been a continuous feature. (The 1980/81 figure for Vale of Glamorgan is erroneous, (Table 4.8); on the basis of the level of arisings during the other six years, it is highly probable that the true 1980/81 figure is less than 30,000 tonnes).

Arisings for the eleven Districts of Mid Wales have remained below 30,000 tonnes per annum. When data have been available for Brecknock, Radnor, and Meirionnydd, levels have not risen above 10,000 tonnes. Except for the first year, the lowest annual arising within any single District, has occurred in Districts from Mid Wales. In chronological order from 1979/80 onwards these were Meirionnydd, Ceredigion (two consecutive years), Preseli (two consecutive years) and Radnor. In 1978/79, Cynon Valley had the lowest arising, with a surprisingly low level of 943 tonnes. At the other extreme, Ogwr and Newport had the largest annual arising for 1978/79 and 1984/85 respectively, with Cardiff maintaining this position in the intervening period.

As a group, the Districts of North Wales occupy a position mid way between the other two groups, exhibiting features akin to both. For example, in Aberconwy, Delyn, Rhuddlan, Colwyn and Glyndwr, arisings have been consistently below 30,000 tonnes and below 10,000 tonnes in Dwyfor. These levels are similar to those produced by Districts in Mid Wales, whilst Ynys Mon and more recently, Wrexham, Alyn and

Deeside and Arfon, have produced levels approaching those of the South Wales Districts.

Some interesting points have emerged from the calculation of data on non-domestic waste arisings and their subsequent analysis. These data are, however, of limited value; they represent a variety of waste types, each varying in physical and chemical properties and hence, requiring different disposal techniques. For example, inert waste such as builders' rubble can be disposed of to landfill, whilst PCBs (Polychlorinated biphenyls), require more specialist disposal methods, such as high temperature incineration. Thus, detailed information concerning specific types and quantities of non-domestic waste arisings are essential for their handling, transport and disposal.

4.3.8 Sub-Categories of Non-Domestic Waste Arisings

Non-domestic waste arisings, are sub-divided by the ADC, according to physical property, (Table 4.11). This classification, provides valuable information for waste management, in that, wastes with similar properties, and perhaps, disposal requirements, are identified and recorded together.

Noticably, inert and non-flammable wastes comprise over 50% of non-domestic waste arisings for thirty-one authorities, being over 90% for fifteen of these. The majority of non-domestic waste should not, therefore, pose any major disposal difficulties in terms of special treatment.

Table 4.11. Sub-Categories of Non-Domestic Waste Arisings

District	Notifiable Toxic tonnes	%	Potentially Combustible tonnes	%	Inert & Non-Flammable tonnes	%	Total Waste tonnes
ABERCONWY	225	2	4,500	43	5,625	55	10,350
AFAN	165	0	3,000	9	30,442	91	33,607
ALYN & DEE	1,896	1	4,000	2	161,050	97	166,946
ARFON	1,765	6	2,415	9	24,045	85	28,225
BLAENAU G.	7,837	1	55,719	7	848,078	92	911,634
BRECKNOCK	12	0	1,589	49	1,660	51	3,261
CARDIFF	5,296	1	74,658	16	390,941	83	470,895
CARMARTHEN	0	0	40	4	1,000	96	1,040
CEREDIGION	100	1	2,200	12	15,600	87	17,900
COLWYN	240	2	759	7	10,071	91	11,070
CYNON VALL.	90	0	15,340	3	559,630	97	575,060
DELYN	330	1	3,000	9	29,150	90	32,480
DINEFWR	0	0	400	22	1,375	78	1,775
DWYFOR	0	0	3,000	45	3,700	55	6,700
GLYNDWR	1,544	25	860	14	3,660	61	6,064
ISLWYN	0	0	15,700	34	30,600	66	46,300
LLANELLI	18,482	6	2,000	1	276,465	93	296,947
LLIW VALLEY	10,615	50	2,864	13	7,820	37	21,300 **
MEIRIONNYDD	0	0	0	0	1,800	100	1,800
MERTHYR TYD	381	0	6,439	2	325,676	98	332,496
MONMOUTH	1,692	2	6,202	7	84,814	91	92,708
MONTGOMERY	44	0	15,030	60	10,040	40	25,114 *
NEATH	2,648	10	15,200	58	8,306	32	26,154 *
NEWPORT	11	0	131,000	32	265,000	68	407,100
OGWR	1,829	1	5,169	2	215,944	97	222,942
PRESELI	1,625	1	3,662	3	110,126	96	115,413
RADNOR	0.5	0	1,300	32	2,740	68	4,040
RHONDDA	555	0	5,510	5	106,110	95	112,175
RHUDDLAN	1,020	8	5,000	42	5,980	50	12,000
RHYMNEY VAL	1,128	0	61,500	17	290,000	83	352,628
SOUTH PEMB	4,243	23	6,510	35	7,807	42	18,560 *
SWANSEA	1,570	1	123,000	58	88,553	41	213,123 *
TAFF-ELY	3,275	1	0	0	460,119	99	462,807
TORFAEN	9,857	5	75,676	39	109,801	56	195,334
V.OF GLAM	3,450	2	47,247	30	108,628	68	159,325
WREXHAM	34,812	59	15,104	26	9,050	15	58,966 **
YNYS MON	10,550	13	0	0	71,720	87	82,270

** = Notifiable toxic waste constitutes more than 50% of total non-domestic waste arisings

* = Notifiable toxic & potentially combustible wastes constitute more than 50% of total non-domestic waste arisings

Source of tonnage data: Association of District Councils, 1979.

The six authorities for which inert waste comprised less than 50% of non-domestic arisings, are Lliw Valley, Montgomery, Neath, South Pembrokeshire, Swansea and Wrexham. Cross-reference to their respective waste disposal plans proves inconclusive, as different categories of waste are used. One possible explanation is that waste from the construction industry may have been omitted from the category 'inert and non-flammable waste', by these authorities.

Potentially combustible waste ranges from 0 to 60% of total non-domestic waste arisings. These figures are, perhaps, misleading. In twenty-two Districts, potentially combustible arisings are below 20%; for seventeen the level is below 10%. The national average, (20.2%), has been affected by a small number of abnormally high levels in Districts such as Montgomery, Swansea, Neath and Brecknock.

Notifiable toxic waste will be dealt with in detail in Section 4.4, but at this point it is worth noting the normally low levels recorded. In twenty-three Districts, toxic waste comprised less than 1% of total non-domestic waste arisings. The levels for Wrexham, Lliw Valley, South Pembrokeshire and Glyndwr, appear abnormally high. The first three are WDAs with a high degree of industrialisation. For example, Milford Haven and Pembroke Dock in South Pembrokeshire, are the location of heavy industries including oil refining, shipbuilding and electricity generation. The case of Glyndwr, however, is more difficult to explain, since it has a predominantly rural economy.

At the other extreme, the absence of any notifiable toxic waste for Carmarthen, Dinefwr, Dwyfor, Islwyn and Meirionnydd is somewhat surprising, especially in the case of Islwyn, located in the industrial South, (Figure 4.6). The other four Districts lie within rural Mid Wales, but even so, it is likely that they would have some toxic waste arisings, however small.

4.4 Special Waste Arisings

Special waste, also called toxic waste, is defined as waste which:-

'a) consists of or contains any of the substances listed in Schedule 1 of the Regulations and which by reason of the presence of such substances has any of the following properties:

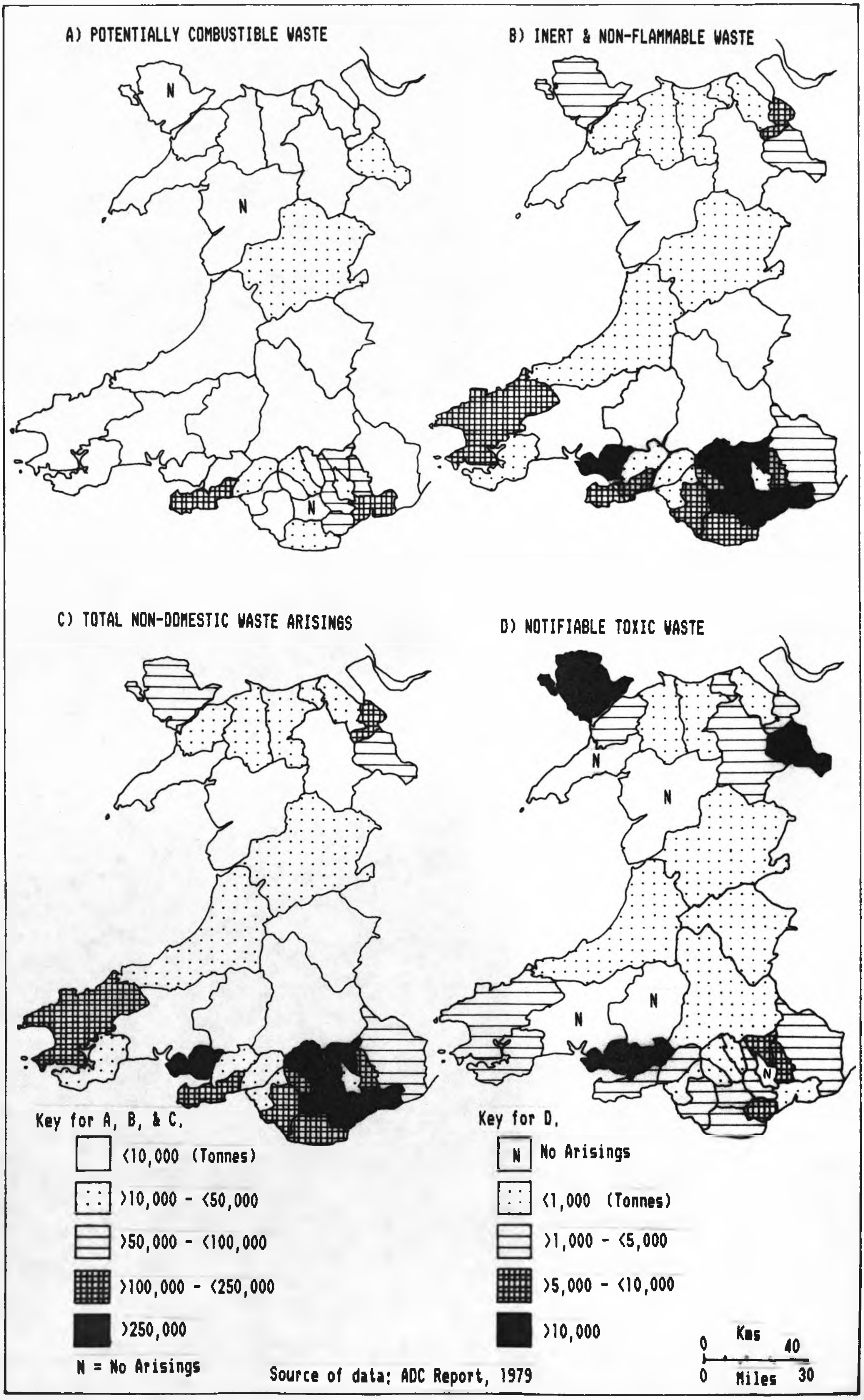
i) the ability to be likely to cause death or serious damage to tissue if a single dose of not more than 5cm^3 were ingested by a child of 20Kg body weight; or

ii) the ability to be likely to cause serious damage to human tissue by inhalation, skin contact or eye contact on exposure to the substance for 15 minutes or less; or

iii) a flash point of 21°C or less; or

b) is a medicinal product, as defined in Section 130 of the Medicines Act, 1968, which is available only in accordance with

Figure 4.6. Non-Domestic Waste Arisings By Type.



a prescription given by an appropriate practitioner as defined in S58 (1) of that Act.' (WO, Circular 8/81, 1981).

4.4.1 Data Sources for Special Wastes

Data for 'toxic' or special waste arisings in Wales, are totally inadequate for any in-depth analysis. This situation gives cause for concern, as these arisings are potentially the most harmful to the Welsh environment. The only data available are:-

i) Data collected by the ADC for 1977/78, (Table 4.11). The category 'notifiable toxic waste', recorded by the ADC is classified as special waste, but it is not clear how much of the 'potentially combustible' waste would be classified as special waste under the 1980 legislation. For this reason, it is intended to consider only the notifiable toxic waste arisings in this analysis,

ii) The Gregson Report on Hazardous Waste Disposal, (House of Lord's, 1981). The report contained a limited amount of data for each Waste Disposal Authority.

Notwithstanding the three year interval between the two data sets, comparison reveals that the categories 'hazardous' waste in the Gregson Report and 'notifiable toxic' waste in the ADC Report, are certainly comparable, (Table 4.12). For example, arisings for Colwyn, Dwyfor, Meirionnydd, Rhondda, Rhuddlan, Swansea and Torfaen, remained static; an indication that the same data were supplied to

Table 4.12 Comparison of Special Waste Arisings Statistics 1978 and 1981

District	1978 (a) Tonnes	1981 (b) Tonnes	1981 as % of 1978 %	Percentage of Total Waste Arisings 1978/79 %	1981/82 %
ABERCONWY	225	44	19	0,9	0,1
AFAN	165	264,679*	160,411	0,3	433,2+
ALYN & DEE	1,896,4	2,000	105	6,3	4,5
ARFON	1,765	5,504	312	4,9	14,9
BLAENAU G.	7,837	26,558*	339	8,0	16,8
BRECKNOCK	12	36	300	0,1	0,2+
CARDIFF	5,296	1,600	30	2,0	0,4
CARMARTHEN	-	27	270	-	0,1
CEREDIGION	100	5	5	0,4	0,0
COLWYN	240	240s	0	0,7	0,8
CYNON VALL.	90	11,610*	12,900	0,4	47,4
DELYN	330	3,852	1,167	0,9	9,4
DINEFWR	-	136	136	-	0,4
DWYFOR	-	-s	-	-	-
GLYNDWR	1,544	670	43	8,5	3,0
ISLWYN	-	2,501	2,501	-	3,2
LLANELLI	18,482	5,600	30	24,4	14,9
LLIW VALLEY	10,616,5	11,221	106	27,2	25,5
MEIRIONNYDD	-	-s	-	-	-
MERTHYR TYD	381	99	26	0,4	0,1
MONMOUTH	1,692	2,136	126	8,4	7,8
MONTGOMERY	44,4	289	657	0,2	1,6
NEATH	2,648	9,256	349	4,5	19,6
NEWPORT	11,1	14,191*	129,009	0	10,1
OGWR	1,829	1,800	98	0,7	1,6
PRESELI	1,625	1,335	82	4,7	3,7
RADNOR	0,5	-	100	0	-
RHONDDA	555	555s	0	0,4	0,6
RHUDDLAN	1,020	1,020s	0	3,3	3,1
RHYMNEY VAL	1,128	1,076	95	0,6	0,7
SOUTH PEMB	4,243,2	2,636	62	7,1	8,8
SWANSEA	1,570	1,570s	0	1,2	1,3
TAFF-ELY	3,275	1,828	56	7,1	2,9+
TORFAEN	9,857	9,857s	0	15,2	14,5x
V.OF GLAM	3,450	6,348	184	8,4	15,3
WREXHAM	34,812	36,812	106	74,1	71,3
YNYS MON	10,550	9,500	90	11,9	12,8
Total	127,290,1	436,591			

* Gross change between 1978 and 1981 data
s Same data have been recorded - No waste arising
+ Percentage calculated using 1980/81 data) 1981/82 data
x Percentage calculated using 1979/80 data) not available

Source: (a) ADC Report, 1979. (b) House of Lord's, 1981.

both reports. Small increases or decreases in arisings of 10% or less, occurred in Alyn and Deeside, Lliw Valley, Ogwr, Rhymney Valley and Ynys Mon.

4.4.2 Change in Special Waste Arisings between 1978 and 1981

Given that definitional differences are negligible, the large changes in production reported by some Districts over the three year period, are difficult to explain. Increases recorded for Afan, Cynon Valley and Newport, are exceptionally large, to the extent that the accuracy of the data is questionable.

At the other extreme, it is surprising that Dwyfor and Meirionnydd have recorded no special waste arisings for 1978 and 1981. A total of nine Districts in 1978 and seven in 1981, had arisings of less than 50 tonnes. The majority of these, seven and six respectively, being located in Mid Wales.

Total special waste arisings for Wales, increased by 343%, from 127,290.1[1] in 1978 to 436,591 tonnes in 1981. This is mostly accounted for by the previously mentioned large increase in Afan. A more detailed analysis reveals that in 1980/81 CIPFA reported total waste arisings for Afan of only 61,100 tonnes, 37,000 tonnes of which has been calculated as domestic waste. The remaining 24,100 tonnes includes all forms of non-domestic waste. The figure of 264,679 tonnes recorded in the Gregson Report, is, therefore, totally inaccurate. The Welsh total for 1981 should more

[1]. The total figure given in the ADC Report was 137,791 tonnes (an error of over 10,000 tonnes when the actual figures for the individual Districts are added together).

realistically be below 196,012 tonnes (allowing a maximum of 24,100 tonnes for Afan), even so, this would result in an increase of approximately 50% over the three years.

The final two columns in Table 4.12, show special waste arisings as a percentage of total waste arisings for the corresponding year. The data are not strictly comparable; the ADC and Gregson Reports cover the years 1978 and 1981 respectively, whilst the CIPFA reports run from April to March 1978/79 and 1981/82, that is, the financial year rather than the calendar year. This analysis does, however, indicate the significance of special waste in relation to total waste arisings:-

i) For the majority of Districts, special waste comprises only a small proportion of total waste arisings; less than 1% for nineteen Districts in 1978/79 and thirteen Districts in 1981/82,

ii) Six Districts recorded exceptionally high percentages of special waste in 1978/79 and/or 1981/82, in relation to their total waste arisings. These may be compared with other waste arisings within the Districts concerned, to establish the likelihood of their accuracy, (Table 4.13).

In each case, with the exception of Afan, the total amount of waste arising is greater than the amount recorded for special waste. Thus, in seven out of the eight cases, the levels for special waste are theoretically possible; the figure for Afan has already been shown to be totally inaccurate.

Table 4.13 Analysis of Unusually High Special Waste Arisings

a) 1978 - ADC Report

District	ADC Report 1978	Total Waste 1978/79	Arisings From WCA	Arisings From Commerce & Industry	Other Arisings
Llanelli	18,482	75,590	35,050(30,844)	5,000	35,540
Lliw Valley	10,616.5	39,000	37,000(31,450)	0	2,000
Wrexham	34,812	47,000	35,000(30,800)	11,000	1,000
Ynys Mon	10,550	88,900	27,800(23,630)	61,100	0

b) 1981 - Gregson Report

District	Gregson Report 1981	Total Waste 1981/82	Arisings From WCA	Arisings From Commerce & Industry	Other Arisings
Afan	264,679	61,100*	37,000*(ND)	22,000*	2,100*
Cynon Valley	11,610	24,500	23,750(21,375)	750	0
Lliw Valley	11,221	44,000	39,000 (ND)	0	5,000
Wrexham	36,812	51,640	40,640(35,763)	10,000	1,000

Figures in brackets represent calculated domestic waste arisings
* = 1980/81 CIPFA data used   ND = No data
WCA = Waste Collection Authority

Source: ADC Report,(1979), House of Lord's,(1981),
CIPFA Waste Disposal Statistics (Actuals) Reports

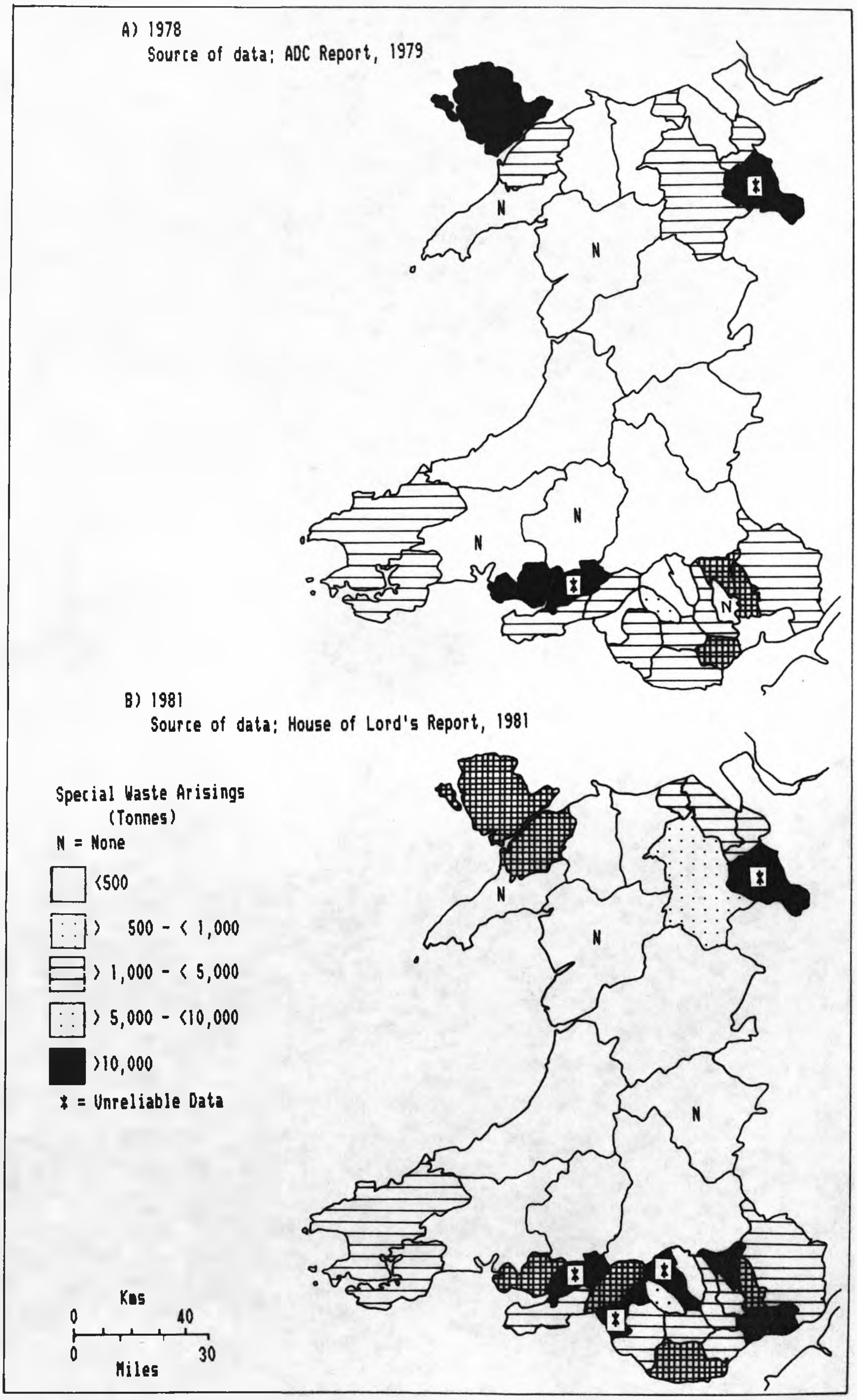
Waste arising from the Waste Collection Authority, is mostly comprised of domestic refuse, as a comparison with the calculated domestic waste arisings shows, (Table 4.13). With the exceptions of Ynys Mon and Llanelli, when the amount of calculated domestic waste is subtracted from the total amount of waste arising, the remaining figure, (which comprises arisings from commerce, industry, non-domestic waste and waste from other sources), is lower than the amount of special waste claimed to have been produced.

The evidence suggests that only in the cases of Llanelli and Ynys Mon, could the abnormally high levels of special waste claimed to have arisen, been possible. In all other instances, the high figures are totally inaccurate.

The distribution of special waste arisings for 1978 and 1981 are illustrated in Figure 4.7. The rural Districts of Mid Wales have the lowest arisings, whilst South Wales, North East and North West Wales tend to have higher arisings, over 1,000 tonnes. When observed in their regional groupings, each with its own distinctive characteristics, it is easier to detect Districts which appear to be different from the norm for their region. For example, the 1978 figures for Newport, Cynon Valley, Afan and Merthyr Tydfil are unusually low for the region. When these are compared to their levels for 1981, it becomes apparent that one or both sets of data are unreliable.

In summary, data for special waste arisings have been found to contain inaccuracies. However, the data serve as a rough guide to production levels and are sufficient to establish regional

Figure 4.7. Special Waste Arisings, 1978 and 1981.



similarities in production levels. The absence of trend data, however, prevents the investigation of change in special waste arisings over time. This deficiency cannot be resolved by using data from different sources.

4.5 The Implications for Waste Management

Accurate information regarding the quantity of different types of waste produced, is an essential requirement for both central and local government, if they are to fulfil their repsective responsibilites adequately:-

i) Central government requirements for data on waste types, relate to assessing the overall provision of disposal facilities for certain types of waste produced within Wales and the efficiency of the WDAs. For example, whilst some WDAs may elect not to provide facilities for the disposal of certain wastes, the total absence of such facilities within Wales would not be acceptable from the point of view of attracting industries producing such wastes and the total dependence upon importing WDAs elsewhere;

ii) Local authorities have a statutory duty to ensure that adequate arrangements are made for the disposal of all controlled waste (household, commercial and industrial waste), within their administrative areas, (this does not necessarily imply that all waste is disposed of within the WDA, but that all waste is adequately disposed, either internally or exported).

WDA requirements for data on waste type, are twofold:

a) Practical requirements: Some wastes require special disposal methods, such as incineration, and are not suitable for landfill disposal. Others may be disposed to landfill, but require careful handling and co-disposal with other, inert wastes.

b) Administrative purposes: Information is needed for the licensing of disposal facilities; both the type and quantities of waste to be disposed at each disposal facility are set down within the waste disposal licence, (COPA, Section 6.2). The preparation of a waste disposal plan, also requires information on current and future arisings. The plan must show the adequate planning of future disposal facilities for all waste types. Finally, the movement and disposal of special wastes, defined under the Control of Pollution Special Waste Regulations, 1980, requires prior notification to the WDA, in terms of a consignment note stating the type and quantity of waste involvea, (Sections 4 to 7).

In summary, WDAs require accurate data on waste arisings by type, in order to meet their statutory duties. These data are a necessary pre-requisite for the adequate disposal of waste and the planning of future disposal facilities.

In the light of the numerous deficiencies in the data recorded for waste types, the ability of both central and local government to fulfil their functions, is questionable. In particular, the absence of trend data for most types of waste, suggests that the planning of future disposal facilities and allocation of resources, is totally inadequate for many authorities.

CHAPTER 5

5. WASTE DISPOSAL IN WALES: CHANGING PATTERNS AND TRENDS

5.1 Introduction

The efficient and environmentally sensitive disposal of all waste arising, is the principal objective, (and statutory duty), of each WDA. No other aspect of waste management has such potentially serious consequences in terms of environmental impact and public health and safety. Responsible waste management, therefore, necessitates the careful monitoring of all wastes disposed and the disposal facilities provided. In this way, a continual assessment of the adequacy of current disposal facilities, together with the planning of future requirements, can be made.

The following sections include an assessment of the ability of the Welsh WDAs to adequately monitor the situation and to provide the appropriate facilities for waste disposal. The assessment is based upon the adequacy of data for various aspects of waste disposal and focuses on:-

i). Total Waste Disposed

ii). Waste Disposal Methods

- a). Landfill
- b). Other Methods
- c). Recycling
- d). Export and Import of Waste for disposal

iii). Special Waste Disposal.

5.2 Total Waste Disposed

Under the Control of Pollution Act, 1974, Part I Section 1:

> 'It shall be the duty of each disposal authority to ensure that the arrangements made by the authority and other persons for the disposal of waste are adequate for the purpose of disposing of all controlled waste which becomes situated in its area ...and all controlled waste which is likely to become so situated.' (COPA, 1974, Chapter 40).

Although, this Section of the Act, remains to be implemented, it clearly states the responsibility of the WDAs. The Act requires adequate 'arrangements' for disposal to be made; this does not necessarily imply that all waste arising within a WDA is disposed of internally. There is, in fact, some movement of wastes across WDA boundaries in Wales and between Wales and England; these will be analysed in detail in Sections 5.3.4 and 5.4.

Table 5.1 contains data for total waste arisings and the total amount of waste disposed, nationally. A comparison of the figures per se is of limited value, as they represent a varying number of returns, (with the exception of waste arisings for 1978/79). To compensate for the missing data, 'adjusted' totals have been calculated; these include values for the missing data, based on the mean of the figures recorded for the preceeding and following years.

The difference between the adjusted totals for waste arisings and waste disposed, are recorded in Column 6. These suggest that the

Table 5.1 Comparison of Total Waste Arisings and Waste Disposed, Wales

Year	Total Waste Arisings (tonnes)		Total Waste Disposed (tonnes)		Difference (tonnes)
	CIPFA	Adjusted	CIPFA	Adjusted	
1978/79	2,328,350	*	2,394,170	2,394,170	+65,820
1979/80	1,975,083	2,276,776	2,046,471	2,348,415	+71,639
1980/81	2,062,966	2,272,110	2,117,115	2,329,935	+57,825
1981/82	2,127,660	2,356,726	2,166,520	2,346,911	- 9,815
1982/83	2,283,683	2,399,661	2,325,133	2,437,036	+37,375
1983/84	2,242,942	2,310,482	2,228,611	2,291,901	-18,581
1984/85	2,183,836	2,353,931	2,172,322	2,346,616	- 7,315

* = no adjustment required, (all 37 WDAs provided data)
All figures are tonnages

Source; Based on data in the CIPFA Waste Disposal Statistics Reports (Actuals).

amount of waste disposed was greater than the total waste arising, for four years, indicating a net importation of waste for disposal in Wales. During the remaining three years, arisings exceeded the amount disposed, implying a net export of waste. The unadjusted figures, however, suggest that waste was imported during the first five years and exported for the last two years. This discrepancy may be due to inaccuracies in the adjusted figures.

At District Council level, the balance between arisings and amount disposed, exports and imports, varies considerably according to individual circumstances. A comparison of the figures for total waste disposed, (Appendix 5.1), with total waste arisings, (Table 4.2), reveals the following points:-

i) For the majority of WDAs, (65%), total waste arisings and total waste disposed are identical, implying that no export or import of waste takes place, or that these balance one another;

ii) The short duration of waste exports and imports:
Differences are recorded by only thirteen WDAs. Most are short term, for one year only (seven WDAs) or over two years (three authorities). Differences over a longer period, implying a policy of waste importation or exportation, are recorded by three WDAs. Monmouth and Wrexham have recorded imports over seven and five consecutive years, repectively. Taff-Ely, has recorded imports for four years and exportation for one year;

iii) Few authorities have exported or imported waste:

a) Three WDAs, Cynon Valley, Rhondda, and Rhymney Valley, recorded exports only;

b) Two authorities, Aberconwy and Taff-Ely, recorded both imports and exports at some point during the seven year period,

and c) Eight authorities recorded imports only.

A comparison of these figures with the Welsh totals, (Table 5.1), reveals a discrepancy for 1981/82. The adjusted Welsh totals show an overall export of waste for the year. This is contradicted by the data for individual WDAs, (Appendix 5.1), which record two Districts with imports, but no exports. It must be assumed that the calculated values for the missing data are not representative of the true levels. No alternative or surrogate data are available and it is acknowledged that there is a wide margin of error in the adjusted figures, given the irregular nature of waste data for some WDAs.

5.2.1 Trends in Total Waste Disposed

For most authorities, the amount of waste disposed has been shown to equate with the total waste arising. The trends and patterns for waste disposal will, therefore, exhibit similarities to those previously described for waste arisings. Annual changes in the total amount of waste disposed have been analysed, (Appendix 5.2) and are summarised in Table 5.2. The main findings are :-

Table 5.2

i) Summary of Changes in Amount of Waste Disposed. (Tonnes)

Change Tonnes	1978/79 to 1979/80	1979/80 to 1980/81	1980/81 to 1981/82	1981/82 to 1982/83	1982/83 to 1983/84	1983/84 to 1984/85	Total
No change	2	7	8	4	1	3	25
< 1,000	+8 -6	+5 -1	+3	+2 -1	+4	+2 -2	34
> 1,000 & < 5,000	+3 -4	+3 -1	+7 -1	+5 -4	+5 -4	+6 -5	48
> 5,000 & <10,000	+3 -1	+2 -3	+2 -4	+5 -1	+3 -6	+1 -2	33
>10,000 & <20,000	+2 -1	+3 -1	+3 -2	+2 -1	-4	+2 -4	25
>20,000	+1 -3	+3 -4	+1 -1	+1 -4	+4 -3	+4 -1	30
No Data	3	4	5	7	3	5	27
Increase	+17	+16	+16	+15	+16	+15	+95
Decrease	-15	-10	- 8	-11	-17	-14	-75
No Change	2	7	8	4	1	3	25

+ = Increase   - = Decrease

Source of data: Appendix 5.2i

ii) Summary of Changes in Amount of Waste Disposed (Percentage)

Change %	1978/79 to 1979/80	1979/80 to 1980/81	1980/81 to 1981/82	1981/82 to 1982/83	1982/83 to 1983/84	1983/84 to 1984/85	Total
No change	7	7	9	5	1	5	34
< 10	+9 -6	+7 -3	+8 -4	+5 -3	+8 -5	+6 -7	71
>10 & <20	+1 -3	-6	+4 -2	+4 -5	-6	+3 -2	36
>20 & <30	+3 -1	+1	+2	+3 -1	+3 -3	-1	18
>30 & <40	-2	+2 -1			+2 -2	+1 -2	12
>40 & <50	+1 -1	-1	+1	-1	-1	+1	7
>50 & <100		+3 -1	-2	+1 -1	+3	+4	15
>100		+1		+1			2
No Data	3	4	5	7	3	5	37
Increase	+14	+14	+15	+14	+16	+15	+98
Decrease	-13	-12	- 8	-11	-17	-12	-73
No Change	7	7	9	5	1	5	34

+ = Increase   - = Decrease

N.B. Differences between Tables i and ii, in the number of Authorities recording 'no change', are due to percentages between 0.1 and 0.5 being rounded down to 0.

Source of data: Appendix 5.2ii

i) The amount of waste disposed has remained constant or changed only slightly, in just seven WDAs. Lowest annual changes, (less than 500 tonnes), over the seven year period, are recorded by Meirionnydd. Whilst, Afan, Dwyfor, Llanelli, Preseli, Rhuddlan and Vale of Glamorgan, all record annual changes of less than 5,000 tonnes, when data are available;

ii) Some authorities have experienced large scale changes. Notably Cardiff, where quantities have varied by over 40,000 tonnes each year;

iii) A number of WDAs, have experienced large scale changes over a two or three year period, namely, Cynon Valley, Newport and Ynys Mon;

iv) In percentage terms, Dwyfor, Islwyn, Preseli and Vale of Glamorgan have continuously recorded annual changes of 10% or less. This is also true for Afan, Arfon and Llanelli, where data are available;

v) Percentage change constantly exceeds 10% in two Districts, Cardiff and Delyn;

vi) No national trend can be discerned. The number of Districts which record annual increases, remains consistently in the region of fifteen to seventeen (for tonnage) and fourteen to sixteen (for percentage), each year,

vi) Analysis of both individual WDAs and the situation nationally, is frequently inhibited by missing data.

Change in the level of waste to be disposed, is not inherently problemmatic for waste management. For example, no problems ensue from a decrease in the quantity of waste to be disposed, or in situations were change is predictable; where the size and type of change remains constant, regardless of whether the level of change is 5% or 50%, it creates fewer difficulties, because, it is predictable. Thus, type of change, (increase or decrease), size and consistency in the size of change experienced, together with the type of waste involved, may combine to create serious problems for waste disposal.

Difficulties arise when a combination of sudden and unpredicted, significant increases occur, which may be further intensified according to the type of waste involved. On this basis, those Districts with widely fluctuating figures, are likely to experience most problems in the management and provision of disposal facilities. Two authorities, Cynon Valley and Montgomery, exhibit large fluctuations in the quantity of waste disposed, including annual increases in excess of 100%, (Appendix 5.2ii). These are the extreme cases, but with certain exceptions (Afan, Arfon, Dwyfor, Islwyn, Llanelli, Meirionnydd, Merthyr Tydfil, Preseli, Rhuddlan and Vale of Glamorgan), fluctuations in the annual amount of waste disposed in all WDAs gives cause for concern.

5.2.2 Spatial Patterns in Total Waste Disposed

The distribution of total waste disposed, (Figure 5.1), repeats previous spatial patterns. The atypical behaviour of some WDAs, that is, unusual levels of waste disposed, is more clearly identified in relation to other authorities within the same regional group.

Notably, Wrexham Maelor is the only District outside of South Wales, to dispose of more than 100,000 tonnes per annum. Wrexham together with Ynys Mon and Alyn and Deeside, constantly record above average disposal figures for North Wales. The remaining North Wales Districts, and all those in Mid Wales, typically dispose of less than 40,000 tonnes per annum.

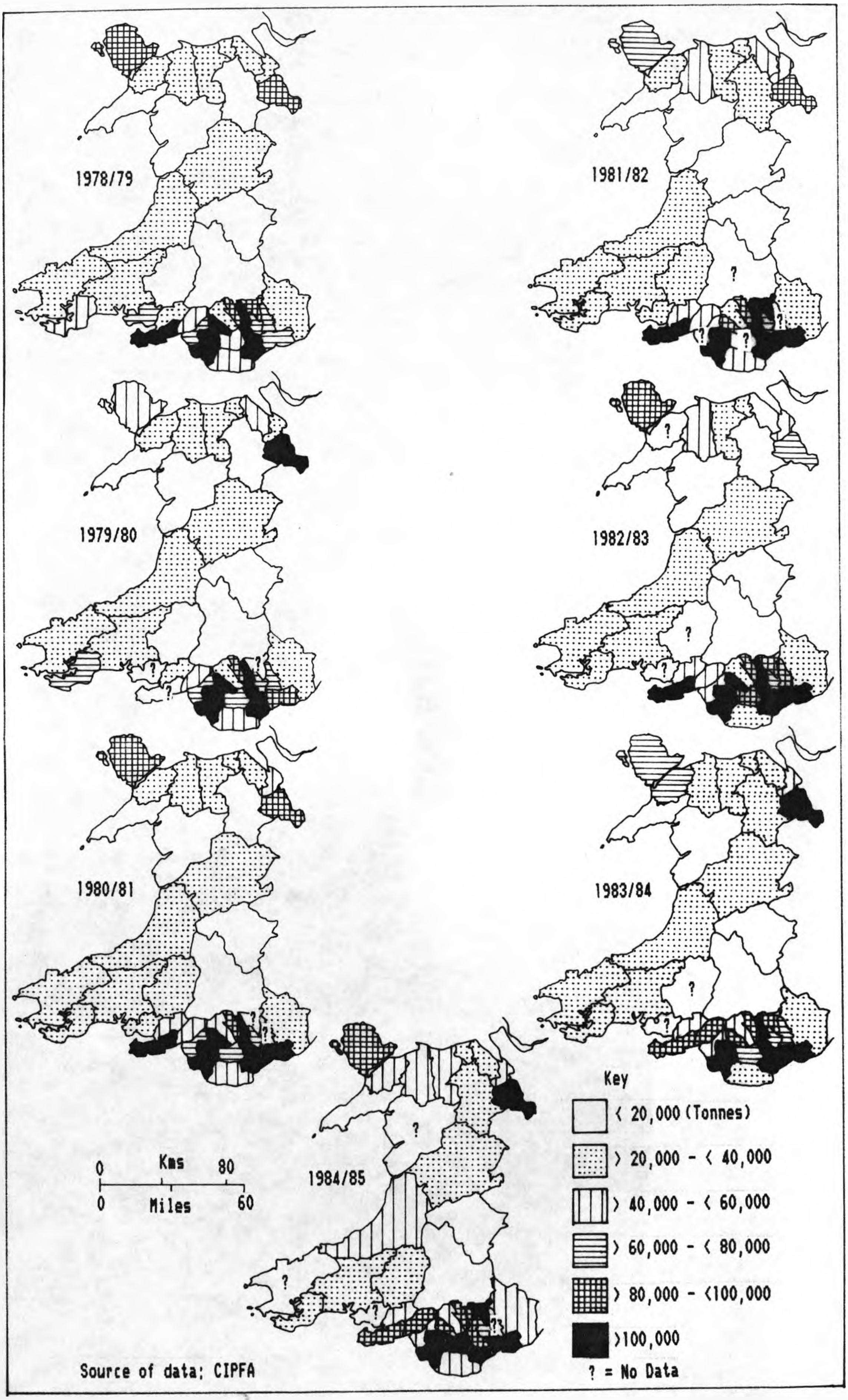
The largest amounts of waste are disposed in South Wales. These WDAs do not, necessarily, experience the most difficult disposal problems. Difficulties only arise when the amount of waste to be disposed exceeds the capacity of the disposal facilities available; the amount of waste to be disposed, is not in itself a problem.

5.2.3 Waste Disposal Bodies

CIPFA data for the total amount of waste disposed, are divided into four categories:-

i) waste disposed by the disposal authority directly;
ii) waste disposed by agent authorities within the WDA;
iii) waste disposed by contractors,

Figure 5.1. Total Amount of Waste Disposed.



and iv) waste disposed by other WDAs.

Categories i and ii, include waste which is solely disposed within the District Council area. Waste disposed of by contractors may be disposed either within or outside of the District, whilst waste disposed by other WDAs represents waste exported, for disposal by another Welsh District or an English County.

Comparison of the data available for total waste arisings, (Table 4.2), total waste disposed, (Appendix 5.1) and the amount of waste disposed by the various disposal bodies, (Appendices 5.3 and 5.4), reveals a number of facts:-

i) Out of a total of 259 records, (thirty-seven WDAs over the seven year period), total waste arisings, total waste disposed and amount of waste disposed by the WDA itself, were identical in 192 cases. Data were not available for a further eighteen cases. In most Districts, therfore, all waste arisings are disposed of within the local authority's area by the WDA itself;

ii) In thirty-eight cases, total waste arisings equate with total waste disposed, but disposal was not solely by the WDA (Appendix 5.4). Waste was disposed by a combination of disposal bodies:-

a) In eleven cases, disposal was undertaken by a combination of the WDA itself, together with 'other WDAs', (Appendix 5.4). The amount of waste disposed of by 'other WDAs' represents waste disposed outside of the WDA, that is, exported;

b) The WDA and 'contractors' jointly disposed of waste in eighteen cases. The location of the contractors either within or outside of the WDA's area is not known, therefore, the exportation of waste for disposal cannot be assumed;

c) In six cases, all three disposal bodies were involved. Some waste exportation may be identified, (other WDAs), some disposed of internally, (WDA itself), and for some waste the site of disposal is unknown, (contractors).

d) All waste was exported for disposal by other WDAs in one case, Alyn and Deeside, 1978/79,

and e) Contractors disposed of 100% of the waste arising and disposed, in two cases, (Delyn, 1983/84 and 1984/85). Again, site of disposal is unknown, therefore, waste exportation cannot be asssumed.

iii) Aberconwy, Cynon Valley, Rhondda, Rhymney Valley and Taff-Ely, all record total waste arisings in excess of total waste disposed. It can only be concluded that there are errors in one or both data sets,

iv) An excess of total waste disposed over total waste arising within the WDA, is recorded in the remaining twenty-four cases, implying waste importation:-

a) In fifteen cases, all waste disposal was carried out by the WDA itself. That is , 'total waste disposed' was equal to 'waste disposed by WDA'. This implies that the WDA itself, imported waste for disposal;

b) Disposal was undertaken by both the WDA and contractors in five instances, (Taff-Ely for one year and Wrexham during four years). In each case, the amount of waste disposed by the WDA itself, is in excess of total waste arisings. Thus, regardless of the amount of waste disposed by contractors, (which may represent imports, exports or internal disposal), the WDA has imported some waste,

c) Waste disposal was undertaken by the WDA together with 'other WDAs', in three cases recorded by Monmouth. This implies that the District simultaneously exported and imported waste. The exported waste was disposed of by 'other WDAs', whilst imports are represented by the difference between total waste arising and total waste disposed.

d) A combination of all three disposal bodies, disposed of waste in one case, (Brecknock, 1984/85), indicating both the export and import of waste for disposal.

In summary, data on the quantity of waste disposed by the various disposal bodies, are frequently insufficient to establish the exact quantities of waste being disposed of internally, and both exported and imported for disposal. To what extent this merely reflects the deficiency in the published data base to record suitable variables, rather than actual data weaknesses, is uncertain. However, data for some authorities have been found to be erroneous, in cases where reported waste arisings exceeded reported quantities of waste disposed.

5.3 Methods of Waste Disposal

Waste disposal in Wales is dominated by landfill, (Table 5.3). In excess of two million tonnes per annum[1] are disposed of by this method. In percentage terms, disposal to landfill constitutes over 90% of all waste disposal. Indeed, most other disposal methods include disposal to landfill as their end process. For example, incineration produces ashes or residues which require disposal. Thus, the percentage of untreated and treated waste disposed to landfill, is probably in the region of 99%.

Disposal methods used by 'contractors and other WDAs', (Table 5.3), are not recorded by CIPFA. Some of this waste will be exported for disposal outside of Wales, whilst that disposed within the Principality, is most likely to be disposed to landfill.

5.3.1 Landfill

Dependency upon landfill disposal has been noted previously. Although, the method of disposal used for some waste, such as, waste disposed by contractors and other WDAs, is not known, the

[1] This includes an adjustment for missing data.

Table 5.3 i) Waste Disposal Methods : Wales (Tonnes)

Disposal Method	1978/9	1979/0	1980/1	1981/2	1982/3	1983/4	* 1984/5
Landfill Untreated	2,289,623	1,951,398	2,068,597	2,113,870	2,241,519	2,019,236	1,949,243
Landfill After P/S	33,470	34,600	0	13,000	26,000	0	*
Other WDAs & Contract.	52,327	35,473	22,518	18,150	30,614	0	144,893
Direct Incineration	18,750	25,000	26,000	21,500	27,000	25,000	18,000
Other	0	0	0	0	0	184,375	60,186
Total	2,394,170	2,046,471	2,117,115	2,166,520	2,325,133	2,228,611	2,172,322
No. of Returns	37	34	35	33	34	35	33

ii) Waste Disposal Methods: Wales (Percentage)

Disposal Method	1978/9	1979/0	1980/1	1981/2	1982/3	1983/4	* 1984/5
Landfill Untreated	95.6	95.3	97.7	97.6	96.4	90.6	89.7
Landfill After P/S	1.4	1.7	0	0.6	1.1	0	*
Other WDAs & Contract.	2.2	1.7	1.1	0.8	1.3	0	6.7
Direct Incineration	0.8	1.2	1.2	1.0	1.2	1.1	0.8
Other	0	0	0	0	0	8.3	2.8

* = Categories changed in 1984-85
P/S = Pulverising or Shredding

Source of data: CIPFA Waste Disposal Statistics (Actuals) methods used by individual WDAs can be assessed. This reveals that in most cases, (165 out of 259 records), all waste disposed within each WDA, is disposed of untreated to landfill, by the WDA itself, (Appendices 5.1, 5.3 and 5.5); in a further nineteen cases, data are not available.

The selection, management and planning of landfill facilities, therefore, is predominantly the responsibility of the WDAs. Their aim must be to ensure that adequate landfill capacity is available. This requires a continual assessment of the amount of waste being disposed, (the tipping rate), and the remaining capacity of each landfill site. Landfill site management will be discussed later, (Chapter 6); this section focuses upon the adequacy of data on waste disposed to landfill, for the assessment of tipping rates and the prediction of future requirements. The analysis will also aim to reveal shortfalls in disposal capacity since 1978/79.

The amount of waste disposed of untreated to landfill, varies considerably between WDAs, ranging from none to 466,853 tonnes, (Cardiff, 1982/83). Alyn and Deeside (1978/79), Cynon Valley (1984/85), Delyn (1983/84 and 1984/85) and Dinefwr (1984/85) have all recorded no waste disposed untreated to landfill, (Appendix 5.5). The explanations are:-

i) In the cases of Cynon Valley and Dinefwr, waste was disposed to landfill, but received prior treatment;

ii)Alyn and Deeside experienced a shortage of landfill capacity within the WDA; all waste was disposed by neighbouring Wrexham

Maelor as a temporary arrangement in 1978/79 and 16,2000 tonnes in the following year, 1979/80,

iii) Contrary to data supplied to CIPFA, (Appendix 5.5), Delyn WDA disposed of waste untreated to landfill during 1983/84, a fact confirmed in the District's waste disposal plan:-

'..Ddol Quarry at Ysceifiog accepts domestic refuse (that is to say putrescible waste) and is the final disposal site of all wastes collected by Delyn Borough Council...... Delyn Borough Council's agreement with the owner/operator, makes the Council the sole depositor of waste on the site....The site has been in operation since June 1982, and has an estimated further life of four years. Last year 1983/84 the site received approximately 21,000 tonnes of refuse.' (Delyn Borough Council, 1984).

The most likely explanation is that the waste disposed of by the WDA at Ddol Quarry, has been classified as waste disposed by contractors, because the site is privately owned. It is highly probable, that the explanation also applies to the data for 1984/85. This reflects the selection of variables by CIPFA; these are inappropriate for the analysis of waste disposal methods.

The average quantity of waste disposed untreated to landfill has been calculated for each WDA, over the seven year period. The lowest averages are recorded by Meirionnydd (7,808 tonnes), Radnor (10,725), Brecknock (12,811), Dwyfor (16,652) and Dinefwr

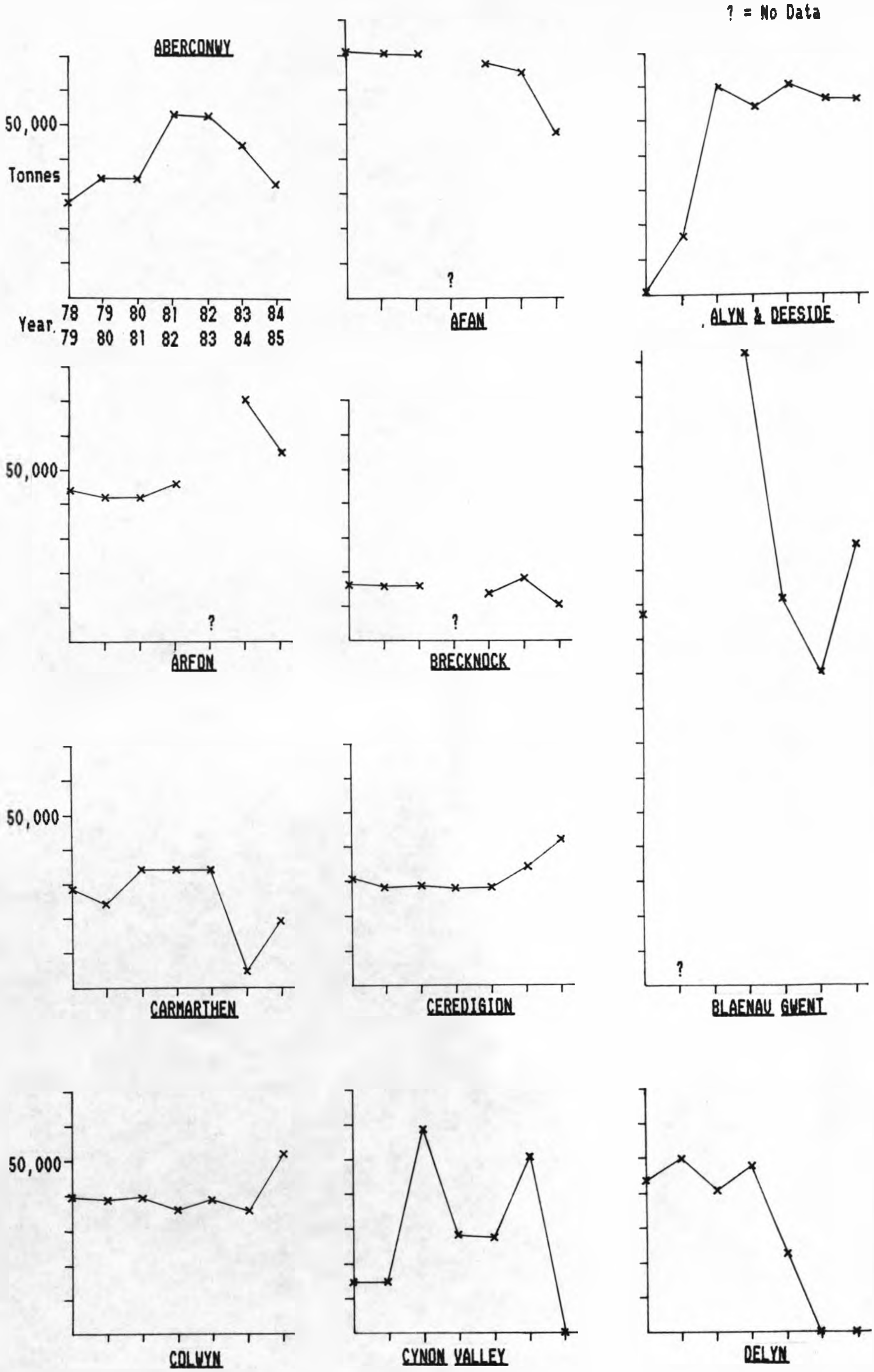
(17,808). With the exception of these five Mid Wales Districts, no other WDA has a mean of less than 20,000 tonnes.

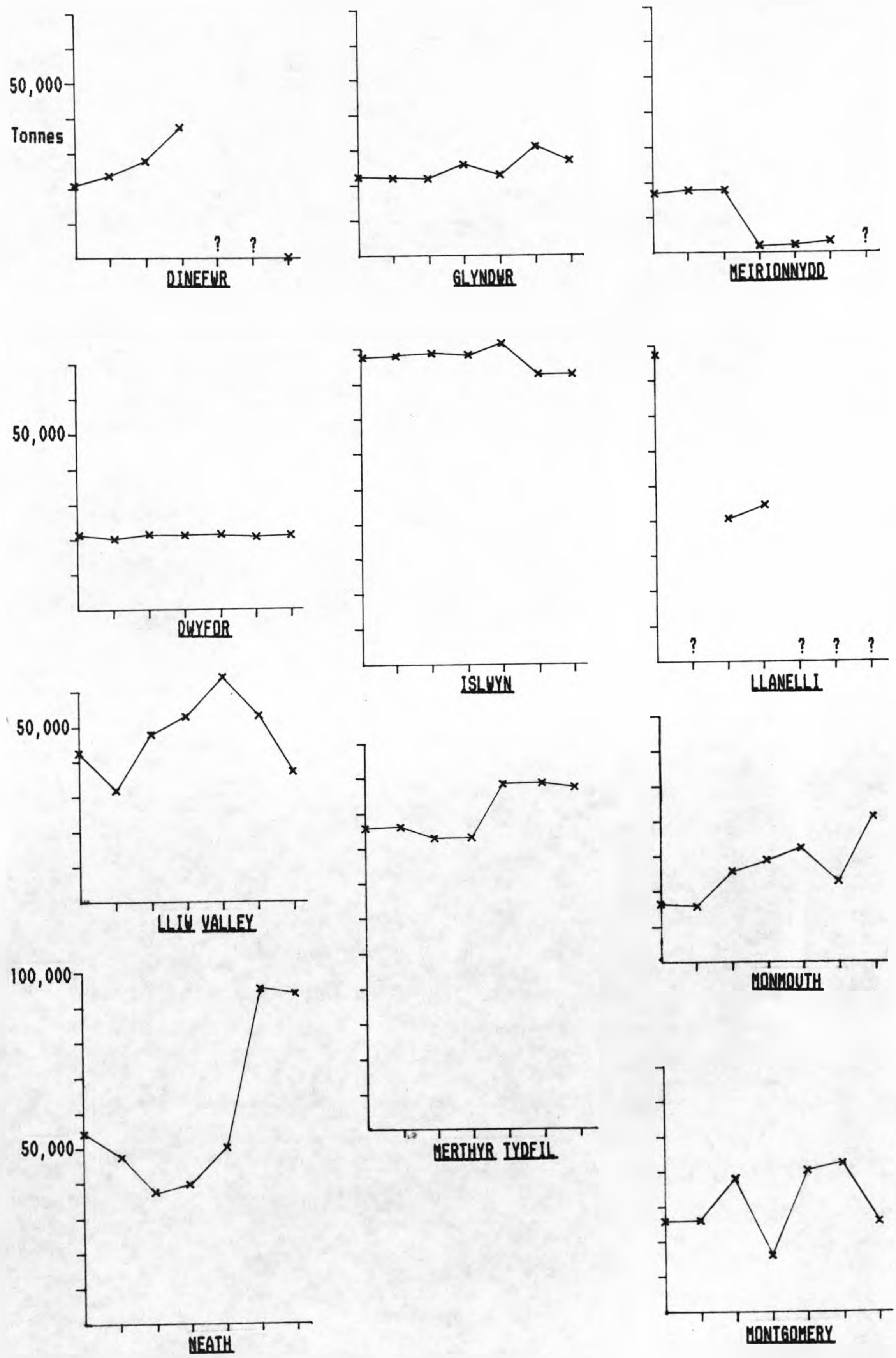
The highest mean figures are recorded by South Wales WDAs; Cardiff (331,883), Ogwr (142,669), Rhymney Valley (136,435), Newport (116,929), Blaenau Gwent (111,933) and Swansea (111,453). All other Districts record an average of less than 100,000 tonnes. Noticeably, nine of the ten highest mean figures, are for WDAs located in South Wales; the remaining WDA being Wrexham Maelor, in North Wales.

Although the 'mean' serves to indicate the average amount of waste to be disposed and allows comparison between WDAs, actual changes experienced by the authorities have greater relevance. These represent real increases or decreases in the amount of waste to be disposed and, hence, the amount of landfill space required. In practical terms, annual change has implications for a whole range of waste management decisions regarding resource allocation and forward planning, for example, the availability of sufficient cover material during periods of abnormally high quantities of waste disposed to landfill. Fluctuations in the annual amounts of waste disposed untreated to landfill, therefore, reveal the degree of flexibility required in the planning of disposal facilities.

Figure 5.2 demonstrates graphically, the size of fluctuation in the amount of waste disposed untreated to landfill by each WDA. The relative 'stability' of levels in some Districts becomes readily apparent, whilst in other WDAs, levels are notably irregular. WDAs exhibiting similar behavioural patterns may be grouped accordingly:-

Figure 5.2. Trends in the Amount of Waste Disposed Untreated to Landfill: Individual Authorities.

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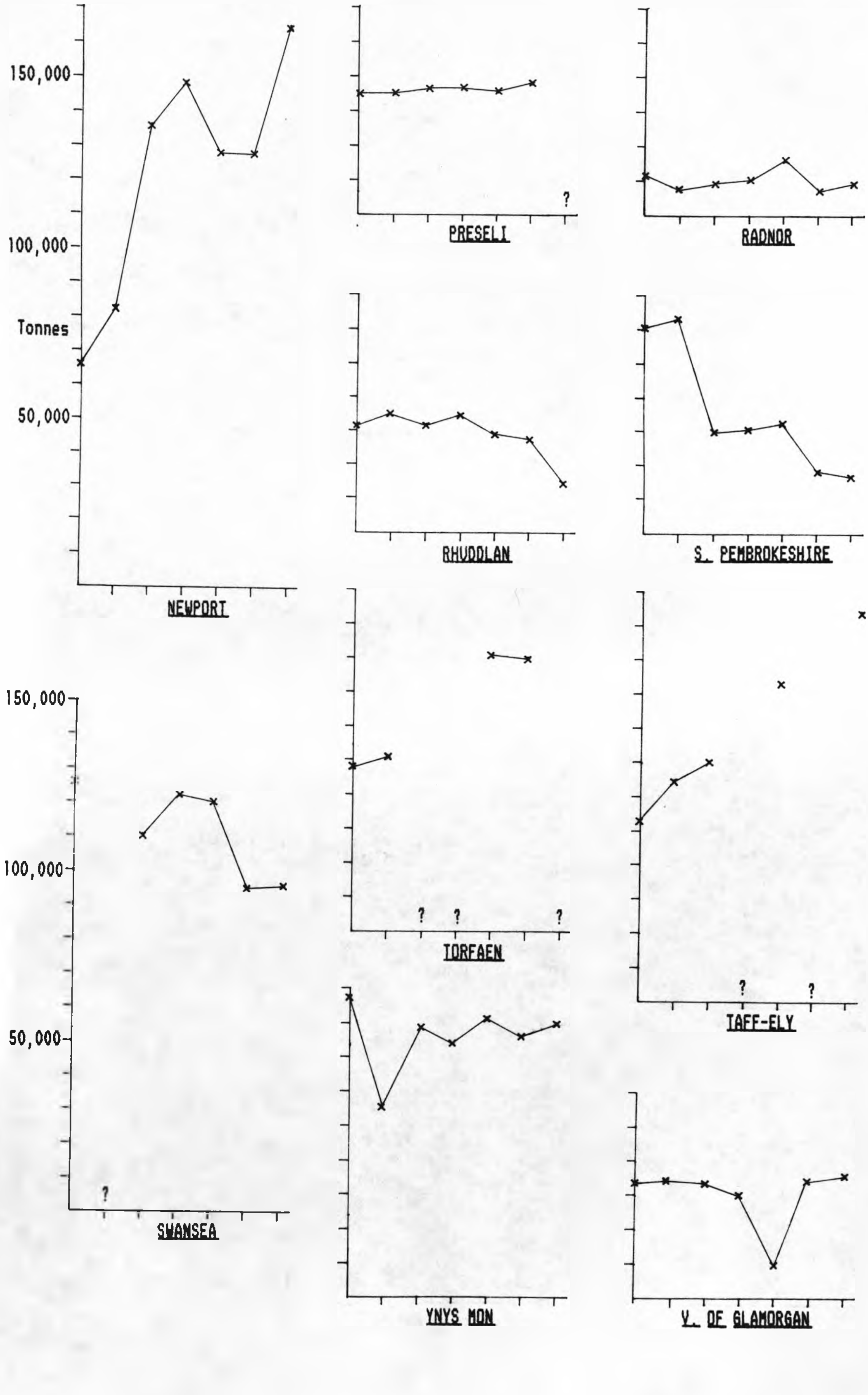
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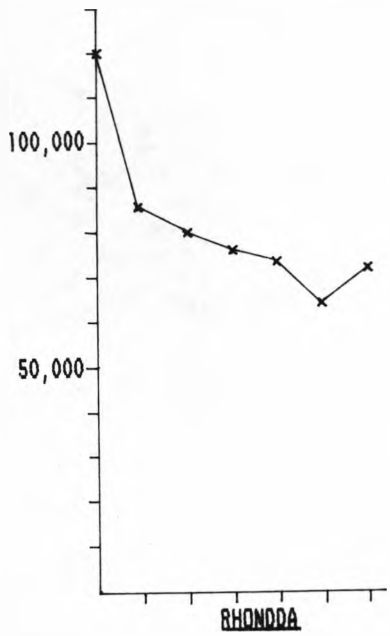
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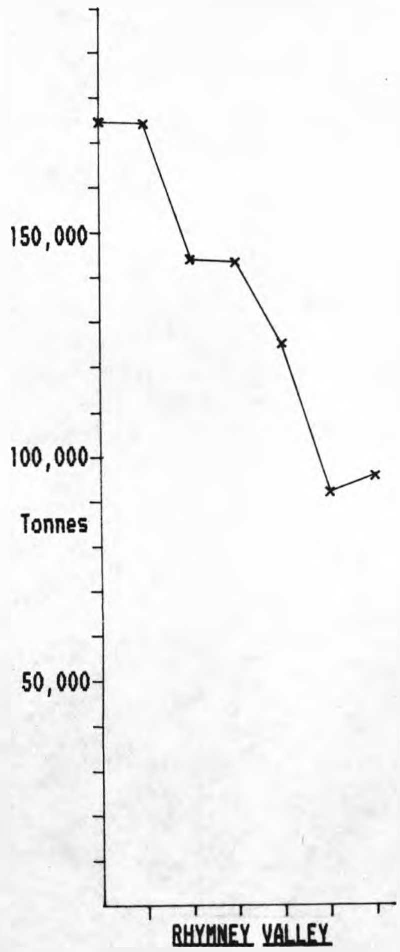
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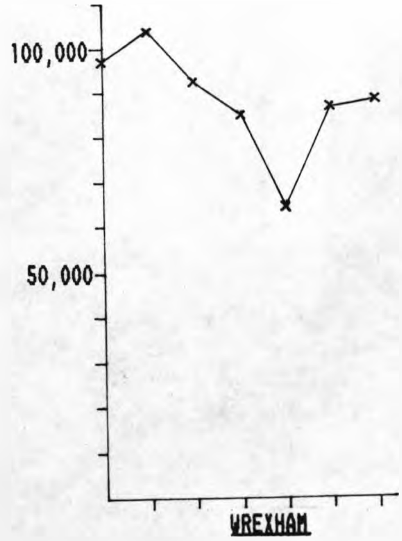
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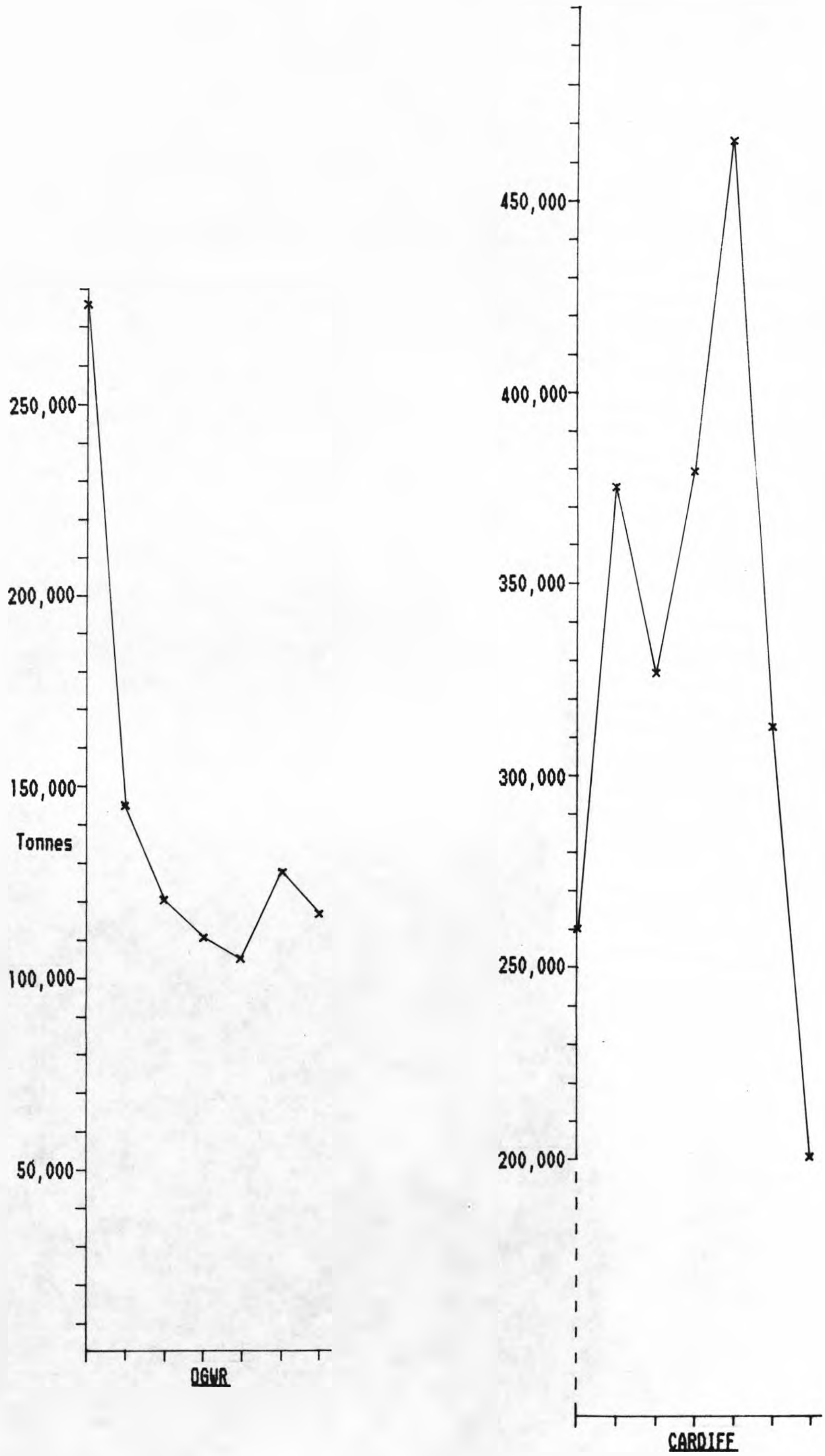


Source of data: CIPFA

i) Ceredigion, Dwyfor, Glyndwr, Preseli, Radnor, and Islwyn, all exhibit fairly constant levels over the seven year period. The first five authorities are located in Mid Wales;

ii)Brecknock exhibits fairly stable levels over the six years for which data are available;

(Groups i and ii, above, exhibit constant and hence, predictive annual levels of waste disposed to landfill. The remaining thirty graphs show varying degrees of uncertainty).

iii) In some cases, sudden changes may be explained by changes in exports, imports, or the use of other disposal methods:-

a) Alyn and Deeside exported all waste to Wrexham Maelor in 1978/79 and a good proportion the following year;

b) Delyn recorded no waste disposed untreated to landfill in 1983/84 and 1984/85. The true level has been shown to be in the region of 21,000 tonnes per annum;

c) The fall in level recorded by Meirionnydd since 1981/82, is due to a change in disposal method. Previously all waste (except for 100 tonnes in 1978/79) was disposed untreated to landfill, but since 1981/82 waste has been 'treated', for example by baling, prior to landfill;

d) The Vale of Glamorgan exported 24,648 tonnes to other WDAs and 2,566 to contractors during 1982/83. In previous years, exports were in the region of 8,000 tonnes, (other WDAs) and 1,500 tonnes to contractors. The abnormally high exports during 1982/83, explain the sudden change in the graph, (the situation returned to normal in 1983/84);

e) Figures for the Cynon Valley during the first two and last years, are the result of a change in disposal method, with waste being treated prior to disposal;

f) A change in the categories used by CIPFA from 1983/84 onwards, has resulted in the decrease of 8,621 tonnes recorded by Monmouth; this was re-classified as waste disposed at 'household amenity sites'. In 1984/85, the same District recorded all waste disposed to landfill under the category of 'compacted crude' prior to landfill;

g) An 11,250 tonne increase over a six year period, in the amount of waste disposed by incineration and other methods, caused the decline in levels disposed to landfill by Rhondda WDA,

h) Rhymney Valley also exhibits an overall decline during the first six years, but with two periods of no change. The large decrease recorded for 1983/84, was due to 20,000 tonnes of waste undergoing compaction prior to landfill disposal and 9,970 tonnes disposed of at household amenity sites.

Category iii, represents cases where change can be explained, whilst Category iv, includes WDAs for which missing data have obscured the analysis of trends:-

iv) The analysis of change within eleven authorities, is restricted because data are missing. In the cases of Brecknock, Dinefwr and Preseli, the information that is available shows these to be fairly stable. The remaining eight authorities, exhibit wide variations;

v) The largest, unexplained changes are recorded for Neath, Newport, Ogwr and Cardiff. Differences between the highest and lowest annual figures for these four South Wales Districts were 48,473, 98,850, 170,684 and 265,848 tonnes respectively.

Annual changes have been highest for Cardiff: +113,411, -44,982, +52,173, +86,219 and -154,101 tonnes. The lowest annual change, (-44,982), is greater than the total range recorded by twenty-seven other WDAs over the seven year period; for seven authorities the range was less than 10,000 tonnes.

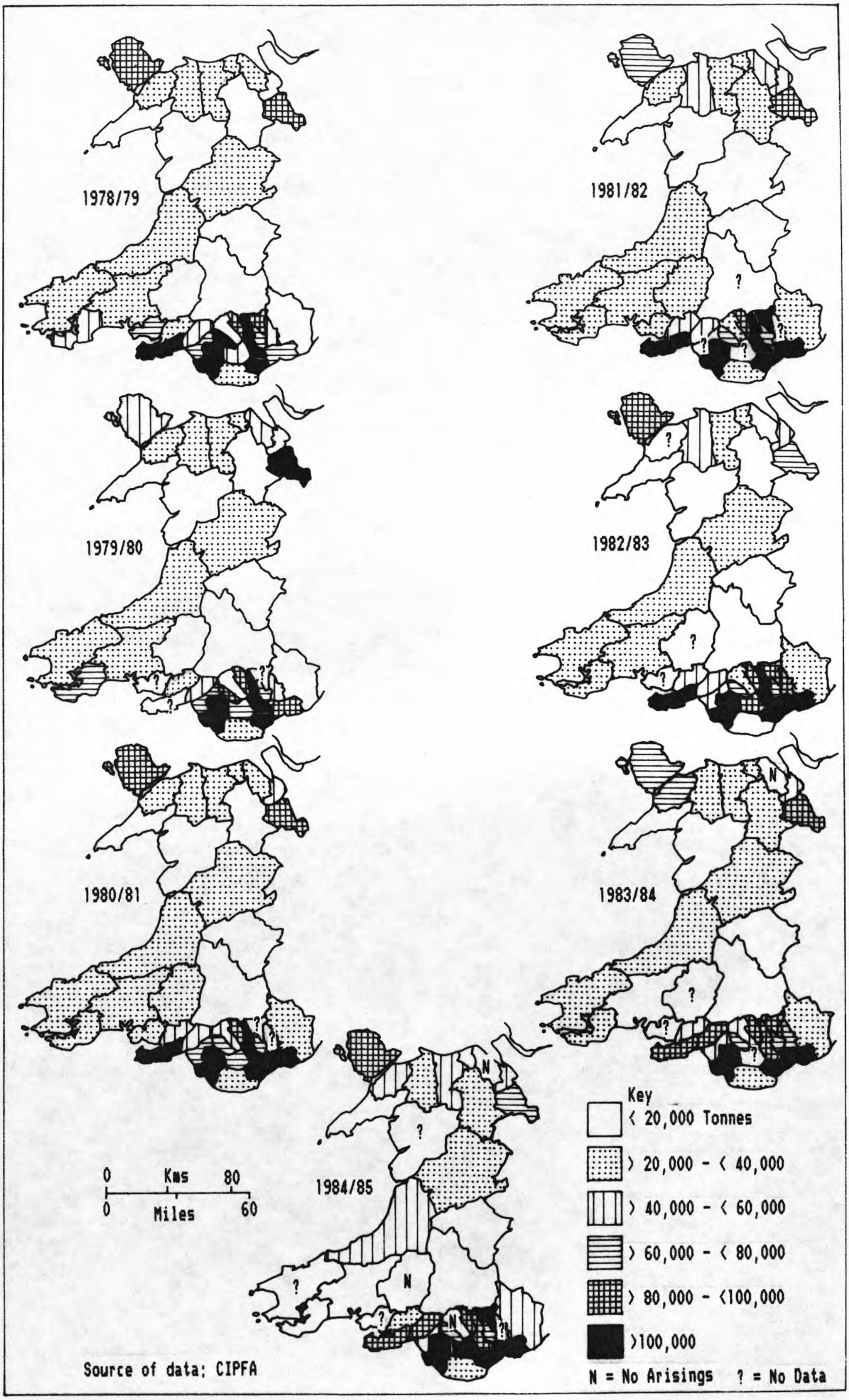
vi) The Districts of Aberconwy, Carmarthen, Lliw Valley, South Pembrokeshire, Swansea, Wrexham and Ynys Mon exhibit a mixture of small or sometimes no change, together with sudden large scale changes.

(Categories v and vi, represent those authorities which experience the largest fluctuations in the annual quantities of waste requiring landfill disposal).

In summary, analysis of the amount of waste disposed untreated to landfill, reveals that few authorities record consistent quantities of waste for disposal. For the majority, levels fluctuate unpredictably; no authority exhibits a continual increase or decrease over the seven year study period. The implications for waste management are immense; the provision of disposal facilities and prediction of future levels are likely to be inadequate, unless the reasons for change are understood and known well in advance. The level of uncertainty which prevails for many authorities, may encourage the unnecessary allocation of excess resources for waste disposal purposes or alternatively, a shortfall in the provision of disposal capacity.

Finally, regional patterns may be discerned in the amount of waste disposed untreated to landfill, (Figure 5.3). Districts with the lowest annual disposal levels, are located in Mid Wales. No WDA in the Mid Wales region disposes of more than 40,000 tonnes per annum untreated to landfill, with the exception of South Pembrokeshire. Each year at least three Mid Wales Districts disposed of less than 20,000 tonnes, namely Meirionnydd, Radnor and Brecknock. In North Wales, Ynys Mon and Wrexham Maelor have consistently recorded above average disposal levels, whilst Delyn and Alyn and Deeside have occasionally done so.

Figure 5.3. Amount of Waste Disposed Untreated to Landfill.



Six authorities in South Wales, Cardiff, Ogwr, Swansea, Rhymney Valley, Merthyr Tydfil and Newport, have maintained high levels of disposal to landfill. Vale of Glamorgan, Cynon Valley, Lliw Valley and Neath (with the exception of 1983/84) have recorded below average landfill disposal figures for their region.

These regional patterns provide a practical basis for inter-WDA co-operation. The Welsh WDAs have been slow to initiate joint schemes. However, the tendency for neighbouring authorities within each region to experience similar landfill requirements, should make the establishment of joint arrangements more acceptable. Some authorities have recently commenced co-disposal at shared landfill sites, for example, Rhuddlan, Aberconwy and Colwyn WDAs, jointly dispose of waste at a site in Colwyn. This degree of co-operation may be unnecessary for those authorities with adequate landfill capacity. However, where the possibility of a shortfall in landfill capacity exists, given sufficient foresight, appropriate arrangements with neighbouring authorities may avert any serious problems.

5.3.2 Other Disposal Methods

The deployment of alternative disposal methods within the Principality, has been minimal, (Table 5.3). Identification of the actual disposal methods used, is frequently obscured. The classsification of 'other' disposal methods by CIPFA is unsatisfactory; this includes a mixture of specific disposal methods, such as incineration, together with disposal bodies. In addition, new categories were introduced in 1983/84.

The majority of 'other' methods recorded, (Table 5.4), involve disposal by 'other WDAs' and/or 'contractors'. The actual method of disposal used is unknown; presumably most is disposed direct to landfill. Only in those cases where actual disposal methods have been specified, can disposal other than direct to landfill be assumed. These will be investigated accordingly and disposal by other WDAs and contractors, is excluded from the following analysis.

Fifteen authorities have at some stage used alternative disposal methods, for at least part of their waste arisings. In most instances, only relatively small quantities of waste, over a one or two year period, are involved.

Only three Districts can be accredited with waste management policies which include the treatment of waste prior to disposal on a regular and large scale basis. These are Meirionnydd, Torfaen and Rhondda. In Meirionnydd, the installation of a pulverising plant in 1981, has resulted in 91.2%, 89.6% and 83.3% of total waste arisings being pulverised prior to landfill disposal, during the intervening period. The impact of the treatment plant on waste disposal within the District, has been significant, (Figure 5.2).

Torfaen has continually recorded the pre-treatment of waste prior to landfill disposal, with the exception of those years when data were not available. Large quantities of waste have been pre-treated; this implies that the treatment of waste has been a continuous policy.

Finally, the only WDA to undertake waste incineration on a large scale is Rhondda, in South Wales. An average of 23,036 tonnes of

Table 5.4 Waste Disposal Methods Other Than to Landfill Untreated
(Tonnes)

District	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
ABERCONWY							11,313o
ARFON							175r
ALYN & DEE	30,100o	16,200o					
BLAENAU G.	7,350o	ND	ND				
BRECKNOCK	950o	1,717o	1,717o	ND	1,900o		3,203o
CARDIFF							16,820r
CARMARTHEN						80r	2,552o
							80r
CEREDIGION						600r	
COLWYN						7501	
CYNON VALL.	10,720s	10,800s					44,717c
DELYN							22,192c
DINEFWR	1,750o				ND	ND	27,500c
DWYFOR							350o
LLIW VALLEY							5,000o
MEIRIONNYDD	100o			13,000s	13,000s	12,500b	ND
MERTHYR TYD	125o		3,400o	3,400o			50o
MONMOUTH	3,400o	3,636o	3,636o				
NEATH							500r
OGWR	97o	4,000o	4,000o	3,000o			
RADNOR							1,000o
RHONDDA	18,750i	25,000i	26,000i	21,500i	27,000i	25,000i	18,000i
RHUDDLAN							15,0000o
RHYMNEY VAL						20,000c	86r
						120r	
TAFF-ELY	35o					ND	64,670o
							31,768r
TORFAEN	22,750s	23,800s	ND	ND	13,000s		ND
V.OF GLAM	8,420o	8,420o	8,265o	10,250o	27,214o	88r	3,563o
							40r
WREXHAM		1,500o	1,500o	1,500o	1,500o	7,000x	16,000o

Key to Disposal Methods:
i = Direct Incineration
o = Other WDAs and Contractors
s = landfill after shredding and pulverising

New categories in use from 1983-84 onwards:
b = Baling before landfill c = Compaction
1 = Landfill after incineration r = Reclaimed x = Other methods

Source: CIPFA Waste Disposal Statistics (Actuals) Reports

waste is incinerated each year, with annual levels ranging from 18,000 to 27,000 tonnes. During the seven year period, incineration accounted for 13.5%, 22.7%, 24.8%, 22.2%, 27.0%, 26.4% and 20.9%, respectively of the annual amount of waste disposed.

An alternative source of data relating to disposal methods is the ADC Report, (ADC, 1979). This reveals that:-

> '32 district councils employ direct landfill without prior treatment of the waste, 4 councils pre-treat part of their waste by shredding or pulverisation to the extent of 20%, 12%, 20% and 30% respectively. The total amount of waste subjected to shredding or pulverisation in Wales is thus of the order of 21,000 tonnes, equal to 1.05 % of the total disposed of by local authorities.' (ADC, 1979).

Four WDAs were reported to pre-treat part of their waste, namely, Cynon Valley, Llanelli, Monmouth and Torfaen. CIPFA data for the following year, (Table 5.4), reveals only Cynon Valley and Torfaen pulverising waste prior to disposal. Whilst for Monmouth, 'other WDAs and contractors' disposed of some waste during 1978/79; this may have been pre-treated prior to disposal. In the case of Llanelli, no pulverisation of waste is recorded for 1978/79.

The ADC Report also states that:

> 'In only one district (Rhondda) is incineration adopted- and then only in respect of 25% of the waste disposed of by the district council.' (ADC, 1979)

Figures previously calculated for the Rhondda generally indicate a similar level, although in 1978/79 incineration accounted for only 13.5% of the total amount of waste disposed.

The dominance of landfill and apparent indifference towards other disposal methods, is explained by the relative costs involved, (Table 5.5). In simple economic terms, landfill disposal is the cheapest method available and as a result, the most popular in use. The average unit cost per tonne for landfill (completely controlled tipping) of £1.43 compares very favourably with those for part controlled/part pulverised and part controlled/part incinerated.

The cheapest rate recorded for landfill disposal is for Afan WDA, at 40p per tonne. A further five authorities record costs of less than £1.00 per tonne, namely Merthyr Tydfil, Neath, Newport, Ogwr and Taff-Ely. All six WDAs are located in South Wales and record large quantities of waste arisings. This suggests that these authorities achieve economies of scale not possible elsewhere.

Above average unit costs per tonne (over £2.50), are recorded by Aberconwy, Alyn and Deeside, Brecknock, Delyn, Glyndwr, Meirionnydd and Preseli; three are located in North Wales and four in Mid Wales. Meirionnydd endures the highest cost for landfill disposal at £5.66 per tonne; £1.90 more than any other WDA. The case of Meirionnydd is an exceptional one. The abnormally high cost of landfill disposal in this District is entirely due to the environmental constraints imposed by its location within the Snowdonia National Park. Indeed, the high cost of locating suitable landfill sites and transporting waste to those sites, reached a threshold level were it became

Table 5.5 Unit Cost of Disposal According to Method Employed

District	Net Expenditure (£)	Unit Cost Per Tonne (£)
i) Completely Controlled Tipping:		
ABERCONWY	68,424	2,60
AFAN	29,100	0,40
ALYN & DEE	65,714	3,14
ARFON	44,290	1,18
BLAENAU G.	46,158	1,04
BRECKNOCK	41,142	3,76
CARDIFF	322,955	1,46
CARMARTHEN	42,001	2,02
CEREDIGION	57,747	2,27
COLWYN	33,783	1,18
DELYN	77,065	2,96
DINEFWR	20,261	1,10
DWYFOR	21,837	1,25
GLYNDWR	52,177	3,02
ISLWYN	78,950	1,15
LLIW VALLEY	38,869	1,48
MEIRIONNYDD	82,674	5,66
MERTHYR TYD	83,850	0,99
MONTGOMERY	49,085	1,21
NEATH	39,052	0,90
NEWPORT	34,409	0,48
OGWR	55,070	0,60
PRESELI	85,463	2,64
RADNOR	8,161	1,13
RHUDDLAN	48,533	1,52
RHYMNEY VAL	267,250	2,42
SOUTH PEMB	50,300	1,36
SWANSEA	147,096	1,29
TAFF-ELY	74,390	0,98
V.OF GLAM	61,248	1,73
WREXHAM	58,550	1,12
YNYS MON	61,432	1,08
TOTAL	£2,247,046	Average £ 1,43
ii) Part Controlled/Part Pulverised:		
CYNON VALLEY	118,695	5,05
LLANELLI	117,180	2,99
MONMOUTH	94,349	4,29
TORFAEN	126,000	8,00
TOTAL	£456,224	Average £ 4,65
iii) Part Controlled/Part Incinerated:		
RHONDDA	428,100	£ 11,27
WELSH TOTAL	£3,131,370	Average £ 1,72

Source: ADC (1979).

economically viable to invest in a pulverising plant. The plant became operational in 1981/82 and the impact upon waste disposal is clearly seen in Figure 5.2.

The average cost for part controlled/part pulverised disposal, £4.65 per tonne, far exceeds that for completely controlled tipping, £1.43. Costs per tonne for pulverisation, however, vary considerably, ranging from £2.99 in Llanelli to £8.00 per tonne in Torfaen. These costs are only exceeded by the cost of incineration recorded for Rhondda, (£11.27 per tonne).

The cost of landfill will, inevitably, rise as the number of suitable sites declines and competition for land increases. However, it is likely that landfill will continue to dominate waste disposal. Alternative methods of disposal will only be introduced once a financial threshold has been reached, as evidenced by Meirionnydd. Even so, the initial capital outlay and operational costs involved in the installation of treatment plant, may act as a deterrent. For example, the incineration plant operated by Rhondda Council cost just under £1 million in 1973. Maintenance of plant is also high; operating costs recorded for the Cynon Valley's pulverisation plant stood at £42,000 during 1974/75.

In recent years, the high costs of operating some pulverisation plants have resulted in closure. For example, the pulverisation plant and associated weighbridge operated by Cynon Valley was closed in March 1980. Subsequently, all disposal in the WDA has been by landfill untreated. Thus, circumstances differ not only between Districts, but within Districts over time. The decision to introduce treatment plant and in particular, the type and capacity of plant needed, requires a sound knowledge of the size and nature of waste arisings. In some instances the relative costs of disposal methods may be miscalculated, a fact acknowledged in the ADC Report:

> 'The wide variation in unit costs between District Councils from a lowest of 0.40p per tonne to a highest of £11.27 per tonne, with an average of £1.72 per tonne possibly reflects different methods and standards of disposal, the difference in the character of the areas served by the district council and the nature of the sites used for waste disposal. It should also be borne in mind that errors in estimating weights may have an effect on extreme values where the same method of disposal is employed.' (ADC, 1979).

5.3.3 Recycling

It has been noted previously, that few authorities utilise alternative disposal techniques, including recycling. Only seven WDAs recycled waste during 1977/78, (ADC, 1979); two authorities reclaimed waste oils, four recycled small quantities of cardboard and paper (two of these also recycled tins, rags and some metals), one WDA recycled glass and another (presumably Rhondda) recovered metals prior to waste incineration. The WDAs concerned are not identified by the ADC and total eight rather than seven, as reported.

The ADC report also claimed that:

> 'Many of the remaining district councils are known to have ventured into the recycling field on many occasions (particularly of waste paper) only to withdraw when the climate has become uneconomic. A significant extension of the reclamation of waste materials by district councils is not to be expected in this situation and in view of the present attitude to public expenditure.' (ADC, 1979).

The variable nature of recycling in Wales during 1977/78, is confirmed in trend data collected by CIPFA, (Appendix 5.6). No District has a continuous record of waste reclamation. The longest trend, over five years, is recorded by Colwyn, but ceased in 1982/83. Four authorities report waste reclamation over a three year period; Preseli (discontinued after 1982/83), Rhondda (discontinued after 1980/81), Rhymney Valley and Vale of Glamorgan. In all other cases, recycling is recorded for only one or two years. Consequently, the number of Districts recording waste reclamation each year, has fluctuated, reaching a maximum of six during 1984/85.

The quantities recycled have generally remained small:-

i) The largest amount of recycled waste, is reportedly 31,768 tonnes during 1984/85, for Rhymney Valley. This is an exceptional case and the type of waste involved is not specified;

ii) In one third of cases, the quantity of waste recycled is less than 100 tonnes, (Appendix 5.6);

iii) There is no apparent correlation between type of waste and amount recycled. For example, quantities of recycled paper range from 26 to 500 tonnes, ferrous metals range from 5 to 520 tonnes and 'other' waste ranges from 12 to 16,820 tonnes.

A further source of information on recycling, is the sale of reclaimed waste, recorded by CIPFA. A comparison of this data with those for the quantity of waste recycled, reveals a number of discrepancies, (Appendix 5.6):-

i) On nine occasions, income from sales of reclaimed waste are recorded, but no tonn age figures reported: Cardiff (on three occasions), Meirionnydd (one), Merthyr Tydfil (one), Rhondda (one) and South Pembrokeshire (three). This indicates obvious errors within the data,

ii) In twelve cases, quantities of recycled waste are identified, but no sales recorded. However, recycled waste is not necessarily sold, therefore, these may be explained.

In summary, analysis of the data available for waste recycling in Wales reveals two main facts. Firstly, that the data base is deficient, thus, an accurate assessment is not possible. Secondly, very little recycling takes place and is, on the whole, poorly monitored. The ADC Report expressed a similar view, stating:

'No estimates are available of the quantity of waste recycled by district councils in Wales but it is evident that the percentage is minute.' (ADC, 1979).

The ADC Working Party also expressed a desire to see more recycling introduced in the Principality. The situation in 1984/85, seven years after the Report was published, remained little changed.

5.3.4 Export and Import of Waste for Disposal

The exportation of waste does not necessarily imply inadequate management; this depends upon the circumstances under which exportation takes place. Waste exportation may occur in three situations:-

i) The exportation of bulky waste, usually domestic and commercial wastes, by the WDA, where:

a) joint arrangements exist between neighbouring authorities for the co-disposal of waste at shared facilities,

b) in crisis situations, during a shortfall in disposal capacity, that is, landfill capacity;

ii) The export of special wastes by private producers and operators. These wastes often require special disposal facilities and may be transported long distances in spite of haulage costs. This category constitutes the majority of waste exportation in Wales and will be dealt with in Section 5.4.

The export of bulky, non-toxic waste, (categories i)a and b), implies insufficient disposal capacity. The high transport costs incurred, would under normal circumstances, inhibit exportation.

In 1977/78, six WDAs exported non-toxic waste, (ADC, 1979); wastes were exported from Alyn & Deeside to Wrexham Maelor, Newport to Monmouth, Vale of Glamorgan to Ogwr, Cardiff and Taff-Ely, Merthyr Tydfil to Rhymney Valley, Brecknock to Radnor, and Preseli to Cardiff. With the exception of Preseli, movement was between neighbouring WDAs, thus, minimising transport costs. In a further three instances, waste was transported for disposal outside of Wales, from Alyn and Deeside to St. Helens, Monmouth to Hereford and Symonds Yat, and from Newport into the Bristol Channel. Again, these involve neighbouring WDAs and in the latter case, disposal at sea. Unfortunately, the quantities and types of waste involved are not recorded, (ADC, 1979).

Data on waste exportation, are not recorded by CIPFA. However, waste exportation and importation may be identified using alternative data sets, (Appendix 5.4). For example, all waste disposed by 'other WDAs' represents exports. The instances of waste exportation revealed are:-

i) Between 1978/9 and 1984/5, eight authorities exported waste: Aberconwy, Alyn and Deeside, Blaenau Gwent, Brecknock, Dwyfor, Monmouth, Radnor and Vale of Glamorgan;

ii) In four authorities, Alyn and Deeside, Vale of Glamorgan, Monmouth and Brecknock, this was a continuation of waste exports, initially identified in the ADC data;

iii) Two authorities have exported waste over a number of years. These are Brecknock (six years), and Vale of Glamorgan (five years). The quantities involved are fairly consistent,

iv) In the remaining WDAs, exports have occurred over three years (one authority), two years (three authorities) and one year (one authority). These suggest instances of short term expediency, rather than long term arrangements. One case, Alyn and Deeside, has been discussed previously and the need to export waste for two years explained in terms of landfill shortage. In the remaining cases, however, the data do not permit any further analysis; the receiving, or importing, authorities are not identified.

The importation of waste is not recorded by CIPFA, but again, can be inferred from the difference recorded between total waste arisings and total waste disposed. Presumably, where Districts dispose of more waste than they claim arose within their administrative area, the difference comprises imports.

On this basis, ten authorities imported waste between 1978/79 and 1984/85, (Appendix 5.4). Brecknock, Cardiff, Colwyn, Delyn and Llanelli imported waste over a one year period only and Arfon and Torfaen over two years. Three authorities recorded more long-term importation; Taff-Ely four years, Wrexham five years and Monmouth for seven years.

It has been established previously, that waste has been exported to Torfaen, Wrexham, Monmouth and Taff-Ely, with the latter three receiving waste for disposal over a number of years. However, the importation of waste by Cardiff, (ADC, 1979), is not evident in the CIPFA data.

In summary, eight authorities have experienced difficulties in the provision of adequate disposal facilities for non-toxic waste within their administrative area. Three Districts, Brecknock, Monmouth and Vale of Glamorgan, have exported waste on a regular basis, implying the establishment of long term arrangements with neighbouring authorities. Monmouth both exports and imports waste, indicating that facilities are adequate to dispose of certain types of waste, but not others.

Significantly, five authorities have exported waste for three years or less, indicating short term difficulty in the provision of disposal facilities. This implies that the planning of facilities has been inadequate and is manifest in the time lag between the exhaustion of an old landfill site and availability of a replacement site. This supposition cannot, however, be substantiated, because of the total lack of relevant data.

5.4 Special Waste Disposal

5.4.1 Introduction

The term 'special waste', has been defined previously (p66), and is synonymous with 'hazardous' or 'toxic' waste. In practice, such waste varies considerably in its physical and chemical properties, including wastes as diverse as hydrochloric and other acids (liquids), waste oils (liquids and sludge), tars, asphalts and metal oxides (solids). Consequently, a variety of disposal techniques including landfill, incineration, recycling and various forms of chemical treatment, are required.

Industrial processes are, primarily, responsible for the production of such wastes and responsibility for their disposal, lies with the producer. The role of the WDA, is to ensure that adequate arrangements are made for the safe disposal of such wastes. Three options for disposal are available:-

i) In-house disposal at the site of production, that is, at facilities provided on the premises;

ii) Disposal at facilities available elsewhere within the WDA, and iii) Exportation for disposal within another WDA.

In each case, the agreement of the WDA must be sought. The first two options require the granting of a waste disposal licence, in which the type of waste, quantities and conditions of disposal are set out. The third option, requires prior notification, by way of a consignment note, indicating intent to transport special waste.

Local authority policy regarding special waste, is indicated by the propensity of each WDA to grant the appropriate waste disposal licences. Those authorities which acknowledge full responsibility for the disposal of all wastes arising within their area, will consent to the disposal of special wastes internally. Consequently, these will record the disposal of special wastes within their area.

No comprehensive source of data is available concerning the disposal of special wastes. The following analysis, is necessarily based upon a combination of data sources, namely the ADC Report, (ADC, 1979), the Gregson Report, (House of Lord's, 1981) and the EEC Report, (Wathern, 1983). Each source is deficient in some respect, but the combination of all three may compensate for individual weaknesses. However, difficulties regarding data compatibility are revealed and discrepancies between data sets merely serve to discredit the data. Notwithstanding these difficulties, jointly the three data sets cover most aspects and provide an over view of the Welsh situation.

The following study is divided into two subsections:-

1) The disposal of waste within individual WDAs

2) The export and import of special waste for disposal:

a)within Wales

b)outside of Wales

5.4.2 Disposal of Waste within Individual WDAs

The earliest data available relate to 1977/78. These record special waste arisings for Wales, at 137,791 tonnes, (ADC, 1979). The ADC commented :-

'The disposal of this noxious waste presents a special problem which is not likely to diminish in the foreseeable future. There are four plants for the separation and recovery of waste oil; one of these installations is also used for the recovery of cleaning fluids. These plants are more than adequate for the needs of Welsh industry and are capable of expansion many times beyond their current capacity. Two sludge treatment plants are available in one town.

Additionally, there is one plant for the incineration and chemical treatment of toxic wastes. In the year 1977/78 it was utilised for the treatment of 18,345 tonnes of toxic wastes, including wastes containing inorganic acids, alkalis, chrome acids. cyanides, laboratory wastes, organic acids and miscellaneous sludges. These wastes originated in Wales and beyond.' (ADC, 1979).

The above plant, operated by Re-Chem International, is located at Pontypool within Torfaen WDA. It remains the only major facility currently available for the disposal of special waste in Wales. The other facilities identified, are waste-specific, dealing only with waste oil and cleaning fluids. Their location is not identified in the report.

The availability of disposal facilities since 1978, can be surmised from information recorded in both the Gregson and EEC Reports, (Appendix 5.7). Although, the EEC data exclude waste disposed in-house by private industry, the report is the sole source of trend data for special waste and indicates a number of points:-

i) Nineteen authorities reported no special waste disposal within their areas for the period 1978 to 1982, (Wathern, 1983), all waste being exported;

ii) Seven WDAs recorded the disposal of special waste. Two authorities, Ceredigion and South Pembrokeshire, disposed of waste for one year only; the method used is not recorded. The remaining five WDAs, namely Afan, Blaenau Gwent, Cardiff, Preseli and Vale of Glamorgan, all used landfill disposal; the first two combining this with incineration and recycling, respectively;

iii) Three WDAs claimed no special waste arose within their area;

iv) Data were not available for the remaining eight authorities,

v) Little or no change over time is recorded. Both Afan and Blaenau Gwent have used landfill disposal with incineration or recycling every year since 1978, (no data were available for Afan in 1982). The only other WDA to have consistently disposed of waste internally is Vale of Glamorgan.

Two conclusions may be inferred. First, that few authorities dispose of special waste internally and secondly, landfill is the most common method of disposal, with few available alternatives. However, a comparison of the EEC data for 1981, with those recorded in the Gregson Report for the same year, (Appendix 5.7), reveals the following:-

i) Gregson recorded nineteen WDAs disposing of waste within their area; the corresponding figure in the EEC report, was five;

ii) Gregson reported twelve WDAs using landfill disposal and seven combining landfill with other methods; the EEC Report, identified three WDAs utilising landfill disposal and two combining this with other disposal methods;

iii) Landfill disposal was recorded in one set of data, but not in the other, for a total of fourteen authorities;

iv) Gregson reported the use of incineration in Neath WDA and land spreading in Preseli; these were not identified by the EEC study;

v) The quantities of waste recorded differ in each case. Some allowance can be made, where surveys relate to different periods, but in many instances the differences recorded are too great for this to be a viable explanation,

and vi) For eighteen WDAs, the two data sets are in agreement. Seventeen have recorded no special waste disposal internally at any time. The remaining authority, South Pembrokeshire, recorded no special waste disposed internally for 1981.

The discrepancies revealed are significant. Not only are differences in quantity recorded, but more importantly, differences in disposal methods. It is difficult to establish with any certainty which data set contains the largest number of accurate returns. Cross-reference to the ADC Report is not possible; the latter did not identify the WDAs concerned. For three authorities, however, explanations are possible; the quantities of special waste reportedly disposed in Blaenau Gwent, Merthyr Tydfil and Torfaen, exceed the total amount of special waste arisings recorded; the data are, therefore, erroneous.

A further three authorities have consistently disposed of waste internally, namely Afan, Blaenau Gwent and Vale of Glamorgan, (Wathern, 1983). These record fairly consistent levels through time, but reveal differences between the two data sets. In the circumstances, the trend data should be viewed as the more reliable.

The situation with respect to the internal disposal of special wastes, may be clarified by two further studies:

i) First, data recorded for the percentage of special waste disposed by various disposal bodies, (Table 5.6), identifies only four Districts, Arfon, Delyn, Dwyfor and Preseli, which disposed of 50% or more of their special waste arisings internally, (mostly to landfill), during 1981. Indeed, only sixteen WDAs, (43%), recorded internal disposal; for eight, the level was less than 10% of special waste disposed. Twelve Districts recorded some disposal by private contractors. Presumably, this involved waste disposed internally, as exports should have been recorded under the column 'exports'.

Table 5.6 Special Waste Disposal Bodies, 1981

District	% of Waste Disposed by Disposal Body Export	Private	District	Other	Calculated Exports *
	%	%	%	%	%
ABERCONWY	90,9	9,1			100,0
AFAN	90,0	?	0,8		70,2
ALYN & DEE	98,0	2,0			?
ARFON	14,6	27,3	58,1		100,0
BLAENAU G,	91,4	8,6			21,7
BRECKNOCK	100,0				100,0
CARDIFF	100,0				88,0
CARMARTHEN	100,0				?
CEREDIGION	99,75		0,25		100,0
COLWYN	100,0				100,0
CYNON VALL,	100,0				100,0
DELYN	39,0	61,0			?
DINEFWR	83,4			16,6	0
DWYFOR		50,0	50,0		0
GLYNDWR	100,0				?
ISLWYN	100,0				100,0
LLANELLI	99,0	neg,			?
LLIW VALLEY	100,0				100,0
MEIRIONNYDD	0,0	0,0	0,0		100,0
MERTHYR TYD	100,0				100,0
MONMOUTH	100,0				100,0
MONTGOMERY	99,0		neg,		?
NEATH	71,8	28,2			100,0
NEWPORT	90,5	8,7	0,8		?
OGWR	100,0				?
PRESELI	33,0	16,0	51,0		93,0
RADNOR	0,0	0,0	0,0		100,0
RHONDDA	100,0				100,0
RHUDDLAN	98,0		2,0		100,0
RHYMNEY VAL	100,0				?
SOUTH PEMB	100,0				100,0
SWANSEA	100,0				100,0
TAFF-ELY	100,0				?
TORFAEN	77,2	11,0	11,8		?
V,OF GLAM	97,2	2,8			85,0
WREXHAM	56,4		11,0	32,6	?
YNYS MON	100,0				100,0

* Based on data collected by Wathern *et al*, (1983)
? = Unknown/No data provided

Source; Based on data contained in the House of Lord's Select Committee Report, (1981),

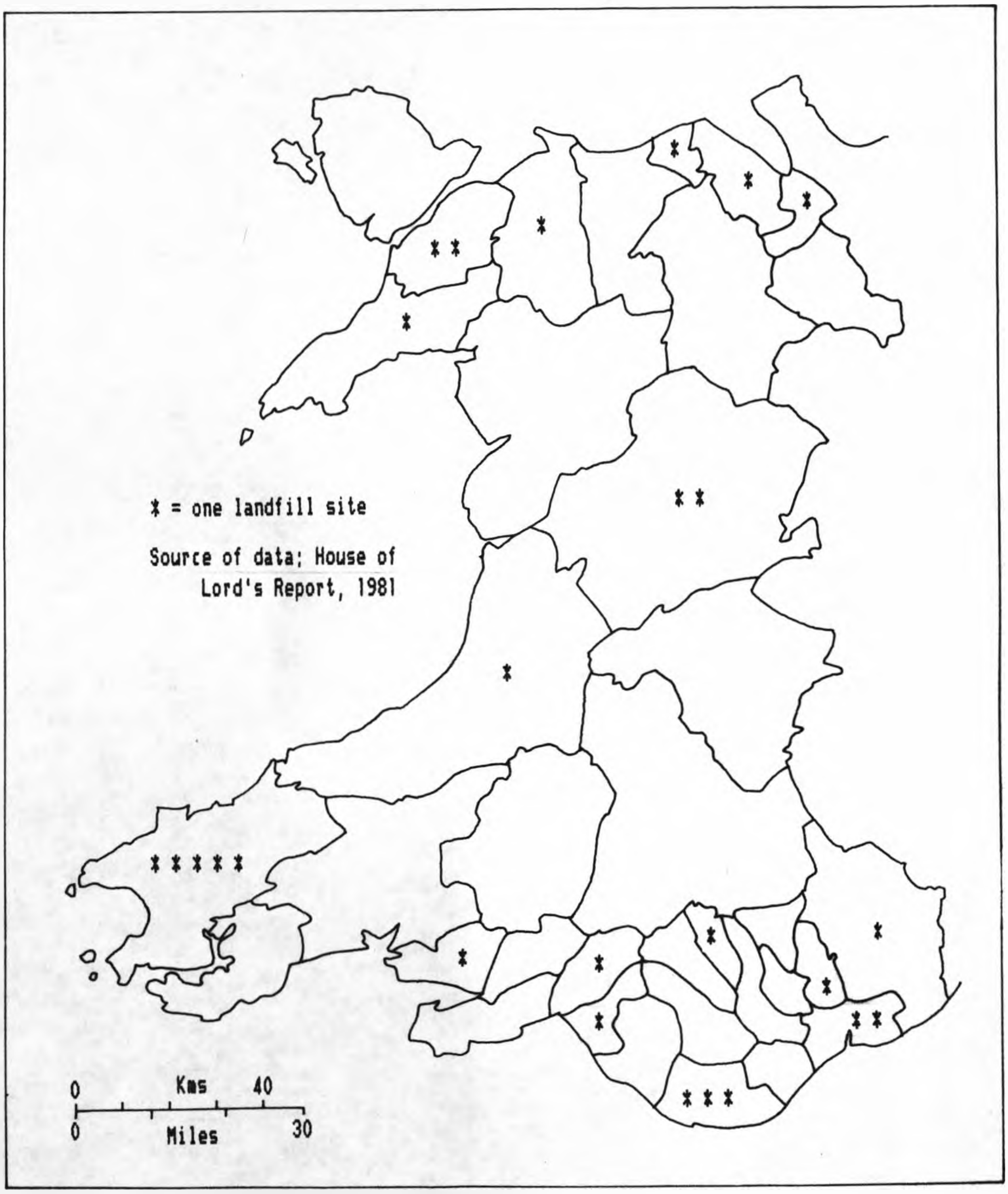
ii) Secondly, the distribution of landfill sites receiving special waste, indicates those authorities which have issued the appro-priate waste disposal licences, (Figure 5.4). A total of twenty-six sites were located within just seventeen authorities. Notably, the distribution of sites reflects the underlying industrial base; most sites are located in South Wales, Preseli and along the North Wales coast.

With the exception of landfill, few alternative facilities for the disposal of special waste exist within the Principality. Thus, the amount of special waste disposed within WDAs, is likely to be very small.

In summary, the analysis of special waste disposal internally within WDAs, is restricted by the inadequate data base. The few data available are both deficient and of questionable reliability. Little credence can be given to the specific quantities of waste recorded and often recorded disposal methods differ between data sets.

Two conclusions can, however, be made. First, that the disposal of special waste takes place in less than 50% of authorities; to what extent this reflects the policy of WDAs not to permit disposal within their administrative areas, is uncertain. Secondly, that the quantities disposed are small, usually less than 5,000 tonnes and in most instances below 500 tonnes. On the whole, therefore, most waste is transported out of the WDA for disposal elsewhere.

Figure 5.4. Landfill Sites for Special Waste Disposal.



5.4.3 The Export and Import of Special Waste

The need to export waste for disposal, implies a deficiency in disposal facilites within an authority. This may be either intentional by the WDA or unavoidable, if suitable sites are not present. There is, however, one exception, where the provision of facilities is not economically viable, that is, it is cheaper to export waste for disposal. The export of large quantities or high proportions of waste is, however, more likely to reflect a WDA policy of no internal disposal.

Gregson reported all special waste arisings within seventeen authorities, exported for disposal elsewhere, (Table 5.6). A further ten WDAs exported between 90 and 99.9%. Of the remaining Districts, four exported over 50%, three exported less than 50%, one had no exports and two, Meirionnydd and Radnor, claimed to have no special waste arisings.

Examination reveals a number of discrepancies within the data, Table 5.6:-

i) Afan recorded percentages for both waste exports and waste disposed by the WDA, but not for waste disposed of privately. Logically, if the latter is not known, percentage figures cannot be calculated for any other category;

ii) Delyn recorded 3,352 tonnes disposed to landfill within the District, (87% of total special waste arisings). Thus, exports comprised 13%, yet the WDA recorded an export level of 39%. Thus, there is a discrepancy of 26%,

iii) Similar analysis for Vale of Glamorgan suggests actual exports of 81.7%, whilst the WDA has recorded a level of 97.2%

The accuracy of the data for some WDAs, is further questioned by comparison with data collected for the EEC study; these have been converted into percentages for comparative analysis, (Table 5.6). Insufficient data are available to permit comparison for twelve authorities and for thirteen, (35%), the data were inconsistent.

Despite the questionable accuracy of the data, these clearly show that the majority of Districts export most of their special waste for disposal. The destination of this waste can be divided into two categories- a)within Wales and b)outside of Wales.

5.4.4 The Exportation of Special Waste for Disposal Within Wales

The movement of special waste within Wales, is illustrated in Figure 5.5. This shows a total of thirty-six movements of waste between authorities; these were recorded in the ADC Report.[1] In fourteen cases, movement is between neighbouring WDAs. The remaining twenty-two, involve movement over longer distances, with Torfaen WDA the major reception point. This authority has been shown previously,

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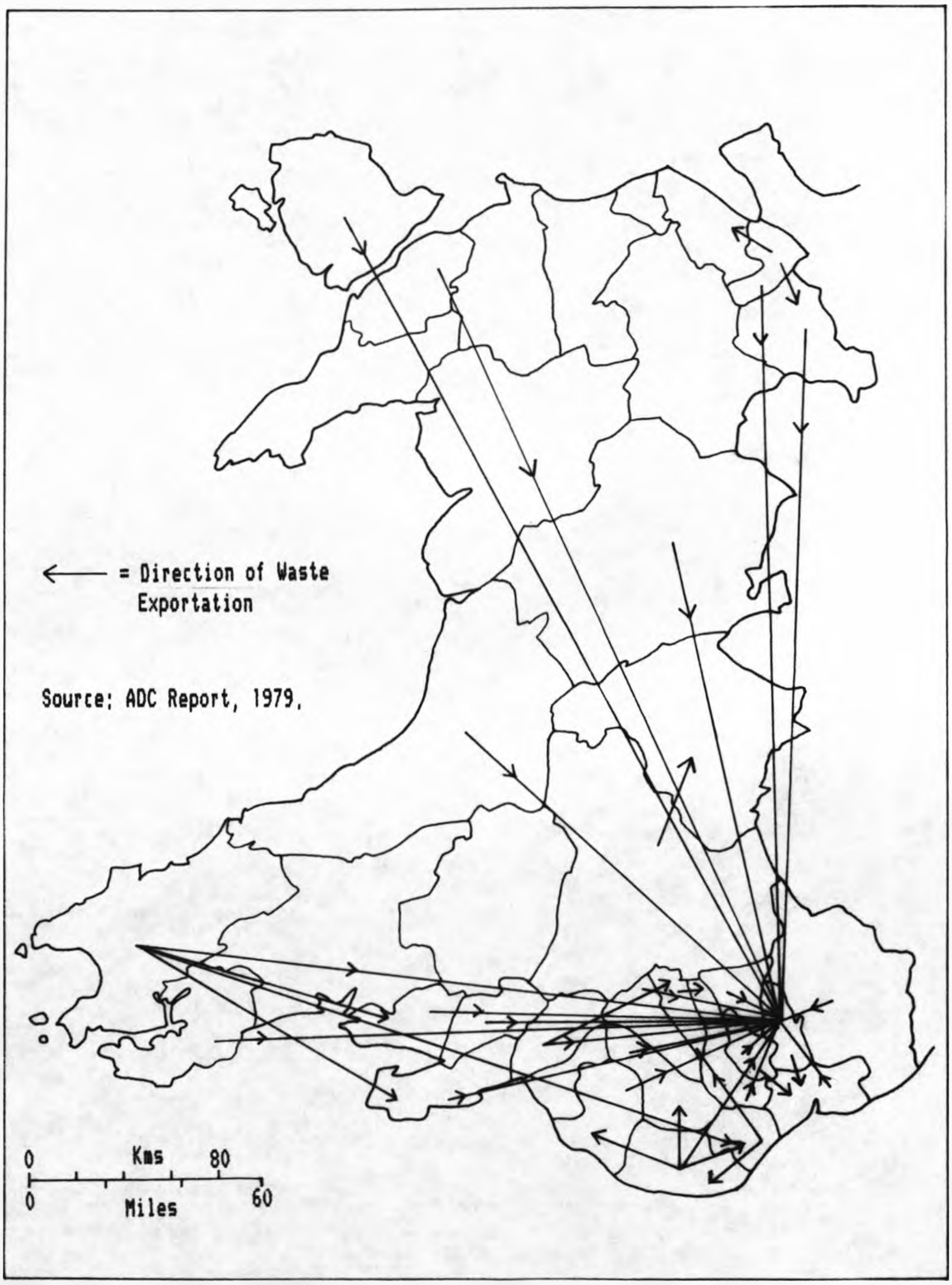
[1]. Figure 5.5 does not correspond with the map produced by the ADC. Various omissions were made from the latter; only nineteen WDAs were shown to export waste, with ten receiving waste for disposal. The corresponding figures contained in the text are, twenty-nine and thirteen.

Figure 5.5. The Exportation of Special Waste for Treatment and/or Disposal Elsewhere in Wales.



(Section 5.4.2), to be the location of the main treatment plant for special waste disposal, within Wales. Hence, the long distance movement of waste from as far away as Ynys Mon, Arfon, Alyn and Deeside and Wrexham Maelor.

In total, twenty-nine WDAs are shown to export waste, with only thirteen importing authorities. Whilst the majority of waste movements recorded, are for WDAs in South Wales, those recorded elsewhere are for authorities with at least some areas of heavy industrial development, (Wrexham Maelor, Alyn and Deeside, Arfon and Ynys Mon in the North and South Pembrokeshire and Preseli in the West). There are only four exceptions, (Montgomery, Monmouth, Ceredigion and Brecknock), these are all located in rural Mid Wales.

Unfortunately, the ADC Report does not identify the quantities or types of waste involved. The circumstances under which exportation has occurred, are also not known.

5.4.5 The Exportation of Special Waste for Disposal Outside of Wales

Although, no data are available, it is a generally held belief, that the majority of special waste produced in Wales, is exported for disposal in England. The ADC Report acknowledged that:

> '..if toxic waste is produced in any Welsh District, some of it is almost certain to be exported to one of the 46 disposal sites in England or one in Scotland. Though there is some movement to other districts in Wales - eight Welsh Authorities receive toxic waste originating outside their

districts- the quantity is relatively small - and includes a quantity imported into Wales from outside.' (ADC, 1979).

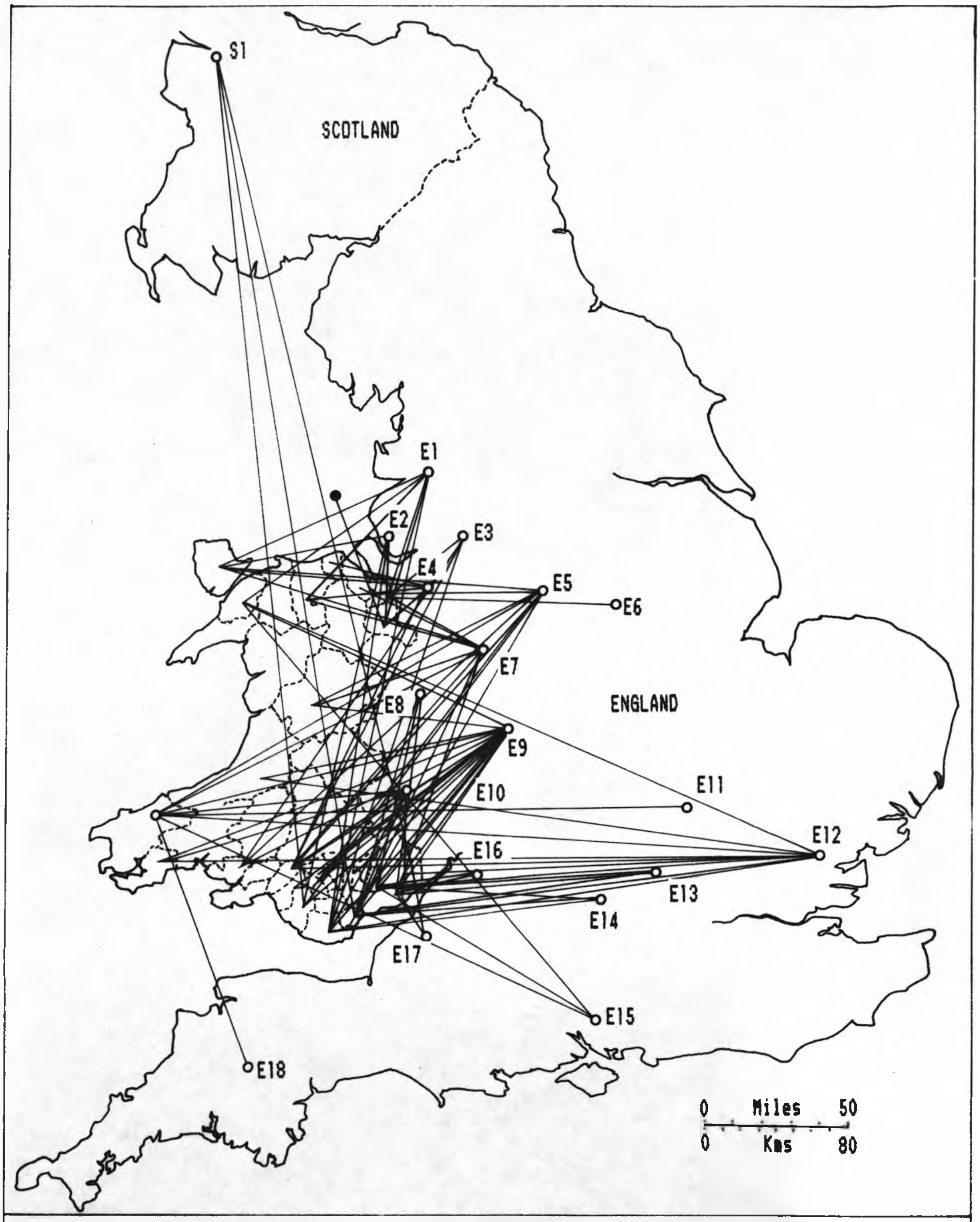
Figure 5.6 shows the export of waste from Welsh WDAs to disposal points throughout England and Scotland. The majority of disposal sites lie in the English Midlands, thus minimising transport costs. A few cases, presumably requiring more specialist disposal facilities, involve transportation over quite long distances, such as the movement of waste from Cardiff, Monmouth and Ogwr to Glasgow, and from Districts on the West coast of Wales, such as Arfon and Preseli, across to sites in Eastern and Southern England, including Pitsea, Fareham and Botley.

In total, forty-nine 'sites' receive special waste exported from Wales; forty-six are in England, one in Scotland and two at sea. Of these, twenty-six receive waste from individual Welsh WDAs, whilst other sites accept waste from a number of authorities. The latter sites include Rainham in Essex, Alfreton and Matlock in Derbyshire, Hereford in Hereford and Worcester, and Aldridge, Walsall, Birmingham, and Brownhills in the West Midlands.

A total of nineteen English WDAs, (counties), are involved in the disposal of special waste exported from Wales. Those involved and the number of sites located in each authority, are:-

Avon (4), Bedfordshire (1), Buckinghamshire (2), Cheshire (6), Derbyshire (4), Devon (1), Essex (2), Gloucestershire (3), Greater Manchester (3), Hampshire (3), Hereford & Worcester (2), Lancashire (2), Merseyside (2), Nottinghamshire (1),

Figure 5.6. The Exportation of Special Waste for Treatment and/or Disposal Outside of Wales.



Key to Disposal Sites:

E1 = Heywood, Darwen & Chorley
E2 = St.Helens
E3 = Manchester & Salford
E4 = Ellesmere Port, Vale Royal, Gateworth, Warrington, Witton, Widnes, & Eastham
E5 = Matlock, Alfreton & Clay Cross
E6 = Nottingham
E7 = Chesterton, Brownhills & Burton-on-Trent
E8 = Much Wenlock & Baschurch
E9 = Aldridge, Walsall, Wolverhampton, & Birmingham
E10 = Hereford
E11 = Eslaw
E12 = Pitsea & Rainham
E13 = Woodham & Aylesbury
E14 = Golders Grove & Harwell
E15 = Fareham, Botley & Southampton
E16 = Sandhurst, Stroud, Upper Parking, & Lydney
E17 = Clay End, Bath, Bristol, Almondsbury & Portishead
E18 = Bampton
S1 = Glasgow
● = Disposal at Sea

Source: ADC Report, 1979.

Oxfordshire (2), Shropshire (2), Staffordshire (2), West Midlands (4), and West Yorkshire (1).

5.4.6 Policy Implications

The situation is clearly one of heavy dependency by Welsh Districts upon English WDAs. Although, the movement and disposal of waste shown in Figure 5.6 is almost certainly carried out exclusively by private industry, the WDAs have control over the situation through the conditions imposed in site licences. English WDAs have permitted the establishment of facilities for special waste disposal, whilst the Welsh authorities have been more cautious. The apparent inability or unwillingness of so many WDAs to deal with special waste disposal within their area, has serious implications should the English Counties refuse to continue importing waste from Wales. The ADC Report expressed concern at this situation in 1979:-

> 'It is of great economic and environmental importance that facilities do not exist in Wales for the treatment and disposal of the toxic waste produced within its boundaries, it being necessary for all but a small percentage to be exported.... The transportation of toxic waste to all parts of Britain, as far afield as Glasgow, Essex, the Midlands and north of England and Devon, inevitably implies an additional cost on Welsh industry. All the District Councils are aware of this and three consider that it acts as a constraint in retaining and attracting certain industries to their localities. It constitutes a specific problem within the wider issue of making provision within Wales for the disposal of general industrial waste.'

and

> 'Welsh industry is worried that receiving points in England may, at some time, be closed to them and that Wales has no alternative sites. This is a positive disincentive to industry contemplating coming to Wales.' (ADC, 1979).

Despite the implications of their current policies, the majority of WDAs, (twenty-seven), have indicated no intention of changing their current export practice, (Wathern, 1983). They clearly reveal no concern at their dependency upon other authorities or the impact of their policy on local industry. In addition, only three Welsh WDAs have acknowledged time constraints on the export of special waste from their area. Thus, the export of most special waste arisings for disposal out of Wales, is likely to continue until outside forces compel a change or central government intervenes.

The situation regarding most aspects of special waste disposal in Wales, has been found to be unsatisfactory. Data are unreliable and often contradictory. Clearly, there is a need for central government involvement, initially to collate sufficient data on the quantities and type of special wastes involved, with a view to assessing the situation and subsequently, to investigate the possibility for introducing regional disposal centres.

CHAPTER 6

6. LANDFILL SITE SELECTION: A GEOGRAPHICAL ANALYSIS

6.1 Definition

Until recently, the term 'controlled tip' was in use throughout Britain to define sites where waste disposal on land occurred. This has now been replaced by 'landfill', perhaps partly through the influence of the corresponding American terminology, that is, 'sanitary landfill'.

The Department of the Environment has used the following definition for the term landfill site

> 'Landfill site' means all areas, whether within the curtilage of industrial premises or not, used for the ultimate disposal or permanently for the storage of waste notwithstanding that waste is periodically removed for disposal elsewhere' (DoE, 1976a, p2)

In reality, this incorporates a wide range of sites. Individual sites represent the combined effect of variations in two main sets of parameters. First, physical characteristics such as size, morphology and hydrogeology, which are all related to the previous land use of the site, and secondly, management policies with regard to the type and amount of waste disposed, disposal techniques and general site management. Such management policies are themselves subject to external forces, in particular, legislative controls and the policy of the WDA concerned.

6.2 Legislative Requirements

Two main 'areas' of legislation are effective in controlling the location and operating conditions at landfill sites. These are planning controls and legislation specifically related to waste management. Landfill sites require planning permission under the Town and Country Planning Acts of 1947 and 1971. In addition, structure and local plans produced under planning legislation, affect landfill site location in that the site must conform with the aims and strategy within the structure plan. One such example is Policy Number 118, contained within the Clwyd County Structure Plan:-

> 'The disposal of refuse and tipping of toxic and non-toxic waste will be permitted only where the proposed site does not adversely affect amenity or public health, particularly through the pollution of water sources. Wherever practicable, sites will be chosen to enable the reclamation of derelict sites, subject to the provisions of Policy 114, rather than to sterilise productive agricultural land.' (Clwyd County Council, 1982).

The main legislation dealing specifically with waste management is contained within COPA, 1974. Part I, Sections 3 to 11 of which control the location and conditions imposed at landfill sites. These Sections introduce a site licensing system, whereby all waste disposal facilities must be licensed by the WDA. The WDA may refuse to grant a licence if it is satisfied that this is necessary in order to prevent the pollution of water or danger to public health. In addition, the WDA may grant a licence, but impose specific conditions which the site operator must adhere to. WDAs are advised by the Department of the Environment to be flexible and not impose too severe conditions, although the advice is somewhat ambivalent:

> '..the licence must ensure that treatment and disposal are carried out with reasonable freedom from risk to the environment, to public health and safety and to public amenity; these conditions must clearly be paramount in considering the terms of a site licence....But authorities should also take account of the need for sufficient treatment and disposal facilities to be available. Hence it is important that restriction on quantities or types of waste and on methods of disposal are only imposed for sound scientific or practical reasons.' (DoE, 1976b, p3)

6.3 Data Sources

Published information regarding landfill sites currently in use within Wales is extremely limited. The ADC Report contains data on the number of District Council operated landfill sites within each WDA for 1978, together with the present and future capacity of the sites at that time, (ADC, 1979, Table 8); the location, physical characteristics and general site management practices were omitted. The number of landfill sites used for the disposal of toxic waste in each WDA, were recorded by Gregson (House of Lord's Select Committee, 1981), but no other information was supplied.

Further information is contained within the EEC Report (Wathern, 1983). This included a statistical analysis of sites, at national level, according to previous land use, amount of waste disposed, frequency of monitoring, and pollution problems identified. Again, the number and location of landfill sites within individual WDAs, site characteristics and management practices were excluded. No comparisons were made of variations in landfill site policy in different WDAs.

Unpublished data collected by Wathern et al. in 1983 have been used in the following analysis, together with data collected in a further postal questionnaire circulated to WDAs during August 1984, (Appendix 6.1). This questionnaire was identical to that used by Wathern (Wathern, 1983), in order to supplement and up-date the data previously collected. Data obtained by the two questionnaires are shown in Appendices 6.2 and 6.3. Further data have been obtained through analysis of the waste disposal plans prepared by individual WDAs. As a result, data on the distribution of current landfill sites and some indication of physical characteristics and management practices, have been collated at District Council level. This will provide an indication of site selection policy in individual WDAs.

Table 6.1 contains quantitative data from the 1983 (Wathern) and 1984 questionnaires, on the number of landfill sites currently in use in Wales. Some additional sites where tipping had ceased, were

Table 6.1 Welsh Landfill Sites, 1983 and 1984

District	Large sites 1983	Large sites 1984	Other sites 1983	Other sites 1984	Total Sites 1983	Total Sites 1984	Change
Aberconwy	1	1	0	2	1	3	+2
Afan	1	1	2	2	3	3	0
Alyn & Deeside	1	1	8	5	9	6	-3
Arfon	1	1	7	1	8	2	-6
Blaenau Gwent	1	1	0	0	1	1	0
Brecknock	3	4	1	0	4	4	0
Cardiff	2	2	8	0	10	2	-8
Carmarthen	ND	1	ND	0	ND	1	?
Ceredigion	5	5	0	0	5	5	0
Colwyn	1	1	0	1	1	2	+1
Cynon Valley	1*	1	ND	4	>1	5	?
Delyn	ND	1	ND	4	ND	5	?
Dinefwr	1	1	0	0	1	1	0
Dwyfor	1	1	19	0	20	1	-19
Glyndwr	4	3	0	0	4	3	-1
Islwyn	2	2	0	0	2	2	0
Llanelli	2	1	4	4	6	5	-1
Lliw Valley	2	2	0	1	2	3	+1
Meirionnydd	1	1	4	3	5	4	-1
Merthyr Tydfil	1	1§	3	3	>3	3	?
Monmouth	2	2	0	0	2	2	0
Montgomery	2*	2	ND	1	>2	3	?
Neath	2	2	1	1	3	3	0
Newport	ND	1	ND	6	ND	7	?
Ogwr	1*	1	ND	2	>1	3	?
Preseli	2	ND#	1	15	3	>15	?
Radnor	3	1	2	1	5	2	-3
Rhondda	2	2	1	1	3	3	0
Rhuddlan	1	0	0	0	1	0	-1
Rhymney Valley	4	1	6	1	11	3	-8
South Pemb	2	1	3	8	5	9	+4
Swansea	3	ND#	0	16	3	>16	?
Taff-Ely	2*	2	ND	7	>2	9	?
Torfaen	2*	2	ND	4	>2	6	?
Vale of Glam.	2	2	6	7	8	9	+1
Wrexham	2	ND#	12	16	14	>16	?
Ynys Mon	2	2	2	2	4	4	0
Totals	65	53	90	118	155	171	

ND = No Data § = Shared Site with Rhymney Valley > = More than
# = No data provided for WDA sites, only non-domestic and private sites
? = Insufficient data to calculate change

* = Source of data; Telephone Conversation with WDA
Source of all other data; Postal Questionnaires (1983 and 1984)

also identified; these have been omitted and only those actively in use at the time of the questionnaires, recorded. Although, it is possible to identify weaknesses in both sets of data, it is thought that this is the first time data on landfill sites on an all-Wales basis have been collated; requests to the Welsh Office to supplement data proved unsuccessful.

In general, the quantity and quality of responses to the 1984 questionnaire were superior to those for 1983. All thirty-seven WDAs responded, compared with thirty in 1983, (twenty-nine of which completed the section on landfill sites). Possibly, this was due to the length of the 1983 questionnaire, of which the section on landfill sites was only a part.

Consequently, no data are available for three Districts, Carmarthen, Delyn and Newport, for 1983. A further five Districts provided only very limited information on their main sites when contacted by telephone. These were Cynon Valley, Montgomery, Ogwr, Taff-Ely and Torfaen. One District, Merthyr Tydfil, did not identify any sites accepting domestic waste; a number of sites are, however, identified in the District's Waste Disposal Plan.

In reply to the 1984 questionnaire, the Districts of Preseli, Swansea and Wrexham Maelor only provided copies of the disposal licences currently in force within their areas. In these cases, therefore, only privately operated sites were identified and not the main domestic waste disposal sites operated by the WDAs. A number of other Districts provided copies of current disposal licences for 1983 and/or 1984, but also included data on their own municipal sites. Finally, two neighbouring authorities, Merthyr Tydfil and Rhymney Valley both supplied data on one site which they share. This site has been recorded under Merthyr Tydfil.

The figures of 155 and 171 sites for 1983 and 1984 respectively are not, therefore, true totals. Neither does the increase of sixteen,represent an actual increase; the greater number for 1984 is indicative of the higher response rate for that year. The majority of 'increases' or 'decreases' recorded for individual WDAs are the result of inconsistency in the thoroughness of the replies. For example, in 1983 Dwyfor supplied disposal licences for every site operated within the WDA, but in 1984 identified only one main WDA site. There was not, therefore, a sudden closure of nineteen sites, but a less thorough reply to the questionnaire. On this basis, by combining the 'more likely' figures, that is the highest for each District, the true Welsh total is probably in the region of 220 to 230 sites. Notwithstanding the closure of some sites and opening of others during the intervening period, it is likely that this figure underestimates the total, as a number of Districts have not identified all their sites in either questionnaire.

The main problem lies in identifying the number of 'other sites', (Table 6.1). The large, WDA operated sites used for municipal waste are quite readily identifiable in most cases. However, the privately run sites, in particular the very small sites, accepting small quantities of inert material, are frequently omitted from the questionnaire responses for both years, or have been included for one year only.

To avoid the problem of data inconsistency regarding the small privately operated sites, it is intended to omit these from detailed analysis, for the following reasons:-

i) First, such sites often consist of areas of less than one hectare in size, used for the disposal of inert builder's rubble or waste from a caravan or camping site. They are too small to warrant the use of a weighbridge, are run by private operators who often have no necessity to keep detailed records and subsequently, data are generally unreliable and often totally lacking;

ii) By their very nature, these sites are of minor significance compared with the main municipal sites, which may be considerably larger and accept far greater quantities of different types of waste. Consequently, municipal sites are likely to have a greater environmental impact and pose a greater risk of pollution;

iii) Municipal sites are the responsibility of the local authorities, who are accountable for their efficient and environmentally sensitive management. In theory, the more permanent nature of municipal sites and the infrastructure required, means that they should be better equipped to monitor procedures, for example, by the instalment of a weighbridge;

iv) Industrial waste, unlike domestic waste, is more irregular in terms of the type, amount and location of arisings. It is dependent upon a complex chain of variables, such as raw materials, transport networks and so on. Domestic waste, however, is more simplistic, being directly related to population. Parts II and III of this study will attempt to analyse patterns and trends in domestic waste. Consequently, this section will focus upon sites accepting municipal (domestic) waste. The disposal of domestic waste arisings is the responsibility of the WDAs and takes place at the municipal sites, with the exception of a small number of private sites, where the WDA has an arrangement with the operators; these have been included in the following analysis.

For the reasons stated, municipal sites have been recorded separately in Table 6.1. These are the sites used by the WDAs for the disposal of domestic waste arising within their area. Many are also used for the disposal of non-domestic waste, including toxic waste in some cases. Thus, the criteria used to select the sites for analysis, are that they accept domestic waste (more than 1 tonne/day with the exception of one site operated by Brecknock WDA), and are used for the disposal of waste by, (or on behalf of), the WDA. It is acknowledged that this definition excludes some large disposal sites used solely for non-domestic waste disposal. In general, these are private sites of a very different nature, usually involving 'in-house' disposal, being located in the vacinity of the industry concerned and hence, involving slightly different decisions regarding location, management and monitoring.

The number of large WDA sites identified by the 1983 questionnaire was sixty-five, with the corresponding figure of fifty-three for 1984. The total number of different sites recorded over the two years was seventy-one, of which forty-seven were recorded for both years, eighteen were recorded for 1983, but not for 1984, and six were recorded in 1984 only.

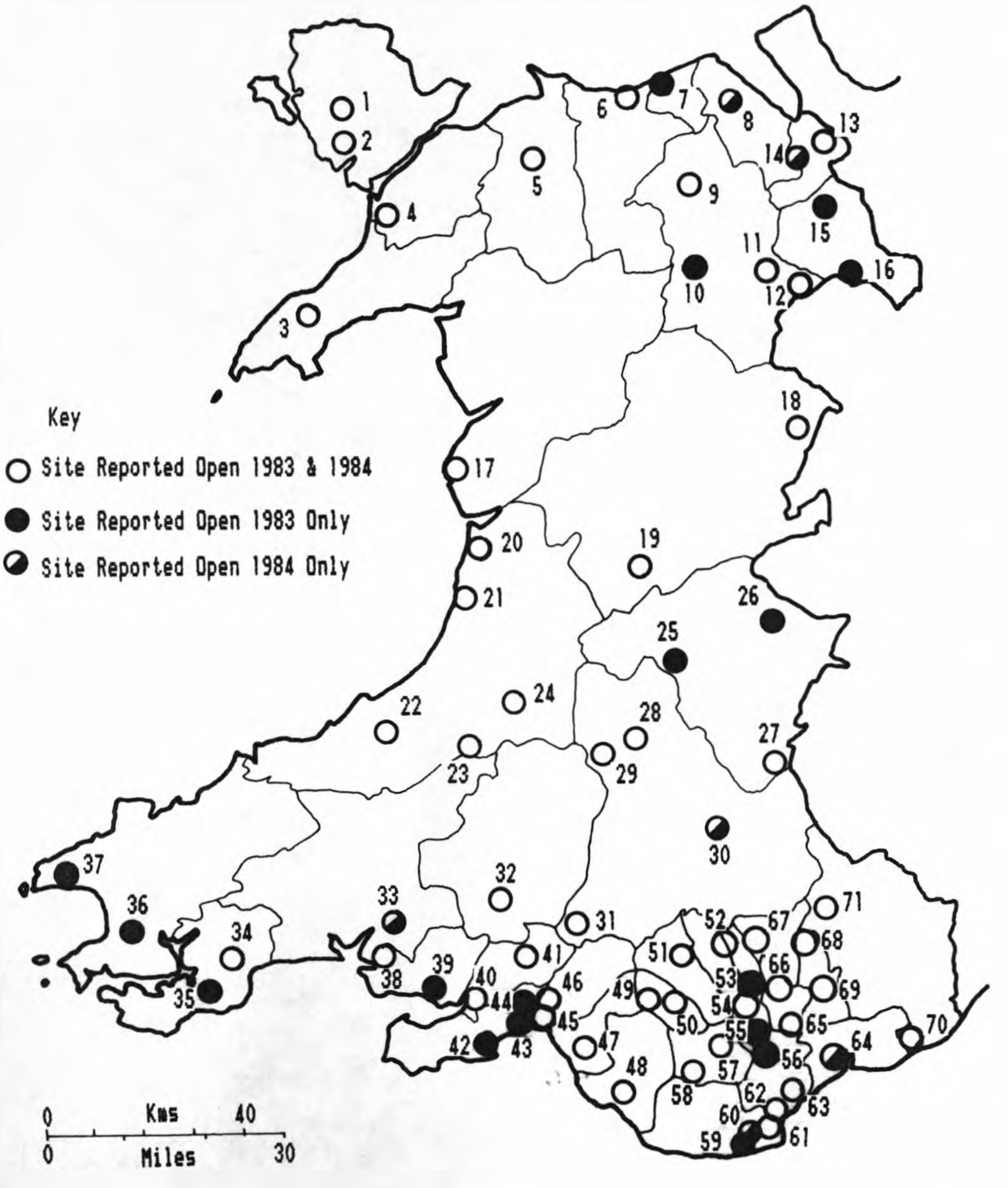
Analysis of the data, in particular the opening dates for the sites and their estimated future capacity, reveals that some of the differences in the number of sites recorded by individual WDAs, cannot be accounted for by the closure or opening of new sites. Only two of the six sites recorded for the first time in 1984, were new sites. The other four were in operation during 1983, but had not been identified in the questionnaire returns. Six of the eighteen sites identified in 1983, but not recorded in 1984, had almost definitely closed, with closure possible in a further two. The remaining ten sites had sufficient future capacity available in 1983 to ensure that they would still be operating by at least the end of 1984. It is highly likely, therefore, that a further fourteen sites were in operation during both years. Thus, of the seventy-one sites identified, sixty-one were probably in operation during both 1983 and 1984, with eight closures and two new sites opened during the time between the circulation of the two questionnaires. Allowing for those Districts which failed to provide any data, the total number of sites operated by the WDAs in Wales is probably in the region of sixty-five to seventy sites.

6.4 Distribution and Characteristics of Landfill Sites

6.4.1 Distribution

Figure 6.1 shows the locations of the seventy-one WDA operated

Figure 6.1. Waste Disposal Authority Landfill Sites, 1983/84.



Key to Sites:

1 Clegir Mawr
2 Penhesgyn Gors
3 Maesoglan
4 Cilgwyn
5 Valley Tip
6 Abergele
7 Rhyl
8 Ysceifiog
9 Lon Parcwr
10 Bryn Bras
11 Wenfrwd
12 Lower Halton
13 Broken Bank
14 Etna
15 Gwersyllt
16 Caedyah Farm
17 Tywyn
18 Carreg Hofa
19 Bryn Posteg
20 Borth
21 Aberystwyth
22 Rhydeinon
23 Lampeter
24 Tregaron
25 Nantmel
26 Cefn Coch
27 Clyro
28 Rhosferno
29 Llanwrtyd Wells
30 Felinfach
31 Tycanol
32 Wernddu
33 Carmarthen
34 Kingsmoor
35 Pincheston
36 Haverfordwest
37 St.David's
38 Kidwelly
39 Northumberland
40 Cwrt y Carne
41 Rhydfro
42 Clyne
43 Tir John
44 Crymlyn
45 Briton Ferry
46 Cadoxton
47 Cwmafan
48 Tythgeston
49 Treorchy
50 Ferndale
51 Bryn Pica
52 Trecatti
53 Aberbargoed
54 Gelligaer
55 Maesycwmmer
56 Caerphilly
57 Fforest Uchaf
58 Llanharran
59 Barry Docks
60 Wenvoe
61 Penarth Docks
62 Penarth Moors
63 Rhymney Moors
64 Maesglas
65 Wattsville
66 Trinant
67 Silent Valley
68 Blaenavon
69 Tirpentwys
70 Rogiet
71 Llanfoist

Source of data: a)for 1983 - EEC Questionnaire
b)for 1984 - Landfill Questionnaire

landfill sites known to exist in 1983 and/or 1984. Sites are individually named and are located as accurately as possible. Distinctions are made between those sites which were named in 1983, 1984 and those which were identified for both years.

It has been established that eighteen sites were recorded for 1983, but not in the following year. For seven sites located in the Districts of Preseli, Wrexham Maelor and Swansea, this was because no data on WDA sites were provided in 1984; the disposal capacity identified for two of these in 1983, (Gwersyllt in Wrexham Maelor and Haverfordwest in Preseli), suggests that these two were probably closed by 1984. The remaining eleven sites were located in authorities which did supply data for the following year. Based on the small capacity remaining for six of these in 1983, it is highly probable that they ceased operating. Closure was also probable for a further two sites, but not definite. The remaining three sites, however, should have been identified in the 1984 questionnaire, but were not.

Ceredigion WDA failed to supply any new data in 1984 for the five sites located within its area in 1983, but reported that conditions at these sites had not changed and all sites were still in operation. However, the remaining capacity recorded for three sites (Aberystwyth, Lampeter and Rhydeinon) in 1983 was not sufficient to last until August 1984 and theoretically, these should have closed.

A total of six 'new' sites were recorded in 1984. Analysis of the opening dates for these sites reveals that four, (Ysceifiog, Etna, Wenvoe and Maesglas), were in operation prior to 1983 and, therefore, should have been identified in the 1983 questionnaire returns. However, in the cases of Ysceifiog and Maesglas the authorities concerned failed to supply any data. In many respects, the cases of Etna and Wenvoe are of more concern, because the WDAs provided data, but failed to identify these sites. Only two new sites, Felinfach in Radnor and Carmarthen in Carmarthen WDA, are known to have opened since the circulation of the 1983 questionnaire.

The situation revealed by combining the two data sets, is that all Districts, with the exception of Rhuddlan, have at least one landfill site which is operated by or on behalf of the WDA. Rhuddlan's one disposal site was closed in September 1984 and subsequently, all waste arisings disposed at Colwyn Borough Council's Abergele site, (Rhuddlan Borough Council, 1984).

There does not appear to be any apparent relationship between the size of District and number of sites established to service it. Whilst most authorities operate one or two sites, those with four or more include Glyndwr (96,597 ha), Ceredigion (179,331 ha) and also Rhymney Valley (a mere 17,578 ha).

Details on landfill site characteristics recorded in the two sets of questionnaire returns have been collated and are included in Appendices 6.2 and 6.3. The information recorded is limited, but allows analysis of site age, lifespan and future capacity, together with size, previous use, type and amount of waste received and any pollution problems. Analysis of the two data sets reveals numerous discrepancies in the data recorded; these are investigated in detail in the following sections. The availability of the two data sets does, however, have one advantage, in that data can be substituted from one year to the other, to compensate for gaps in each data set. Thus, the following analysis includes all WDA sites identified over the two years, whether in operation during both years, for 1983 only and then closed, or new sites opened in 1984.

6.4.2 Size of Site

Appendix 6.4 contains an analysis of the amount of waste disposed and size of site. These have been summarised in Tables 6.2 and 6.3 respectively. Data for 1984 have been analysed where possible, as these are more recent, but have been supplemented by 1983 data where necessary. Analysis of data on site size (area), shows that the units of measurement recorded for two sites were for volume (m^3) rather than area and since no data are available on the depths of these sites, the data cannot be converted. For three sites, Broken Bank (Alyn & Deeside), Tregaron (Ceredigion) and Wenvoe (Vale of Glamorgan), no data were available for either year.

Table 6.2, shows that the majority of sites, (60.6%), have an area of less than 10 hectares. A total of twenty-four sites, (33.8%), were less than 5 hectares in size. Only 12.7% were between 10 and 20 hectares and 19.7% over 20 hectares. Two sites, Bryn Pica (Cynon Valley) and Clyne (Swansea) were claimed to be 185 and 200 hectares respectively, and the Penarth Moors site (Cardiff), 69 hectares. However, reference to the City of Swansea waste disposal plan reveals the Clyne site to be 64 acres/25.9 ha, (City of Swansea, 1985); the Cynon Valley waste disposal plan does not contain details

Table 6.2 Summary of Data on the Size of Welsh Landfill Sites (ha)

Area (ha)	In Operation 1983 & 1984	New Sites 1984	Site Closed By 1984	Total Sites	
< 5	18	1	5	24	33,8%
> 5 - < 10	17	1	1	19	26,8%
>10 - < 20	9	0	0	9	12,8%
> 20	12	0	2	14	19,7%
Different Units	2	0	0	2	2,8%
No Data	3	0	0	3	4,2%
Total	61	2	8	71	100,0

Source; Based on information in Appendix 6,4,

Table 6.3 Summary of Data on the Amount of Waste Disposed Per Annum at Welsh Landfill Sites (Tonnes)

Amount of Waste (Tonnes)	No, of Landfill Sites	Percentage of all Landfill Sites
< 5,000	11	15,5
> 5,000 - < 10,000	7	9,9
>10,000 - < 25,000	16	22,5
>25,000 - < 50,000	16	22,5
>50,000 - <100,000	11	15,5
>100,000	5	7,0
No Data	5	7,0
Total	71	100,0

Source; Based on information in Appendix 6,4, of site size. The figures of 69 and 38 hectares for the two City of Cardiff sites are confirmed in the Waste Disposal Plan. No other site had an area greater than 50 hectares. Seven sites were only 1 hectare in size and of the eight sites which ceased operation by 1984, five were less than 5 hectares in area.

Analysis is made difficult by discrepancies revealed in the two data sets, Appendix 6.4. In only ten out of the seventy-one sites, were corresponding figures recorded. A further ten sites either closed or opened and, therefore, no comparison is possible. In twenty-four cases, data were only available for one year, whilst for the remaining twenty-five sites, different areal data were recorded. Four of these were by less than 0.5 ha. Theoretically, these may be accounted for by differences in the way the data have been rounded into integers for the two data sets. The remaining twenty-one instances exhibit the following differences:-

>0.5 and <1.00 ha = 3 sites, >1.0 and <2.00 ha = 6 sites, >2.0 and <5.00 ha = 5 sites, >5.00 and <10.00 ha = 3 sites, >10.00 and <20.00 ha = 3 sites, >20.00 ha = 1 site

To what extent increases in site size recorded between 1983 and 1984 represent site extensions, is not clear. However, decreases in site size are more easily identifiable as data inaccuracies; decreases were recorded for a total of ten sites, (Appendix 6.4).

6.4.3 Amount of Waste Disposed

Similarly, data inconsistencies are probably present in the records on amount of waste disposed. However, waste arisings are, by nature, prone to fluctuations in level. It is, therefore, impossible to establish to what extent the differences recorded are due to these fluctuations or to errors in data recording. Large differences, in excess of 10,000 tonnes, are particularly suspect, especially when these result in a large percentage change in the amount disposed at the site concerned. Such sites include Bryn Pica (Cynon Valley), Wernddu (Dinefwr), Kidwelly (Llanelli), Rhydfro and Cwrt y Carne (Lliw Valley), Briton Ferry (Neath), Kingsmoor (South Pembrokeshire), Fforest Uchaf and Llanharran (Taff-Ely) and Tirpentwys (Torfaen). Comparison of the two data sets, shows that sixteen sites recorded differences in excess of 10,000 tonnes; six of these were for amounts greater than 20,000 tonnes. Differences of less than 10,000 tonnes were recorded for a total of seventeen sites; six were for amounts below 1,000 tonnes. Eleven sites recorded identical disposal levels for the two years and in a further twenty-seven cases, no comparisons were possible.

Despite the above reservations regarding data accuracy, data for 1984 have been analysed and where necessary supplemented by data from the 1983 survey. Data on the amount of waste disposed at landfill sites are summarised in Table 6.3. Only five sites (7.0%) receive more than 100,000 tonnes of waste per annum. Two of these are in the City of Cardiff WDA, and one in each of Newport, Rhymney Valley and Vale of Glamorgan. As expected, these are all South Wales WDAs with large waste arisings. By contrast, eighteen sites (25.4%) disposed of less than 10,000 tonnes per annum. Eleven of these received less than 5,000 tonnes; all but one, (Broken Bank, Alyn and Deeside), being located in the WDAs of Mid Wales.

CIPFA data on the amount of waste disposed direct to landfill are shown in Table 6.4. The amount of waste disposed at all WDA landfill sites in each District, are also shown. Comparison of the data, reveals that corresponding levels were recorded in only four Districts. Lack of data prevented comparison in a further four authorities and the remaining twenty-nine all exhibit differences in their data. Variations of less than 1,000 tonnes, and between 1,000 and 10,000 tonnes, were recorded for six and nine WDAs respectively. The remaining fourteen authorities all exhibit more major differences in their data. The largest data discrepancies, in excess of 100,000 tonnes, were recorded for Rhymney Valley and Vale of Glamorgan; Wrexham and Merthyr Tydfil exhibited differences in excess of 50,000 tonnes. The final ten WDAs had discrepancies of between 10,000 and 50,000 tonnes.

There are a number of possible explanations for discrepancies in the data, but none of these can account for all the differences recorded. For example, in some cases data may have been recorded for slightly different periods, but this does not explain major differences. The data in Column A, include waste which has been disposed direct to landfill or to landfill following collection from household amenity sites. However, two WDAs, Rhondda and Meirionnydd, pre-treated waste prior to landfill disposal. When the additional amounts of treated waste (15,000 and 12,500 tonnes respectively), are added to the totals in Column A, large differences of 4,500 and 13,500 tonnes remain.

In eighteen out of the twenty-nine WDAs for which recorded amounts differ, the waste disposed of at authority landfill sites was less

Table 6.4 Comparison of CIPFA Data and Landfill Questionnaire Data

District	A Disposal to landfill by WDA 1983/84	B Total Waste Disposed at WDA Sites 1984	Difference
	Tonnes	Tonnes	Tonnes
Aberconwy	38,800	60,520	21,720
Afan	55,734	55,734	0
Alyn & Deeside	47,520	*51,030	3,510
Arfon	60,226	55,000	5,226
Blaenau Gwent	88,000	87,900	100
Brecknock	15,520	10,672	4,848
Cardiff	312,752	312,756	4
Carmarthen	4,104	30,000	25,896
Ceredigion	29,000	27,200	1,800
Colwyn	28,780	28,288	492
Cynon Valley	46,418	47,492	1,074
Delyn	0	24,000	24,000
Dinefwr	?	29,000	?
Dwyfor	16,600	16,586	14
Glyndwr	27,200	26,200	1,000
Islwyn	71,000	*77,200	6,200
Llanelli	?	60,000	?
Lliw Valley	44,500	38,800	5,700
Meirionnydd	2,500	1,500	1,000
Merthyr Tydfil	98,880	30,000	68,880
Monmouth	32,232	32,232	0
Montgomery	39,600	21,055	18,545
Neath	98,073	86,100	11,973
Newport	120,000	120,000	0
Ogwr	127,500	97,500	30,000
Preseli	37,800	*16,006	21,794
Radnor	8,200	*10,464	2,264
Rhondda	69,500	80,000	10,500
Rhuddlan	30,000	0	30,000
Rhymney Valley	95,780	*233,900	138,120
South Pemb	20,000	20,000	0
Swansea	94,084	?	?
Taff-Ely	?	96,365	?
Torfaen	79,755	52,250	27,505
Vale of Gl.	36,009	*187,780	151,771
Wrexham	87,420	*36,500	50,920
Ynys Mon	79,500	74,200	5,300

? = No Data
* = 1983 Data used in calculations

Source of Data: A = CIPFA Waste Disposal Statistics (Actuals) Reports
B = 1984 Questionnaire on Landfill sites

than the WDA claimed to dispose direct to landfill. One possible explanation is waste exportation by the WDA. However, only two of the authorities concerned, Brecknock and Dwyfor, recorded waste exports of 2,010 and 350 tonnes respectively. In eleven cases, the amount of waste disposed at WDA operated sites, exceeded the amount claimed to have been disposed to landfill by the WDA. In these instances, agreements to dispose of waste for neighbouring WDAs or contractors may account for the differences, although this is highly unlikely; only two WDAs exported waste and most contractors operate their own disposal site.

6.4.4 Type of Waste Disposed

The type of waste disposed at landfill sites has been recorded and classified into domestic, industrial, commercial and toxic or special waste. Of the seventy-one sites identified, sixteen (22.5%) accepted only domestic waste for disposal and forty-eight (67.6%) received domestic waste together with commercial and/or industrial wastes. It has been shown previously, (Section 5.4.2), that most WDAs do not favour the disposal of special wastes within their administrative areas, the majority of this waste being exported for disposal elsewhere. This is reflected in the small number of WDA operated sites which receive special waste for disposal. Only seven sites (9.9%) accepted special wastes. In six cases this was combined with the disposal of domestic and industrial wastes and in one case with domestic waste only. These sites were located in the heavily industrialised areas of Alyn and Deeside, Preseli, Vale of Glamorgan (two sites), Rhymney Valley, Merthyr Tydfil and Blaenau Gwent.

Records on the type of waste accepted at sites, albeit at a very general level, appear to be more consistent than for other site variables recorded. Data on the type of waste disposed at sites in 1983 and 1984, are available for forty-three sites. Differences were observed in five cases. One site accepting only domestic waste in 1983, disposed of domestic and industrial waste in 1984, whilst three sites no longer received industrial and/or commercial waste. The remaining site accepted special waste together with domestic and industrial waste in 1983, but subsequently, only disposed of domestic and industrial wastes. It is not possible to establish whether these differences represent a change in WDA policy at particular sites or errors in questionnaire returns.

6.4.5 Date of Site Opening

Appendix 6.5 contains data on site age and estimated future capacity. Analysis of landfill site opening dates recorded in the two sets of questionnaire returns, shows a surprising lack of consistency; this should be a relatively easily recorded variable. No comparison was possible in thirty-five cases, due to inadequate data and site closure or new sites opening. In the remaining thirty-six instances, fifteen recorded the same date, but for twenty-one sites, dates varied. Differences of one year, two to five years, and five to ten years, were recorded for five, three and eight sites respectively. For a further five sites, dates differed by more than ten years. Some authorities provided noticeably poor data, recording inconsistent dates for a number of sites within their administrative area; Brecknock, Lliw Valley, Rhondda and Ynys Mon being the most inconsistent. Obviously, the greatest discrepancies are recorded for older sites, in particular, pre-1974 sites. Records on the early history of such sites may be totally inadequate or absent. However, this does not excuse the recording of widely varying dates by current WDAs within a period of twelve months.

6.4.6 Site Age

Analysis of site age and lifespan, is necessarily based upon site opening dates. The use of such apparently unreliable data has obvious implications. However, the following calculations of site age and lifespan have been made, based on the information supplied to the 1984 questionnaire.

The majority (53.5%) of landfill sites operated by the WDAs during 1983/84 were pre-1974 sites, that is, more than ten years old in 1984 and in existence prior to the introduction of the Control of Pollution Act. Since 1974, thirty-two new sites (45.1%), have opened. Eighteen of these opened between 1974 and 1980, and fourteen (19.7%), since 1980. No date has been provided for Borth landfill site, in Ceredigion. The oldest recorded sites were Broken Bank, (Alyn and Deeside), opened in 1918 and Ferndale (Rhondda), 1945. Exact dates were not supplied for ten sites; these were recorded as either pre-1974, pre-1970 or pre-war.

6.4.7 Site Lifespan

Site lifespan has been calculated, based on the age of the site in 1983 or 1984 (depending on data availability) and the estimated future capacity of the site. The resultant data are shown in

Appendix 6.5 and summarised in Table 6.5. WDA site selection policy regarding the acceptable life of a landfill site and the ability of WDAs to obtain long term landfill sites, is indicated by the lifespan of landfill sites within their administrative areas. To a certain extent, sites with short lifespans of less than five years, are indicative of short term expediency, rather than long term planning. Five sites (7.0%) have recorded lifespans of less than five years. These are Felinfach in Brecknock (1yr 6mths), Abergele in Colwyn (2 yrs 5mths),Trinant and Wattsville in Islwyn (2yrs and 3yrs 2 mths respectively), and Caerphilly in Rhymney Valley (3 yrs 3 mths). A large proportion of the landfill sites, 47.8%, have a recorded lifespan of less than fifteen years. A total of thirty-three sites (46.5%), have a lifespan between fifteen and forty years. Only four sites (5.6%) have an estimated life of over forty years. These are Broken Bank in Alyn and Deeside (65 years), Carmarthen in Carmarthen WDA (50yrs), Clyro in Radnor (50 yrs) and Maesycwmmer in Rhymney Valley (40yrs).

Two authorities, Colwyn and Islwyn, operated sites all of which had a lifespan of less than five years, whilst the sites in Llanelli WDA area had a recorded life of less than ten years. At the other extreme, sites operated by Arfon, Carmarthen, Dwyfor, Newport and Rhondda, had lifespans in excess of thirty years.

6.4.8 Previous Use of Sites

Data on the use of a site prior to its conversion for waste disposal (Appendices 6.2 and 6.3), serve to indicate in a very general way the WDA's policy on site selection. That is, whether the authority

Table 6.5 Summary Data: The Lifespan of Welsh Landfill Sites

Lifespan (Yrs)	No. of Sites	Percentage	Cumulative %
< 5yrs	5	7.0	7.0
> 5 - <10yrs	11	15.5	22.5
>10 - <15yrs	18	25.3	47.8
>15 - <20yrs	8	11.3	59.1
>20 - <30yrs	15	21.1	80.2
>30 - <40yrs	10	14.1	94.3
>40 - <50yrs	1	1.4	95.7
>50yrs	3	4.2	99.9
Total	71	100.0	

Source: Based on data in Appendix 6.5

has chosen to undertake land reclamation on already derelict sites or has used 'virgin' sites. Previous use has been classified into four basic categories, agricultural, natural environment, quarries and other. The first two, represent 'virgin', unspoiled land, whilst the later two incorporate derelict and spoiled land. The category 'other' includes disused docks and industrial land, old railway cuttings and other 'waste land'. Natural environment sites constitute land of possible nature conservation interest, such as marshland, wetlands, woodland and scrubland, and estuarine and coastal areas, such as salt flats and tidal marsh.

Agricultural land constitutes the most common previous use of the seventy-one sites identified. A total of thirty sites were located on agricultural land. Disused quarries formed the second most common use, with twenty-two sites, followed by natural environment (twelve sites), and other (seven sites). For Wales as a whole, therefore, more landfill sites are located on previously unspoiled land than on derelict or disturbed land. There are, nevertheless, marked regional differences between the previous use of landfill sites.

Figure 6.2 shows the distribution of sites, classified according to previous use. Analysis of the data on a regional basis reveals definite spatial patterns, (Table 6.6). In Mid Wales, 70.4% of landfill sites are located on agricultural land, compared with only 18.7 % in South Wales. North Wales falls between these two, with 41.7%. Total figures for sites located on unspoiled land, that is, agricultural sites combined with natural environment sites, are 81.5%, 37.5% and 66.7% in Mid, South and North Wales respectively. To what extent this reflects site availability rather than preference

Figure 6.2. The Previous Use of WDA Landfill Sites, 1983/84.

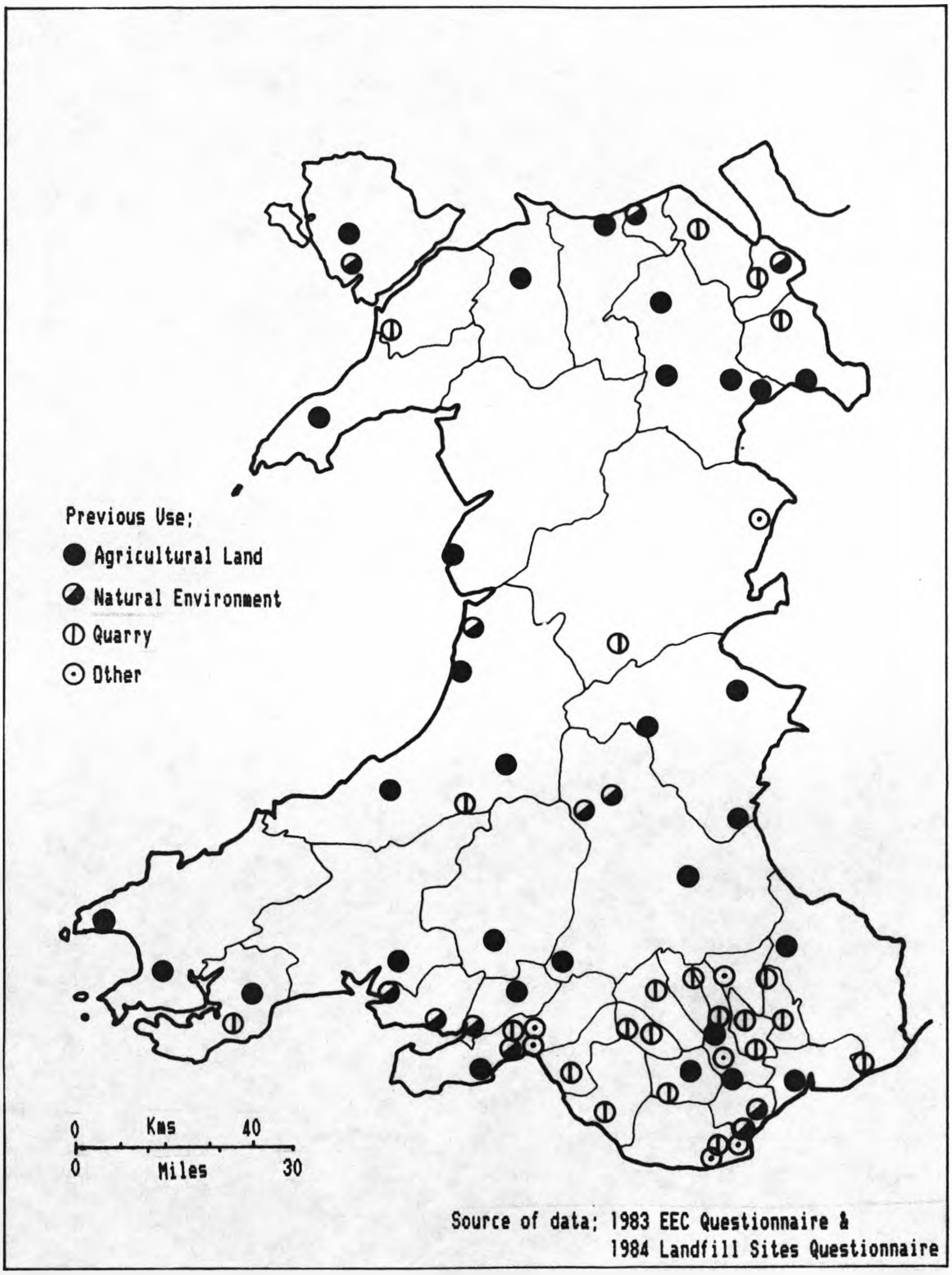


Table 6.6 Previous Land Use of Welsh Landfill Sites, By Region.

Land Use	North		Mid		South		Total	
	No	%	No	%	No	%	No	%
Agriculture	5	41,7	19	70,4	6	18,7	30	42
Natural	3	25,0	3	11,1	6	18,7	12	17
Sub-total; Unspoiled Sites	8	66,7	22	81,5	12	37,5	42	59
Quarry	4	33,3	4	14,8	14	43,7	22	31
Other	0	0,0	1	3,7	6	18,7	7	10
Sub-total; Derelict Sites	4	33,3	5	18,5	20	62,5	29	41
Total	12	100,0	27	100,0	32	100,0	71	100

Source; Based on data in Appendices 6,2 and 6,3, (1984 Questionnaire), for one type of site is unclear. Certainly, Mid Wales Districts have an abundance of agricultural land, making low-grade agricultural land more available for alternative uses than it would be elsewhere. In addition, such predominantly rural areas have few derelict sites other than quarries.

In contrast, approximately six out of every ten landfill sites in South Wales are located on land which is already derelict or disturbed. Here, disused quarries form the largest single previous use of landfill sites, with 'other' land uses, the second most common. These statistics reflect the degree of dereliction which has resulted from the region's long history of industrialisation, including periods of expansion and decline. Availability of derelict sites for waste disposal is probably greater in South Wales than elsewhere in the Principality with the result that 62.5% of landfill sites in the region are on derelict and/or disturbed land. The corresponding Mid Wales figure is 18.5%.

Only twelve sites have been located in North Wales. Five are on agricultural land, three on areas of natural environment and four in disused quarries. This is a small number from which to draw conclusions, although it does appear that the region has no strong tendencies towards any particular type of site, perhaps reflecting the mixed agricultural and industrial landscape which provides a range of site types.

6.4.9 Pollution Problems

Environmental degradation invariably occurs sooner or later as a result of poor site selection and management. This is most readily manifest in the contamination of watercourses by tip leachate. Another major problem is the build up of landfill gas, in particular, methane. By comparison more minor problems include infestation by rodents and insects, wind blown litter, scavenging birds and obnoxious odours.

Both the 1983 and 1984 questionnaires asked Districts to record pollution problems occurring at their landfill sites. In response, a total of twenty-three 'problem' sites were identified, (Table 6.7, Columns 4 and 5). Five sites were recorded for both 1983 and 1984, five for 1983 only and thirteen for 1984. Of the five sites recorded for 1983 only, one had closed by 1984, no data were available for two sites and a further two no longer recorded problems. Pollution problems were recorded at a total of eighteen sites in 1984. Five of these had been previously identified in 1983 and thirteen were new cases, six of these were sites which operated in 1983, but had not recorded any problems. No data were available for 1983 in a further six cases. The remaining site at Carmarthen, was a new site opened since 1983.

Landfill sites with pollution problems that give cause for concern are monitored by the Welsh Water Authority (WWA). Data from the WWA on landfill sites monitored in 1977-8 and 1983 have been obtained, (Welsh Water Authority, 1978 and 1983, Per.Com.). The data include all sites irrespective of whether they are WDA or private sites, current or disused, or the type of waste received. In 1977-78 the WWA monitored nineteen sites: of these nine are not considered further as one accepts non-domestic waste only and the remainder had

Table 6.7 WDA Landfill Sites with Recorded Pollution Problems

Site	WWA 1977-78	WWA 1983	Questionnaire 1983	Questionnaire 1984	Date (1984)	Previous Land Use
Abergele (Colwyn)	+	-	+	+	1982	AGRI
Gwersyllt (Wrex)	+	-	-	-	S/C	QUAR
Nantmel (Radnor)	+	+	+	-	1965*	AGRI
Rhydeinon (Cered)	+	+	+	+	1966	AGRI
Haverfordwest (Pre)	+	+	-	-	S/C	AGRI
Rhydfro (Lliw Val)	+	+	-	-	1976	AGRI
Clyne (Swansea)	+	+	+	-	1974p*	AGRI
Crymlyn (Swansea)	+	+	-	-	1974p*	QUAR
Tycanol (Brecknock)	+	+	-	-	1975	AGRI
Fforest Uchaf (Taff)	+	-	ND	+	1973	AGRI
Clegir Mawr (Ynys M)	-	+	+	+	1976	AGRI
Cilgwyn (Arfon)	-	+	+	-	1974	QUAR
Maesoglan (Dwyfor)	-	+	-	+	1951	AGRI
Cwrt y Carne (Lliw)	-	+	-	+	1972	NATE
Briton Ferry (Neath)	-	+	-	-	1964	OTHE
Cwmafan (Afan)	-	+	-	-	1970	QUAR
Gelligaer (Rhymn V)	-	+	-	+	1976	AGRI
Penarth Docks (VoGl)	-	+	-	-	1982	OTHE
Trinant (Islwyn)	-	+	-	-	1983	QUAR
Maesglas (Newport)	-	+	-	-	1960	AGRI
Tir John (Swansea)	-	-	+	-	1974p*	NATE
Silent V (Blaen G)	-	-	+	+	1981	OTHE
Llanfoist (Monmout)	-	-	+	+	1970p	AGRI
Wattsville (Islwyn)	-	-	+	-	1982	QUAR
Penhesgyn Gors (Yny)	-	-	-	+	1970	NATE
Etna (Alyn & Dee)	-	-	-	+	1978	QUAR
Bryn Posteg (Montg)	-	-	-	+	1982	QUAR
Carmarthen (Carm)	-	-	-	+	1984	AGRI
Wernddu (Dinefwr)	-	-	-	+	1982	AGRI
Llanharran (Taff)	-	-	-	+	1973	QUAR
Blaenavon (Torf)	-	-	-	+	1978	QUAR
Tirpentwys (Torf)	-	-	-	+	1972	QUAR
Rogiet (Monmouth)	-	-	-	+	1982	QUAR

+ = pollution present - = no pollution recorded ND = no data
* = 1983 data used

Source: 1983 and 1984 Questionnaires
Welsh Water Authority, 1978 and 1983.

either closed by 1983 or were not recorded in the questionnaire returns. Table 6.7, Column 1, shows those sites which were monitored in 1977-78 and still in operation in 1983.

Twenty-five sites were monitored in 1983, of which seventeen were current, WDA operated sites, (Table 6.7, Column 3). Comparison of Columns 2 and 3 shows that seven sites were monitored in both years; an indication that these were still causing concern five years later. Ten sites were monitored in 1983 for the first time. Over the two years for which WWA data are available, a total of twenty WDA sites in use in 1983, were monitored.

Analysis of the WWA data, together with data from the two questionnaires, shows that of the seventy-one WDA sites operating in 1983 and/or 1984, pollution problems were recorded at a total of thirty-three sites. This represents an alarming 46.5% of all WDA operated landfill sites. However, only one site, Rhydeinon in Ceredigion, was identified in all four data sets as having continual problems.

Comparison of WWA data for 1983 and the questionnaire returns for the same year, show corresponding records for only five out of a total of twenty-two sites, (Table 6.7, Columns 3 and 4). Five 'problem' sites identified in the questionnaire returns, were not monitored by the WWA. One possible explanation is that these sites may have experienced non-water related problems and, therefore, would not be monitored by the Water Authority. In the reverse situation, however, all sites monitored by the WWA should have been identified by the WDAs as problem sites. This was not the case for twelve sites. The Disposal Authorities concerned did not admit to the presence of problems at these sites in their questionnaire returns. Four of the sites, Haverfordwest (Preseli), Rhydfro (Lliw Valley), Crymlyn (Swansea) and Tycanol (Brecknock), were monitored by the WWA in both 1977-78 and 1983 and, therefore, had a history of pollution.

An investigation of the characteristics of sites experiencing water pollution problems, reveals some interesting findings. Of the twenty WDA sites monitored by the WWA in 1977-78 and/or 1983, twelve (60%) were located on agricultural land, five in disused quarries, two on other sites and one on a site of possible nature conservation interest.

Seven sites monitored in 1977-78, were still causing problems in 1983. These must be viewed as the more serious cases as they have continued to cause problems over a minimum period of six years. The most notable feature of these sites is that six are on agricultural land. Thus, although only 42% of Welsh landfill sites are on agricultural land, these comprise 86% of all long-term leachate problem sites in the Principality. The fact that sites on agricultural land are more prone to pollution, has obvious implications for landfill site selection, (Plates 1, 2 and 3).

6.5 The Impact of the Control of Pollution Act on Site Selection

To a certain extent, the current situation regarding landfill sites is one which has been inherited by the modern WDAs. Analysis of all

Plate 1.

Plate 1. Pre-1974 Landfill site, located in close proximity to a main water course.

Plate 2. Entrance to Wenfrwd Landfill Site Llangollen, Clwyd.

Plate. 3. Wenfrwd Landfill Site: Located on Agricultural Land,
Adjacent to the River Dee in the Vale of Llangollen.

currently operated sites may, therefore, give a false impression of present landfill site selection policy. A more accurate picture is presented by an analysis of those sites opened since the introduction of COPA, in 1974.

Examination of the Act, reveals a failure to include controls over site selection by WDAs. The responsibility of each WDA is laid down in Section 1 of COPA and has been described previously (p79). The Act is open to interpretation; it does not make it a statutory requirement for WDAs to undertake detailed, systematic investigations of all potential landfill sites in their area, or to give differential weighting to environmental criteria over economic considerations. Indeed, no mandatory criteria and little guidance are available to waste disposal authorities. The Department of Environment paper on the licensing of disposal sites (DoE 1976b) only provides hydrogeological guidelines for the selection of landfill sites, consequently site selection procedures vary amongst the WDAs.

COPA does, however, require consultation with the planning and water authorities to provide additional opinions and objections to a specific site. The effectiveness of these bodies in influencing site selection is limited; potential landfill sites being identified by the WDAs. The ability of consultees to influence WDA selection and changes in site selection policy since the introduction of COPA, may be revealed by a comparison of the characteristics of pre- and post-1974 landfill sites.

6.5.1 Changes in Site Type

Information on the opening dates of WDA landfill sites, categorised according to previous land use, is presented in Table 6.8. This indicates an apparent change in choice of site since 1974. Agricultural land constituted the most common type of pre-1974 site, being twice as numerous as either quarries or natural environment sites. However, since 1974 new sites have been fairly evenly split between agricultural land and disused quarries, with a threefold increase in the use of 'other' sites. The combined total for agricultural and natural environment sites, that is, unspoiled virgin sites, fell from 71% to 43% of the total sites selected.

The apparent change in landfill site selection policy must, however, be put in perspective. The thirty-two new sites selected since 1974 are representative of site selection in only twenty-four WDAs. Thus, the overall impact of COPA will only become apparent once all Welsh WDAs have selected new sites.

It should also be noted that of the twenty-four WDAs which have recently chosen new sites, eleven have chosen one or more sites on agricultural land or land with a possible nature conservation interest. For six of these, either no pre-1974 sites are currently operating or no data are available to make comparisons. However, five WDAs, (Ynys Mon, Radnor, Preseli, Brecknock and Lliw Valley), are currently operating pre-1974 sites which are also located on virgin land. In these cases, therefore, there is a continuation in the policy of selecting non-derelict sites. The Districts of Montgomery, Neath, and Torfaen, have maintained policies of

Table 6.8 Change in Type of Site Chosen Over Time

Date Opened	Agri		Nat En		Quarry		Other		Total	
	Previous Land Use									
Pre-1974	18	47%	9	24%	9	24%	2	5%	38	100%
Post-1974	12	37%	2	6%	13	41%	5	16%	32	100%
No Date	-	-	1	100%	-	-	-	-	1	100%
Total	30	42%	12	17%	22	31%	7	10%	71	100%

Table 6.9 Regional Differences in Site Selection Pre- and Post-1974

Site Type	Region: North Pre	North Post	Mid Pre	Mid Post	South Pre	South Post
Agriculture	3 (50%)	2 (33%)	12 (67%)	7 (78%)	2 (14%)	3 (18%)
Nat.Environ	3 (50%)	-	3 (17%)	-	4 (29%)	2 (12%)
Quarry	-	4 (67%)	2 (11%)	2 (22%)	7 (50%)	7 (41%)
Other	-	-	1 (5%)	-	1 (7%)	5 (29%)
Total	6 100%	6 100%	18 100%	9 100%	14 100%	17 100%

Table 6.10 Age of Landfill Sites: Pre-and Post-COPA

	Date Site Opened: Pre-1974		Post-1974		Date Unknown		Total	
Sites Causing Concern	10	50%	10	50%	-	0%	20	100%
All Welsh WDA Sites	38	54%	32	45%	1	1%	71	100%

reclaiming derelict sites by landfill, operating both pre- and post-1974 sites located on disturbed land.

A shift in policy can be detected in only three cases, Alyn and Deeside, Monmouth and Wrexham Maelor. Here, pre-1974 sites were located on virgin land, whilst derelict or disturbed land has been used for recent sites. In all other cases, no comparisons are possible due to the lack of data on pre-1974 sites.

Thirteen WDAs have not required new sites since the introduction of COPA. Nine of these are currently using one or more sites located on previously 'virgin' land. Based on the behaviour of other WDAs which have had to select sites recently, it is highly probable that a number of these will continue to select sites on virgin, unspoiled land. Of the remaining sites, one WDA, Rhuddlan, exports all waste arisings to a neighbouring authority, and only three WDAs have a history of using disturbed or derelict land.

Regional differences concerning choice of site are again evident. In Mid Wales, the ratio of sites on former agricultural land to those in quarries, is comparable for both pre- and post-1974; in percentage terms, the proportion of agricultural sites to all other site types actually increased by 11%. Site selection in South Wales reveals the percentage of derelict sites increasing from 57% to 70%. In North Wales data are available for only a small number of sites. However, four out of the six post-1974 sites selected, are in disused quarries. This represents quite a change from the pre-1974 situation, (Table 6.9).

6.5.2 Impact on Problem Sites

Analysis of the number of pre- and post-1974 sites with recorded pollution problems, may be used to assess the effectiveness of the consultation procedures introduced by the Act. Sites which are a threat to water courses and are monitored by the WWA, have been classified according to age. These are shown in Table 6.10. Whilst only 45% of the total landfill sites in operation during 1983/84 were post-1974 sites, these comprised 50% of all problem sites. In percentage terms , therefore, 31% of post-COPA sites experienced water-related problems, compared with 26% of pre-COPA sites. Notably, 60% of the post-1974 sites with pollution problems, were located on agricultural land, yet this site type constituted only 37% of sites.

6.5.3 Consultation Procedures

Analysis of sites with pollution problems and type of site selected, shows that COPA has failed to make any significant impact in terms of landfill site selection. Consultation procedures have not had the desired effect of providing a check on WDA site selection and consequently, inappropriate sites continue to be chosen.

In the main, this must be viewed as a failure of COPA, although other contributory factors can be identified. The site licensing provisions contained within COPA lay down a statutory consultation procedure, both for private and WDA operated sites. This has enabled the WWA to comment on the operational conditions suggested for inclusion in the licence or resolution, depending on whether it is a private or WDA operated site, and to indicate any neccessary additional conditions. The role of the WWA is, however, limited to sites which have already been identified by the WDAs as potential sites, rather than the Water Authority being involved in the initial search for potential sites.

Further inadequacies within the consultation system were reported by the WWA within less than a year of the implementation of the site licensing provisions of COPA, (WWA 1978). The WWA commented that:

> 'Despite the many months prior warning given by the early implementation of the procedure for site licensing and some advance publicity, the majority of the consultations from Waste Disposal Authorities were received in the last few weeks before the 14 June 1977 deadline, resulting in some disruption of other pollution control work and, occasionally, a need to request an extension of the normal consultation period.' (WWA 1978).

Although, the Disposal Authorities concerned are not identified by the WWA, it appears that last minute consultations were widespread throughout the Principality. The implication is, that in many instances a lack of organisation, or perhaps co-operation, on behalf of the WDAs obstructed the smooth running of the consultation procedure. The resultant time constraints imposed on consultees may make their task difficult, if not impossible. Certainly, the thoroughness of response would suffer, especially where the number of consultations requested is large.

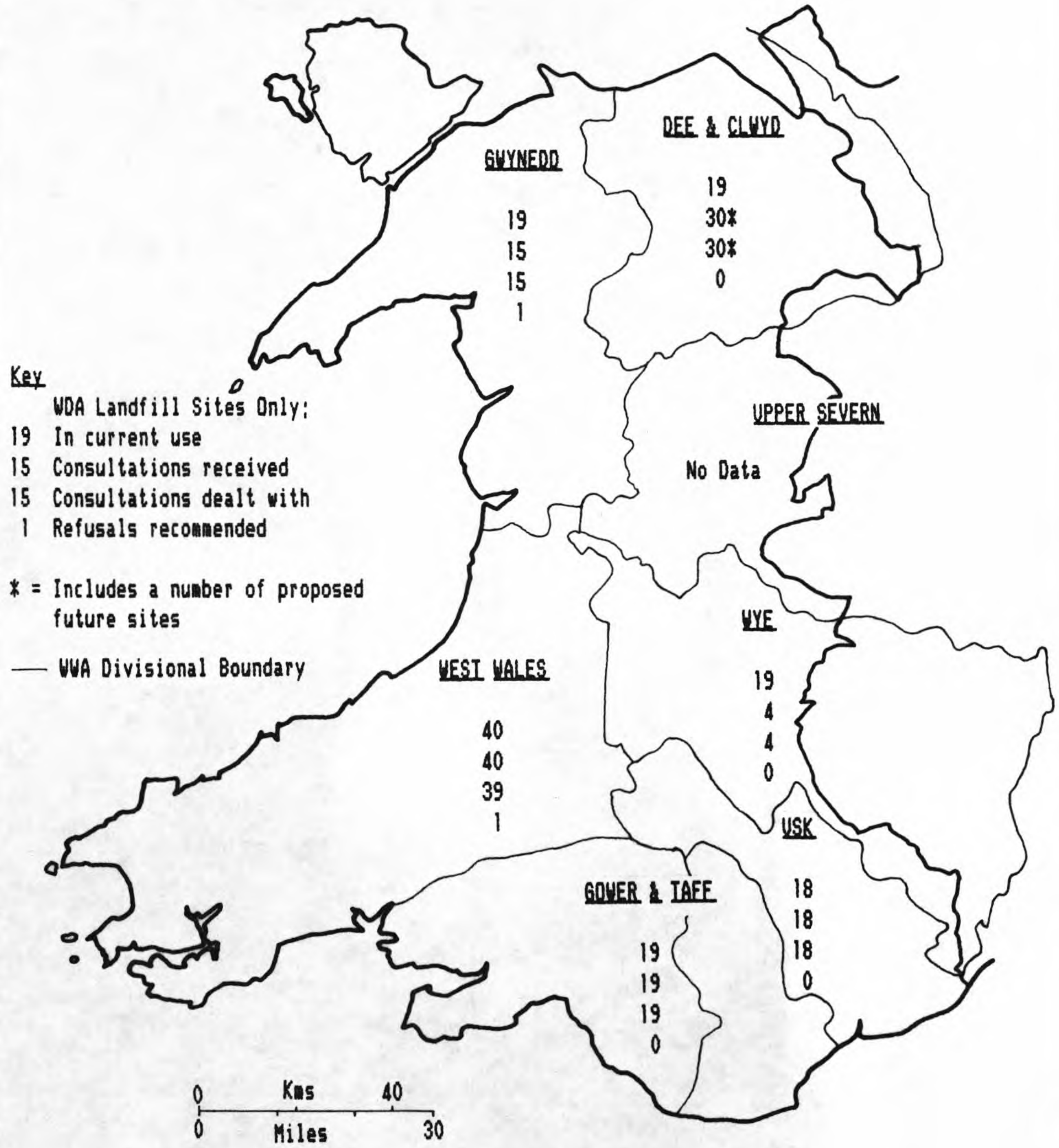
Figure 6.3 shows the number of consultations received by the WWA for Disposal Authority operated sites, between the implementation of the site licensing provisions in June 1977 and the end of that year. These have been classified according to the administrative divisions within the WWA. Comparison of the number of WDA sites identified within each area and those recorded for 1983/84 by the questionnaire (Figure 6.1), shows major discrepancies. No explanation can account for all of the differences, although the Dee and Clwyd and Wye Divisions cover areas of England and, therefore, include consultations regarding English WDA sites. Some differences may be due to the interval between the two data sets; Figures 6.3 and 6.1 refer to sites operating in 1977 and 1983/84 respectively.

In the Usk, West Wales, Gower and Taff Divisions, the number of consultations received and dealt with corresponds with the number of sites in current use. The Gwynedd and Wye Divisions, however, had not received consultations for four and fifteen WDA operated sites repectively, six months after the licensing deadline had passed.

The Dee and Clwyd Division is exceptional, in that it dealt with eleven consultations for proposed future sites, in addition to those for sites currently in operation. The increased ability of this Division to involve itself in site selection, must be seen as a consequence of the expertise present within its staff; the Division employed the only specialist hydrogeologist working for the WWA at that time[1]. This serves to demonstrate the need for more suitably

[1]. Since the restructuring of the WWA in 1984, the hydrogeologist previously employed by the Dee and Clwyd Division, is currently based with the newly created 'Northern Division'.

Figure 6.3. WWA Multi-Purpose Divisions in Wales: Consultations Received on the Licensing of Waste Disposal Sites.



Source of data: Welsh Water Authority, 'Water Quality Supplement', 1977-78.

qualified personnel in the Welsh Water Authority, a fact recognised by the Authority itself in 1978:

> 'Concern is still felt about the extent of hydrogeological expertise available within the Authority, particularly in view of the move, at national level, towards a 'dilute and disperse' policy on tip leachates.' (WWA 1978).

In conclusion, the introduction of the Control of Pollution Act, 1974, does not appear to have had any effect on site selection; this is not surprising since the Act failed to cover what is, in terms of environmental impact, by far the most important aspect of waste management. The Act relies on consultation procedures with other bodies to ensure good site selection, but this faith appears to be misplaced. The failure of Disposal Authorities to allow consultees, such as the WWA, adequate time in which to make assessments, can severly undermine the whole procedure. Shortage of expertise within the WWA itself, has also caused difficulties. Consequently, perhaps the most important aspect of site investigation, the hydrogeology, may receive inadequate attention. This is confirmed by the large number of post-1974 sites which are polluting local watercourses. Finally, the WWA has commented on the inadequacies of current legislation in preventing and alleviating pollution from landfill sites:

> 'The legislation now in force does nothing to alleviate pollution still emanating from sites (including certain notorious industrial waste disposal sites) where tipping has ceased, in some cases many years ago. Deficiencies in legal

powers, the often-delayed effects of tipping, problems in establishing who is responsible for the pollution and difficulties in treating strong and complex discharges still hinder progress in reducing this type of pollution.' (WWA 1978).

6.6 Landfill Site Selection and Nature Conservation: A Conflict of Interests

Waste disposal and conservation represent two land uses which, by the nature of their requirements, are often in direct competition with one another for sites; both being restricted to land of low economic value, located away from residential areas. This is particularly so in areas of high population density, where competition for space is intense. The Nature Conservancy Council (NCC) has identified two main areas of conflict between waste disposal and nature conservation. These are the impact on the geological interest of old quarries and on wildlife habitats, such as bogs and saltmarshes, chosen as sites for dumps, (NCC, 1981).

Waste disposal activities result in large-scale land disturbance, accompanied by leachate and methane gas production. These inevitably destroy the fauna and flora within the site itself and may produce harmful effects within a wide radius. In the majority of cases, therefore, no compromise is possible. Consequently, a choice has to be made, with both WDA and conservation body putting forward strong cases. Occasionally, such conflicts involve public inquiries and may only be resolved by the intervention of the Secretary of State for Wales. For example, in June 1980, Swansea

City Council was prevented from depositing waste over 32 hectares of Crymlyn Bog SSSI by the intervention of the Secretary of State, (NCC, 1981). In the majority of instances, however, either the site is of minor conservation interest and will not be defended by the NCC or is of major significance and afforded some protection by its designation as a Site of Special Scientific Interest (SSSI), National or Local Nature Reserve. It is the policy of the NCC not to defend minor sites, but to reserve its political influence for sites of major importance.

Two areas of investigation can be determined. First, sites where an initial conflict has been resolved. These are now in sole use as either waste disposal or nature conservation sites. Secondly, sites where there is a continual conflict of interests. These represent a compromise, where landfill sites have been located in close proximity to conservation areas. Consequently, problems may arise where fauna and flora are harmed and remedial action is required by the WDA and/or conservation body. Further conflict inevitably occurs when the WDA applies for a series of landfill site extensions which gradually encroach upon the conservation area. The long term security of the conservation area is, thus, under constant threat.

6.6.1 Single Use Sites

The extent of the conflict between waste disposal and nature conservation within Wales, is undocumented. However, it is hoped that by combining data on the previous use of landfill sites, together with information collected from the NCC on site consultations, that an assessment of the conflict which has occurred over current landfill sites can be made. This will indicate those sites where waste disposal has been given priority over conservation and sites where disposal and conservation are neighbouring land uses. Unfortunately, data on potential landfill sites considered by WDAs, but dismissed because of their significant conservation value, are not available. This would have indicated those cases where conservation interests have successfully taken precedence, without objections having to be made.

Investigation of the previous use of landfill sites (Section 6.4.8.), has shown that 17% of WDA sites operated in 1983/84 were located on former areas of natural vegetation. Such sites are of possible nature conservation interest, as they include wetland, wood, estuarine and coastal habitats. However, potential landfill sites which have an intrinsic nature conservation interest are not limited to these 'natural' sites. Other site types, such as disused quarries may, given time, develop interesting fauna and flora, as they undergo a series of plant successions. A botanical survey of derelict land in North Wales, in particular, mineral extraction sites, has revealed the significant nature conservation importance of such sites, (Day, 1979, and Day and Deadman, 1981). For example, over 200 species of plant have been recorded at a complex of disused limestone quarries and mines at Minera, near Wrexham, Clwyd. The site, which has 'an unusually abundant calcicolous flora including 17 species of orchids', has subsequently been designated an SSSI, (NCC, 1979). Indeed, many totally man-made habitats, as diverse as agricultural land, disused quarries and railway cuttings, can given time develop into a wildlife resource of considerable significance.

The importance of artificial ecosystems is increasingly realised by conservation bodies such as the NCC, (Ratcliffe, 1977).

Data on the previous use of current landfill sites may not, therefore, reveal the true conservation interest of such sites. Consequently, during 1984 a postal questionnaire was circulated to the NCC's Regional Officers in Wales, (Appendix 6.6). WDA operated landfill sites where identified within each NCC administrative area and Officers were asked whether the NCC had been consulted or had objected to the location of any site. Information regarding the particular conservation value or designation of a site was also requested.

Information received from the NCC on individual sites is shown in Figure 6.4. Unfortunately, no reply was received for Arfon District in the NCC's North Wales Region. However, this only affected one site. NCC information regarding the other seventy sites was as follows:

i) NCC not consulted for thirty-four sites

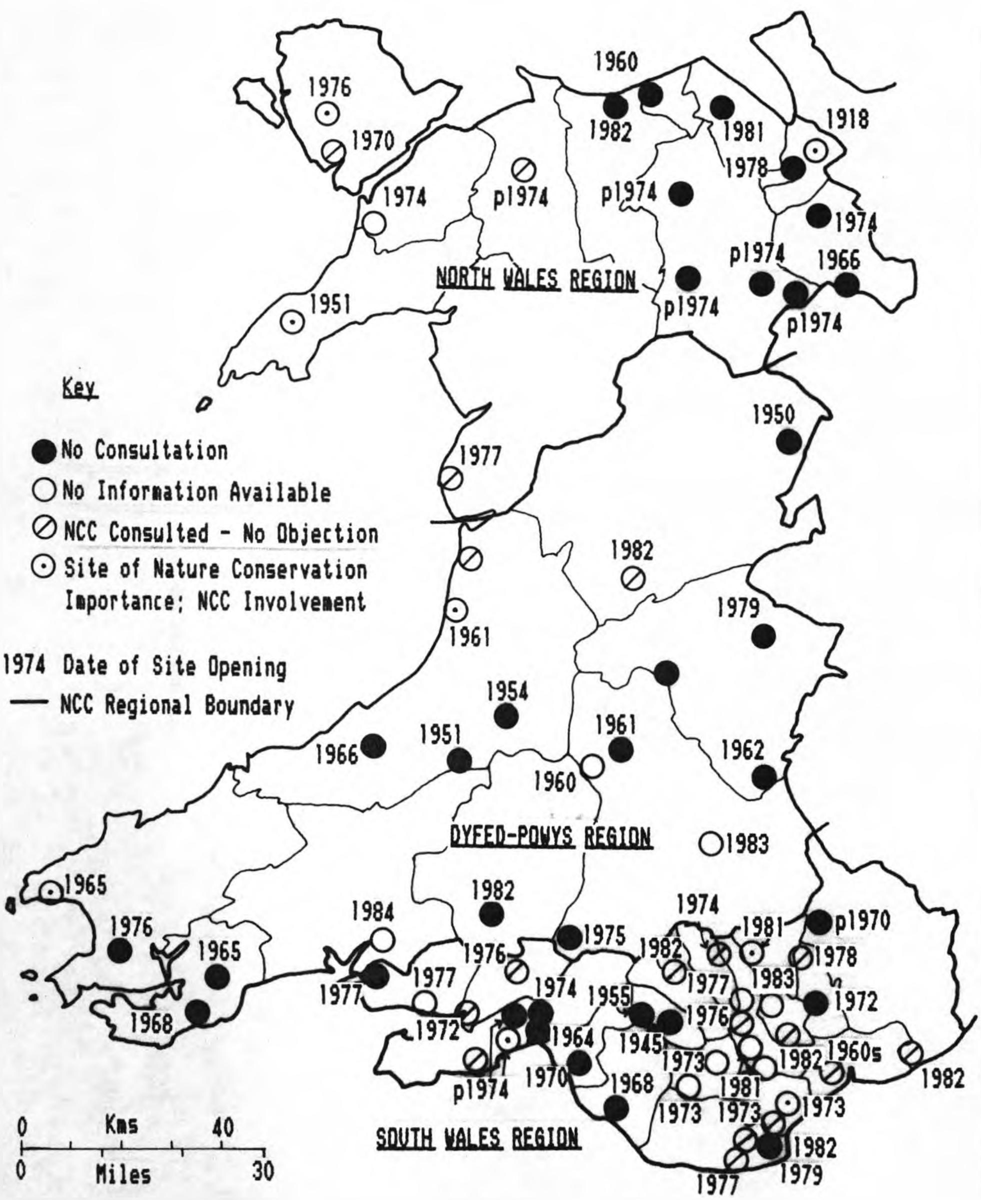
ii) NCC consulted and had no objections to eighteen ~~ten~~ sites

iii) No data available for ten sites

iv) NCC involvement continuing at eight sites, which are located in close proximity to SSSIs or Nature Reserves.

With the exception of the last eight sites, therefore, either no conflict has arisen or no data are available from which to draw conclusions. In many instances the NCC may not have been consulted or data may not be available, because disposal operations commenced

Figure 6.4. WDA Landfill Sites: Consultations Received By the Nature Conservancy Council.



Source of data; 1983 EEC Questionnaire &
1984 Landfill Sites Questionnaire
NCC Regional Officers, (Per. Com.).

prior to the establishment of NCC records[1]. For example, twenty-three of the thirty-four sites for which no consultation was received, were pre-1973 sites, whilst of the eighteen for which consultations were received, twelve were post-1973, five were pre-1973 and no date were available for the remaining site, (Figure 6.4).

It has been shown previously (p158) that the majority of Welsh landfill sites (53%) were in operation prior to 1974. Thus, the original conservation value of many older landfill sites may be unknown. The loss of valuable wildlife resources during the selection of most currently used landfill sites cannot, therefore, be assessed. However, since the introduction of the Control of Pollution Act, 1974, WDAs have a statutory obligation to consult the NCC regarding the conservation value of proposed landfill sites. Given an adequate consultation period, the NCC should, theoretically, be in a far better position to assess the value of proposed landfill sites.

6.6.2 Sites of Continuing Conflict

Landfill sites located in close proximity to important sites of conservation interest are, regardless of site age, well documented; four of the eight sites identified by the NCC for their conservation interest, are known to have been in operation by 1965, a further site was classed as 'pre-1974', and the remaining sites opened in 1973, 1976 and 1981, (Figure 6.4). The sites in question are:-

---

[1]. The Nature Conservancy Council, in its present form, was established under the Nature Conservancy Council Act, 1973.

i) St.David's, Preseli WDA

The original proposal from Preseli WDA, was for a site at Dowrog Common, a designated SSSI. Early consultation, however, led to alternative location at St. David's Airfield. Subsequently, both the tip and neighbouring heaths have also been designated. The NNC Officer responsible has commented,

> 'We would have opposed the St.David's site with hindsight.' (NCC, Per. Com., 1984a).

ii) Aberystwyth, Ceredigion WDA

Landfill site located very close to an important conservation site.

iii) Maesoglan, Dwyfor WDA

> 'This tip was established in 1949 at the north end of what is now recognised as a nationally important (in conservation terms) base-rich valley mire known as Cors Geirch SSSI.
>
> A recent application by the local authority to extend the tip onto adjacent sections of the valley mire was withdrawn following various objections, notably from NCC.' (NCC, Per. Com., 1984b).

iv) Clegir Mawr, Ynys Mon WDA

There was no NCC involvement when the tip was initially established. However, the NCC comments:

> 'Extensions to the refuse tip have recently been suggested, but not formally proposed, involving an isolated mesotrophic-mire which has recently been designated SSSI (Y Werthyr SSSI).' (NCC, Per. Com., 1984b).

v) Broken Bank, Alyn and Deeside WDA

This site has caused concern regarding its proximity to the Dee Estuary SSSI and the potential harmful effects of water pollution.

vi) Tir John, City of Swansea WDA

The fen surrounding the Tir John site, is an SSSI, part of which is a proposed National Nature Reserve. The tip is on the site of a former power station and was opened prior to NCC's establishment. The site is being monitored by NCC and consultations are proceeding regarding possible site extensions.

vii) Silent Valley, Blaenau Gwent WDA

The site is upstream of an SSSI, which is also a local nature reserve, managed by the Gwent Trust for Nature Conservation. Adjacent to the site, is the highest naturally occurring beechwood in Britain, (Blaenau Gwent Borough Council, 1985). NCC is involved in negotiations with the WDA concerning site extensions, pollution problems and improvements to the site boundary.

viii) Rhymney Moors (Lamby Way), City of Cardiff WDA.

The site borders an SSSI in the estuary of the River Rhymney. Consultations between the NCC and WDA regarding this site are ongoing.

The constant conflict which arises when waste disposal and nature conservation form neighbouring land uses, is illustrated by the above examples. Attempts by the WDAs to obtain site extensions and hence, increase the life expectancy of their landfill sites, appear to be the norm. In economic terms, this is a much cheaper option than moving to a new site. In the above examples, however, the case for nature conservation appears sufficient to resist WDA proposals.

Data from other sources, notably WDA waste disposal plans and NCC annual reports, reveal other cases where waste disposal and nature conservation have been or continue to be in conflict:-

a) The proposed site at Loughor Estuary, East of Penclawdd, Swansea, which is an area of European conservation significance, (Swansea City Council, 1985);

b) The proposed site at Margam Moors, adjacent to Kenfig Burrows SSSI, (Afan Borough Council, 1985);

c) Site extensions at Crymlyn Bog SSSI, Swansea, (NCC, 1981);

d) Site extension on to the raised bog SSSI at Gors Goch, Llanwllch, Carmarthen , (NCC, 1981);

e) Proposed site location at Dowrog Common SSSI, Preseli

f) Proposed site at Gors Gyfelog SSSI (Dwyfor). NCC have not had to object to a proposed site next to the SSSI, because investigations have revealed that the proposed landfill site is hydrologically isolated from the mire and its catchment.

g) Site extensions at Pant-y-Sais, Neath, where the fenland has been established as a Local Nature Reserve, (NCC, 1981),

and h) Proposals at Wern Ddu Claypits SSSI, near Caerphilly, Rhymney Valley, (NCC, 1981).

The majority of these cases have occurred in the industrial South, a fact acknowledged by the NCC;

> 'Waste Disposal presents a considerable problem in South Wales, which supports 65% of the population of the Principality and most of its industry within only 19% of its area.' (NCC, 1981).

Conflicts between nature conservation and waste disposal are unlikely to diminish in the future, as both land uses compete for the continually decreasing amount of open space available. This is particularly true for those Districts which are already highly industrialised and heavily populated. However, landfill site location may be equally as difficult in some rural Districts, especially those located within National Parks or areas of high landscape value, such as Areas of Outstanding Natural Beauty (AONB). The conflict between landscape conservation and disposal is discussed in more detail in the following section.

6.7 Landfill Site Selection and Landscape Conservation

A number of Welsh WDAs are restricted in their selection of landfill sites by the special protection afforded areas of high landscape value within their administrative boundaries. The degree of restriction imposed is dependent upon the type of protection or 'designation' and its areal extent. Designated areas of national importance include National Parks and Areas of Outstanding Natural Beauty (AONB). At a local scale 'Country Parks' and a range of 'Special Landscape Areas', have been established by many local planning authorities. The National Parks and all AONBs, together with those parts of the coast designated as Heritage Coast, are shown in Figure 6.5. In addition, where local authority landscape conservation areas have been identified within a District's waste disposal plan, these have been included.

The severest restrictions on landfill site selection, imposed as a consequence of landscape conservation, undoubtedly occur within the National Parks. This is due, in the main, to the quality of their landscape, which is nationally recognised, and to their areal extent. It is, therefore, intended to restrict analysis of the impact of landscape conservation areas on waste disposal, to National Parks only.

6.7.1 Waste Disposal Within National Parks

The Dower Report , 1945, defined a National Park as,

> 'An extensive area of beautiful and relatively wild country..',

one of the main objectives of designation being that

> 'the characteristic landscape beauty is strictly preserved..' (Dower, 1945).

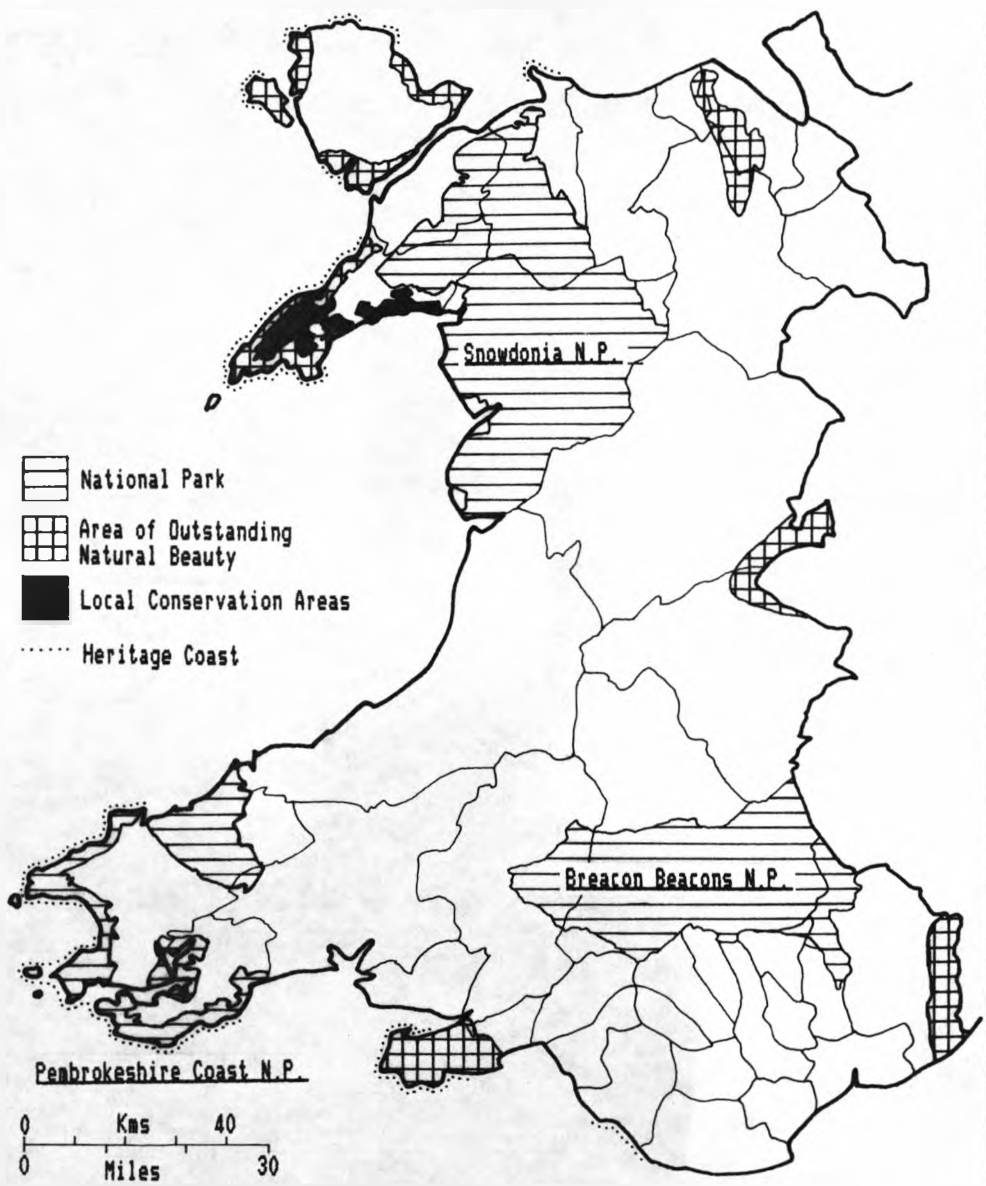
Subsequently, under the National Parks and Access to the Countryside Act, 1949, a total of ten National Parks were designated within England and Wales. Three, the Brecon Beacons, Snowdonia and Pembrokeshire Coast National Parks, lie within Wales. Snowdonia is Wales' largest National Park, covering some 212,000 hectares, followed by the Brecon Beacons, 134,000 ha and Pembrokeshire Coast National Park, with 58,350 hectares, (Gilg, 1978).

Figure 6.5 shows the location of the Parks and the WDAs affected by their designation. Clearly, some disposal authorities, such as Meirionnydd, Aberconwy, Arfon, South Pembrokeshire and Preseli, are severly restricted. Districts located on the margins of National Parks may be less affected. However, the presence of different types of protected area may combine to restrict landfill site selection, as in the case of Dwyfor.

National Park policy and policies contained within County and Local Structure Plans regarding landscape conservation areas, state a presumption against waste disposal within such areas. In practice, this does not totally prohibit landfill site location, but makes planning permission difficult to obtain and imposes tighter restrictions on site operations.

The problems this poses for WDAs can be clearly demonstrated in the case of the Pembrokeshire Coast National Park. Two WDAs, Preseli and South Pembrokeshire, are governed in their choice of landfill site by the policy of the National Park. For example, in

Figure 6.5. Landscape Conservation Areas in Wales.



Source of data: WDA Waste Disposal Plans response to Preseli's Draft Waste Disposal Plan, the National Park Officer stated:-

> 'The National Park Authority is fundamentally opposed to the use of any site within or adjacent to the National Park for landfill tipping.' (Preseli.D.C, 1985).

Both Districts feel that this policy is too severe:-

> 'The policy of the Park makes planning consent difficult to obtain, and greatly reduces the number of sites available for landfill and reclamation in the future.' (South Pembrokeshire District Council, 1985);

and 'Such a blanket policy is considered to be unreasonable and to place this Council in a particularly difficult situation in finding suitable sites.' (Preseli D.C., 1985).

A point made by both WDAs, is that waste arisings produced by the large number of visitors to the National Park, place an increased burden on the collection and disposal operations within the Districts. Under the circumstances, therefore, they feel that the policy of the National Park appears to be unfair:-

> 'This policy is particularly onerous since the Welsh Water Authority would prefer sites in locations where any effluent was discharged to tidal waters rather than inland water courses and also in view of the fact that the attraction of the National Park generates a considerable additional burden

of refuse for disposal during the Summer months and itself depends upon an effective refuse collection and disposal system.' (Preseli District Council, 1985).

This final point is also made in the South Pembrokeshire Plan:

'It appears to be of no significance that a major portion of the refuse generated in the District arises from areas within the National Park, particularly at the height of the tourist season.' (South Pembrokeshire D.C, 1985).

No figures are produced by either WDA, but statistics produced for Dwyfor, which is also subject to tourist pressure during the summer, suggest that the population increases from 26,000 to over 100,000, (Dwyfor D.C.,1985). Undoubtedly, waste management within such Districts has the additional burden of coping with large seasonal fluctuations in arisings.

A possible solution to the waste disposal problem has been suggested by the Pembrokeshire Coast National Park Authority. It has urged Preseli and South Pembrokeshire District Councils to investigate the feasibility of a joint scheme to dispose of wastes using alternative methods, including recycling schemes. (Preseli District Council, 1985). This solution has been considered by the WDAs and consequently, a new site at Rudbaxton, Preseli, will be used by both authorities in the near future. However, no alternative techniques will be introduced, because of the prohibitive cost involved.

Indeed, most WDAs restricted in their choice of landfill site selection by the presence of landscape conservation areas, have at some stage investigated the possibilities of alternative disposal techniques and/or the use of sites in neighbouring authorities. For the majority of Welsh WDAs, costs of transporting waste long distances for disposal or of the installation of incinerators or pulverisers are prohibitive. However, for these authorities, conditions imposed for sites located within conservation areas, such as engineering, monitoring, and screening, may be so expensive, that alternative solutions may become economical.

For example, the limitations on landfill site selection within Dwyfor WDA are tremendous. Conservation areas, including the Snowdonia National Park, AONBs and Landscape Conservation Areas, comprise 75% of the total area of the District, (Dwyfor D.C, 1985). Each of these categories covers approximately 25% of the total area, (Figure 6.5). In addition, there are thirty SSSIs within the WDA and ninety kilometres of coastline have been designated as 'Heritage Coast'. Inevitably, therefore, the District's current WDA site is located within a landscape conservation area, albeit the site was selected prior to the designation of the landscape area:

> 'Environmentally the site is well located, lying in a remote area within the shallow valley of the Cors Geirch, the bottom of which is flat and marshy in character. There are few habitable premises having a direct visual aspect of the site which is within a large area of the Llyn Peninsula now

designated as a landscape conservation area'. (Dwyfor District Council, 1985)

The site has sufficient capacity to last until 1987. No further site extensions are possible; the site is adjacent to an SSSI. The District has undertaken extensive surveys to identify a replacement site and has also investigated alternative methods of disposal. Transportation of waste for disposal in the neighbouring authorities of Arfon and Meirionnydd has been considered and carefully costed. This solution has been found to be uneconomical, (Dwyfor District Council, 1985).

Due to restrictions imposed on site selection, no site capable of accepting the large quantities of untreated waste, could be found. Consequently, the pre-treatment of waste to reduce its volume prior to disposal has been considered essential. This change in policy has enabled the WDA to select a smaller site outside the designated areas. The new site is a former sand and gravel quarry at Llwyn Isaf, Clynnog, which will have sufficient capacity, when combined with a pulverising plant, to dispose of the WDA's waste for the next fifteen years. The cost of disposal per tonne has been estimated at £15.06, (Dwyfor District Council, 1985). This represents the cheapest alternative and is indicative of disposal costs for WDAs within National Parks. The abnormally high landfill disposal costs for Meririonnydd, also constrained by National Park designation, have been shown earlier, (p110). By comparison, the national average cost of disposal per tonne, was £2.54 for 1984/85, (CIPFA, 1986b).

Districts which incorporate areas of National Park within their administrative boundary, consequently exhibit a very different spatial pattern of waste disposal. Landfill site location within designated areas, is the exception rather than the norm, due to the difficulty in obtaining planning permission and the strictness of site operations imposed. The absence of a suitable site outside the designated area, may necessitate the export of waste for disposal or the introduction of alternative disposal methods. As a result, costs of disposal are high irrespective of which solution is chosen and reflect the high environmental standards required within National Parks.

6.8 Other Considerations for Landfill Site Selection

Technological advances in site engineering, disposal techniques, pollution control and the ability to alter access routes, make waste disposal technically feasible at any given location. However, technology is expensive and beyond the resources of most Welsh WDAs, particularly the rural Districts with small populations and limited budgets. Indeed, it has been established previously (p91), that landfill remains the dominant method of disposal in Wales, because it is the cheapest alternative. The main objective of every WDA, is to be seen to manage waste collection and disposal at the lowest possible cost to the rate payer. In many respects, this is a situation imposed on the WDAs by the low priority accorded waste management in local authority budgets. All too often, waste disposal is treated as the 'Cinderella of Local Government', (Rhymney Valley D.C. 1985), particularly during economic recessions, when severe limitations are imposed on local authority spending.

Ultimately, therefore, the main consideration for site selection is cost. In the constant search for new sites, potential landfill sites may be rated according to the 'least cost' incurred by their development. Estimates for the total cost of developing each site must include both the initial capital outlay and running costs. Capital expenditure is required for site acquisition, site preparation and infrastructure, including site access, together with the final cost of site restoration. Running costs include site maintenance, monitoring and wages. However, two other major factors require careful investigation and may ultimately, be the decisive factors. These are transport costs between collection points and the disposal site, and site capacity. Potential sites must provide sufficient disposal capacity to make the necessary investment worthwhile.

6.8.1 Distance to Disposal and Transport Costs

> 'In assessing the cost of waste disposal account must be taken of the cost of waste collection as the two are interrelated. It is unrealistic to make economies in the costs of disposal when these are more than outweighed by additional costs of collection caused, for example, by excessive haulage costs.' (Newport B.C. 1984).

The need to reduce transport costs to an absolute minimum, is a theme common to all waste disposal plans. Waste, particularly domestic waste, is by nature both bulky and heavy and therefore, costly to transport over long distances. Thus, the cost of haulage is a substantial factor in landfill site selection. Sites which are near to centres of population, that is, centres of waste production, have an obvious advantage over more distant sites.

Table 6.11 shows the average haul to disposal recorded by WDAs over a five year period. Unfortunately, CIPFA ceased data collection on this variable after 1982/83 and no recent data are available from other sources. Over the five year period, the mean distance to disposal site, increased markedly from 8.9 to 13.0 km, indicating exhaustion of the most accessible sites.

Individual recordings range from 0.5 to 50 km, reflecting the diversity of transport arrangements required for waste disposal by WDAs. This is also indicative of the variation in expenditure required for transport. However, the reliability of the data provided by some Districts is questionnable. For example, four authorities, Alyn and Deeside, Islwyn, Rhymney Valley and Swansea, claimed an average distance to disposal as low as 2 km in 1978/79. In view of the size of the Districts, population distribution, landfill site locations and the figures recorded in subsequent years, the 1978/79 data for these four, are highly improbable.

Distances for some Districts have remained fairly consistent over the five years. For example, annual figures for Cardiff, Colwyn, Lliw Valley, Merthyr Tydfil, Rhuddlan, and Ynys Mon, have varied by only 1 km or less. This indicates continued use of the same disposal sites. Other authorities have recorded sudden changes in haulage distances, reflecting the use of new sites. Two examples are Monmouth and Vale of Glamorgan, where this has resulted in increased

Table 6.11 Average Haul to Disposal (Km)

District	1978/9	1979/0	1980/1	1981/2	1982/3	Mean
ABERCONWY	30,5	30,0	30,0	30,0	18,0	27,7
AFAN	ND	ND	ND	ND	16,0	16,0
ALYN & DEE	1,0	5,0	8,0	ND	7,0	5,2
ARFON	10,2	13,0	10,0	10,0	10,0	10,6
BLAENAU G.	8,0	ND	ND	8,0	9,0	8,3
BRECKNOCK	12,8	ND	6,0	8,0	8,0	8,7
CARDIFF	6,6	7,0	7,0	7,0	7,0	6,9
CARMARTHEN	12,9	16,0	20,0	20,0	20,0	17,8
CEREDIGION	5,0	15,0	15,0	16,0	16,0	13,4
COLWYN	11,0	11,0	11,0	12,0	12,0	11,4
CYNON VALL.	8,1	ND	16,0	16,0	14,0	13,5
DELYN	6,0	6,0	6,0	10,0	10,0	7,6
DINEFWR	ND	ND	40,0	40,0	ND	40,0
DWYFOR	17,7	15,0	-	15,0	15,0	15,7
GLYNDWR	8,6	ND	-	10,0	11,0	9,9
ISLWYN	0,7	-	4,0	4,0	4,0	3,2
LLANELLI	17,7	ND	19,0	19,0	19,0	18,7
LLIW VALLEY	9,3	9,0	9,0	9,0	9,0	9,1
MEIRIONNYDD	12,5	12,0	6,0	6,0	12,0	9,7
MERTHYR TYD	8,0	8,0	8,0	8,0	8,0	8,0
MONMOUTH	8,0	8,0	8,0	8,0	50,0	16,4
MONTGOMERY	ND	27,0	27,0	25,0	27,0	26,5
NEATH	6,3	10,0	10,0	10,0	10,0	9,3
NEWPORT	10,0	9,0	ND	6,0	6,0	7,7
OGWR	10,8	13,0	13,0	13,0	13,0	12,6
PRESELI	6,2	ND	10,0	10,0	10,0	9,0
RADNOR	10,0	12,0	16,0	16,0	20,0	14,8
RHONDDA	6,3	6,0	6,0	ND	8,0	6,6
RHUDDLAN	10,5	11,0	11,0	11,0	11,0	10,9
RHYMNEY VAL	0,5	9,0	ND	9,0	9,0	6,9
SOUTH PEMB	ND	ND	ND	12,0	16,0	14,0
SWANSEA	1,2	12,0	6,0	ND	6,0	6,3
TAFF-ELY	ND	ND	ND	ND	ND	ND
TORFAEN	4,0	4,0	4,0	ND	13,0	6,2
V.OF GLAM	8,9	8,0	8,0	16,0	17,0	11,6
WREXHAM	7,2	5,0	5,0	5,0	5,0	5,4
YNYS MON	9,9	10,0	10,0	10,0	10,0	10,0
Welsh Mean	8.9	11.2	12.0	12.9	13.0	

Source of data: CIPFA Waste Collection Reports, 1978/9 to 1982/83 haulage distances. In comparison, Aberconwy and Newport, have reduced their distance to disposal, but these are exceptions. The fluctuation in Distances recorded for Brecknock, Cynon Valley, Meirionnydd, Newport, Radnor and Swansea, may be indicative of temporary arrangements employed over a one or two year period.

Long haulage distances, in excess of 20 km, were recorded by Aberconwy, Carmarthen, Dinefwr, Monmouth , Montgomery and Radnor, for a period of at least one year. With the exception of Aberconwy, these are all located in Mid Wales and are characterised by small populations dispersed over large areas. Under these circumstances, haulage distances above the national average, are to be expected.

The mean haul to disposal for the whole five year period has been calculated for each authority, with the exception of Torfaen WDA which failed to produce any data, (Table 6.11). The highest mean figure, 40 km, was recorded for Dinefwr in Mid Wales. Distances in excess of 20 km, were also recorded by Aberconwy and Montgomery. The lowest figure reported, was 3.2 km for Islwyn WDA, in the South. No other District recorded a mean below 5 km, although seventeen reported figures of between 5 and 10 km.

Analysis of the five year average figures on a regional basis, reveals a predictable pattern. The shortest mean distance to disposal was recorded for South Wales, at 9.43 km. This region is characterised by small WDAs and high population densities, two factors which greatly reduce haulage distances between waste collection and disposal. By contrast, the mean for Mid Wales, 16.38 km, was 74% higher than in the South. The rural nature of these

Districts mitigates against short haulage distances. The mean figure for North Wales was 11.61 km.

Annual averages for the three regions provide a more detailed picture of recent trends. For example, average haulage distances in South Wales between 1978/9 and 1982/3 were 7.09, 8.64, 9.17, 10.42, and 10.50 km respectively, indicating a steady increase. A similar pattern is revealed for Mid Wales, with the exception of 1980/81, where average distances of 9.50, 15.00, 14.80, 15.54, and 19.00 km, were recorded. Mean distances of 11.55, 11.77, 11.37, 12.87, and 10.89 km, were recorded for North Wales. These fluctuations may be partly attributed to the effect of missing data; two WDAs failed to provide data, one in 1980/81 and the other in 1981/82. The absence of data for one or more WDAs, can considerably affect the calculated mean, if the WDAs concerned usually record an extreme value, either above or below the regional norm. Thus, annual figures should not be attributed with too great a degree of accuracy. Figures for South Wales in particular, are subject to the effects of missing data.

Data on distance to disposal serves as an indication of the proximity of landfill sites to centres of population, but does not necessarily reflect accurately the cost of transport to individual WDAs. The cost of transport per tonne is not only affected by haulage distance, but by many other factors such as the capacity and efficiency of the collection vehicle, for example, whether the vehicle is used to its full capacity and the efficiency with which the collection route has been planned.

Table 6.12 shows the cost of collection per tonne between 1978/9 and 1984/85. These figures are calculated by CIPFA, rather than submitted by the WDAs in their questionnaire returns. They are calculated using total gross expenditure and the number of tonnes collected. Consequently, they do not only reflect the efficiency of the transportation system employed, but are affected by different rates of expenditure on items such as employees, depots, the provision of dustbins and sacks, transport and moveable plant. The latter two items, however, incur the greatest expense in the majority of cases. In the absence of data specifically calculated for transportation alone, these provide an indication of the range of costs entailed for waste collection.

The Welsh mean, (Table 6.12), shows a general increase of approximately 25%, over the seven years. This trend is to be expected given increases in the cost of living, in particular, the price of petroleum. Thus, annual changes in the cost of collection are representative of a whole range of contributory factors, rather than just changes in haulage distance. Neither is it possible to isolate the contributions made by individual items of expenditure to changes in the overall cost. Comparisons between annual means cannot, therefore, be used to show changes in the cost of collection as a result of changes in landfill site location.

Despite these limitations, the data indicate different rates in the cost of collection incurred by individual WCAs. The calculated mean for the seven years, reveals only two authorities with costs per tonne of less than £10.00; these are Afan and Rhymney Valley, in South Wales. Indeed, of the ten authorities with rates below £15.00,

Table 6.12 Gross Cost of Collection per Tonne. (£)

District	1978/9	1979/0	1980/1	1981/2	1982/3	1983/4	1984/5	Mean
Aberconwy	21,87	21,72	25,57	19,37	20,60	41,78	44,88	27,97
Afan	ND	ND	ND	ND	4,34	5,38	5,41	5,04
Alyn & Deeside	25,01	16,48	17,40	ND	20,08	14,76	14,95	18,11
Arfon	14,59	14,05	20,75	21,41	ND	25,71	24,62	20,19
Blaenau Gwent	24,69	ND	ND	27,06	10,93	31,20	4,34	19,64
Brecknock	18,66	ND	22,96	6,05	13,33	36,28	43,16	23,41
Cardiff	19,62	19,93	20,64	23,08	23,64	21,42	21,23	21,37
Carmarthen	16,15	21,17	25,81	24,63	19,58	20,70	20,92	21,28
Ceredigion	12,95	15,71	19,62	18,30	20,10	17,86	21,59	18,02
Colwyn	13,46	15,49	17,67	17,81	19,35	16,80	ND	16,76
Cynon Valley	14,76	ND	22,30	25,70	26,60	27,67	27,01	24,01
Delyn	12,03	14,80	17,38	19,30	20,45	32,67	27,85	20,64
Dinefwr	ND	ND	13,27	10,10	ND	ND	13,94	12,44
Dwyfor	11,24	15,39	15,86	16,42	19,56	17,19	16,98	16,09
Glyndwr	22,14	ND	18,95	17,42	19,59	21,29	21,34	20,12
Islwyn	9,22	11,14	13,57	15,97	16,80	8,13	9,13	11,99
Llanelli	14,46	ND	19,94	19,51	ND	8,16	9,34	14,28
Lliw Valley	13,75	16,19	15,68	ND	13,12	13,35	14,49	14,43
Meirionnydd	12,70	12,54	19,45	23,91	25,24	ND	32,64	21,08
Merthyr Tydfil	9,14	10,95	12,18	11,89	13,67	11,92	12,70	11,78
Monmouth	21,58	24,31	26,34	32,80	31,88	36,80	28,46	28,88
Montgomery	ND	7,50	8,13	30,92	28,37	29,97	24,79	21,61
Neath	16,90	19,78	21,90	22,97	26,38	23,35	29,37	22,95
Newport	14,74	14,09	ND	13,20	13,45	14,56	14,02	14,01
Ogwr	16,72	29,71	23,03	22,50	23,72	25,13	26,04	23,84
Preseli	14,65	ND	18,03	21,28	19,62	19,29	ND	18,57
Radnor	19,97	21,24	43,92	28,00	19,58	ND	15,37	24,68
Rhondda	25,42	25,74	25,79	ND	18,84	24,66	33,65	25,68
Rhuddlan	12,32	14,99	18,74	20,71	22,87	22,56	21,79	19,14
Rhymney Valley	9,72	10,64	8,24	10,16	ND	5,88	8,88	8,92
South Pemb	ND	ND	ND	13,95	12,93	15,28	21,72	15,97
Swansea	14,37	13,42	14,66	ND	15,14	18,05	17,51	15,52
Taff-Ely	ND	9,21	10,73	ND	8,11	ND	13,10	10,29
Torfaen	6,99	8,21	9,68	ND	10,62	17,27	ND	10,55
Vale of Gl.	11,00	15,94	18,20	20,88	23,71	23,80	22,38	19,42
Wrexham	21,23	25,77	29,08	30,39	31,16	25,48	ND	27,18
Ynys Mon	14,42	19,87	22,52	22,74	25,02	25,21	23,31	21,87
Welsh Mean	15,83	16,64	19,33	20,28	19,34	21,20	20,81	18,59

ND = No Data

Source of data: CIPFA Waste Collection Statistics Reports 1978/9 to 1984/5
This variable was calculated by CIPFA based upon WCA expenditure and tonnage collected

nine are in South Wales. This region has the lowest overall mean of £16.10 per tonne, compared with North and Mid Wales, (£20.88 and £20.55 repectively). It has been shown previously, that Districts in South Wales have the shortest haulage distances and it is highly probable that there is a strong positive correlation between distance to disposal and cost of collection. However, the inclusion of other non-transport linked costs in the calculation of the cost of collection per tonne, has corrupted this data, making the outcome of any correlation analysis meaningless. Another influencing factor is that the South Wales authorities, which cater for much larger quantities of waste than elsewhere in the Principality, may be able to achieve economies of scale, which are not possible to the same extent in Mid and North Wales.

An alternative source of information on the role of transport costs in site selection, are the WDA waste disposal plans. In many instances, however, data are ommitted or are not comparable, having been calculated differently. Comments regarding the location of current sites and their proximity to main centres of waste production/population are made. For example, Colwyn Borough Council has commented on the proposed site at Llysfaen:-

> 'The location of the site is close to the optimum for transport costs in the collection of waste.'

and

> the site 'lies very close to the population weighted centre of the Borough.' (Colwyn B.C, 1984).

Similarly, Etna tip in Alyn and Deeside and the proposed tip at Penybont, Radnor, are claimed to be centrally placed for collection purposes. Many other potential sites identified during WDA surveys, are dismissed on the grounds of transport costs, whilst site selection criteria, where disclosed, usually include provision for minimising transportation costs. For example:-

> 'Landfill sites will be developed close to the main centre of population to minimise the overall cost of waste collection and disposal.' (Merthyr Tydfil B.C, 1985).

> 'Landfill sites local to centres of population have many advantages; they are the cheapest method of disposal when compared with the alternatives.' (Dinefwr B.C. 1985).

> 'Sites should be close to centres of waste arisings.' (Rhymney Valley D.C, 1985).

and

> 'when identifying potential disposal sites one has to consider the economics of transporting the waste to any particular location..' (Afan B.C., 1985)

The Welsh Office has encouraged inter-WDA co-operation in the disposal of waste, especially where a shortage of suitable landfill sites poses difficulties, (Welsh Office, 1985). Shared disposal sites are possible, where distances are not too great. For example, the Pwll Du site used by both Monmouth and Blaenau Gwent, straddles the boundary between the two WDAs. Although, some authorities are prepared to transport waste over slightly longer distances; the transportation of waste from South Pembrokeshire to Rudbaxton in Preseli, has been estimated to cost £62,500 per annum, equivalent to £3.78 per tonne. In extreme circumstances, WDAs faced with transporting waste over long distances, may introduce transfer stations, where waste can be transferred from collection vehicles into alternative transport which is more economical and better suited for long distance haulage. Many waste disposal plans reveal that WDAs have considered joint arrangements with neighbouring authorities and in some cases the use of transfer stations, but have discounted this possibility on the grounds of the excessive transportation costs involved, (South Pembrokeshire D.C., 1985), (Islwyn B.C., 1983), (Radnor D.C., 1985) and (Glyndwr D.C., 1985).

6.8.2 Site Capacity

Undoubtedly, one of the main criteria for landfill site selection, is site capacity. In simple economic terms, a site must have sufficient capacity to warrant the expenditure on its development. At what point a site becomes economically viable, is very much dependent upon the alternatives available to each WDA. Potential sites and alternative disposal techniques are carefully considered and costed. Consequently, the capacity of sites selected by different WDAs will vary greatly, but each WDA will aim to maximise its resources by obtaining sites with the greatest capacity available.

Site capacity may be calculated in terms of tonnage, cubic metres or even years. Using surveying techniques, cubic capacity can be readily calculated based on the size of void to be filled and the height above surface level to which tipping is permissible (Lynch, 1972); at some sites waste is deposited above the level of the surrounding land, so that the completed site is dome shaped. This technique extends the capacity of the site.

Computation of the cubic capacity of a site, enables the quantity of waste which may be deposited, to be calculated by the conversion of cubic metres into tonnes. The calculation requires a conversion factor for the amount of waste which occupies a cubic metre. No standard conversion rate can be used for all sites, however, as the amount of waste which occupies one cubic metre varies. The type of waste, pre-treatment prior to disposal, the addition of cover material and the method of disposal, in particular, compaction during disposal, all influence the density of waste within the site. Consequently, conversion factors should be selected for individual landfill sites according to the conditions of disposal employed; Appendix 6.7 shows some of the conversion rates used by Radnor District Council. Research has identified the probable densities of waste resulting from varying disposal methods and waste types; these are readily available to WDAs, (Wilson, 1981).

The lifespan of a site, in terms of the number of years it will remain in operation, is dependent upon its cubic capacity, the density at which waste is deposited and the tipping rate, that is, the number of tonnes disposed per annum. This calculation requires an accurate estimation of both waste density and the amount of waste disposed each year. The consequences if either of these figures should be inaccurate, are considerable. For example, a site of 1 million m^3 which receives 100,000 tonnes per annum, will have a lifespan of ten, six or five years depending on whether waste disposal densities of 1, 0.6 or 0.5 tonnes/m^3 are used. Alternatively, the same site used to dispose of waste at a density of 0.6 tonnes/m^3, but at tipping rates of 90,000, 100,000 and 110,000 tonnes p.a., would have a lifespan of six and a half years, six years and five years five months, respectively. Thus, inaccuracies in either variable, can have far-reaching implications for waste management, particularly if the lifespan of a site is overestimated and full capacity is reached before expected.

The capacity or lifespan of sites identified during the 1983 and 1984 questionnaires, have been discussed previously, (Section 6.4.7.), and summarised in Table 6.5. A total of 52.2% of the sites in operation, had a lifespan in excess of fifteen years, 25.3% between ten and fifteen years and 22.5% less than ten years. Further evidence of the minimum site capacity acceptable to individual WDAs, is present in the site selection criteria identified in waste disposal plans. For example:-

> 'Conclusions...b)That alternative site or sites be found in the district with a capacity of not less than 20 years (240,000 tonnes).' (Radnor.D.C., 1985).

> 'The basic criteria used for the subsequent assessment were:

i) Minimum volume available $300,000m^3$ which would be roughly equivalent to 6 years lifetime for the whole of Preseli or 10 years lifetime for the southern half of the District. This minimum working life is required to justify the acquisition and development costs.' (Preseli D.C. 1985).

A minimum capacity of ten years, is a standard requirement for landfill site selection in the majority of WDAs. The actual cubic capacity this requires has been shown to depend on the tipping rate and waste density. Obviously, WDAs with large waste arisings will require large sites in excess of two to three million cubic metres. For example, two WDA sites are currently used by Cardiff City Council. These have a combined capacity of 2,250,000 m^3 remaining, which should provide a mere seven and a half years tipping space for the authority's waste, (Cardiff.C.C, 1985.). By contrast, a site of only $770,000m^3$, will serve the northern area of Monmouth D.C. for nineteen years, at a tipping rate of 31,800 tonnes p.a.

In conclusion, site capacity or 'lifespan' is a major consideration for landfill site selection. Potential sites must have sufficient disposal capacity to warrant the necessary expenditure on infrastructure. The minimum capacity set by individual WDAs varies depending upon policy and the alternatives available. Economies of scale favour the selection of the largest site available, in order to maximise resources. In addition, the economics of transportation require site location to be as near as possible to sources of waste production. Thus, the process of site selection requires the cost-benefit analysis of these factors for each potential site. The most economical balance between transport costs and site capacity will determine the final choice.

6.9 Summary

Landfill site selection is the single most important aspect of waste management. The efficient, economical and environmentally sensitive disposal of waste, depends upon the correct choice of site in terms of site location, site type and capacity. Such a complex decision-making process requires reliable data on a wide range of variables, including the type and quantity of waste arising, the main centres of production, and many other parameters. However, the reliability of data on most aspects of waste, has been proven to be questionable, (Chapters 2 to 5).

The aim of this Chapter, has been to investigate the nature of the main landfill sites operated by the Welsh WDAs. It was hoped to assess variations in, and the adequacy of, site selection policy and to identify the constraints affecting site location. However, the dearth of published data on landfill sites in Wales, has resulted in only the most basic information being collected by postal questionnaire. Data from two questionnaires, has frequently proved to be contradictory for the most simple variables, such as site opening date and site size. This has obvious consequences for analysis.

Notwithstanding the deficiencies within the data, some conclusions can be made:-

a) WDA Landfill Site Characteristics:

i) There are (at least), seventy-one landfill sites operated by local authorities in Wales, for the disposal of domestic (and other) waste;

ii) All WDAs, with the exception of Rhuddlan WDA, operate one or more landfill sites;

iii) Most sites, forty-three (60.6%), are of less than 10 hectares in size; with seven less than 1 hectare;

iv) Only five sites, all in South Wales, received more than 100,000 tonnes of waste in 1983/84, whilst eleven sites disposed of less than 5,000 tonnes, (ten of these were located in Mid Wales and one in North Wales). There are, therefore, regional variations in the amount of waste disposed and hence, site capacity required;

v) Comparison between the amount of waste claimed in the questionnaire returns to be disposed at WDA sites, and that reported to CIPFA, has revealed differences in excess of 10,000 tonnes per annum for fourteen WDAs, (two were by more than 100,000 tonnes);

vi) Only seven (9.9%) of WDA operated sites accept toxic waste for disposal;

vii) Over 50% of current sites are pre-1974 sites, that is selected and opened prior to COPA;

viii) Almost one quarter (23%) of sites have a total lifespan of less than ten years. In contrast, only 6% were estimated to have a lifespan in excess of forty years;

ix) Forty-two sites (59%) are located on land which was previously virgin, unspoiled land. The most common previous use of landfill sites is agricultural land (42%);

x) Distinct regional variations are exhibited in terms of previous land use. In Mid Wales, 81.5% of all sites are located on agricultural or natural environment sites. By contrast, in South Wales, 62.5% of sites are located on derelict land,

xi) Almost half, (thirty-three), of the WDA operated sites have experienced some form of pollution problem; twenty of these recorded water pollution-related problems. Sites located on agricultural land, comprised 86% of all long-term leachate problem sites. Thus, there appears to be a strong relationship between site type and pollution problems.

b) The Impact of the Control of Pollution Act, 1974:

i) The introduction of COPA does not appear to have made any significant impact on type of site selected. Consequently, 50% of all 'problem' sites are those which have been opened since 1974;

ii) Consultation procedures introduced by COPA have frequently been made ineffective by WDAs not providing sufficient time for consultees to undertake adequate surveys;

iii) Although, the NCC has not been consulted with respect to thirty-four sites, the majority of these were in operation prior to the establishment of the NCC. A total of eight sites are presently subject to consultation between the NCC and the WDAs, due to their proximity to areas of significant nature conservation interest;

c) Additional Constraints on Site Selection:

i) Policies contained within local and county structure plans, may be restrictive, but only in terms of sites put forward for consultation, rather than initial site selection;

ii) Some authorities, notably, Dwyfor, Meirionnydd, Brecknock, Radnor, Preseli and South Pembrokeshire, are considerably restricted in their search for sites, by the designation of large areas for landscape conservation. In particular, they are constrained by the policies of the National Park Authorities. Consequently, disposal costs are high, reflecting the need for pre-treatment, or the costly transportation of waste for disposal elsewhere;

iii) Minimising haulage distances and, therefore, transport costs, are a major consideration in landfill site selection. Average haulage distances, exhibit regional patterns; the shortest, (9.43km), being recorded by the South Wales region. In contrast, the mean for Mid Wales was 16.38km, reflecting the larger size of the WDAs and more dispersed populations;

iv) On the whole, haulage distances increased during the five year period studied. This may reflect the exhaustion of landfill sites nearest to the centres of population;

v) The cost of waste collection increased by 25%, between 1978/9 and 1984/85. Regional variations are again, evident. Nine of the ten WDAs recording the lowest costs of collection, are in South Wales. This is probably a reflection of the shorter haulage distances for these WDAs, but the data are insufficient to substantiate this theory;

vi) Despite central government encouragement to establish joint disposal facilities in order to alleviate some of the problems experienced, little headway has been made. Given the often prohibitive costs of transport, the possibilities for joint disposal schemes appear minimal,

and vii) A main concern of site selection, is the size of site acceptable. A minimum size (capacity) is required for a site to be financially viable and ideally, the search for sites will be restricted to potential sites which exceed this threshold. Accurate data on current and future waste arisings, tipping rates and densities, are vital in the calculation of site capacity, both for estimating the capacity of current and future sites. Inaccurate and unreliable data will inevitably result in over- or underestimation of capacity, with serious consequences.

The final conclusion above (c vii), stresses the need for reliable data in strategic planning and the selection of landfill sites. The use of unreliable data, is most readily manifest as poor landfill sites, chosen to meet short-term requirements during crisis-situations, when a shortage of landfill capacity has occurred. Undoubtedly, such crisis-situations have arisen in a number of WDAs in the past, as evidenced by sites with a short lifespan, (a small capacity in relation to the WDA's needs), and severe pollution problems. Indeed, an analysis of the estimated lifespan remaining in WDA landfill sites, has revealed this may be the case in a number of authorities at present. Given the data deficiencies which have been revealed in Part I, this situation is to be expected; the findings summarised in section 'a' above, are the direct consequence of a long history of inadequate data collection by the majority of Welsh WDAs and apparent inability of central government to intervene.

CHAPTER 7

7. SUMMARY OF CURRENT DATA BASE INADEQUACIES & THE IMPLICATIONS FOR POLICY

Chapters 1 to 6 comprise a critical review of the current state of waste management in Wales. The findings are at best disappointing; deficiencies within the data base being numerous. This chapter attempts to summarise all the weaknesses identified, both within the data base and within the current administrative and legislative frameworks. The aims of the chapter are threefold:-

i) to summarise all weaknesses identified in the first six chapters;

ii) to speculate why they have occurred,

and

iii) to assess the implications for policy.

7.1 Weaknesses within the data base

Analysis of the numerous data sets on waste disposal and collection, reveals similarities in the nature of the deficiencies within the data. These may be readily divided into seven main types of deficiency :-

i) Incomplete data sets.

Perhaps the main obstacle to analysis, is the absence of data either for an individual District or for a particular data set. This is due to the lack of co-operation from certain Districts for one or more years, when they have failed to provide any data. In some cases, however, a questionnaire has been returned, but has not been fully completed. Consequently, missing data inhibits analysis of trends over time and comparison of values between Districts.

ii) Data estimation.

Section 3.4 showed that few WDAs weigh the waste arising and/or disposed within their area. The highest number of authorities which weighed, a) the waste collected and b) waste disposed, in any one year, was fifteen and seventeen respectively, in 1984/85. Few of these weighed a very large proportion of the total waste arising. Thus, most authorities rely upon estimates, based on counting lorries or numbers of sacks. These methods are subject to inaccuracies, as lorries and sacks do not contain a constant amount of waste, either in terms of volume or weight.

iii) Use of different classifications.

Comparison of data from different sources is often prohibited by the use of different classifications for waste. The lack of a uniform system of waste classification, both by WDAs and by data collection agencies, has been shown in Section 4.2 and illustrated in Figure 4.2. Data produced using different classifications are, for the most part, not comparable, as different types of waste are included or excluded from certain categories depending on the classification used. This restricts the synthesis of data sets from different sources for analysis; a particular disadvantage in the Welsh context, as there are little data available.

iv) Use of different units of measurement.

The use of different units of measurement impedes, but does not prevent data comparisons. Obviously, where a mixture of imperial and metric measurements are used, these can be standardised to metric units. The use of a standard metric system of measurement by all WDAs would, however, be a logical solution to the problem.

v) Use of data recorded on different timescales.

Some parameters are either not recorded on a regular basis, or are recorded at intervals which differ from District to District. Consequently, the resultant data are not strictly comparable as they relate to different periods.

vi) Change in variable recorded over time.

Some variables recorded by CIPFA have, after a number of years, been changed or discontinued. For example, average haul to disposal was recorded for the first five years only, being discontinued after 1982/83. This variable was a useful indicator of the location of landfill sites; increasing haulage distance suggests that landfill sites located nearest to the main centres of population have been exhausted.

Further difficulty arises when variables are changed. For example, the variable 'percentage of waste collected by type' was initially divided into four categories: bulky household waste, normal household waste, commercial waste and industrial waste. After the first two years, the categories bulky and normal household waste were amalgamated. Such discontinuity, or alteration to variables, prevents the analysis of trends over time.

vii) Selection of variables for measurement.

The variables for which data are available, do not always provide the information required. For example, most data collected by CIPFA relate to the costs of waste collection and disposal, rather than the environmental impact. Thus, the data base is deficient with respect to certain parameters.

The consequences (of such inadequacies in the data base) for the analysis of waste collection and disposal, are very much dependent upon the method of analysis used. Data analysis may take two forms. First, a particular variable may be singled out for investigation or secondly, a specific area/authority may be selected. Weaknesses in the data affect these two methods of study differently. For example, the analysis of a specific variable would probably include an investigation at regional or national levels. This would require a comparison of data from different authorities. Thus, incompatible data, resulting from the use of different waste classifications and different intervals of recording, would seriously affect inter-authority analysis. The study of a specific authority would not, however, be affected in this way. Figure 7.1 illustrates the way in which data inadequacies affect these two methods of analysis.

A summary of the data inadequacies inherent in the main data sets used in Chapters 1 to 6, is presented in Figure 7.2. The figure includes both published data sets, such as those produced by CIPFA, and data collected specifically for this study. The two main deficiencies common to most data sets are those of missing data and data estimation. Finally, no variable or data set is without some form of deficiency.

Figure 7.1. Data Base Inadequacies and Their Impact on Data Analysis.

DATA WEAKNESSES

	Missing Data	Data Estimation	Different Units of Measurement	Different Intervals in Data Recording	Change in Variable Definition Over Time	Variable Not Recorded	Different Classification
Variable Analysis	✓	✓	✓	✓	✓	✓	✓
Areal Analysis;							
i) Individual WDA	✓	✓			✓	✓	
ii)Groups of WDAS	✓	✓	✓	✓	✓	✓	✓

Figure 7.2. The Main Variables and Weaknesses in Their Data Sets.

DATA WEAKNESSES

	VARIABLES	Missing Data	Data Estimation	Different Units of Measurement	Different Intervals in Data Recording	Change in Variable Definition Over Time	Variable Not Recorded	Different Classification
A	Total Waste Arisings	✓	✓					
A	Waste Arisings per Head of Population	✓	✓					
A	Different Types of Waste Arising	✓	✓	✓	✓	✓		✓
A	Toxic Waste Arising	✓	✓	✓	✓	✓		✓
D	Total Waste Disposed	✓	✓					
D	Amount disposed to Landfill	✓	✓					
D	Amount Disposed of by Other Methods	✓	✓					
D	Amount of Waste Exported & Imported	✓	✓					
L	Haulage Distance	✓	✓			✓		
L	E.I. of Disposal	✓					✓	
L	Landfill Site Characteristics	✓		✓				✓
L	Future Landfill Site Capacity		✓	✓	✓			

A = Variables for Waste Arisings
D = Variables for Waste disposed
L = Variables for Landfill Sites

E.I. = Environmental Impact

7.2 Explanations for Deficient Data

Data inadequacies are a consequence of a variety of causal factors, some of which work in isolation, whilst others have a cumulative effect. An investigation of the causal factors involved, reveals that a hierarchy of cause and effect relationships is at work. These are illustrated in Figure 7.3.

The figure shows that the data deficiencies identified in Section 7.1., can be broadly summarised into two groups based on data availability. In the first case, data are available, but are deficient in some respect. These deficiencies are further sub-divided into two categories:-

i) Deficiencies related to the monitoring and recording of waste by Waste Disposal Authorities:

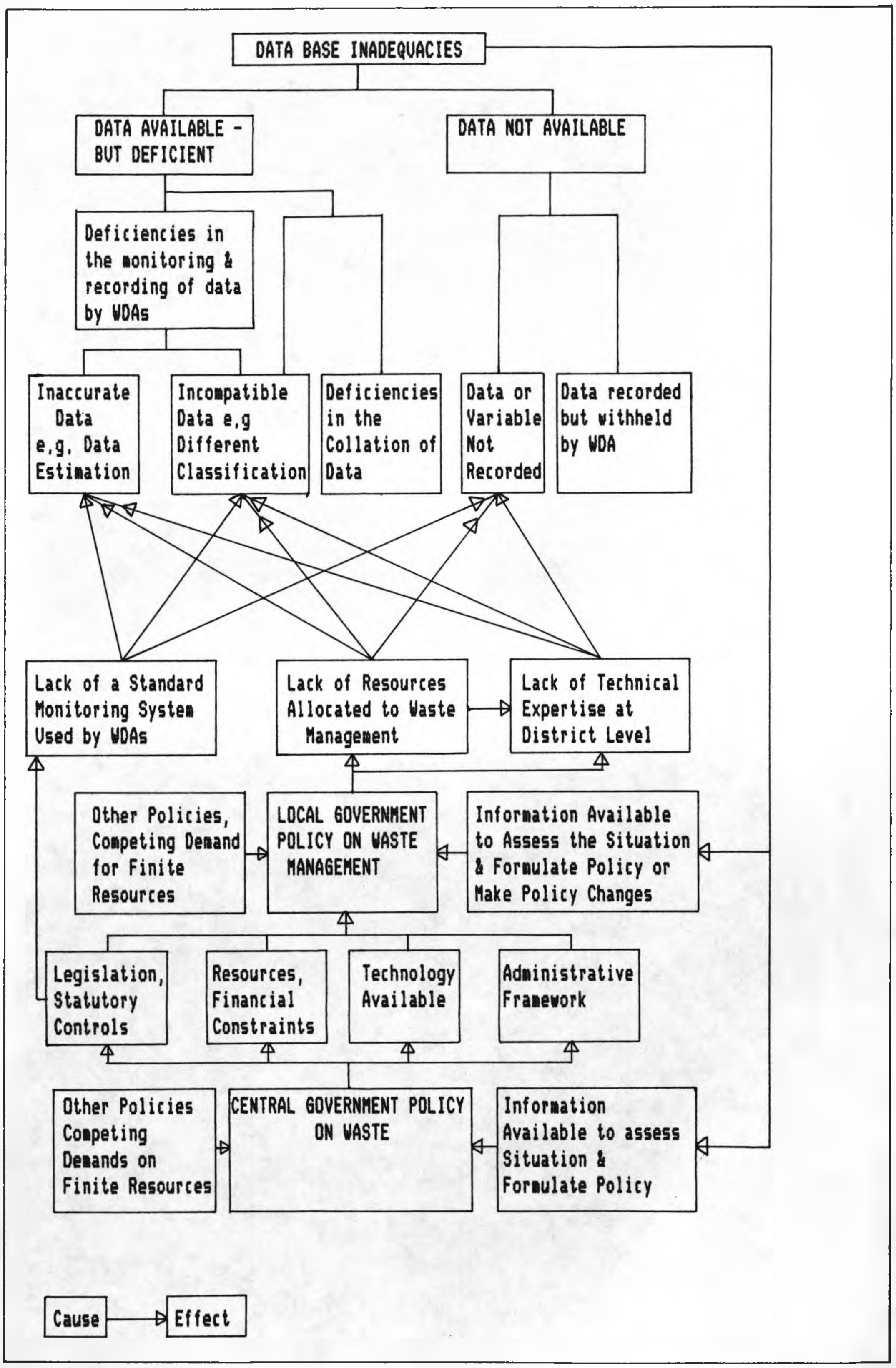
a) inaccurate data, such as estimated data;

b) incompatible data, as a result of variations in the data collection techniques employed by different WDAs, e.g the use of different waste classifications or intervals between the recording of data;

ii) Deficiencies related to data collection and collation by Data Collection Bodies, e.g discontinuity of compatible data may occur as a result of changes made to the definition of a variable.

The second group of deficiencies in the data base occur when data are not available. This group also contains two subdivisions:-

Figure 7.3. Conceptual Structure of the Cause and Effect Relationships Between Data Inadequacies and Government Policy.



i)Data are unavailable, because a variable is not recorded;

ii)Data are unavailable, because they have been withheld from the data collection body. Often data collection bodies, such as CIPFA, rely upon the goodwill of WDAs to supply the data requested. WDAs are under no obligation to provide information, with the exception of offical government surveys and even so, the degree of co-operation may vary. Often, non-co-operation is interpreted as a means of concealing incompetence, that is, the data requested may not have been recorded or are deficient in some respect and have not, therefore, been supplied. In the circumstances, the validity of such theories can not be tested.

The lower part of Figure 7.3 shows a series of cause and effect relationships which combine to produce the various deficiencies previously identified in the data base. The first tier in the chain shows the three immediate causes of deficient data:

i) a lack of resources,
ii) a lack of technical expertise
and iii) the absence of a standard monitoring system.

The dominant causal factor, in the opinion of the author, is the lack of resources allocated to waste management by local authorities. Support for this view is contained within the published data and has also been disclosed during discussions with Waste Disposal Officers. Frequently, waste management is afforded a low priority and consequently, the financial budget allocated may only cover the most basic needs of waste collection and disposal, with monitoring and data recording low on the list. In these circumstances, equipment necessary for monitoring various parameters, (for example weighbridges vital for the recording of weight data), may be totally lacking.

Inadequate finance also has implications for staffing levels, both in terms of numbers and technical expertise. Thus, authorities may be deficient in manpower and expertise for the monitoring of some or many parameters. This is reflected by the range of qualifications held by Officers in charge; few have qualifications specific to waste management.

These two causal factors are determined by the policies of individual local authorities. Their impact will vary from District to District depending on the priority and amount of resources allocated to waste management. Thus, while some Districts will produce good data, others will be deficient in this respect. Local authority policy is, therefore, a second tier or secondary causal factor.

The formulation of local government policy for waste management, is itself the product of three groups of factors. First, policy on waste is not considered in isolation, but is relative to the policies and requirements of other areas of local government responsibility, such as housing; these are in direct competition for the finite resources available. Secondly, policy can only be formulated given the information which is available. The impact of a specific policy may only be appraised given adequate quantitative and qualitative trend data, showing the situation prior to and after the implementation of the policy. However, if the data are not available to indicate whether the policy is having the desired effect, then it is likely that the status quo will remain. This negative feedback only acts to perpetuate the current state of affairs.

The third group of factors determining local government policy are the constraints imposed on local government by central government. Thus, central government policy acts as a third tier or tertiary causal factor in the heirarchy of cause and effect relationships affecting data adequacy.

Central government policy on waste is reflected in four main areas:-

a) legislation on waste, such as the Control of Pollution Act, 1974;
b) resource allocation, both in terms of the financial constraints imposed on local government in general and in terms of its own budget for research on waste related topics, administration and monitoring the effectiveness of local government;
c) the level of technology available. Technological advances are likely to be directly related to government spending on research,
d) the administrative framework, that is, the location of responsibility for waste collection and disposal. Under the current framework, it is the District Councils in Wales which are responsible for the administration of waste collection and disposal, rather than the County Councils.

The formulation of central government policy on waste, like that of local authorities, is greatly influenced by two main factors. The first of these, is the relative importance with which waste management is viewed in relation to other demands on resources. The second influential factor is that of the information available upon which to base decisions. Both the evaluation of current policy and the assessment of the type of policy changes required, are dependent upon the data available. Thus, the lack of adequate data once again, works as a negative feedback loop within the system, serving to maintain the current situation.

Data are vital to policy appraisal, the formulation of new policy and subsequently, legislation. Yet, central government continues to implement policy and allocate resources based upon information which has been shown to be both inaccurate and inadequate.

Although, some WDAs may produce reliable data, the requirement is for a uniform system of data collection by all local authorities throughout the Principality. The introduction of such a system is only possible if implemented by central government. Figure 7.3 shows that the lack of such a standard monitoring system is a primary causal factor in the production of inaccurate and inadequate data. This is a direct consequence of central government policy and the need, therfore, is for central government to initiate a system of data collection.

At a superficial level, the production of inadequate data by local authorities appears to be indicative of incompetence and an inability to discharge their responsibilites effectively. However, closer examination reveals that although there may be some truth in this, the situation is the result of factors outside their control. A great deal of the blame must be apportioned to central government policy and it is here that the solution to the problem also lies.

Although it is diff_icult to foresee any major changes in the financial constraints on waste management, the implementation of a standard sytem of monitoring and data collection would have major advantages. Both central and local governments would benefit from the app_raisal of their respective policies. The aims of such policy being to achieve the highest level of good waste management practice possible within the financial constraints imposed.

PART II DATA REQUIREMENTS FOR GOOD WASTE MANAGEMENT

CHAPTER 8

8. BEST PRACTICE AND DATA REQUIREMENTS

8.1 The Objectives of Good Waste Management

The objectives of waste management within each WDA are clearly set out in their respective waste disposal plans. Although the contents of the plans vary in detail, most follow the structure suggested in the DoE guidelines on the preparation of a waste disposal plan (DoE 1976c). Consequently, the objectives specified in the guidelines have been adopted by most authorities. Often these are presented as the overall objectives, with more specific targets added. Some examples are shown in Appendix 8.1.

The government guidelines suggest that:-

> 'The overall objective of a waste disposal strategy is the disposal of waste at the least possible cost to the community with due regard to the safeguarding of the environment and the use of waste as a resource.' (DoE 1976c p2)

Thus, all WDAs are required to undertake their statutory duty using the best practicable means available within the financial and environmental constraints imposed. Notwithstanding the very real differences in the constraints experienced by individual WDAs, there is scope for the introduction of a system of best practice, both in terms of procedures and data collection. The ultimate aim of such a system is twofold. First, to raise the level of waste management within individual WDAs and secondly, to standardise practices throughout the Principality. To be effective, the implementation of such a system would have to be uniform, ensuring the standardisation of good practice and data collection. This would enable both local and central government to assess whether their respective policy objectives are being realised. In effect, 'best practice' is essential to good waste management and will inevitably result in higher standards.

8.2 <u>Best Practice</u>

Best practice comprises the technical and administrative procedures which collectively constitute good waste management practice. These may be viewed as an aid to good waste management and are applicable to five aspects of management:-

i)administration;

ii)waste arisings;

iii)waste disposal;

iv)landfill site selection,

and v)strategic planning .

With the exception of 'administration', it is intended to limit the investigation of best practice to data collection requirements rather than the various procedures involved. Categories ii to v, in particular, involve the use of highly technical procedures such as hydro-geological investigations and landfill site engineering, outside the scope of this study. The production of good data, however, has proved essential in the appraisal of both local and central government policy. In turn, policy appraisal is not a finite process, but the precursor of changes in practice, leading ultimately and hopefully, to higher standards of waste management and monitoring. Thus, improvements in data collection may initiate a chain of events having a positive feedback effect.

8.2.1 Administration and Best Practice

The absence of a uniform administrative and management structure for waste was identified in Section 2.1. It was shown that under current British legislation, the waste disposal authorities in England are the County Councils, whilst the collection authorities are the District Councils; in Scotland and Wales the District Councils are responsible for both functions.

The transfer of responsibility for waste disposal from the District Councils to the Welsh Counties would undoubtedly bring many advantages:-

i) Cost-effectiveness would be achieved through economies of scale. For example, a large number of landfill sites are currently in use, each with its own equipment and infrastructure. However, this duplication of equipment and infrastructure would not be necessary if only one or two main landfill sites served a whole County;

ii) The larger resource base of the Counties would enable the purchase of expensive plant and equipment, currently beyond the budgets of most Districts. Alternative methods of disposal, including recycling, may become viable on a County basis;

iii) Landfill site selection would benefit from the larger number of sites to choose from. The optimum use of landfill sites, together with higher standards of site management and monitoring, would reduce the environmental impact of waste disposal;

iv) Staffing levels could be improved by a greater efficiency of manpower, with fewer staff required to maintain just one or two large landfill sites;

v) County Councils have the resources to employ the technical expertise required for waste management. Indeed, some relevant expertise may already be present. For example, within the Departments responsible for the control and monitoring of mineral workings; a knowledge which would combine well with landfill site selection,

vi) The smaller number of administrative units involved, eight rather than thirty-seven, would benefit both monitoring and data collection and help to facilitate the introduction of a standard system of data collection.

Inadequate resources and manpower at District level have been identified as major contributory factors in the low standards of waste management practiced. The extent to which they affect individual WDAs is difficult to ascertain, but these constraints would be considerably alleviated by the transfer of responsibility to the larger administrative units of the County Councils. The decision to re-locate responsibility for waste disposal rests with central government, as does the inititative for the introduction of a standard system of data collection. It is at this level, therefore, that improvements in administrative procedures and data collection must be made first.

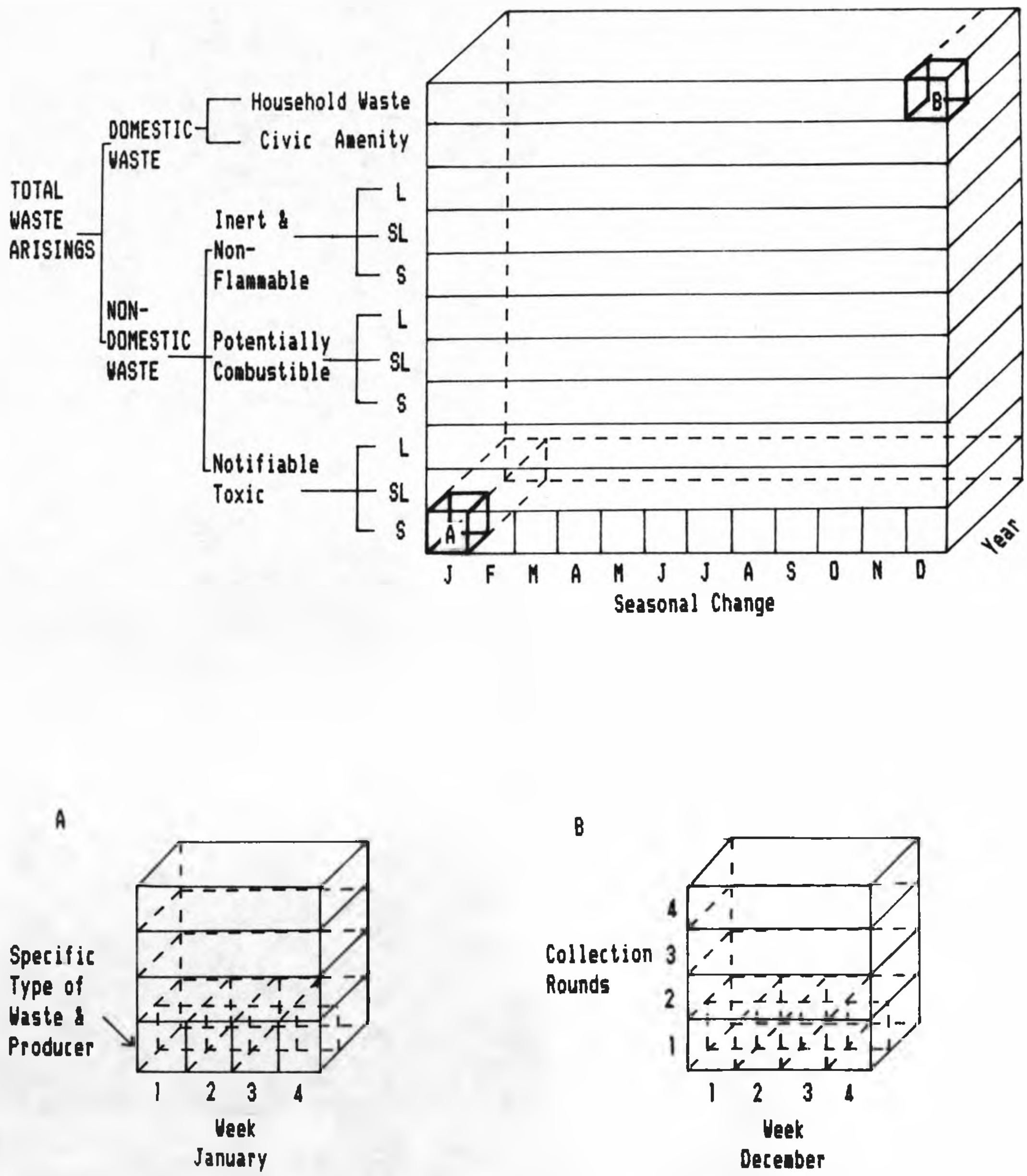
To be effective, both central and local government administration requires good data on each of the other five aspects of best practice. These are, therefore, components of waste administration.

8.2.2 Waste Arisings: Data Requirements for Best Practice

The collection of detailed information on the size and nature of the waste disposal problem, is a necessary prerequisite to management decisions regarding the best practicable solution. Data on the amount and types of waste arising are, therefore, essential to good management.

Figure 8.1 shows the complexity of the information required on waste arisings. The waste classification used, is that of the Association of District Councils (ADC 1979). This classification is more practicable, particularly for waste disposal and transportation purposes, when a knowledge of the properties of waste is required.

Figure 8.1. Data Requirements for Waste Arisings



units of measurement; tonnes, kilogrammes and litres
L = Liquid, S = Solid, SL = Sludge

The hierarchical system illustrated, has numerous advantages for data collection and subsequently, for monitoring change over time and space:-

i) Detailed information on individual waste producers, specific waste types and amounts, locations and production over time, can be recorded within individual cells, (Figure 8.1.'A');

ii) The detailed information recorded in each cell can be easily aggregated to show waste arisings for an individual producer over time, for a specific type of waste, or for combined categories of waste, such as notifiable toxic waste. This is particularly helpful in the production of monthly or annual statistics;

iii) Seasonal fluctuations and trends over time may be monitored and comparisons made for specific waste types, combined categories of waste or for waste producers;

iv) The system may be used to record the import and export of waste, noting the types and amounts of waste involved and the names and locations of the producers. Again, the benefits of data aggregation for monitoring purposes, can be employed to show seasonal fluctuations, trends through time and over space, and changes in type of waste;

v) The system can be adapted to record the amounts and types of waste collected solely by the waste collection authority. These can be recorded separately from all other waste arisings.

Detailed data for individual collection rounds may be recorded on a weekly basis, (Figure 8.1.'B'). Thus, the tonnage of waste collected, the efficiency of collection techniques and the cost of collection to the waste collection authority can be calculated,

vi) The system is based upon the use of standard units of measurement, (tonnes/kilogrammes and litres), and standard intervals for data collection. Consequently, the data produced would be compatible and hence, would facilitate data aggregation and inter-authority comparisons.

This system indicates the data requirements for waste arisings in quantitative terms, that is, the variables to be recorded, the frequency of recording, and the classification and units of measurement to be used. However, of central importance to the whole system is the quality of the data produced. The ability to weigh waste accurately and not rely on estimates is essential. The use of weighbridges by local authorities is, therefore, a standard requirement of best practice.

8.2.3 Waste Disposal; Data Requirements for Best Practice

The amount and type of waste to be disposed within an authority, determines the methods of disposal and capacity of disposal facilities required. This informational requirement is, therefore, of vital importance in the planning of current resources and future provision. It has been shown previously, Sections 5.2.4 and 5.3.3, that with the exception of toxic waste, nearly all waste arising within local authorities is disposed of internally.[1] Thus, the information collected on waste arisings, Figure 8.1, can with a few alterations be used to record total amounts of waste disposed. This does not, however, provide information on what waste is disposed, where, when and by whom.

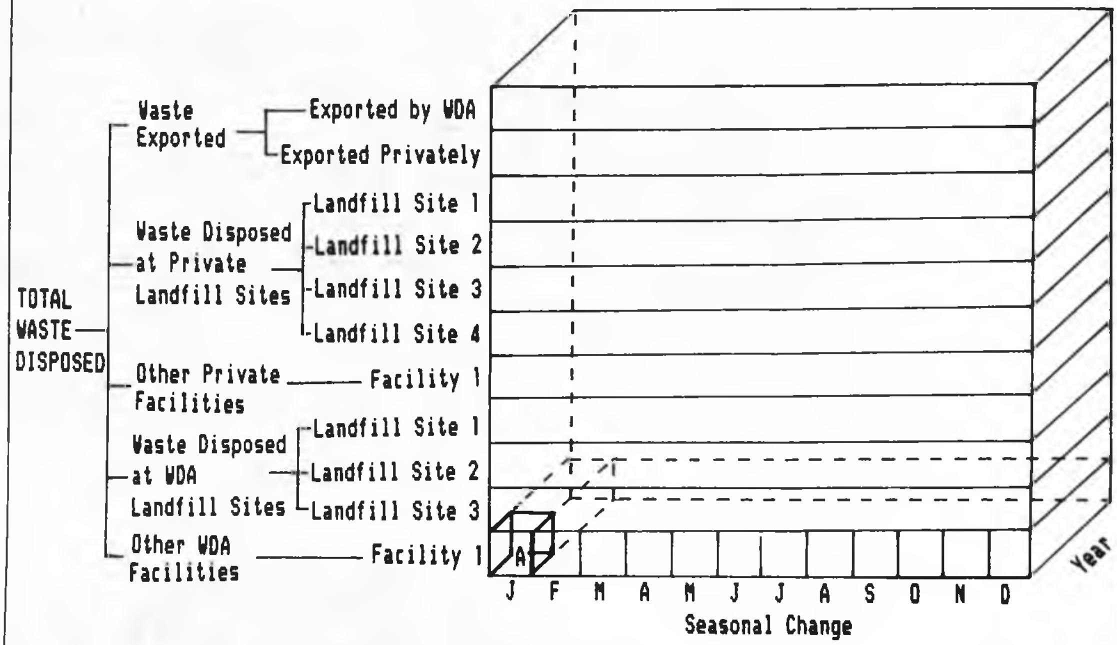
Figure 8.2 illustrates how data on waste disposal should be recorded to facilitate monitoring, analysis and hence, management. The system follows a logical progression, from individual records relating to the specific types of waste disposed at a particular waste disposal site, to cumulative categories, such as the amount of waste disposed at all WDA landfill sites or the amount of a specific type of waste disposed within a local authority. This system, in common with that for recording waste arisings, has many advantages:-

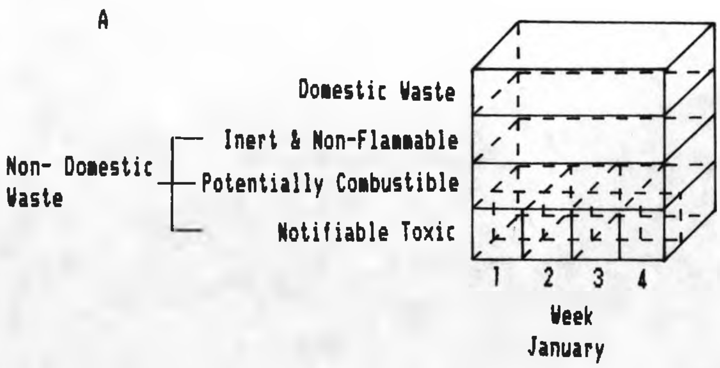
i) Waste disposed at individual disposal facilites may be recorded, showing types of waste, amounts, seasonal fluctuations and annual trends. This information would enable site assessments to be made, such as the rate of tipping and the remaining site capacity;

ii) For analytical purposes, the data collected in 'i' may be collated in a variety of ways. First, by waste type. The amount of each type of waste disposed can be calculated either for WDA facilities, privately operated facilities or for the whole District. Secondly, waste disposal can be recorded in terms of the disposal body. For example, the total amount of waste disposed by the WDA or by each private operator. This enables

[1]. There are some exceptions; for example, domestic waste from Rhuddlan is exported for disposal to neighbouring Colwyn.

Figure 8.2. Data Requirements for Waste Disposal





units of measurement: tonnes, kilogrammes and litres costs of disposal to be calculated;

iii) Records on the import or export of waste for disposal can be maintained, showing the type and amount of waste involved and the exporting or importing body, together with the method of disposal,

iv) Recycling constitutes a further type of waste 'disposal' not shown in Figure 8.2. In the few authorities where recycling takes place, records should be maintained by the local authority irrespective of whether the recycling is a privately run or WDA operated process. Data on the amounts and type of waste recycled together with fluctuations in the amount of raw waste material available and changes in the market for the finished product, enable an assessment to be made on whether the process is viable and should be continued.

In common with the data collected on waste arisings, those for waste disposal must, necessarily, be based upon the same standard waste classification, units of measurement and recording intervals. Again, accurate weight data ~~is~~ are required, using weighbridge records. Whilst, the use of a weighbridge may not be a requirement for private operators, local authority operated disposal facilities could be required to install them or at least, to use a centrally located weighbridge for all waste disposed at WDA operated facilities.

8.2.4 Landfill Site Selection: Data Requirements for Best Practice

Although, many of the data requirements for the selection of WDA operated landfill sites apply equally to the selection of private sites, this section focuses on the selection of WDA sites. The WDA has a statutory duty to ensure the disposal of all waste situated within its area or likely to become so situated, (Control of Pollution Act, 1974). In practical terms this means the disposal of all domestic waste and by arrangement, some non-domestic waste, at WDA operated landfill sites. Industrial producers of waste, however, have more options. Often their waste arisings are exported for disposal, particularly special or toxic waste. Some waste is disposed in-house by incineration and sometimes by landfill. Such requirements are taken into consideration when locating industrial units.

In terms of environmental impact, landfill site selection represents the most sensitive area of waste management. Selection of the best option available, both in environmental and economic terms, requires accurate information on a wide range of variables. This analysis, however, is restricted to the data requirements for waste and excludes many other influential factors within the decision making process, such as the financial and technical constraints on site selection.

Accurate data on the types and quantity of waste to be disposed by the WDA, together with detailed information on the main areas of production (recorded in Figures 8.1 and 8.2), are essential in the selection of landfill sites. This information indicates the size and nature of the disposal problem and underlies the disposal policy of the WDA and ultimately, the nature of the landfill site/s required. In effect, these data are essential in determining the following aspects of site selection:-

i) The number and capacity of landfill sites required;

ii) The type of landfill policy to be adopted. Some WDAs pre-treat waste prior to disposal, for example by using pulverisation, whilst others dispose of waste direct to landfill;

iii) The policy regarding leachate attenuation and containment. That is, whether to select:-

a) a landfill site which contains both waste and leachates;

b) one which allows the slow migration of leachates, yet permits significant attenuation;

or c) one which allows the rapid migration of leachates and insignificant attenuation, (DOE, 1976b and 1978);

iv) The type of site preferred. That is, whether the WDA has a policy of derelict land reclamation by landfill. Depending upon the nature of the waste, such a policy may be unattainable in practical terms,

and v) The amount, density and location of waste to be disposed, determine the cost of haulage to disposal. Proximity to the centre of waste production is, therefore, important in limiting transport costs. Thus, data on the location of the main waste producing areas are vital in establishing the radius within which the search for potential sites must be restricted in order to meet financial constraints.

Notwithstanding the importance of other factors, such as site availability and financial constraints, the need for accurate waste data in the site selection process is vital. Inaccurate data may have serious implications for the level and nature of site provision sought and the area of search used. Consequently, it is unlikely that the most cost-effective or environmentally suited option will be chosen.

8.2.5 Strategic Planning: Data Requirements for Best Practice

Under Section 2 of the Control of Pollution Act, 1974, Part I, it is the duty of each Disposal Authority to produce a waste disposal plan. DoE guidelines on the preparation of a waste disposal plan (DoE, 1976c), suggest that the plan should include an assessment of the current situation, a forecast of future arisings and an evaluation of the different strategies that present themselves. In preparation for the plan, Section 2 of the Act requires each authority to:-

> '..carry out an investigation with a view to deciding what arrangements are needed for the purpose of disposing of controlled waste which is situated in its area and of controlled waste which is likely to be so situtated', (COPA, 1974).

It is, therefore, the statutory duty of each WDA to undertake some strategic planning. The importance of good data in the preparation of the plan is indicated by the obligatory 'investigation'. However, the adequacy and accuracy of such planning, will vary in relation to the accuracy of the 'investigation' and the data collected. Although, government guidelines are available on both the preparation of a waste disposal plan and waste disposal surveys, (DoE, 1976c and 1976a), the majority of plans were only completed during 1986, some eight years after implementation of Section 2. This suggests that a certain amount of difficulty was encountered by many authorities.

Best practice not only requires efficient day to day management, but also adequate planning for future provision. The statutory requirement for strategic planning is, therefore, a welcomed aspect of central government administration. However, accurate forecasting must, necessarily, be based upon data covering all aspects of waste arisings and waste disposal within a local authority area, (Figures 8.1 and 8.2). In particular, trend data covering at least a five year period, are necessary to calculate probable levels in arisings over the next five years and beyond. Indeed, the DoE guidelines suggest that the waste disposal plans should include a projection of future increases or decreases in the types and quantities of waste arising over the next ten years. Such projections require accurate information on both domestic and non-domestic waste arisings.

Forecasting future levels of non-domestic waste arisings is problematic, as these are highly sensitive to changes in the economy. Fortunately, swings in the economy are more likely to lead to dramatic decreases in waste arisings than to large increases. This is because increases in industrial production require advanced planning and do not occur over night. Thus, the resultant increases in waste can be foreseen. In contrast, economic recession may very quickly affect levels of production once a financial threshold is reached below which production is no longer viable. Consequently, either production must be curtailed or temporarily ceased, with a similar fall or halt in waste arisings. Furthermore, the WDA is unable to predict future changes in industrial waste arisings, but must rely upon information supplied by individual waste producers and their own predictions.

The situation regarding domestic waste is somewhat different. The WDA has sole responsibility for the disposal of domestic waste and consequently, for the prediction of future arisings and the provision of disposal facilities. The prediction of domestic waste arisings requires data on two main variables:-

i) First, trend data for waste arisings over as long a period as possible and at a variety of scales, from individual collection rounds to the whole District, as shown in Figure 8.1,

and ii) Secondly, census data showing the corresponding populations.

These data are essential in the calculation of the relationship between domestic waste arisings and population. Once this relationship has been identified, population trends over the next five or ten years can be used to calculate probable levels of waste production. This exercise can be carried out at a variety of scales, with varying degrees of accuracy in the resultant predictions. In general, the more detailed the scale of investigation, the more accurate the resultant projections will be. For example, the investigation can be taken further by analysing the relationship between the socio-economic characteristics of the population within each collection round and the type and quantity of waste produced. Again, future predictions can be made on the basis of these relationships together with the predicted changes in population.

The level of analysis chosen, is predetermined by the accuracy and availability of waste data. For example, the use of population data for individual collection rounds and analysis of socio-economic characteristics, is a pointless exercise if waste arisings for collection rounds are estimated rather than weighed accurately. Thus, the waste data is too coarse to identify sensitive changes in the relationships between waste arisings and household type. Accuracy in strategic planning for domestic waste arisings is, therefore, directly related to accuracy in day to day data collection and, especially, the collection of good weight data.

8.3 Summary

The review of waste management in Wales has revealed many deficiencies in current practice, in particular, the lack of good data essential to both local and central government for the appraisal of their respective policies. Deficient data have been shown to be a consequence of inadequate monitoring and data collection. In the Welsh context, this in turn is related to the absence of a standard system of best practice covering all aspects of waste management. Whilst some authorities achieve a high standard of waste management practice, existing procedures could be improved in the majority of WDAs. For most authorities, data are inadequate for assessing either the efficiency of day to day management or for strategic planning. Clearly, there is a need to introduce a system of best practice and for implementation to be uniform, that is, to be used by all WDAs to ensure the standardisation of data collection and hence, good practice.

CHAPTER 9

9. THE PREDICTION OF WASTE ARISINGS

9.1 Introduction

Section 8.2.5. stressed the importance of strategic planning as a necessary part of best practice in waste management. The ability to accurately predict future waste arisings and hence, disposal requirements, was demonstrated as central to strategic planning. It was suggested that census data may be used to predict future waste arisings by first, establishing the relationship or ratio between population and domestic waste and secondly, using population trends together with the calculated ratio, to predict future waste arisings. In addition, the use of data on the number of domestic hereditaments within a WDA will be investigated as an aid to prediction.

This chapter attempts to identify the exact nature of the relationship between domestic waste arisings and two key variables, population and domestic hereditaments, at different scales and shows how this information can be used to:-

a) predict future arisings

and b) calculate current arisings in those WDAs where data collection is inadequate at present.

9.2 Relationships Between Domestic Waste Arisings, Population and Domestic Hereditaments at Various Scales

9.2.1 Population Trends and Waste Prediction: Wales

Table 9.1 shows the relationship between domestic waste arisings and population at the national level, for the period 1978/79 to 1984/85. Only in the first year did all thirty-seven WDAs provide data on waste arisings, (Column 5). For all subsequent years, therefore, the population totals have been adjusted by subtracting the population figures for those Districts which failed to provide waste data. The resultant relationship or ratio, defined as waste arisings per head of population per annum, varies between 0.387 and 0.456 tonnes. Although, the range appears to be small, 0.069 tonnes/ 69 kilogrammes, when multiplied by a population of 1,000,000, for example, the waste arisings could vary by as much as 69,000 tonnes.

In percentage terms, the difference between the smallest and largest annual ratios was 15.1%, (69 kilogrammes calculated as a percentage of 456), and occurred in consecutive years. In all other cases, the percentage change from the preceeding year was below 10%, (Column 6). No trend in the annual percentage change is apparent; these vary from increases to decreases in alternate years.

The ratios enable predictions of future waste arisings to be calculated based upon population trends. The projected population figures can be treated with some degree of accuracy as they are produced by the Office of Population Censuses and Surveys (OPCS),

Table 9.1 Domestic Waste Arisings and Population: Wales

Year	Domestic Waste Arisings tonnes	Population (Adjusted)	Arisings per head tonnes	No. of WDAs	% change between Years
1978/79	1,212,800	2,767,900	0.438	37	-
1979/80	1,014,600	2,322,100	0.437	32	- 0.2%
1980/81	1,184,000	2,608,300	0.454	35	+ 3.9%
1981/82	1,051,900	2,527,700	0.416	33	- 8.4%
1982/83	1,204,500	2,641,737	0.456	34	+ 9.6%
1983/84	1,006,700	2,597,700	0.387	34	-15.1%
1984/85	985,700	2,540,300	0.388	33	+ 0.3%

Source of Data: CIPFA Waste Disposal Statistics Reports (Actuals)

Table 9.2 Predictions for Domestic Waste Arisings: Wales

Year	Population Estimate	Predicted Domestic Waste Arisings (Tonnes) Minimum		Maximum	Range (Tonnes)
1983	2,808,000	1,086,696	to	1,280,448	193,752
1986	2,810,000	1,087,470	to	1,281,360	193,890
1991	2,822,000	1,092,114	to	1,286,832	194,718
1996	2,839,000	1,098,693	to	1,294,584	195,891

Source of population projections: Welsh Office, 1985 and are based upon Census data.[1] The waste arisings data used in the calculation of the ratios, however, have been shown throughout this study to be inaccurate and unreliable for many WDAs. It should be stressed, therefore, that any predictions for waste should be treated as estimates, providing a rough indication of probable future arisings. Thus, the predictions for domestic waste arisings shown in Table 9.2, should be viewed with caution. These have been calculated using both the minimum and maximum ratios calculated for the period 1978/79 to 1984/85, (Table 9.1), hence the predicted level of waste arisings for each year are shown as a range, rather than a single level. Accordingly, this method of prediction is quite coarse and an error in prediction of almost 200,000 tonnes (15%), above the lowest level of prediction, is possible, (Column 5).

The retrospective estimate for 1983 has been included in the Table, because only thirty-four WDAs provided waste data for that year (Table 9.1); the figure in Table 9.2 represents all thirty-seven authorities. Similarly, data for 1986 have not yet been published, but the figure shown in the Table indicates the probable level of arisings in anticipation of the 'actual' statistics. Finally, the population figures used, are 1983 based projections made by the Welsh Office and are available for five year cohorts, (Welsh Office, 1985b).

9.2.2 Domestic Hereditaments and Waste Prediction: Wales.

The relationship between domestic waste arisings and the number of domestic hereditaments may also provide a useful indication of waste

[1] OPCS admits that a degree of inaccuracy is unavoidable in the production of Census data and has listed the reasons for this in various publications, (OPCS, 1982, 1983 and 1984).

arisings where data are available, but is of limited use in the prediction of future arisings, due to the difficulties encountered in the prediction of future hereditaments. Table 9.3 shows the relationship between domestic waste and the number of domestic hereditaments, over a seven year period. Noticably, fewer WDAs have been used in this analysis, than was possible in the analysis of waste arisings and population, because both the figures for waste arisings and hereditaments required adjustment to make allowances for missing data. Thus, the data on waste arisings differ from those in Table 9.1.

The resultant relationship or ratio, is expressed as the amount of arisings per hereditament, (Column 4). This varies from 1.002 to 1.201 tonnes, a range of 0.199 tonnes/199 kilogrammes. In common with the pattern in the relationship between waste and population, the largest difference, a decrease of 16.6%, occurred in consecutive years. In fact, percentage changes in the ratio between years, follows the same pattern as shown in Table 9.1, with increases and decreases experienced alternately. This suggests that the variables population and domestic hereditaments, may be used jointly to confirm changes in waste arisings. However, the results indicate that at a national scale, population statistics appear to provide a greater degree of accuracy, in so far as the range recorded in the relationship between waste arisings and population is smaller.

9.2.3 Population and Waste Prediction: The Waste Disposal Authorities

The relationship between domestic waste arisings and population in

Table 9.3 Domestic Waste Arisings and Domestic Hereditaments: Wales

Year	Domestic Waste Arisings tonnes	No. Domestic Hereditaments	Arisings per hereditament tonnes	No. of WDAs	% change between years
1978/79	1,076,469	942,700	1,142	32	-
1979/80	846,600	765,086	1,106	26	- 3,2%
1980/81	1,042,000	906,063	1,150	32	+ 4,0%
1981/82	893,343	812,839	1,099	29	- 4,4%
1982/83	1,204,500	1,003,228	1,201	34	+ 9,3%
1983/84	984,700	983,135	1,002	32	-16,6%
1984/85	967,680	956,551	1,012	32	+ 1,0%

Source of data on waste and domestic hereditaments; CIPFA Waste Collection Statistics Reports (Actuals), the thirty-seven Welsh WDAs, has been analysed in detail. Explanatory notes on the method used are presented in Appendix 9.1. In brief, the method of analysis selected was bivariate regression analysis, in which the two variables were regressed to establish the degree of association between them. This work was carried out on the Liverpool University IBM 3083 computer, using the SPSSx package, (SPSS Inc., 1986).

The resultant correlation coefficients (R), for the seven years studied are shown in Table 9.4. In each case, a high positive correlation is recorded. The highest correlation, R=0.95 (at 0.001 level), was recorded for 1981/82 and was subsequently followed by the lowest correlation, R=0.83, in 1982/83. Notwithstanding the relatively small sample size, (between thirty-two and thirty-seven), these values are statistically highly significant. The standard error of estimate (σ) and coefficient of determimnation (R^2), are also included in the Table.

Figures 9.1(a to g) and 9.2, demonstrate the relationship graphically. The independent variable, (population), has been plotted on the 'x' axis and the dependent variable, (domestic waste arisings), on the 'y' axis. Each point on the scattergraph represents a waste disposal authority and shows the levels of population and waste arisings recorded by the authority for that year. Where more than one authority has recorded the same levels, the number of authorities is given for that point on the graph.

A positive linear relationship is clearly visible in each graph and the regression line, or 'line of best fit' has been drawn. The

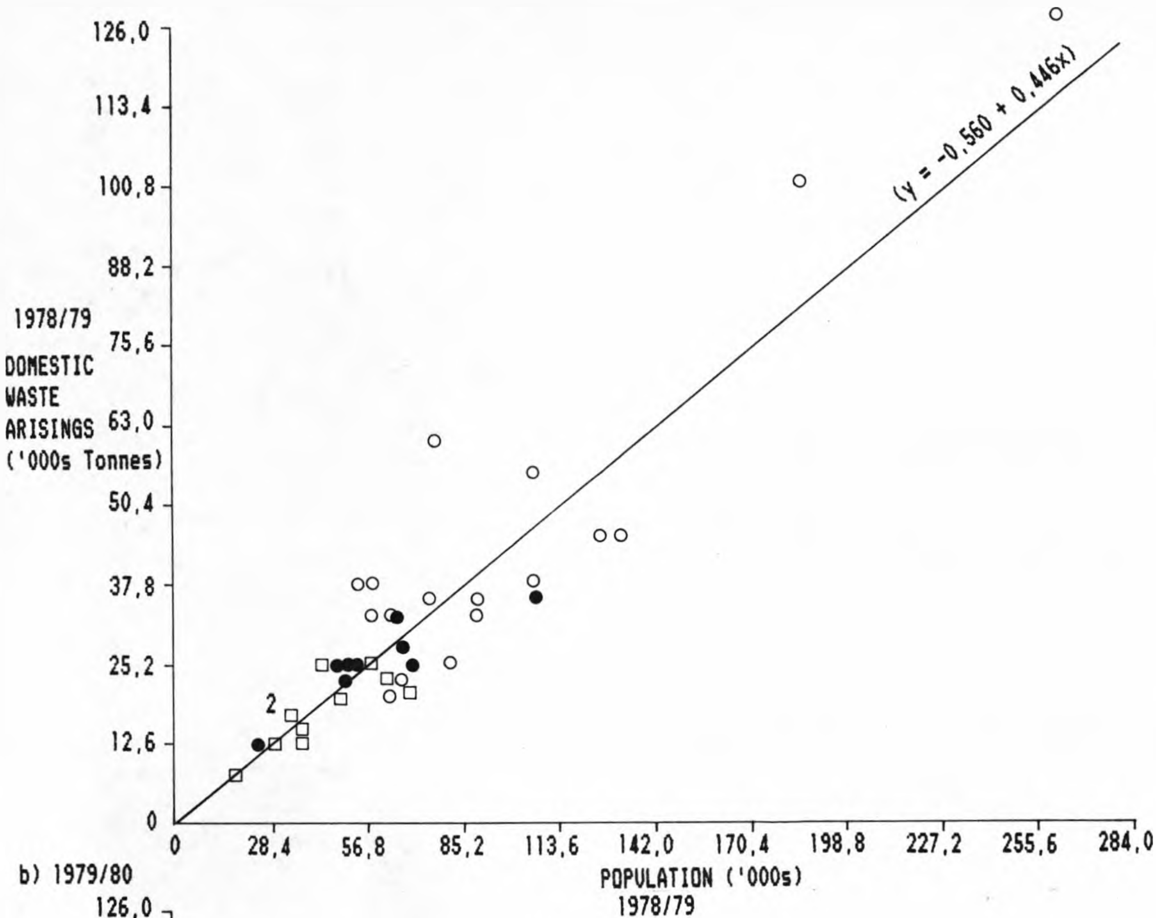
Table 9.4 Correlation between Domestic Waste Arisings and Population: 1978/9 to 1984/5

Year	(R)	No. of WDAs	σ	R^2	Percentage Unexplained
1978/79	0,92721	37	8,73774	0,86	14
1979/80	0,84514	32	8,85770	0,71	29
1980/81	0,89444	35	9,39367	0,80	20
1981/82	0,94589	33	6,50039	0,89	11
1982/83	0,82610	34	12,31511	0,68	32
1983/84	0,91882	34	7,90844	0,84	16
1984/85	0,91283	33	8,75295	0,83	17
All 7 Yrs	0,88947	238	9,29059	0,79	21

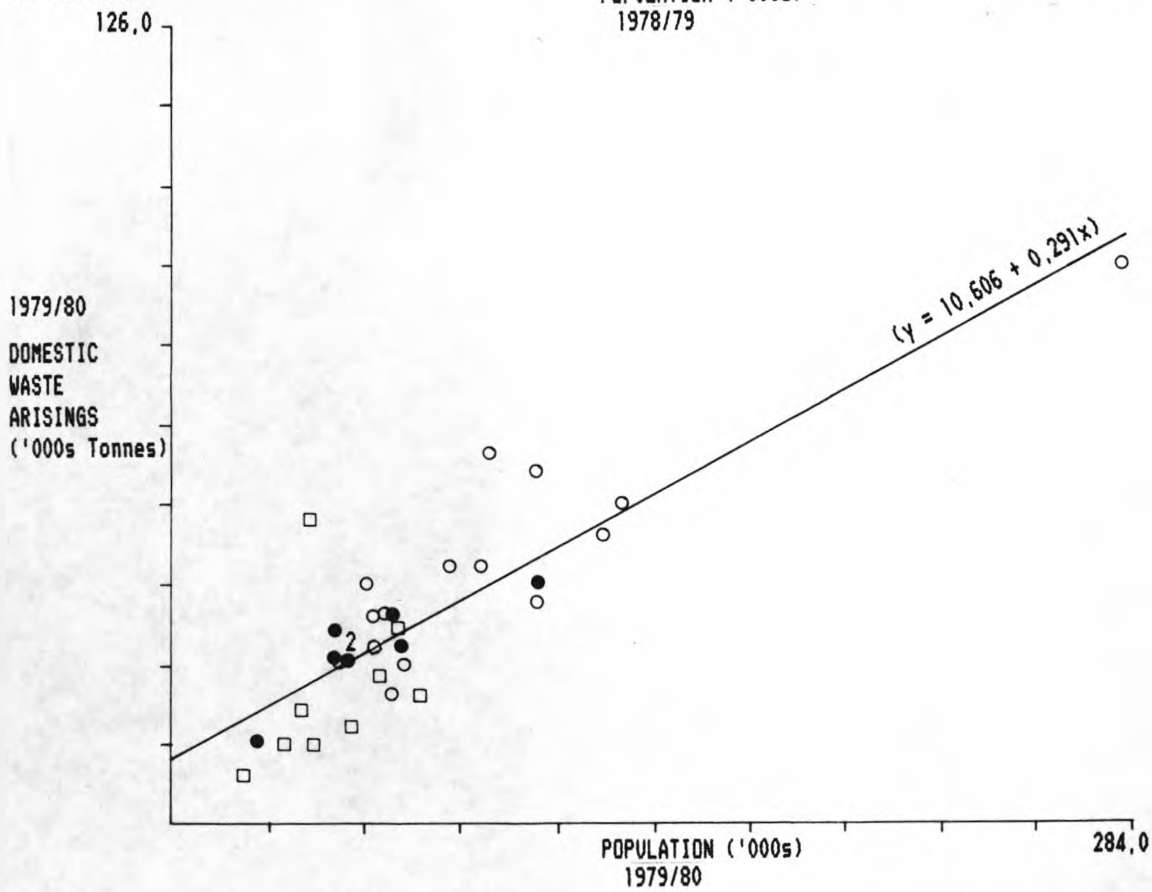
(R) = Correlation Coefficient
σ = Standard Error of Estimate
R^2 = Coefficient of Determination

Figure 9.1. Population and Domestic Waste Arisings: Annual Scattergraphs, 1978/79 to 1984/85.

a) 1978/79

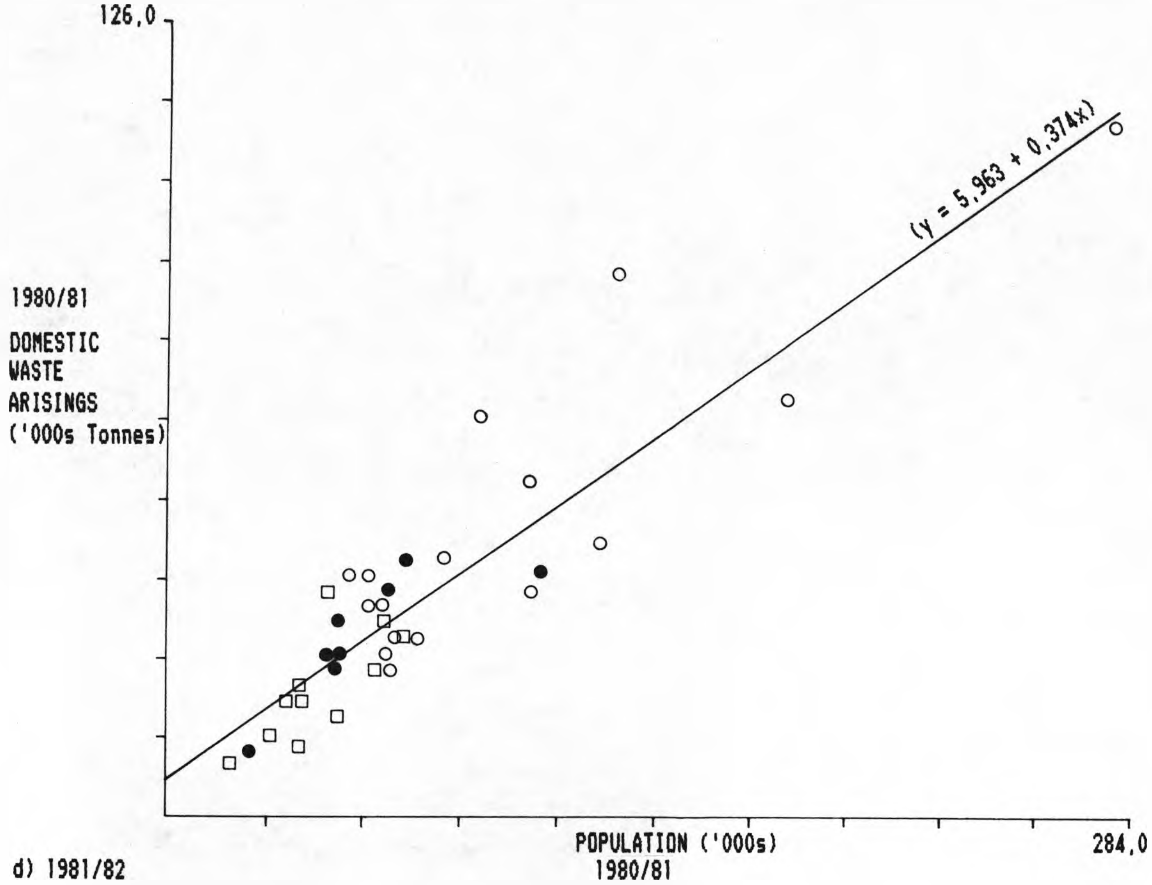


b) 1979/80

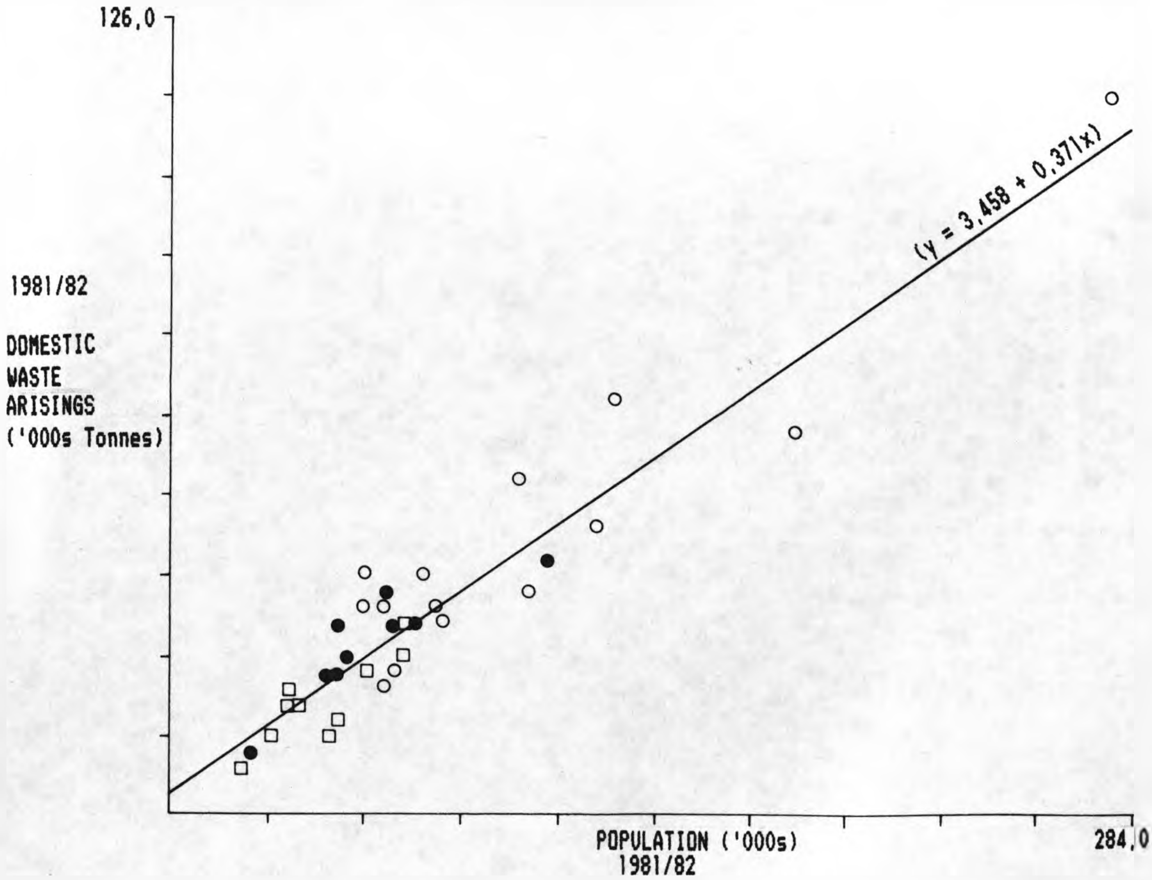


● = North Wales WDA □ = Mid Wales WDA ○ = South Wales WDA

c) 1980/81

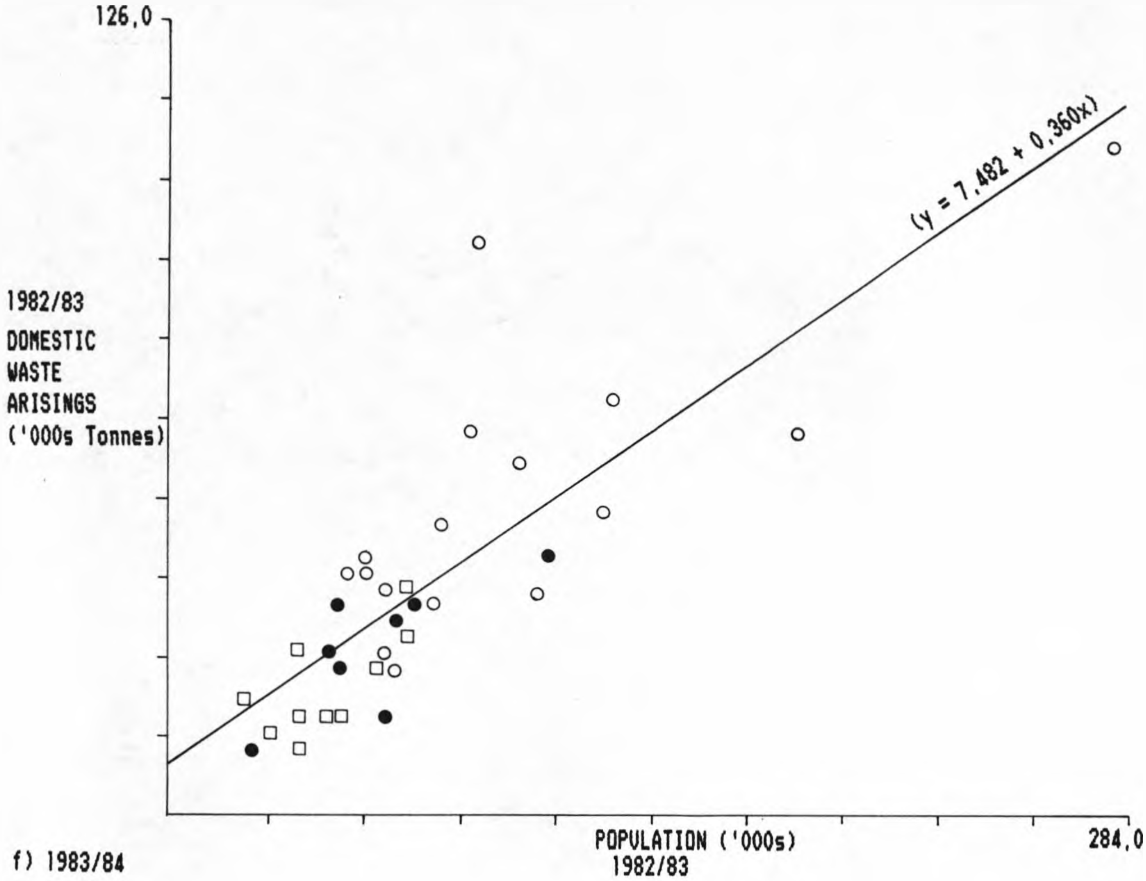


d) 1981/82

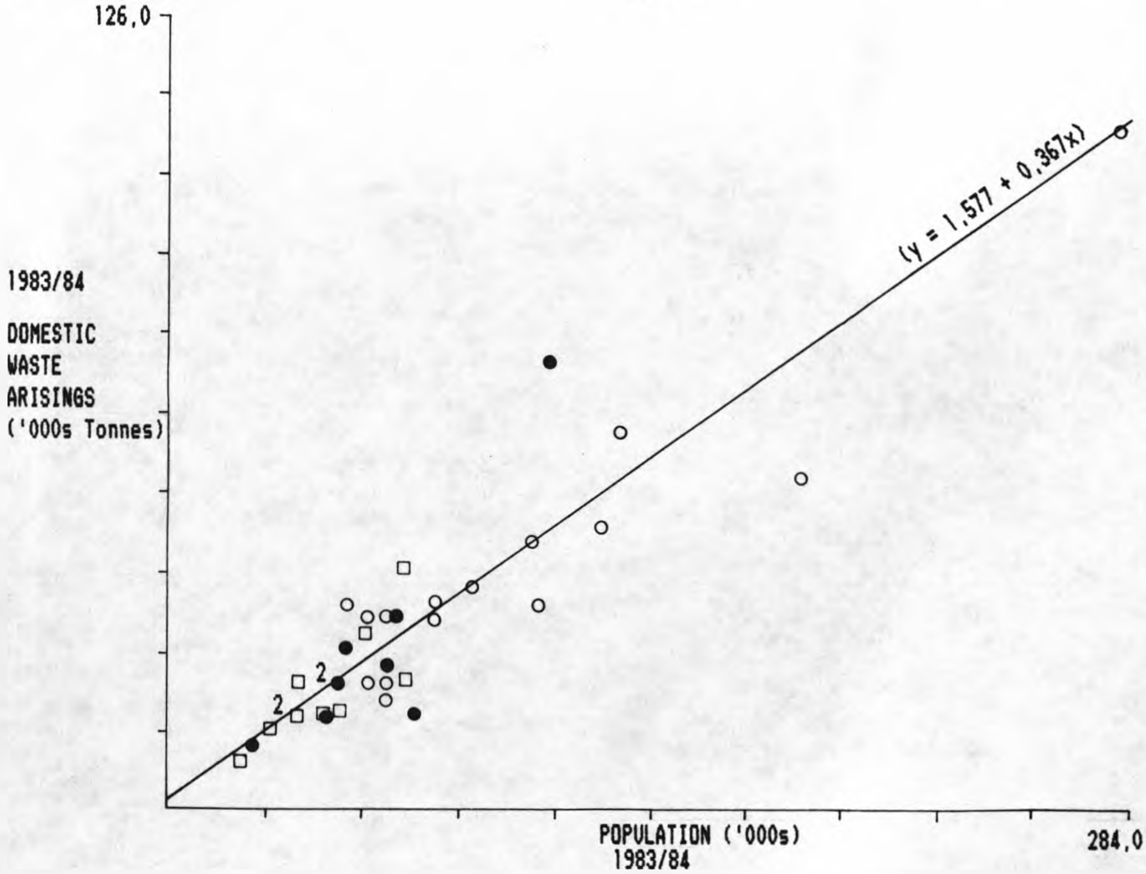


● = North Wales WDA □ = Mid Wales WDA ○ = South Wales WDA

e) 1982/83



f) 1983/84



● = North Wales WDA □ = Mid Wales WDA ○ = South Wales WDA

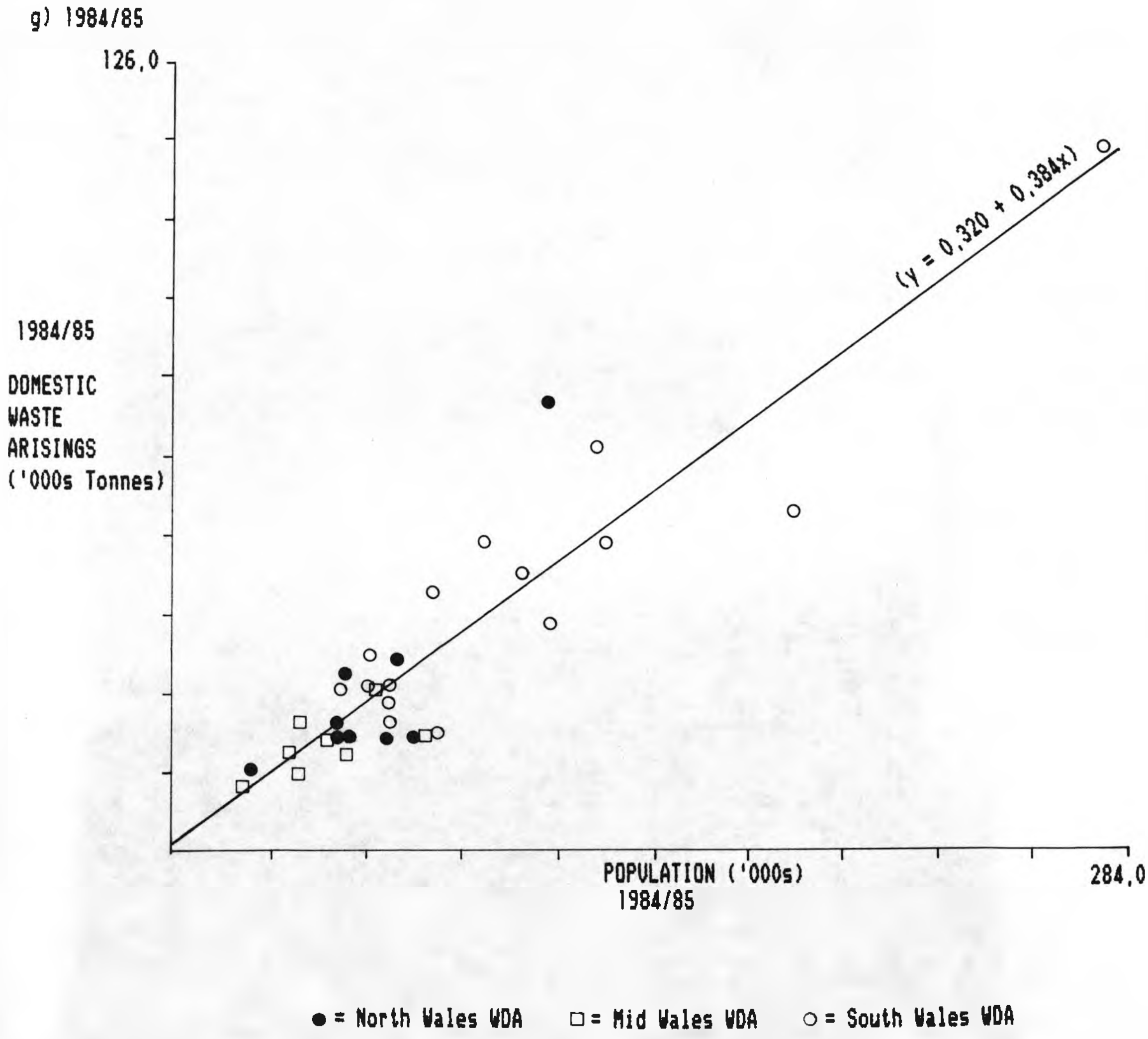
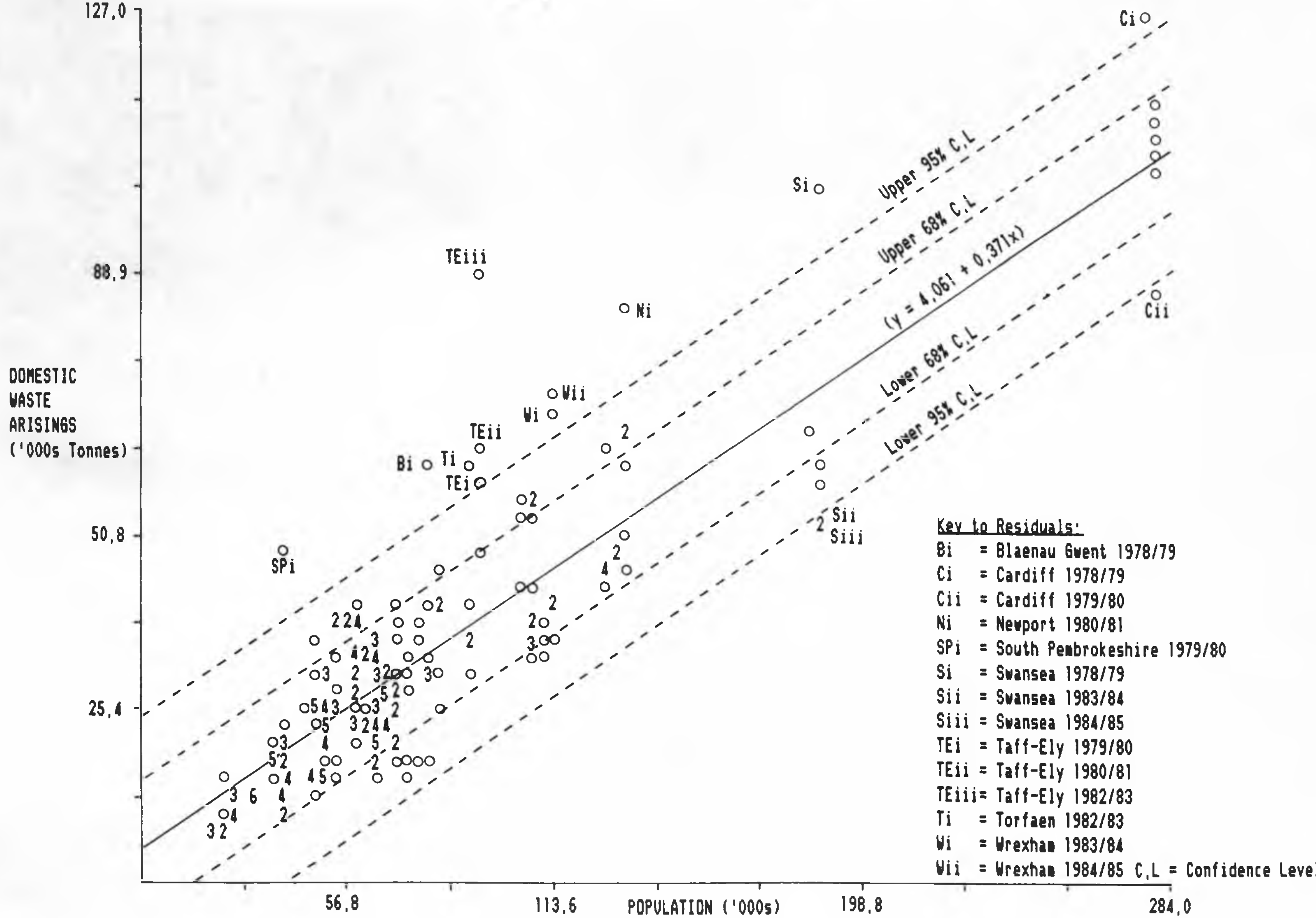

g) 1984/85
126,0
1984/85
DOMESTIC
WASTE
ARISINGS
('000s Tonnes)
(y = 0,320 + 0,384x)
POPULATION ('000s)
1984/85
284,0
● = North Wales WDA
□ = Mid Wales WDA
○ = South Wales WDA

Figure 9.2. Population and Domestic Waste Arisings: Cumulative Scattergraph, 1978/79 to 1984/85.



equations used in the calculation of the individual regression lines are included in Appendix 9.2. Within each graph, the line of best fit can be used to predict the probable level of waste arisings in those authorities for which no data were recorded for that year. For example, in 1980/81 two Districts, Blaenau Gwent and Torfaen failed to provide data on their waste arisings. The estimated populations for these Districts were 78,000 and 90,700 respectively. Using the regression line in Figure 9.1c, the probable level of domestic waste arisings within these WDAs was 35-36,000 tonnes in Blaenau Gwent and 39-40,000 tonnes in Torfaen.

A more accurate estimate can be calculated using the equation for 1980/81 shown in Appendix 9.2. The resultant estimates are 35,129 and 39,877 tonnes respectively. However, these must be adjusted to include the standard error of estimate, shown in Table 9.4. Thus, at the 68% confidence level, the estimates are 35,129(±9,394) tonnes and 39,877(±9,394) tonnes. This implies that for 68 cases in every 100, the actual level of waste arising, will lie within one standard error (±9,394 tonnes), of the predicted value. At the 95 per cent level of confidence, for 95 cases out of 100, waste arisings will lie within two standard errors of the predicted value, that is, ±18,788 tonnes.

The coefficient of determination, shown in Table 9.4, can be used to show the amount (percentage) by which the variation in waste arisings can be explained (statistically) by the variable population. This figure is simply the square of the correlation coefficient. Thus, for 1980/81, 80% of the level of waste arisings can be explained by the population level. Alternatively, 20% of waste arisings for this year, are not explained by population, Table 9.4, Column 6.

The predicted levels of waste arising for the two Districts compare favourably with data for the preceeding and following years. For example, in Blaenau Gwent, no data were provided for 1979/80, but the level of arisings recorded in 1981/82 was 31,730 tonnes and in Torfaen the 1979/80 figure was 40,800 tonnes; no data were provided for 1981/82. In the latter case, the estimate calculated for 1980/81 was only 2.3% below the actual level recorded for the previous year. For both Districts, the difference between the predicted level and actual level for the preceeding or following year, was less than one standard error of estimate/standard deviation.

Domestic waste arisings have similarly been calculated, for all WDAs which have failed at some point during the seven year period to provide data. These are shown in Table 9.5 and the appropriate standard error values are shown in Table 9.4. Again, a comparison has been made between estimated levels of waste arisings and 'actual' data available for either the preceeding or following year. A comparison of the differences between predicted and actual levels in tonnes (Column 6), and figures for the standard error of estimate, (Table 9.4), reveals that for thirteen cases, the 'actual' figures were more than one standard error from the predicted values. In four cases, the difference was by more than two standard errors.

Column 7 shows the percentage difference between the actual and estimated levels; frequently, the difference is disappointingly large. These discrepancies call into question the accuracy of the

Table 9.5 Predicted Domestic Waste Arisings for Authorities with Missing Data, Based on Population Estimates

Year	WDA	Population Estimate	Waste Estimate(r)	Actual Data	Difference tonnes	%
1979/80	Alyn & Deeside	72,200	31,600	41,400	+ 9,800	28.4%
	Blaenau Gwent	79,000	33,577	60,100	+26,523	44.1%
	Brecknock	39,000	21,946	14,732	- 7,214	49.0%
	Llanelli	75,500	32,560	35,050	+ 2,490	7.1%
	Swansea	186,900	64,952	66,000	+ 1,048	1.6%
1980/81	Blaenau Gwent	78,000	35,129	31,730	- 3,399	10.7%
	Torfaen	90,700	39,877	40,800	+ 923	2.3%
1981/82	Afan	54,600	23,715	37,000	+13,285	35.9%
	Brecknock	40,900	18,632	9,883	- 8,749	88.5%
	Taff-Ely	93,600	38,184	62,500	+24,316	38.9
	Torfaen	90,300	36,960	61,000	+24,040	39.4%
1982/83	Arfon	54,663	27,142	25,000	- 2,142	8.6%
	Dinefwr	36,800	20,717	17,500	- 3,217	18.4%
	Llanelli	76,400	34,960	37,540	+ 2,580	6.9%
1983/84	Dinefwr	36,700	15,042	16,300	+ 1,258	7.7%
	Llanelli	74,900	29,057	ND	?	ND
	Taff-Ely	93,000	35,698	49,100	+13,402	27.3%
1984/85	Meirionnydd	31,500	12,412	13,500	+ 1,088	8.1%
	Preseli	70,200*	27,268	37,800	+10,532	27.9%
	Llanelli	74,500	28,918	ND	?	ND
	Torfaen	90,200*	34,945	34,722	- 223	0.6%

*=Mid 1983 Population estimate used. ND= No data
r = ± Standard error of estimate shown in Table 9.4

Source of raw data; CIPFA Waste Disposal Statistics Reports (Actuals) predictive model. However, there are a number of possible explanations:-

i) First, the questionable accuracy of the data on waste arisings for the previous or following years, used in the comparison. These Districts have failed to provide data for at least one year, which suggests that they may have problems with data collection or collation. Thus, the accuracy of data for subsequent years must be questioned;

ii) A comparison of Table 9.5 with Table 3.2, reveals that only two of the WDAs recorded in Table 9.5 have at any time weighed a percentage of their waste arisings. These were Brecknock (15%) and Llanelli (3%) in 1978/79. Curiously, neither has weighed any waste since. It would appear, therefore, that the data used in the comparison are mere estimates, rather than accurately monitored waste arisings,

iii) Finally, some change in waste arisings between years can be expected and will constitute part of the difference. However, this should account for only a small change in line with population figures and cannot account for the large differences recorded in Table 9.5.

It should be stressed, that the predictive model is itself based for the most part upon estimated data. The accuracy of the model could be greatly improved if accurate weight data were available for more Districts.

Figure 9.2 shows the cumulative scattergraph for all seven years, (Figure 9.1 a to g). Again, the correlation coefficient has been calculated at R=0.89 (at 0.001 level) and is statistically highly significant for the total of 238 pairs of variables analysed. Although, this confirms the high degree of association between the two variables, its use in waste prediction is limited, as projections for future arisings are best made using the most recent data available, that is, data for 1984/85.

9.2.4 Domestic Hereditaments and Waste Prediction: The Waste Disposal Authorities

The degree of association between the number of domestic hereditaments and the quantity of domestic waste arising has also been analysed in detail using the methods described in Appendix 9.1. Table 9.6 shows the resultant correlation coefficients. On the whole these are slightly higher than those for population and waste arisings, Table 9.4. The percentages for the variation in arisings explained by the variable domestic hereditaments, are also generally higher than the corresponding coefficient of determination levels for population. Based upon these and subsequent findings, it is suggested by the author, that the number of domestic households is a more accurate indication of domestic waste arisings than population; a household comprising four people does not produce double the quantity of waste as a household of two people. It would appear that each household produces a standard level of waste irrespective of the size of the household and that each additional member produces a proportionally diminishing amount of waste. Thus, the number of

Table 9.6 Correlation between Domestic Waste Arisings and Domestic Hereditaments: 1978/9 to 1984/5

Year	(R)	No. of WDAs	σ	R^2	Percentage Unexplained
1978/79	0,93673	32	8,70225	0,88	12
1979/80	0,88919	26	7,95676	0,79	21
1980/81	0,90739	32	8,29675	0,82	18
1981/82	0,96180	29	5,66360	0,92	8
1982/83	0,81441	34	12,68138	0,66	34
1983/84	0,91439	32	8,13077	0,83	17
1984/85	0,91658	32	8,66846	0,84	16
All 7 Yrs	0,89553	217	9,16511	0,80	20

(R) = Correlation Coefficient
σ = Standard Error of Estimate
R^2 = Coefficient of Determination

hereditaments is a more accurate indication of waste arising than population.

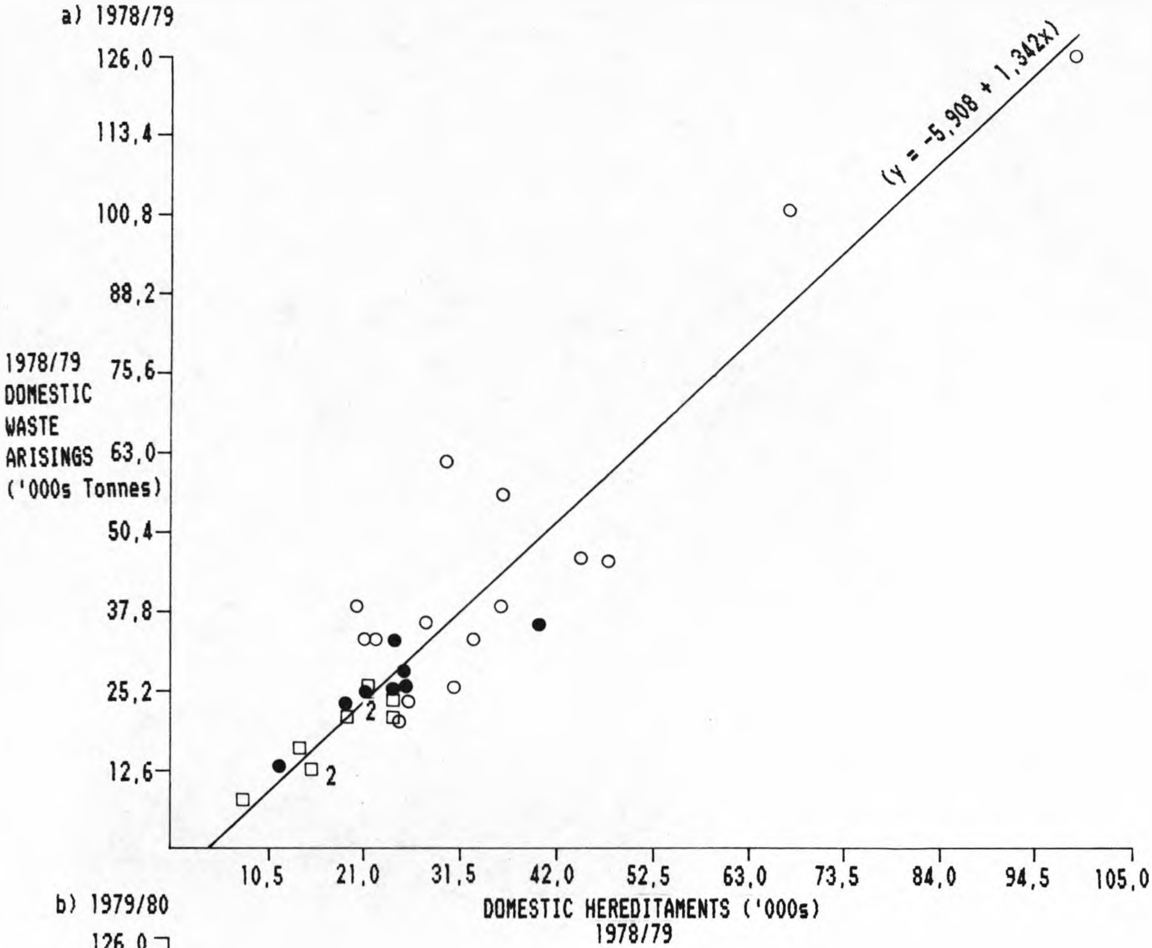
Figure 9.3 (a to g) illustrates the distribution of points in a scattergraph for each year over the seven year period analysed. The respective regression lines have been included and the calculations used for these are shown in Appendix 9.3. Again, the regression lines and equations used in their calculation, may be utilized to predict waste arisings in those Districts which failed to provide any waste data.

Over the seven year period, some forty-two cases of missing data were recorded, when either data on waste arisings or domestic hereditaments were not available. In thirty-two cases, waste data were available, but data on domestic hereditaments were missing, whilst in the remaining ten cases the situation was reversed. Domestic waste arisings have been predicted for these ten cases using the ratios between domestic hereditaments and waste arisings in Appendix 9.3. The predicted waste arisings are shown in Table 9.7.

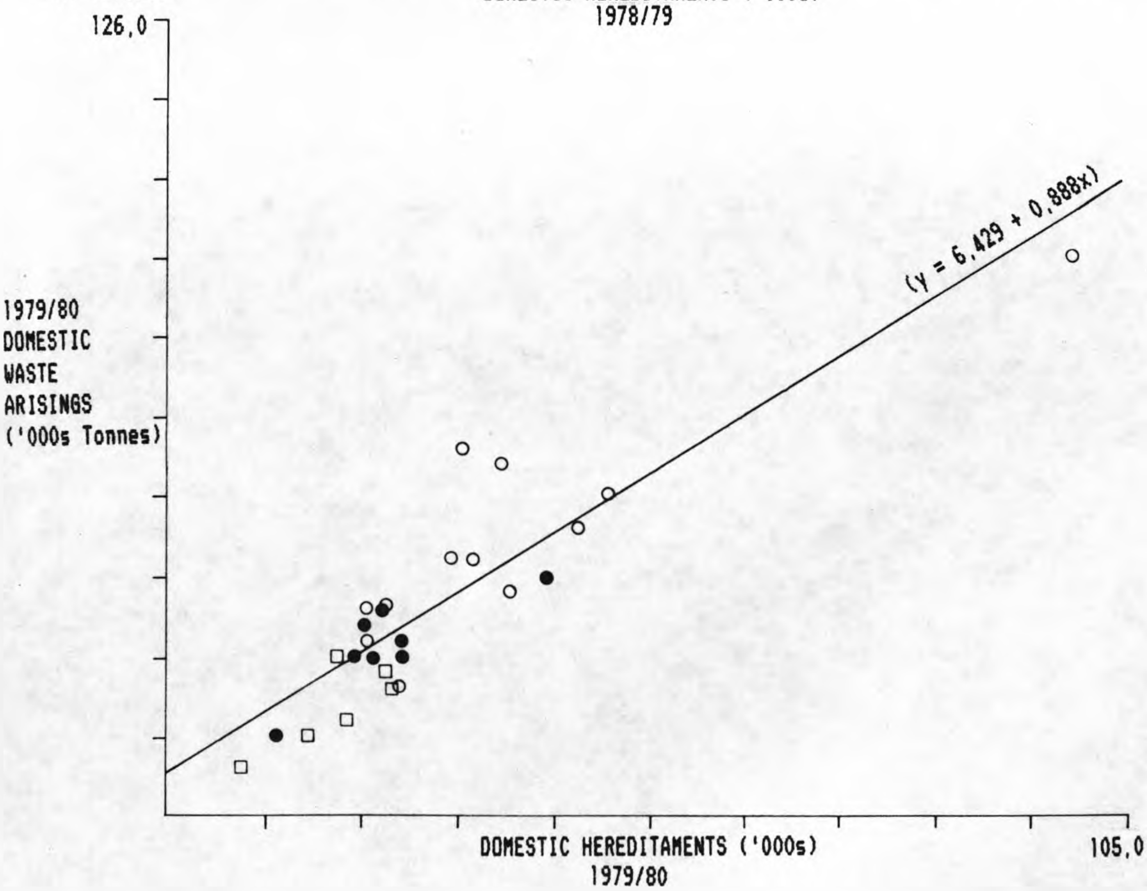
Table 9.7 includes comparisons between the predicted waste arisings and 'actual' data available for either the preceeding or following year. Only in one case, Brecknock (1981/82), does the actual level of arisings recorded, exceed the predicted level by more than one standard error of estimate (Table 9.6); it is, however, within two standard errors.

Figure 9.3. Domestic Hereditaments and Domestic Waste Arisings: Annual Scattergraphs. 1978/79 to 1984/85.

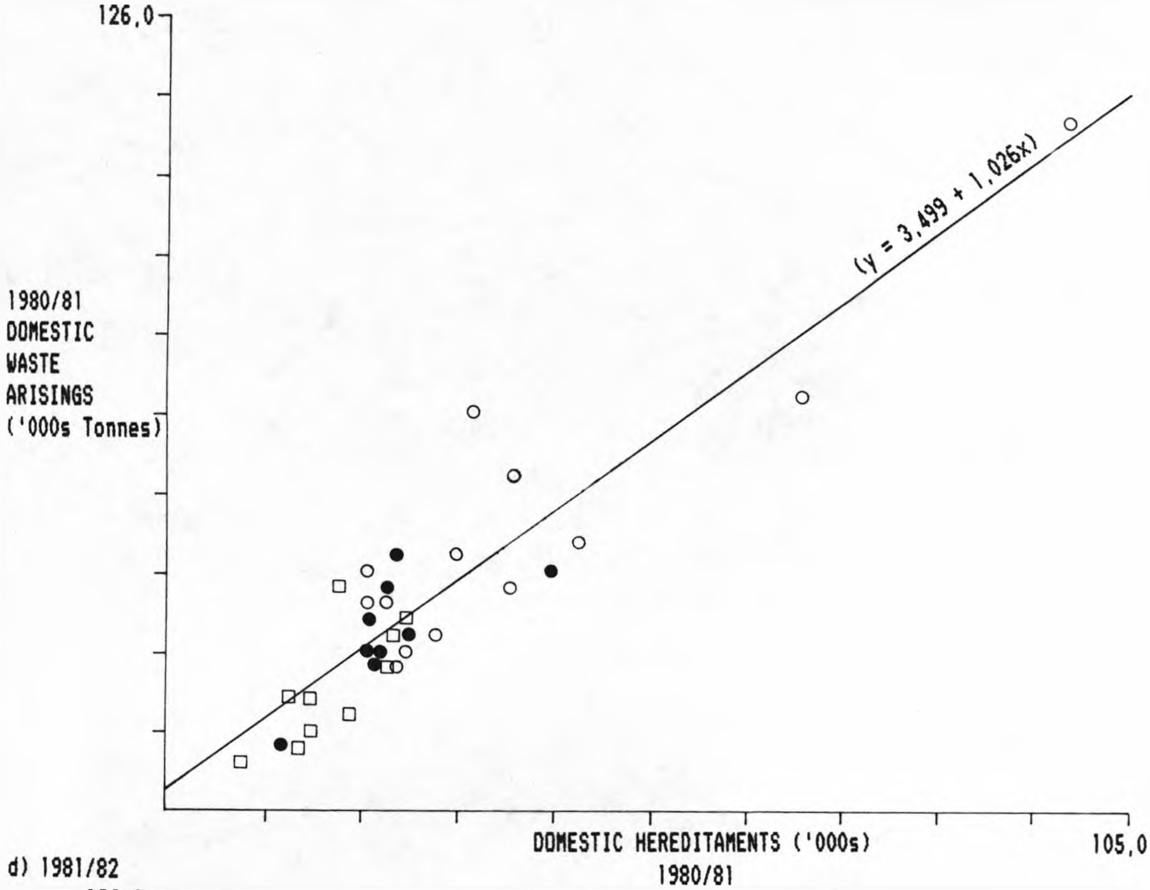
a) 1978/79



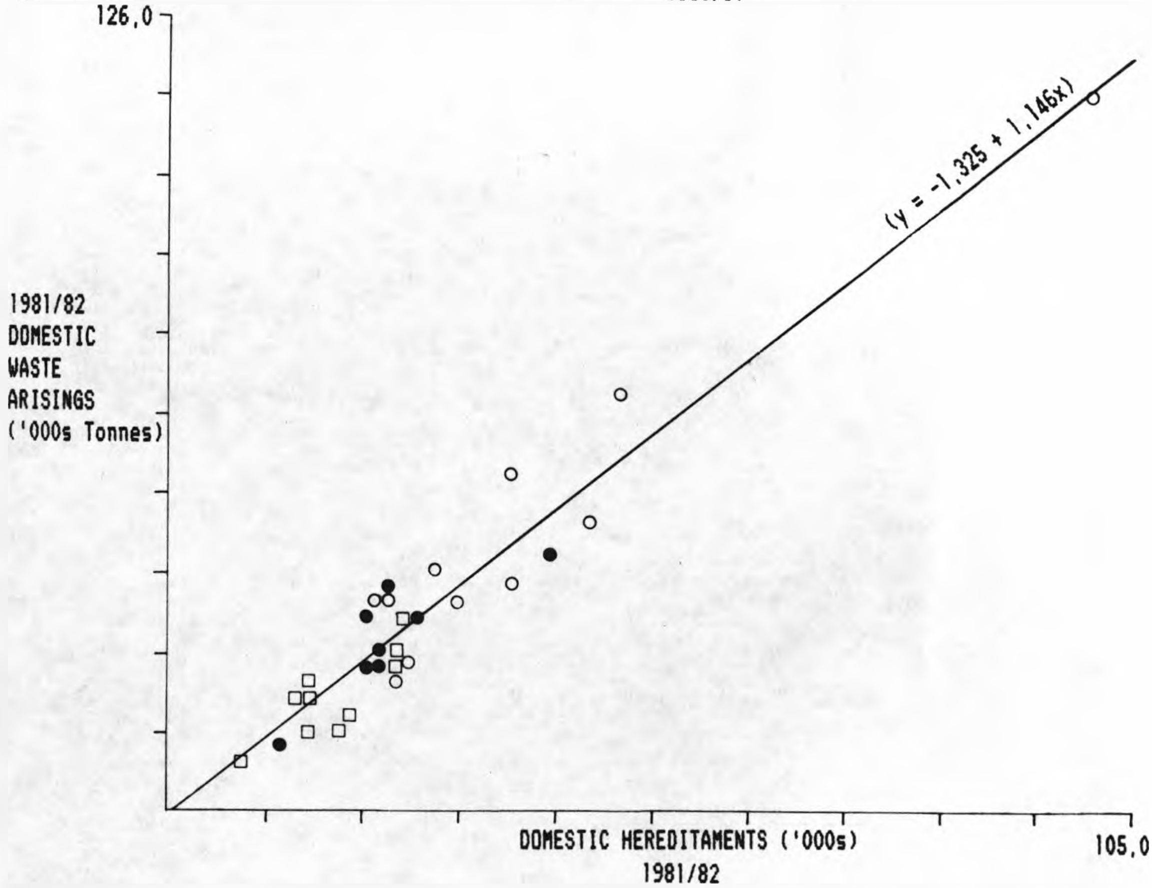
b) 1979/80



c) 1980/81

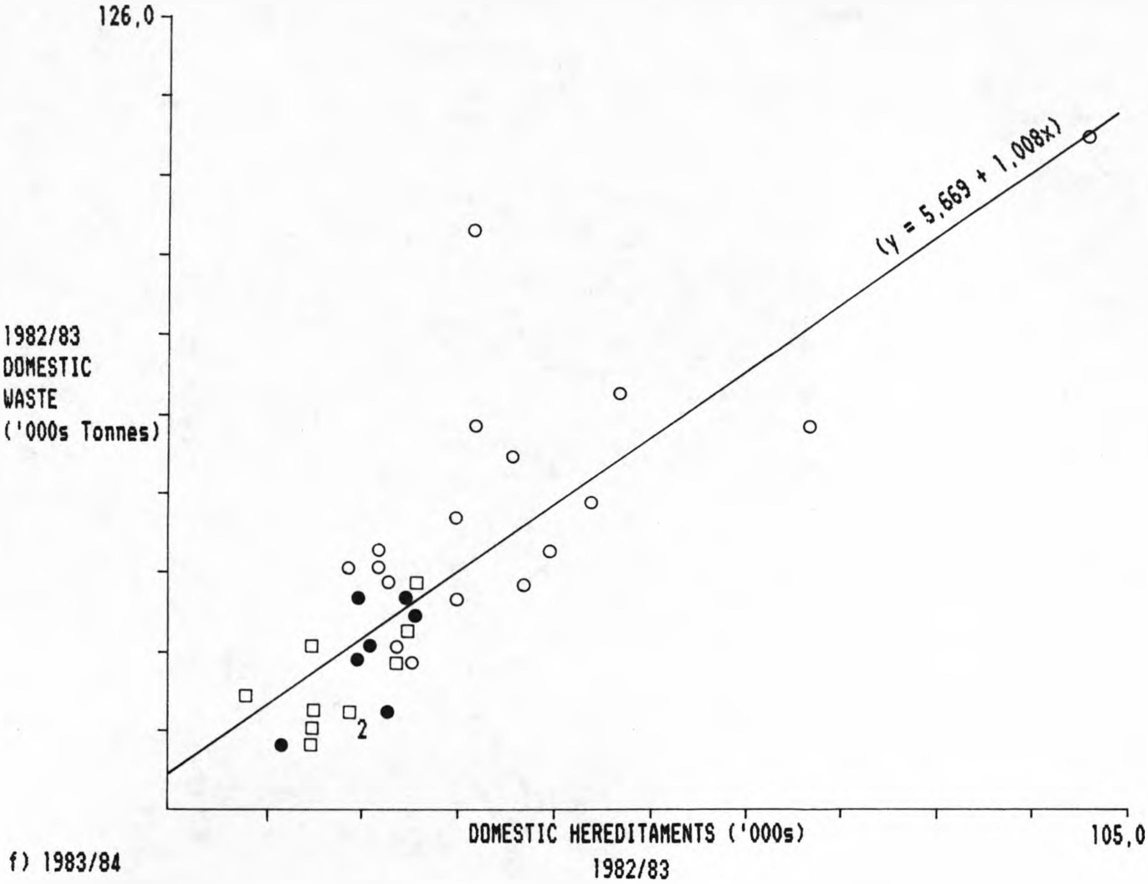


d) 1981/82

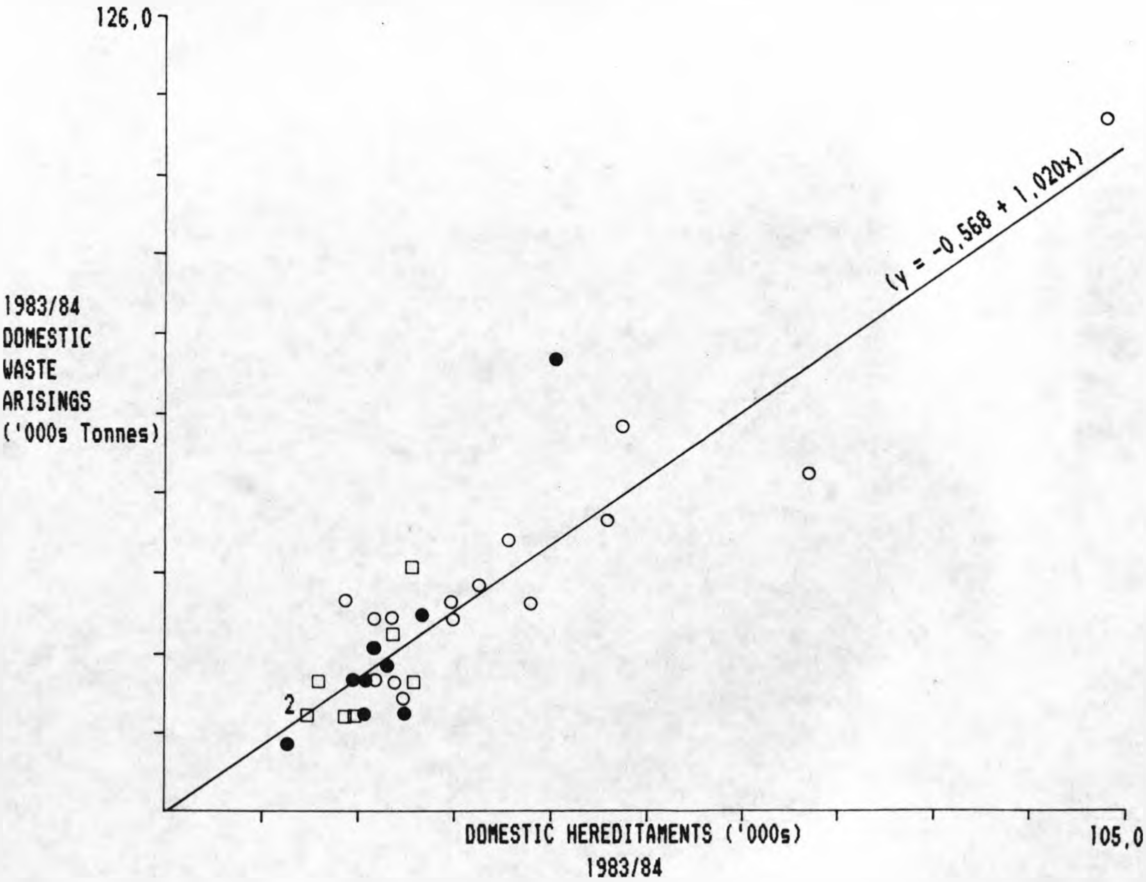


● = North Wales WDA □ = Mid Wales WDA ○ = South Wales WDA

e) 1982/83



f) 1983/84



● = North Wales WDA   □ = Mid Wales WDA   ○ = South Wales WDA

g) 1984/85

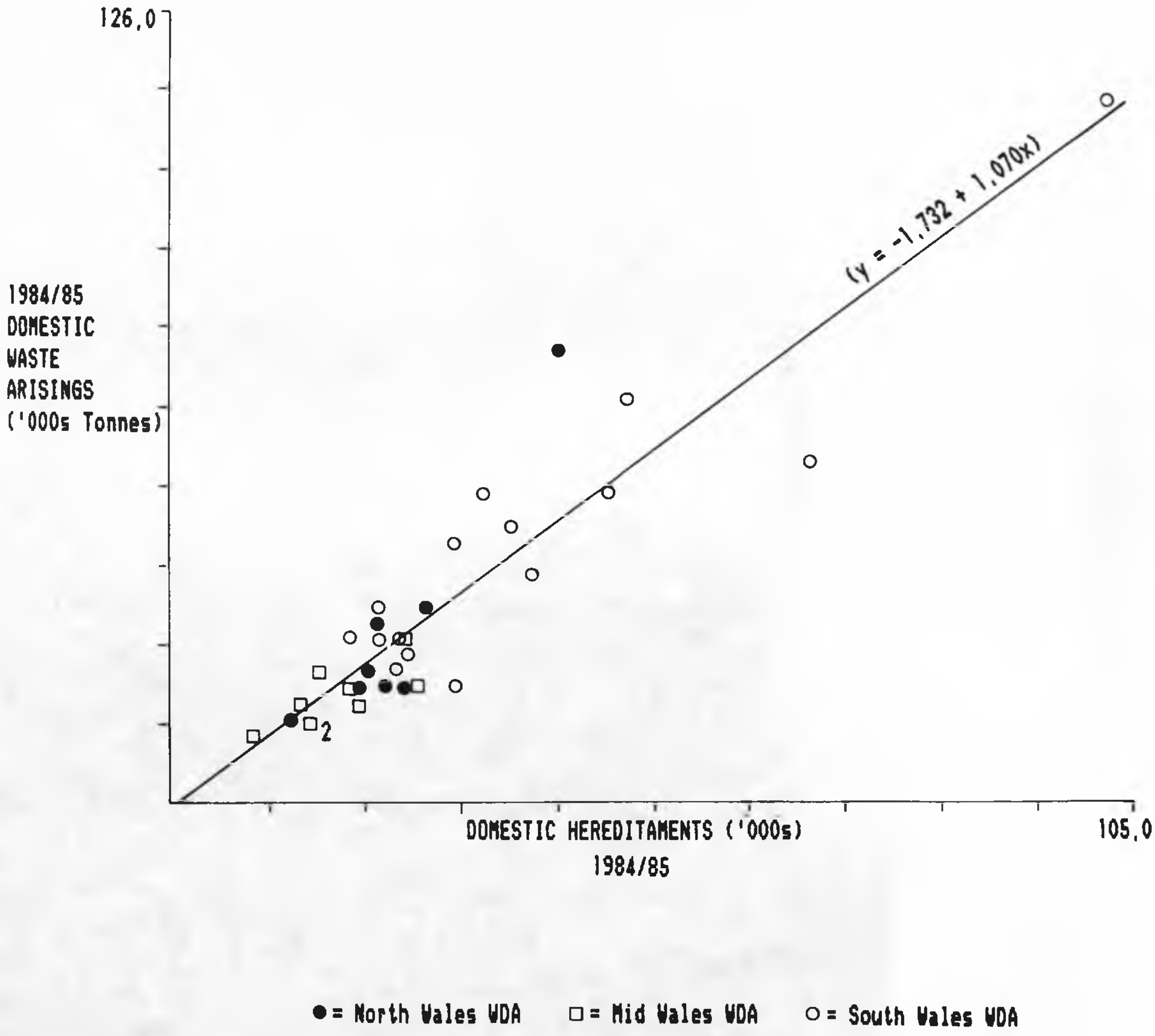

126,0
1984/85
DOMESTIC
WASTE
ARISINGS
('000s Tonnes)
(y = -1,732 + 1,070x)
2
DOMESTIC HEREDITAMENTS ('000s)
1984/85
105,0
● = North Wales WDA
□ = Mid Wales WDA
○ = South Wales WDA

Table 9.7 Predicted Domestic Waste Arisings for Authorities with Missing Data Based on Number of Domestic Hereditaments

Year	WDA	Domestic Hereds.	Waste Estimate(r)	Actual Data	Difference Tonnes	%
1979/80	Alyn & Deeside	25,269	28,869	24,600	-4,269	17.3%
	Llanelli	29,136	32,303	35,050	+2,747	7.8%
	Swansea	69,009	67,712	66,000	-1,712	2.6%
1980/81	Torfaen	33,337	37,717	40,800	+3,083	7.6%
1981/82	Brecknock	15,561	16,513	9,883	-6,630	67.1%
1982/83	Arfon	22,835	28,696	25,000	-3,696	14.8%
	Llanelli	29,637	35,556	37,540	+1,984	5.3%
1983/84	Llanelli	29,865	29,898	ND	?	ND
1984/85	Meirionnydd	15,784	15,151	13,500	-1,651	12.2%
	Llanelli	29,865	30,213	ND	?	ND

ND= No data
r = ± Standard error of estimate shown in Table 9.6

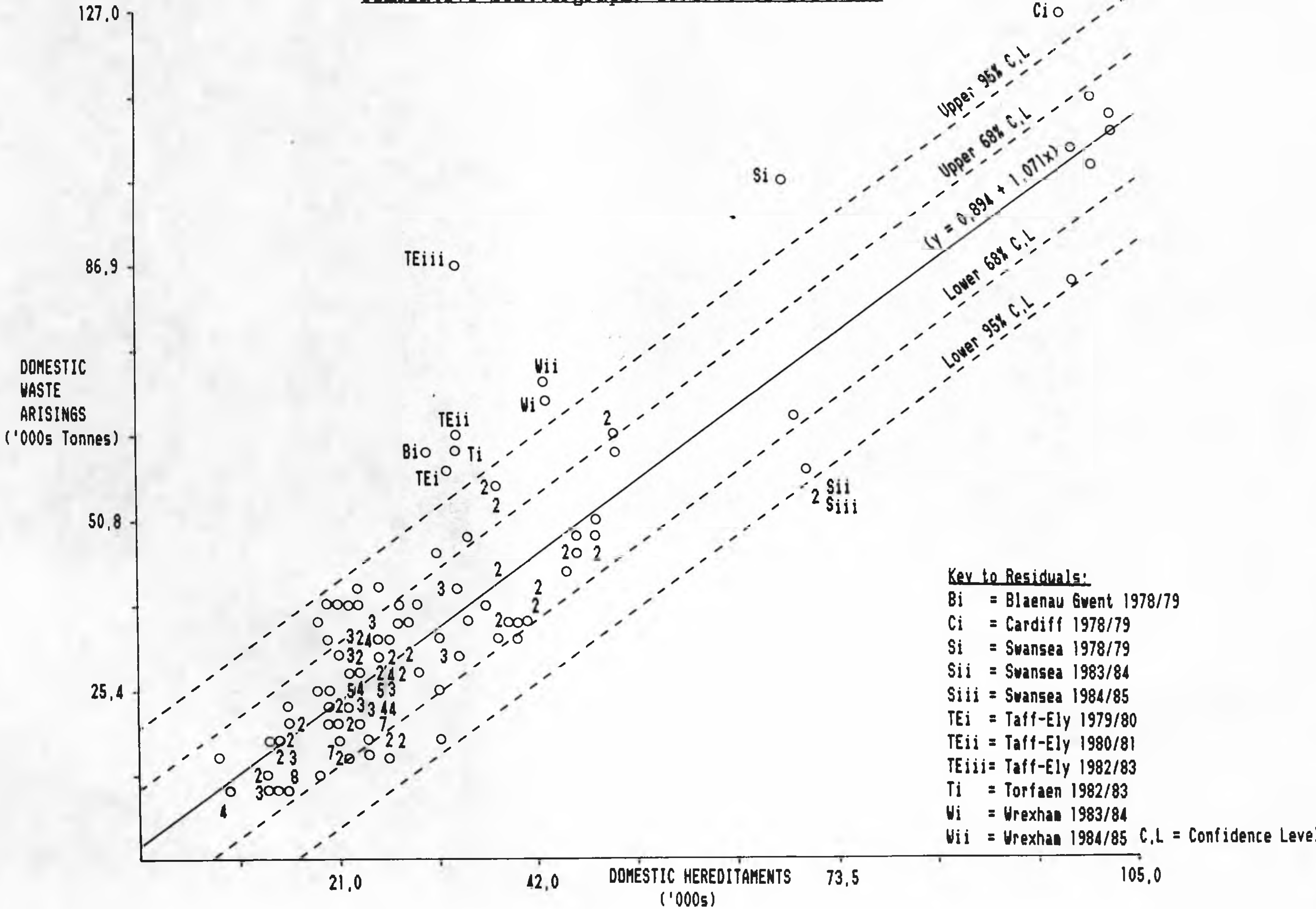
Source of raw data; CIPFA Waste Disposal Statistics Reports (Actuals)

In percentage terms, the differences recorded, are lower than those recorded for waste predictions based upon population estimates. Again, there is considerable discrepancy in some cases, notably Brecknock (1981/82), Meirionnydd (1984/85), Llanelli (1982/83) and Torfaen (1980/81). Undoubtedly, the same explanations must apply as for discrepancies between population based predictions and actual waste data. Although domestic hereditaments may be used to provide a useful indication of probable levels of waste arisings, a degree of inaccuracy is inevitable and is inherent in this predictive model, because inaccurate waste data have been used in its development.

Finally, Figure 9.4 presents the cumulative scattergraph for the period 1978/79 to 1984/85. The correlation coefficient of R=0.89 (at 0.001 level), is based upon 217 pairs of records. The regression line may be utilised to estimate, retrospectively, the probable average level of waste arisings for any authority over the seven year period. This is particularly valid for those WDAs which consistently failed to provide waste data, such as, Llanelli (four years) and Torfaen (three years). The levels of domestic waste arisings have been calculated for these two WDAs, as 32,281(±S.E) and 36,680(±S.E.) tonnes. The calculations are based upon the formulae shown in Appendix 9.3 and the standard error has been calculated at±9.16511, that is,±9,165 tonnes (Table 9.6).

The probable levels of domestic waste arisings for Llanelli and Torfaen, were also calculated using population as the associated variable, in order to investigate the degree of similarity in the two predictions. The resultant predicted levels of waste arisings were 32,075(±9,291) and 37,643(±9,291), respectively. Thus, the

Figure 9.4. Domestic Hereditaments and Domestic Waste Arisings: Cumulative Scattergraph, 1978/79 to 1984/85.



differences between the two sets of estimates were only 206 and 963 tonnes, with a difference of 126 tonnes between the standard errors.

An investigation of the residuals has been restricted to those revealed during analysis of all Welsh WDAs, over the whole seven year period. This provides the largest sample size possible, 238 and 217 pairs of data for the independent variables population and domestic hereditaments, respectively. Thus, the most extreme residuals over the seven years, will be revealed.

Figures 9.2 and 9.4 show those residuals which lie more than two standard errors from the regression line. The first of these, Figure 9.2, contains fourteen such residuals. The WDAs involved have been identified, together with the relevant year.

A number of factors are most noticeable:-

i) Eleven of the residuals represent six WDAs within South Wales, two are for one authority in North Wales and one for an authority in Mid Wales;

ii) Twelve of the residuals lie more than two standard errors above the regression line;

iii) Four WDAs, namely Cardiff, Swansea, Taff-Ely and Wrexham, are represented by two or more residuals. In each case, and particularly for the first three, whilst population levels have remained fairly constant, large changes in waste arisings have been recorded;

iv) The residuals are fairly evenly divided between individual years over the seven year period. No single year or short period can be attributed to the occurrence of most residuals,

and v) Analysis of the domestic waste arisings for these Authorities (Table 4.9) reveals that the residuals represent either the largest or lowest waste arisings recorded for each authority concerned, (depending upon whether the residual lies above or below the regression line). On the whole, waste arisings within these authorities fluctuate greatly; seven of the residuals represent a level of waste arisings more than 40% above the mean for their District. In four of the eight WDAs, data are missing for one or more years.

In addition, seven of the eight authorities concerned are in the top ten largest WDAs in Wales, (in terms of population). Although, this may suggest the presence of some related factor in their behaviour, it is more likely that because of the size of their populations and waste arisings, fluctuations in arisings appear more readily as residuals. For example, for an authority producing 100,000 tonnes per annum, a fluctuation in arisings of 10,000 tonnes represents a change of only 10%, whilst for an authority producing 25,000 tonnes per annum, this is equivalent to a 40% increase.

It is highly probable, therefore, that the residuals shown in Figure 9.2 merely represent unreliable data, (in some cases estimates which are quite inaccurate). No explanation is available for the fluctuations in arisings; these do not reflect a concomitant increase in population, thus, population change does not explain the variance in arisings.

Eleven residuals are shown in Figure 9.4, three fewer than were shown in Figure 9.2. On further analysis, two of the 'missing' residuals were cases in which data on the number of domestic hereditaments were missing, (South Pembrokeshire 1979/80 and Newport 1980/91) and so these are not recorded in the scattergraph. The third residual, Cardiff (1979/80) lies just within the 95% confidence limit shown in Figure 9.4.

The eleven residuals represent six of the same authorities from North and South Wales shown in Figure 9.2, and for the same years. Consequently, the same data for waste arisings are represented and the only difference between the two sets of eleven residuals, is the change in the independent variable from population to domestic hereditaments. Thus, the same findings apply, that is, that the variance in waste arisings is not explained by change in the number of domestic hereditaments. The residuals more probably reflect inaccurate waste data.

9.2.5 Population and Waste Prediction: Regional Groupings

The numerous points plotted in Figure 9.1 represent individual WDAs and have been differentiated according to their geographical location within Wales. They are divided into the three broad regions of North, Mid and South Wales. In each case there is a propensity for WDAs from the same region to cluster together. These regional groupings have been outlined in each diagram.

The cluster of Mid Wales Districts is always nearest to the intersection of the 'x' and 'y' axes, that is, these authorities are characterised by low population levels and low waste arisings. The South Wales Districts show an opposite trend. These cluster furthest away from the intersection and are characterised by high levels of population and waste arisings. The final group, that of the North Wales authorities, lies juxtapose the other two groups and has fairly average levels of population and waste arisings.

Correlation coefficients (R), have been calculated for each of the regional groups. The figures are presented in Table 9.8. On the whole, there is a high degree of association between population and waste arisings within each Region. With the exception of the 1979/80 value for Mid Wales, at no other time does the coefficient fall below R=0.68(at 0.001 level), most values being greater than R=0.85. It should be noted, that the sample size is considerably smaller when the WDAs are analysed in their respective regions, rather than as a single group. Consequently, the standard error and confidence limits must be calculated using a different procedure, Appendix 9.4.

Values for the coefficient of determination, (R^2), shown in Table 9.8, are highest for the region with the largest sample size, South Wales. Here, the percentage of the variance in waste arisings which may be 'statistically' explained by the level of population, is higher than for the other two regions, where the percentage of the variance which is unexplained, are quite high.

These apparent regional patterns of behaviour may be used to predict waste arisings for an authority, based upon the regression

Table 9.8 Correlation between Domestic Waste Arisings and Population at the Regional Level

	NORTH				MID				SOUTH			
Year	(R)	D	R^2	%UE	(R)	D	R^2	%UE	(R)	D	R^2	%UE
1978/9	0,84395	9	0,71	29	0,73856	11	0,55	45	0,91040	17	0,83	17
1979/0	0,87661	8	0,77	23	0,29926	10	0,09	91	0,87202	14	0,76	24
1980/1	0,82240	9	0,68	32	0,72313	11	0,52	48	0,86187	15	0,74	26
1981/2	0,89500	9	0,80	20	0,84182	10	0,71	29	0,93172	14	0,87	13
1982/3	0,77184	8	0,60	40	0,72656	10	0,53	47	0,75175	16	0,56	44
1983/4	0,87385	9	0,76	24	0,78377	10	0,61	39	0,94258	15	0,89	11
1984/5	0,85867	9	0,74	26	0,68303	9	0,47	53	0,92483	15	0,86	14
Total*	0,78664	61	0,62	38	0,62196	71	0,39	61	0,86712	106	0,75	25

D = Number of WDAs
(R) = Correlation Coefficient
R^2 = Coefficient of Determination
%UE = Percentage Unexplained
Total* = All seven years

line calculations specific to its region. The intercept (a) and slope (b) values required for this analysis, have been calculated for each region and are shown in Appendix 9.5. These values express the ratio between population and waste arisings and have been used to calculate the predicted waste arisings shown in Table 9.9. The accuracy of the predictions (Column 5), again varies when compared with 'actual' waste data for the previous or following year, (Column 7). It is noticeable, however, that there is a considerable improvement in accuracy compared with the predictions made in Table 9.5.; the latter predictions were calculated using a ratio based on all the Welsh WDAs, rather than regional groups. Even so, the large percentage differences recorded for some Districts are disappointing, as is the failure of eight of the 'actual' levels to fall within one standard error of the corresponding predicted values; in seven cases, these lie more than two standard errors away from the predicted value.

9.2.6 Domestic Hereditaments and Waste Prediction: Regional Groupings

The ratio between domestic hereditaments and waste arisings at a regional level may also be used to determine future waste arisings for WDAs within regional groups. In common with the scattergraphs for population and waste arisings, those for domestic hereditaments demonstrate similar strong regional groupings or clusters, (Figure 9.3). The correlation coefficients for each of the regional groupings over the seven year period are shown in Table 9.10. Again, the standard errors and confidence limits have been adjusted using

Table 9.9 Predicted Waste Arisings Based on the Ratio Between Population and Waste Arisings within Regional Groups

Year	Authority	Region	Population Estimate	Waste Estimate	+/-	Actual Data	Difference Tonnes	%
1979/80	Alyn & De.	North	72,200	30,397	(3,444)	24,600	_ 5,797	23.6%
	Blaenau G.	South	79,000	36,829	(5,227)	60,100	+23,271	38.7%
	Brecknock	Mid	39,000	21,457	(8,870)	14,732	- 6,725	45.6%
	Llanelli	South	75,500	35,935	(5,227)	35,050	- 885	2.5%
	Swansea	South	186,900	64,399	(5,227)	66,000	+ 1,601	2.4%
1980/81	Blaenau G.	South	78,000	38,342	(7,237)	31,730	- 6,612	20.8%
	Torfaen	South	90,700	42,629	(7,237)	40,800	- 1,829	4.5%
1981/82	Afan	South	54,600	25,719	(5,348)	37,000	+11,281	30.5%
	Brecknock	Mid	40,900	16,210	(2,886)	9,883	- 6,327	64.0%
	Taff-Ely	South	93,600	39,552	(5,348)	62,500	+22,948	36.7%
	Torfaen	South	90,300	38,381	(5,348)	61,000	+22,619	37.1%
1982/83	Arfon	North	54,663	23,692	(6,110)	24,880	+ 1,188	4.8%
	Dinefwr	Mid	36,800	15,961	(4,371)	17,500	+ 1,539	8.8%
	Llanelli	South	76,400	41,942	(8,403)	37,540	- 4,402	11.7%
1983/84	Dinefwr	Mid	36,700	14,334	(4,106)	16,300	+ 1,966	12.1%
	Llanelli	South	74,900	29,037	(4,448)	ND	?	ND
	Taff-Ely	South	93,000	35,326	(4,448)	49,100	+13,774	28.1%
1984/85	Meirion.	Mid	31,500	12,996	(3,044)	13,500	+ 504	3.7%
	Llanelli	South	74,500	29,704	(5,409)	ND	?	ND
	Preseli	Mid	70,200	21,055	(3,044)	37,800	+16,745	44.3%
	Torfaen	South	90,200	35,375	(5,409)	34,722	- 653	1.9%

Waste estimate is plus or minus the adjusted standard error (shown in brackets), based on 95% Confidence Limits
Actual data = data for the preceeding or following year
Standard errors have been adjusted to allow for small sample size, (explained in Appendix 9.4)

Table 9.10 Correlation between Domestic Waste Arisings and Number of Domestic Hereditaments at the Regional Level

	NORTH				MID				SOUTH			
Year	(R)	D	R^2	%UE	(R)	D	R^2	%UE	(R)	D	R^2	%UE
1978/9	0,88783	9	0,79	21	0,90690	8	0,82	18	0,92102	15	0,85	15
1979/0	0,85457	8	0,73	27	0,74648	6	0,56	44	0,87044	12	0,76	24
1980/1	0,74189	9	0,55	45	0,73573	10	0,54	46	0,89854	13	0,81	19
1981/2	0,86457	8	0,75	25	0,83242	10	0,69	31	0,96003	11	0,92	8
1982/3	0,79565	8	0,63	37	0,70992	10	0,50	50	0,73842	16	0,54	46
1983/4	0,91816	9	0,83	17	0,71222	8	0,51	49	0,93967	15	0,88	12
1984/5	0,91067	8	0,83	17	0,75469	9	0,57	43	0,92417	15	0,85	15
7Yrs	0,80428	59	0,65	35	0,74002	61	0,55	45	0,87112	97	0,76	24

(R) = Correlation Coefficient
D = Number of WDAs
R^2 = Coefficient of Determination
%UE = Percentage Unexplained

the method shown in Appendix 9.4, to allow for the small sample sizes involved. In spite of the small sample sizes, the coefficients are statistically significant, ranging from R=0.71 to R=0.96(at 0.001 level).

Probable waste arisings within each region have been calculated using the adjusted standard errors (Appendix 9.4) and the intercept and slope values contained in Appendix 9.6. The resultant levels of waste arisings predicted for authorities with missing data, are shown in Table 9.11. The percentage differences recorded between these figures (Column 5) and actual arisings for other years, (Column 7), are large for some authorities, notably for Brecknock; the only WDA for which the 'actual' level of arisings lies more than one standard error from the predicted level.

Two main conclusions can be drawn;

i) First, that these 'differences' are considerably less than those recorded using calculations on an all-Wales basis, (Table 9.7),

and ii) Secondly, predictions based on the relationship between domestic hereditaments and waste arisings are more accurate than those using population, (Table 9.9).

9.3 <u>Summary</u>

Regression analysis has shown that a high degree of association exists between size of population, number of domestic hereditaments

Table 9.11 Predicted Waste Arisings Based on the Ratio Between Domestic Hereditaments and Waste Arisings within Regional Groups

Year	Authority	Region	Domestic Hereds.	Waste Est.	+/-	Actual Data	Difference Tonnes	%
1979/0	Alyn & Dee.	North	25,269	27,320	(3,716)	24,600	- 2,720	11.1%
	Llanelli	South	29,136	37,413	(6,035)	35,050	- 2,363	6.7%
	Swansea	South	69,009	66,660	(6,035)	66,000	- 660	1.0%
1980/1	Torfaen	South	33,337	40,113	(6,677)	40,800	+ 687	1.7%
1981/2	Brecknock	Mid	15,561	15,368	(2,961)	9,883	- 5,485	55.5%
1982/3	Arfon	North	22,835	24,334	(5,821)	24,880	+ 546	2.2%
	Llanelli	South	29,637	42,880	(8,592)	37,540	- 5,340	14.2%
1983/4	Llanelli	South	29,865	30,377	(4,556)	ND	ND	ND
1984/5	Meirionnydd	Mid	15,784	14,448	(2,735)	13,500	- 948	7.0%
	Llanelli	South	29,865	31,073	(5,431)	ND	ND	ND

Waste estimate is plus or minus the adjusted standard error (shown in brackets), based on 95% Confidence Limits
Actual data = data for the preceeding or following year
Standard errors have been adjusted to allow for small sample size, (explained in Appendix 9.4)

and domestic waste arisings. These relationships can be quantified in terms of coefficients of correlation and may subsequently be used to predict waste arisings either in cases where data are missing or to make future predictions. Analysis has shown that accuracy in prediction increases in relation to decreases in scale, that is, that these are negatively related. The probable explanation for this, is the increase in internal homogeneity found, with each reduction in the size of area analysed. Thus, predictions for WDAs within specified regions are more accurate than those based on the whole of Wales, as the variations within each region are smaller than those for Wales as a whole. Furthermore, predictions based on the ratio between domestic hereditaments and waste arisings appear to be the most accurate.

In a situation where data are totally inadequate for some authorities, these methods of prediction, no matter how coarse, are valuable in the prediction of probable levels of waste arisings. The accuracy of such 'predictive models' is, however, dependent upon the quality of the data on which they are based. The models used here, have been based upon waste data which, for the most part, have been estimated rather than weighed, therefore, some inaccuracy is inevitable. However, these findings suggest that those authorities with good waste data may be used as a template to establish definite relationships between population, housing and domestic waste arisings and that this information may subsequently be used to predict arisings in other WDAs with far more accuracy.

CHAPTER 10

10. WASTE PREDICTION AND POPULATION SOCIO-ECONOMIC CHARACTERISTICS

10.1 Introduction

Two main conclusions were drawn in Chapter 9:-

i) First, that there is an increase in the accuracy of waste prediction commensurate with a decrease in the geographical scale of investigation. Obviously, the use of data at the smallest scale available, that is the smallest geographical area, reduces the effects of aggregation and enables the identification of regional (and sub-regional) variations in the relationships between waste and population,

ii) Secondly, it was suggested that those WDAs with reliable weight data may be used as 'templates' for establishing the nature of the relationships between waste arisings, population and the number of households at a local scale, and that these relationships may have general applicability to WDAs with similar characteristics.

Chapter 11 will focus on the suggestion made in part ii (above), using Alyn and Deeside District Council as a case study to investigate the exact nature of these relationships; the analysis being based upon the weight data available for this particular WDA. This Chapter, forms a preliminary investigation of the case study and identifies methods of further sub-dividing and classifying population in a meaningful way with respect to waste production and prediction.

It is a commonly held belief that different 'types' of population produce different types and quantities of waste. Indeed, regional variations in waste production have been identified throughout this study and have been related, for example, to 'industrial and densely populated South Wales' or 'rural and sparsely populated Mid Wales'. Such regional or macro level patterns represent the cumulative effect of numerous local variations, that is, at the micro level. This appears to be the result of strong tendencies within the population for small groups with similar lifestyle characteristics to concentrate in distinct geographical locations. The ability to classify these groups and their sub-regional variations into identifiable and meaningful categories is a necessary prerequisite for the investigation of their impact on waste production and, hence, prediction.

The logical basis of such a classification is the census data produced by the Office of Population Censuses and Surveys (OPCS). There are many advantages to using these data:-

i) National coverage - the data produced cover the whole of Great Britain;

ii) Data compatibility - the data are compatible, having been collected systematically by questionnaire survey on the same date;

iii) Data availability - the data are readily available at a variety of geographical scales, from national level to individual streets and households;

iv) Trend data - the census has been updated every ten years since 1801 (with the exception of 1941),

and v) Type of data recorded - a whole range of variables are recorded, including housing, employment and population structure. These have been considerably expanded since 1951; for the purposes of this study, many may be used as indicators of wealth, lifestyle and, consequently, propensity to produce different types and quantities of waste.

Two national classifications of population, based upon census data, have been developed within the United Kingdom. Both use multivariate analysis techniques, such as cluster analysis, in an attempt to classify population at the micro level according to the socio-economic characteristics of residential areas. This is done by identifying areas with similar census characteristics. Discussion of the statistical techniques upon which they are based, is available in the literature (Webber, 1975, 1979 and Openshaw, 1980, 1982, and 1983), and is not included here.

The two classifications are:-

i) ACORN - A Classification Of Residential Neighbourhoods,

and ii) The 'Super Profiles' Classification.

10.2 ACORN - A Classification Of Residential Neighbourhoods

ACORN was developed by Richard Webber of CACI, in the late 1970s, but had its foundations in earlier work Webber had undertaken in connection with OPCS, at the Centre for Environmental Studies, (Webber, 1975). OPCS had been interested in the development of a multivariate socio-economic classification in order to derive a standard classification of areal units with which to summarise census and survey data, (Webber & Craig, 1978). Webber experimented with a series of national classifications, at a variety of scales including District, Ward and Enumeration District (EDs), (Webber, 1978, & 1979).

Initially, work was focused on classifications at the 'macro' scale, such as the socio-economic classification of local authority areas. This was because of the computational problems in handling the quantity of data necessary for the development of a classification at ED level; there are approximately 130,000 EDs in Britain, each of which comprises around 150 households, (Charlton et al., 1985). Appendix 10.1 shows the classification for the 457 District Authorities developed by Webber and Craig (1978), based on 1971 Census of Population Small Area Statistics (SAS) data. A total of forty variables were used in the analysis and resulted in the production of thirty clusters or groupings of authorities with like characteristics. These clusters, together with the 'family' groups into which they were aggregated, are shown in Appendix 10.1, (only the Welsh local authorities have been included in the Table).

ACORN was initially developed as a ward-based classification. It utilised 1971 census data to classify the 15,000 wards into thirty-six clusters and seven families. It was then modified into an ED level classification and later updated using 1981 census data; two additional clusters were added. This 'new' ACORN was launched in 1983. It uses forty SAS variables to classify census enumeration districts into thirty-eight different clusters or neighbourhood types. These are then aggregated into eleven neighbourhood groups.

The 1981 ACORN Profile for Great Britain is shown in Appendix 10.2. This lists the ACORN groups and types and gives the number and proportion of the national population within each category. The ACORN system has been refined to the extent that each of the twenty million residential addresses in Britain can be individually classified according to its postcode, to reflect the social characteristics of the people living there. The commercial potential of the system is vast and is being fully utilised by CACI in terms of market analysis and advertising. CACI offers a wide range of services including market modelling and targeting, customer profiles, area analysis and direct mailing, (CACI, Webber, 1985) But, herein lies the main drawback to this system in terms of its use in academic work. It is only available commercially and must be purchased from CACI.

An additional point to consider is that the system has received some criticism (Openshaw _et al_., 1980, & Charlton _et al_., 1985). Five major faults have been identified in the new and old ACORN classifications, namely that:-

'1. They were not, apparently, subjected to any detailed evaluation.

2. They used raw data in the computation of similarities and, owing to the presence of correlated variables, the similarities would be heavily biased by the choice of variables.

3. The "old ACORN" was a seemingly poor classification that had only been based on a minute sample of the data (see Openshaw et al., 1980), and yet marketplace pressures forced CACI to retain much of it for quite different 1981 census data (for example, some of the variable definitions had changed and the importance of various indicator variables had changed considerably since 1971).

4. The new ACORN was based on, seemingly, a far more comprehensive analysis, yet it was constrained to match existing ACORN types.

5. There appears to be a feeling among some commercial users that the new ACORN is not as powerful a discriminator between different areal types as perhaps it could be.' (Charlton et al., 1985).

10.3 The Super Profiles Classification

The Super Profiles classification is a 'second generation' census ED classification. In common with the new ACORN system, Super Profiles is ED-based, and capable of being aggregated upwards for example to ward and District level or used in finer detail, such as the classification of individual postcodes. The methods upon which the system is based were developed by Stan Openshaw and are presented in Openshaw (1982) and (1983). The final product, however, was developed in 1982, as a result of collaborative research by Stan Openshaw, Colin Wymer and Martin Charlton at the University of Newcastle and Peter Batey and Peter Brown at the University of Liverpool.

The classification selected uses fifty-five variables, (Appendix 10.3); a further ten variables have been used in more recent analyses. The classification comprises 150 clusters or 'Super Profiles'. This number of clusters was selected because it appeared to be the optimum or

> 'best level of discrimination, in terms of distinguishing significant variation in consumer behaviour..' (Brown & Batey, 1987a).

The 150 Super Profiles provide a more sensitive, or finer classification, than ACORN and enable distinct types of area to be isolated. In many respects, this level of classification is too fine, particularly with regard to the analysis of waste production where data on waste arisings are at a much coarser level. However, the system comprises an hierarchical classification, in which the 150 Super Profiles are aggregated first into twenty-two 'Super Profile Groups' and further into eleven 'Lifestyles'. At each stage of aggregation, the classification becomes less sensitive and the internal homogeneity of the groups or clusters declines. Appendices

10.4 and 10.5 summarise the important features of each of the Super Profile Groups and Lifestyles, respectively. These may be compared with those for ACORN, Appendix 10.2.

Further information on the mean values for each of the sixty-five variables used in the classification at Super Profile Group level, is presented in Brown (1986b). This also includes a ranking of the top ten local authorities within each Super Profile Group, that is, the ten authorities which are most representative of each Group. A number of Welsh authorities are featured and these are shown in Appendix 10.6.

The Super Profiles system has also been developed for commercial use by the private sector and was launched by Demographic Profiles Ltd in 1986, (Demographic Profiles Limited, 1986) but unlike ACORN is freely available for use in academic research, (Brown, 1986a). The classification of all EDs and Districts within the County of Clwyd, in terms of their constituent Super Profiles, Super Profile Groups and Lifestyles, has been made available for this investigation and is analysed with regard to waste production in Chapter 11.

10.4 Socio-Economic Classifications and Waste Prediction: Current Research

The nature of the relationship between household type and waste arisings has been the subject of investigation since the 1920s; the 'household' being both the basic unit of domestic waste production and of socio-economic variations within the population. A series of household-based classifications have been related to waste arisings since the first attempt in 1926. This was based on the division of households into three categories according to their rateable value (Dawes, 1929). Later models included classifications based upon working class, middle class and better class property (Higginson, 1965) and type of property, for example, multi-storey flats in blocks of more than 4 floors, houses and bungalows and tenement type property, (Higginson, 1982).

The recent development of both the ACORN and Super Profiles Classifications, has presented new opportunities for analysis. In particular, these provide a much more sophisticated and comprehensive classification upon which to investigate variations in waste production. The use of the ACORN system in the forecasting of household waste has been the subject of research by Aspinwall & Company under a DOE waste management research contract since 1983. This work is still in progress and to date very little has been published regarding the findings, (nor has any unpublished material been made available). It is known, however, that this work has focused mainly upon two 'trial' Waste Collection Authorities in England, (Doncaster, South Yorkshire and Byker, Tyne and Wear), and that the ACORN 'Groups' (eleven categories), are being used rather than the thirty-eight ACORN 'Types', (Davies, 1983).

The only 'findings' to be made public by Aspinwalls to date are as follows:-

> 'There are clear differences in waste output between rounds, depending upon the ACORN profiles of the areas they serve. The more affluent neighbourhoods in Bury (ACORN Groups B, E and J)

typically generate 15-17 kgs. per household per week; the less affluent (ACORN Groups C, D, F and G) 10-11 kgs per week.

Seasonal variations in waste output are also markedly different. Rounds servicing the less prosperous ACORN C, D, F, and G neighbourhoods show virtually no seasonal variation in waste output and are essentially constant throughout the year. Rounds servicing the more prosperous ACORN B, E and J neighbourhoods show a distinct seasonal increase during the summer months with peaks in May and October. Weight output is lowest in February.' (Davies and Marsh, 1986).

Only seven out of the eleven ACORN Groups are mentioned. Furthermore, it would appear that variations in waste production between individual groups are negligible, but two main 'categories', 'wealthy' and 'poor', are distinguishable and exhibit definite differences in waste production. These findings are 'interim' only, but there are several points to be raised concerning the work:-

i) First, that both the ACORN classification and Aspinwalls' final results, will not be made freely available for academic and other use. Both organisations are primarily interested in servicing the private and public sectors, on a commercial basis;

ii) ACORN has been superceded by the Super Profiles classification, which being based upon a larger number of variables, has the ability to define areas with a greater degree of internal homogeneity,

iii) Although, research based upon English authorities may be applicable to those in Wales, it is probable given the regional variations within the Principality, that Welsh authorities may be subject to slightly different forces. One prime example, is the administrative base for waste management which differs considerably from that in England. Thus, there is a need to undertake analysis within Wales.

Undoubtedly, there are many difficulties inherent in the analysis of household waste production. However, an investigation of the relationship between domestic waste production and the socio-economic characteristics of households, based on the Super Profiles classification, is included at District level in the following Section and at the 'micro' level in Chapter 11.

10.5 The Socio-Economic Classification of the Welsh Waste Disposal Authorities

10.5.1 The Super Profiles Classification of the WDAs

Table 10.1 shows the classification of the Welsh authorities at both SP Group (SPG) and Lifestyle level. Two methods have been used to classify the Districts:-

Table 10.1 Classification of Welsh WDAs into Socio-Economic Categories: Super Profile Groups and Lifestyles

District	SP LIFESTYLES SPL	% of Pop	SPL	Index Related	SP GROUPS SPG	% of Pop	SPG	Index Related
ABERCONWY	4	32,24	4	372	20	26,7	20	543
AFAN	9	27,58	10	187	13	21,7	7	241
ALYN & DEE	6	39,45	6	245	4	27,7	3	241
ARFON	4	20,74	4	239	7	15,2	20	293
BLAENAU G.	8	36,26	8	349	7	35,9	7	460
BRECKNOCK	4	35,08	4	405	7	21,1	21	560
CARDIFF	1	20,69	1	232	1	16,6	11	449
CARMARTHEN	4	59,27	4	685	20	31,9	19	732
CEREDIGION	4	58,02	4	671	20	38,3	20	780
COLWYN	5	34,03	5	414	5	34,0	5	414
CYNON VALL.	8	52,47	8	505	7	48,4	7	620
DELYN	3	20,73	3	211	2	17,1	19	236
DINEFWR	8	36,44	4	370	7	36,4	19	503
DWYFOR	4	77,97	4	901	20	63,9	20	1,303
GLYNDWR	4	47,65	4	551	20	29,4	20	598
ISLWYN	8	35,35	8	340	7	35,3	7	452
LLANELLI	8	30,50	8	294	7	30,1	7	385
LLIW VALLEY	8	24,66	8	237	7	24,7	7	315
MEIRIONNYDD	4	65,38	4	756	20	56,3	20	1,148
MERTHYR TYD	8	41,83	8	403	7	38,1	7	488
MONMOUTH	4	32,25	4	373	19	18,1	19	483
MONTGOMERY	4	60,87	4	704	20	33,8	19	724
NEATH	8	29,23	8	281	7	29,2	7	374
NEWPORT	8	17,92	8	172	7	13,1	11	187
OGWR	8	19,41	8	187	7	18,2	7	232
PRESELI	4	43,69	4	505	20	24,2	19	520
RADNOR	4	56,35	4	651	19	29,7	19	793
RHONDDA	8	75,45	8	727	7	69,8	7	894
RHUDDLAN	5	28,86	5	351	5	28,9	5	351
RHYMNEY VAL	8	30,02	8	289	7	27,4	7	350
SOUTH PEMB	4	47,35	4	547	20	35,7	20	728
SWANSEA	8	19,67	8	189	7	15,1	7	193
TAFF-ELY	3	26,49	3	269	7	21,9	3	500
TORFAEN	9	29,14	9	184	13	22,2	15	286
V.OF GLAM	3	21,23	3	216	2	19,5	21	568
WREXHAM	9	21,64	10	140	12	17,3	12	204
YNYS MON	4	41,37	4	478	22	7,8	20	567

Source of original data: Brown, 1987.

i) First, the dominant Lifestyles and SPGs shown in Columns 2 and 6 respectively, are those which comprise the largest proportion of the authority's population, (Columns 3 and 7). For some authorities, over half of the population falls within just one SPG or Lifestyle. This is the case for eight Districts with respect to the Lifestyle categories, namely Carmarthen, Ceredigion, Dwyfor, Meirionnydd, Montgomery, Radnor (all lifestyle 4, 'Rural Britain') and Cynon Valley and Rhondda (both lifestyle 8, ' Dark Satanic Mills'). Three authorities have more than 50% of their populations within a particular SPG; Dwyfor and Meirionnydd (both SPG 20, 'Rural Areas') and Rhondda (SPG 7, 'Skilled and Semi-skilled Families').

Obviously, the higher the percentage, the greater the internal homogeneity of the population within the authority. Consequently, any 'behavioural patterns' which may be related to specific socio-economic groups, should be more strongly exhibited by those authorities with high proportions of their population within a single SPG or Lifestyle. Conversely, in cases where the dominant SPG comprises a small proportion of the population, behavioural patterns may be more difficult to detect. The dominant Lifestyle categories in two authorities, constitute less than 20% of the population; the corresponding number for SPGs, is nine authorities.

ii) The second method used, is based upon the 'index' value for each WDA. This is calculated as follows:-

$$\text{Index} = \frac{\underline{\text{Proportion of SPG Population found in District}}}{\text{Proportion of SPG Population found in UK}} \times 100$$

It represents the difference between the proportions of the national and District populations within each SPG or Lifestyle. The national average is expressed as 100, thus an index of 437 indicates that the proportion of the authority's population within the SPG or Lifestyle is 337% greater than the national average. High index values indicate deviation from the national average, and again, any 'behavioural patterns' associated with the dominant SPG or Lifestyle, may be more strongly exhibited.

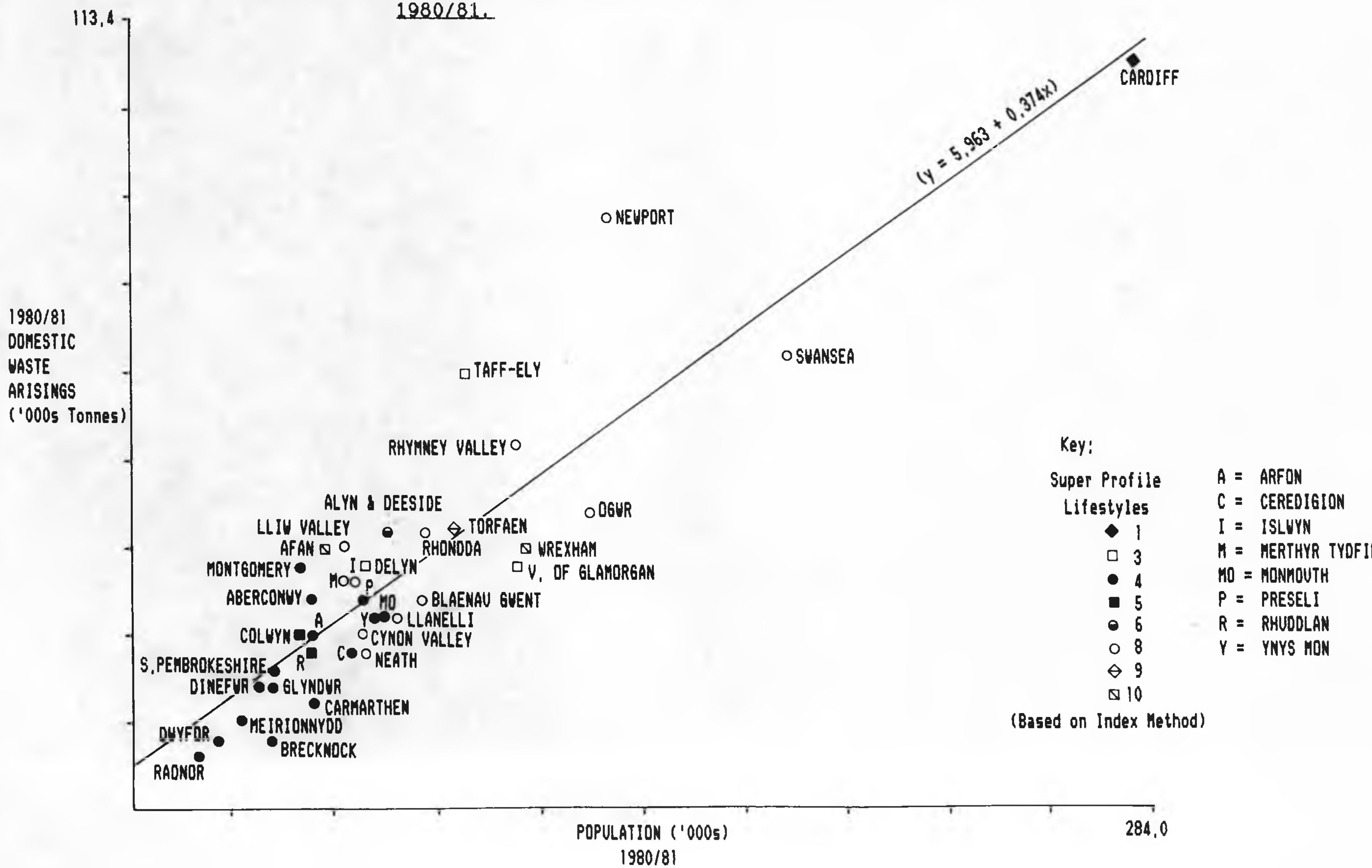
The dominant Lifestyles and SPGs produced using the index method, are shown in Columns 4 and 8, (Table 10.1); the indices upon which they are based are shown in Columns 5 and 9. A total of seven and nine authorities respectively, have an index greater than 600 for Lifestyles and SPGs. This represents a difference of 500% from the national average. That is, the proportion of the population falling within one SP category, is more than 500% above the UK average for that category. Thus, these WDAs are likely to exhibit the strongest behavioural tendencies.

A comparison of the dominant lifestyle categories produced by the two methods, (Columns 2 and 4), shows a high degree of similarity. Only in three cases, Afan, Dinefwr and Wrexham, is a difference in Lifestyle category recorded. In each case, the tendency is for low population percentages and low index values. These indicate that the population of the District comprises a number of socio-economic types, none of which is large enough to assert a strong presence.

The designation of Districts into dominant SPGs, produces two quite different classifications based upon the two methods. Columns 6 and 8 show that fourteen authorities (38%), are re-classified. In each case, the percentage of the population comprised within the main SPG or Lifestyle, was less than 37% and less than 20% in six cases. In general, the main SPGs contain a much lower proportion of the population (Column 7) than the SP Lifestyles, (Column 3). This is to be expected, as the twenty-two SPGs are aggregated together to produce the eleven Lifestyles. Thus, the population percentage recorded for one Lifestyle is divided amongst two or three member SPGs. Conequently, it is less likely that any one SPG will be completely dominant or at least, show the degree of dominance exhibited by some of the Lifestyle categories. For this reason, those authorities with a high proportion of the population contained within a single SPG, are quite exceptional. Table 10.1 shows four such WDAs, with more than 40% of their population within a single SPG. In each case, the SPG category remains the same, regardless of the method of classification used.

The four classifications shown in Table 10.1, were used to assess whether authorities with the same dominant SP Lifestyle or group, exhibit similar characteristics with regard to waste arisings. The domestic waste arisings (1980/81), and the total population (mid 1981 estimate), within each authority, were regressed and the resultant scattergram used as a basis for analysis, (Figure 10.1). The year 1981 was selected, because both ACORN and Super Profile

Figure 10.1. Socio-Economic Clusters: Super Profile Lifestyles, 1980/81.



classifications are based upon census data collected during that year. Thus, with time the classifications become more inaccurate and, therefore, the optimum year for analysis, is census year.

During analysis, each of the classifications (Table 10.1), were assessed. Those produced by the 'index method' were found to reveal the best clustering of Districts with similar SP categories and of these, the classification of WDAs according to the dominant SP Lifestyles, produced the best result, Figure 10.1.

A number of points emerge from the distribution of WDAs by SP Lifestyle, shown in Figure 10.1:-

i) Districts in category 4, 'Rural Britain', tend to cluster nearest to the intersect of the 'x' and 'y' axes. These authorities are characterised by small populations and low waste arisings;

ii) Districts in category 8, 'Dark Satanic Mills', tend to have larger populations, with high waste arisings;

iii) Two authorities, Colwyn and Rhuddlan, both in category 5, 'Older Suburbia', exhibit very similar waste production characteristics;

iv) Some categories contain only one authority and, therefore, no comparisons are possible. However, Cardiff (category 1, 'the Stockbroker Belt'), is noticeably different from all other WDAs;

v) Two lifestyles, 10, (Underprivileged Britain) and 3 (Young Married Suburbia), appear to occupy the middle ground between categories 4 and 8. They do not produce a tight cluster, and appear to exhibit characteristics closer to those in category 4 than category 8.

In previous analyses , Figures 9.1 to 9.4, WDAs were shown to cluster in regional groupings. Figure 10.1 suggests that there may be some variation in the relationship between SP Lifestyle and waste production, at a regional level. This relationship is analysed in Table 10.2i. Most noticeably, there is a 100% correlation between Mid Wales and category 4, 'Rural Britain', whilst all twelve of the WDAs in category 8, 'Dark Satanic Mills', are located in South Wales; this represents 71% of all South Wales WDAs. The North Wales authorities are more divided, the largest category, Lifestyle 4, containing four WDAs, (44%).

10.5.2 A Comparison between ACORN and Super Profiles

Figure 10.2 shows the clustering of WDAs according to their ACORN category. Again, a number of points are revealed:-

i) Districts classified as ACORN type 7 (Rural Wales), in common with those in Lifestyle category 4, cluster near to the intersection of the 'x' and 'y' axes;

ii) The four Districts in ACORN type 23, (Welsh Regional Centres), represent the opposite extreme to those in type 7. These four, Cardiff, Newport, Ogwr and Swansea, all have a

Table 10.2 The Socio-Economic Classification of WDAs: Regional Patterns

i) SP Lifestyles

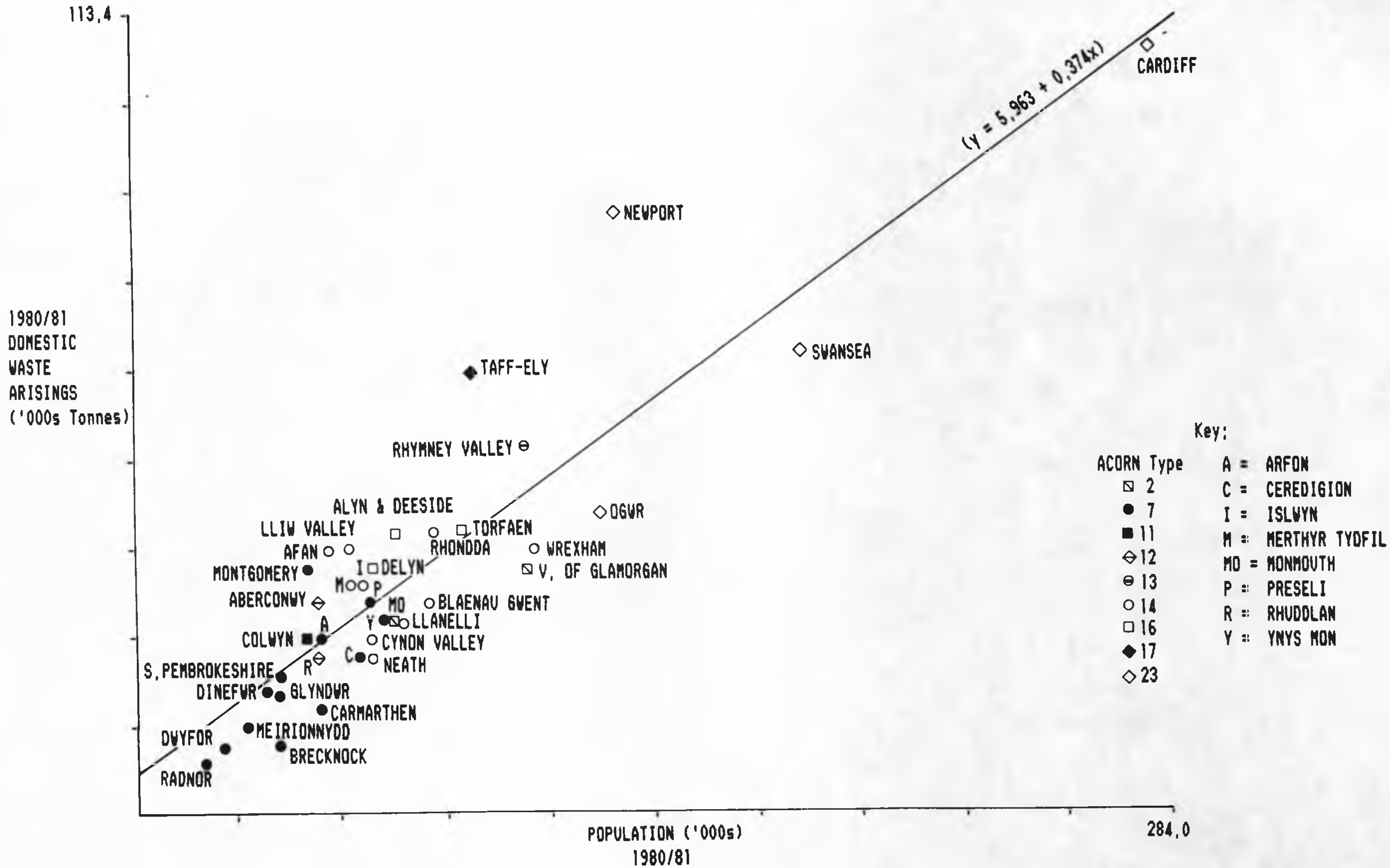
SP Lifestyle	No. of WDAs in Each Welsh Region North	Mid	South
1 Stockbroker Belt	0	0	1
3 Young Married Suburbia	1	0	2
4 Rural Britain	4	11	0
5 Older Suburbia	2	0	0
6 Lower Middle Class	1	0	0
8 Dark Satanic Mills	0	0	12
9 Council Tenants	0	0	1
10 Underprivileged Britain	1	0	1

ii) ACORN Type

ACORN Type	No. of WDAs in Each Welsh Region North	Mid	South
2 Rural Growth Areas	0	1	1
7 Rural Wales	3	10	0
11 Resort Retirement Centres	1	0	0
12 Port Retirement Centres	2	0	0
13 Lowland Heavy Industrial Areas	0	0	1
14 Upland Heavy Industrial Areas	1	0	9
16 Areas with Large Industrial Plants	2	0	1
17 Small Town Manufacturing Areas	0	0	1
23 Welsh Regional Centres	0	0	4

Source of original data;
i) SP Lifestyle Classification - Brown, (1987).
ii) ACORN Classification - Webber and Craig, (1978).

Figure 10.2. Socio-Economic Clusters: ACORN. 1980/81.



population greater than 100,000 and waste arisings greater than 40,000 tonnes per annum;

iii) A number of ACORN types appear to lie between the two extremes of types 7 and 23. In particular, ten Districts all classified as type 14 (Upland Heavy Industrial Areas), exhibit markedly similar characteristics and form a fairly compact cluster. A further three WDAs, Alyn and Deeside, Delyn and Torfaen, (type 16, Areas with Large Industrial Plants), form another small cluster of authorities which lie mid-way between the two extremes. This is also true for Aberconwy and Rhuddlan, both of which are in ACORN type 12, (Port Retirement Centres);

iv) Three ACORN types are each represented by only one authority and, therefore, no clusters or behavioural tendencies can be detected

Table 10.2ii shows that the classification of Welsh authorities into ACORN types, also reveals regional patterns, though not to the same extent as those produced by the SP Lifestyle classification. Ten Mid Wales authorities (91%) are classified as 'Rural Wales'; the remaining authority is in type '2', (Rural Growth Areas). In South Wales, nine WDAs (53%) are in type 14 (Upland Heavy Industrial Areas); the remaining eight WDAs are divided amongst five ACORN types. The nine North Wales authorities reveal no dominant grouping, but are divided between five ACORN types.

A comparison of Figures 10.1 and 10.2, together with Table 10.2i and ii, indicates that analysis of the Welsh WDAs using both the ACORN and Super Profile classifications, has produced similar findings. The degree of association between the two systems is presented in two matrices, Table 10.3. Part 'i', compares the nine dominant ACORN types and eight SP Lifestyles used to classify the WDAs. The degree of association varies, but is most noticeable between ACORN type 7 and Lifestyle 4, and between ACORN type 14 and Lifestyle 8. With regard to the association between the ACORN types and SP Groups, (Table 10.3ii), type 14 and Group 7 appear to be highly associated.

It should be noted, however, that any findings based upon the matrices, may merely reflect the number of authorities in each category, rather than the degree of association between the two systems. For example, ACORN type 14 contains ten authorities, of which nine (90%) are in SPG 7 and one (10%) in SPG 12. This may be compared with ACORN type 17, for which there is just one authority in SPG 3 (100%). Although, the second example reveals a 100% association, the first case is statistically more important, being based upon a larger sample.

10.5.3. Summary

Three main conclusions may be drawn from the analysis of the relationship between waste production and the socio-economic characteristics of populations at District level:-

i) First, that similarities in waste production are discernable for authorities of similar SP categories;

Table 10.3 Comparison of the ACORN and SP Classifications at District Level: All Welsh District Councils.

i) ACORN and SP Lifestyles

ACORN Categories	SP Lifestyle Categories 1	3	4	5	6	8	9	10	Total
	number of Districts								
2		1	1						2
7			13						13
11				1					1
12			1	1					2
13						1			1
14						8		2	10
16		1			1		1		3
17		1							1
23	1					3			4
Total	1	3	15	2	1	12	1	2	37

ii) ACORN and SP Groups

ACORN Categories	SP Group Categories 3	5	7	11	12	15	19	20	21	Total
	number of Districts									
2							1		1	2
7							5	7	1	13
11		1								1
12		1						1		2
13			1							1
14			9		1					10
16	1					1	1			3
17	1									1
23			2	2						4
Total	2	2	12	2	1	1	7	8	2	37

Source; i) ACORN Classification, Webber and Craig, 1978.
ii) SP Groups and Lifestyles, Brown, 1987.

ii) Some categories which individually reveal no strong pattern, may be amalgamated together for analytical purposes,

iii) WDAs from the same regions within Wales are more likely to be classified under the same category. Thus, supporting the theory that the regions of North, Mid and South Wales, exhibit quite different characteristics and that these have considerable repercussions for waste management. The implications of these findings for waste management will be discussed in the conclusion.

PART III A CASE STUDY IN WASTE MANAGEMENT AND DATA COLLECTION

CHAPTER 11

11. WASTE ARISINGS AND POPULATION SOCIO-ECONOMIC CHARACTERISTICS AT THE MICRO SCALE: ALYN AND DEESIDE WASTE DISPOSAL AUTHORITY

11.1 Introduction

Chapter 9 investigated the possibilities of waste prediction based on population and households at national, regional and District levels. However, it was noted that accuracy in prediction is achieved through the use of data at the finest scale possible, that is, at sub-District level. Chapter 10, in particular Section 10.5, showed that the development of census based socio-economic classifications presents new possibilities for the analysis of waste arisings and subsequent development of models for waste prediction. It was shown that behavioural patterns, based on the relationship between waste arisings and socio-economic groups, are discernable at District level.

In consideration of the findings made in Chapters 9 and 10, this Chapter is based upon a case study, and takes the analysis a stage further, to sub-District level. It represents a natural progression in the research and is purely concerned with methodological development.

The authority of Alyn and Deeside in North Wales, is used to investigate the feasibility of and methodological difficulties encountered by the analysis of relationships between Census Small Area Statistics and Refuse Collection Vehicle (RCV) Round data. This analysis is undertaken with a view to developing a predictive model, capable of general application, for domestic waste arisings.

The selection of Alyn and Deeside as a suitable case study, was based upon a number of factors:-

i) First and most importantly, the District operates a weighbridge at its landfill site and maintains a comprehensive record of all waste arising from the RCV collection rounds. Accurate weight data are essential for this analysis and Alyn and Deeside is one of only six Welsh WDAs (1984/85), which weigh 100% of the waste collected (Table 3.2);

ii) Full co-operation was obtained from the District and the necessary data were made readily available,

iii) The District is a member of the North Wales regional group of WDAs and does not exhibit the 'extremes' of either the industrial South or rural Mid Wales Districts, but rather a mixture of these two, as evidenced by its position in Figures 10.1 and 10.2. It is fairly representative of the 'average' Welsh situation for a number of variables, recording values near to the calculated national mean, (Table 11.1). This is particularly the case for population, number of domestic hereditaments and domestic waste arisings; three of the most important variables for waste prediction. However, it is

Table 11.1 Comparison Between Alyn & Deeside and National Mean

Variable	Alyn & Deeside	Welsh Mean
Population mid 1984 estimate	73,300	76,979
Population density (persons per ha)	4.75	3.62
No. of Domestic Hereditaments	26,400	29,476
No. of Commercial Hereditaments	3,100	4,006
No. of Industrial Hereditaments	170,000	127,500
Waste from the Collection Authority*	34,100	34,852
Waste disposed by the WDA directly	47,500	61,433
Waste disposed to landfill untreated	47,500	59,064
Expenditure per tonne landfill (£)	2.10	2.45
Cost of Collection per tonne (£)	14.90	20.81
Waste Collected per head (Kg)	678	543
Average haul to disposal (Km)	10.60	11.94

* Includes Household Amenity Waste
All data relate to 1984/85 unless otherwise stated

Calculated from data contained in CIPFA Waste Disposal & Waste Collection (Actuals) Reports, 1984/85.

recognised that Alyn and Deeside is only truly representative of those WDAs with similar characteristics, such as the other North Wales District Authorities.

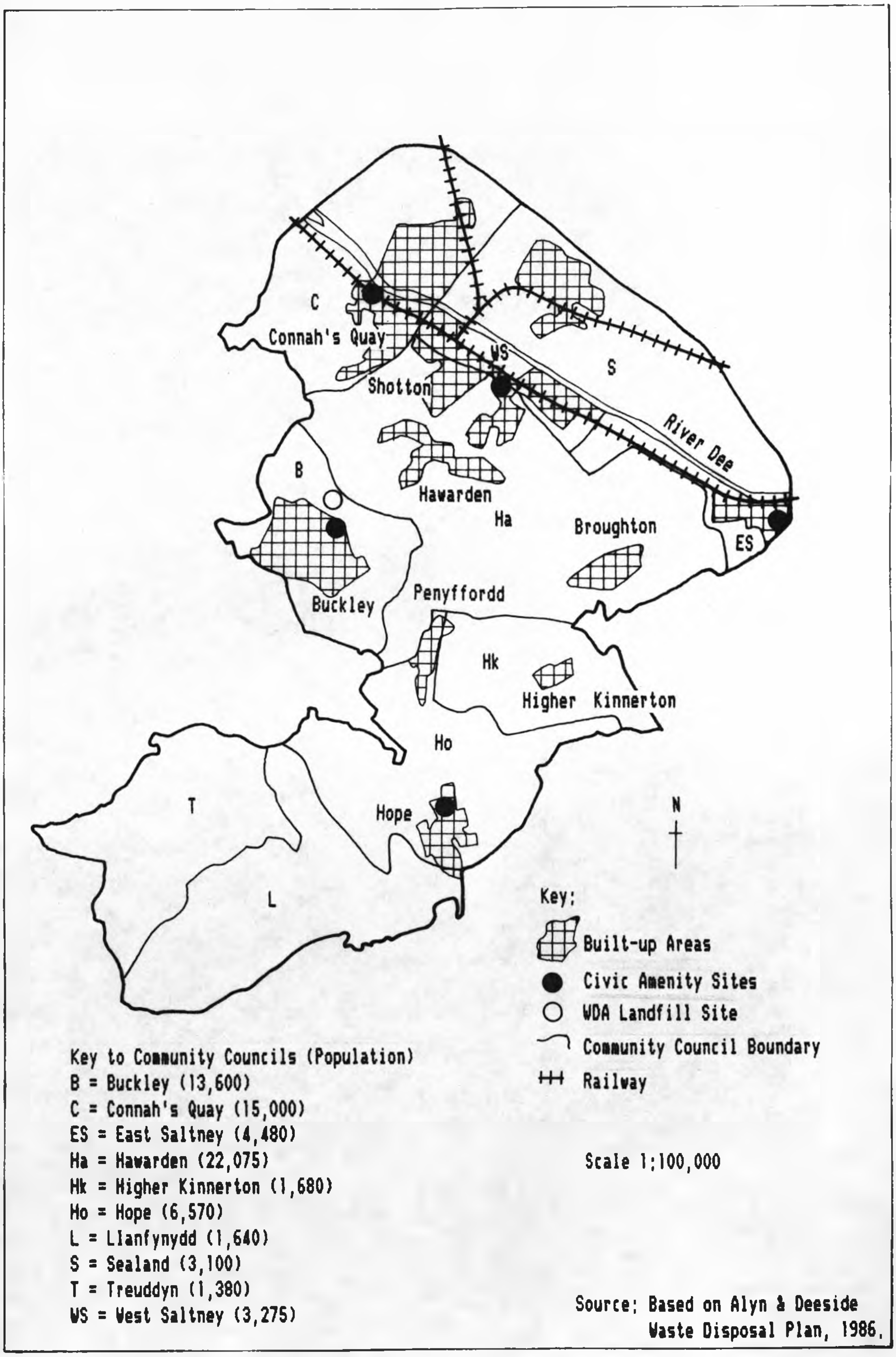
11.2 ALYN AND DEESIDE WASTE DISPOSAL AUTHORITY

11.2.1 The Geography of Alyn and Deeside

Alyn and Deeside District Council is situated within the County of Clwyd, in North East Wales, (Figure 11.1). It was formed during local government re-organisation in 1974, by the merger of two urban authorities, (Buckley and Connah's Quay), with the rural District of Hawarden. Consequently, it comprises a mixture of rural and urban areas, with some stark contrasts, for example, between industry and agriculture, wealth and poverty, high and low population densities, and between areas of new industrial development and those of industrial dereliction.

The mid 1985 population estimate for the whole District, was 72,900 (Welsh Office, 1986), with an anticipated population level in 1996 of 80,000. This represents a population growth of 9%; far higher than that for Clwyd (7.2%) or the Welsh average (1.6%). It is anticipated that the majority of this increase will be catered for in the areas around Buckley and Connah's Quay, (Alyn and Deeside, 1986), thus, maintaining the traditional pattern of settlement. The distribution of population by community council is shown in Figure 11.1, together with the major settlements.

Figure 11.1. Alyn and Deeside Waste Disposal Authority Area.



Industrial development has traditionally been concentrated in the north, along the Dee Estuary. The recent closure of the area's main employer, the British Steel Corporation's Shotton Works, with the loss of 15,000 jobs, has resulted in increased attempts to attract new industries to the area by offering very favourable incentives. Thus, a number or new industrial estates have sprung up in recent years including the Deeside Industrial Park, Dock Road Industrial Park at Connah's Quay, Factory Road Industrial Park at Sandycroft, and further industrial estates at Buckley and Saltney, (Figure 11.1). Chief among these is Deeside Industrial Park, designated for large-scale capital investment, (Clwyd County Structure Plan, Policy Number 32, Clwyd County Council, 1982). This recent industrial development has followed the pattern of traditional industrial location and hence, the distribution of industry and settlement have largely remained unchanged.

Agriculture is an important feature in the economy of the area, comprising sheep farming, with dairying and the rearing of beef cattle. The Community Councils south of Buckley and Hawarden, namely, Treuddyn, Llanfynydd, Hope and Higher Kinnerton, are predominantly agricultural in nature. Thus, the southern half of the District is clearly more rural, with few main settlements. In addition, there is a presumption against the use of agricultural land in these areas for non-agricultural purposes, (Clywd County Structure Plan, Policy Number 40., Clwyd County Council, 1982).

11.2.2 Waste Management in Alyn and Deeside

Responsibility for waste management lies with the District's

Engineering Services Department. A total of forty staff are employed on the technical, administrative and manual aspects of waste management; thirty-six being employed solely in refuse collection. This comprises the collection of household and commercial waste arising within the District and includes waste from retail premises, offices and schools, in addition to all household waste, but does not include any waste arising from an industrial process, (Alyn and Deeside, 1986). Since mid 1986, a system of seven collection rounds has been used to collect refuse from the whole District. In addition, the District provides a number of purpose-built Civic Amenity Skip sites, which are located near to the main centres of population, (Figure 11.1).

The authority operates a single landfill site, Etna or Fennah's tip, near Buckley, (Figure 11.1). The site is a former clay pit, quarried by the brick-making industry that once thrived in the area. It has a natural lining of impermeable clay and provides an excellent containment site for waste disposal. Household and commercial refuse collected by the authority is disposed of at the Etna site, (Plates 4 and 5), which fortunately for the authority is located:

> 'close to the calculated geo-centre, for its refuse collection activities' (Alyn and Deeside D.C, 1986).

A weighbridge has been installed at the site and is used to monitor all waste disposed, including waste collected by the WDA (from the Civic Amenity sites and RCV collection rounds), and waste delivered by private individuals, mostly comprising waste from the

Plate 4. Etna Landfill Site, Alyn and Deeside: Located in a former Clay Pit.

Plate 5. Compaction of Waste at the Tip Face, Etna Landfill Site.

construction industry. In 1986, the remaining capacity of the site was estimated to be three years and provision for future disposal requirements had already been made at two further clay pits, Drury Brickworks and Standard Brickworks. Again, these are located near to the Etna site at Buckley; both have an estimated capacity of six to eight years, (based on the current rate of tipping).

Private disposal facilities within the District comprise fourteen licensed landfill sites of which three are limited to waste from the industry within whose boundaries they are located, one is a temporary site for the disposal of waste from a new by-pass and the remainder accept only inert, non-toxic, non-leachate producing waste. In addition to these, there is one licensed treatment plant for waste oils. Noticeably, only one site is licensed to receive special wastes. This is the British Steel Broken Bank Tip at Shotton, which disposes of 2,300 tonnes of special wastes per annum.

11.3 DEVELOPING A FEASIBLE METHODOLOGY

11.3.1 Introduction: Methodology and Data Requirements

Selection of the optimum level of analysis is an important initial stage in any investigation. It is theoretically possible to analyse the relationship between domestic waste arisings and population socio-economic characteristics, at a variety of scales, including District level, ward, ED, street, postal code and individual household. However, the practicalities of such an investigation necessitate a balance between on the one hand using as fine a level of detail as possible, and on the other, pitching the investigation at a level which is feasible. To a large degree, this is predetermined by the data available within each WDA, unless it is possible to initiate a detailed investigation, for example, at individual household or street level. However, this requires both considerable resources and the fullest co-operation and participation of the local authority concerned; in most cases, given the financial constraints already imposed upon local authorities, this is not practicable. In addition, it may be argued that analysis of individual households, notwithstanding the use of random sampling techniques, may produce spurious findings as a result of atypical behaviour. Thus, a certain degree of aggregation is desirable to establish the 'norm' for a particular socio-economic group.

In Alyn and Deeside, data on domestic waste arisings are available for RCV collection rounds on a half daily basis. For each half day, the streets serviced can be readily identified and the number of households calculated. Data at a finer level, that is, for individual streets and households, are not available. Thus, the level of analysis used here has been pre-set.

Whilst the authority maintains a record of the number of premises serviced, it does not record the population within each round. The primary role of the District as the Waste Collection Authority, necessitates the need for data on the number of premises, rather than the number of people within each round. For administrative purposes, population data are, perhaps, only required at District level, for example, in the calculation of costs per head of population.

Consequently, an attempt was made to calculate the population within each round and half-day round, based upon data from the electoral register. This proved unsuccessful, for a number of reasons:-

i) The electoral register contains only the population aged eighteen years and over, not the total population. The ratio between the under eighteen and eighteen and over age groups was calculated at District level, with a view to applying this to the eighteen and over population for each round, and hence calculating the total population. This method was subsequently rejected on the basis that the ratio would probably vary substantially according to the socio-economic characteristics of the population in each round and, therefore, the calculated totals would be unreliable;

ii) Occasionally, it was not possible to identify a street which was named in the collection round schedule, but not in the electoral register and vice versa;

iii) Frequently, streets, and main streets in particular, may be divided between two or more collection rounds. In such cases, the proportion of the street population contained within each collection round is unknown,

iv) Although, the electoral register is regularly updated, it is not totally accurate and is subject to over- and under-representation of the true situation. Changes in population such as deaths, change of address, house construction and demolition with their consequent impact, and absences away from home, are often slow to be noted.

The possibility of using census data as an alternative was explored, but proved too time consuming. If some of the difficulties listed above where to be overcome, this would have required a street by street analysis of the data for the whole District. An additional consideration was that this data source is also subject to problems; it relates to 1981 and thus, with the passage of time, becomes more inaccurate. Consequently, it was decided to omit the analysis of waste arisings and population at round level. The following analysis, therefore, focuses attention on the relationship between socio-economic groups and waste arisings, using the household as the basic unit.

The next stage requires the ability to assign socio-economic classifications, Super Profile categories, to the daily or half-day collection rounds. Super Profile (SP) classifications including Super Profiles, Super Profile Groups and Super Profile Lifestyles, were obtained for Alyn and Deeside at ED level. The Lifestyles classification containing just eleven categories, was selected as the most appropriate level of classification for analysis. This was primarily because the larger number of categories in the other two levels of classification, 150 and 22 respectively, appeared too fine in relation to the coarseness of the waste weight data available. For example, the use of the 150 SP categories would lead to the classification of a large number of small groups of households, whilst the waste data are available for groups of streets. Secondly, an analysis of the 140 EDs within the District revealed that only 49 of the 150 SP Profiles (SP s) were represented in Alyn and Deeside. Whilst this is high, given the number of EDs present and indicative of the diverse nature of the area, it represents only one third of all SP categories.

Table 11.2 shows the number of SPGs and Lifestyles represented in Alyn and Deeside. Again, neither level of classification is fully represented; fifteen out of twenty-two SPGs and ten out of the eleven SP Lifestyles are present. The missing Lifestyle category is Lifestyle b, the 'Metro Singles', containing young professionals in bed sitters and/or older white collar flat dwellers and/or young single white collars in rented property, (Appendix 10.5). This Lifestyle is the smallest, containing only 3.48% of the national population (with the exception of the Lifestyle containing 'Unclassified' areas). Thus, the Lifestyle classification presents the best option for investigation; Plates 6 to 13 illustrate most of the SP Lifestyles present in Alyn and Deeside.

11.3.2. The RCV Collection Round Data Base

Since 1978, it has been the policy of Alyn and Deeside WDA to weigh and classify all household wastes delivered, both by the WDA and by others, for disposal at the disposal site. Thus, data are available for the last nine years. However, this investigation has, necessarily, been restricted to the period between July and December 1986. A number of factors have prevented analysis over a more extended period:-

i) First, in July 1986 the system of waste collection was

Table 11.2 Alyn & Deeside Waste Disposal Authority: Super Profiles Analysis

i) SP Groups

Super Profile Group	No. of EDs	Population	%Population	Index Clwyd	Index National
1	2	1,028	1.43	22	19
2	13	7,443	10.34	101	133
3	6	3,565	4.95	223	241
4	35	19,937	27.70	255	231
5	14	6,770	9.41	73	114
6	0	0	0	0	0
7	10	4,177	5.80	76	74
8	0	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	0	0
12	21	11,471	15.94	117	187
13	19	9,459	13.14	136	136
14	0	0	0	0	0
15	3	1,910	2.65	74	47
16	1	367	0.51	70	17
17	0	0	0	0	0
18	1	448	0.62	46	23
19	6	2,386	3.32	47	88
20	5	1,905	2.65	30	53
21	2	688	0.96	473	188
22	2	417	0.58	171	76
Total	140	71,971	100.00	-	-

ii) SP Lifestyles

Lifestyle	No. of EDs	Population	%Population	Index Clwyd	Index National
1	2	1,028	1.43	21	16
2	0	0	0	0	0
3	19	11,008	15.30	123	155
4	11	4,291	5.96	38	68
5	14	6,770	9.41	73	114
6	51	28,393	39.45	220	245
7	1	367	0.51	70	7
8	10	4,177	5.80	67	55
9	24	12,035	16.72	109	106
10	6	3,485	4.84	57	44
11	2	417	0.58	171	76
Total	140	71,971	100.0		

Classification provided by P.J.B.Brown, 1987.

Plate 6. An example of households in SP Lifestyle 3, 'Young Married Suburbia', Alyn and Deeside District Council.

Plate 7. An example of households in SP Lifestyle 4, 'Rural Britain', Alyn and Deeside District Council.

Plate 8. An example of households in SP Lifestyle 5, 'Older Suburbia', Alyn and Deeside District Council.

Plate 9. An example of households in SP Lifestyle 6, 'Lower Middle Class', Alyn and Deeside District Council.

Plate 10. An example of households in SP Lifestyle 7, 'Multi-Ethnic Areas', Alyn and Deeside District Council.

Plate 11. An example of households in SP Lifestyle 8, 'Dark Satanic Mills', Alyn and Deeside District Council.

Plate 12. An example of households in SP Lifestyle 9, 'Council Ten ants', Alyn and Deeside District Council.

Plate 13. An example of households in SP Lifestyle 10, 'Underpriviledged Britain', Alyn and Deeside District Council.

changed. After investigation by the District's work study unit, the previous system of eight RCV rounds and forty men, was extensively modifed and the current system of seven rounds and thirty-six men introduced. Thus, for the purposes of relating waste arisings to collection rounds, it was not possible to use trend data for the whole period (1978 to 1987), as pre- and post-July 1986 data are not compatible;

ii) Secondly, occasional problems with the weighbridge, have meant that old records may contain estimated data for periods when the weighbridge was out of order. During the period July to December 14th 1986, all data relate to accurate weights. Since 24th December 1986, however, the weighbridge has not functioned and is in an irreparable state. Given the short lifespan remaining at the Etna tip, the decision has been made not to install a replacement, but to wait until the new landfill site becomes operative;

iii) Weighbridge data are available for half days and therefore, if possible analysis at half-daily RCV round level is preferred. Thus, the exact point in the daily round at which the split is made must be known. This is more readily available for the current RCV rounds. The identification of half day splits for the old rounds becomes problematic, once new crews have been employed and the previous drivers have left,

iv) Finally, for the purposes of waste prediction, the use of the most recent data available is preferred and should enable a more accurate projection of future arisings.

Appendix 11.1 shows the weight data for six RCV rounds during the twenty-three week period studied; Round 7 is a rural round and no split is made during the day. The daily rounds have been divided into morning and afternoon, and the weight of waste collected for each of these is recorded. Occasionally, a round may be split into three parts, with three trips made to the tip during the day, the more usual practice, however, is for only one 'split' during the day. The daily split does not coincide with lunch time, but is the point at which the refuse collection vehicle is full and must go to the tip. Whilst the vehicle goes to the tip, the remaining men continue the round, pulling the refuse bags out to the kerbside ready for collection; a process known as 'advancing'.

It is usual practice to complete as much of the round as possible during the morning; a reflection of the working hours, 7.30a.m to 4.00p.m. The men work to a bonus scheme and attempt to complete the round as early in the day as possible. A comparison of the daily splits shown in Appendix 11.1 clearly indicates larger quantites collected during the morning rounds ; this is particularly so on Fridays.

Each of the seven RCV rounds is asigned to a driver and his crew. The round is divided into five daily rounds, which are worked in the same order every week, from Monday through to Friday. Each daily RCV collection round comprises a set list of streets to be serviced. An example round is shown in Appendix 11.2. The rounds were drawn up by the District's work study unit and represent the amount of work required of the men each day, and not a schedule to be strictly adhered to. Thus, an accurate picture of which streets are serviced before and after the daily split, can only be obtained by questioning the driver of each round. Appendix 11.2 shows the order in which the driver and crew for Round 2, had decided to work their round on Day 2. Thus, each Tuesday, the crew collect from the streets listed 'M' in the morning round and those marked 'A' in the afternoon. On this basis, the weight of waste recorded when the vehicle makes each journey to the tip, can be related to the streets and households marked 'M' and 'A' respectively.

Table 11.3 contains an analysis of the half-day rounds. The average weight of waste collected during each half-day has been calculated and recorded as tonnages and is also expressed as a percentage of the average daily collection. In cases where a second split has been made during the day, that is, there is an occasional third weight recording for a round, all data for that day have been omitted from the analysis, unless the round is usually divided into three sections, for example, Round 6, Day 4. Average tonnages vary considerably, the highest level recorded is 8.08 tonnes (Round 5, Day 2, morning), whilst the lowest is 1.59 tonnes for a Friday afternoon, (Round 4, Day 5, afternoon). The first four rounds all record the lowest half-day collection on a Friday afternoon.

Total daily averages have been calculated for each round, (Table 11.4). These figures were subsequently used to calculate the percentage of waste collected during the morning and afternoon rounds. A comparison of the morning and afternoon percentages (Table 11.3) supports the theory that most waste is collected during the morning round; Round 1 Day 3 and Round 3 Day 4 being the only exceptions. For eleven of the daily rounds, the morning round

Table 11.3 Analysis of Collection Rounds by Weight & Households Serviced

Collection Rounds		Average tonnes		Weight %		Premises Collected Number		Premises Collected %		
		a.m	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	diff
1	2	3	4	5	6	7	8	9	10	11
Round One										
Day 1	(22)	6,10	4,83	55,8	44,2	780	194	80,1	19,9	24,3
Day 2	(21)	6,09	5,20	53,9	46,1	579	405	58,8	41,2	4,9
Day 3	(22)	6,11	6,29	49,3	50,7	636	354	64,2	35,8	14,9
Day 4	(22)	5,81	5,39	52,0	48,0	590	396	59,8	40,2	7,8
Day 5	(21)	5,20	3,81	57,7	42,3	779	85	90,2	9,8	32,5
Round Two										
Day 1	(16)	6,56	6,03	52,1	47,9	639	319	66,7	33,3	14,6
Day 2	(18)	6,53	5,78	53,0	46,9	615	496	55,3	44,6	2,3
Day 3	(11)	6,23	5,99	51,0	49,0	852	226	79,0	21,0	28,0
Day 4	(16)	6,74	5,29	56,0	44,0	671	328	67,2	32,8	11,2
Day 5	(22)	5,85	3,66	61,5	38,5	804	119	87,1	12,9	25,6
Round Three										
Day 1	(23)	6,13	5,54	52,4	47,5	776	299	72,2	27,8	19,7
Day 2	(23)	6,69	5,04	57,0	43,0	824	307	72,9	27,1	15,9
Day 3	(23)	6,67	4,69	58,7	41,2	674	377	64,1	35,9	5,4
Day 4	(23)	6,13	6,12	50,0	50,0	599	409	59,4	40,6	9,4
Day 5	(23)	5,36	3,89	57,9	42,0	498	261	65,6	34,4	7,7
Round Four										
D1(17)		3,11/2,97/1,37		41,7/39,9/18,4		254 287 95		39,9 45,1 14,9		*A
D2(13)		3,43/2,83/1,35		45,1/37,2/17,7		294 175 183		45,1 26,8 28,1		*B
Day 3	(21)	3,17	1,94	62,0	38,0	197	235	45,6	54,4	-16,4
Day 4	(23)	3,30	2,10	61,1	38,9	261	219	54,4	45,6	- 6,7
Day 5	(23)	3,39	1,59	68,1	31,9	278	269	50,8	49,2	-17,3
Round Five										
Day 1	(23)	7,15	3,55	66,8	33,0	614	292	67,8	32,2	1,0
Day 2	(23)	8,08	3,23	71,4	28,6	567	412	57,9	42,1	-13,5
Day 3	(23)	7,04	3,45	67,1	32,9	654	343	65,6	34,4	- 1,5
Day 4	(23)	6,77	3,82	63,9	36,1	534	370	59,1	40,9	- 4,8
Day 5	(21)	4,82	3,96	54,9	45,1	529	258	67,2	32,8	12,3
Round Six										
Day 1	(23)	7,06	4,21	62,6	37,4	549	307	64,1	35,9	1,5
Day 2	(22)	7,20	4,56	61,2	38,8	713	196	78,4	21,6	17,2
Day 3	(23)	6,83	4,56	60,0	40,0	705	363	66,0	34,0	6,0
D4(20)		5,48/5,19/3,56		38,5/36,5/25,0		369 262 353		37,5/26,6/35,9		*C
Day 5	(23)	5,19	5,12	50,3	49,7	462	338	57,7	42,3	7,4

(22) = number of records/weeks the data are based upon.
*A = Two splits, differences are: -1,8/ +5,2/ -3,5
*B = Two splits, differences are: 0/ +10,4/ -10,4
*C = Two splits, differences are: -1,0/ -9,9/ +10,9

Source of original data: Alyn and Deeside District Council

Table 11.4 Summary Statistics for Alyn & Deeside Collection Rounds

Collection Rounds	Average Weight tonnes	Minimum Weight tonnes	Maximum Weight tonnes	Range tonnes	Range %	No. of Premises Serviced	Amount of Waste per Premise
1 2	3	4	5	6	7	8	9
Round One							
Day 1 (22)	10,92	9,16	13,03	3,87	42	974	11,21
Day 2 (21)	11,29	9,20	13,29	4,09	44	984	11,47
Day 3 (22)	12,40	9,50	14,74	5,24	55	990	12,52
Day 4 (22)	11,20	10,00	12,20	2,20	22	986	11,36
Day 5 (21)	9,01	7,16	10,62	3,46	48	863	10,44
Round Two							
Day 1 (16)	12,59	11,34	14,46	3,12	27	958	13,14
Day 2 (18)	12,31	8,52	14,22	5,70	67	1,111	11,08
Day 3 (11)	12,22	6,02	15,38	9,36	155	1,078	11,34
Day 4 (16)	12,03	9,69	13,70	4,01	41	999	12,04
Day 5 (22)	9,51	7,54	11,23	3,69	49	928	10,25
Round Three							
Day 1 (23)	11,66	9,94	12,88	2,94	30	1,075	10,85
Day 2 (23)	11,71	9,69	14,08	4,39	45	1,131	10,35
Day 3 (23)	11,36	9,99	12,84	2,85	28	1,051	10,81
Day 4 (23)	12,25	10,96	13,45	2,49	23	1,008	12,15
Day 5 (23)	9,25	7,79	10,87	3,08	39	759	12,19
Round Four							
Day 1 (17)	7,45	6,40	8,93	2,53	39	636	11,71
Day 2 (13)	7,61	7,08	8,10	1,02	14	652	11,67
Day 3 (21)	5,11	4,12	6,18	2,06	50	432	11,83
Day 4 (23)	5,40	4,26	6,71	2,45	57	480	11,25
Day 5 (23)	4,99	4,44	5,86	1,42	32	547	9,12
Round Five							
Day 1 (23)	10,70	9,76	12,18	2,42	25	906	11,81
Day 2 (23)	11,31	10,38	12,78	2,40	23	979	11,55
Day 3 (23)	10,50	6,50	11,44	4,94	76	997	10,53
Day 4 (23)	10,60	9,11	13,10	3,99	44	904	11,73
Day 5 (21)	8,78	7,60	12,21	4,61	61	787	11,61
Round Six							
Day 1 (23)	11,28	10,04	12,32	2,28	23	856	13,18
Day 2 (22)	11,76	10,26	13,32	3,06	30	909	12,94
Day 3 (23)	11,39	9,96	13,28	3,32	33	1,068	10,66
Day 4 (20)	13,97	12,70	16,02	3,32	26	984	14,20
Day 5 (23)	10,31	9,36	12,54	3,18	34	800	12,89
Round Seven							
Day 1 (23)	4,26	3,72	4,80	1,08	29	300	14,20
Day 2 (23)	3,59	3,14	4,00	0,86	27	220	16,32
Day 3 (23)	2,58	2,24	3,00	0,76	34	182	14,18
Day 4 (23)	3,29	2,75	3,94	1,19	43	194	16,96
Day 5 (23)	2,35	1,86	3,52	1,66	89	173	13,58

(22) = number of records/weeks which data are based upon

Source of original data; Alyn and Deeside District Council collects more than 60% of the day's total collection; in a further six cases, between 55 and 60% is collected in the morning.

Table 11.3 also includes an analysis of the number of premises serviced. Whilst weights were reliably recorded at the weighbridge, the daily split for each round and, therefore, the number of premises serviced before and after the journey to the tip, is dependent upon information from the RC vehicle drivers. A comparison of the percentages of premises serviced in the morning and afternoon, with the percentage of the day's waste collected in the morning and afternoon, frequently reveals very different figures, (Column 11: this merely represents the difference in percentages recorded in columns 5 and 9, and 6 and 10, not one expressed as a percentage of the other). Some variation is probable, given the different rates at which different types of household produce waste, as this investigation will attempt to show. However, in fourteen of the twenty-eight cases shown, differences of more than 10% are recorded and cannot be accounted for by variations in waste production per household.

Analysis of waste arisings per household also indicates that a number of the half-day splits suggested by some drivers, are unreliable. Table 11.5 shows the average waste collected per household/premise for each half-day round. These figures were calculated from the data contained in Table 11.3, Columns 3 and 7 (for mornings) and Columns 4 and 8 (afternoons). For some rounds, extreme values are readily identifiable, such as those for Round 1 Days 1 and 5, Round 2 Days 3 and 5, and Round 3 Day 1, and indicate

Table 11.5 Analysis of Calculated Waste Arisings per Household

Collection Rounds	Waste Arisings per Household Morning Kgs		Afternoon Kgs	Difference Kgs	%*
Round One					
Day 1	7,82		24,90	17,08	24,3
Day 2	10,52		12,84	2,32	4,9#
Day 3	9,61		17,77	8,16	14,9
Day 4	9,85		13,61	3,76	7,8
Day 5	6,67		44,82	38,15	32,5
Round Two					
Day 1	10,23		18,90	8,67	14,6
Day 2	10,62		11,65	1,03	2,3#
Day 3	7,31		26,50	19,19	28,0
Day 4	10,04		16,13	6,09	11,2
Day 5	7,28		30,76	23,48	25,6
Round Three					
Day 1	7,90		18,53	10,63	19,7
Day 2	8,12		16,42	8,30	15,9
Day 3	9,90		12,44	25,40	5,4
Day 4	10,23		14,96	4,73	9,4
Day 5	10,76		14,90	4,14	7,7
Round Four					
Day 1	12,24	10,35	14,42	1,89/4,07	-1,8#/5,2/-3,5#
Day 2	11,67	16,17	7,37	4,50/8,80	0#/10,4/-10,4
Day 3	16,09		8,25	7,84	-16,4
Day 4	12,64		9,59	3,05	- 6,7
Day 5	12,19		5,91	6,28	-17,3
Round Five					
Day 1	11,64		12,16	0,52	1,0#
Day 2	14,25		7,84	6,41	-13,5
Day 3	10,76		10,06	0,70	- 1,5#
Day 4	12,68		10,32	2,36	- 4,8#
Day 5	9,11		15,35	6,24	12,3
Round Six					
Day 1	12,86		13,71	0,85	1,5#
Day 2	10,10		23,26	13,16	17,2
Day 3	9,69		12,56	2,87	6,0
Day 4	14,85	19,81	10,08	4,96/9,73	-1,0#/-9,9/10,9
Day 5	11,23		15,15	3,92	7,4

Round Four, Days 1 and 2, and Round Six, Day Four, are split into three, more than one 'difference' is, therefore, recorded
= Most reliable data
* From Table 11,3

Source of original data: Alyn and Deeside District Council inaccurate half-day splits. In cases where one half-day figure is inaccurate, that for the other half of the day will also be erroneous and therefore, both figures should be rejected. In other cases, inaccuracies may be more difficult to detect.

As a general rule of thumb, the average daily figures (Table 11.4 Column 9) may be used to indicate approximate arisings per household. However, some variation in the figures for morning and afternoon rounds is inevitable, where differences occur in the nature of the collection round before and after the split, that is, in terms of the socio-economic characteristics of the population.

A further test of the reliability of the half-day figures for waste arisings per household, are the differences between the respective percentages of waste collected in each half-day and the percentages of premises it is claimed are serviced in each half-day. These figures were recorded in Table 11.3, Column 11, and are based on the percentage data shown in the same Table; they have also been included in Table 11.5.

A comparison of the figures shown in Table 11.5, in particular, Columns 4 and 5, shows that the most reliable data are those for Round 1 Day 2, Round 2 Day 2, Round 5 Days 1 and 3 and Round 6 Day 1, (these are marked '#'). At the other extreme, household data (based on the daily split), for Round 1 Days 1 and 5, Round 2 Days 3 and 5, and Round 3 Day 1, appear to be totally inaccurate. In between these two extremes, are a number of half-day rounds, the household data for which is of indeterminable accuracy. In general, the larger the weight difference and percentage difference recorded for these, the greater the likelihood that the data are unreliable.

The accuracy and reliability of information on the number of households serviced in each half-day period, is affected by two main factors:-

i) First, as Table 11.3 has shown, the reliability of information from the drivers is questionable in some cases. Obviously, the point at which the split is made, will vary from week to week given prevailing circumstances, such as the weather, time of year, the number of crew present and perhaps, reliability of the RC vehicle. Drivers were, therefore, asked to indicate the most common point on the collection round at which the split was made, (the mode). However, the weight data were also averaged over a twenty-three week period, which should have modified any affect that this would have had.

The main difficulty arises when the point of split given is incorrect, (and deliberately so). Some drivers were sensitive to any questioning which they thought may be related to a work study investigation and further rationalisation of manpower. In some cases, a point on the schedule was selected which appeared to be exactly half-way, yet was later doubted by other members of staff who note the times when the RC vehicles leave and return to the depot,

ii) The number of households producing waste on each round will vary as new property is constructed, old property demolished and some property lies vacant. Thus, the number of premises recorded for each collection round schedule was probably out of date within a few weeks of its production in July, 1986. Fortunately, the differences are only likely to be small, with any large changes in housing reported by the drivers.

Thus, great care is needed in the selection of half-day rounds for analysis. The differences recorded in Table 11.3, Column 11 may serve as a rough indication as to the reliability of the point of split. To avoid this problem, one solution would be to use daily rounds, as the actual number of households serviced is less open to question. Only in one or two instances have daily rounds been adjusted. For example, when a round has not been completed on the day alotted and an extra collection has been made during the following day. These cases are recorded and, therefore, can be easily eliminated from the analysis. An example is shown in Appendix 11.1, Round 5, Day 5, for the week ending 2/11/86.

Daily RCV round data are shown in Appendix 11.3. and have been summarised in Table 11.4. Where recorded data appear to be suspect, or the round has on occasions been split into three, the data have been omitted from the calculations. For example, the summary statistics for Round 5, Day 5 are based upon twenty-one records/weeks, the data for the week ending 2/11/86 (discussed above) and another case, being omitted.

Average daily tonnages vary considerably, but show clearly that without exception, the lowest tonnages are collected on Fridays.

Round 7, collects the least waste and from noticeably fewer premises than any other round. This is the 'rural round', serving farms and outlying communities. Consequently, a great deal of time is spent in travelling between premises. Due to the nature of this round and the small amount of waste collected, no split is made during the day.

Some of the highest daily tonnages are collected by Round 2, which services the densely populated communities of Shotton, Sealand and Buckley. Here, households are concentrated in housing estates, enabling more premises to be serviced in a short space of time.

Table 11.4, Columns 4 and 5, show the minimum and maximum weights collected for each round during the period of study. The smallest collection made, 1.86 tonnes, was for Round 7 on a Friday, whilst the largest amount, 16.02 tonnes was collected by Round 6 on a Thursday. Significantly, eleven out of the thirty-five daily rounds (31%), recorded the maximum daily tonnage collected, in the week following the August Bank Holiday. That is, during the week ending 31/8/86.[1] This is statistically significant, given the twenty-three week period studied, and indicates that collections made directly after holiday periods are atypical; these warrant careful analysis. No explanation is available for the remaining 69% of maximum tonnages recorded.

Given the diversity of the rounds, a better indicator of variation in quantity, is the 'range'. This has been calculated for each round, (Column 6). The largest range recorded, 9.39 tonnes, was for

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[1]. No collection was made on Monday 25th August, 1986. This was replaced by a collection made on Saturday, 30th August.

Round 2 Day 3. This figure may be shown as a percentage, that is, the maximum weight expressed as a percentage increase above the minimum, (Column 7). Thus, the range of 9.36 tonnes for Round 2, Day 3, represented a 155% increase above the minimum. Column 7 shows that the percentage increase varies considerably, but is generally larger than might be expected; the lowest increase recorded was 14%. The percentage increase was less than 30% in only eleven cases, in another eight it lay between 30 and 40%, in a further eight cases between 40 and 50%, whilst in the remaining eight, it was more than 50%. Thus, within-round variations are considerable and rounds used in analysis must be selected with care. Alternatively, the average weights over the twenty-three week period may be used for each round in order to modify any 'extreme' data.

Table 11.4, Column 8, shows the number of premises serviced by each round. These figures, together with those for the average weight of waste collected, (Column 3), have been used to calculate the average amount of waste collected from/produced per premise/household, (expressed as kilograms per premise per week). These figures are of particular interest and suggest definite differences in waste arisings per household. For example, the largest arisings are for the rural round, Round 7, whilst the smallest levels are produced by Round 4, Day 5, which collects from housing near the Industrial Estate at Sandycroft.

One final point of consideration in the analysis of waste arisings per household, is the impact of different forms of household heating. Waste from households with oil or gas heating contains a high paper content. Conversely, waste from households using solid fuel heating contains very little paper, but quantities of ash. In the former case, the waste arising is likely to be bulky, but quite light in weight, whilst the latter is characterised by less bulky waste, which is heavier and of a higher density.

The recent increase nationally in the paper content of waste, has been related to an increase in oil and gas central heating, (Wilson, 1981). However, analysis of the impact of various forms of household heating at a local scale is difficult to determine. This would require detailed fieldwork, probably in the form of a questionnaire, to ascertain the type of heating used by each household within a collection round (800 to 1,000 households). An alternative approach, involves the analysis of smoke control areas, within which the use of solid fuel heating is controlled. In theory, such areas could be used as a 'control', to indicate waste arisings in the absence of solid fuel heating. However, this would require a knowledge of the exact waste arisings from the area, excluding any household waste from outside the smoke control zone.

Within Alyn and Deeside there is one smoke control area, designated under the Connah's Quay Urban Smoke Control Order, 1960. This comprises a total of 452 households from 17 streets. Analysis revealed that these households were, amongst many others, serviced by three collection rounds, (Round 1, Days 2, 3 and 4). It was, therefore, not possible to determine the waste arisings from households solely within the smoke control area. Thus, the impact of household heating systems on waste arisings and in particular, the impact on the relationships between waste arisings and socio-economic group, remains an unknown factor.

In summary, variations in average waste arisings per household have been differentiated using data for daily rounds. The use of half-daily round data presents some difficulties, as the reliability of data on the number of households serviced in each half-day round may be unreliable. Thus, half-day rounds must be selected and used with caution. Two additional factors, the impact of bank holidays and the form of household heating used, have been identified as important in the analysis of waste arisings; unfortunately, neither are readily quantified and their impact is undetermined. In spite of these difficulties, the attempt to relate variations in waste arisings to different socio-economic groups is considered a worthwhile exercise. The next stage in the analysis requires the designation of selected half-day and daily rounds into Super Profile Lifestyle categories, in order to relate variation in waste production to different socio-economic groups.

11.3.3 Relating Socio-Economic Characteristics to Collection Rounds

The classification of all 140 Enumeration Districts (EDs) within Alyn and Deeside into SP Lifestyles, was shown in Table 11.2. The classification was carried out by Peter Brown, (Department of Civic Design, University of Liverpool); a member of the team which has developed the SP Classification. The analysis was carried out on the University's IBM 3083 computer, using an adapted version of the CCP package developed by Openshaw, (1982).

The next stage in the analysis, involves relating the SP categories to actual areas on the ground and in particular, to collection rounds. Ordnance Survey (O.S.) maps showing the ED boundaries at a scale of 1:10,000, were made available for analysis by the Planning Department of Clwyd County Council. The boundaries were transferred to 1:25,000 maps to facilitate handling, (Figure 11.2). Collection Round schedules comprising a list of streets, were provided by Alyn and Deeside WDA. Subsequently, what appeared to be a simple task of relating one to the other, proved a major exercise and a number of difficulties were experienced for a variety of reasons:-

i) First, neither the 1:10,000 nor 1:25,000 O.S. maps show street names, with the exception of major and rural roads;

ii) No list or index of the streets within individual EDs is maintained by any organisation, including the Office of Population Censuses and Surveys, or the County and District Councils. Street lists from the electoral register were examined, but proved to be totally incompatible with EDs;

iii) The collection round schedules were designed to maximise waste collection efficiency and do not adhere to any administrative boundaries, (such as ward, ED, parish or the Polling Districts used in the electoral register), other than the District boundary, (Figure 11.3). Thus, a street which is serviced by one collection round, may traverse two and sometimes more ED boundaries. In such cases, if the EDs have the same SP Lifestyle classification, there is no problem, but where different Lifestyles are involved, the rounds may have to

Figure 11.2. Enumeration Districts and SP. Lifestyles at 1:25,000.

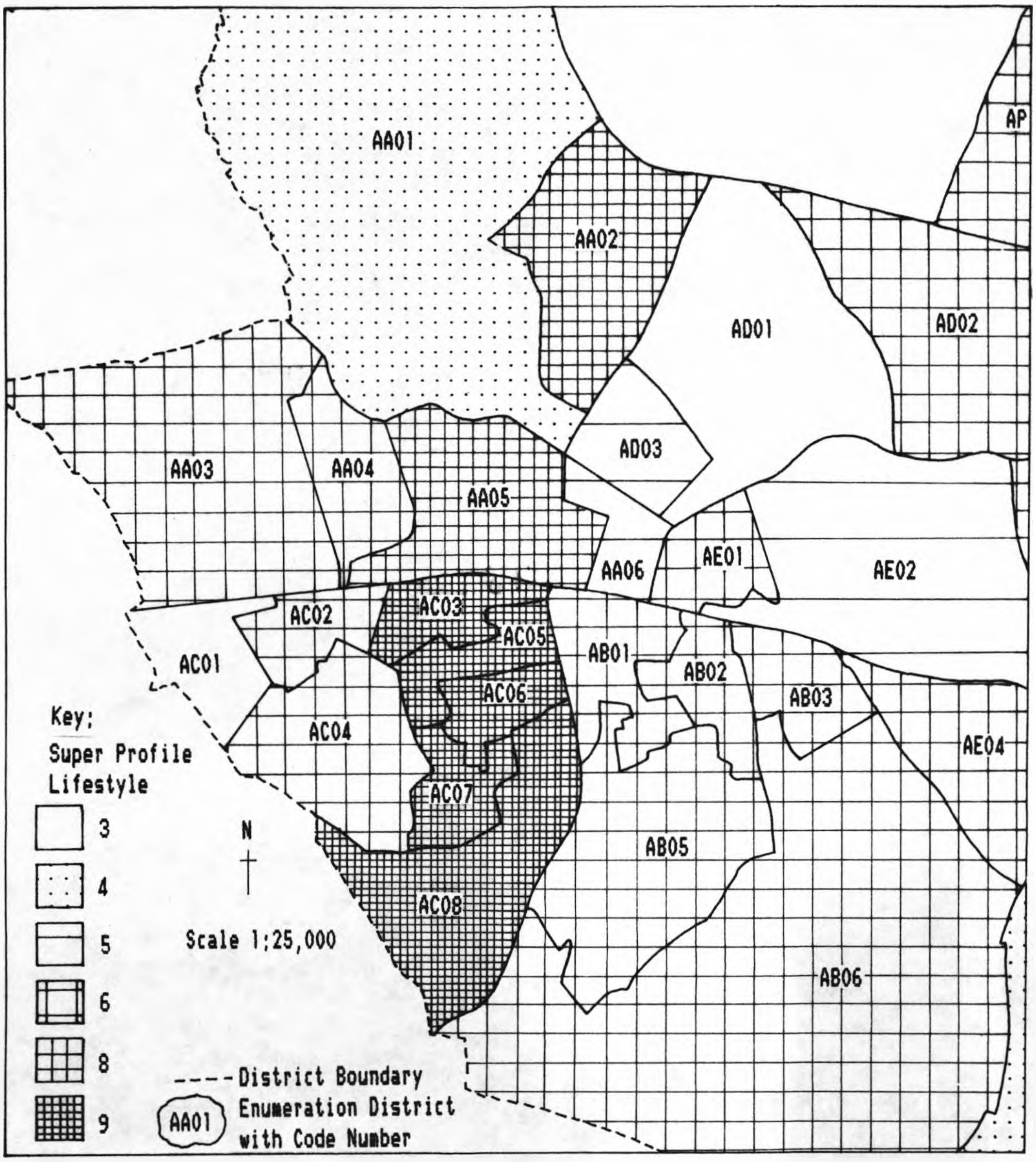
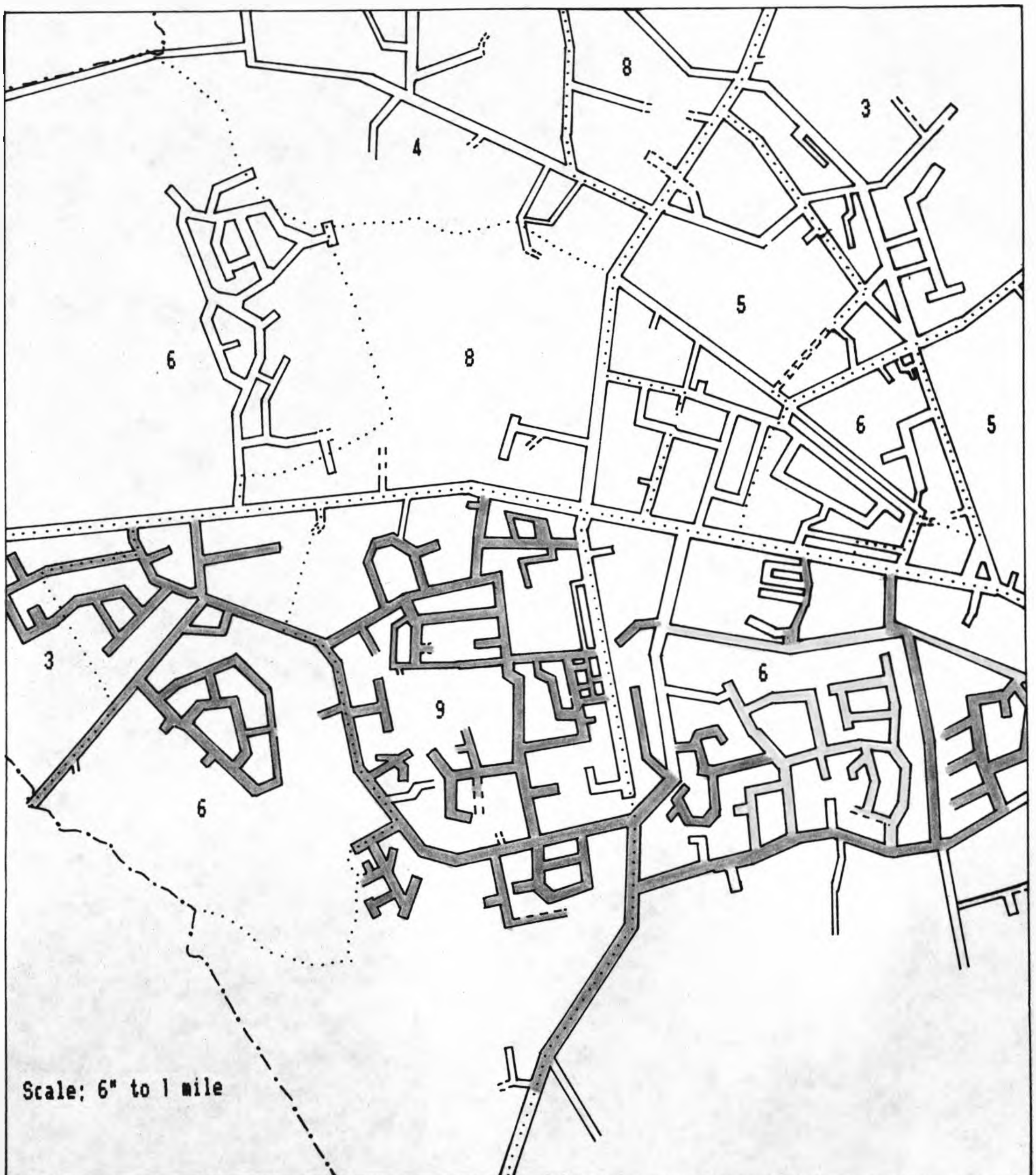


Figure 11.3. Relating RCV Collection Rounds to Enumeration Districts and SP. Lifestyles.



Key

Street

Enumeration District Boundary

District Boundary

Rounds;

Round 3 Day 3 Afternoon

Round 3 Day 4 Morning

Round 3 Day 4 Afternoon

Round 6 Day 4 Afternoon

Round 6 Day 5 Afternoon

6 = Super Profile Lifestyle

Source: a) Based on Alyn & Deeside Street Plan No.4
b) Refuse Collection Rounds Street Lists
c) Super Profile Classification, (Brown, 1987).

be excluded from analysis. Sometimes a vehicle may service a small community and then travel quite a distance to the next collection area; for example, the rural round, Round 7. Thus, there is a considerable distance between the EDs involved and there is more chance that they will have different SP Lifestyles. It appears that there is a higher probability of neighbouring EDs having the same SP Lifestyle, (Figure 11.2);

iv) Occasionally, it has not been possible to locate some of the streets named on the RCV Collection Rounds. This is because some streets have been named incorrectly, and some are not named on the schedule, (e.g. 'unnamed cul-du-sac'), whilst others are on new housing estates not yet shown on O.S. maps,

v) On the rural round, Round 7, there is a considerable degree of aggregation. Often, areas rather than streets are named. In such circumstances, it is difficult to determine which premises are being served and, therefore, which SP Lifestyle categories are included within each round.

Table 11.6 shows the classification of the RCV half-day rounds according to the SP Lifestyle categories they cover. Only the main SP Lifestyles within each round are shown. In cases where there is a complex mixture of Lifestyle categories or a number of categories comprise a small percentage of the round, these have been classified as 'mixed'. For the reasons previously stated, it has not been possible to categorise all the rounds; such cases are included in the 'unclassified' category.

Table 11.6 Classification of Half-Day Collection Rounds by SP Lifestyle

Collection Rounds	Percentage of each half-day round falling within individual Super Profile Lifestyles (%)											
	SP Lifestyles											
Round One	1	3	4	5	6	7	8	9	10	11	Mixed	U
Day 1a a.m												100
p.m												100
Day 2 a.m					17			55	28			
p.m		20			66				14			
Day 3 a.m											100	
p.m							8	86	6			
Day 4 a.m		11			81			8				
p.m				15	85							
Day 5 a.m		38			42				20			
p.m					2				95		3	
Round Two	1	3	4	5	6	7	8	9	10	11	Mixed	U
Day 1 a.m				65			35					
p.m				55			45					
Day 2 a.m								59			41	
p.m								51	33		16	
Day 3 a.m					77						23	
p.m		31					36				33	
Day 4 a.m		19			74						7	
p.m					82						18	
Day 5 a.m					32			33	13		22	
p.m					94			6				
Round Three	1	3	4	5	6	7	8	9	10	11	Mixed	U
Day 1 a.m		36	40								24	
p.m				44				56				
Day 2 a.m					52						48	
p.m										71	29	
Day 3 a.m		17			39						44	
p.m								100				
Day 4 a.m		11			71						18	
p.m								100				
Day 5 a.m				46							54	
p.m		60					40					
Round Four	1	3	4	5	6	7	8	9	10	11	Mixed	U
Day 1												100
Day 2												100
Day 3b												100
Day 4												100
Day 5 a.m				34	19				47			
p.m					69						31	

Continued..

Table 11.6 Continued..

Collection Rounds		Percentage of each half-day round falling within individual Super Profile Lifestyles (%)											
		SP Lifestyles											
Round Five		1	3	4	5	6	7	8	9	10	11	Mixed	U
Day 1	a,m		56			18		9	17				
	p,m						20	59	21				
Day 2	a,m								93			7	
	p,m		22				57					21	
Day 3	a,m		47			33						20	
	p,m		50			48						2	
Day 4	a,m				25	42						33	
	p,m					55			38	7			
Day 5c	a,m					68						32	
	p,m		100										

Round Six		1	3	4	5	6	7	8	9	10	11	Mixed	U
Day 1	a,m												100
	p,m	38				18						44	
Day 2	a,m			12		77						11	
	p,m					95			5				
Day 3	a,m		24		50	22						4	
	p,m				73	14						13	
Day 4	a,m					100							
	mid					100							
	p,m					100							
Day 5	a,m				15	57		13				15	
	p,m					100							

Round Seven	1	3	4	5	6	7	8	9	10	11	Mixed	U
Day 1												100
Day 2												100
Day 3												100
Day 4												100
Day 5												100

All statistics are based upon data covering a 23 week period, with the exceptions of;-
a & b = based upon 22 records/weeks and c = based upon 21 records

U = Unclassified a,m = morning round p,m = afternoon round
Mixed = A mixture of SP Lifestyles, each too small to classify separately
mid = midday shift for Round with two splits

Source: Original RCV round data from Alyn and Deeside District Council
SP Lifestyle Classification for EDs from Peter Brown, Dept. of Civic Design, University of Liverpool

Lifestyles 6 (Lower Middle Class) and 9 (Council Tenants) frequently appear as major SP Lifestyles within many rounds, whilst Lifestyles 1 (Stockbroker Belt), 4 (Rural Britain), 7 (Multi-Ethnic Areas), and 11 (Unclassified), occur the least often. It is immediately apparent, therefore, that not all the SP Lifestyle categories cover a sufficiently large part of a RCV round to enable analysis to take place. In addition, the number of rounds falling predominantly under one SP Lifestyle, may be too few to provide an adequate sample for analysis. This is more clearly shown in Table 11.7. The Table shows only those half-day rounds within which one SP Lifestyle category comprises 50% or more of the round; the percentages have been calculated in terms of the proportion of the total number of premises serviced during the half-day round which fall under the SP Lifestyle shown. The respective percentages are listed in Column 3 and have been used to rank the rounds within each SP Lifestyle in decreasing order.

Table 11.7 shows that for seven rounds, 100% of the premises serviced fall under just one category. These present the optimum situation for analysis. The arisings per household, (Table 11.5), can be related to the SP Lifestyles in these rounds. An important consideration in this stage of the analysis, is the reliability of the figures on waste arisings per household for the half-day rounds in question. Table 11.7 contains an index of reliability. This is merely the difference recorded in Table 11.3, Column 11, between the percentage of waste collected and the percentage of premises claimed to have been serviced during each half-day. A comparison of Columns 3 and 5 (Table 11.7), reveals that the waste arisings data for six of the seven half-day rounds which

Table 11.7 Analysis of RCV Half-Day Rounds: SP Lifestyles

RCV Collection Round	SPL	% of Round in SPL	Arisings per household Kgs	Index of Reliability
R,5,D,5 p,m	3	100	15,35	12,3
R,3,D,5 p,m	3	60	14,90	7,7
R,5,D,1 a,m	3	56	11,64	1,0
R,5,D,3 p,m	3	50	10,06	-1,5
R,6,D,3 p,m	5	73	12,56	6,0
R,2,D,1 a,m	5	65	10,23	14,6
R,2,D,1 p,m	5	55	18,90	14,6
R,6,D,3 a,m	5	50	9,69	6,0
R,6,D,4 a,m	6	100	14,85	-1,0
R,6,D,4 mid	6	100	19,81	-9,9
R,6,D,4 p,m	6	100	10,08	+10,9
R,6,D,5 p,m	6	100	15,15	7,4
R,6,D,2 p,m	6	95	23,26	17,2
R,2,D,5 p,m	6	94	30,76	25,6
R,1,D,4 p,m	6	85	13,61	7,8
R,2,D,4 p,m	6	82	16,13	11,2
R,1,D,4 a,m	6	81	9,85	7,8
R,2,D,3 a,m	6	77	7,31	28,0
R,6,D,2 a,m	6	77	10,10	17,2
R,2,D,4 a,m	6	74	10,04	11,2
R,3,D,4 a,m	6	71	10,23	9,4
R,4,D,5 p,m	6	69	5,91	-17,3
R,5,D,5 a,m	6	68	9,11	12,3
R,1,D,2 p,m	6	66	12,84	4,9
R,6,D,5 a,m	6	57	11,23	7,4
R,5,D,4 p,m	6	55	10,32	- 4,8
R,3,D,2 a,m	6	52	8,12	15,9
R,5,D,2 p,m	7	57	7,84	-13,5
R,5,D,1 p,m	8	59	12,16	1,0
R,3,D,3 p,m	9	100	12,44	5,4
R,3,D,4 p,m	9	100	14,96	9,4
R,5,D,2 a,m	9	93	14,25	-13,5
R,1,D,3 p,m	9	86	17,17	14,9
R,2,D,2 a,m	9	59	10,62	2,3
R,3,D,1 p,m	9	56	18,53	19,7
R,1,D,2 a,m	9	55	10,52	4,9
R,2,D,2 p,m	9	51	11,65	2,3
R,1,D,5 p,m	10	95	44,82	32,5
R,3,D,2 p,m	11	71	16,42	15,9

R = Round, D = Day, a,m = morning, p,m = afternoon
mid = midday collection for Rounds with two splits,

Source/Calculated from;

i) RCV Collection Round data provided by Alyn & Deeside District Council

ii) Super Profiles Classification, provided by Peter Brown, Dept, of Civic design, University of Liverpool, comprise just one SP Lifestyle, are not of sufficient reliability to form any conclusions regarding the relationship between the SP Lifestyles in question and waste arisings per household. Only the morning collection for Round 6 Day 4, appears to be reliable. This indicates that for SP Lifestyle 6, the arisings per household are in the region of 14.85 kgs per week. In all other cases, the Table clearly indicates that analysis is prohibited by a number of factors:

i) Lower percentages (below 90%) of the round within a single SP Lifestyle and, therefore, the probable effect of other SP Lifestyles within the round;

ii) Poor levels of 'reliability', that is, indices greater than 10, shown in Column 4,

and iii) a combination of i and ii.

The problem of unreliable 'splits' and hence, number of households serviced in each half-day round, prohibits any futher analysis of the association between SP Lifestyle and waste arisings per household, at half-day level. The possibility of following each round and observing the daily split at first hand, was investigated, but subsequently rejected. This was mainly on the advice of the authority's Work Study Unit and Refuse Collection Supervisors, who maintained that under scrutiny the RCV crews would behave differently from their normal practice. Thus, in consideration of the time and resources necessary to undertake the investigation, the degree of co-operation needed from the crews, their unions and the authority, in addition to the questionable accuracy of the findings, it was decided against any further investigation. An additional consideration was that the aim of the investigation was to develop a methodology which not only has universal application, but is also practical to operate given the limited resources and manpower of the Welsh WDAs.

It was subsequently decided to investigate the possibility of using full daily rounds for analysis, the main advantage being the reliability of the data on household numbers. However, there is also a major drawback inherent in the analysis of the larger areas serviced by daily rounds. Obviously, the larger the area of study, the greater the likelihood that it will comprise more than one SP Lifestyle. Thus, there is a higher probability that rounds will contain two or more SP Lifestyles.

Table 11.8 shows the classification of daily rounds into SP Lifestyles. As predicted, the rounds are divided between a larger number of lifestyle categories; eighteen out of the thirty-five daily rounds (51%), comprise four or more lifestyles, compared with only five of the sixty-one half-day rounds (8%). Conversely, whilst twenty-two (36%) of the half-day rounds contained just one or two lifestyles, the corresponding figure for daily rounds was two, a mere 6%.

In spite of the more divided nature of the daily rounds, the most promising cases have been sumarised in Table 11.9. In only one case, Round 6 Day 4, is a 100% correspondence between a collection round and SP Lifestyle, (Lifestyle 6, Lower Middle Class), recorded. The

Table 11.8 Analysis of RCV Daily Rounds by SP Lifestyle

Collection Rounds	Percentage of each round falling within individual Super Profile Lifestyles (%)											
					Lifestyle							
Round One	1	3	4	5	6	7	8	9	10	11	Mixed	U
Day 1a												100
Day 2		10			41,5			27,5	21			
Day 3							4	43	3		50	
Day 4		5,5		7,5	83			4				
Day 5		19			22				57,5		1,5	
Round Two	1	3	4	5	6	7	8	9	10	11	Mixed	U
Day 1				60			40					
Day 2								55	16,5		28,5	
Day 3		15,5			38,5		18				28	
Day 4		9,5			78						12,5	
Day 5					63			20	6		11	
Round Three	1	3	4	5	6	7	8	9	10	11	Mixed	U
Day 1		18	20	22				28			12	
Day 2					26					35,5	38,5	
Day 3		8			20			50			22	
Day 4		5,5			35,5			50			9	
Day 5		30		23			20				27	
Round Four	1	3	4	5	6	7	8	9	10	11	Mixed	U
Day 1												100
Day 2												100
Day 3b												100
Day 4												100
Day 5				17	44				23,5		15,5	
Round Five	1	3	4	5	6	7	8	9	10	11	Mixed	U
Day 1		28			9	10	34	19				
Day 2		11				28,5		46,5			14	
Day 3		48,5			40,5						11	
Day 4				12,5	48,5			19	3,5		16,5	
Day 5c		50			34						16	
Round Six	1	3	4	5	6	7	8	9	10	11	Mixed	U
Day 1	19				9						22	50
Day 2			6		86			2,5			5,5	
Day 3		12		61,5	18						8,5	
Day 4					100							
Day 5				7,5	78,5		6,5				7,5	
Round Seven	1	3	4	5	6	7	8	9	10	11	Mixed	U
Day 1												100
Day 2												100
Day 3												100
Day 4												100
Day 5												100

All data are for a 23 week period, except for : a & b = based upon 22 records/weeks and c = based upon 21 records. U = Unclassified
Mixed = A mixture of SP Lifestyles, each too small to classify separately

Source: Original RCV round data from Alyn and Deeside District Council
SP Lifestyle Classification for EDs from Peter Brown, 1987.

Table 11.9 Analysis of Selected RCV Daily Rounds: SP Lifestyles

RCV Collection Round	SPL	% of Round in SPL	Waste Arisings per household (Kgs)
R.5.D.5	3	50%	11.61
R.6,D.3	5	61.5%	10.66
R.2.D.1	5	60%	13.14
R.6,D.4	6	100%	14.20
R.6,D.2	6	86%	12.94
R.1,D.4	6	83%	11.36
R.6,D.5	6	78.5%	12.89
R.2,D.4	6	78	12.04
R.2.D.5	6	63	10.25
R.2,D.2	9	55	11.08
R.3,D.3	9	50	10.81
R.3.D.4	9	50	12.15
R.1.D.5	10	57.5	10.44

R = Round, D = Day

Source of data:

i) RCV Collection Round data provided by Alyn & Deeside District Council

ii) Super Profiles Classification: Peter Brown, Dept. of Civic Design, University of Liverpool waste arisings per household for Lifestyle 6 are 14.20 kilograms per household per week. Initially, this may appear to be an insufficient 'sample' from which to make generalisations regarding Lifestyle 6. However, this one daily collection round does, in fact, represent 984 premises, (Table 11.4) and is, therefore, an important finding. This gains further significance in view of the fact that 39.45% of the total population of Alyn and Deeside, is classified under Lifestyle 6, (Table 11.2ii). It also compares favourably, with the analysis of the morning collection for Round 6 Day 4 (Table 11.7), which indicated arisings of 14.85kgs per household per week for Lifestyle 6.

In no other case was it possible to extrapolate waste arisings per household for a specific Lifestyle category. This was due to the presence of other Lifestyles within each round and the inability to quantify and isolate their influence on waste arisings from that of the dominant Lifestyle. The possibility of using algebraic formulae based upon the known value of Lifestyle 6, was considered, but subsequently rejected for daily rounds, because the number of 'unknowns' was greater than one, that is, no round met the requirements for the analysis, (the presence of Lifestyle 6 and only one other Lifestyle). However, three half-day rounds met this requirement. On further investigation, two of these were based upon data with reliability indices considered too high to warrant analysis, (25.6 and 17.2). The third case, (Round 1 Day 4, afternoon), however, had an index of 7.8 and contained just two Lifestyles, 5 and 6. Based upon the information available, it was possible to calculate average waste arisings per household for Lifestyle 5; the method used is shown in Appendix 11.4. The resultant value for Lifestyle 5, is 10.23 kgs of waste per household per week. It should be noted that this figure is based upon a sample size of fifty-nine households, (15% of the households serviced in the afternoon, Table 11.3). These findings suggest that there is a considerable difference in arisings between Lifestyles 5 (Older Suburbia) and 6 (Lower Middle Class); a difference of 3.97 kgs per household per week.

A further attempt was made to analyse the data, but at a coarse level, by amalgamating some of the lifestyle categories together. This was done for the half-day and daily rounds listed in Tables 11.7 and 11.9, that is, cases where one lifestyle comprised over 50% of the round. The sample was further restricted to those rounds with the most reliable data, (a reliability index of less than 10). The statistical technique used is described in Appendix 11.5.

For the analysis, Lifestyles 3 and 5, and 8, 9, and 10 were amalgamated to form two separate groups; Lifestyle 6 constituted a third group. These groupings were the best arrangement possible, given the Lifestyle categories for which samples were available. They do not, however, necessarily represent the optimum grouping for Lifestyles.

The results show that no significant variation can be discerned for daily rounds. For half-day rounds, however, 83% of the variance between the three groups is probably the result of differences in waste production between households in different Lifestyles. The inability to detect any significance at daily level, may reflect the smaller number of samples and the lower percentage of each round contained within a single Lifestyle category. That is, any behavioural differences are more likely to have been modified by the greater presence of other Lifestyles, than is the case for half-day rounds.

In summary, it has been possible to show the methodological development of a technique with which to analyse the relationships between socio-economic groups and domestic waste arisings. Notwithstanding the numerous pitfalls which have been identified, it has been possible to analyse and show differences in waste production between socio-economic groups, both at District and sub-District levels. In particular, it has been possible to identify average waste arisings per household for two lifestyle categories and to show variation in arisings between groups of lifestyles.

These findings indicate that given the time and resources required to gather more reliable information, it should be possible to establish differences in waste arisings from households in different socio-economic groups and subsequently, to apply these findings to other WDAs. This study has been deliberately confined to the analysis of data already available, in particular, data available to the WDAs without deployment of the considerable resources and manpower necessary for the collection of further information, such as the recording of waste data for individual streets and households, or the modification of collection rounds to coincide with EDs or other areas. Throughout, the emphasis has been on the development of a feasible method of analysis, which can be applied with the minimum amount of manpower and resources; given the financial constraints imposed on waste management at present, anything more elaborate would not be practical. It may be, that the analysis used here, employing the most basic information available, may have revealed more substanial results in another WDA. A major point of consideration, however, is that this analysis would not have been possible in the majority (84%) of Welsh WDAs, since they do not weigh all of their waste arisings.

PART IV SUMMARY

CHAPTER 12

12 CONCLUSIONS AND SUGGESTED IMPROVEMENTS IN WASTE MANAGEMENT PRACTICE, POLICY AND LEGISLATION

12.1 Conclusions

This study proposed to achieve two main aims:-

i) First, the appraisal of the Welsh Waste Disposal Authorities, their policies and ability to adequately fulfil their statutory responsibilities,

and ii) subsequently, the appraisal of central government policy, in particular, the location of administrative responsibility for waste management in Wales and the ability of the Welsh Office to monitor WDA compliance with statutory requirements.

In fulfilment of these aims, Part 1 comprised an analysis of various aspects of waste management in Wales, at WDA, regional and national levels. This investigation was, however, impaired by the unreliable nature of the data available. The current data base was found to be deficient on a number of grounds. Chief amongst these, the inability of most authorities to weigh a sufficiently large proportion of their waste; either they do not operate a weighbridge or they have opted to weigh only part of their waste. Consequently, data must be treated as 'rough estimates', unless the authority concerned is known to weigh a large percentage of the waste arising. In addition, published data are, in many cases, both inaccurate and incomplete. In particular, the absence of data for some authorities for one or more years has prevented the analysis of both trends over time for the authorities concerned and comparison between authorities for any given year.

Attempts to combine data from various sources, in order to resolve their individual deficiencies, presents additional problems. Frequently, differences in the classification of wastes, (the variables recorded), the accuracy and units of measurement used, and the timing and intervals between measurement, have resulted in the production of incompatible data. Furthermore, a number of important variables required for the analyisis of waste management, are not recorded in the main sources of published data, such as CIPFA. For example, data on landfill sites, their characteristics, management, and environmental monitoring, are conspicuously absent. Such data inadequacies bear no criticism of CIPFA, but merely reflect the organisation's role as an accounting agency, primarily concerned with the economics of waste collection and disposal, rather than the environmental consequences.

The collection of unpublished data is restricted, in that the quantity of information sought, must be sacrificed in order to obtain some data for the most essential variables. Undoubtedley, the fact that no single body, (including the Welsh Office), collates information on an all-Wales basis, covering the administrative, financial and environmental aspects of waste management, is a major contributory factor in the lack of compatible data. Welsh Office statistics are available for a number of other topics including population, housing and agriculture. Thus, not only does the Welsh Office have the facilities to collate and publish statistics on waste, it is also the approriate body for such a task, having the authority to obtain the fullest co-operation from all WDAs. This would not, however, solve the problem of inadequate weight data, unless the use of weighbridges was made obligatory.

Notwithstanding the inadequate data base, a number of findings on various aspects of waste management in Wales, have been made. These go some way towards meeting the two chief aims of the study:

i)Administration:

The ability of the present administrative structure, that is the WDAs, to adqequately fulfil their statut ory duties, is highly questionable. They are deficient in two main areas, a) inadequate resource base, and b) lack of technical expertise. This is reflected in the inability of many authorities to comply with the most basic procedural duties, introduced by the Control of Pollution Act, 1974. Some Districts, (40%), have contravened the Act, by failing to issue the correct number of disposal licences and/or failing to maintain a register of all disposal licences. In addition, most WDAs have been slow to comply with Section 2 of the Act. This requires the preparation of a waste disposal plan;

ii) Patterns and Trends in Waste Arisings:

No trends are discernable for waste arisings at national or local scales. This lack of consistency in the reported levels for all categories of waste arisings over time, has implications for the provision of adequate disposal capacity, both current and long term. To what extent this situation reflects 'actual' change, rather than estimated change, is uncertain. The implications are, however, that unless the causal factors are identified and can be related to the size and type of change experienced, the prediction of future arisings and hence disposal facilities, is a matter of guesswork rather than scientific method.

Despite the deficiencies in the data base, spatial patterns are discernable for most types of waste arisings, and consequently, for waste disposal. The thirty-seven WDAs may be classified into three regional groups, (North, Mid and South Wales), based upon their propensity to exhibit similar characteristics and disposal requirements. The apparent homogeneity of authorities within a regional group, presents two main opportunities for waste management:-

a) First, the possibility for inter-authority co-operation. For example, the use of joint disposal facilites. In particular, the provision of facilities for the disposal of special wastes on a regional basis,

and b) Secondly, the potential for analysis. The investigation of those authorities within each region, which are known to have accurate weight data, may be used to develop generalisations which have applicability for all WDAs within the same regional group. Thus, authorities with inadequate data, may benefit from their more efficient neighbours.

iii) Waste Disposal Methods

Landfill is the dominant method of disposal in Wales, the majority of waste being disposed directly, untreated to landfill. This reflects the economics of waste disposal; landfill being the cheapest method available. Consequently, few authorities operate other disposal methods. It is unlikely, therefore, that WDAs will change their disposal policies in the foreseeable future. Alternative methods of disposal may, however, become viable should responsibility for waste management be transferred to a higher administrative level, such as, the Counties.

iv) The Provision of Landfill Sites

For the majority of authorities, the total amount of waste disposed is sent untreated to landfill, by the WDA. In such cases, the WDA has total responsibility for the provision and management of landfill sites. The export of non-special waste by a small number of WDAs over short periods of time, suggests the inadequate provision of sufficient landfill capacity within their areas. In addition, the occurence of pollution problems at many WDA operated landfill sites, (46%), indicates the selection of unsuitable sites. Thus, the inability of authorities to monitor waste production and disposal within their areas, is manifest in:

a)the selection of inappropriate sites

and b)the occurrence of shortfalls between disposal capacity and amount of waste to be disposed.

v) Special Waste Disposal

The apparent unwillingness of most authorities to permit the disposal of toxic waste within their areas, is perhaps, an admission of their own incompetence. Undoubtedly, the current policy of exportation for special wastes, has serious implications:

a) First, it places an additional burden upon Welsh industry, which must bear the cost of transporting waste for disposal. The absence of disposal facilities must also influence industrial location. Thus, the ability to attract new industries to the Principality, is also impaired,

and

b) Secondly, the reliance upon English Disposal Authorities to continue to import special waste, places the Welsh WDAs in a position of uncertainty. The time limit for waste exportation is frequently unknown. Should exportation be restricted by the importing authorities, which is a distinct possibility, the Welsh WDAs would be placed in a very serious situation; it is doubtful whether most have any contingency plans prepared for such a situation.

In conclusion, the aims of this study have been fulfilled to the extent permitted by the data available. The appraisal of the efficiency of the Welsh WDAs, has been impaired by the inadequate data base, but this in itself must be interpreted as an indication of poor administrative practice and has serious implications for waste management:-

i) At local authority level, policy decisions and strategic planning within many WDAs, are based upon inaccurate and inadequate information. The consequences for the cost-effective and environmentally sensitive disposal of wastes, are considerable, particularly in terms of landfill site capacity and selection,

ii) In view of the deficient data base, the ability of central government to adequately appraise the situation in Wales, must also be questioned. The recent decision not to transfer responsibility for waste from the Districts was, it seems, based upon inadequate information. The decision was not surprising; the inability to appraise the current situation, together with the lack of political motivation, were negative forces working to maintain the status quo.

The analyses in Part I, reveal a general inability of local authorities to adequately fulfil their responsibilities. In view of these findings, the ability of the Welsh Office to adequately monitor the situation and take steps to introduce an improved administrative structure, has also been shown to be defficient.

12.2. 'Treating The Symptoms, But Not The Cause'

Part 1 identified a major deficiency in waste management, that is, the inadequate data base. The chief aim of Parts II and III, therefore, has been the provision of a constructive and practical solution to this problem.

Most of the difficulties encountered by waste management in Wales, are the consequences of factors outside of the control of the WDAs, being primarily the result of a lack of resources and the low priority accorded waste management; the deficient data base is symptomatic of these external forces. However, in the present economic and political environment, it is unlikely that more resources will be allocated to the WDAs or that responsibility for waste management will be transferred from the present WDAs. Consequently, a practical solution to the problem of deficient data, is required. The aim has been to develop such a solution with regard to domestic and commercial waste, for which the WDAs have sole responsibility.

The solution is based upon two facts established in Part I of this study. First, that a small number of authorities record accurate data, based upon weighbridge records and secondly, that groups of authorities can be discerned which exhibit similar characteristics. Thus, the potential exists for the application of a predictive model, based upon case study authorities within each region, capable of application on a regional basis.

The methodological development of a predictive model, at various scales of management, has been demonstrated, (Chapters 9 to 11). The model has been deliberately confined to the use of data currently available to WDAs, on the basis that extra data collection would not be possible for most authorities. The methodology developed is both practical and capable of accurate prediction, if based upon accurate data; logically, accuracy in prediction is determined by the accuracy of the data upon which it is based.

Unfortunately, the application of the model at Enumeration District level, failed to achieve the desired aim. That is, it was not possible to establish variations in the average level of domestic waste arisings between households in each of the different socio-economic categories. However, this failure was due more to unfortunate circumstances, (the unreliable nature of the daily split for each round), than a weakness in the model and would be resolved by WDAs undertaking their own research.

A limited degree of success was obtained with respect to the analysis of two socio-economic categories, thus confirming the potential of the model to discriminate differences in waste arisings at a fine scale of investigation. Undoubtedly, the findings suggest considerable scope for further work in terms of a better data base on which to work, (as opposed to further methodological development). In particular, this is one area where the involvement of central government would be of great benefit. The deployment of adequate funding for research and the full co-operation of selected WDAs, would undoubtedly resolve any data problems. Consequently, the findings, that is, the propensity of different socio-economic groups to produce different amounts of waste, could be usefully deployed with respect to:

i) The prediction of future domestic waste arisings in all WDAs,

ii) The estimation of current levels of waste arisings in those authorities with a deficient data base.

12.3 Recommendations

The study has identified numerous weaknesses in the current administration of waste in Wales. In the light of these, the main recommendation must, inevitably, be the relocation of responsibility for waste management from the District Councils to the County Councils or an alternative, regional structure. The larger resource base would bring many benefits:-

i) First, the advantages for the 'new' WDAs would include:

a)The resources to employ staff with the necessary expertise;

b)The resources to deploy staff and equipment to monitor waste production and disposal. In particular, to install weighbridges at disposal sites;

c)The possibilities for alternative waste disposal techniques, including recycling, which may become viable at this scale of administration;

d)The ability to cater for special waste disposal, and the potential for regional disposal centres;

e)The larger geographical unit, would provide a wider choice of potential landfill sites. Thus, site selection procedures would benefit,

and f)The improvement in monitoring and increased options for disposal, would provide the necessary basis for accurate strategic planning.

ii) Secondly, central government would benefit by the smaller number of administrative units to monitor and from the improved data base, upon which to make an assessment of WDA efficiency and appraise its own policy and legislation.

In the present situation, and given the unlikelihood of a change in the administrative framework, a number of alternative recommendations are valid. These are, necessarily, aimed at central government, as responsibility for the current state of affairs lies primarily with the Welsh Office. Waste management could be improved by the following procedures:-

i) The establishment of a standard system of data collection by central government, covering all aspects of waste management;

ii) Assistance for WDAs with respect to planning and waste prediction. Government funding for research to develop a predictive model based upon regional patterns, is required;

iii) The provision of technical and expert advice;

iv) The encouragement of inter-WDA co-operation and establishment of joint facilities for disposal;

v) The establishment of facilities for the disposal of special wastes on a regional basis,

vi) Finally, and, inevitably, there is a need for central government to monitor its own policies and effectiveness.

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APPENDIX A

Appendices Referenced in the Text

APPENDICES FOR CHAPTER 2

Appendix 2.1 Statutory Provisions Concerning Waste Collection and Disposal

Some of the main statutory provisions (in chronological order), which have affected waste management over the last hundred years, are as follows:-

Public Health Act, 1875.

Public Health Act, 1897, (Chapter 38).

Alkali and Works Regulation Act, 1906, (Chapter 14).

Public Health Act, 1936, (Chapter 49).

Town and Country Planning Act, 1947, (Chapter 78).

Litter Act, 1958, (Chapter 34).

Public Health Act, 1961.

Civic Amenities Act, 1967, (Chapter 53).

Local Government Act, 1972, (Chapter 70).

Town and Country Planning Act, 1971.

Dangerous Litter Act, 1971

Deposit of Poisonous Waste Act, 1972, (Chapter 21).

Control of Pollution Act, 1974, (Chapter 40).

Health and Safety at Work Act, 1974.

APPENDICES FOR CHAPTER 3

Appendix 3.1 The CIPFA Questionnaire for Waste Disposal Statistics 1984/85 Actuals

Continued..

WASTE DISPOSAL STATISTICS 1984—85 ACTUALS

Code:

WD85A ☐☐☐ *1985

·I

For CIPFA use only

1

1. Name of Authority ______________________________

	No.	
2. Population (RG's estimate for June 1984)		(2)
3. Area (Hectares)		(3)

	£	
4. Exclusive Penny Rate Product		(4)

Revenue Expenditure

	£	
5. Employees		(5)
Running Expenses:		
6. — Administrative Support Services		(6)
7. — Transport		(7)
8. — Other Operational Expenses		(8)
Payments for Treatment/Disposal by Other Bodies:	£	
9. — By Contractors		(9)
10. — By Other WDA's		(10)
11. — By Agent Authorities		(11)
12. Contributions to Districts for Conveying Refuse		(12)
Capital Financing Charges:	£	
13. — RCCO		(13)
14. — Debt Charges (including leasing charges)		(14)
15. Total Expenditure		(15)

Income

Disposal Charges to Commerce and Industry:		
16. — By WDA and Agent Authorities		(16)
17. — Proportion of District Income		(17)
18. Other Disposal Charges		(18)

continued .....

Sales: £

19. — Reclaimed Waste (19)

20. — Heat, Electricity, RDF and Other (20)

21. Other Income (21)

22. Total Income (22)

£

23. Net Expenditure (23)

ANALYSIS OF PRIMARY PROCESSING AND TREATMENT COSTS
(exclusive of administrative support, transport and capital financing costs)

Expenditure £

24. Transfer including — Compacting (24)

25. — Shredding (25)

26. — Baling (26)

27. — Household Amenity Sites (27)

28. Incineration (28)

29. Separation and Incineration (29)

30. Reclamation (30)

31. Other Methods (31)

32. Total Primary Processing and Treatment Expenditure (32)

Income £

33. Transfer Including — Compacting (33)

34. — Shredding (34)

35. — Baling (35)

36. — Household Amenity Sites (36)

37. Incineration (37)

38. Separation and Incineration (38)

39. Reclamation (39)

40. Other Methods (40)

41. Total Primary Processing and Treatment Income (41)

continued .....

ANALYSIS OF FINAL DISPOSAL COSTS
(exclusive of administrative support, transport and capital financing costs)

Expenditure

	£	
42. Landfill by WDA (landfill direct plus landfill after processing and treatment)		(42)
43. Final Disposal by Contractors, Agents and Other WDA's		(43)
44. Total Final Disposal Expenditure		(44)

Income

	£	
45. Landfill by WDA (landfill direct plus landfill after processing and treatment)		(45)
46. Final disposal by Contractors, Agents and other WDA's		(46)
47. Total Final Disposal Income		(47)

Capital Expenditure

	£	
48. Landfill — Redevelopment		(48)
49. — Restoration		(49)
50. Transfer Including — Compacting Crude		(50)
51. — Shredding		(51)
52. — Baling		(52)
53. — Household Amenity Sites		(53)
54. Incineration		(54)
55. Separation and Incineration		(55)
56. Reclamation		(56)
57. Other Methods		(57)
58. Total Capital Expenditure		(58)

Personnel Employed

	FTE	
59. Local Authority Personnel (WDA and Agent Authorities)		(59)
60. Contractors' Personnel		(60)
61. Total Personnel		(61)

Land

Land Restored to Use during the Year:

	Hectares	
62. — Agriculture		(62)
63. — Recreation		(63)
64. — Industry and Other		(64)

continued .....

Hectares

65. Total Land Restored to Use During Year (65)

66. Land Utilised for Waste Disposal at 31 March 1985 (66)

Reclamation

Tonnes

67. Paper (67)

68. Non-Ferrous Materials (68)

69. Ferrous Materials (69)

70. Glass (70)

71. Other Materials (71)

72. Total Reclamation (72)

Waste Disposal

Tonnes

73. By WDA Directly (73)

74. By Agent Authorities (74)

75. By Contractors (75)

76. By Other WDA's (76)

77. Total Waste Disposed of (77)

78. Percentage of Waste Weighed % (78)

Waste Arising within WDA Area

Tonnes

79. From Waste Collection Authorities (79)

80. From Commerce and Industry (80)

81. From Other Sources (81)

82. Household Amenity Waste (82)

83. Total Waste Arising (83)

Primary Processing and Treatment

Tonnes

84. Transfer — Compacting Crude (84)

85. — Shredding (85)

86. — Baling (86)

87. — Household Amenity Sites (87)

88. Incineration (88)

89. Separation and Incineration (89)

90. Reclamation (90)

91. Other Methods (91)

continued .....

	Tonnes	
92. Total Primary Procesing and Treatment		(92)

Final Disposal by WDA

	Tonnes	
93. Landfill Untreated		(93)

Landfill After:	Tonnes	
94. Compacting Crude		(94)
95. Shredding		(95)
96. Baling		(96)
97. Household Amenity Sites		(97)
98. Incineration (Residue)		(98)
99. Reclamation (Rejects)		(99)
100. Total Landfill by WDA		(100)
101. Total Additional Cover Material		(101)

MEMORANDUM

PLEASE AGREE FIGURES BELOW WITH ANY OTHER AUTHORITY CONCERNED

Waste Received from Other WDAs

Authority	Tonnage
Total	

Waste Transferred to Other WDAs

Authority	Tonnage
Total	

continued .....

APPENDICES FOR CHAPTER 4

Appendix 4.1 Domestic and Non-Domestic Waste Arisings, 1977-78.

District	Waste Domestic	Arisings (Tonnes) Non-Domestic	Total
ABERCONWY	16,000	10,350	26,350
AFAN	39,248	33,607	72,855
ALYN & DEE	18,500	166,946	185,446
ARFON	18,740	28,225	46,965
BLAENAU G.	44,300	911,634	955,934
BRECKNOCK	10,741	3,261	14,002
CARDIFF	71,018	470,895	541,913
CARMARTHEN	19,760	1,040	20,800
CEREDIGION	16,000	17,900	33,900
COLWYN	23,000	11,070	34,070
CYNON VALL.	22,202	575,060	597,262
DELYN	22,000	32,480	54,480
DINEFWR	16,750	1,775	18,525
DWYFOR	10,760	6,700	17,460
GLYNDWR	11,200	6,064	17,264
ISLWYN	20,645	46,300	66,945
LLANELLI	26,000	296,947	322,947
LLIW VALLEY	23,400	21,300	44,700
MEIRIONNYDD	12,800	1,800	14,600
MERTHYR TYD	25,800	332,496	358,296
MONMOUTH	17,600	92,708	110,308
MONTGOMERY	15,600	25,114	40,714
NEATH	17,190	26,154	43,344
NEWPORT	41,000	407,100	448,100
OGWR	37,961	222,942	260,903
PRESELI	18,493	115,413	133,906
RADNOR	5,500	4,040	9,540
RHONDDA	23,026	112,175	135,201
RHUDDLAN	20,000	12,000	32,000
RHYMNEY VAL	50,100	352,628	402,728
SOUTH PEMB	18,000	18,560	36,560
SWANSEA	61,000	213,123	274,123
TAFF-ELY	36,230	462,807	499,037
TORFAEN	31,000	195,334	226,334
V.OF GLAM	24,852	159,325	184,177
WREXHAM	36,000	58,966	94,966
YNYS MON	26,000	82,270	108,270
TOTAL	948,416	5,536,509	6,484,925

Source of data; Association of District Councils, 1978

Appendix 4.2 The Calculation of Trend Data for Domestic and Non-Domestic Waste Arisings

CIPFA produces the only trend data currently available for waste. The data collected, however, reflect the agency's concern with the finances of waste management and relate to the costs of waste collection and disposal. No data are recorded for waste arisings by type, for example, domestic and non-domestic wastes. These can, however, be calculated by combining other variables:-

A) Total waste arisings are recorded in the CIPFA statistical reports on waste disposal and are sub-divided into three 'sources'. These are respectively, waste arising within each WDA from i) the collection authority, ii) commerce and industry and iii) other sources.
Waste arising within each WDA from the collection authority comprises:

> ' all waste arising within the WDA area for which the WDA has responsibility for disposal. Waste that is imported from outside the WDA area should be excluded. Industrial or commercial waste that is disposed of directly by the firms' own contractors should be excluded. Household amentiy waste taken direct to the disposal point by the public should be included.' (CIPFA, 1978 to 1985.)

These figures, therefore, include all household or domestic waste, plus some industrial or commercial waste which is collected by the WDA itself. As such, the data are of limited use, except for accounting collection charges and planning manpower and vehicular requirements.

B) The annual statistical reports on waste collection, contain data for the following categories:-

a). Total Quantity of Waste Collected (tonnes)

b). Waste Collected by Type- i)household (%)
ii)commercial (%)
iii)industrial (%)

C) The calculation of domestic and non-domestic waste arisings is, therefore, possible using data from the two sets of reports, (A and B). That is, using the amount of waste collected by the collection authorities and the percentage of this which is classified as 'household' waste, to calculate actual 'household' or domestic waste in tonnes.

Appendix 4.3 Comparison of Domestic and Non-Domestic Waste Statistics from Different Data Sources

	Domestic Waste				Non-Domestic Waste			
	ADC	CIPFA	Difference		ADC	CIPFA	Difference	
District	1977/78	1978/79	*		1977/78	1978/79	*	
	tonnes	tonnes	tonnes	%	tonnes	tonnes	tonnes	%
ABERCON	16,000	22,050	+ 6,050	+38	10,350	2,450	- 7,900	- 76
AFAN	39,248	ND	ND	ND	33,607	ND	ND	ND
ALYN &	18,500	22,140	+ 3,640	+20	166,946	7,960	-158,986	- 95
ARFON	18,740	17,374	- 1,366	- 7	28,225	18,822	- 9,403	- 33
BLAENAU	44,300	54,090	+ 9,790	+22	911,634	44,414	-867,220	- 95
BRECKNO	10,741	11,049	+ 308	+ 3	3,261	3,683	+ 422	+ 13
CARDIFF	71,018	115,207	+44,189	+62	470,895	144,825	-326,070	- 69
CARMART	19,760	20,385	+ 625	+ 3	1,040	4,076	+ 3,036	+292
CEREDIG	16,000	20,169	+ 4,169	+26	17,900	4,731	- 13,169	- 74
COLWYN	23,000	24,960	+ 1,960	+ 8	11,070	7,540	- 3,530	- 32
CYNON V	22,202	22,639	+ 437	+ 2	575,060	943	-574,117	-100
DELYN	22,000	29,247	+ 7,247	+33	32,480	7,615	- 24,865	- 76
DINEFWR	16,750	ND	ND	ND	1,775	ND	ND	ND
DWYFOR	10,760	9,727	- 1,033	-10	6,700	6,859	+ 159	+ 2
GLYNDWR	11,200	10,370	- 830	- 7	6,064	7,830	+ 1,766	+ 29
ISLWYN	20,645	30,280	+ 9,635	+47	46,300	47,065	+ 765	+ 2
LLANELL	26,000	30,844	+ 4,844	+19	296,947	44,746	-252,201	- 85
LLIW VA	23,400	31,450	+ 8,050	+34	21,300	7,550	- 13,750	- 64
MEIRION	12,800	11,039	- 1,761	-14	1,800	2,961	+ 1,161	+ 64
MERTHYR	25,800	21,297	- 4,503	-17	332,496	67,008	-265,488	- 80
MONMOUT	17,600	15,352	- 2,248	-13	92,708	4,848	- 87,860	- 95
MONTGOM	15,600	ND	ND	ND	25,114	ND	ND	ND
NEATH	17,190	18,800	+ 1,610	+ 9	26,154	39,800	+ 13,646	+ 52
NEWPORT	41,000	39,512	- 1,488	- 4	407,100	26,638	-380,462	- 93
OGWR	37,961	34,349	- 3,612	- 9	222,942	241,432	+ 18,490	+ 8
PRESELI	18,493	21,120	+ 2,627	+14	115,413	13,480	-101,933	- 88
RADNOR	5,500	6,375	+ 875	+16	4,040	5,166	+ 1,126	+ 28
RHONDDA	23,026	17,500	- 5,526	-24	112,175	121,270	+ 9,095	+ 8
RHUDDLA	20,000	18,480	- 1,520	- 8	12,000	12,720	+ 720	+ 6
RHYMNEY	50,100	45,182	- 4,918	-10	352,628	130,918	-221,710	- 63
SOUTH P	18,000	ND	ND	ND	18,560	ND	ND	ND
SWANSEA	61,000	86,700	+25,700	+42	213,123	39,800	-173,323	- 81
TAFF-EL	36,230	ND	ND	ND	462,807	ND	ND	ND
TORFAEN	31,000	18,357	-12,643	-41	195,334	46,643	-148,691	- 76
V.OF GL	24,852	27,754	+ 2,902	+12	159,325	13,251	-146,074	- 92
WREXHAM	36,000	30,800	- 5,200	-14	58,966	16,200	- 45,715	- 77
YNYS MO	26,000	23,630	- 2,370	- 9	82,270	65,270	- 17,000	- 21

* = Differences in tonnage and percentages, between 1977/8 and 1978/9 are expressed as an increase above or decrease below the 1977/8 level

Source of data: ADC Report, 1978
CIPFA Waste Collection and Disposal Reports (Actuals)

Appendix 4.4 Percentages of Domestic and Non-Domestic Waste Arisings: Comparison of Different Data Sources

	A ADC Data % 1977/78		B CIPFA Data % 1978/79		C Difference %
	Dom	Non-Dom	Dom	Non-Dom	
ABERCONWY	61	39	90	10	29*
AFAN	54	46	60	40	6
ALYN & DEE	10	90	73	27	63*
ARFON	40	60	48	52	8
BLAENAU G	5	95	55	45	50*
BRECKNOCK	77	23	75	25	2
CARDIFF	13	87	44	56	31*
CARMARTHEN	95	5	83	17	12
CEREDIGION	47	53	81	19	34*
COLWYN	67	33	77	23	10
CYNON VALL	4	96	96	4	92*
DELYN	40	60	79	21	39*
DINEFWR	90	10	ND	ND	ND
DWYFOR	62	38	59	41	3
GLYNDWR	65	35	57	43	8
ISLWYN	31	69	39	61	8
LLANELLI	8	92	41	59	33*
LLIW VALLEY	52	48	81	19	29*
MEIRIONNYDD	88	12	79	21	9
MERTHYR TYD	7	93	24	76	17
MONMOUTH	16	84	76	24	60*
MONTGOMERY	38	62	ND	ND	ND
NEATH	40	60	32	68	8
NEWPORT	9	91	60	40	51*
OGWR	14	86	12	88	2
PRESELI	14	86	61	39	47*
RADNOR	58	42	55	45	3
RHONDDA	17	83	13	87	4
RHUDDLAN	62	38	59	41	3
RHYMNEY VAL	12	88	26	74	14
SOUTH PEMB	49	51	31	69	18
SWANSEA	22	78	68	32	46*
TAFF-ELY	7	93	78	22	71*
TORFAEN	14	86	28	72	14
V,OF GLAM	13	87	68	32	55*
WREXHAM	38	62	65	35	27*
YNYS MON	24	76	27	73	3

* = Difference is greater than 20%

Source of data; ADC Report, 1979
CIPFA Waste Collection and Disposal Reports (Actuals)

Appendix 4.5 Percentage of Waste Collected: Household and Non-household Waste

WDA	1978/9 H	NH	1979/0 H	NH	1980/1 H	NH	1981/2 H	NH	1982/3 H	NH	1983/4 H	NH	1984/5 H	NH	1985/6 H	NH	D
ABER	90	10	83	17	83	17	83	17	91	9	85	15	85	15	85	15	8
AFAN	ND	ND	ND	ND	ND	ND	ND	ND	67	33	46	54	53	47	53	47	21
ALYN	90	10	86	14	75	25	ND	ND	85	15	60	40	90	10	90	10	30
ARFN	71	29	71	29	70	30	70	30	ND	ND	80	20	80	20	80	20	1
BLAE.	90	10	ND	ND	ND	ND	87	13	95	5	86	14	86	14	86	14	9
BREC	75	25	ND	ND	85	15	80	20	70	30	70	30	70	30	70	30	10
CARD	91	9	91	9	91	9	91	9	91	9	91	9	91	9	90	10	1
CARM	98	2	98	2	94	6	94	6	70	30	76	24	70	30	70	30	24
CERE	81	19	82	18	90	10	90	10	90	10	82	18	66	34	82	18	16
COLW	96	4	96	4	96	4	96	4	80	20	65	35	ND	ND	69	31	16
CYNO.	96	4	ND	ND	90	10	90	10	90	10	93	7	88	12	50	50	38
DELY	89	11	83	17	78	22	85	15	85	15	85	15	94	6	95	5	9
DINE	ND	ND	ND	ND	90	10	86	14	ND	ND	ND	ND	75	25	70	30	5
DWYF	78	22	83	17	67	33	67	33	69	31	69	31	75	25	75	25	16
GLYN	85	15	ND	ND	80	20	80	20	75	25	75	25	75	25	75	25	5
ISLW	90	10	90	10	15	85	80	20	77	23	85	15	85	15	65	35	65
LLAN	88	12	ND	ND	78	22	78	22	ND	ND	ND	ND	ND	ND	ND	ND	0
LLIW	85	15	85	15	85	15	ND	ND	85	15	85	15	85	15	87	13	2
MEIR	83	17	83	17	83	17	83	17	85	15	ND	ND	100	0	100	0	2
MERT	63	37	63	37	63	37	63	37	76	24	76	24	75	25	75	25	13
MONM	76	24	76	24	80	20	75	25	80	20	75	25	80	20	80	20	5
MONT	ND	ND	83	17	83	17	80	20	70	30	70	30	70	30	70	30	10
NEAT	94	6	94	6	95	5	94	6	95	5	99	1	99	1	99	1	4
NEWP	88	12	88	12	ND	ND	65	35	65	35	65	35	65	35	67	33	2
OGWR	75	25	80	20	80	20	80	20	80	20	85	15	86	14	85	15	5
PRES	96	4	ND	ND	94	6	94	6	94	6	94	6	ND	ND	ND	ND	2
RADN	85	15	65	35	65	35	65	35	70	30	ND	ND	70	30	80	20	20
RHON	70	30	70	30	5	95	ND	ND	80	20	80	20	80	20	80	20	65
RHUD	84	16	84	16	84	16	84	16	84	16	84	16	84	16	75	25	9
RHYM	82	18	82	18	68	32	68	32	ND	ND	55	45	83	17	83	17	28
SPEM	ND	ND	ND	ND	ND	ND	80	20	80	20	88	12	96	4	96	4	8
SWAN	85	15	80	20	40	60	ND	ND	40	60	40	60	63	37	65	35	40
TAFF	ND	ND	90	10	80	20	ND	ND	90	10	ND	ND	80	20	80	20	10
TORF	58	42	60	40	62	38	ND	ND	58	42	85	15	ND	ND	83	17	27
VOGL	75	25	75	25	4	96	80	20	81	19	92	8	86	14	82	18	76
WREX	88	12	88	12	88	12	88	12	88	12	88	12	88	12	88	12	0
YNYS	5	15	85	15	85	15	85	15	85	15	85	15	90	10	90	10	5

H = Household Waste, NH = Non-household Waste,
D = Largest change between consecutive years
ND = No data

Source of data: CIPFA Waste Collection Statistics Reports (Actuals).

Appendix 4.6 Waste Arisings from the Waste Collection Authorities

WDA	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
ABER	24,500	29,592	29,592	30,000	31,500	21,000	21,000
AFAN	37,012	37,000	37,000	ND	39,000	32,890	25,740
ALYN	24,600	ND	41,400	30,057	33,500	14,856	17,408
ARFO	24,471	25,216	24,643	24,880	ND	25,000	28,300
BLAE	60,100	ND	ND	31,730	31,700	32,000	40,014
BREC	14,732	ND	9,883	ND	9,850	15,530	11,500
CARD	126,601	86,972	107,871	113,350	105,426	108,368	111,463
CARM	20,801	15,200	16,000	15,200	15,500	15,820	15,816
CERE	24,900	23,000	23,000	23,000	23,000	27,000	25,000
COLW	26,000	25,000	25,250	23,000	25,000	14,740	18,020
CYNO	23,582	24,000	26,000	23,750	23,750	18,353	21,848
DELY	32,862	32,400	35,000	35,000	14,495	22,900	17,071
DINE	18,540	17,000	17,500	17,500	ND	ND	16,300
DWYF	12,470	12,154	10,800	10,900	10,905	11,000	13,300
GLYN	12,200	12,000	17,000	17,600	14,795	19,725	19,700
ISLW	33,645	34,000	34,000	34,000	35,000	21,000	21,000
LLAN	35,050	ND	27,050	37,540	ND	ND	ND
LLIW	37,000	27,325	38,500	39,000	39,000	21,000	24,000
MEIR	13,300	13,295	13,490	13,525	13,675	13,500	ND
MERT	33,805	33,680	33,680	33,680	40,780	29,800	29,700
MONM	20,200	19,450	27,497	25,414	28,400	18,944	18,445
MONT	26,114	26,158	36,158	13,000	16,000	15,600	16,550
NEAT	20,000	20,000	21,950	20,900	25,700	29,700	25,000
NEWP	44,900	51,472	85,000	65,000	65,000	60,000	63,000
OGWR	45,799	45,000	42,000	46,000	48,000	45,500	48,500
PRES	22,000	30,000	30,500	30,500	36,000	37,800	ND
RADN	7,500	7,440	7,500	7,500	16,500	8,500	9,000
RHON	25,000	40,000	40,000	29,500	45,000	30,000	18,000
RHUD	22,000	24,000	23,000	23,000	23,000	21,000	17,000
RHYM	55,100	55,100	53,000	53,000	55,000	42,300	42,300
SPEM	18,400	48,000	20,000	20,000	24,000	14,000	12,500
SWAN	102,000	ND	66,000	60,000	59,590	2,884	53,110
TAFF	36,265	58,760	62,500	ND	89,500	ND	49,100
TORF	31,650	40,800	ND	ND	61,000	34,722	ND
VOGL	37,005	35,064	34,165	34,685	34,990	32,075	34,970
WREX	35,000	37,360	38,500	40,640	41,000	69,770	71,200
YNYS	27,800	28,100	28,620	29,200	29,000	29,500	30,000

ND = No data

Source of data; CIPFA Waste Disposal Statistics Reports (Actuals)

Appendix 4.7 Waste Arising within Each WDA Area: Other Sources(tonnes)

District	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
ABERCONWY	0	0	0	5,950	4,500	4,619	4,704
AFAN	2,100	2,100	2,100	ND	0	0	0
ALYN & DEE	5,500	ND	6,300	5,075	7,500	18,745	161
ARFON	4,500	5,330	0	105	ND	3,420	350
BLAENAU G.	0	ND	ND	90,000	27,395	22,000	0
BRECKNOCK	0	ND	0	ND	0	1,500	0
CARDIFF	0	245,775	187,315	13,798	13,027	121,068	11,655
CARMARTHEN	3,660	5,800	9,000	9,000	9,000	ND	0
CEREDIGION	0	0	0	0	0	2,000	14,900
COLWYN	5,000	800	750	1,000	1,000	0	410
CYNON VALL.	0	0	0	0	0	1,927	20,541
DELYN	2,000	600	0	1,000	500	0	1,080
DINEFWR	0	0	0	4,000	ND	ND	0
DWYFOR	0	0	1,700	1,700	1,700	2,000	100
GLYNDWR	0	0	0	0	0	0	0
ISLWYN	0	0	0	0	0	0	0
LLANELLI	35,540	ND	0	0	ND	ND	ND
LLIW VAL	2,000	0	3,000	5,000	16,000	3,500	8,000
MEIRIONN	200	205	210	215	220	0	ND
MERTHYR	38,500	38,500	38,500	38,500	41,300	40,000	40,480
MONMOUTH	0	0	0	0	0	0	1,202
MONTGRY	0	0	0	0	0	0	1,150
NEATH	2,000	2,000	0	0	0	17,692	0
NEWPORT	0	0	0	0	0	0	0
OGWR	178,372	39,000	27,000	17,000	27,000	30,000	20,000
PRESELI	0	0	0	0	0	0	ND
RADNOR	240	0	0	0	0	0	0
RHONDDA	0	0	0	0	0	2,000	0
RHUDDLAN	100	2,000	2,000	2,000	0	0	1,000
RHYMNEY	60,000	60,000	30,000	30,000	30,000	37,200	19,200
SOUTH P	32,900	5,000	0	0	2,000	0	0
SWANSEA	0	ND	0	0	ND	5,000	4,222
TAFF-ELY	0	0	0	ND	0	ND	0
TORFAEN	0	0	ND	ND	0	33	ND
V.OF GLA	3,000	5,325	5,325	5,400	1,989	3,148	895
WREXHAM	1,000	1,000	1,000	1,000	1,000	8,160	8,200
YNYS MON	0	0	0	0	0	5,000	5,000

ND = No data

Source of data; CIPFA Waste Disposal Statistics Reports (Actuals)

Appendix 4.8 Waste Arising within Each WDA Area from Commerce and Industry

	tonnes						
Dist	1978/9	1979/0	1980/1	1981/2	1982/3	1983/4	1984/5
ABER	0	0	0	8,050	8,000	13,705	13,684
AFAN	22,120	22,000	22,000	ND	19,000	16,136	21,944
ALYN	0	ND	3,000	9,550	10,000	589	13,210
ARFO	7,225	4,620	11,357	12,015	ND	21,236	16,000
BLAE	38,404	ND	ND	36,525	36,500	26,000	84,139
BREC	0	ND	3,000	ND	3,050	500	1,500
CARD	133,431	40,696	33,275	253,486	329,250	72,054	77,887
CARM	0	0	4,000	5,800	5,500	7,710	5,653
CERE	0	0	0	0	0	0	2,000
COLW	1,500	6,500	6,500	5,000	6,000	13,000	9,570
CYNO	0	0	24,000	750	750	28,065	1,291
DELY	2,000	9,000	0	5,000	4,500	0	1,077
DINF	0	1,750	6,000	8,500	ND	ND	10,000
DWYF	4,116	4,116	4,000	4,000	4,000	3,350	2,950
GLYN	6,000	6,000	1,000	4,400	4,930	7,225	7,250
ISLW	43,700	43,700	43,700	43,700	43,700	50,000	50,000
LLAN	5,000	ND	8,490	0	ND	ND	ND
LLIW	0	0	0	0	0	0	0
MEIR	500	500	500	510	605	1,000	ND
MERT	16,000	16,000	16,000	16,000	16,000	16,000	16,000
MONM	0	0	0	2,000	1,500	2,657	20,294
MONT	0	0	0	5,200	22,000	23,200	4,550
NEAT	36,600	30,000	23,900	26,180	30,828	46,931	67,548
NEWP	21,250	30,883	40,000	75,000	55,000	55,000	100,000
OGWR	51,610	63,000	55,000	50,000	30,000	44,000	40,000
PRES	12,600	5,000	6,000	6,000	0	0	ND
RADN	3,801	2,100	2,500	2,500	300	200	500
RHON	113,770	70,000	65,000	67,500	55,000	57,500	71,000
RHUD	9,100	8,000	7,000	8,000	6,000	5,000	11,000
RHYM	61,000	61,000	61,000	61,000	40,000	25,716	22,600
SPEM	8,200	8,500	10,000	10,000	6,000	4,000	4,000
SWAN	24,500	ND	43,000	62,000	61,410	31,800	32,600
TAFF	9,957	0	0	ND	0	ND	96,437
TORF	33,350	27,200	ND	ND	32,533	20,000	ND
VOGL	1,000	1,000	1,200	1,200	0	0	0
WREX	11,000	11,100	11,000	10,000	9,640	24,990	25,500
YNYS	61,100	28,845	52,295	45,000	53,000	40,000	40,000

ND = No data

Source of data: CIPFA Waste Disposal Statistics Reports (Actuals)

APPENDICES FOR CHAPTER 5

Appendix 5.1 Total Amount of Waste Disposed (Tonnes)

District	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
ABERCONWY	24,500	29,592	29,592	44,000	44,000	38,800-	44,688
AFAN	61,232	61,100	61,100	ND	58,000	55,734	55,734
ALYN & DEE	30,100	31,000	50,700	44,682	51,000	47,520	47,500
ARFON	36,196	35,166	36,000	37,000	ND	60,226+	55,000
BLAENAU G.	98,504	ND	ND	158,255	95,595	88,000	134,960
BRECKNOCK	14,732	14,600	14,600	ND	12,900	17,530	14,000
CARDIFF	260,032	373,443	328,461	380,634	466,853+	312,752	215,056
CARMARTHEN	24,461	21,000	29,000	30,000	30,000	23,530	21,469
CEREDIGION	24,900	23,000	23,000	23,000	23,000	29,000	42,000
COLWYN	32,500	32,300	32,500	29,000	32,000	28,780	55,695
CYNON VALL.	23,582	24,000	50,000	24,500	24,500	46,418-	44,717
DELYN	36,862	42,000	35,000	41,000	19,495	25,000	22,192
DINEFWR	18,540	18,750	23,500	30,000	ND	ND	27,500
DWYFOR	16,586	16,270	16,500	16,600	16,605	16,950	18,350
GLYNDWR	18,200	18,000	18,000	22,000	19,725	27,200	27,200
ISLWYN	77,345	77,700	77,700	77,700	78,700	71,000	71,000
LLANELLI	76,090+	ND	35,540	37,540	ND	ND	ND
LLIW VALLEY	39,000	27,325	41,500	44,000	55,000	44,500	42,000
MEIRIONNYDD	14,000	14,000	14,200	14,250	14,500	15,000	ND
MERTHYR TYD	88,305	88,180	88,180	88,180	98,080	98,930	97,800
MONMOUTH	21,150+	21,167+	29,214+	29,214+	31,800+	32,232+	49,035
MONTGOMERY	26,114	26,158	36,158	18,200	38,000	39,600	25,450
NEATH	58,600	52,000	45,850	47,080	56,528	98,073	97,648
NEWPORT	66,150	82,355	125,000	140,000	120,000	120,000	165,000
OGWR	275,781	147,000	124,000	113,000	105,000	127,500	117,500
PRESELI	34,600	35,000	36,500	36,500	36,000	37,800	ND
RADNOR	11,541	9,540	10,000	10,000	16,800	9,000	10,000
RHONDDA	138,770	110,000	105,000	97,000	100,000	94,500	86,000
RHUDDLAN	31,200	34,000	32,000	33,000	29,000	30,000	33,000
RHYMNEY VAL	176,100	176,100	144,000	144,000	125,000	109,076-	96,100
SOUTH PEMB	59,500	61,500	30,000	30,000	32,000	20,000	20,500
SWANSEA	126,500	ND	109,000	122,000	121,000	94,084	96,132
TAFF-ELY	53,242+	65,780+	69,500+	ND	94,900+	69,500	113,770
TORFAEN	72,350+	75,350+	ND	ND	93,533	79,755	ND
V.OF GLAM	41,005	41,389	40,690	41,285	36,979	38,201	40,426
WREXHAM	97,000+	104,761+	94,215+	88,700+	66,640+	102,920	104,900
YNYS MON	88,900	56,945	80,915	74,200	82,000	79,500	80,000

+ = Amount of waste disposed exceeds total waste arisings recorded by WDA, therefore, implying waste importation.

- = Total waste arisings recorded by WDA exceed amount of waste disposed, therefore, implying waste exportation.

Source of data: CIPFA Waste Disposal Statistics Reports (Actuals)

Appendix 5.2 Annual Change in the Amount of Waste Disposed

i) Changes in Tonnage

District	Change 1978/79 1979/80	Change 1979/80 1980/81	Change 1980/81 1981/82	Change 1981/82 1982/83	Change 1982/83 1983/84	Change 1983/84 1984/85
ABERCONWY	+ 5,092	0	+ 14,408	0	- 5,200	+ 5,888
AFAN	- 132	0	ND	ND	- 2,266	0
ALYN & DEE	+ 900	+ 19,700	- 5,318	+ 6,318	- 3,480	- 20
ARFON	- 1,030	+ 834	+ 1,000	ND	ND	- 5,226
BLAENAU G.	ND	ND	ND	- 62,660	- 7,595	+ 46,960
BRECKNOCK	- 132	0	ND	ND	+ 4,630	- 13,530
CARDIFF	+113,411	- 44,982	+ 52,173	+ 86,219	-154,101	- 97,696
CARMARTHEN	- 3,461	+ 8,000	+ 1,000	0	- 6,470	- 2,061
CEREDIGION	- 1,900	0	0	0	+ 6,000	+ 13,000
COLWYN	- 200	+ 200	- 3,500	+ 3,000	- 3,220	+ 26,915
CYNON VALL.	+ 418	+ 26,000	- 25,500	0	+ 21,918	- 1,701
DELYN	+ 5,138	- 7,000	+ 6,000	- 21,505	+ 5,505	- 2,808
DINEFWR	+ 210	+ 4,750	+ 6,500	ND	ND	ND
DWYFOR	- 316	+ 230	+ 100	+ 5	+ 345	+ 1,400
GLYNDWR	- 200	0	+ 4,000	- 2,275	+ 7,475	0
ISLWYN	+ 355	0	0	+ 1,000	- 7,700	0
LLANELLI	ND	ND	+ 2,000	ND	ND	ND
LLIW VALLEY	- 11,675	+ 14,175	+ 2,500	+ 11,000	- 10,500	- 2,500
MEIRIONNYDD	0	+ 200	+ 50	+ 250	+ 500	ND
MERTHYR TYD	- 125	0	0	+ 9,900	+ 850	- 1,130
MONMOUTH	+ 17	+ 8,047	0	+ 2,586	+ 432	+ 16,803
MONTGOMERY	+ 44	+ 10,000	- 17,958	+ 19,800	- 1,600	- 14,150
NEATH	- 6,600	- 6,150	+ 1,230	+ 9,448	+ 41,545	- 425
NEWPORT	+ 16,205	+ 42,645	+ 15,000	- 20,000	0	+ 45,000
OGWR	-128,781	- 23,000	- 11,000	- 8,000	+ 22,500	- 10,000
PRESELI	+ 400	+ 1,500	0	- 500	+ 1,800	ND
RADNOR	- 2,001	+ 460	0	+ 6,800	- 7,800	+ 1,000
RHONDDA	- 28,770	- 5,000	- 8,000	+ 3,000	- 5,500	- 8,500
RHUDDLAN	+ 2,800	- 2,000	+ 1,000	- 4,000	+ 1,000	+ 3,000
RHYMNEY VAL	0	- 32,100	0	- 19,000	- 15,924	- 12,976
SOUTH PEMB	+ 2,000	- 31,500	0	+ 2,000	- 12,000	+ 500
SWANSEA	ND	ND	+ 13,000	- 1,000	- 26,916	+ 2,048
TAFF-ELY	+ 12,538	+ 3,720	ND	ND	- 25,400	+ 44,270
TORFAEN	+ 3,000	ND	ND	ND	- 13,778	ND
V.OF GLAM	+ 384	- 699	+ 595	- 4,306	+ 1,222	+ 2,225
WREXHAM	+ 7,761	- 10,546	- 5,515	- 22,060	+ 36,280	+ 1,980
YNYS MON	- 31,955	+ 23,970	- 6,715	+ 7,800	- 2,500	+ 500

ND = No data + = Increase - = Decrease
Source of data; Calculated using data in Appendix 5.1

Appendix 5.2 continued..

ii) Percentage Change

District	Change 1978/79 1979/80	Change 1979/80 1980/81	Change 1980/81 1981/82	Change 1981/82 1982/83	Change 1982/83 1983/84	Change 1983/84 1984/85
ABERCONWY	+ 21	0	+ 49	0	- 12	+ 15
AFAN	0	0	ND	ND	- 4	0
ALYN & DEE	+ 3	+ 63	- 10	+ 14	- 7	- 0
ARFON	- 3	+ 2	+ 3	ND	ND	- 9
BLAENAU G.	ND	ND	ND	- 40	- 8	+ 53
BRECKNOCK	- 1	0	ND	ND	+ 36	- 20
CARDIFF	+ 44	- 12	+ 16	+ 23	- 33	- 31
CARMARTHEN	- 14	+ 38	+ 3	0	- 22	- 9
CEREDIGION	- 8	0	0	0	+ 26	+ 45
COLWYN	- 1	+ 1	- 11	+ 10	- 10	+ 93
CYNON VALL.	+ 2	+108	- 51	0	+ 89	- 4
DELYN	+ 14	- 17	+ 17	- 52	+ 28	- 11
DINEFWR	+ 1	+ 25	+ 28	ND	ND	ND
DWYFOR	- 2	+ 1	+ 1	0	+ 2	+ 8
GLYNDWR	- 1	0	+ 22	- 10	+ 38	0
ISLWYN	0	0	0	+ 1	- 10	0
LLANELLI	ND	ND	+ 6	ND	ND	ND
LLIW VALLEY	- 30	+ 52	+ 6	+ 25	- 19	- 6
MEIRIONNYDD	0	+ 1	0	+ 2	+ 3	ND
MERTHYR TYD	0	0	0	+ 11	+ 1	- 1
MONMOUTH	0	+ 38	0	+ 9	+ 1	+ 52
MONTGOMERY	0	- 38	- 50	+109	+ 4	- 36
NEATH	- 11	- 12	+ 3	+ 20	+ 73	0
NEWPORT	+ 24	+ 52	+ 12	- 14	0	+ 37
OGWR	- 47	- 16	- 9	- 7	+ 21	- 8
PRESELI	+ 1	+ 4	0	- 1	+ 5	ND
RADNOR	- 17	+ 5	0	+ 68	- 46	+ 11
RHONDDA	- 21	- 4	- 8	+ 3	- 5	- 9
RHUDDLAN	+ 9	- 6	+ 3	- 12	+ 3	+ 10
RHYMNEY VAL	0	- 18	0	- 13	- 13	- 12
SOUTH PEMB	+ 3	- 51	0	+ 7	- 37	+ 2
SWANSEA	ND	ND	+ 12	- 1	- 22	+ 2
TAFF-ELY	+ 23	+ 6	ND	ND	- 27	+ 64
TORFAEN	+ 4	ND	ND	ND	- 15	ND
V.OF GLAM	+ 1	- 2	+ 1	- 10	+ 3	+ 6
WREXHAM	+ 8	- 10	- 6	- 25	+ 54	+ 2
YNYS MON	- 36	- 42	- 8	+ 10	- 3	+ 1

ND = No data   + = Increase   - = Decrease

Source of Original data; Appendix 5.2i & 5.1

Appendix 5.3 Amount of Waste Disposed By WDA Directly

District	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
ABERCONWY	24,500	29,592	29,592	44,000	44,000	38,800	33,375
AFAN	61,232	61,100	61,100	ND	58,000	55,734	55,734
ALYN & DEE	0	14,800	50,700	44,682	51,000	47,520	47,500
ARFON	36,196	35,166	36,000	37,000	ND	60,226	55,000
BLAENAU G.	91,154	ND	ND	158,255	95,595	88,000	134,960
BRECKNOCK	13,782	12,883	12,883	ND	11,000	15,520	10,797
CARDIFF	260,032	373,443	328,461	380,634	466,853	312,752	215,056
CARMARTHEN	24,461	21,000	29,000	30,000	30,000	4,104	18,917
CEREDIGION	24,900	23,000	23,000	23,000	23,000	29,000	42,000
COLWYN	32,500	32,300	32,500	29,000	32,000	28,780	55,695
CYNON VALL.	23,582	24,000	50,000	24,500	24,500	46,418	44,717
DELYN	36,862	42,000	35,000	41,000	19,495	0	0
DINEFWR	16,790	18,750	23,500	30,000	ND	ND	27,500
DWYFOR	16,586	16,270	16,500	16,600	16,605	16,600	18,000
GLYNDWR	18,200	18,000	18,000	22,000	19,725	27,200	27,200
ISLWYN	77,345	77,700	77,700	77,700	78,700	71,000	71,000
LLANELLI	76,090	ND	35,540	37,540	ND	ND	ND
LLIW VALLEY	39,000	27,325	41,500	44,000	55,000	44,500	37,000
MEIRIONNYDD	13,900	14,000	14,200	14,250	14,500	15,000	ND
MERTHYR TYD	88,180	88,180	84,780	84,780	98,080	98,880	97,750
MONMOUTH	17,750	17,531	25,578	29,214	31,800	32,232	49,035
MONTGOMERY	26,114	26,158	36,158	18,200	38,000	39,600	25,450
NEATH	58,600	52,000	45,850	47,080	56,528	98,073	97,648
NEWPORT	66,150	82,355	125,000	140,000	120,000	120,000	165,000
OGWR	275,684	143,000	120,000	110,000	105,000	127,500	117,500
PRESELI	34,600	35,000	36,500	36,500	36,000	37,800	ND
RADNOR	11,541	9,540	10,000	10,000	16,800	8,200	9,000
RHONDDA	138,770	110,000	105,000	97,000	100,000	94,500	86,000
RHUDDLAN	31,200	34,000	32,000	33,000	29,000	30,000	18,000
RHYMNEY VAL	176,100	176,100	144,000	144,000	125,000	95,780	96,100
SOUTH PEMB	59,500	61,500	30,000	30,000	32,000	20,000	20,500
SWANSEA	126,500	ND	109,000	122,000	121,000	94,084	96,132
TAFF-ELY	53,207	65,780	69,500	ND	94,900	69,500	49,100
TORFAEN	72,350	75,350	ND	ND	93,533	79,755	ND
V.OF GLAM	32,585	32,969	32,425	31,035	9,765	36,009	36,863
WREXHAM	97,000	103,261	92,715	87,200	65,140	87,420	88,900
YNYS MON	88,900	56,945	80,915	74,200	82,000	79,500	80,000

ND = No Data

Source: CIPFA Waste Disposal Statistics (Actuals) Reports

Appendix 5.4 Recorded Differences Between Total Waste Arising, Total Waste Disposed and Disposal By the WDA

District	Year	Total Arisings tonnes	Waste Disposed tonnes	Waste Disposed By: WDA tonnes	Contrs. tonnes	Other WDAs tonnes
ABERCONWY	1983-84	44,624	38,800	38,800	0	0
	1984-85	44,683	44,683	33,375	1,618	9,695
ALYN & DEE	1978-79	30,100	30,100	0	0	30,100
	1979-80	31,000	31,000	14,800	0	16,200
ARFON	1983-84	59,876	60,226	60,226	0	0
	1984-85	54,650	55,000	55,000	0	0
BLAENAU G.	1978-79	98,504	98,504	91,154	0	7,350
BRECKNOCK	1978-79	14,732	14,732	13,782	0	950
	1979-80	14,600	14,600	12,883	0	1,717
	1980-81	14,600	14,600	12,883	0	1,717
	1982-83	12,900	12,900	11,000	0	1,900
	1983-84	17,530	17,530	15,520	0	2,010
	1984-85	13,000	14,000	10,797	1,000	2,203
CARDIFF	1982-83	447,703	466,853	466,853	0	0
CARMARTHEN	1983-84	23,530	23,530	4,104	19,426	0
	1984-85	21,469	21,469	18,917	2,552	0
COLWYN	1984-85	32,000	55,695	55,695	0	0
CYNON VALL.	1983-84	48,345	46,418	46,418	0	0
DELYN	1983-84	25,000	25,000	0	25,000	0
	1984-85	21,192	22,192	0	22,192	0
DINEFWR	1978-79	18,540	18,540	16,790	1,750	0
DWYFOR	1983-84	16,950	16,950	16,600	0	350
	1984-85	18,350	18,350	18,000	0	350
LLANELLI	1978-79	75,590	76,090	76,090	0	0
LLIW VALLEY	1984-85	42,000	42,000	37,000	5,000	0
MEIRIONNYDD	1978-79	14,000	14,000	13,900	100	0
MERTHYR TYD	1978-79	88,305	88,305	88,180	125	0
	1980-81	88,180	88,180	84,780	3,400	0
	1981-82	88,180	88,180	84,780	3,400	0
	1983-84	98,930	98,930	98,880	50	0
	1984-85	97,800	97,800	97,750	50	0
MONMOUTH	1978-79	20,200	21,150	17,750	0	3,400
	1979-80	19,450	21,167	17,531	0	3,636
	1980-81	27,497	29,214	25,578	0	3,636
	1981-82	27,414	29,214	29,214	0	0
	1982-83	29,900	31,800	31,800	0	0
	1983-84	30,222	32,232	32,232	0	0
	1984-85	46,832	49,035	49,035	0	0
OGWR	1978-79	275,781	275,781	275,684	97	0
	1979-80	147,000	147,000	143,000	4,000	0
	1980-81	124,000	124,000	120,000	4,000	0
	1981-82	113,000	113,000	110,000	3,000	0
RADNOR	1983-84	9,000	9,000	8,200	0	800
	1984-85	10,000	10,000	9,000	0	1,000
RHONDDA	1984-85	94,000	86,000	86,000	NA	NA

Appendix 5.4 Continued..

District	Year	Total Arisings tonnes	Waste Disposed tonnes	Waste Disposed By: WDA tonnes	Contrs. tonnes	Other WDAs tonnes
RHYMNEY VAL	1983-84	118,016	109,076	95,780	13,296	0
TAFF-ELY	1978-79	46,222	53,242	53,207	35	0
	1979-80	58,760	65,780	65,780	0	0
	1980-81	62,500	69,500	69,500	0	0
	1982-83	89,500	94,900	94,900	0	0
	1984-85	145,537	113,770	49,100	64,670	0
TORFAEN	1978-79	65,000	72,350	72,350	0	0
	1979-80	68,000	75,350	75,350	0	0
V.OF GLAM	1978-79	41,005	41,005	32,585	1,400	7,020
	1979-80	41,389	41,389	32,969	1,400	7,020
	1980-81	40,690	40,690	32,425	1,265	7,000
	1981-82	41,285	41,285	31,035	1,830	8,420
	1982-83	36,979	36,979	9,765	2,566	24,648
	1983-84	38,201	38,201	36,009	2,192	0
	1984-85	40,426	40,426	36,863	3,563	0
WREXHAM	1978-79	47,000	97,000	97,000	0	0
	1979-80	49,460	104,761	103,261	1,500	0
	1980-81	50,500	94,215	92,715	1,500	0
	1981-82	51,640	88,700	87,200	1,500	0
	1982-83	51,640	66,640	65,140	1,500	0
	1983-84	102,920	102,920	87,420	15,500	0
	1984-85	104,900	104,900	88,900	16,000	0

Source: CIPFA Waste Disposal Statistics Reports (Actuals)

Appendix 5.5 Amount of Waste Disposed of Untreated to Landfill (Tonnes)

District	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
ABERCONWY	24,500	29,592	29,592	44,000	44,000	38,800	33,375
AFAN	61,232	61,100	61,100	ND	58,000	55,734	47,684
ALYN & DEE	0	14,800	50,700	44,682	51,000	47,520	47,500
ARFON	36,196	35,166	36,000	37,000	ND	60,226	55,000
BLAENAU G.	91,154	ND	ND	158,255	95,595	88,000	126,660
BRECKNOCK	13,782	12,883	12,883	ND	11,000	15,520	10,797
CARDIFF	260,032	373,443	328,461	380,634	466,853	312,752	201,005
CARMARTHEN	24,461	21,000	29,000	30,000	30,000	4,104	18,917
CEREDIGION	24,900	23,000	23,000	23,000	23,000	29,000	42,000
COLWYN	32,500	32,300	32,500	29,000	32,000	28,030	51,695
CYNON VALL.	12,862	13,200	50,000	24,500	24,500	46,418	0
DELYN	36,862	42,000	35,000	41,000	19,495	0	0
DINEFWR	16,790	18,750	23,500	30,000	ND	ND	0
DWYFOR	16,586	16,270	16,500	16,600	16,605	16,000	18,000
GLYNDWR	18,200	18,000	18,000	22,000	19,725	27,200	26,950
ISLWYN	77,345	77,700	77,700	77,700	78,700	71,000	71,000
LLANELLI	76,090	ND	35,540	37,540	ND	ND	ND
LLIW VALLEY	39,000	27,325	41,500	44,000	55,000	44,500	37,000
MEIRIONNYDD	13,900	14,000	14,200	1,250	1,500	2,000	ND
MERTHYR TYD	88,180	88,180	84,780	84,780	98,080	98,880	97,750
MONMOUTH	17,750	17,531	25,578	29,214	31,800	23,611	42,144
MONTGOMERY	26,114	26,158	36,158	18,200	38,000	39,600	25,450
NEATH	58,600	52,000	45,850	47,080	56,528	94,323	92,548
NEWPORT	66,150	82,355	125,000	140,000	120,000	120,000	165,000
OGWR	275,684	143,000	120,000	110,000	105,000	127,500	117,500
PRESELI	34,600	35,000	36,500	36,500	36,000	37,800	ND
RADNOR	11,541	9,540	10,000	10,000	16,800	8,200	9,000
RHONDDA	120,020	85,000	79,000	75,500	73,000	64,500	71,000
RHUDDLAN	31,200	34,000	32,000	33,000	29,000	27,500	14,000
RHYMNEY VAL	176,100	176,100	144,000	144,000	125,000	93,750	96,100
SOUTH PEMB	59,500	61,500	30,000	30,000	32,000	20,000	16,500
SWANSEA	126,500	ND	109,000	122,000	121,000	94,084	96,132
TAFF-ELY	53,207	65,780	69,500	ND	94,900	ND	113,770
TORFAEN	49,600	51,550	ND	ND	80,533	79,755	ND
V.OF GLAM	32,585	32,969	32,425	31,035	9,765	36,009	35,866
WREXHAM	97,000	103,261	92,715	87,200	65,140	87,420	88,900
YNYS MON	88,900	56,945	80,915	74,200	82,000	79,500	80,000
TOTAL('000s)	2,289.6	1,951.4	2,068.6	2,113.9	2,241.5	2,019.2	1,949.2

ND = No Data

Source: CIPFA Waste Disposal Statistics (Actuals) Reports

Appendix 5.6 <u>Reclaimed Waste. (Tonnes)</u>.

District	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
ARFON							175f*
BRECKNOCK	26p						
CARDIFF							16,820o
CARMARTHEN						80g*	80g
CEREDIGION						500p* 100g*	
COLWYN	312o	423o	425o	311o	318o		
CYNON VALL.	33p 248f 41n	ND					
DWYFOR	100o*						
ISLWYN			6f*				
NEWPORT		170p				ND	
PRESELI			500f* 1,250o*	500f* 1,250o*	520f* 1,000o*		
RHONDDA	206f 48o	336f	270n			ND	
RHYMNEY VAL					100n*	103n* 5f* 12o*	36n* 15g* 35o*
TAFF-ELY							31,768T*
V.OF GLAM					104f 12n	86f 2n	40f
WELSH TOTALS:							
Paper (p)	59	170	0	0	0	500	0
Other (o)	460	423	1,675	1,561	1,318	12	16,855
Ferrous Metal(f)	454	336	506	500	624	91	215
Non-ferrous Metals (n)	41	0	270	0	112	105	36
Glass (g)	0	0	0	0	0	100	95
Combined (T)							31,768
No. of Districts	5	3	4	2	4	4	6

* = WDA has not recorded any corresponding income from sale of reclaimed waste
ND = No Data

Source: CIPFA Waste Disposal Statistics (Actuals) Reports

Appendix 5.7 <u>Special Waste Disposal Within WDA Area</u>

District	1978	1979	1980	1981	1981 Gregson	1982	
ABERCONWY	-	-	-		-	4L	-
AFAN	2,000L	1,000L	500L	500L	2,000L	N/A	
	8,000I	8,000I	8,000I	8,000I	?I	-	
ALYN & DEE	-	-	-	-	40L	-	
ARFON	-	-	-	-	4,708L	-	
BLAENAU G	48L	3,123L	100L	25L	203L	219L	
	6,350R	6,365R	6,332R	6,397R	53,500R	6,416R	
CARDIFF	-	-	9L	267L	-	-	
CEREDIGION	4?	-	-	-	4?	-	
DELYN	-	-	-	-	3,352L	-	
DWYFOR	-	-	-	-	8L	-	
LLANELLI	-	-	-	-	2L	-	
MERTHYR TYD	-	-	-	-	190L	-	
MONTGOMERY	-	-	-	-	neg.L	-	
NEATH	-	-	-	-	85L	-	
					2,500I		
NEWPORT	-	-	-	-	117L	-	
					1,136I		
					300R		
PRESELI	-	-	-	26L	707L	50L	
					218LS		
RHUDDLAN	-	-	-	-	20L	-	
SOUTH PEMB	-	-	24?	-	-	-	
TORFAEN	-	-	-	-	1,238L	-	
					19,163I/C		
VALE.OF GLAM	195L	201L	310L	294L	1,161L	420L	
WREXHAM	-	-	-	-	4,064L	-	
					12,000S		

L= Landfill
I= Incineration
R= Recycled
I/C= Incineration & Chemical Treatment
S= Sea Disposal
LS= Land Spreading
N/A= Not Available
?= Not Known
Neg.= Negligible

Source: Questionnaire Data, Wathern (1983)
House of Lord's Select Committee Report, (1981)

APPENDICES FOR CHAPTER 6

Appendix 6.1 The Collection of Unpublished Data on Landfill Sites by Postal Questionnaire

Examination of the published data available on waste, has revealed numerous inconsistencies and weaknesses. Chief amongst these, is the absence of data related to the most important aspect of waste disposal, landfill sites. The only information available, has been collected by Wathern et al., most of which, has not been published or thoroughly analysed. Furthermore, incomplete replies from some Authorities, have meant that additional data are required to establish the situation fully. Thus, it has been necessary to obtain information directly from the WDAs.

Mosher (1958), suggests four methods of data collection. These are, a) documentary sources, b) observation, c) interviewing and d) postal questionnaire. In the circumstances, a postal questionnaire is considered to be the best option; documentary sources have proved inadequate and observation has not been possible. Some interviews have been necessary, but on a very limited scale, (it was found impractical to interview each Waste Disposal Officer). Consequently, the postal questionnaire has been formulated and distributed to all 37 WDAs. Three main considerations were foremost in the design and application of the questionnaire:-

a) First, that the data produced should be compatible, in terms of variables, units of measurement and recording intervals, with other data already available;

b) Secondly, questions should be clear and simple, to avoid misinterpretation and inadequate replies,

and c) Finally, the questionnaire should be kept short and succinct, to encourage a response, rather than appear too onerous a task.

Continued..

In the light of these requirements, only data relating to landfill sites have been requested and questions kept to a minimum. Officers were asked to complete the same set of questions, for each site within their area. The following is a brief synopsis of the reasoning behind each question asked:-

i) The name and location of each site was requested. This would enable the distribution of sites to be analysed, both for Wales as a whole and within individual Authorities;

ii) Information related to site size (Area ha) would enable any differences in selection policy regarding the minimum and maximum size of site acceptable, to be analysed. It would also be useful in the analysis of the future capacity (tonnes) of each site;

iii) Questions concerning the date of site opening and future capacity (years) were included, with a view to analysing total site lifespan and hence the ability to select sites with a long term future, rather than opt for short-term expediency. This information would also indicate the urgency of the current need for new sites. Date of site opening would also indicate whether a site was selected before or after COPA.

iv) The type of waste tipped and amount, would reveal the tipping rate, (amount of waste tipped per annum) and could be cross-checked with data relating to the amount of waste disposed by the WDA per annum.

v) The previous land use of each site was requested, as an indicator of site type and hence selection policy. That is, whether the WDA selected sites for example, on derelict land or agricultural land. The information could also be used to assess whether pollution problems at particular sites are related to site type.

The overall aim of the combination of questions included in the

Continued..

questionnaire, was to elucidate variations in landfill site characteristics and hence, differences in the site selection policies of the WDAs. Although, the information requested was minimal, it was thought to be sufficient for this purpose. The decision to request only the most essential information was subsequently reaffirmed by the 100 percent response rate to the questionnaire.

<u>The 1984 Landfill Sites Postal Questionnaire</u>

Name of Landfill Site	
Location (Grid Reference)	
Area (ha²)	
Previous use of the site	
Date when site was opened	
Future capacity (Years)	
Type of waste tipped (Tonnes): i) Domestic waste ii) Industrial waste (non-toxic) iii) Toxic waste	

Appendix 6.2 Data from the 1983 Questionnaire on Landfill Sites

District	Site Name and Location / Previous Use (PU) / Size (ha)	Type of Waste Tipped	Grid Reference / Future Capacity / Pollution Problems (P)	Date Opened
Aberconwy	Valley Tip, (near Dolgarrog). PU= Agric. S= 13ha	D+I 44,000t p.a.	GR.7780 6595 3yrs P=none	Pre 1974
Afan	Eagle Brickworks (Cwmafan) PU= Quarry S= 6.6ha	D+I 58,000t p.a.	GR.8940 2140 2yr P=none	1971
Alyn & Dee	*Broken Bank Tip PU=Marsh land S=?	DIT 4,030t p.a.	GR.? Unlimited P=none	1918
Arfon	Cilgwyn (Carmel) PU= Slate quarry S= 20.6ha	D+I 40,000t p.a.	GR.450 540 25yrs P=L & WBL	1975/6
Blaenau	Silent Valley (Cwm) PU= Derelict/Ind. S=3,000,000 m³	DIT 76,300t p.a.	GR.SO 185 073 20yrs P=Yes	1981
Brecknock	Rhosferno (Garth) PU=Scrubwood S=0.9ha	D+I 1,800t p.a.	GR.SN981506 6yrs P=none	1958
	Llanwrtyd Wells PU=Scrubwood. S=0.4ha	D+I 218t p.a.	GR.SN879 461 3/4yrs P=none	1930s
	Tycanol (Ystradgynlais) PU=Agric. S=1.8ha	D+I 3,940t p.a.	GR.SN76117711 4yrs P=none	1981
Cardiff	Ferry Road (Penarth Moors) PU=Esturial area S=69ha	DCI 171,529t p.a.	GR.ST 1773 5yrs P=none	1974
	Lomby Way (Rumney Moors) PU=Esturial area S=38ha	DI 208,761t p.a.	GR. ST219782 5yrs(ex80yrs) P=none	1974
Camarthen	No response to questionnaire			
Ceredigion	*Aberystwyth PU=Agric. S=7ha	D 7,500t p.a.	GR. 580805 1yr P=none	1961
	*Borth PU=Bog S=4ha	D 5,000t p.a.	GR. 615894 10yrs P=none	?

Continued..

District	Site	Use	Area	Type	Input	Life	Grid ref.	Pollution	Date
Ceredigion..	*Lampeter	PU=Quarry	S=1ha	DT	2,300t p.a.	1yr	GR. 585487	P=none	1951
	*Rhydeinon	PU=Agric.	S=5.4ha	D	11,300t p.a.	6mths	GR. 432546	P=Leachate	1966
	*Tregaron	PU=Agric.	S=?	D	1,100t p.a.	5yrs	GR. 662579	P=none	1954
Colwyn	Gofer Site (Abergele)	PU=Agric.	S=20ha	D+I	26,500t p.a.	3yrs	GR.SH975 775	P=Leachate	1970
Cynon V.	No information on sites received								
Delyn	No information on sites received								
Dinefwr	Wernddu	PU=Agric.	S=5.7ha	D+I	6,500t p.a.	10yrs	GR.SN645 153	P=none	1982
Dwyfor	Maesoglan	PU=Agric.	S=6.7ha	D+I	16,800t p.a.	6mths	GR. 302 379	P=none	1951
Glyndwr	Lon Parcwr (Ruthin)	PU=Agric.	S=30ha	D+I	18,700t p.a.	10yrs	GR.SJ125 597	P=none	Pre 1974
	Lower Halton (Chirk)	PU=Agric.	S=7ha	D+I	6,000t p.a.	5yrs	GR.SJ306 385	P=none	Pre 1974
	Wenffrwd (Llangollen)	PU=Agric.	S=7ha	D+I	1,500t p.a.	2yrs	GR.SJ235 423	P=none	Pre 1974
	*Bryn Bras (Corwen)	PU=Agric.	S=4ha	D+I	1,000t p.a.	2yrs	GR.097 454	P=none	Pre 1974
Islwyn	Trinant	PU=Tip/wood	S=4.3ha	D+I	38,600t p.a.	5yrs	GR.2095 9975	P=none	1982
	Graig Yr Trwyn (Wattsville)	PU=Quarry	S=4.2ha	D+I	38,600t p.a.	3yrs	GR.9205 9145	P=Leachate	1980
Llanelli	Kidwelly	PU=Marsh Land	S= 9.6ha	D	40,640t p.a.	2.5yrs	GR. SN401 069	P=none	1977

Continued..

Llanelli..	*Northumberland PU=Foreshore S= 6.5ha	D ?	GR.SS 505988 1977 2.5yrs P=none
Lliw V.	Pwllfawatkin Tip (Rhydfro) PU=Agric. S=8.9ha	D+I 27.250t	GR.SN 697 084 1981 p.a. 19yrs P=none
	Cwrt y Carne (Gorseinon) PU=Marsh land S=3.5ha	D+I 27.250t	GR.SN 569 002 1979 p.a. 1.5yr P=none
Meirionnydd	Tywyn PU=Agric. S=2.8ha	D+I 1,500t	GR.54588016 1977 p.a. 10yrs P=none
Merthyr T.	No data supplied for WDA sites, only small private sites		
Monmouth	Llanfoist (Abergavenny) PU=Agric. S=5ha	DIC 18,000t	GR.SO 297 130 Pre 1970 p.a. 2yrs P=Leachate & WBL
	Ifton Quarry (Rogiet) PU=Quarry S=2.2ha	D+C 12,908t	GR.ST 465 885 1977 p.a. 10/11yrs P=none
Montgomery	No response to questionnaire		
Neath	Giants Grave (Briton Ferry) PU=Waste land S=35ha	D+I 45,000t	GR.2733 1955 Pre 1930 p.a. 7/8yrs P=none
	Cadoxton PU=Vacant land S=11.5ha	D+I 25,000t	GR.2765 1989 1974 p.a. 3/5yrs P=none
Newport	No response to questionnaire		
Ogwr	No response to questionnaire		
Preseli	*Whitchurch (St. David's) PU=Agric. S=6ha	DIT 16,006t	GR. 786 266 1965 p.a. 5yrs P=none
	*Winsel Farm (Haverfordwest) PU=Agric. S=4.9ha	D+I 20,000t	GR. 924 132 1976 p.a. 1yr P=none
Radnor	Clyro (Hay on Wye) PU=Agric. S=2ha	D+I 2,200t	GR.SO216 435 1962 p.a. 3yrs P=none
	*Nantmel PU=Agric. S=10ha	D+I 8,000t	GR.172 599 1965 p.a. 10yrs P=Leachate & WBL

Continued..

Radnor..	*Cefn Coch			GR. 2316 7335	1979
	PU=Agric.	D	3,650t p.a.	1yr	
	S=0.3ha			P=none	
Rhondda	Abergorchy (Treorchy)			GR.SS 957979	1950
	PU=Colliery tip	D+I	50,000t p.a.	2yrs	
	S=3ha			P=none	
	Highfield (Ferndale)			GR.SS 992976	1950
	PU=Colliery	D+I	40,000t p.a.	1.5yrs	
	S=1.9ha			P=none	
Rhuddlan	*Marsh Road (Rhyl)			GR.ST002 802	1960
	PU=Marsh land	D+I	?	1yr	
	S=40ha			P=none	
Rhymney V	Coed Top Hill (Gelligaer)			GR.ST116 969	1973
	PU=Agric	D+I	102,200t p.a.	3yrs	
	S=5ha			P=none	
	*Maesycwmmer			GR.ST 164 948	1981
	PU=Railway cut.	DIT	159,900t p.a.	38yrs	
	S=2ha			P=none	
	*Trecatti (Dowlais)			GR.SO086 074	1980
	PU=Opencast mine	DIT	58,400t p.a.	1yr	
	S=1ha			P=none	
	*Markham Road (Aberbargoed)			GR.SO 162 007	1977
	PU=Quarry	D+I	29,200t p.a.	2yrs	
	S=7ha			P=none	
	*Mill Road (Caerphilly)			GR.ST147 876	1981
	PU=Agric.	D+I	22,300t p.a.	3mths	
	S=1ha			P=none	
S.Pemb	Kingsmoor			GR.SN 116 067	1965
	PU=Common land	D+I	13-18,000t	2yrs	
	S=4.5ha			P=none	
	*Pincheston			GR. 065 032	1968
	PU=Quarry	D+I	13-18,000t	soon	
	S=1.2ha			P=none	
Swansea	*Clyne			GR.	Pre 1974
	PU=Agri/Wood	D+I	?	3yrs	
	S=200ha			P=Leachate	
	*Crymlyn Quarry			GR.	Pre 1974
	PU=Quarry	D	?	5yrs	
	S=20ha			P=none	
	*Tir John			GR.	Pre 1974
	PU=Marsh land	D	?	30yrs	
	S=50ha			P=Leachate	
Taff-Ely	No response to questionnaire				

Continued..

Torfaen	No response to questionnaire			
V. of Glam	Penarth Docks		GR.ST 180 725	1982
	PU=Dock	D 31.200t p.a.	5/6yrs	
	S=4ha		P=none	
	*Barry Docks		GR.	1977
	PU=Docks	DIT 102,780t p.a.	10yrs	
	S=8ha		P=none	
Wrexham	*Caedyah Farm		GR.8900 2125	1966
	PU=Agric.	D 36,500t p.a.	10yrs	
	S=20ha		P=none	
	*Gwersyllt Park		GR. 335 721	1974
	PU=Quarry	D 65,000t p.a.	1yr	
	S=24.5ha		P=none	
Ynys Mon	Clegir Mawr (Gwalchmai)		GR. 372 772	1948
	PU=Agric.	D+I 35.000t p.a	2yrs	
	S=11ha		P=Leachate	
	Penhesgyn Gors Farm (Menai)		GR.372 747	1965
	PU=Marsh land	D+I 24.000t p.a.	10yrs	
	S=20ha		P=none	

PU = Previous Use S = Size GR. = Grid Reference P = Pollution Problems
? = No data WBL = Wind Blown Litter
Type of Waste (tonnes): D = Domestic Waste, I = Industrial, C = Commercial
T = Toxic
Underlining = Differences in data, 1983 and 1984 Questionnaires
* = No difference between data in 1983 and 1984 Questionnaires

Source: Unpublished Data from 1983 Questionnaire, (Wathern)

Continued..

Appendix 6.2: Supplementary Information, Additional Sites 1983

Cynon Valley	Bryn Pica		GR.	SO007 050	?
	PU = Quarry	D+I 35,000t	p.a.	?	
	S=27ha		P=?		
Montgomery	Carreg Hofa	GR.			?
	PU=Other	? 6,500t	p.a.	?	
	S=?		P=?		
	Bryn Posteg (Llanidloes)		GR.		?
	PU=Quarry	? 10,400t	p.a.	?	
	S=?		P=?		
Ogwr	Tythegston		GR.	852 789	?
	PU=Quarry	DC 100-120,000t		?	
	S=8ha		P=?		
Torfaen	Tirpentwys		GR.		?
	PU=Quarry	D 22,750t	p.a.	?	
	S=?		P=?		
	Garn-Yr-Erw (Blaenavon)		GR.		?
	PU=Quarry	D+I 8,250t	p.a.	?	
	S=?		P=?		
Taff-Ely	Fforest Uchaf (Pontypridd)		GR.		?
	PU=Agric.	? 31,700t	p.a.	?	
	S=?		P=?		
	Llanharan		GR.	000840	?
	PU=Quarry	? 38,300t	p.a.	?	
	S=?		P=?		

Source of data: Unpublished data collected by Wathern (1983): from telephone conversations with WDA Officers who had failed to respond to the questionnaire

Appendix 6.3 1984 Questionnaire on landfill sites:

District	Name and Location / Previous Use (PU) / Size (ha)	Type of Waste	Grid Reference / Future Capacity / Pollution Problems (P)	Date Opened
Aberconwy	Valley Tip, (near Dolgarrog). PU= Marsh land S= N/A	D+I 60,520t	GR.7818 6572 p.a. 4mths P=none	Pre 1974
Afan	Eagle Brickworks (Cwmafan) PU= Quarry S= 12.2ha	D+I 55,734t	GR.8940 2140 p.a. 1yr P=none	1970
Alyn & Dee	Etna Clay Hole (Buckley) PU= Clay hole S= 7ha	D+I 47,000t	GR.2860/6520 p.a. soon P=leachate	1978
Arfon	Cilgwyn (Carmel) PU= Slate quarry S= 16ha	D+I 55,000t	GR.500 540 p.a. 20yrs P=none	1974
Blaenau	Silent Valley PU= Derelict S=9,000,000 m^3	DIT 87,900t	GR.SO185 073 p.a. 25yrs P=leachate & windblow	1981
Brecknock	Felinfach PU=Agric. S=1ha	D+I 5,532t	GR.SO083093 p.a. 6mths P=none	1983
	Rhosferno (Builth Wells) PU=Cutting S=2ha	D+I 1,500t	GR.SN981 506 p.a. 5yrs P=none	1961
	Llanwrtyd Wells PU=Agric. S=1ha	D+I 520t	GR.SN879 461 p.a. 6yrs P=none	1960
	Tycanol (Ystradgynlais) PU=Agric. S=2.5ha	D+I 3,120t	GR.SN761771 p.a. 2(ex8yrs) P=none	1975
Cardiff	Penarth Moors PU=Esturial area S=69ha	DCI 145,646t	GR.ST 1773 p.a. 3yrs P=none	1973
	Rumney Moors PU=Esturial area S=38ha	DCI 167,110t	GR. ST217 p.a. 5yrs P=none	1973
Camarthen	Carmarthen PU=Agric. S=7ha	D+I 30,000t	GR. 470 175 p.a. 50yrs P=controlled	1984
Ceredigion	No change since first questionnaire			

Continued..

Colwyn	Gofer Site (Abergele)			GR.SH972 781	1982
	PU=Agric.	D+I	28,288t p.a. 5mths		
	S=3.7ha			P=controlled	
Cynon V.	Bryn Pica (Aberdare)			GR.SO 006055	1982
	PU=Opencast mine	D+I	47,492t p.a. 25yrs		
	S=185 ha			P=none	
Delyn	Ddol Quarry (Ysceifiog)			GR. SJ17	1981
	PU=Quarry	D	24,000t p.a. 4yrs		
	S=168,000m³			P=none	
Dinefwr	Vernddu			GR.SN646 154	1982
	PU=Agric.	D+I	29,000t p.a. 8yrs		
	S=5ha			P=leachate	
Dwyfor	Maesoglan			GR. 302 379	1951
	PU=Agric.	D+I	16,586t p.a. 1.5yrs		
	S=6.7ha			P=leachate	
Glyndwr	Lon Parcwr (Ruthin)			GR.SJ125 597	Pre 1974
	PU=Agric.	D+I	18,700t p.a. 4yrs		
	S=?			P=none	
	Lower Halton (Chirk)			GR.SJ306 385	Pre 1974
	PU=Agric.	D+I	6,000t p.a. 3yrs		
	S=?			P=none	
	Venffrwd (Llangollen)			GR.SJ235 423	Pre 1974
	PU=Agric.	D+I	1,500t p.a. 3yrs		
	S=?			P=none	
Islwyn	Trinant			GR.	1983
	PU=Tip	D+I	? 1yr		
	S=4ha			P=none	
	Graig Yr Trwyn			GR.	1982
	PU=Quarry	D+I	? 14mths		
	S=3ha			P=none	
Llanelli	Kidwelly			GR. SN401 069	?
	PU=Land nr river	D+I	60,000t p.a. 1.5yrs		
	S=15ha			P=none	
Lliw V.	Pwllfawatkin Tip (Rhydfro)			GR.SN697084	1976
	PU=Agric.	D+I	20,000t p.a. 15yrs		
	S=9.3ha			P=none	
	Cwrt y Carne (Gorseinon)			GR.SN57230007	1972
	PU=Marsh land	D+I	18,800t p.a. 1yr		
	S=3.5ha			P=minor	
Meirionnydd	Tywyn			GR.54588016	1977
	PU=Agric.	D+I	1,500t p.a. 10yrs		
	S=2.8ha			P=none	

Continued..

Merthyr T.		Trecatti		GR.SO 308207	1974
		PU=Common land	D+I 30,000t	p.a. 3yrs(ex25yrs)	
		S=1ha		P=none	
Monmouth		Llanfoist		GR.SO297 130	Pre 1970
		PU=Agric.	D 17,292t	p.a. 6mths(ex3yrs)	
		S=6.23ha		P=leachate	
		Ifton Quarry		GR.ST 464885	1982
		PU=Quarry	D+C 14,940t	p.a. 7/8yrs	
		S=1.1ha		P=leachate	
Montgomery		Bryn Posteg (Llanidloes)		GR..	1982
		PU=Marsh & tip	D+I 12,038t	p.a. 20yrs	
		S=10ha		P=controlled	
		Carreghofa (Welshpool)		GR.	1950
		PU=railway cut.	D+I 9,017t	p.a. 18mths	
		S=7.3ha		P=none	
Neath		Giants Grave (Briton Ferry)		GR.2732 1956	1964
		PU=Salt marsh	D+I 60,000t	p.a. 5/15yrs	
		S=28.3ha		P=none	
		Cadoxton		GR.2765 1990	?
		PU=Salt marsh	D+I 26,100t	p.a. 1/2yrs	
		S=11.4ha		P=none	
Newport		Docks Way (Maesglas, Newport)		GR.ST330185	1960s
		PU=Agric.	D+I 120,000t	p.a. 13yrs	
		S=28.3ha		P=none	
Ogwr		Tythegston		GR.SS 854789	1968
		PU=Quarry	D+I 97,500t	p.a. 5/6yrs	
		S=20ha		P=none	
Preseli		Disposal licences supplied for private sites only			
Radnor	i).	Clyro *operated by Brecknock*		GR. 216 435	1970
		PU=Agricult.	D+I 2,464t	p.a. 10yrs	
		S=3ha		P=none	
	ii).	Clyro (Hay on Wye)		GR.SO217 436	Pre war
		PU=Marsh land	D+I 34,675t	p.a. 6yrs	
		S=2ha		P=none	
Rhondda		Abergorchy (Treorchy)		GR.SS 957979	1955
		PU=Colliery tip	D+I 40,000t	p.a. 1.5yrs	
		S=5ha		P=none	
		Highfield (Ferndale)		GR.SS 992976	1945
		PU=Colliery	D+I 40,000t	p.a. 4mths	
		S=6ha		P=none	
Rhuddlan		Waste temporarily exported to Colwyn B.Council.			

Continued..

Rhymney V	Coed Top Hill (Gelligaer) PU=Agric/Woodland D+I 74,000t S=7ha	GR.ST968116 p.a. 1yr P=leachate	1976
S.Pemb	Kingsmoor PU=Common land D+I 20,000t S=3ha	GR.SN 120070 p.a. 3yrs P=none	1960s
Swansea	Only private sites supplied		
Taff-Ely	Fforest Uchaf (Penycoed Cae) PU=Agric. D+I 46,184t S=7.7ha	GR.ST075882 p.a. 2yrs P=minor	1973
	Trecastle Tip (Llanharren) PU=Opencast mine D+I 50,181t S=9.3ha	GR.ST007 816 p.a. 1yr P=yes	1973
Torfaen	Tirpentwys (Pontypool) PU=Valley nr mine D 44,000t S=1ha	GR.SO254 003 p.a. 4/7yrs P=minor	1972
	Garm-Er-Brw (Blaenavon) PU=Hill slope D 8,250t S=1ha	GR.SO 230110 p.a. 10yrs P=Yes	1978
V. of Glam	Penarth Docks PU=Dock D 38,000t S=3.7ha	GR.ST91805725 p.a. 4yrs P=none	1982
	Twyn-Yr-Odyn (Wenvoe) WDA? PU=Quarry DIT 47,000t S=?	GR. 115739 p.a. 15yrs P=none	1979
Wrexham	Disposal licences supplied for private sites only		
Ynys Mon	Clegir Mawr (Gwalchmai) PU=Marsh land D 17,000t S=14ha	GR. 373774 p.a. 18mths P=leachate	1976
	Penhesgyn Gors Farm (Menai) PU=Marsh land D+I 57,200t S=39ha	GR. 531743 p.a. 10yrs P=leachate	1970

D = Domestic Waste, I = Industrial Waste, C = Commercial Waste and
T = Toxic Waste ? = No data

Source: Postal Questionnaire (Appendix 6.1), sent to WDAs August, 1984.

Appendix 6.4 Comparison of 1983 and 1984 Data: Waste Disposed & Site Size

District & Site Name	Amount Waste Disposed 1983	1984	Diff.	Size (ha) of Site 1983	1984	Diff
Aberconwy						
Valley Tip	44,000	60,520	+16,520	13.0	?	?
Afan						
Cwmafan	58,000	55,734	- 2,266	6.6	12.2	+5.6
Alyn & Deeside						
Broken Bank	4,030	?	?	?	?	?
Etna	?	47,000	?	?	7.0	?
Arfon						
Cilgwyn	40,000	55,000	+15,000	20.6	16.0	-4.6
Blaenau Gwent						
Silent Valley	76,300	87,900	+11,600	*	*	*
Brecknock						
Rhosferno	1,800	1,500	- 300	0.9	2.0	+1.1
Llanwrtyd Wells	218	520	+ 302	0.4	1.0	+0.6
Tycanol	3,940	3,120	- 820	1.8	2.5	+0.7
Felinfach	N/S	5,532	N/S	N/S	1.0	N/S
Cardiff						
Penarth Moors	171,529	145,646	-25,883	69.0	69.0	0
Rumney Moors	208,761	167,110	-41,651	38.0	38.0	0
Carmarthen						
Carmarthen	N/S	30,000	N/S	N/S	7.0	N/S
Ceredigion						
Aberystwyth	7,500	N/C	0	7.0	N/C	0
Borth	5,000	N/C	0	4.0	N/C	0
Lampeter	2,300	N/C	0	1.0	N/C	0
Rhydeinon	11,300	N/C	0	5.4	N/C	0
Tregaron	1,100	N/C	0	?	N/C	?
Colwyn						
Abergele	26,500	28,288	+ 1,788	20.0	3.7	-16.3
Cynon Valley						
Bryn Pica	35,000	47,492	+12,492	27.0	185.0	+158.0
Delyn						
Ysceifiog	?	24,000	?	?	*	?
Dinefwr						
Wernddu	6,500	29,000	+22,500	5.7	5.0	-0.7
Dwyfor						
Maesoglan	16,800	16,586	- 214	6.7	6.7	0
Glyndwr						
Lon Parcwr	18,700	18,700	0	30.0	?	?
Lower Halton	6,000	6,000	0	7.0	?	?
Wenffrwd	1,500	1,500	0	7.0	?	?
Bryn Bras	1,000	S/C	S/C	4.0	S/C	S/C
Islwyn						
Trinant	38,600	?	?	4.3	4.0	-0.3
Wattsville	38,600	?	?	4.2	3.0	-1.2
Llanelli						
Kidwelly	40,640	60,000	+19,360	9.6	15.0	+5.4
Northumberland	?	?	?	6.5	?	?

Continued..

District & Site Name	Amount Waste Disposed 1983	1984	Diff.	Size (ha) of Site 1983	1984	Diff
Lliw Valley						
Rhydfro	27,250	20,000	- 7,250	8,9	9,3	+0,4
Cwrt y Carne	27,250	18,800	- 8,450	3,5	3,5	0
Meirionnydd						
Tywyn	1,500	1,500	0	2,8	2,8	0
Merthyr Tydfil						
Trecatti	?	30,000	?	1,0	1,0	0
Monmouth						
Llanfoist	18,000	17,292	- 708	5,0	6,2	+1,2
Rogiet	12,908	14,940	+ 2,032	2,2	1,1	-1,1
Montgomery						
Bryn Posteg	10,400	12,038	+ 1,638	?	10,0	?
Carreg Hofa	6,500	9,017	+ 2,517	?	7,3	?
Neath						
Briton Ferry	45,000	60,000	+15,000	35,0	28,3	-6,7
Cadoxton	25,000	26,100	+ 1,100	11,5	11,4	-0,1
Newport						
Maesglas	?	120,000	?	?	28,3	?
Ogwr						
Tythegston	100,000	97,500	- 2,500	8,0	20,0	+12,0
Preseli						
St. David's	16,006	?	?	6,0	?	?
Haverfordwest	20,000	S/C	S/C	4,9	S/C	S/C
Radnor						
Clyro	2,200	2,464	+ 264	2,0	3,0	+1,0
Nantmel	8,000	?	?	10,0	?	?
Cefn Coch	3,650	S/C	S/C	0,3	S/C	S/C
Rhondda						
Treorchy	50,000	40,000	-10,000	3,0	5,0	+2,0
Ferndale	40,000	40,000	0	1,9	6,0	+4,1
Rhuddlan						
Rhyl	?	S/C	S/C	40,0	S/C	S/C
Rhymney Valley						
Gelligaer	102,200	74,000	-28,200	5,0	7,0	+2,0
Maesycwmmer	159,900	?	?	2,0	?	?
Aberbargoed	29,200	S/C	S/C	7,0	S/C	S/C
Caerphilly	22,300	S/C	S/C	1,0	S/C	S/C
South Pemb						
Kingsmoor	13,000	20,000	+ 7,000	4,5	3,0	-1,5
Pincheston	13,000	S/C	S/C	1,2	S/C	S/C
Swansea						
Clyne	?	?	?	200,0	?	?
Crymlyn	?	?	?	20,0	?	?
Tir John	?	?	?	50,0	?	?
Taff-Ely						
Fforest Uchaf	31,700	46,184	+14,484	?	7,7	?
Llanharran	38,300	50,181	+11,881	?	9,3	?
Torfaen						
Tirpentwys	22,750	44,000	+21,250	?	1,0	?
Blaenavon	8,250	8,250	0	?	1,0	?

Continued..

District & Site Name	Amount Waste Disposed 1983	1984	Diff.	Size (ha) of Site 1983	1984	Diff
Vale of Gl						
Penarth Docks	31,200	38,000	+ 6,800	4,0	3,7	-0,3
Barry Docks	102,780	?	?	8,0	?	?
Wenvoe	?	47,000	?	?	?	?
Wrexham						
Caedyah Farm	36,500	?	?	20,0	?	?
Gwersyllt Park	65,000	S/C	S/C	24,5	S/C	S/C
Ynys Mon						
Clegir Mawr	35,000	17,000	-18,000	11,0	14,0	+3,0
Penhesgyn Gors	24,000	57,200	+33,200	20,0	39,0	+19,0

Key

? = Insufficient or no data
* = Size given in m^3 - unable to convert to hectares
N/S = New Site in 1984; only 1984 data applicable
S/C = Site closed in 1984, only 1983 data applicable
N/C = No change, same data supplied for both 1983 and 1984

Appendix 6.5 Comparison of 1983 and 1984 Data: Site Age & Future Capacity

District &	Site Opening Date			Future Capacity (Yrs)			Total Lifespan
Site Name	1983	1984	Diff	1983	1984	Diff.	of Site *
Aberconwy							
Valley Tip	1974p	1974p	0	3yrs	4m	-1y 8m	>10yrs 4m
Afan							
Cwmafan	1971	1970	1	2yrs	1yr	0	15yrs
Alyn & Deeside							
Broken Bank	1918	?	?	unltd	?	?	>65yrs*
Etna	?	1978	?	?	soon	?	> 6yrs
Arfon							
Cilgwyn	1975	1974	1	25yrs	20yrs	-4yrs	30yrs
Blaenau Gwent							
Silent Valley	1981	1981	0	20yrs	25yrs	+5yrs	28yrs
Brecknock							
Rhosferno	1958	1961	3	6yrs	5yrs	0	28yrs
Llanwrtyd Wells	1930s	1960	30	3yrs	6yrs	+3yrs	30yrs
Tycanol	1981	1975	6	4yrs	2yrs	-1yr	11yrs
Felinfach	N/S	1983	N/S	N/S	6m	N/S	1yr 6m
Cardiff							
Penarth Moors	1974	1973	1	5yrs	3yrs	-1yr	14yrs
Rumney Moors	1974	1973	1	5y(x80)	5yrs	S/D	16yrs
Carmarthen							
Carmarthen	N/S	1984	N/S	N/S	50yrs	N/S	50yrs
Ceredigion							
Aberystwyth	1961	S/D	0	1yr	S/D	0	23yrs*
Borth	?	S/D	0	10yrs	S/D	0	>10yrs
Lampeter	1951	S/D	0	1yr	S/D	0	33yrs*
Rhydeinon	1966	S/D	0	6m	S/D	0	18yrs 6m*
Tregaron	1954	S/D	0	5yrs	S/D	0	34yrs*
Colwyn							
Abergele	1970	1982	12	3yrs	5m	-1yr 7m	2yrs 5m
Cynon Valley							
Bryn Pica	?	1982	?	?	25yrs	?	27yrs
Delyn							
Ysceifiog	?	1981	?	?	4yrs	?	23yrs*
Dinefwr							
Wernddu	1982	1982	0	10yrs	8yrs	-1yr	10yrs
Dwyfor							
Maesoglan	1951	1951	0	6m	1yr6m	+1yr	34yrs 6m
Glyndwr							
Lon Parcwr	1974p	1974p	0	10yrs	4yrs	-5yrs	>15yrs
Lower Halton	1974p	1974p	0	5yrs	3yrs	-1yr	>13yrs
Wenffrwd	1974p	1974p	0	2yrs	3yrs	+1yr	>13yrs
Bryn Bras	1974p	S/C	S/C	2yrs	S/C	S/C	S/C >10yrs
Islwyn							
Trinant	1982	1983	1	5yrs	1yr	-3yrs	2yrs
Wattsville	1980	1982	2	3yrs	1yr2m	-10m	3yrs 2m
Llanelli							
Kidwelly	1977	?	?	2y 6m	1y 6m	0	8yrs 6m*
Northumberland	1977	?	?	2y 6m	?	?	8yrs 6m*

Continued..

District & Site Name	Site Opening Date 1983	1984	Diff.	Future Capacity (Yrs) 1983	1984	Diff.	Total Lifespan of Site *
Lliw Valley							
Rhydfro	1981	1976	5	19yrs	15yrs	-3yrs	23yrs
Cwrt y Carne	1979	1972	7	1y 6m	1yr	+6m	13yrs
Meirionnydd							
Tywyn	1977	1977	0	10yrs	10yrs	S/D	17yrs
Merthyr Tydfil							
Trecatti	?	1974	?	?	3yrs(x25)	?	13yrs
Monmouth							
Llanfoist	1970p	1970p	0	2yrs	6m(x3)	-6m	>14yrs 6m
Rogiet	1977	1982	5	10yrs	7yrs	-2yrs	9yrs
Montgomery							
Bryn Posteg	?	1982	?	?	20yrs	?	22yrs
Carreg Hofa	?	1950	?	?	1y 6m	?	35yrs 6m
Neath							
Briton Ferry	1930p	1964	34	7yrs	5yrs	-1yr	25yrs
Cadoxton	1974	?	?	3yrs	1yr	-1yr	12yrs*
Newport							
Maesglas	?	1960s	?	?	13yrs	?	37yrs
Ogwr							
Tythegston	?	1968	?	?	5yrs	?	21yrs
Preseli							
St. David's	1965	?	?	5yrs	?	?	23yrs*
Haverfordwest	1976	S/C	S/C	1yr	S/C	S/C	S/C 8yrs
Radnor							
Clyro	1962	pWar	22	3yrs	6yrs	+3yrs	>50yrs
Nantmel	1965	?	?	10yrs	?	?	28yrs*
Cefn Coch	1979	S/C	S/C	1yr	S/C	S/C	S/C 5yrs
Rhondda							
Treorchy	1950	1955	5	2yrs	1y 6m	+6m	30yrs 6m
Ferndale	1950	1945	5	1y 6m	4m	+2y 6m	39yrs 4m
Rhuddlan							
Rhyl	1960	S/C	S/C	1yr	S/C	S/C	S/C 24yrs
Rhymney Valley							
Gelligaer	1973	1976	3	3yrs	1yr	-1yr	9yrs
Maesycwmmer	1981	?	?	38yrs	?	?	40yrs*
Aberbargoed	1977	S/C	S/C	2yrs	S/C	S/C	S/C 8yrs
Caerphilly	1981	S/C	S/C	3m	S/C	S/C	S/C 3y 3m
South Pemb							
Kingsmoor	1965	1960s	5	2yrs	3yrs	+1yr	27yrs
Pincheston	1968	S/C	S/C	soon	S/C	S/C	S/C 15yrs
Swansea							
Clyne	1974p	?	?	3yrs	?	?	>12yrs*
Crymlyn	1974p	?	?	5yrs	?	?	>14yrs*
Tir John	1974p	?	?	30yrs	?	?	>39yrs*
Taff-Ely							
Fforest Uchaf	?	1973	?	?	2yrs	?	13yrs
Llanharran	?	1973	?	?	1yr	?	12yrs
Torfaen							
Tirpentwys	?	1972	?	?	4yrs	?	16yrs
Blaenavon	?	1978	?	?	10yrs	?	16yrs

Continued..

District & Site Name	Site Opening Date 1983	1984	Diff.	Future Capacity (Yrs) 1983	1984	Diff.	Total Lifespan of Site *
Vale of Glam							
Penarth Docks	1982	1982	0	5yrs	4yrs	0	6yrs
Barry Docks	1977	?	?	10yrs	?	?	16yrs*
Wenvoe	?	1979	?	?	15yrs	?	20yrs
Wrexham							
Caedyah Farm	1966	?	?	10yrs	?	?	27yrs*
Gwersyllt Park	1974	S/C	S/C	1yr	S/C	S/C	S/C 10yrs
Ynys Mon							
Clegir Mawr	1948	1976	28	2yrs	1y 6m	+6m	9yrs 6m
Penhesgyn Gors	1965	1970	5	10yrs	10yrs	S/D	24yrs

Key

? = Insufficient or no data
N/S = New Site in 1984; only 1984 data applicable
S/C = Site closed in 1984, only 1983 data applicable
S/D = No change, same data supplied for both 1983 and 1984
pWar = Pre War
1974p = Pre 1974

Appendix 6.6 Questionnaire Sent to Nature Conservancy Council Officers

9th August 1984

Dear Sir,

I am investigating landfill site selection procedures used by the Waste Disposal Authorities within the Principality. In particular, how thoroughly they assess potential landfill sites and what parameters are monitored. In addition, whether environmental criteria are given more weight than economic considerations.

One method of assessing the importance given to environmental criteria, is to examine the landfill sites currently being operated and their characteristics. I have enclosed a map and list of current landfill sites within your administrative area. I would be grateful if you could briefly indicte for which of these sites the following apply:-

i) NCC was consulted and had no objections;

ii) NCC was consulted and objected because:
a) the site forms part of a Nature Reserve or SSSI;
b) the site is very close to a Nature Reserve or SSSI;
c) the site is a proposed Nature Reserve or SSSI, or is near to an area proposed as one of these;
d) the site is of other interest - please state particular interest;

iii) NCC was not consulted,

iv) Have there been any proposals to tip on or near to areas of exceptional conservation value within your area, which have been successfully opposed? Please could you supply the name and location of any sites, if possible.

Your assistance is most important and I hope that this research will be of mutual benefit.

Yours faithfully,

Dawn. A. Roberts.

Appendix 6.7 Waste Density Figures (Radnor.D.C.Draft Waste Disposal Plan, 1985)

"For the purpose of this report the following assumptions are made but these have to be treated with caution since there are several factors which can alter the picture and elsewhere in the report, these are being investigated and maybe modified in the light of experience.

Domestic waste as collected	0.133 tonnes per m^3 (7.5m^3 per tonne)
Civic amenity waste (which varies widely)	0.3 tonnes per m^3 (3.3m^3 per tonne)
Refuse vehicles	0.4 tonnes per m^3 (2.5m^3 per tonne this can vary from machine to machine)

The terminal density of tips including waste and cover is assumed to be as follows:-

Refuse of all kinds placed with a track vehicle 0.6 tonnes per m^3 or 1.6m^3 per tonne.

Waste as above laid down with a compactor is said to be 1 tonne per cubic metre or one cubic metre per tonne.

Density of cover material after compaction is assumed to be 1.5 tonnes per cubic metre."

APPENDICES FOR CHAPTER 8

Appendix 8.1 Some Examples of Waste Disposal Authority Objectives

i) City of Swansea, Waste Disposal Plan, 1985:-

"6.1. Overall Aims
The overall aim of the Council's waste disposal strategy is to treat and dispose of the waste arisings in an economical manner having regard to the need to safeguard the environment and to utilise the waste as a resource. This plan is intended to pursue an integrated and co-ordinated strategy covering both the public and private sectors and including all controlled waste. This will involve investment in both sectors and the use of disposal facilities irrespective of ownership and the origin of the waste.

6.2. Specific Objectives

a) To plan the management of waste arisings in Swansea over a 10 year period to 1994, in an economic and environmentally acceptable manner, in anticipation of future conditions.

b) To ensure that waste disposal sites are operated in accordance with agreed standards.

c) To allow for the updating of the plan in response to changes in legislation, technology and local conditions and demands."

(City of Swansea, 1985)

ii) Lliw Valley Borough Council, Waste Disposal Plan, 1985:-

"5.1 Objectives

5.1.1 The objectives of the waste disposal strategy proposed in this plan are the treatment and disposal of wastes as they arise.

a) With minimum environmental impact;

b) with maximum resource benefit commensurate with economic viability;

c) with due regard to optimum costs."

(Lliw Valley Borough Council, 1985)

iii) Merthyr Tydfil Borough Council, Waste Disposal Plan, 1985:-

"6.1 Overall Objectives
The overall objective is to treat and dispose of waste arising in the Borough of Merthyr Tydfil at the least cost to the community with due regard to the long term effects of such action and safeguarding the environment and people.

6.2 Specific Objectives

i) To plan the management of the Borough's waste over ten years to 1995 in anticipation of future conditions.

ii) To ensure that waste disposal sites are operated in accordance with agreed standards.

iii) To minimise the overall cost of waste disposal in the Borough of Merthyr Tydfil.

iv) To allow for the updating of the plan in response to changes in legislation, technology and local conditions.

v) To co-operate with adjoining authorities in sharing facilities to the mutual benefit of the authorities.

vi) To co-operate with outside agencies who will accept certain wastes arising within the Borough and which cannot be accommodated within the Borough.

vii) To provide the Borough's commercial and industrial undertakings with either an economical local disposal point for their controlled waste or the necessary technical information and aid to enable them to dispose of any special waste economically and safely via the national network of disposal sites for such wastes.

viii) To discourage unauthorised tipping.

ix) To review its charging policy regularly so as to take account of the need to conserve resources and to minimise net costs of waste disposal.

x) To reinstate completed land fill sites to either their former condition or a superior condition."

(Merthyr Tydfil Borough Council, 1985)

APPENDICES FOR CHAPTER 9

Appendix 9.1 Explanatory Notes on the Statistical Techniques Used.

a) Statistical Techniques for the Analysis of Relationships

Scientific method requires that when two variables are suspected of being related, an hypothesis is formulated in which the form of the relationship is suggested. This relationship can be written as:-

$$Y = f\ (X)$$

This implies that the value of variable Y at a particular observation, is a function of the value of variable X at that point. Thus, in this situation, Y is the variable which is dependent on, or caused by, the value of the other variable. Y is, therefore, termed the 'dependent variable' and 'X' is the independent variable.

A useful first step in studying the nature of the relationship or association between the two variables, is to plot them against each other. This may be done using a scattergraph or scatterplot, in which the independent variable is plotted along the 'x' axis and the dependent variable is plotted on the 'y' axis. (Figures 9.1 to 9.4 are all examples of scattergraphs). The distribution of points resulting, indicates the nature of any relationship. For example, whether or not it is linear. In this case, each scattergraph reveals a linear relationship.

The next stage in the analytical process, is to quantify the strength of the association. As the relationships shown in the scattergraphs appear to be linear, these may be measured using the Pearson correlation coefficient, denoted by 'r'. This is defined as:-

$$r = \frac{\sum^{n} (x_i - \bar{x})(y_i - \bar{y})}{(n - 1)\sigma_x \sigma_y}$$

Continued..

where n is the number of cases, x and y are the values of the two variables, $\bar{x}$ and $\bar{y}$ are the means of all the values of x and y, and σ_x and σ_y are the standard deviations of the two variables.

The value of 'r' indicates the strength of the linear relationship and ranges from +1 to -1. A perfect correlation occurs when the value of 'r' is 1, indicating that all the points fall on a straight line. When the line has a positive slope, the value of 'r' is positive, that is, +1 and the two variables are said to be positively related. The converse is true for lines with a negative slope. A value of zero indicates that there is no linear relationship, but does not imply that there is no relationship at all. Thus, it is important to examine the correlation coefficient together with the scattergraph and to use the coefficient only to summarize the strength of a linear relationship.

High values of 'r', (near 1), imply a high degree of association between the two variables, but do not necessarily mean that the one variable causes the other. Furthermore, the significance of the value of 'r' is determined by the sample size. That is, the significance of 'r' is related to the number of records or samples for which it has been calculated. This is because, the smaller the sample, the greater the probability of all the points falling close to the line of best fit. Thus, a correlation (r) of 0.8 is not statistically significant for a sample of less than 5, but a correlation of 0.6 is signifcant for a sample of more than 20.

Significance has been tested in this study using critical values of the 't' statistic, (Hammond & McCullagh, 1977). This requires the calculation of 't' from the value of 'r', using the formula:-

$$t = r\sqrt{\frac{n - 2}{1 - r^2}}$$

The significance of the value of t, may then be established with

Continued..

reference to critical values of t in the Student's t-Distribution table. The degrees of freedom used are df = n - 2, that is, the sample size less 2.

Another useful statistic, is r^2, the coefficient of determination. This is the square of the correlation coefficient and represents the percentage of the variance in the dependent variable, which is explained by the independent variable. Thus, a value of 0.89 indicates that 89% of the variance in the dependent variable is explained (statistically), by the independent variable. Alternatively, this can be expressed as the percentage which is unexplained. In this example, 11% of the variance is unexplained by the independent variable.

b) Statistical Techniques for Prediction

A linear relationship between two variables implies that there is a constant arithmetic rate of change between them which produces a straight line relationship. This relationship can be expressed in terms of the regression line or 'line of best fit'. It is calculated using the equation:-

$$Y = a + bX$$

where 'a' is the value of Y when X = 0, ('a' is the intercept), and 'b' is the rate of change or gradient of the line, (the slope).

Thus, the line of best fit may be calculated and drawn on the scattergraph to indicate the nature of the linear relationship. This may then be used to predict values of Y from values of X using the equation:-

$$Yp = a + bX$$

where Yp is the predicted value of Y. The difference between the actual value (Y) and estimated (Yp) value for each case is called

Continued..

the residual and represents the error in prediction. In regression analysis, the 'a' and 'b' values are calculated in such a way that the sum of the squared residuals is smaller than any other possible alternative values, termed the 'method of least squares'. Hence, the regression line is the line of best fit.

Predicting values of Y from values of X using the regression line entails a degree of estimation. The degree of error may be quantified and is termed the 'standard error of estimate'. This is simply the standard deviation (σ) for the residual values and is calculated by the equation:-

$$\sigma = \sqrt{\Sigma d^2 \div n}$$

where d is the deviation of the value of each item from the distribution of the mean. The standard deviation indicates the dispersion of points around the regression line and can be used to express the degree of confidence with which predicted values of Y are made. For example, lines may be drawn either side of the regression line at a distance of 1 standard deviation, to define the area within which a prediction may be made with a 68% confidence limit, (Figures 9.2 and 9.4). This shows that for a given value of 'X' there is a 68% chance, that the true value of Y lies within one standard deviation either side of the regression line.

It should be noted that for sample sizes of less than 30, a different procedure is required to calculate the standard error ('best estimate') and confidence limits. The method used is described in Appendix 9.4.

Appendix 9.2 Regression Line Calculations for Domestic Waste Arisings& Population

Standard equation used for regression line calculation:

y = a + bx   or domestic waste arisings = a + b(population)

where a = the intercept and b = the slope

1978/79:   WCA1 = -0,59992 + 0,44619(POP1)

-> When POP1 = 0, WCA1 = -0,59992 & when POP1 = 142, WCA1 = 62,76

1979/80:   WCA2 = 10,60572 + 0,29078(POP2)

-> When POP2 = 0, WCA2 = 10,60572 & when POP2 = 142, WCA2 = 51,90

1980/81   WCA3 = 5,96293 + 0,37392(POP3)

-> When POP3 = 0, WCA3 = 5,96293 & when POP3 = 142, WCA3 = 59,06

1981/82   WCA4 = 3,45848 + 0,37100(POP4)

-> When POP4 = 0, WCA4 = 3,45848 & when POP4 = 142, WCA4 = 56,14

1982/83   WCA5 = 7,48200 + 0,35966(POP5)

-> When POP5 = 0, WCA5 = 7,48200 & when POP5 = 142, WCA5 = 58,55

1983/84   WCA6 = 1,57739 + 0,36689(POP6)

-> When POP6 = 0, WCA6 = 1,57739 & when POP6 = 142, WCA6 = 53,68

1984/85   WCA7 = 0,32015 + 0,38387(POP7)

-> When POP7 = 0, WCA7 = 0,32015 & when POP7 = 142, WCA7 = 54,83

All 7 Years WCATOT = 4,06153 + 0,37175(POPTOT)

-> When POPTOT = 0, WCATOT = 4,06135 & when POPTOT = 142,

WCATOT = 56,85

Appendix 9.3 Regression Line Calculations for Domestic Waste Arisings & Domestic Hereditaments

Standard equation used for regression line calculation:

y = a + bx

or domestic waste arisings = a + b(domestic hereditaments)

where a = the intercept and b = the slope

1978/79: WCA1 = -5,90836 + 1,34249(DH1)

-> When DH1 = 0, WCA1 = -5,90836 & when DH1 = 42, WCA1 = 50,48

1979/80: WCA2 = 6,42933 + 0,88804(DH2)

-> When DH2 = 0, WCA2 = 6,42933 & when DH2 = 42, WCA2 = 43,73

1980/81 WCA3 = 3,49880 + 1,02642(DH3)

-> When DH3 = 0, WCA3 = 3,49880 & when DH3 = 42, WCA3 = 46,61

1981/82 WCA4 = -1,32540 + 1,14633(DH4)

-> When DH4 = 0, WCA4 = -1,32540 & when DH4 = 42, WCA4 = 46,82

1982/83 WCA5 = 5,66856 + 1,00844(DH5)

-> When DH5 = 0, WCA5 = 5,66856 & when DH5 = 42, WCA5 = 48,02

1983/84 WCA6 = -0,56827 + 1,02012(DH6)

-> When DH6 = 0, WCA6 = -0,56827 & when DH6 = 42, WCA6 = 42,28

1984/85 WCA7 = -1,73215 + 1,06966(DH7)

-> When DH7 = 0, WCA7 = -1,73215 & when DH7 = 42, WCA7 = 43,19

All 7 Years WCATOT = 0,89442 + 1,07090(DHTOT)

-> When DHTOT = 0, WCATOT = 0,89442 & when DHTOT = 42,

WCATOT = 45,87

Appendix 9.4.1 Bessel's Correction for Small Sample Sizes

The division of the thirty-seven Welsh WDAs into their respective regional groups, results in a considerable reduction in the number of samples within each group. Even when data are available for all WDAs, the maximum sample size for each region is North (9), Mid (11) and South (17).

Where the sample size is less than thirty, a different procedure must be used in order to calculate the standard error and confidence limits. There are three stages required:-

i)First, the calculated standard error of estimate (σ) must be corrected to give a 'best estimate' denoted by $\hat{\sigma}$, (Hammond and McCullagh, 1977, p124). The process involved is termed Bessel's Correction, based on the formula:-

$$\hat{\sigma} = s\sqrt{\left(\frac{n}{n-1}\right)}$$

where $\hat{\sigma}$ = the 'best estimate'
s = the sample standard deviation

ii) Secondly, the best estimate is used to find the standard error of the sampling distribution, using the formula:-

$$S.E = \frac{\hat{\sigma}}{\sqrt{n}}$$

where S.E = standard error
n = number of samples

iii) Finally, after selecting the level of confidence required, (e.g. 95%), the Student's t-table is used. The degrees of freedom used in the Table, represent the number of samples less one (n-1). The figure in the table (at the 95% confidence limit), based on the appropriate degrees of freedom, is then multiplied by the standard error to give the 95% confidence limits. The standard errors and confidence limits have been calculated for the regional groups and are shown in Appendix 9.4, Sections 2 and 3.

Continued..

Appendix 9.4.2 Bessel's Correction ($\hat{\sigma}$) for Domestic Waste Arisings and Population

i) NORTH WALES

Year	D	σ	$\hat{\sigma}$	S.E	df	95% t-tab	95% CL (tonnes)
1978/9	9	3.709	3,934	1,311	8	2.31	3,028
1979/0	8	3.844	4,110	1,453	7	2.37	3,444
1980/1	9	5.605	5,945	1,982	8	2.31	4,578
1981/2	9	4.013	4,256	1,419	8	2.31	3,278
1982/3	8	6.822	7,293	2,578	7	2.37	6,110
1983/4	9	9.124	9,677	3,226	8	2.31	7,452
1984/5	9	9.780	10,373	3,458	8	2.31	7,988

ii) MID WALES

Year	D	σ	$\hat{\sigma}$	S.E	df	95% t-tab	95% CL (tonnes)
1978/9	11	4.015	4,211	1,270	10	2.23	2,832
1979/0	10	11.775	12,412	3,925	9	2.26	8,870
1980/1	11	6.387	6,698	2,019	10	2.23	4,502
1981/2	10	3.830	4,037	1,277	9	2.26	2,886
1982/3	10	5.801	6,115	1,934	9	2.26	4,371
1983/4	10	5.450	5,745	1,817	9	2.26	4,106
1984/5	9	3.727	3,953	1,318	8	2.31	3,044

iii) SOUTH WALES

Year	D	σ	$\hat{\sigma}$	S.E	df	95% t-tab	95% CL (tonnes)
1978/9	17	11.944	12,312	2,986	16	2.12	6,330
1979/0	14	8.725	9,054	2,420	13	2.16	5,227
1980/1	15	12.593	13,035	3,366	14	2.15	7,237
1981/2	14	8.926	9,263	2,476	13	2.16	5,348
1982/3	16	15.278	15,780	3,945	15	2.13	8,403
1983/4	15	7.740	8,012	2,069	14	2.15	4,448
1984/5	15	9.414	9,744	2,516	14	2.15	5,409

D = Number of WDAs, σ = standard error of estimate
$\hat{\sigma}$ = 'Best estimate' (converted to tonnes) S.E = Standard Error
df = degrees of freedom
t-tab = value in t-table based on 95% confidence limit and the appropriate degrees of freedom
95% CL = the 95% Confidence Limits. This indicates the range (tonnes), within which there is a 95 per cent probability that the actual level of waste lies above or below the predicted level.

Continued..

Appendix 9.4.3 Bessel's Correction ($\hat{\sigma}$) for Domestic Waste Arisings and Domestic Hereditaments

i) NORTH WALES

Year	D	σ	$\hat{\sigma}$	S.E	df	95% t-tab	95% CL (tonnes)
1978/9	9	3.182	3,375	1,125	8	2.31	2,599
1979/0	8	4.149	4,435	1,568	7	2.37	3,716
1980/1	9	6.606	7,068	2,356	8	2.31	5,442
1981/2	8	4.848	5,182	1,832	7	2.37	4,342
1982/3	8	6.499	6,948	2,456	7	2.37	5,821
1983/4	9	7.435	7,886	2,629	8	2.31	6,073
1984/5	8	8.396	8,976	3,173	7	2.37	7,520

ii) MID WALES

Year	D	σ	$\hat{\sigma}$	S.E	df	95% t-tab	95% CL (tonnes)
1978/9	8	2.689	2,874	1,016	7	2.37	2,408
1979/0	6	5.094	5,580	2,278	5	2.57	5,854
1980/1	10	6.642	7,002	2,214	9	2.26	5,004
1981/2	10	3.932	4,144	1,310	9	2.26	2,961
1982/3	10	5.946	6,268	1,982	9	2.26	4,479
1983/4	8	6.133	6,557	2,318	7	2.37	5,494
1984/5	9	3.348	3,551	1,184	8	2.31	2,735

iii) SOUTH WALES

Year	D	σ	$\hat{\sigma}$	S.E	df	95% t-tab	95% CL (tonnes)
1978/9	15	11.980	12,400	3,202	14	2.15	6,884
1979/0	12	9.097	9,502	2,743	11	2.20	6,035
1980/1	13	10.609	11,043	3,063	12	2.18	6,677
1981/2	11	7.666	8,041	2,424	10	2.23	5,405
1982/3	16	15.624	16,136	4,034	15	2.13	8,592
1983/4	15	7.928	8,206	2,119	14	2.15	4,556
1984/5	15	9.453	9,785	2,526	14	2.15	5,431

D = Number of WDAs, σ = standard error of estimate
$\hat{\sigma}$ = 'Best estimate' (converted to tonnes) S.E = Standard Error
df = degrees of freedom
t-tab = value in t-table based on 95% confidence limit and the appropriate degrees of freedom
95% CL = the 95% Confidence Limits. This indicates the range (tonnes), within which there is a 95 per cent probability that the actual level of waste lies above or below the predicted level.

Appendix 9.5 Intercept (a) and Slope (b) Values for Regional Groups Population Based Values

Region	1978/78	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
North							
Inter.	11,0961	10,9568	8,7399	7,6795	7,1648	-14,3232	-13,7371
Slope	0,2417	0,2692	0,3281	0,3205	0,3023	0,6489	0,6406
Mid							
Inter.	5,5959	10,9575	0,8708	2,2211	2,9592	-0,2375	6,4369
Slope	0,2758	0,2220	0,4181	0,3420	0,3533	0,3970	0,2082
South							
Inter.	1,6937	16,6439	12,0119	6,3536	20,0236	3,0134	2,7938
Slope	0,4335	0,2555	0,3376	0,3547	0,2869	0,3474	0,3612

Appendix 9.6 Intercept (a) and Slope (b) Values for Regional Groups Domestic Hereditament Based Values

Region	1978/78	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
North							
Inter.	6,7635	7,7753	6,1903	3,8238	2,7462	-24,6042	-23,8528
Slope	0,7654	0,7735	0,9123	0,9529	0,9454	2,0163	2,0175
Mid							
Inter.	-0,0303	1,7508	-2,5540	0,0516	1,1076	-3,7164	4,3162
Slope	0,9235	0,8445	1,2248	0,9843	0,9843	1,1488	0,6419
South							
Inter.	-3,1846	16,0419	8,7899	1,0311	19,4870	2,0814	1,3579
Slope	1,3194	0,7335	0,9396	1,1161	0,7893	0,9475	0,9950

APPENDICES FOR CHAPTER 10

Appendix 10.1 Grouping of Local Authority Districts into Clusters and Families: OPCS 1978.

Family	Cluster	Welsh VDA
1. Suburban and Growth Areas	1. High status areas with manufacturing employment	-
	2. Rural Growth Areas	Monmouth, Vale of Glamorgan
	3. Areas of Rapid Growth	-
	4. Older high status residential areas	-
	5. Areas with large student population	-
	6. Outer London	-
2. Rural & Resort Areas	7. Rural Wales & Scottish Island areas	Arfon, Brecknock, Carmarthen, Ceredigion, Dinefwr, Dwyfor, Glyndwr, Meirionnydd, Montgomery, Preseli, Radnor, South Pembrokeshire, Ynys Mon
	8. Rural West	-
	9. Rural East	-
	10. Rural Scotland	-
	11. Resort retirement centres	Colwyn
	12. Port retirement centres	Aberconwy, Rhuddlan
3. Traditional Industry & Mining Areas	13. Lowland heavy industrial areas	Rhymney Valley
	14. Upland heavy industrial areas	Afan, Blaenau Gwent, Cynon Valley, Islwyn, Llanelli, Lliw Valley, Merthyr Tydfil, Neath, Rhondda, Wrexham Maelor
	15. The Black Country & similar areas	-
	16. Areas with large Industrial Plants	Alyn & Deeside, Delyn, Torfaen
	17. Small town manufacturing areas	Taff-Ely
	18. Pennine Towns	-
4. Service Centres	19. Metropolitan service centres	-
	20. The East End of London	-
	21. Scottish service centres	-
	22. Regional service centres	-
	23. Welsh & Merseyside regional centres	Cardiff, Newport, Ogwr Swansea
5. Areas with much local authority housing	24. Scottish industrial areas	-
	25. Overspill areas	-
	26. New Towns	-
	27. Glasgow	-
6. Inner & Central London	28. Kensington & Chelsea	-
	29. Central London	-
	30. Inner London	-

Source: Webber & Craig (1978)

Appendix 10.2 1981 ACORN Profile for Great Britain

ACORN GROUPS (LETTERED) and ACORN TYPES (NUMBERED)	Population 1981 No.	%
A AGRICULTURAL AREAS	1811485	3.4
1. Agricultural Villages	1376427	2.6
2. Areas of farms and smallholdings	435058	0.8
B MODERN FAMILY HOUSING, HIGHER INCOMES	8667137	16.2
3. Cheap modern private housing	2209759	4.1
4. Recent private housing, young families	1648534	3.1
5. Modern private housing, older children	3121453	5.8
6. New detached houses, young families	1404893	2.6
7. Military bases	282498	0.5
C OLDER HOUSING OF INTERMEDIATE STATUS	9420477	17.6
8. Mixed owner-occupied and council estates	1880142	3.5
9. Small town centres and flats above shops	2157360	4.0
10. Villages with non-farm employment	2463246	4.6
11. Older private housing, skilled workers	2919729	5.5
D POOR QUALITY OLDER TERRACED HOUSING	2320846	4.3
12. Unimproved terraces with old people	1351877	2.5
13. Pre-1914 terraces, low income families	762266	1.4
14. Tenement flats lacking amenities	206703	0.4
E BETTER-OFF COUNCIL ESTATES	6976570	13.0
15. Council estates, well-off older workers	1916242	3.6
16. Recent council estates	1392961	2.6
17. Council estates, well-off young workers	2615376	4.9
18. Small council houses, often Scottish	1051991	2.0
F LESS WELL-OFF COUNCIL ESTATES	5032657	9.4
19. Low rise estates in industrial towns	2538119	4.7
20. Inter-war council estates, older people	1667994	3.1
21. Council housing for the elderly	826544	1.5
G POOREST COUNCIL ESTATES	4048658	7.6
22. New council estates in inner cities	1079351	2.0
23. Overspill estates, high unemployment	1729757	3.2
24. Council estates with overcrowding	868141	1.6
25. Council estates with worst poverty	371409	0.7
H MULTI-RACIAL AREAS	2086026	3.9
26. Multi-occupied terraces, poor Asians	204493	0.4
27. Owner-occupied terraces with Asians	577871	1.1
28. Multi-let housing with Afro-Caribbeans	387169	0.7
29. Better-off multi-ethnic areas	916493	1.7

Continued..

Appendix 10.2 Continued...

ACORN GROUPS (LETTERED) and ACORN TYPES (NUMBERED)	Population 1981 No.	%
I HIGH STATUS NON-FAMILY AREAS	2248207	4.2
30. High status areas, few children	1129079	2.1
31. Multi-let big old houses and flats	822017	1.5
32. Furnished flats, mostly single people	297111	0.6
J AFFLUENT SUBURBAN HOUSING	8514878	15.9
33. Inter-war semis, white collar workers	3054032	5.7
34. Spacious inter-war semis, big gardens	2676598	5.0
35. Villages with wealthy older commuters	1533756	2.9
36. Detached houses, exclusive suburbs	1250492	2.3
K BETTER-OFF RETIREMENT AREAS	2041338	3.8
37. Private houses, well-off elderly	1199703	2.2
38. Private flats with single pensioners	841635	1.6
U UNCLASSIFIED	388632	0.7
39. Unclassified	388632	0.7
AREA TOTAL	53446911	100.0

Source: ACORN User's Guide, 1985

Appendix 10.3 Variables Used in the Derivation of the Lifestyle Classification System

Census variables used:

Persons aged 0 - 4 years
Persons aged 5 - 14 years
Persons aged 15 - 24 years
Persons aged 25 - 44 years
Persons aged 45 - 64 years
Persons aged 65 - 74 years
Persons aged 75+ years

Employers and managers
Professional workers
Non-manual workers
Self employed non-professional workers
Skilled manual workers
Semi-skilled manual workers
Unskilled manual workers
Armed Forces personnel

Household size
Single Worker households
Married Couple households
2+ Economically Active/ No children
Females of reproductive age
2 Adults plus with children aged 0 - 15 years
6 or more person household
Single parent household
Lone female Pensioner households
One year migrants
Pensioner migrants

Agricultural workers
Energy + Water workers
Manufacturing workers
Service/Distribution workers

Working at home
Travel-to-work by foot
Travel-to-work by car
Travel-to-work by bus
Travel-to-work by train

Rooms per household 1 - 3
Rooms per household 4 - 6
Rooms per household 7+
Overcrowded households (>1.5 persons per room)
Households share/lack bathroom
Households share/lack inside WC

Owner occupied private households
Council/New Town rented households
'With job' private households
Unfurnished rented private households
Furnished rented private households
Second/holiday homes

African born residents
Caribbean born
Indo/Pakistan born
Non Commonwealth/EEC born

Households without Car
Households with 1 Car
Households with 2 Cars
Households with 3+ Cars

Source: Brown, 1986b

Appendix 10.4 SUPER PROFILE GROUP Characteristics

SPG	No. of SPs	EDs	% of 1981 population	Brief Description of Key Features (Typical l-ocation)
A	7	8495	7.18	Mature professional and managerial families, semi-rural and suburban detached property. (Epsom)
B	6	8033	7.77	Younger professional and managerial families suburban detached and larger semi-detached property. (Wokingham)
C	3	2261	2.05	Younger professional and white collar families, suburban semi-detached property. (Chelmsford)
D	8	12036	11.94	Mixed. largely white collar families in average sized semi-detached property. (London Boroughs of Bexley & Havering)
E	7	9963	8.20	High concentration of one and two person pensioner households in owner-occupied property in white collar worker group. (Bognor Regis)
F	10	5930	3.92	One and two person professional and white collar households, high proportion of students. (London Borough of Kensington & Chelsea)
G	10	10066	7.81	Skilled and semi-skilled families, average unemployment, generally improved terraced housing. (Bolsover - Derbyshire)
H	5	2322	1.99	Large young families containing semi-skilled and unskilled workers in cramped owner-occupied & rented terrace property. (Bradford)
J	8	2871	1.30	White collar families together with some single workers. Widespread conversion of property to rented bedsits. (London Borough of Camden)
K	5	3259	2.31	Young families, including a mixture of white collar and blue collar workers living in a mixture of owner-occupied and rented property. (London Borough of Brent)
L	7	4154	2.56	Unskilled families, high unemployment, flats in converted property. (Liverpool)
M	8	8451	8.49	Mixture of skilled and unskilled blue collar workers, above average unemployment, council housing, low residential turnover. (Scunthorpe)
N	11	10866	9.63	Older skilled and unskilled blue collar workers, council housing, low residential turnover. (South Shields)
P	5	3457	2.23	One and two person older households, council flats, low residential turnover. (Dundee)
R	8	5967	5.62	Younger skilled and semi-skilled large families, council property, low residential turnover. (Motherwell)

Continued..

Appendix 10.4 Continued....

SPG	No. of SPs	No. of EDs	% of 1981 population	Brief Description of Key Features (Typical l-ocation)
S	7	3459	2.86	Unskilled families, high unemployment, ethnic groups, council flats. (London Borough of Hackney)
T	5	2318	1.52	Unskilled families, often with only one parent, high unemployment and average residential turnover. (London Borough of Islington)
V	7	3012	2.70	Larger unskilled families, extremely high unemployment, very cramped council flats. (Glasgow)
W	7	7806	3.74	Rural and farming communities, including some second homes. (Mid Devon)
X	11	8674	4.91	Rural areas, very popular as locations for retirement and second homes. (Criccieth)
Y	3	700	0.51	Military bases, younger families, very high residential turnover. (Aldershot)
Z	2	6331	0.76	All other areas - unclassified

TOTALS:-

Super Profile Groups (SPG)	=	22
No. of Super Profiles (SP)	=	150
No. of Enumeration Districts (EDs)	=	130,431

Source: Brown and Batey (1987a)

Appendix 10.5 SUPER PROFILE LIFESTYLES

Lifestyle	UK. Population No.	%
a - STOCKBROKER BELT		
Middle aged families in exclusive suburbs.	2,065,546	3.85
Older families in select suburban property.	453,144	0.85
Expensive city centre flats/apartments.	926,752	1.73
Middle aged families in up-market semis.	1,324,702	2.47
b - METRO SINGLES		
Young professionals in bed sitters.	698,012	1.30
Older white collar flat dwellers.	360,397	0.67
Young single white collars in rented property	810,944	1.51
c - YOUNG MARRIED SUBURBIA		
Younger families in suburban detached.	1,709,083	3.19
Younger families in larger semis.	2,452,443	4.58
Young well-to-do married in high turnover semis.	1,098,786	2.05
d - RURAL BRITAIN		
Affluent farming communites.	2,002,224	3.74
Older and retired better off rural dwellers.	1,789,541	3.34
Less affluent rural workers and pensioners.	838,080	1.56
e - OLDER SUBURBIA		
White collar family pensioners.	590,513	1.10
Single white collar pensioners.	1,538,455	2.87
Middle aged white collar couples.	2,264,072	4.23
f - LOWER MIDDLE CLASS		
Lower middle class metropolitan semis.	2,502,802	4.67
Military families.	271,528	0.51
Lower middle class in provincial semis.	2,784,811	5.20
Upper working class in council housing.	1,930,628	3.60
Upper working class in semis and terraced.	1,108,420	2.07
g - MULTI-ETHNIC AREAS		
Young multi-ethnic white & blue collar families.	1,238,426	2.31
Unskilled ethnic families in council flats.	1,529,724	2.86
Large ethnic families in cramped terraced property.	1,066,732	1.99
h - DARK SATANIC MILLS		
Unskilled families, inner city conversions.	1,373,574	2.56
Skilled and semi-skilled in improved terraced.	3,097,510	5.78
Skilled and semi-skilled in poorer terraced.	1,083,698	2.02
i - COUNCIL TENANTS		
Middle aged and older couples in council flats	1,194,303	2.23
Blue collar workers in established council houses.	2,284,617	4.26
Blue collar workers with high unemployment.	1,273,816	2.38
Low income older families in council flats.	815,226	1.52
Mature blue collar workers in mining areas.	749,032	1.40
Very low income council houses.	2,122,915	3.96

Continued..

Lifestyle	UK. Population	
j - UNDERPRIVILEGED BRITAIN		
High unemployment semi/skilled in council houses.	3,010,652	5.62
Highly unemployed in crowded council houses.	1,341,722	2.51
Large unemployed families in cramped council flats.	1,446,033	2.70
k - UNCLASSIFIED		
All other areas unclassified	408,048	0.76

SOURCE: Brown and Batey, (1987b)

Appendix 10.6 Ranking of the Top Ten Local Authority Districts within each Super Profile Group

SP Group	Rank	Index	% LAD population	District	County
3C	9	497	0.17	Taff-Ely	Mid Glamorgan
5E	8	414	0.09	Colwyn	Clwyd
7G	1	888	0.15	Rhondda	Mid Glamorgan
7G	3	617	0.13	Cynon Valley	Mid Glamorgan
7G	4	485	0.11	Merthyr Tydfil	Mid Glamorgan
7G	5	464	0.32	Dinefwr	Dyfed
7G	6	457	0.68	Blaenau Gwent	Gwent
7G	7	449	0.12	Islwyn	Gwent
11L	7	449	0.50	Cardiff	South Glamorgan
19W	3	801	0.04	Radnor	Powys
19W	7	736	0.09	Carmarthen	Dyfed
19W	9	721	0.09	Montgomery	Powys
20X	1	1305	0.05	Dwyfor	Gwynedd
20X	2	1144	0.06	Meirionnydd	Gwynedd
20X	10	778	0.10	Ceredigion	Dyfed

$$\text{Index} = \frac{\text{Proportion of SPG Population Found in District}}{\text{Proportion of Total Population Found in District}} \times 100$$

LAD = Local Authority District

Source: Brown & Batey (1986)

APPENDICES FOR CHAPTER 11

Appendix 11.1. Alyn and Deeside District Council. Weight Data for Half-Day Collection Rounds :-

i) Collection Round One (Tonnes)

1986	Day 1		Day 2		Day 3		Day 4		Day 5	
W/Ending	M	AF	M	AF	M	AF	M	AF	M	AF
13/ 7/86	4,52	4,88	5,72	5,54	5,06	6,90	5,72	4,98	4,42	3,12
20/ 7/86	6,16	4,36	5,82	5,18	5,54	6,33	6,99	4,50	5,58	2,74
27/ 7/86	5,92	4,50	5,66	5,08	6,50	5,18	5,50	4,50	5,50	2,50
3/ 8/86	5,98	3,50	5,32	4,70	5,94	5,98	5,84	4,66	5,24	1,98
10/ 8/86	5,70	3,50	5,78	4,86	6,26	5,50	5,56	4,64	5,42	1,74
17/ 8/86	5,62	4,76	5,72	5,20	5,02	6,53	4,50	6,30	4,28	3,50
24/ 8/86	5,05	5,14	5,90	4,96	5,94	6,80	5,14	5,90	5,44	3,88
31/ 8/86*	7,10	3,70	6,50	6,06	7,84	6,90	6,60	5,82+	4,54	4,80
7/ 9/86	5,52	4,89	6,11	5,07	5,76	4,34	4,36	6,17	5,40	3,90
14/ 9/86	6,40	4,90	5,64	5,10	5,90	6,50	5,34	6,48	6,34	3,72
21/ 9/86	5,64	5,44	5,50	5,20	5,98	6,56	4,96	6,16	4,50	3,92
28/ 9/86	6,15	5,10	5,96	4,90	5,86	6,50	6,42	5,78	4,50	4,18
5/10/86	6,50	-	6,11	5,81+	5,91	3,11+	5,61	5,51	5,51	4,71+
12/10/86	6,04	5,90	6,62	5,06	6,42	6,48	6,70	5,34	4,90	4,52
19/10/86	5,90	5,90	6,66	6,63	6,44	6,91	6,32	5,22	5,52	4,34
26/10/86	6,10	4,98	4,08	5,12	5,88	6,52	5,66	4,93	4,12	4,15
2/11/86	6,70	5,08	6,30	5,90	5,60	3,90	6,05	6,15	6,28	5,39
9/11/86	6,40	5,90	6,90	4,90	7,00	6,01	6,25	4,76	5,80	4,35
16/11/86	6,12	3,04	6,66	4,70+	6,16	7,14	6,32	4,90	6,10	4,52
23/11/86	6,85	4,70	6,90	4,75	6,58	6,86	6,56	5,21	4,72	4,52
30/11/86	6,48	5,40	7,06	4,50	6,38	6,90	5,66	5,90	5,22	4,37
7/12/86	7,13	5,90	7,17	4,90	6,06	6,80	5,90	5,82	6,11	4,14
14/12/86	6,38	4,90	6,60	5,60	6,34	6,86	6,44	4,68	5,50	5,12

Key to all Tables in Appendix 11.1:

Day 1 = Monday, Day 2 = Tuesday, ...
M = Morning
AF = Afternoon
* = Bank holiday week
- = No data
+ = Third collection made during the same day
# = An additional collection made on Day 6.

Continued..

ii) Collection Round Two

1986	Day 1		Day 2		Day 3		Day 4		Day 5	
W/Ending	M	AF	M	AF	M	AF	M	AF	M	AF
13/ 7/86	5,96	5,32+	5,94	6,32	5,32	2,33+	3,90	3,90+	5,32	3,62
20/ 7/86	5,50	6,64	6,42	4,58	5,32	2,86+	4,34	4,14+	6,60	3,32
27/ 7/86	6,06	6,28	6,06	5,58	5,20	5,80	4,40	4,32+	5,32	3,82
3/ 8/86	6,32	5,62	6,32	5,42	4,88	1,96+	4,38	4,02+	5,54	4,30
10/ 8/86	5,90	6,04	6,40	5,76	5,42	5,90	5,78	5,34	5,38	2,90
17/ 8/86	7,20	4,92	6,78	4,58	5,38	2,02+	6,77	5,08	6,10	3,62
24/ 8/86	6,02	5,94	4,60	3,36+	5,76	2,02+	6,44	4,76	5,64	3,34
31/ 8/86*	7,16	6,08	7,10	7,12	5,92	6,12	6,74	4,78+	5,42	3,50
7/ 9/86	6,14	5,42	6,12	6,39	5,06	6,03	5,62	5,30	4,98	2,56
14/ 9/86	5,98	5,22+	6,32	6,50	5,58	2,32+	5,96	6,32	5,50	4,34
21/ 9/86	5,64	3,87+	6,08	4,32+	5,32	2,32+	6,02	5,32	5,98	3,58
28/ 9/86	5,98	6,14+	6,48	6,10	5,84	2,52+	6,36	5,03	5,64	3,58
5/10/86	6,20	5,84+	6,32	4,50+	2,12	3,90	6,10	6,02	5,10	3,81
12/10/86	6,04	5,80+	6,42	4,93	1,50	6,37+	7,22	4,52+	5,32	4,12
19/10/86	5,62	6,68	5,46	4,36+	5,22	4,24+	4,74	4,48+	5,20	4,54
26/10/86	5,64	5,70	5,12	3,40	5,80	4,07+	7,00	5,15	6,17	1,60
2/11/86	6,62	4,52+	6,13	4,60	6,58	4,32+	5,96	3,73	6,12	4,15
9/11/86	6,40	6,78	5,82	4,77+	6,12	6,70	6,82	5,48	7,08	2,71
16/11/86	7,34	5,50	6,90	6,24	7,96	7,42	8,40	4,80	6,18	4,34
23/11/86	7,14	5,68	7,22	6,34	7,56	7,08	7,36	6,34	6,34	4,82
30/11/86	7,78	5,68	7,45	6,34	7,68	5,68	7,78	5,22	7,00	4,23
7/12/86	7,36	7,10	7,24	6,80	7,62	5,36	7,82	5,25	6,89	3,56
14/12/86	7,42	6,42	7,12	7,00	7,85	5,94	7,60	5,48	6,10	4,36

iii) Collection Round Three

1986	Day 1		Day 2		Day 3		Day 4		Day 5	
W/Ending	M	AF	M	AF	M	AF	M	AF	M	AF
13/ 7/86	5,94	5,21	6,64	7,44	6,58	3,99	6,74	4,38	5,94	2,52
20/ 7/86	5,94	4,96	6,44	5,04	6,94	5,12	6,00	5,14	5,56	3,56
27/ 7/86	6,34	5,64	6,42	4,80	6,50	4,34	4,98	6,34	5,12	2,67
3/ 8/86	6,94	4,34	6,42	4,02	6,90	3,34	5,48	6,28	5,04	3,64
10/ 8/86	5,24	5,92	6,04	4,30	6,27	4,04	5,96	6,34	4,71	4,06
17/ 8/86	4,68	5,26	6,60	4,26	6,80	4,25	5,40	6,46	5,34	3,68
24/ 8/86	5,54	5,34	5,50	4,19	6,74	4,26	5,34	6,66	5,00	4,01
31/ 8/86*	6,02	5,90	6,86	5,04	5,58	4,97	7,00	6,37	5,81	5,06
7/ 9/86	5,66	4,43	6,50	4,70	6,06	4,18	5,44	5,52	5,00	3,81
14/ 9/86	5,90	5,40	6,84	5,02	6,60	4,86	6,54	6,14	5,34	4,34
21/ 9/86	5,92	5,95	7,02	4,78	6,68	4,34	6,19	6,34	5,28	3,84
28/ 9/86	5,84	5,90	6,34	5,34	6,34	5,22	6,30	5,76	5,34	3,81
5/10/86	6,18	5,86	7,02	4,86	6,69	4,64	6,20	6,70	5,64	3,78
12/10/86	6,38	5,34	5,90	4,89	6,86	4,54	6,35	5,81	5,37	3,94
19/10/86	6,34	6,04	7,17	4,92	5,78	4,21	6,16	5,80	5,22	4,16
26/10/86	6,08	5,26	7,01	4,17	6,96	4,35	5,97	5,78	5,34	3,96
2/11/86	6,84	6,04	6,76	5,96	7,03	5,34	6,81	6,64	5,66	4,12
9/11/86	6,59	5,64	7,26	5,04	7,21	5,32	6,34	6,34	4,67	4,07
16/11/86	6,34	5,84	7,78	4,76	6,72	5,77	6,34	6,14	5,52	4,06
23/11/86	6,71	5,62	7,34	4,96	6,88	5,34	6,34	6,74	5,74	4,34
30/11/86	6,71	6,00	7,30	5,34	6,94	4,82	6,42	6,52	5,78	4,22
7/12/86	6,44	5,84	6,14	6,86	7,34	5,50	6,34	6,00	5,48	4,10
14/12/86	6,34	5,63	6,50	5,34	6,98	5,15	6,35	6,64	5,34	3,76

Continued..

iv) Collection Round Four

1986 W/Ending	Day 1 M	Day 1 AF	Day 2 M	Day 2 AF	Day 3 M	Day 3 AF	Day 4 M	Day 4 AF	Day 5 M	Day 5 AF
13/ 7/86	5,94	5,21+	6,64	7,44	6,58	3,99	6,74	4,38	5,94	2,52
20/ 7/86	5,94	4,96+	6,44	5,04	6,94	5,12	6,00	5,14	5,56	3,56
27/ 7/86	6,34	5,64+	6,42	4,80	6,50	4,34	4,98	6,34	5,12	2,67
3/ 8/86	6,94	4,34	6,42	4,02	6,90	3,34	5,48	6,28	5,04	3,64
10/ 8/86	5,24	5,92	6,04	4,30	6,27	4,04	5,96	6,34	4,71	4,06
17/ 8/86	4,68	5,26	6,60	4,26	6,80	4,25	5,40	6,46	5,34	3,68
24/ 8/86	5,54	5,34	5,50	4,19	6,74	4,26	5,34	6,66	5,00	4,01
31/ 8/86*	6,02	5,90	6,86	5,04	5,58	4,97	7,00	6,37	5,81	5,06
7/ 9/86	5,66	4,43	6,50	4,70	6,06	4,18	5,44	5,52	5,00	3,81
14/ 9/86	5,90	5,40+	6,84	5,02+	6,60	4,86	6,54	6,14	5,34	4,34
21/ 9/86	5,92	5,95+	7,02	4,78+	6,68	4,34	6,19	6,34	5,28	3,84
28/ 9/86	5,84	5,90+	6,34	5,34+	6,34	5,22	6,30	5,76	5,34	3,81
5/10/86	6,18	5,86+	7,02	4,86	6,69	4,64+	6,20	6,70	5,64	3,78
12/10/86	6,38	5,34+	5,90	4,89+	6,86	4,54	6,35	5,81	5,37	3,94
19/10/86	6,34	6,04+	7,17	4,92+	5,78	4,21	6,16	5,80	5,22	4,16
26/10/86	6,08	5,26+	7,01	4,17+	6,96	4,35	5,97	5,78	5,34	3,96
2/11/86	6,84	6,04+	6,76	5,96+	7,03	5,34	6,81	6,64	5,66	4,12
9/11/86	6,59	5,64+	7,26	5,04+	7,21	5,32	6,34	6,34	4,67	4,07
16/11/86	6,34	5,84+	7,78	4,76+	6,72	5,77	6,34	6,14	5,52	4,06
23/11/86	6,71	5,62+	7,34	4,96+	6,88	5,34	6,34	6,74	5,74	4,34
30/11/86	6,71	6,00+	7,30	5,34+	6,94	4,82	6,42	6,52	5,78	4,22
7/12/86	6,44	5,84+	6,14	6,86+	7,34	5,50	6,34	6,00	5,48	4,10
14/12/86	6,34	5,63+	6,50	5,34+	6,98	5,15	6,35	6,64	5,34	3,76

v) Collection Round Five

1986 W/Ending	Day 1 M	Day 1 AF	Day 2 M	Day 2 AF	Day 3 M	Day 3 AF	Day 4 M	Day 4 AF	Day 5 M	Day 5 AF
13/ 7/86	6,62	3,90	8,10	2,90	8,02	3,08	7,80	2,36	3,66	4,74
20/ 7/86	7,06	4,41	9,08	3,54	6,22	4,96	6,22	4,52	4,04	5,20
27/ 7/86	7,00	4,36	7,86	3,36	4,36	6,84	5,42	4,36	4,89	4,34
3/ 8/86	6,62	3,36	9,04	2,94	7,22	3,36	5,36	4,44	3,68	3,94
10/ 8/86	7,00	2,76	8,58	2,88	7,36	3,00	5,46	4,36	3,88	4,20
17/ 8/86	7,66	3,00	5,79	6,16	7,36	2,69	6,16	4,86	4,01	4,62
24/ 8/86	7,16	3,78	8,58	3,34	7,59	3,28	5,76	4,46	3,84	4,44
31/ 8/86*	8,00	4,18	6,36	6,42	7,08	4,36	6,63	6,33	4,80	4,66
7/ 9/86	7,34	4,36	8,32	2,87	7,07	3,78	5,58	4,12	4,30	4,66
14/ 9/86	6,50	3,62	7,26	3,14	8,02	2,24	8,06	1,96	3,64	4,20
21/ 9/86	7,02	3,50	8,32	3,06	7,54	2,62	8,08	4,10	3,84	4,12
28/ 9/86	6,66	3,50	8,74	2,50	6,68	4,18	6,22	4,12	2,90	4,84
5/10/86	7,04	3,50	8,10	2,82	7,98	3,08	8,12	4,98	3,50	4,40
12/10/86	7,04	3,80	8,50	2,68	7,72	2,83	8,14	2,41	7,50	2,50
19/10/86	6,64	3,30	8,34	2,71	7,88	2,84	7,68	2,16	8,06	2,50
26/10/86	8,30	2,70	8,24	3,49	6,72	4,34	5,68	4,01	4,50	4,50
2/11/86	7,60	3,27	8,55	2,92	5,20	3,50	5,50	5,72	5,00	2,20#
9/11/86	7,40	3,80	8,73	2,88	3,16	3,34	7,70	4,60	7,90	1,43
16/11/86	7,02	3,50	7,84	2,61	8,26	2,96	7,70	1,50	7,60	-
23/11/86	7,06	3,34	8,00	2,38	8,00	2,75	8,36	1,91	9,96	2,25
30/11/86	7,10	3,66	7,98	2,81	7,77	3,06	7,78	2,13	3,96	3,64
7/12/86	7,06	3,86	7,70	2,90	8,10	2,62	7,47	4,37	4,28	4,01
14/12/86	7,52	2,24	7,82	2,90	6,72	3,74	4,92	4,19	4,07	4,06

Continued..

vi) Collection Round Six

1986	Day 1		Day 2		Day 3		Day 4		Day 5	
W/Ending	M	AF	M	AF	M	AF	M	AF	M	AF
13/ 7/86	5,75	4,88	7,12	3,61	6,96	3,32	4,52	6,42+	5,06	4,98
20/ 7/86	6,10	5,34	8,10	3,76	7,52	4,12	5,00	7,22+	5,30	5,37
27/ 7/86	6,84	3,52	7,14	4,52	7,08	2,88	4,68	4,46+	6,06	3,90
3/ 8/86	6,96	3,42	6,62	3,64	6,84	3,80	5,52	6,96	4,56	4,82
10/ 8/86	6,26	4,44	7,72	3,36	7,34	3,72	4,52	7,14+	4,88	4,96
17/ 8/86	7,30	3,42	7,32	3,38	7,25	3,72	5,12	7,52	6,08	5,52
24/ 8/86	7,00	3,41	7,10	3,82	7,04	3,52	5,44	6,82	5,11	4,85
31/ 8/86*	6,93	3,68	7,01	4,01	7,90	5,38	5,00	5,62+	5,39	4,51
7/ 9/86	7,50	6,16	7,42	3,32	7,04	3,51	5,35	5,51+	5,04	5,11
14/ 9/86	7,20	3,78	7,43	4,48	7,26	3,84	5,56	4,56+	4,94	5,50
21/ 9/86	7,96	3,76	8,01	4,30	6,12	5,14	5,40	4,34+	4,82	5,24
28/ 9/86	7,56	3,74	7,86	3,96	6,24	4,90	5,30	4,56+	4,96	5,72
5/10/86	7,46	4,46	6,92	4,86	6,48	5,02	5,56	4,70+	4,90	5,28
12/10/86	7,26	4,18	4,10	7,16	6,37	5,10	5,60	4,62+	4,80	5,12
19/10/86	7,24	3,70	7,02	4,58	6,41	4,57	5,56	3,31+	4,84	5,16
26/10/86	7,42	3,74	7,56	4,68	6,40	4,86	5,48	4,56+	4,76	5,04
2/11/86	8,00	4,01	7,27	5,56	7,02	5,33	6,56	6,84	5,82	6,72
9/11/86	6,94	5,38	6,99	5,34	6,68	5,42	6,56	3,56+	4,77	4,59
16/11/86	6,33	3,71	3,50	6,26+	6,81	5,50	6,24	3,44+	5,35	4,80
23/11/86	6,96	4,18	7,34	5,43	6,82	5,56	5,56	5,44+	5,28	5,46
30/11/86	7,26	4,64	7,38	5,94	6,72	5,56	5,84	4,56+	5,76	4,79
7/12/86	7,10	4,83	7,26	5,46	6,56	4,94	5,76	5,10+	5,36	4,94
14/12/86	7,07	4,56	7,64	5,16	6,22	5,28	6,03	2,12+	5,59	5,34

Source of data: Alyn and Deeside District Council

Appendix 11.2 A Sample Collection Round: Round 2 Day 2

Address		No. of Premises	Population 18+	SP Lifestyle
Travel to Shotton				
Shotton Lane	M	118	84	8/10/3
Higher Kinnerton/Aston Park Road (Part)	M	8	4	6
Hafan Glyd	M	17	44	10
Strickland Street	M	39	97	8
Greenbank Road	M	52	47	3
Highcroft M /North Street A		88	177	9/10
Crossways	A	12	26	10
Westminster Crescent	A	58	131	10
Allans Close	A	16	37	9
Dee View Crescent	A	22	32	9
South Bank	M	8	17	9
Aston Road	M	37	77	9
Terrig Street	A	80	160	9
St.Ethelwolds Street	M	12	26	9
Castlehill Street	M	12	20	6/9
Clwyd Street	M	82	178	6/9
Chevrons Road	A	91	106	9/10
Green Lane	A	84	161	10
Central Drive	A	51*	99	9
Sandown Road	M	4	8	9
Melrose Avenue	M	10	16	9
Poplar Avenue/Elmwood	M	39	43	9
Sandown Court	M	17	21	9
Dodds Court	M	30	41	9
Larch Avenue	M	23	29	9
Grange Road	M	11	18	9
Cornwall Road	M	29	62	9/10
Norman Street	M	18	26	9
Grosvenor Road	M	19	44	9
Tudor Close	M	10	19	9
Farmfield Close	M	14	41	9

* = Including trade, M = Morning, A = Afternoon

Source: Alyn and Deeside District Council
Population Data are taken from the Electoral Register

Appendix 11.3 Alyn and Deeside District Council, Daily Weight Data for

i) Collection Round One (Tonnes)

1986 W/Ending	Day.1	Day.2	Day.3	Day.4	Day.5
13/ 7/86	9,40	11,26	11,96	10,70	7,54
20/ 7/86	10,52	11,00	11,87	11,49	8,32
27/ 7/86	10,42	10,74	11,68	10,00	8,00
3/ 8/86	9,48	10,02	11,92	10,50	7,22
10/ 8/86	9,20	10,64	11,76	10,20	7,16
17/ 8/86	10,38	10,92	11,55	10,80	7,78
24/ 8/86	10,19	10,86	12,74	11,04	9,32
31/ 8/86*	10,80	12,56	14,74	14,72	9,34
7/ 9/86	10,41	11,18	13,57	10,53	9,30
14/ 9/86	11,30	10,74	12,40	11,82	10,06
21/ 9/86	11,08	10,70	12,54	11,12	8,42
28/ 9/86	11,25	10,86	12,36	12,20	8,68
5/10/86	6,50+	14,42	13,61	11,12	11,79
12/10/86	11,94	11,68	12,90	12,04	9,42
19/10/86	11,80	13,29	13,35	11,54	9,86
26/10/86	11,08	9,20	12,40	10,59	8,27
2/11/86	11,78	12,20	9,50	12,20	11,67s
9/11/86	12,30	11,80	13,01	11,01	10,15
16/11/86	9,16	13,38	13,30	11,22	10,62
23/11/86	11,55	11,65	13,44	11,77	9,24
30/11/86	11,88	11,56	13,28	11,56	9,59
7/12/86	13,03	12,07	12,86	11,72	10,25
14/12/86	11,28	12,20	13,20	11,12	10,62

Key to all Tables in Appendix 11,3:

* = Bank holiday week
+ = Data for half day only
s = One extra day's collection made on Saturday
# = Incorrectly recorded at weighbridge

Continued..

ii) Collection Round Two (Tonnes)

1986 W/Ending	Day.1	Day.2	Day.3	Day.4	Day.5
13/ 7/86	12,40	12,26	12,21	10,35	8,94
20/ 7/86	12,14	11,00	12,74	11,36	9,92
27/ 7/86	12,34	11,64	11,00	11,34	9,14
3/ 8/86	11,94	11,74	11,16	10,72	9,84
10/ 8/86	11,94	12,16	11,32	11,12	8,28
17/ 8/86	12,12	11,36	12,28	11,85	9,72
24/ 8/86	11,96	11,70	13,26	11,20	8,98
31/ 8/86*	13,24	14,22	12,04	15,72	8,92
7/ 9/86	11,56	12,51	11,09	10,92	7,54
14/ 9/86	12,88	12,82	13,18	12,28	9,84
21/ 9/86	12,75	12,72	12,64	11,34	9,56
28/ 9/86	15,81	12,58	13,68	11,39	9,22
5/10/86	13,44	13,50	6,02	12,12	8,91
12/10/86	12,64	11,35	11,29	13,46	9,44
19/10/86	12,30	11,94	12,20	13,23	9,74
26/10/86	11,34	8,52	15,41	12,15	7,77
2/11/86	14,09	10,73	13,98	9,69	10,27s
9/11/86	13,18	12,55	12,82	12,30	9,79
16/11/86	12,84	13,14	15,38	13,20	10,52
23/11/86	12,82	13,56	14,64	13,70	11,16
30/11/86	13,46	13,79	13,36	13,00	11,23
7/12/86	14,46	14,04	12,98	13,07	10,45
14/12/86	13,84	14,12	13,79	13,08	10,46

iii) Collection Round Three (Tonnes)

1986 W/Ending	Day.1	Day.2	Day.3	Day.4	Day.5
13/ 7/86	11,15	14,08	10,57	11,12	8,46
20/ 7/86	10,90	11,48	12,06	11,14	9,12
27/ 7/86	11,98	11,22	10,84	11,32	7,79
3/ 8/86	11,28	10,44	10,24	11,76	8,68
10/ 8/86	11,16	10,34	10,31	12,30	8,77
17/ 8/86	9,94	10,86	11,05	11,86	9,02
24/ 8/86	10,88	9,69	11,00	12,00	9,01
31/ 8/86*	11,92	11,90	10,55	13,37	10,87
7/ 9/86	10,09	10,70	10,24	10,96	8,81
14/ 9/86	11,30	11,86	11,46	12,68	9,68
21/ 9/86	11,87	11,80	11,02	12,53	9,12
28/ 9/86	11,74	11,68	11,56	12,06	9,15
5/10/86	12,04	11,88	11,33	12,90	9,42
12/10/86	11,72	10,79	11,40	12,16	9,31
19/10/86	12,38	12,09	9,99	11,96	9,38
26/10/86	11,34	11,18	11,31	11,75	9,30
2/11/86	12,88	12,72	12,37	13,45	9,78
9/11/86	12,23	12,30	12,53	12,68	8,69
16/11/86	12,18	12,54	12,49	12,48	9,58
23/11/86	12,33	12,30	12,22	13,08	10,08
30/11/86	12,71	12,64	11,76	12,94	10,00
7/12/86	12,28	13,00	12,84	12,34	9,58
14/12/86	11,97	11,84	12,13	12,99	9,10

Continued..

iv) Collection Round Four (Tonnes)

1986 W/Ending	Day,1	Day,2	Day,3	Day,4	Day,5
13/ 7/86	6,40	6,08	4,46	4,70	5,00
20/ 7/86	6,68	6,68	5,22	6,24	5,26
27/ 7/86	7,21	6,41	4,12	4,78	4,44
3/ 8/86	6,46	6,52	4,87	5,06	4,78
10/ 8/86	6,10	6,61	4,20	5,24	5,00
17/ 8/86	6,48	6,84	4,53	4,92	5,20
24/ 8/86	6,38	6,90	4,42	4,76	5,16
31/ 8/86*	6,90	7,66	6,18	6,71	5,76
7/ 9/86	6,26	6,69	5,09	6,18	4,52
14/ 9/86	7,24	7,22	2,50#	5,26	4,97
21/ 9/86	8,93	7,08	4,18	4,83	4,50
28/ 9/86	6,88	7,62	5,22	5,34	4,74
5/10/86	7,15	6,22	7,04	5,65	5,86
12/10/86	6,49	7,24	5,11	6,12	4,55
19/10/86	6,97	7,52	5,10	4,26	4,76
26/10/86	8,18	8,10	5,14	5,20	4,63
2/11/86	7,52	7,72	5,52	5,88	5,27
9/11/86	7,60	7,99	5,78	4,62	5,30
16/11/86	8,06	8,00	5,52	5,48	4,77
23/11/86	7,25	7,64	5,48	5,93	5,00
30/11/86	7,79	7,76	5,84	5,65	5,02
7/12/86	8,19	7,75	5,60	5,64	5,37
14/12/86	7,66	7,31	5,75	5,72	4,81

v) Collection Round Five (Tonnes)

1986 W/Ending	Day,1	Day,2	Day,3	Day,4	Day,5
13/ 7/86	10,52	11,00	11,10	10,16	8,40
20/ 7/86	11,47	12,62	11,18	10,74	9,24
27/ 7/86	11,36	11,22	11,20	9,78	9,23
3/ 8/86	9,98	11,98	10,58	9,80	7,62
10/ 8/86	9,76	11,46	10,36	9,82	8,08
17/ 8/86	10,66	11,95	10,05	11,02	8,63
24/ 8/86	10,94	11,92	10,87	10,22	8,28
31/ 8/86*	12,18	12,78	11,44	12,96	9,46
7/ 9/86	11,70	11,19	10,85	9,70	8,96
14/ 9/86	10,12	10,40	10,26	10,02	7,84
21/ 9/86	10,52	11,38	10,16	12,18	7,96
28/ 9/86	10,16	11,24	10,86	10,34	7,74
5/10/86	10,54	10,92	11,06	13,10	7,90
12/10/86	10,84	11,18	10,55	10,55	10,00
19/10/86	9,94	11,05	10,72	9,84	10,56
26/10/86	11,00	11,73	11,06	9,69	9,00
2/11/86	10,87	11,47	8,70	11,22	7,20s
9/11/86	11,20	11,61	6,50	12,30	9,33
16/11/86	10,52	10,45	11,22	9,20	7,60+
23/11/86	10,40	10,38	10,75	10,27	12,21
30/11/86	10,76	10,79	10,83	9,91	7,60
7/12/86	10,92	10,60	10,72	11,84	8,29
14/12/86	9,76	10,72	10,46	9,11	8,13

Continued..

vi) Collection Round Six (Tonnes)

1986 W/Ending	Day,1	Day,2	Day,3	Day,4	Day,5
13/ 7/86	10,63	10,73	10,28	16,02	10,04
20/ 7/86	11,44	11,86	11,64	13,66	10,67
27/ 7/86	10,36	11,66	9,96	12,70	9,96
3/ 8/86	10,38	10,26	10,64	12,48	9,38
10/ 8/86	10,70	11,08	11,06	13,10	9,84
17/ 8/86	10,72	10,70	10,97	12,64	11,60
24/ 8/86	10,41	10,92	10,56	12,26	9,96
31/ 8/86*	10,61	11,02	13,28	12,83	9,90
7/ 9/86	13,66	10,74	10,55	13,08	10,15
14/ 9/86	10,98	11,91	11,10	13,74	10,44
21/ 9/86	11,72	12,31	11,26	13,30	10,06
28/ 9/86	11,30	11,82	11,14	13,56	10,68
5/10/86	11,92	11,78	11,50	13,82	10,18
12/10/86	11,44	11,26	11,47	14,04	9,92
19/10/86	10,94	11,60	10,98	13,69	10,00
26/10/86	11,16	12,24	11,26	13,80	9,80
2/11/86	12,01	12,83	12,35	13,40	12,54
9/11/86	12,32	12,33	12,10	15,68	9,36
16/11/86	10,04	13,00	12,31	14,74	10,15
23/11/86	11,14	12,77	12,38	15,12	10,74
30/11/86	11,90	13,32	12,28	15,17	10,55
7/12/86	11,93	12,72	11,50	13,96	10,30
14/12/86	11,63	12,80	11,50	14,05	10,93

vii) Collection Round Seven

1986 W/Ending	Day,1	Day,2	Day,3	Day,4	Day,5
13/ 7/86	3,72	3,14	2,28	3,94	1,86
20/ 7/86	4,20	3,90	2,66	2,96	2,44
27/ 7/86	4,00	3,38	2,24	2,94	2,34
3/ 8/86	4,14	3,30	2,80	3,02	2,32
10/ 8/86	3,91	3,40	2,52	3,20	2,47
17/ 8/86	4,24	3,48	2,46	3,20	2,42
24/ 8/86	4,14	3,64	2,46	3,08	2,20
31/ 8/86*	4,44	3,68	2,90	3,86	3,52
7/ 9/86	4,10	3,51	2,60	2,75	2,40
14/ 9/86	4,34	3,42	2,76	3,20	2,20
21/ 9/86	4,38	3,80	2,40	3,20	2,32
28/ 9/86	4,20	3,60	2,54	3,20	2,36
5/10/86	4,42	3,67	2,26	3,26	2,44
12/10/86	4,40	3,50	2,70	3,24	2,27
19/10/86	4,17	3,64	2,52	3,22	2,08
26/10/86	4,25	3,40	2,54	3,24	2,20
2/11/86	4,52	4,00	2,69	3,40	2,47
9/11/86	4,47	3,77	2,82	3,56	2,24
16/11/86	4,20	3,79	2,55	3,54	2,24
23/11/86	4,50	3,41	3,00	3,35	2,40
30/11/86	4,34	3,82	2,56	3,26	2,42
7/12/86	4,80	3,54	2,64	3,52	2,03
14/12/86	4,20	3,72	2,43	3,46	2,52

Source of data: Alyn and Deeside District Council

Appendix 11.4 Calculation of Waste Arisings per Household: Lifestyle 5

Formula:

$$AV = \left(\frac{85x}{100}\right) + \left(\frac{15y}{100}\right)$$

where: AV = Average weekly waste arisings per household for Round 1 Day 4

x = Average waste arisings per household per week for Lifestyle 6 (This has been calculated previously at 14.20 kgs)

y = Average waste arisings per household per week for Lifestyle 5.

$$13.61 = \left(\frac{85 \times 14.20}{100}\right) + \left(\frac{15y}{100}\right)$$

$$13.61 = 12.07 + \left(\frac{15y}{100}\right)$$

$$1.54 = \frac{15y}{100}$$

$$y = 10.23$$

Therefore, average waste arisings per household per week, for households in Lifestyle 5 are 10.23 kgs. (Based upon data with a reliability index of 7.8)

Appendix 11.5 Analysis of Variance: Daily and Half-Day Round Data

The statistical method selected, is the Kruskal-Wallis One-Way Analysis of Variance. This test has the advantage of being distribution-free and suitable for use with a small or large number of samples, ('small' is defined as three or less samples, each comprising not more than five values). The mathematical basis to the test, is discussed in a number of texts, including Hammond & McCullagh (1977), Norcliffe (1982), Taylor (1977) and Shaw & Wheeler (1985).

Analysis of Daily Rounds

i) H_0 (the null hypothesis): There is no difference in terms of waste arisings per household per week, between the three socio-economic groups.
ii) H_1 (alternative hypothesis): There is a difference in terms of waste arisings per household per week, between the three socio-economic groups.
iii) Rejection level $\alpha = 0.20$

Data:

Sample 1 (SP Lifestyles 3& 5) values	rank	Sample 2 (SP Lifestyle 6) values	rank	Sample 3 (SP Lifestyles9 & 10) values	rank
11.61	7	14.20	13	11.08	5
10.66	3	12.94	11	10.81	4
13.14	12	11.36	6	12.15	9
		12.89	10	10.44	2
sum rank =22		12.04	8		
		10.25	1	sum rank = 20	
		sum rank = 49			

Formula:

$$H = \frac{12}{N(N+1)} \sum \frac{R^2}{n} - 3(N + 1)$$

where: R = the sum of the ranks in each sample;
N = the total number of values,
and n = the number of values in each sample.

$$H = \frac{12}{13 \times 14} \times \left[\frac{22^2}{3} + \frac{49^2}{6} + \frac{20^2}{4} \right] - 3 \times 14$$

$$H = 1.6154$$

The degrees of freedom (df) are equal to the sample number less 1, thus, df=2

Reference to the significance values of the statistic (H), reveals that with df=2, the value of H is not significant at a level of 0.20, (even if a significance value as low as 0.50 is taken, the value of H remains insignificant).

Continued..

Analysis of Half-Day Rounds

i) H_0 (the null hypothesis): There is no difference in terms of waste arisings per household per week between the three socio-economic groups.
ii) H_1 (alternative hypothesis): There is a difference in terms of waste arisings per household per week between the three socio-economic groups.
iii) Rejection level $\alpha = 0.20$

Data:

Sample 1 (SP Lifestyles 3 & 5)		Sample 2 (SP Lifestyle 6)		Sample 3 (SP Lifestyles 8 & 9)	
values	rank	values	rank	values	rank
11.64	9	15.15	18	12.16	11
10.06	3	13.61	15	12.44	12
14.90	16	9.85	2	14.96	17
12.56	13	10.23	4	10.62	7
9.63	1	12.84	14	10.52	6
sum rank = 42		11.23	8	11.65	10
		10.32	5	sum rank = 63	
		sum rank = 66			

Formula:

$$H = \frac{12}{N(N+1)} \sum \frac{R^2}{n} - 3(N+1)$$

$$H = \frac{12}{18 \times 19} \times \left[\frac{45^2}{5} + \frac{66^2}{7} + \frac{63^2}{6} \right] - 3 \times 19$$

$$H = 0.424$$

Degrees of freedom (df) are equal to the sample number less 1, thus, df=2

Reference to the significance values of the statistic, reveals that with df=2, the value of H is not significant at a level of 0.20. In this case, the probability of the null hypothesis being correct is 17.0% and therefore, the probability that the variance between the groups is the result of differences in socio-economic characteristics, is 83%.

APPENDIX B

Appendix 1.1 Published Work

Paper (attached) submitted in part-fulfilment of the regulations:

Roberts, D. A. (1985) 'Landfill Site Selection Policy - A Welsh Case-Study' The Planner. November 1985.

Continued..

Dawn Roberts

Landfill Site Selection Policy –A Welsh Case-study

Policy on waste management within the UK has been dictated by central government through a wide range of legislation, including the Public Health Act, 1936; the Town and Country Planning Acts, 1947 and 1971; and the Health and Safety at Work etc. Act, 1974. Major advances have recently been made through the introduction of the Control of Pollution Act (COPA), 1974, Part 1 *Waste on Land*, which introduced tighter controls over waste management. Section 2 of the Act, which became effective on 1 July 1978, requires each waste disposal authority (WDA) to prepare a plan for the disposal of household, commercial and industrial waste.

The Act fails, however, to cover site selection procedures–it does not compel the WDAs to undertake detailed, systematic investigations of all potential landfill sites in their area, or to give differential weighting to environmental criteria over economic considerations. Indeed, no mandatory criteria and little guidance are available to waste disposal authorities.

The Control of Pollution Act requires consultation with the planning and water authorities to provide additional opinions and objections to a specific site, but these bodies are largely ineffective in influencing site selection, potential landfill sites being identified by the WDAs. The DoE paper on the licensing of disposal sites (DoE 1976) only provides hydrogeological guidelines for the selection of landfill sites and, consequently, site selection procedures may vary amongst the WDAs. Whilst one authority may select sites on the basis of minimising transport costs, another may choose to reclaim derelict sites through tipping, regardless of cost. Economics plays an important role in waste disposal and it is often the 'cheapest' and not the 'best' site which is chosen.

The Welsh situation

The results of the current dearth of legislation to control landfill site selection are clearly to be seen in Wales, as is the inability of the planning and water authorities to influence selection procedures. In the Principality, the 37 district councils are currently the WDAs responsible for the selection of potential landfill sites.

A recent survey of the Welsh WDAs provided some information on the selection of landfill sites (Wathern *et al.* 1983). Authorities were asked to provide information on the use of a site prior to its conversion for waste disposal. Details on a total of 141 sites are broadly summarised in table 1: the figures suggest that waste disposal and aspects of amenity may be in conflict. No indication was given of the factors assessed in site selection, although it appears that proximity is probably a significant factor.

There are only limited data on the environmental implications of landfill in Wales. Of the 141 waste disposal sites identified in table 1 more detailed information on the previous use of 64 sites receiving more than 1 tonne per day was obtained. It was felt that these large sites are likely to have the greatest individual environmental impact and their study would provide at least some insight into the landfill site selection policies used. Some districts, however, were not forthcoming with even such basic data and no information was obtained for four districts (figure 1). Some of these sites receive only domestic refuse, others take both domestic and non-domestic waste, including five which accept toxic waste.

Analysis of the 64 sites according to their previous land use is shown in table 2 and figure 1. In general, the categories 'agriculture' and 'natural environment' may be classified as unspoiled virgin land, whilst 'quarries' and 'other uses' constitute derelict sites in need of reclamation. For Wales as a whole, more landfill sites are located on previously unspoiled land than on derelict or disturbed land. There are, nevertheless, marked regional differences between the previous use of landfill.

In Mid Wales, 75 per cent of landfill sites are on agricultural land and 8 per cent on natural environment sites–thus, 83 per cent of all sites are on previously unspoiled and undisturbed land. To what extent this reflects site availability rather than preference for one type of site is unclear. Certainly, these districts have an abundance of agricultural land, making low-grade agricultural land more available for alternative uses than it would be elsewhere. In addition, such predominantly rural areas have few derelict sites other than quarries.

In South Wales, approximately seven out of every 10 landfill sites are located on land which is already derelict or disturbed. Here, disused quarries form the largest single previous use of landfill sites with 'other' land uses–predominantly disturbed land–the second most common. These statistics reflect the degree of dereliction which has resulted from the region's long history of industrialisation, including periods of expansion and decline. Availability of derelict sites for waste disposal is probably greater in South Wales than elsewhere in the Principality with the result that 69 per cent of landfill sites in the region are on derelict and/or disturbed land.

To date, only 11 sites have been located in North Wales, a small number from which to draw conclusions. Six sites are on agricultural land, two on areas of natural environment and three in disused quarries. The tendency, therefore, is towards agricultural sites although this is not as strong here as in Mid Wales. The data for the whole of Wales imply that the 'most readily available' site is chosen for waste disposal rather than the best site on environmental considerations.

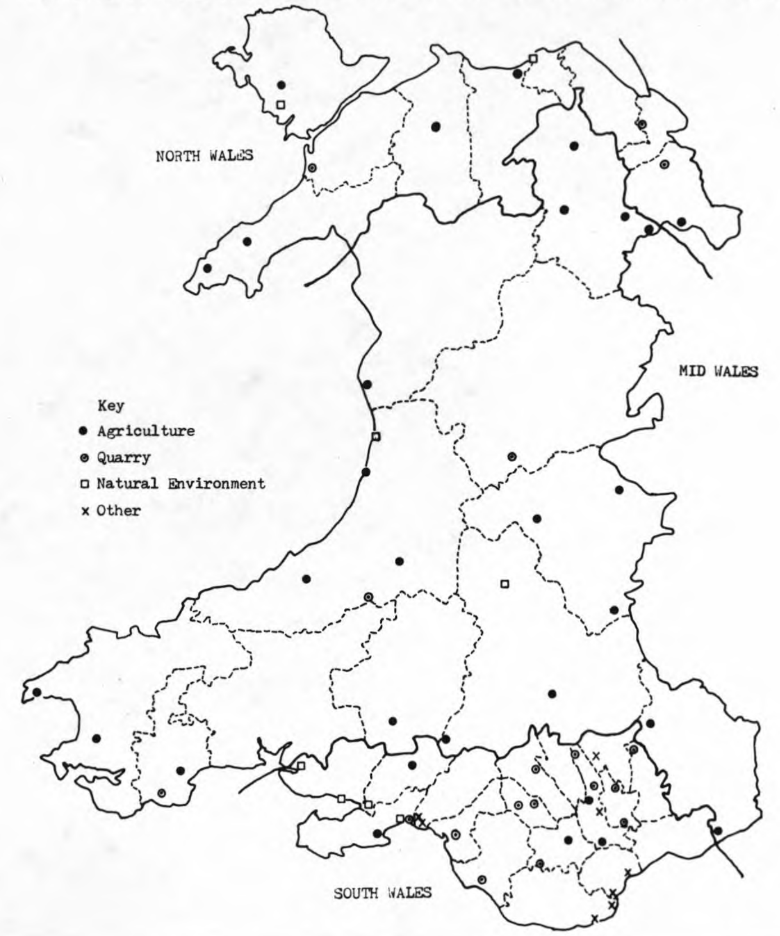
Environmental degradation

Environmental degradation invariably occurs sooner or later as a result of poor site selection and management. This is most readily manifest in the contamination of local watercourses by tip leachate. Landfill sites with pollution problems that give cause for concern are monitored by the Welsh Water Authority (WWA). Data from the WWA on landfill sites monitored in 1977-78 and 1983 are shown in table 3 and have been reclassified according to previous land use. In 1977-78 the WWA monitored 19 tips: of these, eight are not considered further as one accepts non-domestic waste only and the remainder are no longer in use. Eight of the remaining 11 sites (70 per cent) were on agricultural land. In 1983, 15 sites were monitored: eight of these sites were not monitored in 1977-78 (two were new sites opened since 1977-78, the other six being older sites that had only recently started to give cause for concern). Four sites monitored in 1977-78 were still in use in 1983 but were no longer monitored as their pollution problems had been successfully resolved. However, seven sites monitored in 1977-78 were still being monitored in 1983. These must be viewed as the more serious cases as they have continued to cause problems over a minimum period of six years. The most notable feature of these sites is that six are on agricultural land. Thus, although only 45 per cent of Welsh landfill sites are on agricultural land, these comprise 85 per cent of all long-term leachate problem sites in the Principality.

The WWA monitored a total of 19 different landfill sites in 1977-78 and/or 1983. Thus, 29 per cent of current landfill sites have caused concern since 1977. One might expect the majority of these to be pre-1974 sites, in operation prior to the introduction of COPA. In fact, only 11 sites (58 per cent) were pre-1974 sites, whilst seven were new sites opened since 1974. The date of the remaining site is unknown (table 4). Table 4 also shows that the introduction of COPA appears to have had little significant effect upon site selection: of the 32 pre-1974 sites, 11 (34 per cent) had pollution problems compared with seven (27 per cent) of the 26 post-1974 sites. Considering the small sample, these differences are not significant.

Site selection criteria over time can also be investigated. Information on the dates when current landfill sites were opened, categorised according to previous land use, is presented in table 5. These data indicate an apparent change in choice of site since 1974: pre-1974 sites were predominantly on agricultural land but since 1974 there has been significant change; new sites are fairly evenly split between agricultural land and disused quarries, with a threefold increase in the use of other sites.

FIGURE 1. THE PREVIOUS LAND USE OF WELSH LANDFILL SITES



Regional differences

There are regional differences concerning the choice of site. In Mid Wales, the ratio of sites on former agricultural land to quarries is comparable for both pre- and post-1974. Site selection in South Wales is apparently changing, with the number of non-agricultural sites doubling and the number of agricultural sites remaining stable. In North Wales only limited data are available. However, all post-1974 sites are in disused quarries whereas the limited data for the pre-1974 situation indicate a dominance of agricultural sites. These data relate only to the 16 districts which have had to open new landfill sites since 1974 and so represent a rather small sample. Of these 16 districts, seven have recently located landfill sites on agricultural land and one has chosen two new sites, both of which are areas of natural environment. In addition, of the remaining 21 districts that have not yet had to select a new site since 1974, nine are currently using at least one landfill site located on agricultural land. Thus, the extent of the 'change' in policy towards site selection will only finally be identified once all Welsh districts have had to select new landfill sites, but the initial indications are that there has been little change since 1974.

The data available suggest that the majority of current landfill sites in Wales are located on previously unspoiled land. Agricultural land is the most common location of landfill sites, even though it is more susceptible to leachate problems than any other type of site. Perhaps the main reason for this is that poor agricultural land, often too wet to farm, is most available for alternative use; land with such drainage problems should be eliminated during correct site selection procedures. It would appear that in those parts of Wales where agricultural land is abundant, availability together with minimum cost outweighs environmental considerations which would probably entail higher transport, site acquisition and site management costs.

Conclusions

The introduction of the Control of Pollution Act, 1974 does not appear to have had any effect on site selection; this is not surprising since the Act failed to cover

Pre-1974 landfill site in Clwyd: an example of inappropriate site selection and therefore inadequate site selection procedures.

what is, in terms of environmental impact, by far the most important aspect of waste management. The Act relies on consultation procedures with other bodies to ensure good site selection, but this faith appears to be misplaced. Even for perhaps the most important aspect of site investigation–the hydrogeology–the number of suitably qualified personnel in the Welsh Water Authority is limited; the recently created 'Northern Division' of the WWA claims to employ the only hydrogeologist currently employed by the Water Authority in Wales. Prior to the restructuring of the WWA in 1984, the encumbent was employed by the Dee and Clwyd Division–the adequacy of site investigations elsewhere in the Principality must therefore be questioned.

· Planning for future needs–in particular, new landfill sites–should be an integral part of good waste management practice. The production of waste disposal plans is a requirement of COPA Part I, Section 2, implemented in 1978. By 1983 only three WDAs had produced their plans, whilst a further six and four were due for completion by the end of 1983 and 1984 respectively. This is a further indication that the planning for future landfill capacity may be inadequate, resulting in hasty site selection when current landfill capacity is exhausted.

The planning authorities also have a vital role to play in the planning of future waste disposal sites. Of the structure plans submitted by the eight Welsh Counties, only three contain policies on waste disposal, whilst in only eight of the 37 local plans is waste disposal mentioned (most of these are, however, still in draft form) (Planning Services, 1982).

Correct site selection procedures, together with forward planning, will ultimately result in the best available landfill sites being selected, minimising environmental degradation. Consultation between the WDAs and planning authorities is therefore essential not only for the planning of future sites, but for the mutual benefit to the two bodies. In addition, there is a growing need for a uniform system of landfill site selection procedures to be enforced by central government, rather than a continuation of the *status quo* whereby 37 WDAs adopt 37 different policies for site selection.

TABLE 1. PRIOR USE OF DISPOSAL SITES

Previous use of site	Number of sites
1 Agricultural land	59
2 Quarrying	29
3 Other*	42
4 Land with a possible conservation interest	11
Total	141

*The category 'other' includes types ranging from railway cuttings to old docks. Sites of possible conservation interest includes bogs, marshland, salt flats, tidal marsh, wetlands and woodlands.

TABLE 2. PREVIOUS LAND USE OF WELSH LANDFILL SITES

Previous Land Use	No. of Sites	Percentage	
Agricultural Land	29	45.3	57.8 unspoiled land
Natural Environment	8	12.5	
Quarries	19	29.7	42.2 derelict land
Other	8	12.5	
Total	64	100.0	

TABLE 3. WELSH WATER AUTHORITY MONITORED SITES

	Previous Land Use				
Date of monitoring	Agr	Nat Env	Quarry	Other	Total
Sites monitored in 1977-8	8	1	2	–	11
Sites monitored in 1983	9	–	4	2	15
Sites monitored in 1977-8 and 1983	6	–	1	–	7
Sites monitored in 1977-8 and/or 1983	11	1	5	2	19

TABLE 4. AGE OF LANDFILL SITES

	Date Site Opened							
	Pre-1974		Post-1974		Not Known		Total	
	No	%	No	%	No	%	No	%
Sites Causing Concern	11	58	7	37	1	5	19	30
All Welsh Sites	32	50	26	41	6	9	64	100

TABLE 5. CHANGE IN TYPE OF SITE CHOSEN OVER TIME

Date Site Opened	Previous Land Use									
	Agric		Nat Env		Quarry		Other		Total	
	No	%	No	%	No	%	No	%	No	%
Pre-1974	20	63	4	34	6	19	2	3	32	100
Post-1974	8	31	3	12	9	35	6	23	26	100
Not Known	1	17	1	17	4	67	–	–	6	100
Total	29	45	8	13	19	30	8	13	64	100

References

1. Department of the Environment, *The licensing of waste disposal sites*. Waste Management Paper No. 4, HMSO London (1976).
2. Wathern P, Brown I W, Roberts D A, and Young S N, *Welsh Environmental Quality: data source*. Final Report of Contract U/82/201 to the Commission, mimeographed (1983).
3. Welsh Water Authority, *WWA water quality supplement 1977-78*. Welsh Water Authority, Brecon (1978).
4. Planning Services, *The Planning Requirement*. Paper to Welsh Office Waste Disposal Conference, Powys (1982).

Dawn Roberts is a freelance environmental researcher.

Appendix 1.2 List of Additional Publications

Wathern, P., Brown, I.W., Roberts, D.A. and Young, S.N., (1983). Welsh Environmental Quality : data sources. Final Report of Contract U/82/201 to the Commission, mimeographed.

Wathern, P., Brown, I.W., Roberts, D.A. and Young, S.N., (1984). Waste Management in Wales: Evidence Submitted to the Royal Commission on Environmental Pollution Review of Pollution by Wastes.

Wathern, P., Brown, I.W., Roberts, D.A. and Young, S.N., (1984). Monitoring Policy Impacts in the Uplands and Coastal Zone. Final Report of Contract U/83/645 to the Commission of the European Communities.

Brown, I.W., Wathern, P., Roberts, D.A. and Young, S.N., (1985). Monitoring Sand Dune Erosion on the Clwyd Coast, North Wales. Landscape Research. Vol. 10 No.3, Winter 1985.

Wathern, P., Brown, I.W., Roberts, D.A. and Young, S.N., (1985). Assessing the Environmental Impact of European Economic Community Policy. Landscape Research. Vol.10 No. 2 , Summer 1985.

Wathern, P., Brown, I.W., Roberts, D.A. and Young, S.N., (1986). The EEC Less Favoured Areas Directive: Implementation and impact on upland land use in the UK. Land Use Policy , July 1986.

Wathern, P., Brown, I.W., Roberts, D.A. and Young, S.N., (1986). Ecological Evaluation Techniques. Landscape Planning, 12 (1986) 403-420.

Wathern, P., Brown, I.W., Roberts, D.A. and Young, S.N., (1986). Use of Cumulative Sum Analysis to Assess Policy Impacts on the River Ebbw, Wales. Journal of Environmental Management (1986) 23, 139-148.

Wathern, P., Brown, I.W., Roberts, D.A. and Young, S.N., (1987). UK Interpretation and Implementation of the EEC Shellfish Directive. Environmental Management Vol. 11, No. 1, pp7-12.