From pipe dreams to tunnel vision : engineering decision-making and Sydney's sewerage system

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FROM PIPE DREAMS TO TUNNEL VISION

ENGINEERING DECISION-MAKING AND SYDNEY'S SEWERAGE SYSTEM

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DECLARATION

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or diploma of a university or other institute of higher learning, except where due acknowledgement is made in the text.

ABSTRACT

The broad theme of this thesis is engineering decision-making. The various factors that shape technological development are investigated using the development of Sydney's sewerage system as a case study. The thesis focuses on various key decisions, past and present, including the choice of water-carriage technology for sewage collection, the selection of sewage treatment technologies, and on-going preference of engineers and bureaucrats for ocean disposal. Also covered are the legislative and regulatory mechanisms, the policies of the Sydney Water Board with regard to industrial waste disposal and the relationship between the Board and the public.

A study was made of historical documents, engineering reports and papers, parliamentary debates, annual reports, minutes, newspaper reports and secondary sources and personal interviews were conducted. Various bodies of literature were referred to and used, including the books and articles on the history and sociology of engineers, the politics of expertise and public participation and the emerging discipline of science and technology studies.

It is concluded that the development of Sydney's sewerage system has been shaped by social, political and economic factors and that engineers have played a pivotal role in the decisions made through their deliberate shaping of knowledge and the performance of predictions they have made for various options. The decisions made in this way have been defended against public opinion and public participation in the decision-making process has been kept to a minimum.

This thesis supports the argument that technology is socially constructed, that the technical cannot be separated from the social, and that an interactive model of technological development is more appropriate than a linear, causal one. It shows that the role of power in the shaping of technology is crucial, and in particular the alliance of state and professional power that occurs in the shaping of public sector technology.

CONTENTS

INTRODUCTION

SCOPE OF THE THESIS

Many people in industrialised nations are beginning to question the inherent benevolence of technology when previously they had taken it for granted. The social and environmental consequences of many engineering projects now receive more critical scrutiny and the automatic association of technological change with progress is losing currency as controversy surrounds proposed engineering projects and technological innovations. At the same time there is a growing tendency for technological change to be portrayed as a self-perpetuating activity which cannot be controlled.

This thesis will consider the degree to which technological change is self-perpetuating, the question of just who controls technological decisions and the extent to which the adverse outcomes of technologies are the inevitable consequence of technological decision-making processes. These issues will be addressed by examining the process by which decisions about the development and implementation of technologies in the public sector are reached and the extent to which technological decisions are influenced and shaped by various social groups. In particular the role of engineers will be scrutinised.

Decision-making will be interpreted in its broadest sense so that all relevant influences upon it can be considered: those that are conventionally considered to be part of engineering decision making - the narrowly technical and economic; those that shape the philosophy of engineers and help to define "good" engineering practice; those that constrain the engineers from within their organizational niches; and the wider social and political influences upon those organisations that shape the definition of problems and limit the range of acceptable solutions.

The case study upon which this thesis is based is the development of Sydney's sewerage system. The sewerage system was chosen because it is a public sector technology which has purportedly been developed to protect the health and welfare of citizens. Such a seemingly benevolent technological system is therefore a good one to test whether adverse environmental and social consequences were entirely inadvertent and unforeseen or whether the decision making process ensured that such consequences were ignored or discounted.

The development of a sewerage system is also a good case study through which to study the issue of control of technological change and the effects of public opposition. One would expect that public health technology would reflect popular aspirations and choices more than most technologies. The development of urban sewerage schemes does not seem to offer any significant commercial advantage to any one section of the community since it is a public service available to all. And yet despite this, the engineering decisions surrounding the development of Sydney's sewerage system have been controversial and have attracted widespread media attention.

Sewerage technology is generally associated with large scale systems rather than being commodity or product based, and this offers a good opportunity to consider the degree to which technologies can be self-perpetuating when embedded within a highly complex network of people, organisations and physical components.

The development of the Sydney sewerage system can be studied from the genesis of the city, through its incorporation under colonial rule to its growth into a modern city which is the largest in Australia today. The complete history of Sydney's sewerage system can be contained within two hundred years and although the scope of this thesis is also geographically contained within the boundaries of Sydney's metropolitan area the case study also offers interesting insights into the influence of engineering practice in colonial and technologically dominant nations on local engineering decisions.

A historical perspective is necessary because past decisions can have significant effects on later decisions in terms of physical infrastructure, organisational momentum, past experience and engineering practice. Moreover, a long term perspective enables one to see the persistent patterns in decision making so that variables that change with time can be isolated. In particular, changing values and priorities can be discerned whilst more stable cultural values can be differentiated from those which are dependent on changing economic conditions and particular governments.

In this thesis the story of the development of Sydney's sewerage system will be told and its meaning for engineering decisions and technological change in general will be examined. The story has of course been told in part before. Several histories of Sydney's Water Supply and Sewerage system have been commissioned throughout the years by the Sydney Water Board.[1] The latest was published in 1988 to coincide with the Board's centenary.[2] The New South Wales Public Works Department has also commissioned and published a historical account covering some of Sydney's sewerage history.[3] These histories have been descriptive rather than explanatory and written largely to extol the virtues of organisations responsible for the developments.

In this version of the story I will be concerned with the major decisions about which removal technologies, treatment processes and disposal methods would be used and where the treatment and disposal would take place. These decisions are usually portrayed as being concerned only with technical and economic questions, simply a matter of finding the most cost-effective solution. In these terms, sewerage engineers are deemed to be in the best position to make such decisions. However, I will be looking beyond this commonplace assumption to consider the social and political elements of these decisions.

The thesis begins with the decision to sewer Sydney city after its incorporation in 1842, which followed similar moves in British cities. The role of the sanitary reform movements both overseas and in Australia in deciding that the authorities should intervene in what was previously a private matter will be examined and the subsequent debate over whether the solution lay with sewers or alternative methods of removal will be analysed. (chapters 1&2) The various

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[1] For example T.J. Roseby, Sydney's Water Supply and Sewerage 1788 to 1918, William Applegate Gullick, Government Printer, Sydney, 1918; F.J.J. Henry, The Water Supply and Sewerage of Sydney, Halstead Press, Sydney, 1939; W.V. Aird, The Water Supply, Sewerage and Drainage of Sydney, MWS&DB, Sydney, 1961.

[2] Margo Beasley, The Sweat of Their Brows: 100 Years of the Sydney Water Board 1888-1988, Water Board, Sydney, Illawarra, Blue Mountains, 1988.

[3] Lenore Coltheart & Don Fraser, eds, Landmarks in Public Works: Engineers and their Works in New South Wales 1884-1914, Hale & Iremonger, 1987.

experiments with sewage farming, chemical precipitation and septic tanks that occurred in Sydney will be covered in the following chapter (chapter 3) together with an account of the reasoning behind decisions to install these facilities, their success and the reasons why they were discarded in favour of ocean outfalls. Sydney has three major ocean outfalls and the decision to construct these and the debates over their efficacy are covered in chapter 4. Chapter 5 covers the development of an engineering consensus about appropriate forms of treatment and the decisions to install minimal treatment at Sydney's three main ocean outfalls.

The growing environmental awareness of the 1960s and 1970s and the subsequent legislative reforms are discussed in chapter 6 together with an analysis of their effectiveness in influencing the decisions of Water Board engineers. The use of the sewers to dispose of industrial wastes and the associated decisions are considered in chapter 7 as well as the effect such decisions are having on the environment. The thesis finishes with the most recent decisions to build submarine ocean outfalls at each of the major Sydney outfall sites and the defence of these decisions.(chapters 8&9) These are being constructed now and are due to be completed in the early 1990's.

A layout for this thesis is shown in figure 1. Each chapter (shown as a shaded box) covers one or more key features of Sydney's sewerage system. Although there has been some attempt to retain a chronological order, some chapters cover similar time period and the boxes are therefore shown alongside each other rather than all following down the page after one another. For example the sewage farm and experiments with chemical precipitation and septic tanks which are covered in chapter three occurred at the same time as the first ocean outfalls were built. The heavy arrows in figure 1 show the flow of sewage from the first sewers discussed in chapter 2 to both the sewage farm and the Bondi ocean outfall; from the sewage farm to the Malabar ocean outfall when the sewage farm was closed and from the septic tanks on the north shore to the North Head Ocean Outfall. Chapters 6 and 7 cover the diversion of a new waste stream from industry into the sewer system and are therefore shown to the right of the main sewage flow in figure 1.

The first nine chapters of this thesis will basically tell the story of Sydney's sewerage system as it relates to the themes that are relevant to this study and in the last chapter I will interpret the story in the light of recent theoretical work done in the field of technology studies.

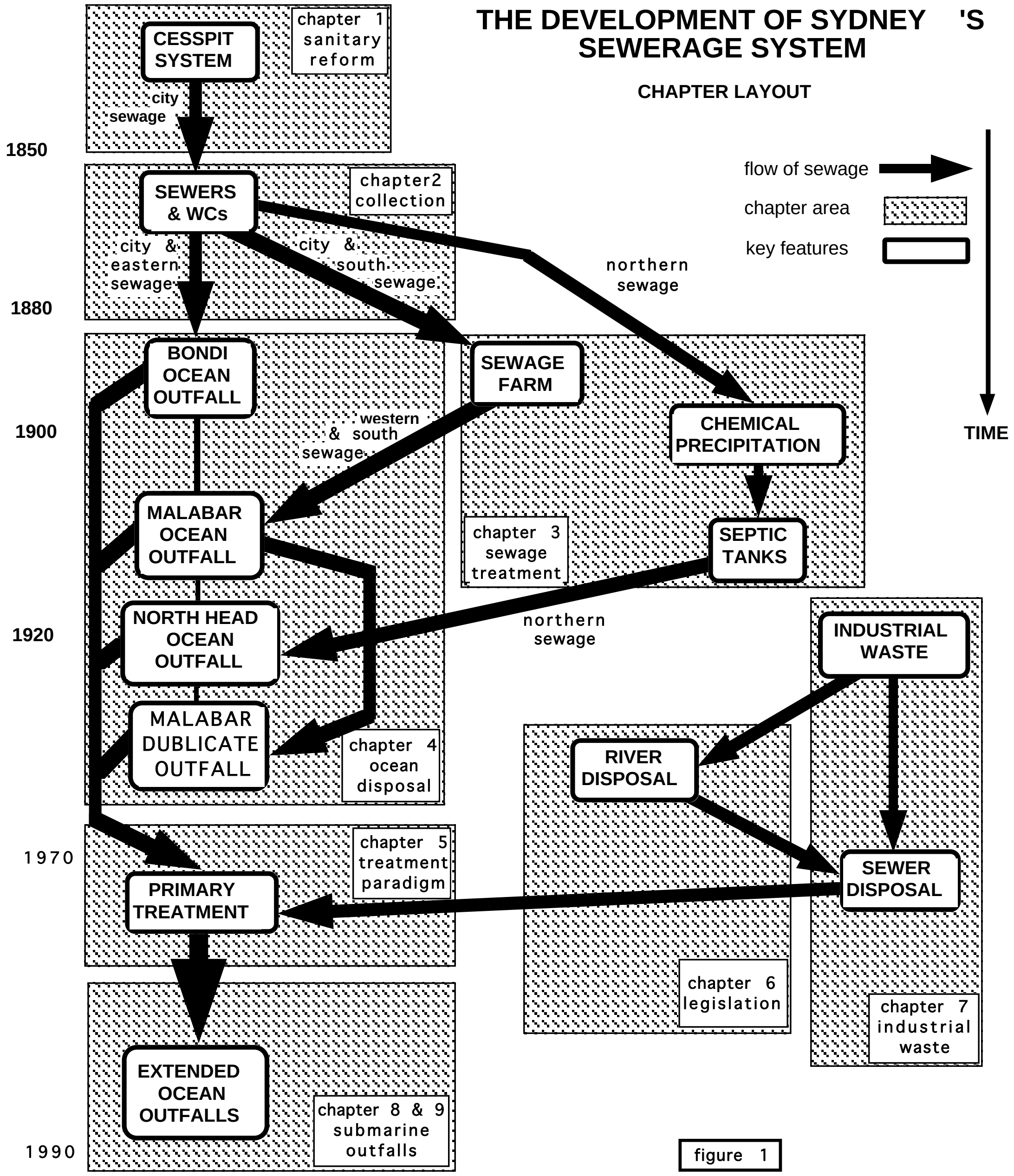

figure 1

RECENT DIRECTIONS IN THE STUDY OF TECHNOLOGY

The study of technology has, in the past, focussed upon three aspects; innovation studies, historical accounts and sociological accounts.[4] The innovation and historical accounts in particular have depicted a linear process of technological development with inventions leading to innovations, innovations leading to the diffusion of technological products and each technological change leading on from the last in an orderly and inevitable progression. Such accounts have tended to be descriptive[5] rather than explanatory.

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[4]Trevor Pinch & Wiebe Bijker, 'The social construction of facts and artefacts: or how the sociology of science and the sociology of technology might benefit each other', Social Studies of Science 14, 1984, p404.

[5] ibid., p405.

Key points of interest have been who the inventors were, when they made their invention and on what scientific or technological advance the invention was based. Even when the meaning of technology has not been restricted to artifacts, technology has been viewed as merely the fruits of applied science. The simplistic view that economic or market forces fully explain technological innovation has also been recognised as inadequate.[6] More recently, however, the science/technology relationship has been reappraised[7] and there is far more study directed at finding out more about the nature of invention, development and innovation.[8] Technology has been considered as a form of knowledge in its own right quite apart from science.[9] But technology as a form of knowledge is just one of many facets of technology. Others include "its material manifestation, content and effects."[10]

Sociologists of technology have, in turn, concentrated on the social effects brought about by new technologies, reinforcing an often unspoken technological determinism which views technology as being developed apart from society with its own internal dynamic of growth. Technology has been seen as a 'black box' and technologies have been evaluated by their external effects, thus ignoring any intrinsic social relationships within the technology.[11] This view has been rejected by most modern scholars of technology and the determinist model replaced with an interactive model. In this newer model the social, economic, political, technological and scientific realms interact and cannot be considered as separate causative influences on one another.

The interactive model has been expressed in various ways. One way has been to view technologies as forming systems which embody the social, economic, political, technological and scientific. The various interpretations and perspectives of a technology can also be drawn out by considering the network of social groups who have an interest in it. Another way is to focus on technological decision makers and the various social, economic and political factors they consider in reaching their decisions, or to focus on the engineers or technologists themselves and to show how they draw all these elements together in technological innovation, design and practice.

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[6] David, Mowery & Nathan Rosenberg, 'The influence of market demand upon innovation: a critical review of some recent empirical studies', Research Policy 8, 1979, pp102-153.

[7] Thomas Hughes, 'The seamless web: technology, science, etcetera, etcetera', Social Studies of Science 16, 1986, pp281-92.

[8] Thomas Hughes, 'Emerging themes in the history of technology', Technology and Culture 7(3), 1979, p700.

[9] Edwin Layton, 'Technology as Knowledge', Technology and Culture 15(1), 1974, pp31-41; Edward Constant, 'Scientific theory and technological testability: science, dynometers, and water turbines in the 19th century', Technology and Culture 24(2), April 1983, pp183-198; Rachel Laudan, 'Conference Report', Technology and Culture 23(1), Jan 1982, pp78-80.

[10] Stewart Russell & Robin Williams, 'Opening the Black Box and Closing it Behind You: On Microsociology in the Social Analysis of Technology', revised version of paper to the British Sociological Association Conference Science , Technology and Society, Leeds 1987, p3.

[11] Brian Wynne, 'Unruly Technology: Practical Rules, Impractical Discourses and Public Discourses', Science and Technology Studies 18, 1988, p149.

Systems and Actor Networks

Thomas Hughes' study of electricity generating systems was a key work in the system view of technological development.[12] Hughes' technological system included physical artifacts, organisations, scientific components (including publications, research programs and university courses), legislative artifacts and natural resources.[13] The perception of technology as multi-faceted has been taken up by others. For example, Wiebe Bijker has defined a "technological frame" which would include current theories, tacit knowledge, engineering practice, specialised testing procedures, goals and practice and would involve various social groups to various degrees.[14] Similarly John Law[15] and Michael Callon[16] use the systems approach.

A technological system, Hughes argued, evolves and expands according to certain patterns. He identified several phases in the development of electrical power supply systems, including invention, development, technology transfer, and later stages during which critical problems were solved, conflicts resolved and the momentum of the system built up. Hughes' study served to highlight the many non-technical aspects of technological decision-making and development. In particular he showed how political factors were critical to the acceptance of a new system. He revealed how technologists concentrate their efforts on particular aspects of a developing technological system which they perceive as problematical and he clearly demonstrated the use of promotion and publicity by advocates of particular technologies.[17]

A notable contribution made by Hughes and his systems approach was incorporated in his concept of "technological momentum". As a technological system grows, he argued, it develops a mass which is made up of institutions and people who have a vested interest in maintaining the system. These include manufacturers who have invested in resources, labour and manufacturing plant for the system, educational institutions that teach the associated science and practice, research institutions, professional societies, as well as people such as engineers and managers who have invested their experience and expertise in the system. The system not only has mass but also direction; that is, development of the system proceeds along conservative lines that can be extrapolated. Changes in direction are resisted and radical inventions are unpopular because they deskill people, wipe out financial investments and stimulate anxiety in large organisations. When faced with a problem that threatens the stability of the system, the engineer, rather than considering building a new system, tries to

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12 Thomas Hughes, 'The evolution of large technological systems' in Wiebe Bijker, Thomas Hughes and Trevor Pinch (eds), The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology, MIT Press, 1987, pp51-82; Thomas Hughes, Networks of Power: Electrification in Western Society, 1880-1930. John Hopkins University Press, 1983.

13 Hughes, Networks of Power, p15.

14 Wiebe Bijker, 'The Social Construciton of Bakelite: Toward a Theory of Invention, in Bijker et al, The Social Construction of Technological Systems, pp159-190.

15 John Law, 'Technology and heterogeneous engineering: the case of Portuguese Expansion' in Bijker et al, The Social Construction of Technological Systems, pp111-134.

16 Michael Callon, 'Society in the making: the study of technology as a tool for sociological analysis' in Bijker et al, The Social Construction of Technological Systems, 83-106.

17 Hughes, 1983, Networks of Power.

rearrange or manipulate the system components or perhaps to incorporate a hostile environment.[18]

Law and Callon also highlighted the role of engineers, as system builders, in preventing the system from being radically changed. They argued that engineers view these systems as being constituted of a number of components which may be animate and inanimate ranging from people, to skills, to artifacts, to natural phenomena. The engineer puts up no barriers between the social, the economic and the political. The engineer, as system builder associates these disparate elements into a form that holds together. Law and Callon argued that engineers treat these various components or elements in the same way, always seeking to change the most malleable and adapting to take advantage of the most durable, in an effort to sustain and hold together the system and achieve the system goals. One thing which Law & Callon do not make clear is that the system goals may become more related to preserving the system than to realising the original goals that it was set up to achieve.[19]

Whilst Hughes looks at the development of a system, other authors have focussed on the original choice between competing technologies which may be at the basis of a technological system. The use of actor networks has been used to elaborate on the role and perceptions of various social groups in this choice. The key point that these analyses make is that the choice of a technology is not merely based on narrow economic and technical considerations, but involves social choice.

Trevor Pinch and Wiebe Bijker adopted this approach. Using the Empirical Programme of Relativism (E.P.O.R.), which argues that scientific knowledge is socially constructed, they put together an analogous programme called the Social Construction of Technology (S.C.O.T.). The interpretive flexibility attributed to scientific findings by the E.P.O.R. programme was applied to technological artifacts and it was consequently argued that various social groups could attribute very different meanings and problems to the one technological product or artifact and for each problem associated with the artifact there would be various possible solutions, including moral, judicial or technological solutions.[20]

The resolution of conflict between different social groups with differing preferences and perceptions cannot be attained in the same way that a consensus is attained within a scientific community. Pinch and Bijker argued that the stabilization of an artifact happens when the relevant social groups see the problem as being solved and that this can occur through rhetorical closure or redefinition of the problem.

Rhetorical closure may be achieved through claims in advertising or propaganda which are aimed at changing or shaping the meaning that various social groups attach to an artifact and thereby enrolling their support. Closure by redefinition can be procured by redefining the problem for which the artifact is then seen to be a solution.

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18 ibid.
19 Law, 'Technology and heterogeneous engineering'; Callon, 'Society in the making'
20 Pinch and Bijker, 'The social construction of facts and artefacts'

Both these forms of closure imply a degree of ultimate consensus which is not always present and Pinch and Bijker seem to ignore the ability of technologists and firms or authorities to force closure despite the objections of consumers or other interest groups which are in a less powerful position. Consumers are only able to exert influence where they have a choice to reject a particular technology through doing without it or choosing a better alternative.

Peter Weingart has observed that technological systems, even those producing consumer goods for the market, can be implemented without regard for public acceptance.

> The alliance of government bureaucracies, engineers and private corporations - the latter acting as quasi-public agencies by being subsidized directly or indirectly - circumvents the market and operates through the medium of political power. Consequently, non-acceptance of such technologies by the public can only find expression in political resistance, leading to legitimation problems with grave political rather than mere market failures.[21]

The same criticisms can be applied to Cowan's concept of the consumption junction. Cowan argues that technological choices can be elucidated by studying the consumer's point of view, finding out why consumers acted the way they did.[22] This only really works in the case of public sector technology if the consumer is considered to be the government or public authority who is paying for or instituting the technology, for it is they who interpret and weigh the views of the users. If the public as user is to influence the choice of a technology it is through the mediated perception of public servants and politicians.

Moreover, as Stewart Russell has pointed out, many alternative technologies are never presented to the consumer or outside social groups because of an internal selection process in the invention and innovation process. Those that are presented are already socially shaped and formed "the product of researchers' or designers' interpretation of need".[23] Making the same point in a different way Rosenberg and Mowery[24] and later Giovanni Dosi[25] pointed out that needs expressed through market signalling are not necessarily the prime movers of innovation.

Russell argued that the problem with the Pinch and Bijker scheme is that social groups are not located within a "structured and historical context"

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[21] Peter Weingart, 'The structure of technological change: reflections on a sociological analysis of technology' in Rachel Laudan (ed), The Nature of Technological Knowledge: Are Models of Scientific Change Relevant?, D.Reidel, 1984, p130.

[22] Ruth Schwartz Cowan, 'The consumption junction: a proposal for research strategies in the sociology of technology' in Bijker et al, The Social Construction of Technological Systems, pp261-280.

[23] Stewart Russell, 'The social construction of artefacts: a response to Pinch and Bijker', Social Studies of Science 16, 1986, p343.

[24] Mowery & Rosenberg, 'The Influence of Market Demand upon Innovation'

[25] Giovanni Dosi,'Technological paradigms and technological trajectories', Research Policy 11, 1982, p148.

and therefore the economic, political and ideological constraints and influences acting upon those groups are not taken into account. For this reason Pinch and Bijker failed to explain, for example, "why a workforce is excluded from the design of equipment it must use, or why a population suffering harm from a toxic effluent cannot bring about the adoption of a different chemical process."[26]

The mechanisms by which a particular alternative or artifact succeeds at the expense of other competing alternatives, therefore, remains unclear if consideration is only given to the various meanings attributed to that artifact. The reason that one set of artifactual interpretations triumphs over others still needs to be examined. The ideas of "rhetorical closure" and "redefinition" may well be generalizable tactics employed in technological controversies, but why some groups are able to apply them more effectively than others is the crucial question.

Emphasis on interpretive flexibility and negotiation can all too often lead to a neglect of the question of power, especially power in its material forms which enables some groups to control negotiation and sometimes arbitrarily limits interpretive flexibility. Politics and the uneven distribution of power and influence between social groups and actors make any simplistic view of a consensus process difficult to defend. In most technological controversies the role of vested interest groups, engineers and government authorities in shaping or overriding the views of less influential social groups needs to be considered.

Engineers, Expertise & Influence

The power of engineers and government authorities in engineering decision making arises in part from the power that is accorded to government but also in part from the use which governments make of the authority which the community vests in its experts. The body of literature on expertise and its use is therefore relevant once the role of power in technological decision making is recognised. Even if one accords a more even spread of power between social groups interested in a technology, the use of experts in enrolling groups, redefining the problems or in rhetorical closure is essential.

Much was written in the 1970s on the use of experise by people in power by authors such as Benveniste[27], Elliot & Elliot[28], King and Melanson[29], Mazur[30], Macrae[31], Primack & von Hippel[32], Sklair[33] and Nelkin[34]. Dorothy Nelkin has

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26 Russell, 'The social construction of artefacts', p336.

27 Guy Benveniste, The Politics of Expertise, Croom Helm, London, 1972, p62.

28 David Elliot & Ruth Elliot, The Control of Technology, Wykeham Publications, 1976.

29 Lauriston King & Philip Melanson, 'Knowledge and Politics: Some experiences from the 1960s', Public Policy xx, Winter 1972, pp83-101.

30 Allan Mazur, 'Disputes Between Experts', Minerva xi(2), April 1973, pp243-262; Allan Mazur, 'Opposition to Technological Innovation', Minerva xiii(1), Spring 1975, pp58-81.

31 Duncan MacRae Jr, `Technical communities and political Choice', Minerva xiv(2), Summer 1976, pp169-190.

32 Joel Primack & Frank von Hippel, Advice and Dissent: Scientists in the Political Arena, Basic Books, New York, 1974.

33 Leslie Sklair, 'Science, technology and democracy' in Godfrey Boyle, David Elliot & Robin Roy (eds), The Politics of Technology, Longman & Open University Press, 1977.

written extensively on the subject. She has observed that it is not only knowledge, but also assumptions of rationality and objectivity, which lead the public to look to the experts for advice and solutions. She argued that government decisions are often defined as technical decisions and the issues at stake also as primarily technical. This is more comfortable for the policy makers.[35] In this way, the decision appears to be subject to objective criteria that can be evaluated by the experts using economic and scientific models, calculations and statistics.[36] Difficult issues such as conflicting interests do not have to be resolved and the alternatives can be compared solely on the basis of cost and effectiveness in solving the immediate problem.[37] Defining a problem as technical also conveniently hides the political choice and priorities involved and reduces the debate to arguments over technical details.[38] Proposals can be "thrust upon the public as if they were non-controversial technical decisions".[39] Unspoken objectives such as maximising economic growth and priorities afforded to industrial concerns do not become explicit.[40]

Leslie Sklair also noted the tendency of policy makers to want to keep issues confined to technical discussion, and in so doing avoid making their objectives and priorities explicit whilst ensuring that any argument is confined to an arena in which experts have authority. If it is admitted that a decision has social and political dimensions then it is much more difficult to maintain that only scientists and technologists should discuss and influence it.[41]

Various writers have observed how those in power use experts to legitimate decisions. Lauriston King and Philip Melanson noted that decision-makers can make use of the esteem given to experts in order to justify, legitimate and gain acceptance for their decisions.[42] This does not mean, they said, that the technical considerations are foremost in making the decision. Rather "specialised knowledge merely becomes another weapon in the decision-maker's political arsenal".[43]

Similarly Joel Primack and Frank von Hippel argued that legitimation might merely involve invoking an authority as a substitute for evidence[44] or informing the public that the policy maker has consulted eminent experts, even if in fact the experts did not whole-heartedly support the proposal but reported confidentially so no one knows the difference. Instances have been reported

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[34] For example Dorothy Nelkin, 'Scientists in an environmental controversy', Science Studies 1, 1971, pp245-261; Dorothy Nelkin, `The political impact of technical expertise', Social Studies of Science 5, 1975, pp35-54; Dorothy Nelkin, ed, Controversy: Politics of Technical Decisions, Sage Publications, 1984.

[35] Nelkin, `The political impact of technical expertise', p36.

[36] Nelkin, Controversy, p18.

[37] Nelkin, `The political impact of technical expertise', p36.

[38] Harvey Brooks, `Scientific concepts and cultural change', Daedalus 94(1), Winter 1965, p68.

[39] Dorothy Nelkin & Michael Pollack, `The politics of participation and the nuclear debate in Sweden, the Netherlands, and Austria', Public Policy 25(3), Summer 1977, p355.

[40] Nelkin, 'Scientists in an environmental controversy', p254.

[41] Sklair, 'Science, technology and democracy', p174.

[42] King & Melanson, 'Knowledge and Politics', pp88-9

[43] ibid., p100.

[44] Primack & von Hippel, Advice and Dissent, p72

where officials have selectively published expert reports, have summarised expert reports in a misleading way, have lied about expert reports, have suppressed information available only to them or have manipulated their advisers to ensure a favourable report.[45]

Duncan Macrae also pointed out that often a decision about a proposal will precede the detailed investigations, feasibility studies and environmental impact statements which are supposed to be enquiring into that proposal.

> It is common for heads of organisations and their advisers to accept that their task is to authenticate or justify the policies previously chosen and to deny the validity of the arguments introduced in support of the alternative recommendations made by others.[46]

This requires that investigations be selective and damaging evidence be suppressed.[47] Nelkin too agrees that technical advice can be slanted by using different criteria for collecting data and interpretations and studies based on diverse premises will require different sampling techniques.[48]

Guy Benveniste, in The Politics of Expertise, argued that one should not assume that experts are fooled by the pretensions that a problem is totally technical. Most engineers are fully aware of the political dimensions of the decisions they make and the advice they give but they cannot make those political dimensions explicit for fear of undermining the faith others have in expertise.[49] They must appear to be apolitical for, after all, they are not elected and it is their perceived neutrality which allows them to have power.

> a principal function of the apolitical definition of the policy expert's role is the exact opposite of the definition: it provides access to social power without political election.[50]

Benveniste also notes that organisations are able to consolidate a monopolistic position by either acquiring widespread external professional consensus on their proposals or by "creating a large integrated research team whose advice cannot easily be dismissed".[51] When widespread consensus is not feasible, organisations can limit outside interference by resorting to secrecy or by not allowing the public enough time to study the huge amount of research data that it has produced before the decision is made.[52]

Similarly King & Melanson pointed out that expertise is not equally available to all those who might wish to use it to support their case and it thus becomes an "instrument of power and privilege".[53] Sklair also argued that public access to

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45 Primack & von Hippel, Advice and Dissent, pp34-5.
46 MacRae, `Technical communities and political Choice', p177.
47 ibid., p177.
48 Nelkin, `The political impact of technical expertise', p45
49 Benveniste, The Politics of Expertise, p62.
50 ibid., p65
51 ibid., p126.
52 ibid., p128.
53 King & Melanson, 'Knowledge and Politics', p100

debate is further limited by the use of specialist jargon and making reports overbearingly and unnecessarily technical and esoteric.[54] Nelkin said that by hiring their own experts opponents of a technological project can either question the evidence put forward by government experts or point to evidence that has been ignored. Debate, however, tends to remain focussed on technical issues rather than the conflicts over values and priorities which are really at the heart of any disagreement.

> Thus power hinges on the ability to manipulate knowledge, to challenge the evidence presented to support particular policies, and technical expertise becomes a resource exploited by all parties to justify their political and economic views. In the process, political values and scientific facts become more difficult to distinguish.[55]

More recently authors such as Barry Barnes[56], David Edge[57], David Dickson[58], Arie Rip[59] and Michael Pollack[60] have also contributed to the literature on experts, covering much of the same ground in new ways. Barnes and Edge demonstrated how the credibility of experts cannot be established by strictly logical arguments and that credibility depends upon the consensus between experts; where experts disagree their influence is weakened. Moreover they argued that power is not only achieved by access to expertise but also by being able to define rationality, define who are the experts and the bounds of their expertise and by being able to control the terms of disputes.[61]

Barnes highlighted the way our society has come to rely on and trust experts because of the impossibility of examining each argument and claim on its merit alone. The "high division of intellectual labour" in our society means that it is necessary to grant authority to knowledge specialists.[62] However he went on to show how the authority of science is extended beyond its accepted bounds and how some experts merely "take on the trappings of science, its symbols and rituals, and thereby seek to clothe themselves in scientific authority." [63]

As previous writers have done Barnes pointed to the ways in which experts are called upon to provide justifications and legitimations rather than technical knowledge. But he went on to argue that the rewards and privileges the expert gets for his/her role in the decision-making process are accompanied by a price of anonymity and confidentiality. Experts must pass all their information upwards to those in power and keep it from the rest of society, thereby ensuring that they are subservient to those in power and are unable to use their information for

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54 Sklair, 'Science, technology and democracy', p173

55 Nelkin, Controversy, p17

56 Barry Barnes, About Science, Basil Blackwell, 1985.

57 Barry Barnes & David Edge, eds, Science in Context: Readings in the Sociology of Science, Open University Press, Milton Keyes, 1982.

58 David Dickson, The New Politics of Science, Pantheon Books, New York, 1984.

59 Arie Rip, 'Experts in Public Arenas' in Harry Otway & Malcolm Peltu (eds), Regulating Industrial Risk, Butterworths, 1985, pp94-110.

60 Michael Pollack, 'Public Participation' in Otway, Regulating Industrial Risk, pp76-93.

61 Barnes & Edge, Science in Context, introduction to part 5.

62 Barnes, About Science, p83.

63 ibid., p96.

other ends. Their own role and that of the public in the decision making is thereby restricted.[64]

Dickson recognised two approaches when dealing with technological controversies. The 'technocratic approach' is the search for a rational solution agreed to by experts and requires solutions to "display both technical efficiency and economic rationality". The 'democratic approach' seeks to maximise participation in decision making and argues that a redistribution of power is just as likely to achieve a favourable outcome as anything the experts will come up with; humane and socially just solutions are sought.[65] Whilst there was increasing pressure for the second approach to be taken, those in power have done their best to gain control of and limit the possibilities of such mechanisms as technology assessment, which were supposed to meet the demands for greater participation in setting technological goals.[66]

Dickson also argued that a move towards a greater role for science in regulation has been used as a way of hindering and manipulating regulation by demanding proof and certainty where uncertainties and judgements are involved and by defending decisions on the grounds that they were dictated by science when political factors influenced the decision.

> arguments about rationality are used to limit the substantive content and impact of rationality itself-or, more accurately, to defend restrictions on regulations against external criticism.[67]

The politics of expertise literature, clearly recognises that technological decision-making is a social and political activity which is often portrayed as a purely technical process. However much of this literature focuses on scientists rather than engineers, and often scientists employed in the role of adviser rather than on engineers employed to design and execute technological projects and to defend the choice of technology in that project. Moreover,there is a tendency to place the expert in a subservient role as adviser and to concentrate on the policy maker as decision maker without exploring the extent to which the relationship is a two way process in which an expert may attempt to manipulate the politician and influence the decision by exploiting the dependence of the politician on him/her for information. Because of this the ideologies or values of that expert are not examined.

This latter angle, with respect to engineers, is covered more fully in the sociological literature. There have been various studies of the social backgrounds of engineers, their personalities, qualities, interests, attitudes, reasons for choosing engineering, professional associations, their work situations and even their ethics.[68] There has been relatively little study of engineers and their

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64 ibid., p100.

65 Dickson, The New Politics of Science, pp219, 264-5.

66 ibid., pp219-256.

67 ibid., p264.

68 For example Robert Perrucci & Joel Gerstl (eds), The Engineers and the Social System, John Wiley & Sons, 1969; J.E.Gerstl & S.P.Hutton, Engineers: The Anatomy of a Profession, Tavistock Publications, 1966; Stanley Hutton & Peter Lawrence, German Engineers: The Anatomy of a Profession, Clarendon Press, 1981; E.G.Semler (ed), The Engineer and Society,

history.[69] Two notable works in this area, which have attempted to elucidate the ideology and social relationships of engineers through the study of the history of the engineering profession, have been Edwin Layton's The Revolt of the Engineers[70] and David Noble's America by Design.[71]

Layton traced the emergence of a professional identity amongst engineers which embraced three key elements; the engineers' self-image as agents of technological change and progress, as unbiassed logical thinkers, and as socially responsible for ensuring the benevolence of technological change. Layton argued that the engineering ideology, which emphasised the superiority of engineers, was accompanied by a dissatisfaction with status and the lack of autonomy of engineers in their work. Engineers felt they were well suited to be society's leaders, to control public works and to solve social problems by the application of logic and scientific principles. This ideology was distinctly elitist and hierarchical. Engineers did not have great faith in democracy and felt that some people were better able to judge things than others.

A more recent study of American and Canadian engineers specialising in water resources problems found that this ideology persists. Engineers were sceptical about involving the public in their decisions. The public were seen to be ill-informed and irrational with such a wide range of opinions that decision-making became impossible. The engineers considered themselves to be more effective decision-makers than other professionals because they were "precise and accurate" and took a practical view rather than an idealistic one.[72]

Sociological studies have also studied what professionalism means to engineers. Kenneth Prandy concluded that professionalism, in the case of engineers, was an expression of a status ideology that, unlike the ideology of class consciousness, accepted the "employers' ideology of stratification". Engineers accepted the existing hierarchical relationships within society because they were "employed in positions in which they either share directly in the exercise of authority, or in which their work gives them the feeling of being close to management."[73] Put another way, technologists support a social system which grants favour and influence to educated elites.[74]

Layton similarly concluded from his historical study that engineers have unquestioningly accepted "the structure, power and basic ideological principles of business."[75] Noble went one step further in saying that engineers have not only

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Institution of Mechanical Engineers, London, 1973; Robert Perrucci & Joel Gerstl, Profession Without Community: Engineers in American Society, Random House, New York, 1969.

69 Hughes, 'Emerging Themes in the History of Technology', p703.

70 Edwin Layton Jr, The Revolt of the Engineers: Social Responsibility and the American Engineering Profession, Cape Western Reserve University, Cleveland and London, 1971.

71 David Noble, America by Design: Science, Technology and the Rise of Corporate Capitalism, Alfred A Knopf, New York, 1977.

72 W.R.Derrick Sewell, `The role of perception of professionals in environmental decision-making', in Keith Attenborough et al (eds), Pollution: the Professionals and the Public, Open University Press, 1976, p151.

73 Kenneth Prandy, Professional Employees: A Study of Scientists and Engineers, Faber & Faber, London, 1965, p185.

74 Stuart Umpleby, 'Is greater citizen participation in planning possible and desirable?' in Boyle et al, The Politics of Technology, p234.

75 Layton, The Revolt of the Engineers, p67.

incorporated capitalist values but also came into being expressly to serve the purposes of the capitalist.[76] In a later book Noble argues that technical people rely upon their ties with power because it is access to power and resources that allows them to dream big and have their designs built.[77] It is no accident, he said, that the best engineering designs are well suited to the requirements of those in power. Noble also claimed that science and technology were about control, manipulation of nature and the construction of devices to improve human power over events. Engineers can hardly help themselves from getting all caught up in such endeavours "propelled by enthusiasm and a will-to-power".[78]

Two recent sociological studies of engineers by Peter Whalley and Robert Zussman also conclude that the engineers in their studies have incorporated business values. Zussman argues that "cost is itself a criterion of technical efficiency" which must be considered along with the physical properties of the materials. Engineering is viewed by engineers as a means to achieve corporate goals rather than an end in itself.[79] An earlier study by Richard Ritti also found that engineers placed greater importance on having the opportunity to help their employing company increase its profits than on any technical goals such as exploring new technologies or establishing their own professional reputation.[80] Whalley suggests that engineering employees "are socialised and selected from the beginning to accept the legitimacy of both bureaucratic authority and the dominance of business values." These are secured by a career structure which rewards the trustworthy.[81]

Most studies of engineering ideology and behaviour have focussed on engineers working in private industry rather than in the public sector and there still remains the question of whether engineers who do not work in the private sector still incorporate or even sympathise with business values, whether they take on just as easily the values of their employer if that employer is a government body; and to what extent economic measures of performance prevail.

Engineering Practice

The sociological and historical material on engineers highlights the ideologies and values and alliances of engineers. But most studies of engineers have not attempted to link their findings with the content of engineering design.[82] Also very little work indeed has been done on the philosophy of engineering compared with the vast studies in the philosophy of science.

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[76] Noble, America by Design, p34.

[77] David Noble, The Forces of Production: A Social History of Industrial Automation, Knopf, New York, 1984, p44.

[78] ibid., p46.

[79] Robert Zussman, Mechanics of the Middle Class: Work and Politics Among American Engineers, University of California Press, 1985, pp121-3.

[80] Richard Ritti, The Engineer in the Industrial Corporation, Columbia University Press, 1971, pp48-9.

[81] Peter Whalley, The Social Production of Technical Work: The Case of British Engineers, MacMillan, 1986, p124.

[82] Donald, McKenzie & Judy Wajcman (eds), The Social Shaping of Technology: How the Refrigerator Got Its Hum, Open University Press, 1985, pp297-8..

Engineers have power in the shaping of technology from two different sources. As experts they can align themselves with those in power and as the originators and designers of technology they occupy a central position in the shaping of technologies before they are even subject to wider debate and competition. Even after the technologies are conceived, in a very real sense many of the views and interpretations of the other social actors are filtered and reinterpreted through the perceptions of the engineers who continue to design and reshape the technologies and decide on their configurations.

Some writers have considered the design process itself. J.Christopher Jones[83] and Christopher Alexander[84] examined pre-engineering design methods to highlight some of the key features of modern design. These authors noted the increasingly self-conscious nature of design, the distancing of design from construction, the consequent division of labour, the need to use models, both physical and abstract, and the increasing removal of the designer from the context of their work.

Eugene Ferguson observed the move away from non-verbal thinking to more analytical and scientific modes of thought as drawing the engineer away from the "complexities of the real world". He suggested that too much emphasis on analysis could leave the way open for stupid mistakes and wrote of the "chaos that results when design is assumed to be primarily a problem in mathematics."[85]

Arnold Pacey also regretted the way design seems to be divorced from the end use context of technological products. He argued that engineers overemphasise construction and neglect maintenance, operation and use. This occurs, he said because of the orientation towards problem solving rather than problem prevention amongst technologically trained experts. He also noted that maintenance work, unlike construction, is inconspicuous, routine, repetitive and even tedious work.[86] Henry Petroski singled out the use of computers in particular as further increasing the separation of the designer from the context of their work and from an intuitive grasp of whether computed results are realistic. Engineers, he said, can gain an "unwarranted confidence" in the numbers they come up with using their computer models.[87]

Petroski', in <u>To Engineer is Human</u> gave an important insight into the experimental nature of engineering design. He pointed out that engineering construction is uncertain by its very nature and that engineers learn more from failures than from successes. He explained how engineers are always trying to reduce the cost of their structures by reducing the materials used and this causes a tendency to reduce safety factors when a design method appears to be continuously successful. In this way "successful structural concepts devolve into

[83] J.Christopher Jones, <u>Design Methods: Seeds of Human Futures</u>, 1980 edition, John Wiley & Sons, 1980.

[84] Christopher Alexander, <u>Notes on the Synthesis of Form</u>, Harvard University Press, 1970.

[85] Eugene Ferguson, 'The Mind's Eye: Nonverbal Thought in Technology', <u>Science</u> 197(4306), 26 August 1977, pp834-5.

[86] Arnold Pacey, <u>The Culture of Technology</u>, Basil Blackwell, 1983, chapter 3.

[87] Henry Petroski, <u>To Engineer is Human: The Role of Failure in Successful Design</u>, St Martins Press, New York, 1985, chapter 15.

failures."[88] D.I.Blockley makes the same observation about design rules. He says that in time a design rule may be extended under economic pressures "until an accident occurs which will define the boundary of its use." [89] Both Petroski and Blockley are structural engineers who apply their analysis to structural engineering. However, other writers have also emphasised the experimental nature of engineering in general.[90]

Recent scholars in the field of technology studies have looked to the parallel but more developed field of history and philosophy of science for approaches to their work. For example, Kuhn's work on the nature of scientific revolutions and the every day, "normal" work of scientists[91] has been found to yield analogies in the area of technological change and engineering practice. Edward Constant, [92] David Wojick[93] and Giovanni Dosi[94] have made notable contributions in this vein.

Constant argued that the routine work of engineers and technologists, which he called 'normal' technology, involves the "extension, articulation or incremental development" of existing technologies. A technological tradition, Constant said, is subscribed to by engineers and technicians who share common educational and work experience backgrounds. The tradition relates to a field of practical endeavour rather than to any academic discipline.[95] Rachel Laudan argued that the function of traditions is to allow technologists to focus on potentially solvable problems and to provide the methods with which to solve those problems.[96]

Dosi described a technological paradigm as "an "outlook", a set of procedures, a definition of the "relevant" problems and of the specific knowledge related to their solution."[97] Such a paradigm, Dosi said, embodies strong prescriptions on which technological directions to follow and ensures that engineers and the organisations for which they work are "blind" to certain technological possibilities. Dosi identified a technological paradigm in four dimensions. The first related to the generic tasks to which it is applied and the second to the material technology it selects. The third related to the physical/chemical properties it exploits and the fourth dimension was the technological and

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88 ibid., p163.

89 D.I.Blockley, The Nature of Structural Design and Safety, Ellis Horwood, Chichester, 1980, p75.

90 Mike Martin & Roland Schnzinger, Ethics in Engineering, McGraw-Hill, 1983; Jerry Gravander, 'The Origin and Implications of Engineers' Obligations to the Public Welfare', PSA 1980 2, 1980, pp443-55.

91 Thomas Kuhn, The Structure of Scientific Revolution, 2nd edition, University of Chicago Press, 1970.

92 Edward, Constant, 'Communities and hierarchies: structure in the practice of science and technology' in Rachel Laudan (ed), The Nature of Technological Knowledge: Are Models of Scientific Change Relevant?, D.Reidel, 1984.

93 David, Wojick, 'The structure of technological revolutions' in George Bugliarello & Dean Boner (eds), The History and Philosophy of Technology, University of Illinois Press, 1979.

94 Dosi, 'Technological Paradigms and Technological Trajectories'.

95 Constant, 'Communities and hierarchies', p29.

96 Rachel Laudan, 'Cognitive change in technology and science' in Laudan, The Nature of Technological Knowledge, p95.

97 Dosi, 'Technological Paradigms and Technological Trajectories', p148.

economic dimensions and tradeoffs which are associated with it. These tradeoffs, he said, provided the direction for improvement of the technology.[98]

Richard Nelson and Sidney Winter also observed that there is sometimes a technological "regime" or paradigm operating which relates to the technicians beliefs about what is feasible or at least worth attempting. They put forward a more convincing explanation of why technological change within a paradigm seems to follow certain directions.

> The sense of potential, of constraints, and of not yet exploited opportunities, implicit in a regime focuses the attention of engineers on certain directions in which progress is possible, and provides strong guidance as to the tactics likely to be fruitful for probing in that direction. In other words, a regime not only defines boundaries, but also trajectories to those boundaries.[99]

In many cases, Nelson and Winter argued, those directions involve improvements to major components of a system. Similarly Laudan said that problems tackled within a tradition tend to be those of cumulative improvement.

There seems to be some confusion in various accounts of technological development between technological research and technological practice. Nelson and Winter's notion of a technological regime, and to a lesser extent Constant and Dosi's concept of a paradigm, seem to focus on the research and development of technology rather than its application. But the idea of a technological regime or paradigm is even more appropriate to the practice of engineering where the practitioner seeks to apply a selected technology in a specific location and situation. The paradigm or regime defines the range of technologies which such an engineer draws upon for such purposes and therefore determines 'normal' practice.

Wojick concentrated more on engineering practice in his description of technological paradigms and he said that 'normal' technology involved the "artful application of well-understood and well-recognised decision-making procedures". In this way there is no ambiguity or doubt about what counts as a good solution within the engineering community.[100]

Not all writers agree about the degree to which Kuhn's work can be applied to technology. It is generally agreed that the work of engineers exhibits some of the qualities of "normal" science in that research is generally of a gradual cumulative nature, making improvements on past achievements and that solutions are sought from within a restricted range of possible solutions. Similarly practice is based on applying the appropriate technological methods from an arsenal of "tried and true" methods. The main points of contention have been whether the idea of a technological paradigm as a "supertheory" or even a set of shared beliefs, values and techniques, is too vague, whether a

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98 ibid.

99 Richard Nelson & Sidney Winter, 'In search of useful theory of innovation', Research Policy 6, 1977, p57.

100 Wojick, 'The structure of technological revolutions', p241

paradigm must be based on an exemplar[101] and whether a technological community is analogous to a scientific community.

The problems with the application of Kuhn's concept of paradigms and scientific revolutions to technology come to the fore when applied to paradigm change or the "technological revolution" that would be analogous to the scientific revolution. Kuhn argued that scientists become aware of anomalies in the paradigms they are working within when there is a recognition by scientists that "nature has somehow violated the paradigm-induced expectations".[102] Contradictions between theory and reality are not sufficient to dislodge an engineering paradigm which is, after all a social construction. The utility of such a social construction having been socially negotiated, the interested parties must then agree about its disutility.

A similar problem is associated with the systems approach. Hughes has coined the term "reverse salient" to describe the situation where components fall behind or out of line as a technological system evolves. This impedes the growth of the whole system.[103] Hughes argued that when a reverse salient can't be corrected within the context of the existing system then the problem becomes radical and the solution may bring about a new and competing system. Whilst engineers perceive their technologies to be successful, to "work", their traditional practice is reconfirmed and the incentive to have such a perception is great. MacKenzie argued that reverse salients depend on goals, actors and what is solvable. Moreover, because the rewards from solving critical problems are great, there is a tendency to identify as critical those problems which are seen by the engineers to be solvable.[104] "Critical" anomalies and "incorrectable" reverse salients are designated as such by the actors involved, they are not in the nature of the world or the system.

Nonetheless some writers have tried to make analogies with Kuhn's concept of anomalies. Constant identified "presumptive anomalies" which are presumed to exist when it is predicted by the engineer that a conventional technology will fail under certain future conditions or it is predicted that an alternative technology will do a better job. The second type of anomaly which Constant identified is the "functional-failure" when the technology does not work very well because conditions have changed, allied technologies have changed or other parts of the system have advanced more quickly.[105]

This difficulty in identifying when a technology is working satisfactorily was recognised by Wojick who defined technological paradigms in terms of an "evaluation policy" which enables engineers and managers to judge their designs and plans. Such evaluation policies, which may be based on scientific theory, engineering principles, rules of thumb, legislation,

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101 Gary Gutting, 'Paradigms, revolutions, and technology' in Laudan, The Nature of Technological Knowledge, pp48-49; MacKenzie & Wajcman, The Social Shaping of Technology, pp11-12.

102 Kuhn, The Structure of Scientific Revolutions, p52.

103 Hughes, Networks of Power, pp79-80.

104 Donald MacKenzie, 'Missile Accuracy: A Case Study in the Social Proceses of Technological Change', in Bijker et al, The Social Construction of Technological Systems, pp197-8.

105 Constant, 'Communities and Hierarchies', p31.

professional standards or moral precepts, determine decision-making procedures within which "normal technology" can take place.[106]

Anomalies occur in such paradigms, Wojick argued, when standard procedures repeatedly "fail to eliminate known ills" or when knowledge shows up the importance of factors which have previously been incorrectly evaluated. Those contesting the evaluation policy may be outside the paradigm community and their view may be disputed. They can then, Wojick says, turn to the government for a ruling.

Constant referred to traditions of testability which may play a role in defining and sustaining specific traditions of technological practice. Such traditions embody norms such as the overt commitment to objective, scientific, replicable and public testing. He argued that traditions of technological testability permit practitioners to know which designs and modifications represent progress by helping them to see how closely they are approaching the ideal.[107]

John Law argued that just because a technology "works" does not mean that it is beyond explanation; what counts as working has to be socially negotiated.[108] Similarly Ruth Schwartz Cowan pointed out that the criteria for "betterness" vary depending on the domain of interest.[109] Trevor Pinch and Wiebe Bijker criticise previous studies of technology because of their asymmetrical focus on "successful" technologies. They argue that whilst there is a need to explain the success of an artifact, equal treatment should be given to technologies which have been discarded. Understanding failure is a crucial element in understanding technology.[110]

STRATEGY OF THIS THESIS

The various bodies of literature, as outlined above are not particularly contradictory and in fact many of the central themes are common to each of them. Their main differences lie in their focus. The literature on competing technologies is most relevant to a stage of technological development before a technological system or paradigm has been set up. At this point vested interests are minimised and professional control is weak or non-existent. The theoretical perspectives provided by this literature are most appropriately used at the initial stages of the development of a sewerage system and, in particular, prior to the consolidation of the sewerage engineering profession.

The key concern of the work on competing technologies is that equal attention must be given to failed technologies if we are to understand technological development. In keeping with this I will not be confining attention to those technologies which were implemented but also considering those which were

106 Wojick, op.cit., p240.

107 Edward Constant, 'Scientific theory and technological testability: science, dynometers, and water turbines in the 19th century', Technology and Culture 24(2), April, 1983, pp195-6.

108 John Law, 'International workshop on new developments in the social studies of technology'. *4S Review*. vol 2. no4, 1984; p9.

109 Cowan, 'The Consumption Junction', p273.

110 Pinch and Bijker, 'The social construction of facts and artefacts', pp405-6.

only discussed, and also those which were tried but later discarded, in particular the debate between water-carriage technologies and dry conservancy technologies for collection of sewage and between various means of treating sewage (chapters 2 & 3). A major weakness in the technology studies literature is in the descriptions of closure, or how disputes are settled, in particular, how various parties are enrolled, the attempts to manipulate public opinion and the use of power and privilege. These are all aspects which will be explored in this thesis. In doing this I will be considering the various interpretations that different people gave to proposed sewerage technologies and uncovering the process by which the interpretations of one group came to dominate and win over the others.

The thesis will also explore the on-going development of a technology once it becomes dominant and subsequently becomes entrenched and will therefore draw on the complementary literature on technological systems and paradigms. I will also be making use of the literature on the history and sociology of engineers and on the politics of expertise to cover political and sociological dimensions that is often neglected by the systems/paradigm approach. The thesis will also consider the translation of ideas into physical artifacts by engineers and seeks to contribute in this way to the newly emergent philosophy of technology literature.

The way I intend to integrate these fragmented bodies of literature is shown in figure 2 on the next page. Of course, such a diagram merely shows how various studies of technology will be fitted together and says nothing about the relationships between the parts, including the various people and social groups, bodies of knowledge, legislation etc. It is hoped that these relationships will become clearer as the case study presented in this thesis unfolds.

The sewerage system will be considered as a technological system to include relevant legislation, administration, education, and organisation. In particular, I will be interested in how these elements of the system defined the problems which the developments in Sydney's sewerage system were supposed to deal with and constrained the technological solutions. The paradigm perspective will be considered by examining whether a sewerage engineering 'paradigm' limited the range of possible solutions considered by engineers.

In particular, the vexed question of just how much control engineers have in shaping and choosing technologies is central to this thesis. One of the key points at issue in recent studies of technology is just how central the engineers are. On the one hand, Law, Callon & Hughes put the system builder at the centre of their studies and the system builder is either the engineer or the organisation for which the engineer works. On the other hand, some writers have put the engineer on a par with other players, or stressed the subordinate role of the engineer as employee. It is hoped that the detailed examination provided in this case study will illuminate the role of the engineer further, although there may be basic differences between various types of technological system that may limit the application of this case study.

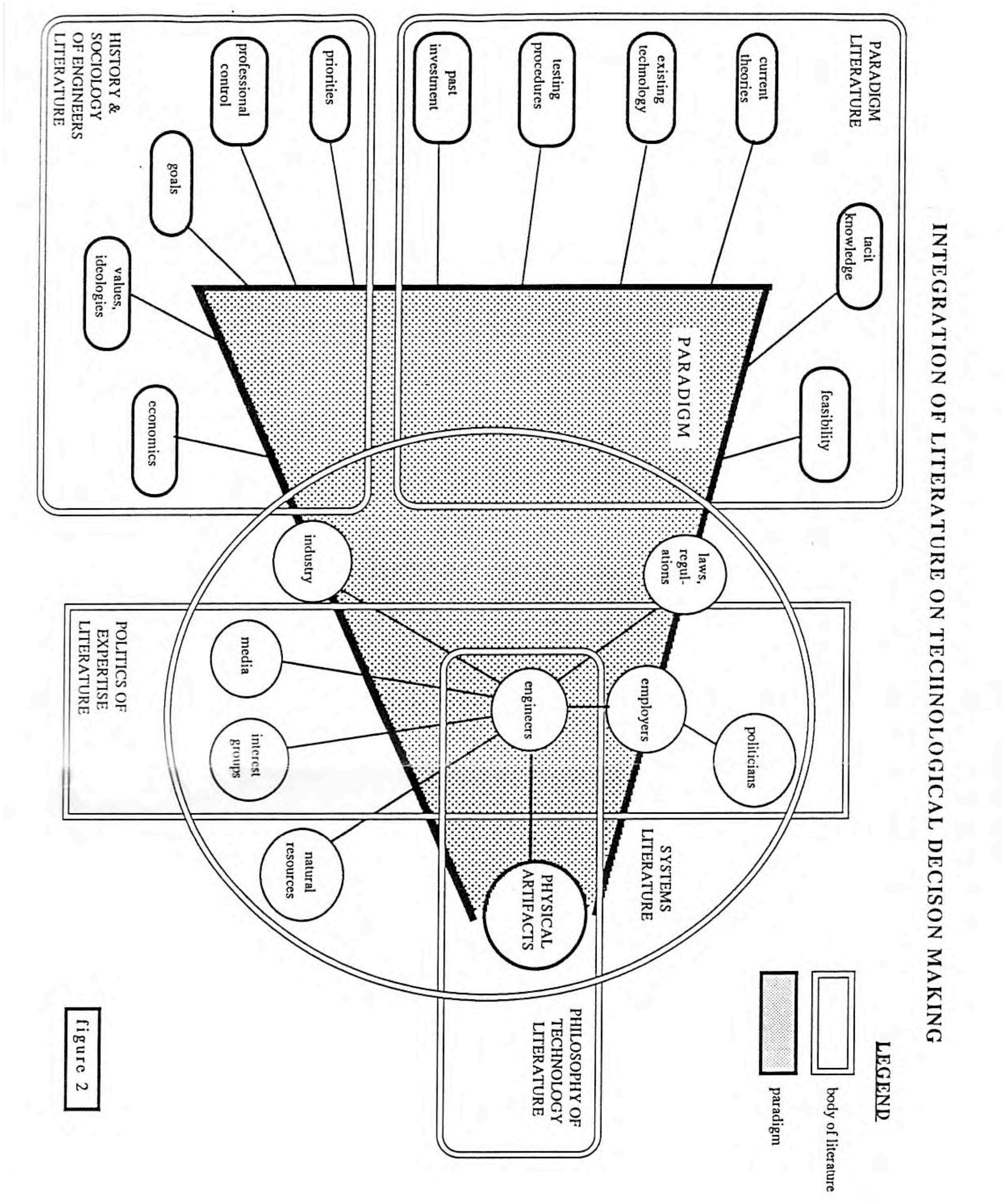

Figure 2 is an attempt to show the relationships between various bodies of literature that deal with technological development. The paradigm is featured as a triangular shape to show the narrowing range of options that are considered by those who subscribe to a paradigm. The form and direction is shaped by various factors that are shown feeding into the base of the triangle that represents the paradigm. These factors include cognitive and technical factors which are discussed in the literature on paradigms but also social, economic and political factors that are covered in the literature on the history and sociology of the engineering profession. The social groups involved and non-human components of a technological system all influence the engineers, who conceive, design and shape the physical artifact. The engineer is therefore shown at the centre of the system, completely embedded in the paradigm. Others components of the system are partly embedded in the paradigm because of their varying degrees of commitment to the paradigm. Whilst the systems literature covers all components of the system, the literature on the politics of expertise focuses on the relationship between policy makers, experts and the public and the literature on the philosophy of technology literature focuses on the relationship between the engineer and the engineering product.

This thesis will not only consider the social construction of technological knowledge but also the social construction of prediction and evaluation mechanisms. This is a problem which is pointed to in various recent studies but has not been sufficiently analysed is the question of how a technology is evaluated: what counts as "working", how problems are identified and recognised. These questions are all central to understanding technological change, whether it be the introduction of a new system or a new paradigm. Closely related to this is the question of prediction: how knowledge of a particular technology and how it will work is constructed. Whilst much work has been done on the social construction of scientific knowledge, little has been done on the social construction of technological knowledge, partly because technological knowledge does not purport to seek truth, only to produce products that "work".

In discussing the issue of the social construction of knowledge, I have made my own personal judgements about how Sydney's submarine ocean outfalls will "work" and drawn my own conclusions from the data presented in the various engineering reports. This poses difficulties for analysis, because I have been unable to remain detached from the debate. This problem, which all analysts must face, means that I have focused on and been more critical of the knowledge claims and predictions of government engineers more than those opposing them. Any resulting impression that government engineers or consultants are somehow perverting the practice of engineering or that different engineers in their position would have reached "the right conclusions" is unintentional. I am merely seeking to show the way engineering knowledge is purposefully shaped.

The role, rhetoric and action of all relevant social groups will be discussed, especially that of the public authorities, politicians, engineering employees, engineering societies, industry representatives, environmentalists, media and public protest groups. Rather than taking arguments at face value, I will be attempting to differentiate between actual goals and rhetorical justifications. The literature on the history and sociology of engineers is relevant here, as is the literature on the politics of expertise and public participation.

The next chapter, then, sets the scene in terms of developments in sanitary reform in Australia and abroad, and examines the values, goals and priorities behind the sanitary reform movement and the pressure for a public sewerage system.

CHAPTER 1

SANITARY REFORM & CONTROL OF THE MASSES

During the nineteenth century, consciousness about the physical environment and its effect, not only on the health but also on the welfare and stability of a society, was greatly heightened. Until the mid-nineteenth century most people living in degraded urban conditions in industrialising countries had resigned themselves to the dirt, pollution and grime as the price that had to be paid for progress.[1] A predominant attitude until this time was that disease was a punishment from God.

Edwin Chadwick and other British sanitary reformers played a large part in changing that perception. With the use of statistics and detailed surveys, yet having no commonly accepted scientific base to back up their claims, they made popular the connection between environment and health which was so important to sanitary reform. They also mapped out a series of social consequences and costs arising from unhealthy environments which alarmed the middle classes and the politicians in Britain and elsewhere. This enabled unprecedented government intervention into new areas of life previously considered matters of private or individual responsibility; in particular, water supply and domestic waste disposal.

The middle decades of the nineteenth century were therefore remarkable for the environmental consciousness which was aroused in influential people in many industrialising countries around the world. Towards the end of the nineteenth century scientific discoveries in the medical field produced a revolution in theories about disease causation and reduced the focus on the environment for disease prevention.[2] But the scene had been set, water supply and sewerage were firmly ensconced by this time as health-saving technologies.

Against this background of sanitary reform, which was imported into the British colonies, Sydney's first sewers were built and its institutions established for dealing with such matters. Decisions were made that were to shape the development of Sydney's sewerage system for years to come.

CESSPITS AND PRIVIES

By 1826 the Tank stream, which had prompted Captain Phillip to choose Port Jackson (Sydney Harbour) as the site for the first white Australian settlement, had been abandoned as a water supply because it was so fouled.[3] (The location of the Tank Stream is shown in figure 1.1) The colonial government had attempted to protect what was after all Sydney's principal water supply but had failed. In 1802 the following order, the second of its kind, was published

> If any person whatever is detected in throwing any filth into the stream of fresh water, cleaning fish, washing, erecting pigsties near it

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[1] Martin Melosi, ed, Pollution and Reform in American Cities 1870-1930, University of Texas Press, 1980, p17.

[2] Martin Melosi, Garbage in the Cities: Refuse, Reform and the Environment, 1880-1980, Texas A. & M. University, 1981, p80.

[3] W.V.Aird, The Water Supply, Sewerage and Drainage of Sydney, M.W.S.&D.B., Sydney, 1961, pp1-3.

or taking water out of the tanks on conviction before a magistrate their home will be taken down and forfeit £5 for each offence to the Orphan Fund.[4]

Figure 1.1 The Tank Stream

Orders issued by the government, fences erected along the stream's banks and the prohibition of certain industries from the area nevertheless failed to prevent the pollution of the Tank stream.[5]

Wanton throwing of filth into the Tank stream was not the only cause of environmental and health problems in early nineteenth century Sydney, however. Domestic sewage wastes were generally disposed of into cesspits (large holes dug in the back yard). The Sydney Morning Herald published a series of articles in 1851 on "The Sanitary State of Sydney" which described open ditches, overflowing cesspools, accumulations of foetid matter, elongated quagmires, heaps of rubbish and noisome smells. At this stage the water closet was still the exception and the common privy was in general use. [6]

The problems arising from the cesspit system arose because cesspits were poorly constructed, inappropriately sited, inadequately maintained and completely unregulated. Often these cesspits were little more than "prolonged on-site excreta storage systems"[7] which polluted waterways and streets when they overflowed, bred disease-carrying insects, seeped into groundwater wells, and

[4] ibid., p2.

[5] F.J.J. Henry, The Water Supply and Sewerage of Sydney, Halstead Press, Sydney, 1939, p43.

[6] Sydney Morning Herald, 1st March 1851.

[7] N.G.Butlin, Sydney's Environmental Amenity 1970-1975, Australian National University Press, Canberra, 1976, p9.

drained into low-lying neighbourhoods where the poorest people lived, saturating the area with sewage.[8] Cesspits were described in a 1875 official report;

> In some cases, on account of imperfect construction, surface water flows into them--in others, in porous soil, water percolates into them; in both cases with every shower they fill up and overflow, contaminating the adjacent premises and gutters, and producing the most intolerable nuisance.[9]

The cesspits were emptied by private arrangement with 'night-cart' men who would often dump their load on vacant land on the borders of the city or into the water reserve surrounding the water supply or they might sell it to market gardeners.[10] The uncleaned carts would return to the city in the morning, sometimes bringing back garden produce from the market gardens, and remain in their smelly condition in the city all day.[11]

The situation worsened as water supplies were improved and water closets were introduced into the more affluent areas. The extra wastewater caused cesspits to overflow more readily and was often directed into open drains leading to the nearest watercourse such as the Tank Stream.[12]

In addition to the problems that could be directly blamed on the cesspits themselves the provision of even the most essential adjuncts to the cesspit system was also inadequate. Often one privy would serve several houses. Landlords were much criticised by the Herald which claimed that they would buy a piece of land and build fifteen or twenty 'boxes' on it, without drains, water or yard paving. Whilst there were no regulations to compel them to do anything more their tenants just had to make do since housing was in short supply.[13]

The continued growth of population in the city ensured that the situation deteriorated. Under a system of private responsibility the problem of insanitary conditions became most acute when the people who were responsible for providing for waste disposal were not those who would be affected if it was wanting. In other words, where landlords built houses for other people to live in, cesspits were ill-constructed, wells were built close to and below the level of cesspits and even where there were sewers or water pipes in the street, houses were not connected to them.

Before the incorporation of the city of Sydney in 1842, the colonial government provided a few public services, the odd drain here and there, but refrained from constructing any general system of sewers because of the expense.[14] There was pressure from various sections of the public for such a sewer system, although ratepayers were not keen to pay for it either. From as early as 1835 the

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8 ibid.; Michael Cannon, Life in the Cities: Australia in the Victorian Age:3, Currey O'Neill Ross P/L, 1983.

9 Sydney City and Suburban Sewage and Health Board, 2nd Progress Report, 1875, p4.

10 Butlin, Sydney's Environmental Amenity, p11.

11 Sydney City and Suburban Sewage and Health Board, 2nd Progress Report, 1875, p4.

12 W.V.Aird, The Water Supply, Sewerage and Drainage of Sydney, p4.

13 ibid.

14 ibid.; F.A. Bland, 'City Government by Commission', Royal Australian Historical Society 14(III), 1928, p123.

newspapers were urging the government to supply "capacious and substantial drains" [15] and by 1842 the Herald was exclaiming,

> With a mass of filth which is everyday accumulating in its reeking depositories, we have scarcely a single sewer to carry it off! [16]

PROBLEMS OF CITY GOVERNANCE AND FINANCE

An aversion on the part of the influential to paying taxes and rates has dogged the history of Sydney's sewerage system forcing those in power to adopt low cost, short term, less effective measures for dealing with sewage collection, treatment and disposal. Those who paid the most rates in the nineteenth century felt they had least to gain from public expenditure on sanitation. Those who suffered most had least say. Before incorporation of the city, the potential city ratepayers seemed willing to forego measures that would give them a degree of self-determination rather than face having to pay rates. Sanitary reform measures, as well as incorporation, were delayed on this account.[17]

In 1835 moves by a group of citizens, concerned about the state of the city, to have elected commissioners installed to oversee city improvements, met with protests from others when the governor suggested these commissioners have the powers to levy a rate.[18] According to the Herald a few years later, a "mob meeting" had been permitted "to roar down the wholesome proposition."[19]

When, finally, Sydney was about to be incorporated in 1842 a series of public meetings were held which questioned the power of a non-representative Legislative Council to create a taxing authority and demanded financial assistance from the colonial government for the provision of public services.[20]

At one such meeting it was pointed out that it would cost at least £500,000 to provide sewerage and other services to the city and that this meant that the city was being incorporated with a huge debt.[21] The need for these services was not questioned, only who should pay for it. The Herald reported of this meeting, which furnished a petition signed by over one thousand people,

> All that this meeting was assembled for, was to induce the government to tax as little as possible, and to grant to the people as much as the Government possibly could grant to enable the people to carry out those objects for which they were to be incorporated.[22]

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15 Sydney Morning Herald, 12th October 1835.

16 Sydney Morning Herald, 7th May 1842.

17 F.A. Larcombe, The Origin of Local Government in New South Wales 1831-1858, Vol. 1, Sydney University Press, 1973, pp10-21.

18 Charles Bertie, The Early History of the Sydney Municipal Council, Sydney, 1911, pp3-5.

19 Sydney Morning Herald, 7th May 1842.

20 Sydney Morning Herald, 31st May 1842.

21 Sydney Morning Herald, 7th June 1842.

22 ibid.

When the city was incorporated in 1842 one of the main tasks of the new city council was to provide a system of sewerage. The need for this was assumed by one and all with few, if any, arguments being made for the retention of an improved and better regulated cesspit system. The main point of contention seems to have been over the costs involved and who should pay them. The city was incorporated without any government endowment and in subsequent years, the city council, continually confronted by complaints and criticism because of their lack of performance, constantly petitioned the colonial government, without success, for an endowment and the assignment of various taxes which were raised in the city by way of tolls and licences.[23]

In a petition in 1847 the city councillors and aldermen estimated the cost of underground sewers would be £380,528 which they argued was quite beyond the financial resources of the council which could barely cover its own running costs. They were reluctant to raise the rates since they considered the citizens to be already highly taxed. They claimed that even if the taxes were raised to the maximum allowed by the colonial government's legislation, it would take forty years to raise the required money.[24]

A series of committees investigated the performance of the City Council from 1848 through to its dismissal in 1853. The first committee, appointed by the council itself, was at pains to prove that the Council did not have enough income to do its job properly. It claimed that it could not possibly hope to "contend against gigantic ends" with "trifling means".[25]

The committee pointed out that the council was in a different situation from that of established British cities in that it had to begin with an unformed city. The committee again claimed that rates could not be raised saying that the council was having trouble collecting them as it was. They argued that any attempt to raise the rates would be seen as "extortionate and unjust" and be met with "determined and effectual resistance"[26] This perception of the situation was confirmed with a campaign by merchants, led by Robert Campbell and David Jones, who refused to pay council rates.[27]

Although a subsequent select committee appointed by the colonial government in 1849 contended that the council had mismanaged their affairs[28] there is ample evidence that the Corporation did not have sufficient funds to provide a comprehensive sewerage system.[29] Following the two reports a few minor changes were made to the Act but the financial situation of the Corporation was substantially the same. [30]

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[23] F.A.Larcombe, The Origin of Local Government in New South Wales 1831-58, Sydney University Press, 1973, p7; F.A.Bland, 'City Government by Commission', p124.

[24] NSW Legislative Assembly, Votes and Proceedings, 1849, vol. 2, p110.

[25] ibid.

[26] ibid.

[27] David Clark, 'Worse than Physic: Sydney's Water Supply 1788-1888' in Max Kelly (ed), Nineteenth-Century Sydney: Essays in Urban History, Sydney University Press, 1978, p56.

[28] NSW Legislative Assembly, Votes and Proceedings, 1849, vol. 2, pp73-76.

[29] Bland, 'City Government by Commission', p137.

[30] ibid., pp149-150; Larcombe, The Origin of Local Government in New South Wales, p120.

In the Council elections of 1850 the Herald, which in the previous year had been aghast that sewers would not be built because of the expense,[31] called for the election of candidates who owned large amounts of property and therefore would feel the full weight of any taxation that might be imposed.[32]

Government efforts to abolish the Corporation because of its inability to provide public services were renewed in 1852 and culminated in September 1853 when it was resolved that three commissioners be appointed for a limited period.[33] Having witnessed the downfall of the Corporation, whose elected members were reluctant to spend public money, the Commissioners took the opposite course and embarked on city improvements seemingly regardless of cost. In the first five months the Commission spent twice as much as the Corporation had spent in the preceding ten years.[34]

The level of rates that the commissioners were able to levy was set by the colonial government and they soon built up a debt and came into conflict with the government. A government select committee appointed in 1854 found that "the Commissioners were injudicious in incurring so large an outlay." [35]

Each time an increase in rates had to be approved a select committee looked into the performance of the Commissioners and found fault with it. Two commentators on this period conclude that their unprecedented expenditure had made the existence of the Commissioners a "political contention"[36] and ratepayers "resented having to foot the bill, much as they admitted the necessity for the improvements."[37]

Although the Commissioners had been responsible for the construction of a whole sewerage system in just three years, the Corporation was reinstated in 1857.

THE CONNECTION BETWEEN DIRT AND DISEASE

The strong aversion that property owners had towards paying taxes provided a substantial obstacle to the implementation of sanitary reforms and it was only the reluctant agreement that they were necessary which allowed them to take place. Public health requirements provided the most obvious reason for constructing sewerage systems. Certainly public health was adversely affected by the insanitary conditions prevailing in Sydney before a general system of sewerage was implemented. In 1856 it was reported by a subcommittee of the Philosophical Society of N.S.W. that the sanitary state of Sydney was worse than that of London and that the death rate in Sydney was higher despite a year of cholera in London.[38]

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31 Sydney Morning Herald, 26th May 1849.

32 Sydney Morning Herald, 4th November 1850.

33 Bland, 'City Government by Commission', pp156-7.

34 ibid., pp160-5.

35 NSW Legislative Assembly, Votes & Proceedings, 1854, p879.

36 Larcombe, The Origin of Local Government in New South Wales, p159.

37 Bland, 'City Government by Commission', p188.

38 Asa Briggs, Victorian Cities, Penguin, 1968, p284.

The connection between disease and poor waste disposal practices was not lost on nineteenth-century Sydney residents despite their different theories of disease. The dominant disease causation theories of the nineteenth century have since been labeled "filth" theories. There was the "contagionist" view which attributed disease to a contagious agent which spread under conditions of filth.[39] The "anti-contagionist" view, on the other hand, attributed disease to the gases and putrefactive odours ("miasmas") which arose from decaying organic matter. Stagnant water, sodden ground and vitiated air were also thought to be sources of disease. Both views saw the remedy in terms of sanitary reform: cleaning up the city.

In the mid-nineteenth century, the transmission of disease had also been linked to impure drinking water after evidence had been collected by John Snow on cholera and William Budd on typhoid.[40] Although it may seem obvious today that water contaminated by faecal matter is unhealthy, the point had to be laboured and defended in Sydney in the nineteenth century.

> It may, perhaps, be the opinion of ignorant persons that the contamination of water in the manner described, however distasteful and disgusting, is not particularly dangerous to public health.... The opinion of medical men on this matter is not founded upon any theory, but is the result of observation.[41]

The Herald suggested that anything from headaches and nausea to instantaneous death could result depending on the concentration of the gases. Whilst acknowledging that there was some debate in medical circles over what caused diseases such as Cholera, Plague and Typhus it was noted that these diseases had "a strong affinity for persons that live in undrained, unwatered, overcrowded, and badly ventilated neighbourhoods."[42] A later government report reiterated

> that defective ventilation, drainage, and sewerage, and a low condition of health, a predisposition to every form of epidemic disease, and a high death rate are all intimately and closely associated as cause and effect, and follow one another in as inevitable sequence as night follows day.[43]

The report urged that an efficient system of sewerage and drainage be promptly constructed.

Had those diseases remained with such persons in their poverty stricken neighbourhoods, the pressure for sewers may not have been quite as intense. But although disease afflicted the poor more than the better off in society who could afford to build, buy and rent houses with plenty of space around them and put a bit of distance between them and the "fever beds" in the city, the epidemics were feared by everyone, regardless of class or position. It was during the panic

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[39] Jon Peterson, 'The Impact of Sanitary Reform Upon American Urban Planning, 1840-1890', Journal of Social History 13, Fall 1979, pp83-103.

[40] Butlin, Sydney's Environmental Amenity, p6.

[41] Sydney City and Suburban Sewage and Health Board, First Progress Report, 1875, p6.

[42] Sydney Morning Herald, 1st February 1851.

[43] Sydney City and Suburban Sewage and Health Board, Eighth Progress Report, 1876, p3.

of 1875, for example, when "one of the most alarming crises of threatened epidemic disease faced by the city [of Sydney] throughout the century" arose, that the calls for sanitary reform were greatest.[44]

Nonetheless the push for sewers came much earlier in the nineteenth century when Sydney ratepayers were not being directly threatened by epidemic diseases and were fairly well insulated against the diseases of the poor who lived in insanitary conditions. Concern for the welfare of the poor did not typically extend to government levels since the poor had no voting power and the rhetoric of *laissez-faire* was at the height of its popularity during the mid-nineteenth century.[45] *Laissez-faire* fiscal policy was directed at minimising interference with businessmen, minimising the burden on the rich and keeping public expenditure to a minimum.[46] Australian colonial governments did not even fund hospitals because to "patch up the social fabric" was "no concern of the government".[47]

At this time, however, sweeping sanitary reforms were being made in Britain and it was the British way of doing things which predominated in Australia partly because the British had control over Australian colonies but also because many of those influential in Australia had recently immigrated from Britain and even those who had not still saw Britain as the model of progress and civilisation.

Edwin Chadwick was a key figure in the sanitary reform movement in Britain and his report on "The Sanitary Condition of the Labouring Population of Britain" in 1842 was instrumental in forcing a fuller acceptance of government responsibility for public health and sanitation in Britain. A previous report by three doctors to the 1838 Poor Law Commission had blamed squalid urban conditions for the spread of disease[48] and Chadwick, who subscribed to the anti-contagionist view of disease causation, agreed.

Chadwick's report had arisen out of the controversy over whether money spent on public health precautions saved money that would otherwise be spent on "poor relief." But in the end the economic cost of disease was only one of the points the report sought to make. It also sought to link disease to lack of sanitation and unsanitary conditions to a decline in morality. Finally it sought to change legal and administrative structures which dealt with public health matters.[49]

The British government did not act immediately on Chadwick's report and several reports later, in 1847, a Metropolitan Commission of Sewers was born and a year later the Public Health Act was passed into law which set up a

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44 A.J.C.Mayne, Fever, Squalor and Vice: Sanitation and Social Policy in Victorian Sydney, University of Queensland Press, 1982, p23.

45 E.J.Hobsbawm, Industry and Empire, Penguin, 1969, p226.

46 ibid., pp234-5.

47 Cannon, Life in the Cities, p142.

48 M.W.Flinn in introduction to Edwin Chadwick, The Sanitary Condition of the Labouring Population of Britain, 1842, edited by M.W.Flinn, Edinburgh University Press, 1965, p16.

49 ibid.

Central Board of Health and established once and for all the principle of state responsibility for public health.[50]

CONTROLLING THE MASSES - DIRT, VICE AND IMMORALITY

The sanitary reform movement in Britain took the form of a veritable moral crusade amongst elite groups and professionals "inspired by both the evangelical concept of duty and, increasingly, a new secular concern for the well-ordered society".[51] The Victorian social doctrine that social progress and morality depended on physical well-being and a pure environment was voiced by the social reformers including Chadwick,

> how much of rebellion, of moral depravity and of crime has its root in physical disorder and depravity . . . The fever nests and seats of physical depravity are also the seats of moral depravity, disorder, and crime with which the police have most to do. [52]

Such sentiments were repeated in British periodicals such as the Edinburgh Review,

> There is a most fatal and certain connexion between physical uncleanliness and moral pollution . . . Those who suffer from fever . . . become unfit for, and have a hatred of, labour . . . have a craving for the stimulus of ardent spirits. . . he is crushed by drunkenness, profligacy, and poverty, and sinks from one stage of vice and misery to another, till the intellectual faculties become dimmed, all moral and religious feeling expires, the domestic affections are destroyed, all regard for law or property is lost . . . [53]

Leading sanitary reformers in the United States held similar beliefs about the connections between insanitary conditions and immorality and crime. In New York, John Griscom and Robert Hartley were both committed to "a pietism widespread in their generation" and their campaigns were based on their observations of the "coincidence, or parallelism, of moral degradation and physical disease"[54]

These concerns found expression in Sydney where the connection between dirt and poverty was interpreted as an indication of the inferiority of the poor.[55] In a series of articles in 1851 the Herald took its readers through a chain of cause and effect from bad drainage to drunkenness, prostitution, and crime. "Vice and dirt

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50 ibid., pp70-73.

51 Anthony S.Wohl, Endangered Lives: Public Health in Victorian Britain, Harvard University Press, Cambridge, Massachusetts, 1983, p6.

52 quoted in ibid., p7.

53 W.O'Brien, 'Supply of Water to the Metropolis', Edinburgh Review 91, April 1850, pp384-7.

54 Charles Rosenberg, No Other Gods: On Science and American Thought, John Hopkins University Press, Baltimore and London, 1976, pp 109-122.

55 Sydney Morning Herald, 22nd March 1851.

are so nearly allied," the paper stated, "that the former seeks to hide itself in the repulsive mantle of the latter."[56]

Nor were such prejudices confined to the media. They were also current amongst professional circles. At an engineering association meeting in Sydney it was claimed in a paper being given by an engineer that nothing predisposed a man "to indulgence in ardent spirits" as much as "the state of bodily health and the deficiency of animal spirits, engendered by drinking impure water or breathing foul air"[57] and he asserted that this was the opinion of respected medical men.

There was an element of the sanitary reform movement that was not only concerned with morality and crime but also maintaining the social order. There was anxiety that disaffected and marginalised members of the society might be politicised and rise up and rebel. For example Christine Boyer writes of the American situation

> Although the fear of the mob and the immigrant lay just beneath the improvers' zeal, some began to say that the answers to social unrest lay in the environmental deprivations that created the ambivalent loyalties and anomalous behaviour of the poor.[58]

In Sydney the Herald argued that the "great unwashed" had no stake in the state, they became bitter and hateful and easily persuaded by "agitators" who sought to further their own political ambitions. It cited as evidence "that wild democracy under the name of Chartism" which took root in the English "dens of filth and fever".[59]

This fear re-emerged with some force twenty five years later when the alien world of city slums was laid bare to the middle-class by government reports and newspaper reports of City Council inspections. The slum dwellers seemed to be living on the fringes of society in a state of dirt, "drunkenness, debauchery, prostitution and crime". It seemed that in these slum areas all socially desirable codes of behaviour were being ignored and to those subscribing to evangelical middle class culture, non-participation in community norms of behaviour threatened the very stability of Sydney society.[60] To the middle-classes it was unbearable that the lower orders should not contribute socially, economically and morally as "useful citizens". To them Sydney's slums were "breeding a debased and self-sustaining sub-society of social and moral outcasts, existing with a minimum of healthy integration upon the fringes of mainstream community life."[61]

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56 Sydney Morning Herald, 15th March 1851.

57 Gustave Fischer, `Water Carriage System of Sewerage, Its Disadvantages, as applied to the Drainage of Cities and Towns', paper read before the Engineering Association of NSW, 1884, p3.

58 Christine Boyer, Dreaming the Rational City: The Myth of American City Planning, M.I.T. Press, Cambridge, 1983, p17; See also Charles Rosenberg, No Other Gods: On Science and American Social Thought, John Hopkins University Press, 1976.

59 Sydney Morning Herald, 8th March 1851.

60 Mayne, Fever, Squalor and Vice, pp105-6.

61 ibid., p111.

It has been argued that the desire to impose order went even deeper than this, however, and it was recognised that on a more psychological level "the control of excretory behaviour furnished the most accessible approach on a mass basis to inculcating habits of orderliness."[62] Sanitary reform was therefore linked to imposing order on the masses.

> To maintain itself a society must proclaim that things have their right places whether within the biological organism or the social. Disorder means a weakening of strength at the margins; excessive helter-skelteredness can lead to dissolution. The control of disorder means the labeling of intrusive and displaced matter as dirt. Such matter then becomes taboo...[63]

GOVERNMENT INTERVENTION VS THE IDEAL OF LAISSEZ-FAIRE

In order to achieve their discipline of the masses, sanitary reformers recognised the necessity for increased government intervention into sanitary affairs. A study of American sanitary reform noted that

> the provision of the most conducive environment, which would ensure the stability of the social order and the progress of civilization, would require constant supervision and disciplinary correction from a centralized political authority.[64]

Moreover, special authorities would be independent of political boundaries, would not be limited by the tax and debt limits imposed on local councils and would be free from municipal control.[65]

Chadwick, the leading sanitary reformer in Britain, was a firm believer in the necessity of expanding central government. His utilitarian principles led him to view such reform as being in the best interests of the manufacturers because order would be maintained amongst the poor and their productive capacity would be maximised.[66] Chadwick's report recommended the establishment of a central health board to plan water supply and sewerage disposal systems.

Such ideas ran counter to *laissez-faire* principles which were also aimed at furthering the interests of businessmen. *Laissez-faire* provided the main ideological platform from which opposition to sanitary reform could operate, particularly in Britain. It provided those whose interests were threatened by sanitary reforms a "legitimate" reason to oppose them, that was not obviously

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[62] Richard Schoenwald, 'Training Urban Man: A Hypothesis about the Sanitary Movement' in H.J.Dyos and Michael Wolf (eds), The Victorian City: Images and Realities, vol. 2, Routledge & Kegan Paul, London and Boston, 1973, p675.

[63] ibid., p673.

[64] Boyer, Dreaming the Rational City, p14.

[65] Joel A Tarr et al, 'Water and Wastes: A Retrospective Assessment of Wastewater Technology in te United States, 1800-1932', Technology and Culture 25(2), April 1984, p252.

[66] James Ridgeway, The Politics of Ecology, E.P.Dutton & Co., New York, p25.

selfish and inhumane.[67] The very act of a government concerning itself with waste disposal was suspect,

> All regulations for securing cleanliness and removing filth, are apt to be considered as invasions of the privacy of the domestic hearth and the person, and amounting to an impertinent intermeddling, in matters concerning which it is insulting even to be inquisitive.[68]

In 1850 contributors to both the Edinburgh Review and the Quarterly Review defended the necessity for a degree of centralisation as implied by sanitary reform. They argued that local self-government was not being threatened by the proposal put forward by Chadwick and others to have a central health board which could plan water supply and sewage systems.

Central power, F.O. Ward argued in the Quarterly Review, would overcome the inefficiencies inherent in Local Boards which squandered the district rates by jobbing or incompetence. Such a central state authority would be above local rivalries and yet be able to step in occasionally to remedy disorders caused by the misconduct of a local power. An economic division of labour in constructing sewerage or water schemes could be facilitated and the competence of work ensured. There was a tendency amongst local councils, the magazine argued, for work to be given on the basis of favours rather than skill and for "the owners of ill-conditioned tenements to take local office, expressly to defeat measures within whose scope their own neglected property would fall." [69]

> Political Centralization is abhorrent to a free people, who see in it the mere substitution of the will of the few for the will of the many; while Sanitary consolidation becomes more popular the better it is understood, because it replaces all arbitrary will whatsoever (whether that of the many themselves, or of the few), by Natural Law . . . [70]

W.O'Brien, an engineer, pointed out in The Edinburgh Review that the private provision of water had been inequitable and inadequate

> The conclusion is inevitable, -a different principle must be adopted: if there must be a monopoly, and no doubt there must, let it be placed in the hands of the Government, or some public body responsible to the consumers. [71]

Total responsibility for water supply, the magazine argued should be put in the hands of a single Board appointed by the Government. They were opposed to the election of Board members because then members might owe their election to their political bias or activity in canvassing and in this way "private interest and political combinations" might interfere with the public good.

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[67] Flinn, The Sanitary Condition of the Labouring Population of Britain, pp31, 42.

[68] J.Hill Burton, 'Sanitary Reform', Edinburgh Review 91, January 1850, p213.

[69] F.O.Ward, 'Sanitary Consolidation - Centralization - Local Self-Government', Quarterly Review 8, March 1851, p453.

[70] ibid., p448.

[71] W.O'Brien, 'Supply of Water to the Metropolis', p399.

These arguments were less relevant in Sydney where water supply was not privately owned. Moreover the possibility that sewerage would be undertaken privately was equally remote. In many ways the assumption that a sewerage system was the answer to waste disposal problems forced responsibility into the hands of government because of the capital intensive nature of such a system. Sewerage disposal requires a centralised system of pipes which are collectively utilised. Since such a sewerage system is expected, because of its cost, to last many years, repayments which are spread over that time may prevent an investor from getting any quick returns. David Clark notes

> As the experience of N.S.W. railway construction had already shown by this time, private enterprise was unwilling to enter into the provision of overhead capital field unless short-run profits seemed assured and the gestation period of investment was short.[72]

Also the free market system which allocates goods according to who is most able to pay would leave a situation where those areas which suffered the worst sanitary conditions would be the very ones which were neglected. This would be self-defeating in that diseases would continue to breed in these areas and not only would the city still be vulnerable to epidemics but the fear of crime, immorality and rebellion would remain.

Perhaps more importantly, private companies are only able to consider direct costs and benefits in their profit statements and yet most of the benefits of a sewerage system are indirect. The main benefit is a decrease in disease which can be measured in economic terms and indeed was considered in this way at the time but such a benefit was available to everyone and could not be charged to individuals.

The question of government intervention therefore was less contentious in Sydney where there was no impinging on areas of private business and where its situation within a colony made arguments about self-determination less meaningful. Moreover the property owning citizens of Sydney had shown themselves quite indifferent to local self-government. Nonetheless, the suggestion, in 1852, that a Board of Works be established to construct sewerage and water works was objected to on the grounds that power would be placed in the government's hands which belonged with local representatives.[73]

Centralisation was also not such a pressing issue in the new colony as it was in Britain where various well-established towns competed with each other for prominence. N.S.W. was already a fairly centralised colony and Sydney had only recently begun to spread out from its central city district with suburban centres just beginning to form. Nonetheless, as those suburban councils formed they jealously guarded what autonomy they had and fought for a say in metropolitan affairs.

Although this may sound like a genuine attempt to retain democratic control, it should be noted that local government franchise in the colony was extremely restricted and combined with a "property-based system of plural voting, linked with special property qualifications and absence of payment for municipal office".

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[72] David Clark, 'Worse Than Psychic', p59.

[73] Sydney Morning Herald, 8th June, 1853.

It meant that local government was controlled by wealthy men[74] rather than enabling grass-roots local self-determination.

The idea of the Colonial government gaining control of water and sewerage supply was opposed by both the supporters of municipal government and the critics of the Colonial government who did not want to see its powers extended.[75] Also the British distrust of centralised government intervention in local affairs continued to be voiced in N.S.W. throughout the nineteenth century.[76] Municipal control of water and sewerage was maintained from the reinstatement of the City Council in 1857 till 1888 despite constant criticism and fault-finding as well as allegations of corruption in the City Council. The performance of the City Council in laying sewers was extremely slow and continued to be dogged by a lack of finance. A defect in the legislation meant that they could not even enforce the payment of sewerage rates and this led to an enormous backlog of unpaid accounts.[77] No sewers were constructed by the Council after 1861 for these reasons.[78]

In 1875 fears of an epidemic reached crisis point and amidst the panic a temporary Board was set up to inquire into the sanitary state of the city. This board, the Sydney City and Suburban Sewage and Health Board, was made up of M.P.'s and government officials and only one representative from the City Council - the City Engineer.[79] The Sewage and Health Board renewed arguments for a permanent sanitary authority, which would operate "without fear or favour" to eliminate all sources of nuisance and public health threats and keep the issue constantly before the public.[80]

The Sewage and Health Board emphasised the importance of making such an authority permanent and independent.[81] This body, they argued, should have tenured members who would not be directly subject to popular control. It was feared that any body which feared unpopularity would not apply sanitary laws stringently.[82]

The Sewage and Health Board were supported by a Health Society deputation to the Premier in 1878 which argued that aldermen on local councils represented vested interests rather than an impartial sanitary administration. Aldermen owned unwholesome buildings and disobeyed laws banning animal slaughter in the City.[83] A further argument for a centralised board was put forward by a

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[74] Mayne, Fever, Squalor and Vice, pp42-43.

[75] Clark, 'Worse Than Psychic', p59.

[76] Mayne, Fever, Squalor and Vice, p48.

[77] Greta Gerathy, 'Sydney Municipality in the 1880s', Journal of the Royal Australian Historical Society 58(1), March 1972, p36.

[78] F.A.Larcombe, The Stabilization of Local Government in New South Wales 1858-1906, Sydney University Press, 1976, p90.

[79] Mayne, Fever, Squalor and Vice, p39.

[80] The Sydney City and Suburban Sewage and Health Board, Seventh Progress Report, 1875, p3.

[81] The Sydney City and Suburban Sewage and Health Board, Nineth Progress Report, 1876, p4.

[82] The Sydney City and Suburban Sewage and Health Board, Eleventh Progress Report, 1876, p4 and Twelfth and Final Report, 1877, p8.

[83] Mayne, Fever, Squalor and Vice, p45.

doctor at the Royal Society of N.S.W. in 1886. F.H.Quaife argued that since drainage should follow the geographical terrain rather than artificial borough boundaries it was difficult for the various municipalities to look after their own drainage and make sure that it was integrated with that of neighbouring municipalities. A central board would have the resources to hire specialists and a trained workforce.[84]

The city council's lack of performance in both sewerage and water supply had also led to much agitation for an entirely new controlling body. Various attempts were made in the N.S.W. parliament to enact legislation for such a body and finally in 1888 a board was established to control and manage the water supply and sewerage works in the city or municipalities within the County of Cumberland which were existing or under construction by the government at the time. The construction of all major works remained the province of the Public Works Department until 1925 and these works were transferred to the Board upon completion. The Metropolitan Board of Water Supply and Sewerage had quite limited powers during this time being little more than a government department with its finances closely controlled by the government.[85]

The Board was constituted in 1888 with three "official members" appointed by the Governor, one of whom would be President of the Board. A further two members were elected by the City Council and two others were elected by the Mayors and Aldermen of several boroughs and municipal districts. A candidate had to be eligible for election to one of the constituent councils and therefore be a property owner.[86]

The compromise between elective and nominee members inherent in this constitution was nevertheless contentious.[87] Even after five years of operation the degree of government control versus direct control by ratepayers was an issue. In 1893 the custom of appointing civil servants already in the employ of the government to the three governor-appointed positions, including the post of President, was attacked in parliament. The grounds for attack were that this ensured that the President and his two co-appointees were not independent and free from ministerial control as had been envisaged in the original act.

> The rate-payers say they cannot expect to get a full consideration of their rights when there is so great a civil service and Government influence on the board.[88]

It was pointed out that the duty of the Water and Sewerage Board was to "exercise economy in expenditure so that the ratepayer may have to pay the lowest possible amount of rates"[89] and it was argued that a more democratically

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84 F.H.Quaife, `Notes on the Sanitary Condition of the Eastern Suburbs,etc', Proceedings of the Royal Society of NSW 20, 1886, pp352-3.

85 Larcombe, The Stabilization of Local Government in New South Wales, pp94-102; Henry, The Water Supply and Sewerage of Sydney, pp2-3.

86 ibid., p4.

87 Metropolitan Water and Sewerage Bill, Legislative Council, 5 May 1880, pp2159-2166.

88 Carruthers, Member for Canterbury, Metropolitan Water and Sewerage Act Amendment Bill, Legislative Assembly, 9 March 1893, p5037.

89 V. Parkes, Member for East Sydney, Metropolitan Water and Sewerage Act Amendment Bill, Legislative Assembly, 20th April 1893, p6284.

constituted Board, that is one with all members elected representatives of ratepayers, would be a more economic one.[90] Similarly those who argued for the retention of government control argued that the Parliament should be able to control the expenditure of the Board.[91]

THE PRICE OF POOR PUBLIC HEALTH

The opposition to public health spending in the nineteenth century was such that sanitary reformers attempted to justify water, sewerage and drainage schemes on economic grounds. The economics of public ill-health were first debated in Britain. Chadwick's report, as noted before, emerged out of the debate over whether the cost of public health measures would save money in poor relief and Chadwick devotes a chapter to the subject titled 'Pecuniary Burdens Created By the Neglect of Sanitary Measures.' In it Chadwick enumerates the costs as including the cost of reduced production when workers are sick, weak or live short lives, the cost of caring for and maintaining the sick, the costs of vice and crime and the cost of destitution. He points out that the death of a male breadwinner can create widows and orphans causing "a source of a constant influx of the independent into the pauperised and permanently dependent classes" and also causing the mean age of the population to be very low.[92]

Similar points were made in British newspapers and periodicals such as the Edinburgh Review.

> We all know that, in the economic sense of the term, a short-lived population is generally a surplus population, -not only because those who are reckless of preserving life will be careless of all its obligations, and will be poor and vicious, but because the tendency of early deaths is chiefly, to shorten the existence of those who produce more than they consume, and to increase the number of those who must be dependent on the charity of others.[93]

The Sydney Morning Herald, the following year, warned that if a fatal disease were to break out "amongst the dense masses of our capital" it would spread throughout the land bringing personal suffering and industrial ruin.

> It would be a species of taxation more grinding and oppressive than any which human laws can impose--taxation which none could resist or evade.[94]

This same argument was put forward in one form or another in most of the nineteenth century reports proposing sewerage systems. For example W. Clark, in his 1877 report goes to some trouble to include mortality statistics and, in the

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90 Jeanneret, Member for Carcoar, Metropolitan Water and Sewerage Act Amendment Bill, Legislative Assembly, 20th April 1893, p6289.

91 McCourt, Member for Camden and Dowel, Member for Tamworth, Metropolitan Water and Sewerage Act Amendment Bill, Legislative Assembly, 20th April 1893, pp6289, 6291.

92 Chadwick, The Sanitary Condition of the Labouring Population of Britain, pp254-5.

93 J.Hill Burton, 'Sanitary Reform', p212.

94 Sydney Morning Herald, 6th November 1850.

appendix even includes a calculation made in Madras of the monetary loss to the community of death and sickness. He says

> For every death there are twenty-eight cases of preventable sickness, which incapacitate the sufferer for active employment for many weeks, entailing pecuniary loss, which when estimated in money is an amount calculated to startle the strongest and should induce a willingness to contribute to the cost of remedial measures. [95]

Sanitary reformers recognised that their main opposition came from landlords and pointed to the indirect benefits a landlord would receive in return for the extra rates that would need to be charged to supply sewerage and drainage. Chadwick, for example, includes the preservation of the property, the ability to get better tenants who can pay higher rents more regularly and the general improvement in rents that would be available if the population was not constantly sick and dying.[96] Similarly the British periodicals pointed out that for half the public money spent on poor relief, "sickly, degraded inmates" of fever nests could be transformed into a "healthy, self-supporting population" that paid its rents regularly.[97]

Another economic benefit of sewerage systems was the savings to be made in not having to empty out cesspools[98] but this was of no interest to landlords nor governments since it was generally a cost paid by the tenant.

CONCLUSION - COMPELLING COSTS AND GOVERNMENT CONTROL

Whilst a concern for public health may have been a contributing factor in the decision of the colonial government that the municipal council should provide for waste disposal, other factors are more relevant. After all it was the poor who suffered most from insanitary conditions and they had no formal say in the affairs of government. A more pressing concern in the eyes of the middle classes was not the suffering of the poor but the consequences to themselves of dirt and disease in the slums.

These consequences were considered in economic and moral terms. The economic costs were considered to stem from the lost productivity, lost rents, stolen and vandalised property and the price of charity. But insanitary conditions were also perceived to have posed a threat to the stability of the society, threatened the status quo and made the well off uncomfortable in their affluence. Also the middle classes feared epidemic diseases that might spread out from the slums.

> the sanitary movement helped initiate a value change, convincing many urbanites that filth was not a nuisance to be tolerated but rather a hazard to their health that could be eliminated.[99]

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[95] W. Clark, Report to the Government of New South Wales, on the Drainage of the City of Sydney and Suburbs, 1877, p7.

[96] Chadwick, The Sanitary Condition of the Labouring Population of Britain, p289.

[97] Ward, 'Sanitary Consolidation-Centralization-Local Self-Government', p456.

[98] Sydney Morning Herald, 8th March 1851.

[99] Tarr et al, 'Water and Wastes', pp256-7

The British debates and the push of the sanitary reformers in Britain made sanitary reform an issue in Sydney in the 1840s and '50s although no epidemics had been experienced in Sydney at this time. The same arguments about the consequences of insanitary conditions which were current in Britain were put forward by the newspapers, politicians and professional people in Sydney. But whilst arguments for sanitary reform were borrowed from Britain so were arguments against it, particularly those based on *laissez-faire* principles which attempted to keep public spending and government intervention to a minimum.

The ideological arguments for keeping public spending to a minimum were reinforced by the very real reluctance of ratepayers and landlords to contribute to the cost of sanitary measures such as sewerage systems which provided no direct benefit to business profits and which were of most benefit to the non-rate-paying urban tenants. Such opposition continually impeded the implementation of measures that had been approved and even demanded and ensured that they were done in the cheapest possible manner.

The power and influence of reluctant ratepayers ensured that economic arguments were always put forward to justify sewerage spending and were perhaps the most important in persuading businessmen, but the motivation of a good many of the sanitary reformers seems more likely to have been one associated with social control. The goal of the government in pushing for public control of waste disposal was to minimise the social and economic disruption caused by pollution at the least cost to the ratepayers.

We can now begin to locate schemes for sewage collection and removal within this political, economic and ideological context. In the next chapter, the decision to install sewers and the competition of water-carriage technology with dry conservancy technologies will be examined.

CHAPTER 2

SEWAGE COLLECTION - FROM CESSPITS TO SEWERS

The first city sewers in Sydney were constructed in the 1850s beneath the main city streets so as not to interfere with private property. They discharged the raw sewage directly into the Harbour at Fort Macquarie (now Bennelong Point,the site of the Opera House) near the Governor's residence. (see figure 2.1) At that time the use of piped water to transport the sewage was perhaps the only method of removal that was taken seriously. The use of flush toilets and water to transport wastes was an old idea dating back as far as 2800 BC to the Minoans and also the Chalcolithics.[1] Despite the antiquity of such systems, referred to as 'water carriage' systems, they were relatively new in 19th century Britain and were considered to be a modern, progressive method of dealing with wastes.

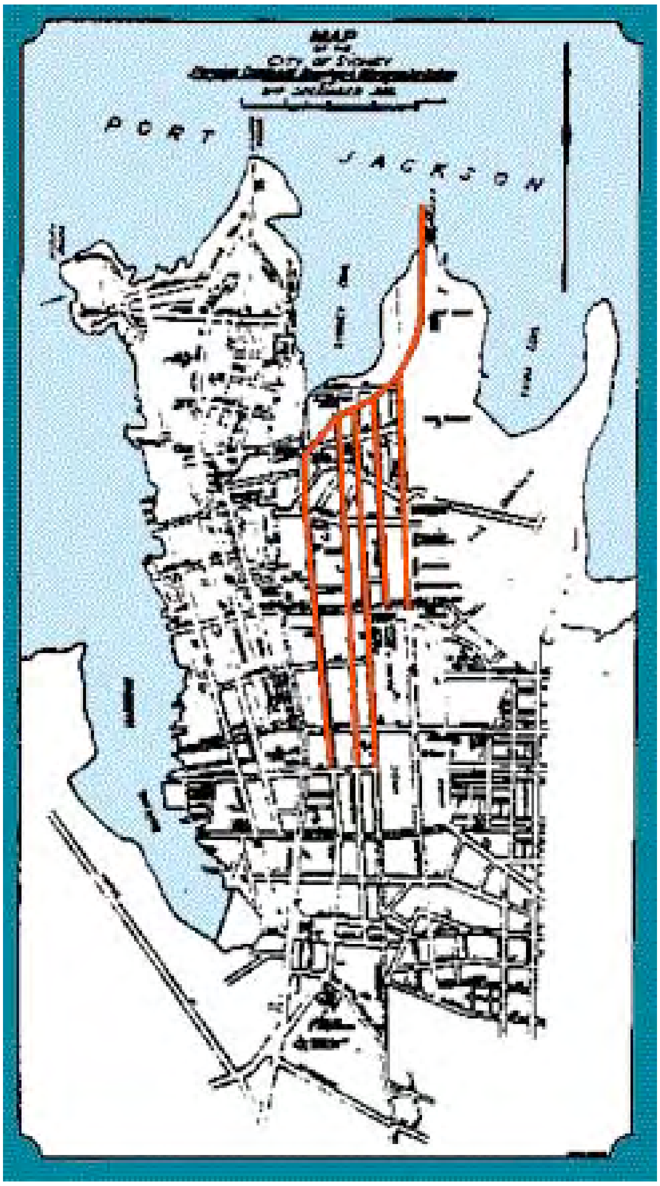

Figure 2.1 Sydney's First Sewers

Source: F.J.J. Henry, The Water Supply and Sewerage of Sydney, Halstead Press, Sydney, 1939.

At first sanitary reform was virtually synonymous with water-carriage sewer construction because British sanitary reformers were demanding sewers as a reform measure. Britain provided the model of sanitary science during the nineteenth century not only in Australia but also in the United States and engineers from these countries would be sent to visit British sewerage works as part of their information gathering duties.[2]

In the latter half of the nineteenth century water-carriage methods were challenged by those who preferred dry conservancy methods of dealing with the human wastes. The movement against water-carriage gained much of its impetus from community dissatisfaction with the gross

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1 Reginald Reynolds, Cleanliness and Godliness, George Allen & Unwin, London, 1943, pp13-20.

2 Joel Tarr et al, 'Water and Wastes: Retrospective Assessment of Wastewater Technology in the United States, 1800-1932', Technology & Culture 25(2), 1984, p234.

environmental pollution which early sewer systems had been responsible for.

COMMISSIONERS, SELECT COMMITTEES AND THE FIGHT FOR CONTROL

Sydney's sewerage system was conceived in the midst of much debate about how much it would cost and how it should be paid for and, because the actual construction of such sewers was so tied up with cost considerations, the first sewers were built amidst arguments about control and competency. The City Engineer, W.B. Rider, who was responsible for this work suffered from this and also from political attempts to discredit the City Commissioners. Throughout his short term of office, Rider, was subject to criticism and public doubts about whether he was a suitable person for the position of City Engineer.[3] Such criticisms probably had some foundation. Rider had been a railway engineer and it seems that he, like so many of the engineers who designed the first sewerage systems, had no previous experience in sewerage works.[4]

In the Select Committee report of 1854, before any sewers had actually been constructed, Rider was criticised for having spent so long on a trigonometric survey of the city and thereby delaying the construction of the sewers. His methods were also criticised. The Committee argued that he had determined a maximum size for the main sewers without working out the areas to be drained, the gradient at which they would be laid out or the amount of rain water they would be expected to carry. They assumed that he had used English sizes despite the geographical, demographic and climatic differences that might be expected between the two countries.[5]

The Select Committee also questioned Rider's integrity. They pointed out that he had recommended that the sewers be built of brick whilst at the same time he owned a brick yard. Although it was generally agreed at this time that bricks were an appropriate material for sewer construction, when this conflict of interest was brought to the public attention in parliament, the City Commissioners were forced to acquire the brick yard on behalf of the city.

The City Commissioners did not escape criticism. The Select Committee accused them of leaving all sewering decisions to the City Engineer, not requiring him to report fully to them and not availing themselves of the opinions of other engineers. The Commissioners, on the other hand, felt such matters should be left to the engineers because sewerage works were "so essentially of an engineering description" and involved so many technical questions.[6]

The Select Committee did not criticise the choice of the harbour as a point of disposal.[7] This disappointed the Sydney Morning Herald which had warned a

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[3] Select Committee, Sydney Sewerage and Water Appropriation Bill, NSW Legislative Assembly, Votes and Proceedings, 1854, p890.

[4] Select Committee on the City Commissioners Department, NSW Legislative Assembly, Votes and Proceedings, 1856.

[5] ibid.

[6] First Yearly Report of the Commissioners, NSW Legislative Assembly, Votes and Proceedings, 1855, p4 of report.

[7] Select Committee, Sydney Sewerage and Water Appropriation Bill

few years earlier that an outlet into the Harbour would have disastrous consequences. Pointing out that the city was surrounded on three sides by harbour water the Herald feared that harbour disposal would create a health risk to those living near the water and to sailors aboard ships in the harbour. It was also feared that the evaporated sewage would be blown back over the city.[8]

> The same wisdom which, fortunately for us, has laid down that a man shall not with impunity become a nuisance to his neighbour, declares that we have no right to expose the lives of even a minority of the public for the benefit of the whole.[9]

Rider survived the criticisms of the Select Committee (and of the Herald) and went on to build Sydney's first sewers. His main opposition came from the Governor General, Sir William Denison, who disliked the idea of a sewage outfall near his residence. Although the Governor put up some good arguments about the nuisances and pollution that such an outfall would cause for the Harbour, Rider, as the City Engineer, was able to meet these objections with "expert" predictions about why this would not happen and to thereby mute the considerable influence of the governor.[10] He argued that Fort Macquarie was the best point of discharge because of the strong seaward current there. Also, he said, sewage should be removed from residential areas to protect public health and Fort Macquarie was so removed. Any point closer to Sydney Cove would be too close to habitation, a nuisance to ships in port and would require the harbour to be regularly dredged.[11]It is ironic that some of the predictions made by the governor (in his own interests) turned out to be more valid than those of the city engineer (who also had his own objectives).

A further government select committee a year later, again criticised the City Commissioners and the City Engineer. They recommended that the Commissioners be dismissed and that Rider and his assistant be immediately sacked and considered incapable of being employed in the public service. Their criticisms centred around the quality of the sewer construction work, the tendering process and the financial management of the work.[12] This report was highly controversial and judged by some to be politically motivated. The chairman of the committee, James Martin, (who will again feature in this story), was accused by the Herald of having ambition extending "to every department of knowledge."[13] The newspaper defended the experts (Rider and assistant) in the following terms,

> it is intolerable to find characters of men jeopardised by the petulant presumption of a novice who dabbles in everything and understands nothing.[14]

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8 Sydney Morning Herald, 29th March 1851.

9 ibid.

10 First Yearly Report of the Commissioners, pp27-28 of report.

11 ibid., pp28-29 of report.

12 Select Committee on the City Commissioners Department, NSW Legislative Assembly, Votes and Proceedings, 1855.

13 Sydney Morning Herald, 15th December 1855.

14 Sydney Morning Herald, 17th December 1855.

The Commissioners survived this further attack on their competence but Rider was replaced as City Engineer by Edward Bell. Bell was asked to investigate the work of his predecessor and found little fault with it.[15] Yet another Select Committee the following year went over the same ground yet again and found that Rider's conduct had been "most unsatisfactory" and his unfaithfulness, carelessness and the trust put in him by his Commissioners had led to an "excessive and improper expenditure" of public money. The Commissioners, they said, had not maintained proper control over their engineers, although it was admitted that it was not easy "to draw the line clearly between a proper and an improper interference with professional men in carrying out engineering works." Nonetheless there were areas they could have been more aware of and they should have realised something was wrong when costs were so much in excess of estimates.[16]

This latest report was adopted by the government except for the allegations about the unfitness of the Commissioners. Shortly afterwards one of the Commissioners resigned because of the bankruptcy of his personal business and since the Sydney Corporation was about to be restored, he was not replaced and the two other Commissioners were given other government appointments.[17]

Rider, as City Engineer, had taken a large part of the blame for what was seen as overspending on sewerage works. Engineers who followed him were not slow to learn the lesson that costs were all important. Bell, in his first year of office, assured the Commissioners in writing that whilst working on the city's drainage he had complied with their desire "so strongly expressed" that he would "keep in view the strictest economy combined with the greatest efficiency".[18]

Ironically it was Rider's choice of the cheapest solution for disposal of sewage which caused the most problems several years later. By the time the Sydney Sewage and Health Board reported to the government in 1875 there were sewage outlets at five different points in the Harbour and each was causing a nuisance (see figure 2.2). A committee appointed by the Board to examine the outlets found that at Rushcutters' Bay an extensive and stinking mud flat had formed which was exposed at low tide. At Woolloomooloo Bay a large bank had formed and sewage floated on the surface of the salt water, oscillating back and forth with the movement of the tides. At Fort Macquarie a "considerable bank" had formed and certain winds blew effluvia over "a considerable area of the northern part of the city." The water flowing from the Tank Stream into Sydney Cove was inky in colour, "apparently putrescent, and floated on the surface of the Bay" for a considerable distance. Finally at Darling Harbour, the committee described accumulating banks of "filthy and putrid mud".[19]

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15 NSW Legislative Assembly, Votes and Proceedings, 1856-7, vol 1, p762.

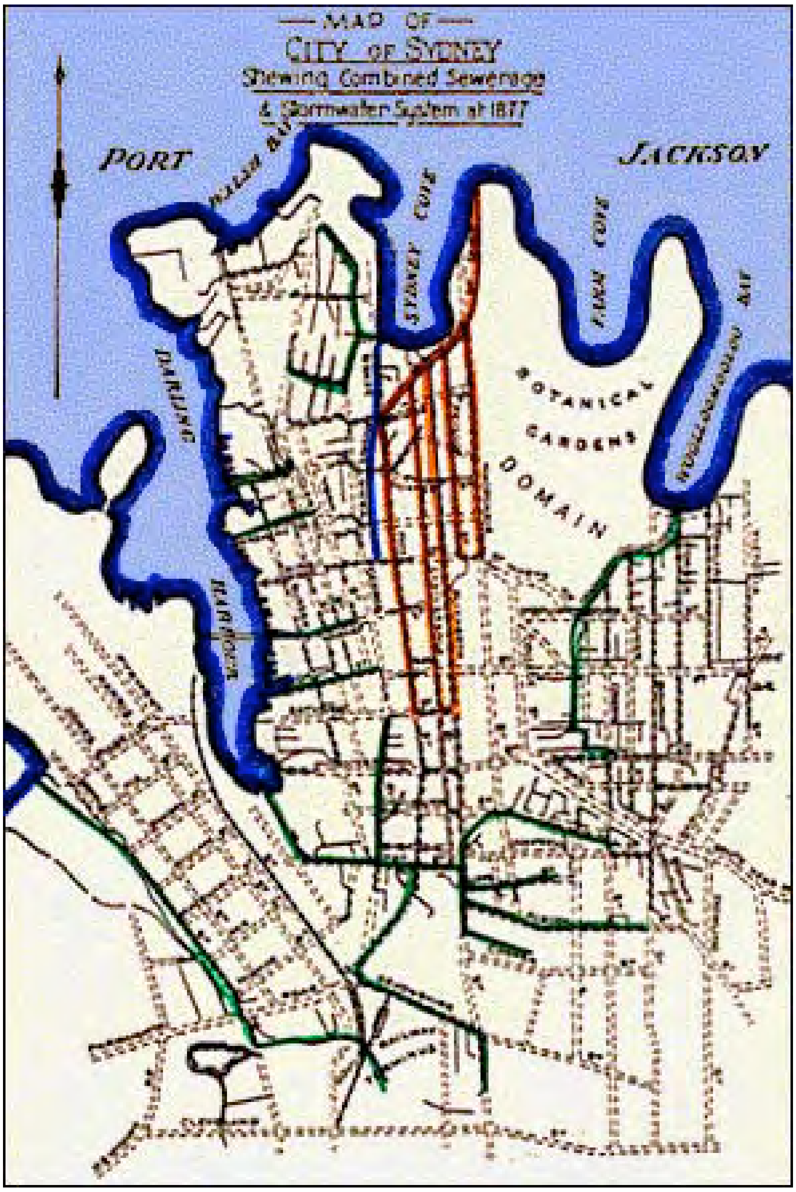
16 Select Committee on the City Commissioners Department, NSW Legislative Assembly, Votes and Proceedings, 1856, pp3-7 of report.

17 F.A. Larcombe, The Origin of Local Government in New South Wales 1831-1858, Vol. 1, Sydney University Press, 1973, pp152-4.

18 Second Yearly Report of the Commissioners, NSW Legislative Assembly, Votes and Proceedings, 1856-7, vol III, p6 of report.

19 Report of the No 7 Committee Appointed by the Sydney City and Suburban Sewage and Health Board, 1875.

Figure 2.2 Sydney Sewers in 1877



Source: F.J.J. Henry, The Water Supply and Sewerage of Sydney, Halstead Press, Sydney, 1939.

Various petitions and personal visits to members of parliament had been made in the 1870's. A petition signed by 3,800 people complained that the existing system of sewerage

> has resulted in depositing all the filth of the city in the harbour, rendering all business occupations upon its shores disgustingly offensive, largely increasing the sickness of the citizens, and silting up year by year navigable water to a large extent. [20]

The petitioners complained that the state of the harbour was well known overseas and was "discouraging immigration and hindering trade". Owners of waterside properties were especially disadvantaged by having the "excreta and

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20 NSW Legislative Assembly, Votes and Proceedings, 1876-7, p685.

offscouring of a hundred thousand people" cast upon them. "The sewer evil" had been caused by the government and should be cleaned up by the government.[21]

Complaints had also been received from the Imperial naval authorities, about the unhealthiness of the anchorage-grounds. Early in 1875 typhoid fever had broken out on board a moored "man-of-war" ship and they attributed it to noxious gases coming from the sewer outlet at Fort Macquarie.[22]

The Sydney Sewage and Health Board recommended that the dry-weather sewage at three of the outlets be carried into deeper water "as the only measure immediately available for effecting any mitigation of the evils at the outlets of those sewers".[23] The Sewage and Health Board recommended that in the long term the city sewage be intercepted and diverted. They proposed that the north draining sewage be piped to Bondi and discharged into the sea at Ben Buckler Point and that the south draining sewage including that of Surry Hills, Redfern and Newtown be piped to a sewage farm, either on the lower part of Shea's Creek (now Alexandria Canal) near Botany Bay or on Webb's Grant on the Southern edge of Botany Bay.[24]

THE WATER-CARRIAGE DEBATE

This decision, which was supported by an English engineer, W.C.Clark, brought out to the colony to advise on water and sewerage matters, prompted public debate over the merits of water-carriage technology which was as fierce in Sydney as anywhere in the world if we are to go by the observation of Gustave Fischer, a local civil engineer. In a paper which he read before the Engineering Association of New South Wales in 1884 Fischer compared the feelings on the issue to those of religious faith.

> An out-and-out water-carriage advocate would go to the stake in support of his views, while the advocates of the different systems are equally bigoted in their own way... This excessive orthodoxy... tends to make men narrow-minded and bigoted, and incapable of taking a broad and impartial view. [25]

The debate was not confined to engineers or professionals however. The newspapers regularly published letters to the editor and editorials arguing the advantages and disadvantages of water-carriage schemes and dry conservancy schemes. The issue was covered almost every day in the Herald in March 1880.

The alternatives to water-carriage technology which were put forward at the time did not include an improved cesspit system. Cesspits were not considered as a serious alternative because they were closely identified with insanitary conditions and disease. Although regulations were established to ensure that

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21 ibid.

22 Sydney City and Suburban Sewage and Health Board, Sixth Progress Report, 1875, p8.

23 ibid., p5.

24 Sydney City and Suburban Sewage and Health Board, Twelfth and Final Report, 1877.

25 Gustave Fischer, `Water-Carriage System of Sewerage, Its Disadvantages, as applied to the Drainage of Cities and Towns', paper read before the Engineering Association of New South Wales, Sept 11, 1884, p2.

they were more adequately constructed, appropriately sited and regularly cleansed, the idea of continuing with a cesspit system was out of the question. Reforms had been called for and politically, drastic changes were required. No-one trusted the cesspit system any longer.

The dry conservancy systems which were put forward as serious alternatives included dry closets, pan systems, and pneumatic systems. The dry closet (often referred to as the earth closet), named in contrast to the water-closet or flush toilet, did not use water to wash away the excrement but rather was a means of collecting the solid excrement in a container. (see figure 2.3) The addition of earth, ashes or charcoal after each visit to the closet deodorised the excrement which was periodically collected at night by cart and taken to a processing plant where it was dried out for use as manure.

The pan system consisted of having a pan under the toilet seat which was collected by night-men at regular intervals and replaced with an empty one. The pan was able to take urine as well as faeces and did not require the use of earth for deodorising. One version of the pan system was described at an 1889 meeting of the Engineering Association of N.S.W. by E.W.Cracknell.[26] A collection pan would be fitted to the toilet seat forming an air- tight joint which would prevent the escape of noxious gases. The full pans would be carted to a Poudrette works where the pans would be emptied, washed out mechanically and returned with a measure of deodorant. This would overcome the nuisance and disease that was spread when pans were not cleaned out and would eliminate the need for householders to have to cope with ashes or dry earth.[27]

At the poudrette factory the night soil would be strained. The liquid would be chemically treated to remove the ammonia and then passed into the sewer whilst the solid portion was dried to make cakes of manure called Poudrette. Such a process was already in operation at Botany at the premises of the NSW Poudrette and Ammonia Company and, he claimed, produced no unpleasant smell and the poudrette was sold at a profit as fertiliser.[28]

The first pneumatic system was merely a means of emptying cesspits using air power rather than hand labour. Later Captain Liernur developed a pneumatic system for transporting dry wastes through pipes by means of a partial vacuum created in those pipes. The waste products would be sucked to their destination. It was argued that Sydney was ideally suited to the Liernur system because of its small depth of soil and the consequent difficulty and expense of excavating through solid rock to enable water-carriage sewers to follow the necessary straight lines and gradients that a gravity dependent system requires. [29]

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[26] E.W.Cracknell, `Sanitary Improvements', Proceedings of the Engineering Association of NSW IV, 1888-9, p94.

[27] ibid., p96.

[28] ibid., p95.

[29] T.B.Belgrave quoted in W.C.Clark, Report on Drainage of the City of Sydney and Suburbs, 1877, p28.

CONSERVING A VALUABLE FERTILISER

The main advantage put forward for all dry conservancy systems was their ability to utilise the waste as fertiliser. There was an element of the population in Sydney, as in Britain, that found the idea of utilising the sewage to be an attractive one. Such utilisation was practiced informally in many parts of the world including the industrialising countries.

Figure 2.3 Earth Closet Advertisement

It had been the hope of some of the early sanitary reformers that the sewage collected in sewers could be utilised on sewage farms. Chadwick, in Britain, had observed that sewage in Edinburgh was in much demand by the farmers and in his 1842 report and afterwards he persistently advocated the utilisation of sewage. At this time the Herald reasoned that the fact that sewage does not easily mix with sea water was evidence that it wasn't supposed to be put there. Rather it should be used as fertiliser; "We shall not always be able to rob the soil, and give it nothing in return" they warned.[30]

Despite the popularity of this idea sewers often discharged into watercourses rather than on to sewage farms. In Sydney in the 1850s the City Engineer, conscious that some people would have liked to have seen him utilising the sewage, claimed he had "paid due regard" to the possibility of turning sewage

30 ibid.

into manure and that he realised that this could determine sewage disposal options. Since the use of sewage for manure was so "enveloped" in uncertainty, he had designed the system so that the sewage could be easily discharged to sea if it was found that fertiliser manufacture was not profitable. However Rider was reluctant to engage in manure production because of the uncertain economics and the probable extra cost and lack of immediate profitability of such an operation.[31] Rider's successor as City Engineer, Bell, found it necessary a couple of years later to at least plan for the interception of sewage for use as fertiliser in the future because the Governor General was in favour of it.[32]

Dry conservancy adherents wanted to see human wastes being utilised as fertiliser but they argued that by mixing water with sewage, as occurred in water-carriage systems, the "constituent parts" were spoiled.[33] Moreover, they argued, the use of water-carriage technology limited the area over which fertilizer could be used whereas dry conservancy methods allowed the manufacture of poudrette cakes which could be transported where required. Dry conservancy ensured that "the whole agricultural value of the excrement" was retained and that the resulting manure was in a form in which it could be stored and transported easily.[34]

Dry conservancy methods were also conservative of water, even if sewers were used for other household wastes, because water would not be required for toilet flushing.[35] This was no minor consideration in Sydney which had a history of inadequate water supply. (A Royal Commission into the water supply in 1867 had revealed that some of the most peopled parts of the city were dependent on wells and water carts and that the main supply of water, the Botany swamps, might not be able to meet rapidly accelerating demands for water. When the Sewage and Health Board reported in 1875 they claimed there was a need for drastic improvement in the city's water supply. A scheme to get water from the Nepean River was begun in 1879.[36])

The Sanitary Reform League, originally named the League for the Prevention of Pollution of Air and Water, was formed in Sydney in 1880 to press for alternatives to the Sewage and Health Board scheme. They claimed that they were not committed to any system in particular but, in response to the proposed scheme of intercepting the existing sewers and conveying the sewage to the sea, they merely wanted

> to ascertain whether, by the light of recent experience in other countries where this question has been carefully considered, another and less objectionable scheme can be devised in place of that adopted by the colonial Government.[37]

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31 First Yearly Report of the Commissioners, p28.

32 Second Yearly Report of the Commissioners, p6.

33 First Yearly Report of the Commissioners, p28.

34 U.R.Burke, Sewage Utilization, 2nd edition, E.&F.N.Spon, London, 1873, p21.

35 ibid., p13-21.

36 David Clark, 'Worse than Physic': Sydney's Water Supply 1788-1888 in Max Kelly (ed), Nineteenth-Century Sydney: Essays in Urban History, Sydney University Press, 1978, pp62-63.

37 Sydney Morning Herald, 4th May 1880.

Many of the League's members including their founder, Sir James Martin, the NSW Chief Justice, favoured dry conservancy methods and were prominent in pushing the case for dry conservancy.

Part of the push for not throwing away a fertiliser came from utilitarian values. But the economic value of sewage was not universally accepted. The Sydney Sewage and Health Board argued that the manure would be of little value when mixed with the dried earth.[38] This was denied by dry closet enthusiasts such as Martin who claimed personal experience of its value on his own property in the country.[39] Promoters of the pan system argued that their system increased the value of the product because it was not mixed with earth. They also argued that the value of the resultant manure meant that the pan system generally covered its costs.[40] In a letter read before the Sanitary Reform League Benjamin Backhouse quotes an English sanitary expert:

> high authorities, have repeatedly shown the great agricultural value of the ingredients contained in faecal matters, proving by history, analysis, and innumerable experiments, how absolutely indispensable it is to national welfare and to the highest condition of health and life that this great agricultural treasure should not be lost.[41]

The desire to see sewage utilised seems to have gone deeper than just the utilitarian reason that it might be an economic way of doing things, however. The idea appealed to deeper values, that may have harked back to an agrarian heritage or perhaps a commonsense distaste for wastage. It seems to be a constant theme even in modern day debates over sewage disposal and is not confined to environmentalists.

PROTECTING THE ENVIRONMENT

Dry conservancy advocates criticised water-carriage as a technology that was not only wasteful but also detrimental to the environment and public health. Martin, in a series of letters published in 1880 in the Sydney Morning Herald under the heading "The Pestilence That Walketh in Darkness", criticised the proposed scheme of sewerage because of the air and water pollution it would cause.[42] Air pollution was a particularly damning accusation since it was believed that "miasmas" were responsible for many of the life-threatening diseases around at that time.

Sewer gas was a big problem in the nineteenth century when knowledge of how to trap the gas and prevent its return back into homes and city streets was scarce and workmanship in sewer construction often cheap and shoddy. In Britain some towns imposed fines if houses were connected to main sewers for this very reason and in Manchester the town was converted to "the apparently

[38] The Sydney City and Suburban Sewage and Health Board, Third Progress Report, 1875, p3.

[39] Sydney Morning Herald, 19th March, 1880.

[40] W.H.Corfield, A Digest of Facts Relating to the Treatment & Utilisation of Sewage, MacMillan & Co, 1871, p57.

[41] Sydney Morning Herald, 15th May 1880.

[42] Sydney Morning Herald, 9th March 1880.

safer and more effective dry conservancy method."[43] A letter writer to the Herald argued,

> A well sewered town may be described as supplied with a system of subterranean retorts, so arranged that the fluids in passing give off the largest volume of gases, which are carefully collected, and then by means of chimney pipes (for house drains serve admirably that purpose), conducted into the very heart of the dwellings.[44]

In many parts of the world early sewers had been built to carry off stormwater drainage and when they were converted to take sewage they did not cope very well. They were often large diameter (big enough for a person to walk through) brick construction which meant that flows were slow and sometimes stagnant. They were frequently obstructed by large objects or a build up of solids, and faulty joints permitted a substantial amount of subsoil leakage.

In Sydney it was found in 1875 that of 5,400 water closets supplied by mains water, 4,500 had a direct connection between the toilet pan and the water pipe supplying flushing water so that when the water supply was cut off, as it frequently was, toilet waste could be sucked back into the water mains.

> The certain consequence of this most unusual arrangement is, that the water supplied to the inhabitants for household purposes is polluted with matter which some high authorities consider too offensive to be admitted even to the public sewers.[45]

The other big problem associated with water-carriage technology was the nuisance generally created at the point of discharge. Because of cost constraints and a certain measure of ignorance, and particularly because water carriage meant that there was a substantial liquid component to dispose of, most early sewers were discharged into the nearest watercourse. This rapidly led to the fouling of that watercourse which was generally quite close to the town and often the source of water supply for that town or one downstream. In Sydney it was the Harbour which was polluted and this was considered to be a public health threat because of the "miasmas" which were coming off the harbour waters and shores.

The pollution from sewer gases and untreated discharges therefore sullied the reputation of water-carriage systems and a letter to the Herald warned

> what a pity then, if youthful blooming Australian cities were to begrime themselves with European folly in the shape of sewage by water carriage with their inevitable melancholy train of cholera, typhus, and exhaustion of the soil.[46]

One of the main premises of those who advocated dry closets was that the faecal matter was the most dangerous part of the human excrement. Sir James Martin

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[43] Anthony S. Wohl, Endangered Lives: Public Health in Victorian Britain, Harvard University Press, Cambridge, 1983, p102.

[44] Sydney Morning Herald, 15th May 1880.

[45] Sydney City and Suburban Sewage and Health Board, Progress Report, 1875, p1.

[46] Sydney Morning Herald, 15th May 1880.

wrote, "Nothing is better known than the fact that it is the solid matter that produces the typhoid fever germ - the liquid, by itself, never." [47]

By keeping this dangerous component out of the sewers, they argued, the sewers could then be safely used for the remaining liquid portion of the household wastes. In a text used in Sydney in the nineteenth century, U.R.Burke, an English Barrister, reasoned that the remaining sewage could be more easily dealt with at its destination because of its lesser strength and volume. Additionally, Burke argued that faeces, because of their "greasy and highly tenacious nature," made drains difficult to clean.

Although water-carriage was associated with some public health problems the association of dry conservancy methods with the old cesspit system was understandable. Water-carriage at least removed the source of the problem from the home, quickly and efficiently. It was thought that if the sewage was allowed any time to putrefy or decompose it would give rise to 'miasmas'. Therefore if the sewage was allowed to sit around waiting for collection for the purposes of utilisation it would only cause the very problems which sanitary reform was supposed to solve.

The first government committees to consider the disposal of wastes in Sydney used exactly this argument.

> Your committee are of opinion, that the use of the Sewers is to carry the filth of the City into the sea as speedily as possible, and that the saving of the sewage [as fertilizer] is a subsidiary matter,..The expense, and to a certain extent, the danger of accumulating matter in Sydney, would in the opinion of your Committee, more than counterbalance any advantages which it could afford.[48]

Later, in 1875, the Sydney Sewage and Health Board came to similar conclusions about dry conservancy schemes.

> Such plans, moreover, all violate one of the most important of sanitary laws, which is that all refuse matters which are liable to become injurious to health should be removed instantly and be dealt with afterwards. With all these plans it is an obvious advantage on the score of economy to keep the refuse about the premises as long as possible.[49]

This principle that sewage must be rapidly removed is also alluded to and emphasised in many learned papers given before the Royal Society of N.S.W. and the Australasian Association for the Advancement of Science up to the turn of the century.[50]

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47 Sydney Morning Herald, 19th March 1880.

48 Select Committee, Sydney Sewerage and Water Appropriation Bill, 1854, p6.

49 Sewage and Health Board, Third Progress Report, p6.

50 for example, Joseph Bancroft, 'Various Hygienic Aspects of Australian Life', Australasian Association for the Advancement of Science I, 1887, pp532-3; George Gordon, 'Household Sanitation', Australasian Association for the Advancement of Science II, 1890, p688; J.Trevor Jones, 'Sanitation of the Suburbs of Sydney', Royal Society of NSW 20, 1886, pp362-3; J.

ARGUMENTS OVER EFFICACY

The relative merits of the various schemes being proposed were difficult to evaluate because they were all fairly new and therefore experimental. One Sydney engineer complained that almost all books and pamphlets on the subject were biased, producing "the most hopelessly confusing discrepancies in all values and quantities."[51] The confusion was not only because of bias but also because there was no agreed upon criterion for such an evaluation. Whilst scientists may judge their theories according to how closely their empirical results accord with those predicted, technology has no intrinsic goal and therefore no intrinsic measure of efficacy. Evaluation policies develop as a field of technology matures and according to David Wojick, these may include scientific theories, engineering principles, rules of thumb, legislation, professional standards and moral precepts.[52]

The efficacy of a technological process or the question of whether it "works" are concepts that are relative to social objectives and the aims and purposes of those who advocate the technologies involved. What counts as working has to be socially negotiated[53] and criteria of effectiveness vary depending on a person's domain of interest.[54] Often technologies are assessed according to set standards or what Edward Constant has called "traditions of testability". Such traditions embody norms such as the overt commitment to objective, scientific, replicable and public testing. He argued that traditions of technological testability permit practitioners to know which designs and modifications represent progress by helping them to see how closely they are approaching the ideal.[55]

It is important to note that traditions of testability or standards must either result from a consensus of opinion or be imposed by a body, whose authority is commonly accepted. Unfortunately when there is no agreement about competing technologies, or even the primary objectives of such technologies, as was the case with water-carriage and dry conservancy technologies, then agreement about standards and criteria of efficacy cannot be reached and the relative worth of each technology cannot be decided on the basis of "efficacy" alone.

There were places in Australia and overseas that were using the earth-closet system to some degree but these examples were used by people on both sides of the debate to prove the success and the failure of such a scheme. Burke, for example, claimed that earth closets of the type invented by Mr Moule, which automatically dropped the earth onto the excretion, had been used successfully in India and he quoted an English report that listed the advantages of the earth

Ashburton Thompson, 'Sewerage of Country Towns: The Separate System', Royal Society of NSW 26, 1892, p133.

51 Sewage and Health Board, Third Progress Report, p6.

52 David, Wojick, 'The structure of technological revolutions' in George Bugliarello & Dean Boner (eds), The History and Philosophy of Technology, University of Illinois Press, 1979, p240.

53 John Law, 'International workshop on new developments in the social studies of technology', 4S Review 2(4), 1984; p9.

54 Ruth Schwartz Cowan, 'The consumption junction: a proposal for research strategies in the sociology of technology' in Wiebe Bijker, Thomas Hughes and Trevor Pinch (eds), The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology, MIT Press, 1987, pp261-280.

55 Edward Constant, 'Scientific theory and technological testability: science, dynometers, and water turbines in the 19th century', Technology and Culture. 24(2), April, 1983, pp183-198.

closet system including the cheaper cost and easier maintenance of earth closets when compared to water-closets and the easier utilisation of the manure.[56]Sir James Martin and others cite successful uses in New Jersey, Paris and Stockholm and also Balmain.[57]Conversely the Sydney Morning Herald argued that the earth closet had been tried in Balmain, Manly, Melbourne and Brisbane without success.[58]

Often the criticisms on both sides were based on the worst representative cases of each others schemes; dry-closets that were shared among far too many people; night-soil collection that was not properly supervised nor regulated; poorly constructed sewerage schemes. For example a Sydney engineer advocating water-carriage sewers, J.B. Henson, admitted that the results of many sewerage systems had been unsatisfactory but he argued, these were designed by people who did not understand sanitary principles. The Herald argued

> It is not fair to compare the principle of water carriage, when badly worked out with that of the earth-closet system, carried out under imaginary, and in our case unattainable conditions. [59]

The debate should also be considered in the context of crisis. The tendency not to implement new systems of technology in the public sector until a crisis makes it no longer possible to put off the inevitable reforms means that such decisions are made when there is little time or flexibility for pioneering uncertain alternatives.

An objection made by the Sydney Sewage and Health Board against earth closets was that it would be practically impossible to get enough "thoroughly dried and sifted earth of the proper quality." The quantity of refuse, enormously inflated by the earth would be impossible to dispose of. These points were especially true if bedroom slops (liquid excreta) were allowed into the earth closets. If they weren't then sewers would still be required and would be just as contaminated as before.[60] The advocates of dry conservancy paid little attention to how the urine of the population would be dealt with.

Dry closet advocates did not expect the dry closets to cater for liquid wastes. The problem of obtaining dry-earth was one that was countered by the claim made by an engineer in a letter to the editor that ashes and street sweepings were even better deodorising agents and at that time were available to every household. These ingredients would have to be carted away as refuse anyway.[61]

The relative economics of the various schemes was another hotly debated issue. The dry conservationists argued that their schemes were more economical because of the value of the manure which would be sold, the savings in water and the lesser treatment that the remaining sewage would require. The value of the manure was a particularly indeterminate matter, and there was little agreement either on its efficacy in improving farm yields or on the price that it would fetch.

56 Burke, Sewage Utilization, pp14-21.
57 Sydney Morning Herald, 16th March 1880, 19th March 1880, 24th March, 1880.
58 Sydney Morning Herald, 13th March 1880, 9th April 1880
59 Sydney Morning Herald, 13th March 1880.
60 Sewage and Health Board, Third Progress Report, p3.
61 Sydney Morning Herald, 24th March, 1880.

Moreover the price that it could be sold for at the time did not reflect the long-term value to the soil. In the relatively young colony of N.S.W. the land had not yet been overworked and deprived of many of its nutrients and fertilisers were not as much in demand then as later. The cost of artificial fertilisers to the farmers was not considered to be a cost that should be attributed to water-carriage systems. The cost of transporting the sewage or poudrette to the farmer, however, was included in the costs of dry conservancy methods and this was one of the key factors in depriving the manure of any value. [62]

Advocates of the Liernur pneumatic system argued that their system would be cheaper because small pipes could be used with a minimum of excavation and easier access for maintenance of the pipes that would be near the surface.[63] The costs of creating a vacuum compared favourably to the cost of pumping the sewage up from low-lying areas and up to the surface for treatment in a water-carriage system. Ventilation shafts would be unnecessary because there would be no build up of sewer gases and flushing of the pipelines would be unnecessary because of the high velocity of any liquids passing through the pipes, thus saving on water.[64] A water carriage system, excavated deep into the rock would be difficult and expensive to repair. Liernur's system of pneumatic pipes would be cheaper to build, easier to maintain and easier to expand as population grew because its parts were "susceptible of independent action".[65]

On the other hand water-carriage proponents argued that because dry conservancy methods did not deal with the large quantities of liquid household wastes, sewer systems would still have to be built and therefore the cost of dry conservancy methods were always additional to the cost of a sewerage system. This argument was made at a time when it was supposed that a combined system of drainage and sewage pipes would suffice for a city.[66] Later it was found that separate systems were required and it is uncertain how this consideration may have influenced the argument.

The operating costs of sewers were definitely lower than those of pan and dry closet systems because of the labour involved in the latter, especially when the labour required to enrich the manure and transporting it to farm land were considered. Moreover, sewerage systems were paid for on a completely different basis from cesspit, pan and dry closet systems which were paid for individually. Sewerage systems were paid for by the municipality or city and the capital cost was spread over a number of years through bond issues and loans.

However, the pan system was used in Sydney suburbs for many years, some until quite recently, as a cheaper, 'temporary' alternative to sewers. The very substantial cost of sewerage schemes made it difficult to argue for them on the

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[62] for a U.S. analysis of sewage as fertiliser see Joel Tarr, 'From City to Farm: Urban Wastes and the American Farmer', Agricultural History XLIX(4), Oct 1975, 598-612.

[63] E.M.de Burgh, Report on the Liernur Pneumatic System of Sewage Collection, NSW Legislative Assembly, 1905, p1217.

[64] ibid.

[65] T.B.Belgrave quoted in W.C.Clark, Report on Drainage of the City of Sydney and Suburbs, p28.

[66] for an analysis of decision-making between separate and combined systems of sewerage see Joel Tarr, 'The Separate vs. Combined Sewer Problem: A Case Study in Urban Technology Design Choice', Journal of Urban History 5(3), May 1979: 308-339.

basis of cost savings. However, the fact that Sydney had already invested a large amount of capital in water-carriage technology (and that capital had been extracted from the rate-payers with great difficulty) before these debates came to the fore. Moreover there were people in high positions who would have baulked at starting all over and especially since this would have meant admitting that earlier decisions had been wrong.

Earlier decisions had in fact set in place the beginnings of a technological system which was set to expand and grow. Such a system, as described by Thomas Hughes in his work on electricity generation,[67] encompasses not only physical equipment but also organisations, professional allegiances, legislative artifacts and scientific components. Such a system develops a momentum that is a powerful conservative force ensuring that development takes place in certain directions that were consolidated early in the system's formation. By the 1870s and 1880s the Sydney sewerage system had accumulated some organisational and financial momentum which made it difficult for dry conservationists to alter its direction.

Another, perhaps more pressing, reason for the triumph of sewers over closets and pans lies in the opportunities they offered in terms of planning and control.

ORDER, SOCIAL CONTROL & PROGRESS

The Sydney Sewage and Health Board argued that Dry Closets were unsuitable for large towns because it was practically impossible to secure proper management of the earth-closets and this was necessary to prevent the closet becoming "a filthy and dangerous nuisance".[68] Professor Corfield, an acknowledged English authority in sanitary matters and a medical man by training, also pointed to the problems that would ensue if the contents of the earth closet were to become moist because liquids had been added or the air was very damp.[69] Other management problems included getting people to apply the dry earth or ashes in sufficient quantity and detail to their excrement. Corfield argued that "decent people" managed their dry closets so that they were clean and inoffensive but was of the opinion that

> the lower classes of people cannot be allowed to have anything whatever to do with their own sanitary arrangements: everything must be managed for them.[70]

The Herald claimed that the danger with earth closets arose from the "ignorance, the recklessness, or the neglect of the people" which could only be fixed with generations of public education, not just public organisation and regulation.[71] Dry closet enthusiasts admitted that the earth system failed in some places because "of a want of ordinary skill or an absence of efficient supervision such as

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67 Thomas Hughes, Networks of Power: Electrification in Western Society, 1880-1930, John Hopkins University Press, 1983.

68 ibid., p3.

69 W.H Corfield, Sewerage and Sewage Utilization, D.Van Nostrand, New York, 1875, p52.

70 Corfield, The Treatment and Utilization of Sewage, pp31-2.

71 Sydney Morning Herald, 13th March 1880.

would cause any other scheme to fail."[72] And indeed proper management was also a problem with water closets when they were first introduced.

> The ordinary water-closet is obviously unsuited for careless and wantonly mischievous people. The pans get broken, the traps choked up, the water is left running on continually from the tap, or the tap is broken and leaks wastefully; in frosty weather there is no water, and the consequence is that the closets become filthy and stinking.[73]

These problems, which were so readily blamed on the carelessness of the poor, arose because poor families were forced to share both earth and water closets with several other families and because of a lack of education about their use. An 1885 British survey found that 90% of houses inspected had broken or unflushable water closets, and five years later it was found that of 3000 houses inspected only 1% did not have plumbing or draining defects.[74]

Despite the problems with water closets, they were being installed by the affluent before water-carriage disposal systems were even available. As the most modern of conveniences they were regarded as a more desirable device. They were relatively simple and automatic to operate and they removed the offensive matter from sight and from inside the home immediately. This was an important consideration given the association of the proximity of excrement and its smells with disease so recently implanted in the minds of the middle classes. Corfield described the reluctance of people in England to use earth closets that had been installed. Many preferred to continue using the privy vaults and cesspits in their back yards because they considered the use of an earth closet close to their dwelling rooms to be unhygienic.[75]

In some ways the introduction of water closets and piped water supplies encouraged the subsequent adoption of water-carriage methods of removal. Significantly, water-carriage systems offered more potential for control and were therefore more attractive to the authorities in Sydney and also in many other cities around the world. Although the actual toilet might remain a private responsibility and therefore be subject to abuse, the automatic nature of the flush toilet removed the need for individual decision making about when and how to remove sewage from the home[76] and the collection, carriage and disposal was necessarily a centralised, government controlled activity. Jon Peterson, an American writer, observed that the old private-lot waste removal system "epitomized the piecemeal, decentralized approach to city building characteristic of the nineteenth century." [77]

Water-carriage systems, as advocated by sanitary reformers and government authorities, required an integrated system of underground pipes that were

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[72] Sydney Morning Herald, 19th March 1880.

[73] Corfield, The Treatment and Utilization of Sewage, p118.

[74] Wohl, Endangered Lives, p102.

[75] ibid., p88.

[76] Tarr et al, 'Water and Wastes', p234.

[77] Jon A. Peterson, 'The Impact of Sanitary Reform Upon American Urban Planning, 1840-1890', *Journal of Social History*, vol 13, Fall 1979, p85.

planned, engineered and coordinated with reference to a larger, city-wide plan.[78] Political boundaries could not fragment a sewerage scheme, rather local councils were forced to give authority to more centralised government bodies in the realm of waste disposal once water-carriage systems were adopted. Water-carriage, with its scale economies, capital intensiveness and need for central administration "was an important factor in facilitating governmental integration."[79]

The visible signs of dirt and disease would be removed from the city streets once and for all and this was an important step in cleaning up and ordering the city environment. A letter to the editor describes how dry closet and pan systems fill the streets with their operations.

> The waggons are encountered in the streets, both night and day, and pedestrians, with the utmost unanimity, pass by on the other side, notwithstanding that the men when carrying the pans to the waggons, put on each an iron cover. Letters of complaint frequently appear in the newspaper, also house property in the neighbourhood of the depots has considerably depreciated in value, and numbers of the houses are without tenants.[80]

People didn't like the frequent visits of the scavengers or "night men" who often had to traipse through the house and were said to be an inconvenience to householders.[81] The Sydney Morning Herald went even further, arguing that to retain any measure of control over dry closets it would be necessary for delivery and collection to be by

> a process of domiciliary visitation by men armed with authority to see that this portion of the domestic arrangements of every house was properly attended to. The people would live under the visitation and supervision of an army of scavengers.[82]

Water-carriage offered not only a government controlled solution to sewage collection but also one that was automatic and therefore not dependent on armies of scavengers or night-cart men. The dry earth and pan systems were dependent upon cartage and manual labour. The replacement of a labour intensive system with a capital intensive one seemed to be in line with progress and technological advancement in other areas of life. The Quarterly Review in England argued,

> Tube-drainage is therefore cheaper than cesspool-drainage, for the same reason, and in the same degree, that steam-woven calico is cheaper than hand-made lace. The filth and the finery are both costly, because they both absorb human toil; the cleanliness and the calico are alike economical, because they are alike products of steam-power.[83]

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[78] ibid., p84.

[79] Tarr et al,'Water and Wastes', p252.

[80] Sydney Morning Herald, 19th April 1880.

[81] Corfield, The Treatment and Utilization of Sewage, p 33.

[82] Sydney Morning Herald, 26th March 1880.

[83] F.O.Ward, 'Sanitary Consolidation-Centralization-Local Self-Government', Quarterley Review 88, 1850, p479.

The widespread belief that progress ensued from technological change and modernisation, also linked water-carriage technology to urban progress. Sewers, despite their ancient heritage were seen to be more scientific than dry conservancy systems which seemed in turn to be somewhat primitive. Florence Nightingale observed in an 1870 Indian Sanitary Report that

> The true key to sanitary progress in cities is, water supply and sewerage. No city can be purified sufficiently by mere hand-labour in fetching and carrying.
> As civilization has advanced, people have always enlisted natural forces or machinery to supplant hand- labour, as being much less costly and greatly more efficient.[84]

The progressive image of sewerage systems and their very real effect in cleaning up cities had a significant effect on the development of a city, especially where it was in competition with other cities for population and investment. It was generally recognised that connection to a sewerage system increased real estate values and it has been argued that businessmen in some places considered sewerage works and water supply as "business investments in the projection of a favourable urban image."[85] The impact on health, although clear in other cities, was not so marked in Sydney until after 1880 if one considers the death rate. (see figure 2.4)

ENGINEERS AND PROFESSIONAL CONTROL

The image of water-carriage technology as scientific and progressive was fostered by engineers whose professional image was thereby enhanced. The debate over methods of sewage collection was not confined to engineers but was readily taken up by doctors and lawyers, military men, architects and non-professional members of the public.

Water-carriage was almost universally endorsed by government officials, local councils and by the various professional groups in Sydney. The Royal Society of N.S.W. resuscitated its sanitary section in 1886 and in papers given by Trevor Jones, the City Engineer, F.H.Quaife, M.D, J. Ashburton Thompson, M.D, Chief Medical Inspector, John Smail, M.Inst.C.E of the Government Sewerage Department and other doctors and engineers water-carriage sewerage systems were discussed with the assumption that they were the only solution to the problem. Dr Ashburton Thompson did discuss scavenging and poudrette manufacture but he made it clear that such measures were temporary solutions pending the sewerage.[86]

The Sanitary Science and Hygiene Section of the Australasian Association for the Advancement of Science also received papers on matters concerning sewage disposal. These papers were usually given by medical men and engineers,

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84 quoted in The Sydney City and Suburban Sewage and Health Board, Third Progress Report, 1875, p6.

85 Joel Arthur Tarr and Francis Clay McMichael, 'The Evolution of Wastewater Technology and the Development of State Regulation: A Retrospective Analysis' in Joel A.Tarr, ed, Retrospective Technology Assessment-1976, San Francisco Press, 1977, p176.

86 J. Ashburton Thompson, 'Aids to Sanitation in Unsewered Districts: Poudrette Factories', Royal Society of NSW 23, 1889, pp450-65.

including government engineers and university professors, who favoured the water- carriage sewerage system. A notable exception was an 1891 paper delivered by Benjamin Backhouse, H.A.R.I.B.A, Chairman of the City of Sydney Improvement Board which favoured Captain Liernur's Pneumatic System.[87]

Obviously engineers did not have a monopoly of control over sanitary decisions at this stage and a person who was trained in almost any field could make their name as a sanitary expert merely by studying the issue carefully and writing about it. Engineers were however closely associated with large-scale public works, the construction of tunnels and the laying of pipes, and overseas engineers were carving out a profession for themselves in the area of sanitation. That sewers had for some time been considered to be an engineering domain, even if the quality of work and financial management of it was subject to question from government, is clearly seen in the early stages of the construction of Sydney's sewerage system.

The reform measures pushed by sanitary reformers in the nineteenth century were largely technological and the development of new technologies associated with water supply and the water-carriage of sewage offered the opportunity for a new professional group to form which claimed to have specialised knowledge in the field. In the 1870s two British civil engineers published books with the term "sanitary engineering" in their titles. This was followed shortly after by an American book.[88]

At first sanitary engineering was loosely defined and included plumbers and others in the sanitary field who were not engineers but it soon started to define itself "more explicitly in a scientific and disciplinary sense".[89] The push for sewerage to be seen as scientific was exemplified at a Sydney meeting where an engineer argued, with respect to the engineering of sewers, that

> ... it must be borne in mind that these principles and the best methods of applying them have been developed gradually and are the outcome of the experience of the past, combined with the results of scientific research. [90]

Attempts were made to exclude non-engineers from the field and establish sanitary engineering as a profession distinct from other professions. This involved the exclusion of tradesmen on the grounds that they specialised in only one aspect of sanitary matters and were not professionals, and the exclusion of physicians because they were not able to execute engineering works. Public health officials and municipal bureaucrats, the engineers argued, did not have sufficient breadth and depth of training. The base for sanitary engineering was

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87 Benjamin Backhouse, \`On the Sewerage Question, and the Desirabiity of introducing the Pneumatic System invented by Captain Liernur.', Australasian Association for the Advancement of Science III, 1891; 408-410.

88 Tarr et al, 'Water and Wastes', pp246-7.

89 ibid., p247.

90 J.B.Henson, \`Sanitary Sewerage', Australasian Association for the Advancement of Science I, 1887, pp530-5.

civil engineering to which a knowledge of physical and natural sciences was added.[91]

> The sanitary engineer has a treble duty for the next few years of civic awakening. Having the knowledge, he must be a "leader" in developing works and plants for state and municipal improvement, at the same time he is an "expert" in their employ. But he must be more; as a health officer he must be a "teacher" of the people to show them why all these things are to be. [92]

At the same time medical professionals in the public health area were carving out their own area of expertise. With the changing ideas about disease causation at the end of the nineteenth century physicians tried to exclude those outside the medical profession from the field of public health and to change the emphasis from collective community susceptibility to disease to personal and individual cure of disease with attention being given to specific agents of disease.[93] Engineers, on the other hand, retained the idea of the importance of environmental sanitation to health whilst it lent importance to their work.

Environmental sanitation fitted well with the engineering perspective which attempted to impose order on the natural environment, find technological fixes for social problems [94] and tended to view the urban environment in terms of a series of problems to be solved. In this way,

> They adhered to a set of values and procedures which stressed efficiency within a benefit-cost framework, and this appealed to late-19th- and early-20th-century reformers attempting to restructure municipal government along lines of professionalism, efficiency, and bureaucratization.[95]

The engineering priority of finding the least cost solutions, and not being swayed from that by other lesser considerations, also caused them to support the no-nonsense water-carriage system over other systems that attached some non monetary value to manure. An engineering text put it quite simply "The all-convincing argument with any but the sentimentalist is that, while there may be manurial value in sewage, no commercially profitable method of utilizing it has been found."[96]

Because water-carriage technology needed to be implemented systematically to ensure effective functioning rather than in the piecemeal or ad-hoc way that dry conservancy methods lent themselves to, it was particularly compatible with engineering ideals since it required planning, engineering expertise and

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91 Tarr et al,'Water and Wastes'; Martin Melosi, Garbage in the Cities: Refuse, Reform and the Environment, 1880-1980, Texas A. & M. University Press, 1981, p120.

92 Ellen Richards quoted in Melosi, Garbage in the Cities, p120.

93 Barbara Gutmann Rosenkrantz, 'Cart before Horse: Theory, Practice and Professional Image in American Public Health, 1870-1920', Journal of the History of Medicine, January 1974, pp63-64.

94 Melosi, Garbage in the Cities, p22.

95 Tarr et al, 'Water and Wastes', p254.

96 A. Prescott Folwell, Sewerage. The Designing, Construction, and Maintenance of Sewerage Systems, John Wiley & Sons, New York, 1901, p8.

centralised management and particularly engineering management.[97] Engineers approached their work in a systematic way and viewed the city as a large integrated system "with the efficient functioning of one part dependent upon the efficient functioning of the whole." In the United States engineers likened their relationship to the city to that of a family physician to the family.[98]

The problems associated with poorly conceived and constructed sewer systems, especially the problems of seepage and sewer gas, were used by engineers to argue for more expertise to be employed with regard to sewerage systems. Water and sewerage systems, as lifelines for the city, were so important, they argued, that only professional experts should be trusted to build and administer truly comprehensive schemes of sewerage.[99]

Water-carriage systems entailed large-scale public works and large capital outlays and the engineers' association with public works, as well as their ability to minimise costs and to prioritise economic considerations, was an asset under the circumstances. Because of the large capital investment involved in sewerage systems and their relative inflexibility to change, water-carriage systems had to be designed with an eye to the future. It was necessary to predict population levels and changes in land usage some years into the future so that adequate capacities were built into the system. The data collection and planning, as well as the land acquisition, overseeing of construction, daily administration and maintenance work required a permanent bureaucracy.[100] And eventually, as happened in Sydney in the Metropolitan Board of Water Supply and Sewerage, that bureaucracy would be dominated by engineers.

In engineer-dominated bureaucracies all over the world engineers organised themselves into hierarchies with division of responsibility, standardised systems of monitoring costs and organising budgets. Such bureaucracies promised greater efficiency and provided the model for all public works construction and management.[101]

Although a close working relationship developed between municipal and government authorities and engineers, engineers tried to divorce themselves from local politics and to establish an image of being neutral experts or consultants. They claimed to represent the qualities of the ideal administrator - "expertise, efficiency, and disinterested, incorruptible professionalism".[102] They formed networks and associations with other engineers to exchange information and practices.[103] The Engineering Society of N.S.W. was formed in 1870 and papers were often given on sanitary engineering topics. Many N.S.W. engineers were members of British Engineering societies and this was put forward as a

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97 Tarr et al, 'Water and Wastes', p257.

98 Stanley K. Schultz and Clay McShane, 'Pollution and Political Reform in Urban America: The Role of Municipal Engineers, 1840-1920' in Martin Melosi (ed), Pollution and Reform in American Cities 1870-1930, University of Texas Press, 1980, p160.

99 ibid., pp162-3.

100 Tarr et al, Tarr et al, 'Water and Wastes', p252; Stanley K. Schultz and Clay McShane, 'To Engineer the Metropolis: Sewers, Sanitation, and City Planning in Late-Nineteenth-Century America', Journal of American History LXV(2), Sept 1978, p398.

101 Schultz & McShane, 'Pollution and Political Reform in Urban America', p165.

102 ibid., p166; Schultz & McShane, 'To Engineer the Metropolis', p399.

103 Schultz & McShane, 'To Engineer the Metropolis', p401.

reason for lack of membership and the failure of various colonial societies during the nineteenth century.[104] In Australia, as in the United States, membership of such societies and their publications consolidated the engineering profession, unified their approach to sanitary problems and helped to give them a more cosmopolitan outlook and a certain independence from local politics.[105]

Nonetheless, claims of political neutrality did not fit the reality of the situation in which engineers were gaining power in public administration and were employees of municipal councils or government bodies subject to political direction.[106] The claim that sewerage decisions should be left to neutral experts was in line with the general engineering strategy noted by Noble that engineers tend to portray themselves as non-partisan in a bid to "insulate them and their activities from political scrutiny".[107]

Whilst pneumatic systems of sewerage offered similar opportunities for engineers and required planning and central administration, they were very experimental. Some engineers did, in fact, favour pneumatic systems. The Engineering Society of N.S.W. heard Gustave Fischer's paper in 1884[108] advocating the pneumatic system but government officials were not enthusiastic. The Sydney Sewage and Health Board quoted an English report that said that such a system was too expensive and, although ingenious, so complicated that it is liable to break down and be difficult to repair. They argued that they knew of no English town in which the adoption of a pneumatic system "would be other than a costly toy".[109]

The government report in which the new scheme of sewerage was proposed for Sydney that same year was equally dismissive. The author, advising engineer W.Clark, claimed that Liernur's system did not cater for house-drainage and therefore a system of sewers would have to be built anyway and the Liernur system would then obviously be too costly.[110] Versions of the pneumatic system were proposed that would deal with house-drainage; one was entered in a competition in Melbourne and proposed a high pressure pneumatic system which used compressed air and a series of tanks to push rather than pull the sewage.[111] Indeed there are vacuum systems of sewerage operating throughout the world today and a vacuum system of sewerage is being planned for the Kurnell community in Sydney and Kiama on the South Coast of NSW because of the particularly difficult terrain there.[112] But these are seen as minor exceptions to the standard water-carriage system.

[104] A.R.Haas, 'Nineteenth Century Engineering Societies', in Institution of Engineers Australia, The Value of Engineering Heritage, National Conference Publication No 85/3.

[105] Schultz & McShane, 'To Engineer the Metropolis', p400.

[106] ibid., p408.

[107] David Noble, The Forces of Production: A Social History of Industrial Automation, Knopf, New York, 1984, p43.

[108] Fischer, 'Water Carriage System of Sewerage'

[109] Sewage and Health Board, Twelfth and Final Report, p9.

[110] W.Clark, Report on Drainage of the City of Sydney and Suburbs, p11.

[111] "Lucifer", Pneumatic High Pressure Sewerage for Cities, Towns and Villages: An Essay on the Sewerage Question, pamphlet, Sydney, 1881.

[112] Kiama Independent, 4th December 1985; 'End of Era at Kurnell', Aquarian 29, 18th September 1987, p3.

Whilst many books written by acknowledged sanitary experts in the nineteenth century devoted much space to the debate between dry conservancy methods and water-carriage system, the texts written by engineers and for engineers were notably lacking in attention given to the debate. Such well-used texts as Latham's massive volume on Sanitary Engineering barely mention the alternatives to sewers except to dismiss them in a line or two.[113] An important exception is perhaps Colonel Waring who although a member of various engineering associations was originally trained as an agricultural scientist and probably placed a higher priority on utilisation of manure than most engineers.[114]

The authorities were also quite dismissive of dry conservancy methods. The Sydney Sewage and Health Board, reporting in the 1870's, felt it was necessary to comment on the dry-earth system of sewage disposal because of all the discussion that had taken place and the strong representations on behalf of that system that were made to them from different quarters but they obviously would have preferred to ignore the idea.

> the whole matter has we find been so thoroughly tried, considered, and discussed for several years past in Europe and in India, that it seems to us unnecessary to take any further evidence here. [115]

And an 1887 report was even more dismissive

> At the best, the so-called dry systems are but inferior substitutes for water-carriage, which, if efficiently constructed throughout, is the cleanest and most convenient of all.[116]

CONCLUSION - ANALYSIS OF A CONTROVERSY

It would be overly simplistic to say that water-carriage technology caused the increased centralisation and bureaucratisation of waste disposal and that the implementation of water and sewerage systems gave rise to the sanitary engineering profession. The technology was favoured by certain sections of the community for the very reason that it was likely to have these results and it was implemented in such a way that it would. Water-carriage technology is an example of what Langdon Winner describes as "inherently political technologies, man-made systems that appear to require, or to be strongly compatible with, particular kinds of political relationships."[117]

The fight between advocates of water-carriage technology and supporters of dry conservancy technologies was an uneven one from the start. The government and the engineers who advised them generally favoured water-carriage systems because they could be controlled more easily and necessitated a centralised

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113 Baldwin Latham, Sanitary Engineering: A Guide to the Construction of Works of Sewerage and House Drainage, 2nd edition, E & F.N.Spon, 1878.

114 Geo. E. Waring, Jr, Modern Methods of Sewage Disposal, D.Van Nostrand, New York, 1894.

115 Sewage and Health Board, Third Progress Report, p3.

116 George Stayton, Sewerage and Drainage of the Western Suburbs, Department of Public Works, 1887, p7.

117 Langdon Winner, 'Do Artifacts Have Politics?', Daedalus 109, 1980, pp123.

government bureaucracy staffed by experts. Sewers were automatic and took responsibility away from individual householders and landlords and private carters, whom, it was felt could not be trusted. Dry closets especially, depended on proper management in the home as well as regular collection and responsible disposal. Sewers removed the cause of trouble quickly and quietly from under peoples' noses.

And whilst the government could achieve sanitary reform aims, engineers saw the opportunity to establish themselves as experts in a new field of sanitary engineering and to increase their role in city management. Very few engineers participated in the newspaper debate; since this was a matter for experts, public opinion was not of much significance. Advocates of the alternative schemes, though often professional people, doctors and lawyers usually, were nonetheless outsiders since the liaison between engineers and city councils was forged early when the first sewerage systems had been built in the face of almost no opposition.

Given these hidden agendas, the public debate was quite secondary as far as the final outcome was concerned but was necessary to justify the increased control of local councils in a partial removal of essential public services from the see-saw world of political life and to indicate that such arrangements were ultimately compatible with a pluralist, democratic society. For this reason dry conservancy alternatives were addressed in official reports but reluctantly and quite dismissively.

Opposition to water-carriage technology was basically value based. Opponents' central concerns were to do with pollution and conservation of resources, but these concerns were not really addressed. Debate was often focussed on technical issues of economics and efficacy. These issues could not be resolved because there were no standard criteria or test of what it meant for a system to be "working" or effective. Overseas experts and overseas experiences were often referred to in the debates in Sydney by both sides of the debate. As Fischer and Burke before him observed, everyone seemed to be able to conjure up quantities and statistics, costs and measurements to support their case.

> we find the most hopelessly confusing discrepancies in all values and quantities which should be but the data and not the deduction of the various authors.[118]

Nor could economic arguments be resolved when proposed schemes were hypothetical, price frameworks varied from place to place and when dry conservancy advocates wanted to include such factors as the long term productivity of the soil and city officials were more concerned with the immediate first cost of any scheme. Moreover the situation was swayed to a considerable extent by the contention at the time that a combined system of sewers and drains was adequate and that dry conservancy methods would require a set of drains as well as sewage collection. Also the fact that Sydney had already invested a large amount of capital in water-carriage technology before these debates put the economics clearly in favour of the existing system.

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118 Burke, Sewage Utilization, px; Fischer, 'Water-Carriage System of Sewerage', p2.

The current theories of disease causation also aided the water-carriage argument and were responsible for a certain amount of distaste in the popular mind for conservancy methods which forced them to accumulate the evil stuff for collection and put up with carts full of it travelling through the streets. Even after the germ theory of disease causation became established engineers were reluctant to completely dismiss the idea of miasmas because of its usefulness to their arguments. In 1901 an engineering text stated

> Fresh sewage if not taken into the stomach is neither injurious to health nor very offensive to smell; but from putrescent excreta and kitchen slops come those noisome gases which, if not themselves bearers of malefic germs, at least lower the vitality and render the body more vulnerable to disease.[119]

The actual evidence that water-carriage methods were safer was less obvious during the 1870s, partly because of the very serious problems associated with poorly constructed water-carriage systems all over the world. Nonetheless many cities had experienced a drop in mortality levels following the construction of sewer systems. The evidence on the side of dry conservancy systems was even less clear cut and the Liernur system was especially risky in its lack of working models and because of its early stage of development.

The attempts by the Sanitary Reform League to inform public opinion about the options were more than counteracted by the calls of the newspapers for sewerage systems. People were encouraged to perceive water-closets as being clean and sewers as being the mark of progress and civilisation. The question of what to do with the sewage once it had reached its destination and the problem of subsequent pollution at the point of discharge were considered by the authorities and the engineers to be a separate and less important question and were not allowed to confuse the issue of how best to collect and remove the sewage. These problems were dealt with as they arose but the dependence of water-carriage technology on waterways for disposal has left a legacy of water pollution problems and it has been argued that

> the reliance on incrementalism and retrofit has obscured the high long-term costs of using waterways for waste disposal and prevented the full consideration of radical alternatives to the water-carriage system that the magnitude of the waste problem deserves.[120]

It is perhaps ironic that, although water-carriage technology won the day and became almost universally considered to be the superior solution to sewage removal, sewerage systems were often slow to be implemented because of their high costs and various dry conservancy methods and individualised household treatment systems (septic tanks etc.) were introduced, and have been maintained in Sydney, even until the present day. Whilst research and development has been aimed at improving sewerage systems, until recently, little work has been done on improving household collection and treatment systems because of their supposed temporary nature. As a result, the problems associated with household

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119 A. Prescott Folwell, Sewerage. The Designing, Construction, and Maintenance of Sewerage Systems, John Wiley & Sons, New York, 1901, p3.

120 Tarr & McMichael, 'The Evolution of Wastewater Technology and the Development of State Regulation', p185.

systems still remain and their reputation is somewhat akin to the reputation of the cesspit system in the nineteenth century.

The next two chapters will consider the subsequent problems of treatment and disposal that followed from the newly instituted water-carriage systems.

CHAPTER 3

SEWAGE TREATMENT - FROM SEWAGE FARMS TO SEPTIC TANKS

During the second half of the nineteenth century sewage treatment methods developed rapidly with most of the research going on in Britain, Europe and the United States. A large number of proposals were made and the debate over which methods were best was often heated. It was a time when articles on sewage treatment appeared not only in engineering journals but also in scientific journals. Many books were written, often by lawyers and medical men as well as by engineers. Sewage treatment was a subject that the general public had an interest in at this time.

Most developments were based on empirical research and the theoretical understanding of how they worked often came later. This is not to say that the investigators were oblivious to scientific discoveries. In fact they often used such discoveries to justify particular treatment technologies and to improve upon them.

The impetus for this research came mainly from Britain where there was a perceived need to clean up the rivers and streams. Many local authorities were forced to experiment with different methods and variations to those methods so as to conform with legal and government requirements. Several companies saw this as an opportunity to make a profit and various processes and materials were patented and marketed.

At first it was thought possible that an ideal treatment solution could be found that effected a high purity of effluent, left no awkward by-products and had no smell. During the second half of the nineteenth century this was what researchers aspired to.

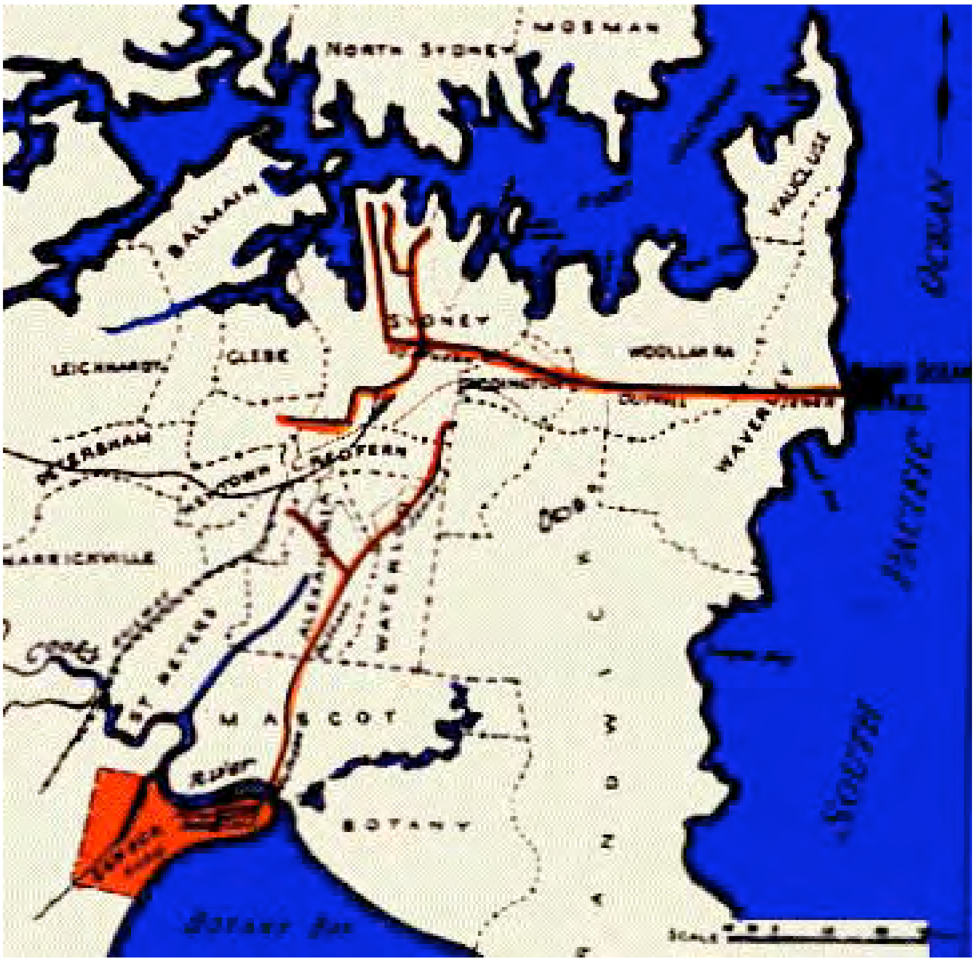
In Sydney, in places where ocean disposal was too expensive in the short term, some of the more popular treatment methods developed overseas were experimented with. Sydney authorities could afford to experiment because ocean disposal was always an option in the long term but the very fact that such schemes were experimental often prejudiced their viability from the start.

In its final report in 1877 the Sydney Sewage and Health Board decided that the city sewage should be intercepted before it was discharged into the Harbour. Most of it would be diverted to Bondi where it could be discharged, without treatment into the sea. This decision will be discussed more fully in chapter four when the preference on the part of engineers for ocean disposal will be considered. In this chapter the various treatments that were implemented where ocean disposal was not available will be explored, in particular the sewage farming option.

SEWAGE FARMS AND THE CONSERVATION LOBBY

In 1877 the Sewage and Health Board also decided that the southward draining city sewage and that of the southern suburbs of Surry Hills, Redfern and Newtown should be taken to a sewage farm on the edge of Botany Bay. (see figure 3.1) This decision followed the investigations of its Engineering Committee which was chaired by E.O.Moriarty, Engineer-in-Chief for Harbours and Rivers. The composition of the committee was not recorded but was likely to have included the City Engineer, the Engineer-in-Chief for Railways and the Commissioner for Roads and Bridges.[1]

Figure 3.1 Diversion of Sewage from Harbour



Source: F.J.J. Henry, The Water Supply and Sewerage of Sydney, Halstead Press, Sydney, 1939.

The Engineering Committee recommended that the southward draining sewage not be used for broad irrigation but that it be treated by a method known as "intermittent downward filtration".[2] This method used the land as a filter through which the sewage drained. Crops could be grown on the land which would be richer after the sewage had filtered through but this was a secondary consideration since the primary purpose of using the land was to purify the sewage effluent before it went into Botany Bay rather than to utilise the sewage as a fertiliser. Much less land was required to treat the sewage in this way than would be necessary if the sewage was used for broad irrigation, a process in which the sewage was used to irrigate the soil and so was directly taken up through the roots of the vegetation.

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1 Sydney City and Suburban Sewage and Health Board, Twelfth and Final Report, 1877, p3.

2 Sydney City and Suburban Sewage and Health Board, No.10 Committee, Second Report, 21st October, 1875.

The Engineering Committee, in the course of their deliberations, requested from the Board a definite indication of their views on sewage farming before they spent too much time and money estimating the costs of such an option. The Sewage and Health Board therefore formally debated the idea in January 1877 and recommended that the sewage farm be established.

The Board's recommendations (especially the ocean outfall at Bondi) were controversial enough for the government to find it necessary to engage an eminent English Engineer, W.Clark, who had been brought out to Australia partly to solve water supply problems, to investigate and report on the drainage and sewerage of Sydney. Clark presented his report, which supported the Board's recommendations for both the Bondi ocean outfall and the Botany sewage farm, to the Colonial Secretary in July 1877.[3]

In 1882 309 acres were resumed by the Government at Webbs Grant for disposal of sewage. The area was bounded on one side by the Cooks River and on the other side by Botany Bay. The land was to be divided into three parts and rotated; one third being under filtration, one third being prepared for crops, and one third with crops growing on it.[4]

Before the sewage farm was fully operational another report was presented to parliament by George Stayton, an engineer with the sewerage branch of the Roads and Bridges Department and a man "of considerable English experience".[5] In a proposed drainage scheme for the Western Suburbs Stayton recommended that the sewage of the Western Suburbs also be channelled onto the sewage farm at Webb's Grant.[6] On Stayton's recommendation an additional 311 acres was resumed at Webb's Grant in 1890. (figure 3.2 shows Stayton's Western Suburbs sewerage scheme.) The land was swampy and even when the Western Suburbs scheme was completed in 1900 only a small part was used for filtering sewage. This extra land was mainly used for the agistment of stock and another small part was leased to Chinese market gardeners.[7]

The idea of a sewage farm was more popular than dry conservancy methods because it seemed to combine the best elements of both worlds; the speedy and automatic removal of wastes from residences, the utilisation of sewage as fertiliser and the avoidance of pollution of waterways.[8]

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[3] W. Clark, Report to the Government of NSW on the Drainage of the City of Sydney and Suburbs, 1877.

[4] W.V.Aird, The Water Supply, Sewerage and Drainage of Sydney, M.W.S.&D.B., Sydney, 1961, p137.

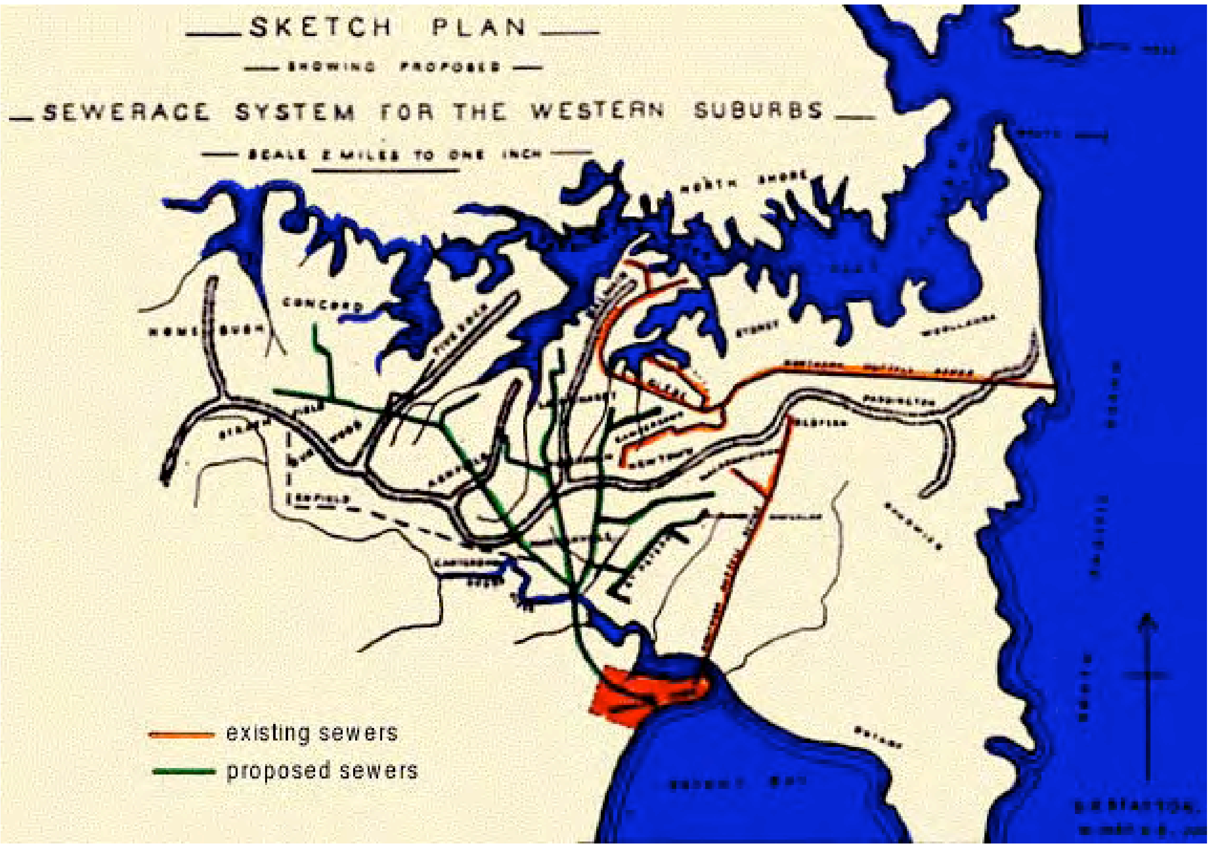
[5] Parliamentary Standing Committee on Public Works, Drainage Works, North Shore, 1888, p6.

[6] George Stayton, Report on a System of Sewerage for the Western Suburbs of the City of Sydney, 1887.

[7] Aird, The Water Supply, Sewerage and Drainage of Sydney, p137.

[8] NSW Legislative Assembly, Votes and Proceedings 1876-7, p685.

Figure 3.2 Western Suburbs Sewerage System



An anonymous poet in the Evening News extolled the benefits of sewage farms.

Dear people! thus to fill my maw,
By outrage of just Nature's law!-
If you but us'd your city's filth
To fatten crops, and feed their tilth,
Till Nature turning "vile" to "good",
Returned your waste in fruit or food!
Your farms and fields would gain in wealth,
Whate'er your city wins in health,
And lustier crops and lengthening lives
Would prove how sense, with science thrives.[9]

Many Sydney-siders had been impressed by the "immense" vegetables produced by Chinese market gardeners who made use of sewage as a fertiliser without any ill-effects. [10] However, the faith that many laypeople had in the value of sewage farming as a sensible and commonsense practice was not reflected in circles where the certainty of economic values were what counted. Mr Watt, the Government Analyst, argued that waterborne sewage had very little manurial value and should be disposed of into the sea where possible.[11] Clark claimed that no process of turning sewage into manure had been a financial success and in

[9] Evening News, 23rd March 1880.

[10] Sewage and Health Board, Tweflth and Final Report, pp 134-5.

[11] ibid., pp134-5.

Sydney, where labour was expensive, it was even less likely to be profitable.[12] A Tasmanian engineer argued that "every pound gained in a year by a sewage farm is gained by a yearly expenditure of more than a pound either in labour or in interest upon capital expended."[13]

By the time Stayton reported in 1887 the Adelaide sewage farm had been established and was just beginning to make a profit. It had 470 acres which were irrigated with the city's sewage and in the Winter intermittent-downward filtration was also used because of the extra rainfall. Stayton said the Adelaide farm

> shows that liquid sewage is an especially valuable fertilizer in a hot climate, and that under good management, a substantial income can eventually be derived from grazing and fattening stock and from the growth and sale of root crops, fodder, plants, fruit and vegetables.[14]

Several British non-engineering experts tried to estimate the value of sewage as fertiliser. For example, Professor Corfield valued it at 1 million pounds per year per 3 million people.[15] Burke, another British expert, pointed out that in England at the time an enormous amount of manure was imported and artificially manufactured. Guano was imported from Peru and other islands and the Peruvian government was already concerned that the deposits would soon be exhausted. The market for artificial fertilisers was also immense.

> Indeed, the number of artificial manure companies paying large dividends, as well as the immense fortunes realized by so many private manufacturers, has almost passed into a proverb, and is perhaps the best index to the enormous demand for artificial manure in this country. [16]

Burke judged any system of sewage disposal by its ability to extract as much of the valuable constituents as possible from the sewage. To him this was equally important as obtaining a pure effluent.[17] This was, however, not a universal view.

The debate within the Sewage and Health Board reflected to some extent the debate going on in the wider community over sewage farms. Members of the Board were unsure about a sewage farm because of the reported experiences of sewage farms overseas and one member argued that it would become a "permanent nuisance, very offensive and dangerous to the health" and that there was a real risk of disease being caused by eating produce grown on a sewage farm.[18]

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12 Clarke, Drainage of the City of Sydney and Suburbs, p13.

13 A. Mault, `The Sewerage of a Seaside Town', Australasian Association for the Advancement of Science 4, 1892, pp772- 3.

14 George Stayton, Sewerage and Drainage of the Western Suburbs, Department of Public Works, 1887, p22.

15 W.H.Corfield, Sewerage and Sewage Utilization, D.Van Nostrand, New York, 1875, pp76-79; 127.

16 Ulick Ralph Burke, A Handbook of Sewage Utilization, 2nd edition, E & F.N.Spon, 1873, pxv.

17 ibid., pxiii.

18 Sewage and Health Board, Twelfth and Final Report, pp131-2.

Moriarty, the Engineering Committee's representative on the Board quoted extensively from various British reports which supported the idea of "downward intermittent filtration." He gave examples of successful farms in Britain and pointed out that the soil was enriched in the process, that there was no evidence of ill-health in neighbouring residences and that there was no evidence that entozoic diseases were propagated by the produce.[19] Mr Dansey, the City Health Officer, and Dr Alleyne, Health Officer, also members of the Board did not feel sewage farms were a health problem either.[20]

The main community opposition to the idea came from those living near the proposed location of the farm. In March, 1880 a meeting of mayors of suburban municipalities was held to consider Clark's scheme of sewerage. Several Mayors expressed their opposition. The Mayor of Alexandria, Mr Henderson, called the scheme for draining the southern suburbs of the city "one of the most monstrous proposals that was ever suggested by any Government." He pointed out that the location intended for a sewage farm was "a perfect swamp" and that 100 acres would be totally insufficient. The Mayor of St Peters, Mr Judd, agreed that the idea was "a most monstrous one".[21] Shortly afterwards, a deputation, claiming to represent 40,000 people went to see the Minister for Works to protest against the plan for the southern draining sewage.[22]

Also the perception that sewage grown vegetables might be harmful had some currency in the community. This found expression in letters to newspapers. For example one letter writer claimed that in Paris many people had asserted that "an injurious flavour of sewage matter" could be detected in vegetables grown in this way.[23] Most people agreed that a poorly managed sewage farm could be a real nuisance but advocates of sewage farming claimed that a properly run farm was safe and healthy and not smelly:[24]

> ... careful investigations in France, Germany, and England have failed to bring to light a single case of injury to health, or of offence arising from sewage irrigation properly conducted.[25]

The debate amongst the experts on the best means of disposing of or treating sewage was every bit as fierce as that over the best way of carrying it away from residences. Burke, an English barrister, wrote in 1873 that

> a well-known sanitary reformer once said to us that he knew only one topic besides polemics upon which men's party spirit got the better of their good sense, and even of their regard for truth and justice, and that was the treatment of sewage.[26]

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19 ibid.

20 ibid.

21 Sydney Morning Herald, 17th March 1880.

22 Evening News, 27th March 1880.

23 Evening News, 20th March 1880.

24 Corfield, Sewerage and Sewage Utilization, p121; W.H.Corfield, A Digest of Facts Relating to the Treatment and Utilisation of Sewage, MacMillan & Co, 1871, pp271-283.

25 Sydney Morning Herald, 24th March 1880.

26 Ulick Ralph Burke, A Handbook of Sewage Utilization, pix.

This led to the most confusing discrepancies in the statistics, Burke observed, so that manure was valued at over £5 per ton by one writer and at less than the cost of carriage by the next. A high authority claimed that a sewage farm was unhealthy to neighbouring residents whilst the statistics showed the death-rate in the area had decreased markedly since the establishment of the farm.[27]

As for the chemical analysis of the effluent, Burke complained,

> One would think that when we had reached the region of pure science a calm voice would speak from the laboratory in the unprejudiced tones of perfect accuracy; [28]

But no, each scientist found differing amounts of nitrogen and reached different conclusions. [29]

The inability to resolve these controversies over scientific points, which had also marked the debate over dry conservancy technologies and would later be typical of controversies over chemical precipitation, artificial filters and septic tanks, were all symptoms of an immature field of study which had not been fully colonised by a professional group with its own paradigm.

A HALF-HEARTED EXPERIMENT IN SEWAGE FARMING

Although Sydney engineers would have preferred ocean disposal, they were not averse to experimenting with intermittent downward filtration which was receiving some good reports overseas as a new and modern way of sewage farming. Its real advantage in many towns and cities in Britain and the United States was that it took up far less land than traditional sewage farming and land was often scarce and the ocean distant in these places. The situation was somewhat different in the newly established city of Sydney but the perception of the value of intermittent downward filtration overseas was transferred to engineers here.

The Sydney Sewage and Health Board decided that the sewage farm would be an experiment which, if it failed, would not be wasted since the sewers could be "extended to Botany or elsewhere". The land could be sold and the outlay to take the sewage to the farm would fit into "any scheme adopted hereafter". The advantage of the scheme, was that it did not "bind the country to any large expenditure".[30]

Moreover, it was readily realised that the lobby for utilisation of the sewage as fertiliser was fairly strong at that time in Sydney and the sewage farm experimentation had the added bonus of placating that lobby. One member of the Sewage and Health Board said,

> I feel sure the inhabitants of this city would be more satisfied to go to the expense of a second great sewer when they know that sewage

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27 ibid., px.
28 ibid., pxi.
29 ibid., pxi.
30 Sewage and Health Board, Twelfth and Final Report, pp143-6.

> farms will not answer. I do not think they will be satisfied until the experiment has been made.[31]

In other coastal towns and cities where ocean disposal was more economic, less effort was made to placate the utilisation lobby. A typical argument which was put forward in the United States in answer to the alleged wastefulness of waterway disposal was put forward by Colonel Waring, an American engineer,

> When our sewage flows off with the drainage, its constituents are, perhaps, quite as likely to come back to us in the form of fish, shell-fish, or seaweed, as they are to come back in the form of crops when it is spread over an irrigation field.[32]

The underlying preference for ocean disposal and the experimental nature of the sewage farm determined the location of Sydney's farm. It was placed at Webb's grant, on the way to the sea on the north-west corner of Botany Bay, bounded on one side by the bay and on the other by the Cooks River. The site was composed of low-lying, raw drift sand and covered in scrub. The land had already been purchased by the government for the purpose of dumping nightsoil and it was a location from which a sewer main could easily be extended to the coast should the experiment fail.

Although one member of the Sewage and Health Board and many locals argued that the land at Webb's grant was far too small an area and totally unsuitable for the purpose, the engineers were considered to be the experts in this area. The choice of location was, however, made on grounds other than maximising the effectiveness of the farming operations.[33] Clark declared the land at Webb's grant to be suitable and that there was sufficient land less than ten feet above sea level available.[34] Stayton also claimed the remote site with its "free sandy soil" 8 or 9 feet above sea level was "admirably fitted" for sewage disposal.[35]

Sewage was first turned on to the farm in August 1887. In the first years of operation of the Botany Sewage Farm about 1.5 million gallons of sewage would arrive at the farm each day. Lime was added to the screened sewage for precipitation and cleansing and the effluent was then transported to the irrigation beds which took up 34 acres at one end of the farm. The irrigation beds were at different levels separated by earthen banks and with filtration drains which channelled the effluent to the Cooks River. These beds were each flooded with effluent in rotation and, while not in use, they were cultivated with the sewage sludge which was ploughed into them.[36]

At first the sewage farm was a great success. (see figure 3.3) On the cultivated land the Board's employees produced cabbages, turnips, lucerne and sorghum and this produce was readily sold. The produce not sold was consumed by pigs

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31 ibid., pp146.

32 Geo.Waring, Jr, Modern Methods of Sewage Disposal, D.Van Nostrand, New York, 1894, p42.

33 Sewage and Health Board, Twelfth and Final Report, p131.

34 Clark, Drainage of the City of Sydney and Suburbs, p13.

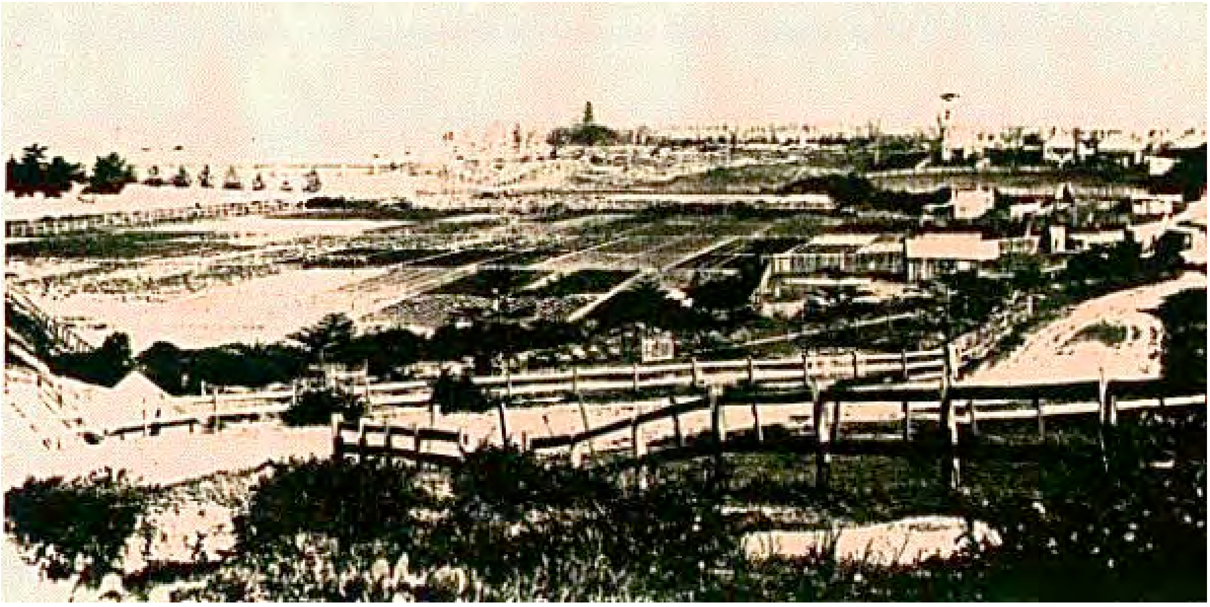
35 Stayton, Sewerage and Drainage of the Western Suburbs, p8.

36 F.J.J. Henry, The Water Supply and Sewerage of Sydney, Halstead Press, Sydney, 1939, pp171-2

and cows purchased for this purpose. Areas not suitable for crop raising were laid out in grass paddocks for agistment of cattle.[37] It was reported in 1890 that lucerne had grown "beyond expectation" and the effluent water, which was analysed by the Government Analyst every quarter, was purified satisfactorily.[38]

> the question of disposal had been solved favourably from a sanitary point of view, and it accords with the opinion of sanitary engineers who have had any experience in the matter, that notwithstanding any prior treatment the sewage should, as a final measure, be disposed over and filtered through land.[39]

Figure 3.3 Sydney's Sewage Farm



In 1893 the Board decided to lease the farm out since it had shown what could be done commercially and in 1894 it was leased for ten years subject to the Board being able to continue to use the land for sewage disposal. It was hoped that in this way the rental for the land would cover the Board's running costs for the farm. It had been costing between £500 and £600 per year to operate the farm. However, the farm was not properly maintained by the lessee. The resultant state of the farm was such that the sewage disposal operations would soon be compromised. After 12 months the Board was forced to cancel the contract.[40]

The flow to the farm increased rapidly each year to 3.25 million gallons per day by 1900. Figure 3.4 shows the increasing flow to the farm and the filtration area set prepared for the sewage. One can see that after 1898 the flow to the farm rapidly increased without a corresponding increase in filtration area. Figure 3.5

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37 ibid.

38 J.M.Smail and W.L.de L.Roberts, `Purification of Sewage', Australasian Association for the Advancement of Science 2, 1890, p684.

39 Henry, The Water Supply and Sewerage of Sydney, p685.

40 ibid.; Aird, The Water Supply, Sewerage and Drainage of Sydney, p138.

shows the increasing number of houses being served by the city's sewerage system. Most of the additional sewage would have gone to the farm.

Figure 3.4 Sewage Farm Area and Flow of Sewage

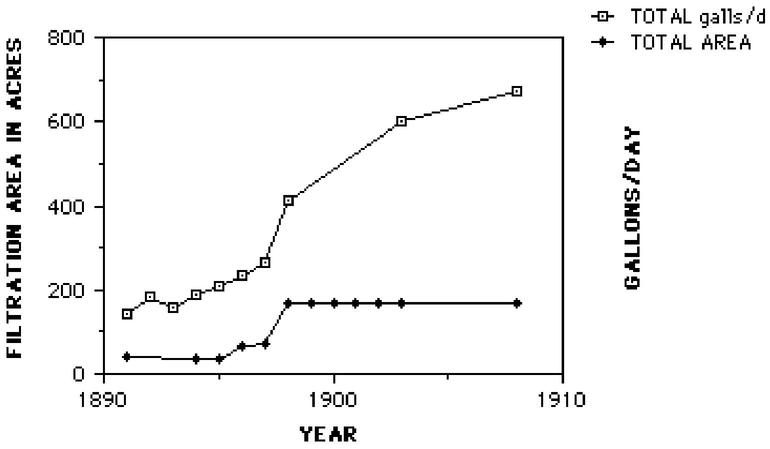
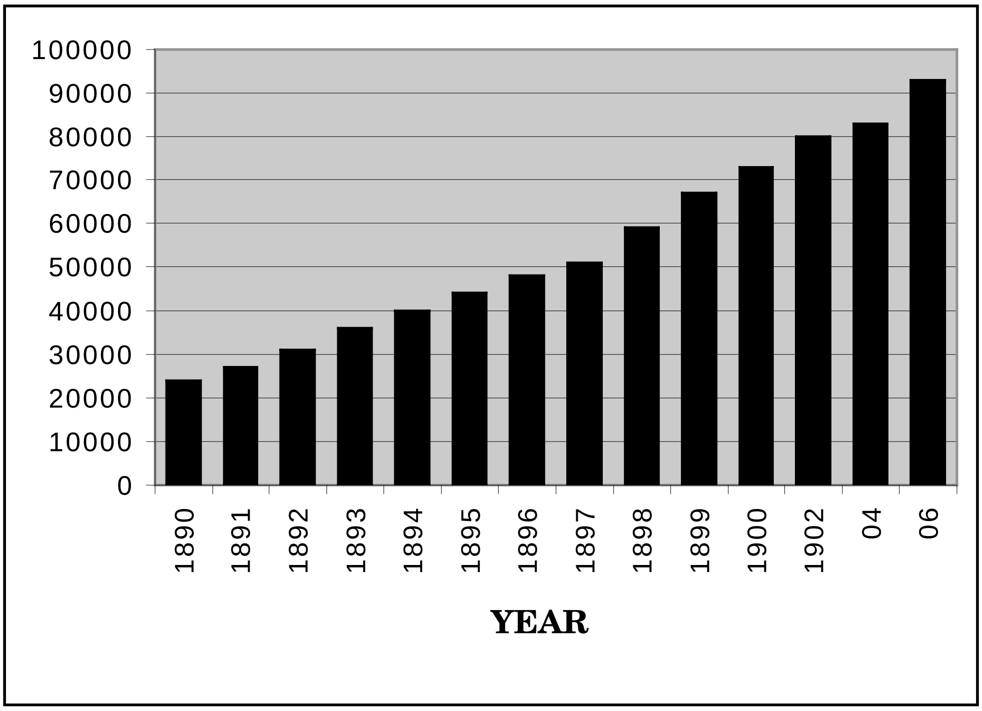


Figure 3.5 Number of Houses Sewered 1890-1906



Information from MWS&DB Annual Reports

The population of the surrounding neighbourhoods also grew and in 1898 the Water Board together with the Public Works Department began some experiments with filters and tanks with the idea of changing to biological treatment of the sewage because of the complaints from neighbouring localities and threats of legal action.[41] By 1900 William Hamlet, the Government Analyst, was proclaiming the Botany sewage farm as a dismal failure. The land was waterlogged and fouled, he said.[42] Complaints about the sewage farm were stepped up in the next few years. In 1903 a local resident described how what seemed like raw sewage was conveyed via open channels onto the land. The sewage percolated through the sand and was washed into the Cooks River where, after the tide receded, the sediment was dried by the sun and blown "all over the place as far as Tempe". The resident said that local fishermen were complaining that their livelihoods were being threatened because fish and prawns were becoming scarce in the Cooks River and also because people were reluctant to buy fish caught in the Cooks River because of the sewage.[43]

The Medical Officer of the Water Board, Dr Mailler-Kendall, responded to these complaints in a way that was to become typical of Water Board dealings with the public. He said that the Board had done all it could to minimise the smell from the farm and satisfy people who were complaining. He suggested that many of the smells came from the Chinese gardens and wool-scouring and boiling down establishments at Alexandria and Botany. Sewage did not harm fish and anyway he had never noticed a fishing industry at Cooks River. Tanneries and wool-washing works all discharged their wastes into the Cooks River and the sewage farm could not be blamed for its pollution. There was no danger to health. The Water Board, he said, wanted to change the sewage farm to a septic system but did not have the money.[44]

The next day Dr Ashburton Thompson, President of the Board of Health, confirmed that the Board of Health considered the Sewage farm to be a very bad nuisance but that he believed that the Water Board engineers had done all they could to stop the nuisance. He said he had advised the local authorities that "the only proper and satisfactory course" was to use the Public Health Act and summons those responsible for the farm management to Court where an order might be made that the nuisance be abated. The Council had not done this however.[45]

The statements of the Water Board Medical Officer also provoked a flock of letters to the editor. It was alleged that sewage was discharged directly into the Cooks River when it rained heavily. One writer exclaimed

> Surely dumping faecal matter in its crude state on the farm is not treatment...the manner in which the whole system is conducted is a disgrace to a civilised community.[46]

Property owners in the area were concerned about the sale and rental value of their properties and the local progress associations were considering combining to take legal action against the board because of the depreciation of property.[47]

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41 Henry, The Water Supply and Sewerage of Sydney, pp173-4.

42 William Hamlet, `Anniversary Address', Royal Society of NSW 34, 1900, p22.

43 Daily Telegraph, 7th May 1903.

44 ibid.

45 Daily Telegraph, 8th May 1903.

46 ibid.

47 ibid.

Two years later citizens of Rockdale and Arncliffe, the suburbs neighbouring the farm, admitted that although the smells from the farm had been retarding settlement in the area for some time and reducing property values the council and the property owners had tried to keep "the knowledge of the prevalence of these odours to themselves, not wishing to make the matter public" and had only spoken about it freely when the Government was proposing to do something about it.[48] This pattern of self-suppression of public complaint by local communities was to be repeated many times in the following decades.

In a later government report it was admitted that the sewage farm did give off "exceedingly disagreeable and offensive" odours although there was no evidence that these odours were unhealthy. The reason that the sewage farm was such a nuisance, the report claimed, was because of the unsuitability of the area. The soil was raw sand and therefore did not contain enough organisms for breaking down the sewage and the location was subject to tides so that the land was periodically saturated with salt water and sewage "to an extent that makes successful operation impossible".[49] This finding is in marked contrast to the assurances given by the engineers earlier on.

Besides the physical unsuitability of the site, the farm was overloaded. The planned rest times for the filter beds were not always practicable and the land had become "sewage sick" so that little profit could be obtained from growing vegetables on it.[50]

The Sydney Sewage farm was compared with those in Melbourne and Adelaide and found to be distinctly lacking. Both these latter farms, the report claimed, were profitably operated without public complaint. The Melbourne farm, at Werribee (4.5 miles from any centre of population) covered 8,847 acres of land, all of which were suitable for farming and would have been classed as agricultural land before the application of sewage. 22-25 million gallons of sewage were disposed of on the farm daily. (cf 931 acres at Botany of which 200 were usable for 7 million gallons daily)[51]

By 1905 complaints had reached such a level that a Parliamentary Standing Committee on Public Works met to consider a scheme for treating the sewage from the Western suburbs which at the time was discharging onto a part of the sewage farm near Arncliffe. The Committee, admitting that complaints had been justified, recommended that four septic tanks and filters be installed to deal with this sewage.[52]

That same year, 1905, swine fever caused the destruction of the farm's pigs and although pig raising had been profitable it was not resumed after this. By 1908 so much of the farm was continually flooded because of the greatly increased flow of sewage (6.75 million gallons daily) that the raising of crops had become a very

48 Parliamentary Standing Committee on Public Works, Scheme for Treatment of Sewage at the Western Suburbs Outfall on the Rockdale Sewage Farm, 1905, p9.

49 Parliamentary Standing Committee on Public Works, Disposal of Sewage from the Western, Southern, Illawarra, and Botany Districts, 1908, p7.

50 ibid., pp7-8.

51 ibid., p10.

52 Parliamentary Standing Committee on Public Works, Scheme for Treatment of Sewage at the Western Suburbs Outfall on the Rockdale Sewage Farm, 1905.

small proportion of the farm's activities and a few years later crops were abandoned altogether.[53]

In 1916 the Southern and Western Suburbs Ocean Outfall Sewer was completed (see next chapter) and the sewage farm ceased to operate. In 1918 there was an attempt to lease out the old filter bed areas and it was found that the soil had already reverted to raw sand.[54]

CHEMICAL PRECIPITATION - A SHORT LIVED EXPERIMENT

By 1891, George Stayton, the government engineer who had recommended that the sewerage of the Western suburbs be treated at the Botany sewage farm by intermittent downward filtration, was arguing against the use of this method for the sewage of Parramatta which lay too far west of the city to consider ocean disposal in the short term. He had just returned from a tour of British sewage treatment works and had presented a report to parliament on methods of sewage purification. Stayton claimed that intermittent downward filtration was not "making any particular advance in England".[55] He was particularly impressed, however, by three different systems of chemical precipitation.[56]

Chemicals were first used to deodorise and disinfect sewage. The idea was not so much to sterilise the sewage as to retard its putrefaction until it could be disposed of so that it would not create a nuisance or endanger the public health. Chemicals used for this purpose included carbolic acid, charcoal, chloride of lime, permanganate, sodium hypochlorite and chlorine.[57]

Chemical precipitation for the purposes of purifying sewage was used in Britain following the Public Health Act of 1875 which was aimed at protecting rivers which had become grossly polluted by the combination of water-carriage technology and discharge into the nearest watercourse. The Act insisted that sewage be treated before discharge. Sewage farming had been the preferred method but land was often scarce or unsuitable in British inland towns and cities. Chemical precipitation before land treatment reduced the amount of land required.[58]

The first chemical precipitant patented was lime. The Botany Sewage Farm had utilised lime precipitation as a preliminary treatment before the effluent was treated by the land, however, it was never referred to as an example of the use of chemical precipitation as it was considered that this part of the process was very minor. At one stage the addition of lime was discontinued at the sewage farm but it was found that the sewage was more beneficial to the crops when the lime was

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53 Henry, The Water Supply and Sewerage of Sydney, pp173-4.

54 ibid.

55 George Stayton, Sewage Purification, NSW Legislative Assembly, 1891, p14.

56 ibid., p1.

57 H.H.Stanbridge, History of Sewage Treatment in Britain, Part 3, Institute of Water Pollution Control, Kent, 1976, p4.

58 John Sidwick, `A Brief History of Sewage Treatment-1', Effluent and Water Treatment Journal, February 1976, p68.

added. The sludge which was precipitated out was used to form banks or was applied directly to the land and the Board claimed that it caused no problem.[59]

Between 1856 and 1876 it is estimated that over 400 patents were granted for chemical precipitants.[60] Little was understood about the science behind precipitants and a writer at the time observed,

> Inventors seem mainly to have looked out for articles which were cheap, or entirely worthless, and heaped them together without any definite notion of the part which they were separately and collectively to play. This alone can count for the recommendation of such bodies as coal-ashes, soot, salt, gypsum, etc., which in almost every case would do more harm than good. Very often we see, especially in the older specifications, materials given as alternatives whose action, if any, must be evidently quite dissimilar the one to the other.[61]

Often the precipitants were unwanted by-products of industrial processes used with some other material.[62]

Many limited liability companies were formed to exploit the situation and make profits from patented precipitation processes. They promoted their processes using test results from experiments often undertaken by their own employees and literature giving a misleading interpretation of the results. By 1884 they had all gone into liquidation and their treatment works had become the property of the local authorities.[63]

At first it was hoped that the expense of treating the sewage could be recouped from turning the precipitated sludge into a valuable fertiliser.[64] This notion was based on a belief that the valuable constituents of the sewage were contained in the solids and that the chemicals used for precipitation would increase the fertilising properties of those solids. It was thought that the precipitated solids would be in a far more convenient form for conversion to manure and transportation to farms and would therefore be a more economical means of utilising the sewage than applying the sewage directly to the land. [65]

It was generally recognised by opponents and proponents alike that chemical precipitation did not purify the sewage but merely clarified it and that the chemical precipitation had to be used in conjunction with some sort of filtering process.[66] For Stayton's Parramatta scheme he proposed that a patented chemical precipitation system, known as the International system, be used. It had two stages. In the first stage the sewage was precipitated and deodorized in settling tanks with a magnetic precipitant and deodorant called "ferozone" (trade

59 M.S.W.&D.B., Annual Report, 1901, p70.

60 Stanbridge, History of Sewage Treatment in Britain, Part 3, p8.

61 J.W.Slater, quoted by Stanbridge, Part 3, History of Sewage Treatment in Britain, p9.

62 Stanbridge, History of Sewage Treatment in Britain, part 3, p9.

63 ibid., p12.

64 Sewage and Health Board, Twelfth and Final Report, p9.

65 Stanbridge, History of Sewage Treatment in Britain, Part 3, p8.

66 J.M.Smail & W.L.de L.Roberts, 'Purification of Sewage', Australasian Association for the Advancement of Science II, 1890, p682.

name for a preparation of salts of iron and alumina). In the second stage artificial filters were proposed rather than sand or earth. The partly purified sewage-effluent would pass through "polarite" filter beds (another trade name for a "specially prepared rustless and magnetic oxide of iron) which were supposed to trap the remaining solids and oxidise putrescible matter held in solution. The sludge could be mixed with refuse or pressed and dried and sold to farmers.[67]

This scheme never went ahead however. On Stayton's advice the Parliamentary Standing Committee on Public Works had recommended against a proposed sewage farm for Parramatta and suggested that instead, the sewage be dealt with by a system of precipitation and filtration "or other effective modern process".[68] However, there was much debate over this controversial decision particularly from sewage farm proponents, and engineers were divided over the relative merits of sewage farming and chemical precipitation with filtration.

As in previous debates over sewage disposal, neither side could agree on the efficacy, nuisance potential, fertilising potential or economics of each proposal. A key point of dispute was the suitability of the site for sewage farming. Stayton argued that the proposed site for the sewage farm was unsuitable because it was low-lying and consisted mainly of clay. He warned that the area would become surcharged and water-logged with sewage and give off offensive smells. He argued that the "International" system of precipitation and filtration that he advocated could be carried out close to populated areas without any smells or nuisance and would be more economical.[69]

The Commissioner and Engineer-in-Chief for Roads, Bridges and Sewers, Mr R.R.P.Hickson, who had proposed the sewage farm at Parramatta, disagreed with Stayton completely. It had been proposed to treat the sewage at Parramatta by a combination of broad irrigation and downward intermittent filtration on 42 acres of sand filling and 22 acres of friable clay "which although not capable of taking so much sewage [as sand] is considered by authorities to be even a better filtering medium".[70] The site, argued Hickson, was the best in the area because of its distance from population, its ability to deal with the drainage of Granville and other nearby Municipalities and its capability of expansion.[71]

Stayton argued that a sewage farm would be costly whilst Hickson disputed that his scheme was more expensive than Stayton's. Hickson claimed that intermittent-downward filtration was the best method of sewage purification to use.

> With reference to the question of the relative advantages of chemical precipitation and land filtration, I can without hesitation say that at the present time no sanitary engineer of eminence in Europe or

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67 Stayton, Sewage Purification, pp4-5.

68 Parliamentary Standing Committee on Public Works, Sewerage Works for Parramatta, 1892, p5.

69 ibid., p8.

70 R.R.P. Hickson, Parramatta Sewerage Scheme, 1892, p6.

71 ibid., p4.

> America will be found who will give unqualified preference to the former.[72]

Precipitation had been adopted, Hickson pointed out, in London and some towns in Britain because land for filtration was not available, was too expensive or was unsuitable. Chemical precipitants merely clarified the sewage and retarded the action of nitrifying organisms in any subsequent filtering process. The International System, Hickson pointed out, had only been around for five years and while over 400 patents had been taken out for various precipitating mediums, "the "survivals" could be counted on the fingers."[73] Almost all the available literature on the advantages of the system, he claimed, was published by the International company itself.[74] Stayton, on the other hand, argued that a recent Commission in Britain had determined that precipitation together with filtration gave "the best effluent known" and that this was a widely used method for towns in Britain.[75]

Another problem with chemical treatment, pointed out by engineers with the Water Board, was the difficulty of varying the dosage according to the varying strength and quantity of sewage during any twenty-four hour period. Some experiments had in fact been carried out at the Botany Sewage Farm with various quantities of lime and a lime/iron sulphate mixture. It was found that the amount required to be added to get a good result was so large that the costs, the increased bulk of sludge produced and the extra machinery required "would far outweigh any advantage obtained".[76]

At the end of his dissenting report, Hickson urged that no action be taken until "a competent and unprejudiced engineering opinion" had been obtained.[77] The then Minister for Public Works agreed with this proposal and an expert board of three engineers was appointed. The board of Messrs Wardell, Chamier and Napier Bell reported in favour of the sewage farm scheme with the only modification being that a separate rather than partially separate system of sewerage be adopted which would exclude all rainwater. They claimed the proposed area would be "amply large enough" and quite suitable for sewage farming.[78]

The Parliamentary Standing Committee again met to discuss the question in the light of the expert board's findings. The Standing Committee excused their previous recommendations that a sewage farm should not be established on the grounds that they had not been given all the information in a way that would have enabled them to come to a proper conclusion.

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72 Hickson, Parramatta Sewerage Scheme, p1.

73 ibid., pp 1-4.

74 ibid., p3.

75 Parliamentary Standing Committee on Public Works, Drainage Works, North Shore, 1888, Minutes of Evidence, p5.

76 Smail & Roberts, 'Purification of Sewage', pp682-3.

77 R.R.P. Hickson, Parramatta Sewerage Scheme, p7.

78 Parliamentary Standing Committee on Public Works, Sewerage Works for Parramatta, Second Report, 1894, p6.

> Evidence, too, respecting the presence of microbes and their action in relation to sewage has been given in the present inquiry with a fullness of detail not supplied in the first inquiry, and from authorities whose testimony necessarily carries considerable weight.[79]

Nonetheless the Standing Committee still recommended against the proposal for a sewage farm on grounds "other than either the nature of the farm or the method of dealing with the sewage." The cost was "a serious amount to expend in connection with the municipality of Parramatta" and Parramatta was unable to pay the rates necessary to cover the interest payments on the capital expenditure. Nor did it want the proposed works.[80]

The government felt that each municipality should manage their own affairs and therefore expected Parramatta to pay for whatever sewerage scheme was finally accepted. The Committee was therefore concerned about the ability of the people of Parramatta to pay for a sewage farm of the size required.

> The extent to which many of the municipalities of the Colony are indebted to the Government, and their failure to make the necessary repayments, are matters of grave importance in the consideration of any proposed further expenditure in this direction; but in coming to a conclusion in regard to the proposed sewerage works the Committee are more directly influenced by the evidence respecting the inadequacy of the proposed sewage farm [81]

The previous Mayor of Parramatta and his Council had been in favour of the scheme during the first inquiry two years before and approval had been given by council for a sewage farm to be constructed. The new Mayor felt that rate-payers would not want to pay the required amount and yet he was sure the Council would not rescind its approval. He argued that the pollution of Parramatta River was caused by Government Institutions anyway and the government should pay for any necessary sewerage system.[82]

It seems that the Standing Committee had used Stayton's report to recommend against the sewage farm when the real reasons for their opposition were quite different and of a much more political nature. Their attempts to hang their opposition on technical grounds were undermined because of the disagreement occurring within the engineering profession.

Complaints about the state of the Parramatta River continued and in 1898, the government ordered a referendum of rate-payers to be taken. 349 people voted in favour of the sewage farm scheme and 111 voted against it but the situation was not resolved until 1905 when special legislation was passed to allow the Public Works Department to construct a sewerage scheme for Parramatta and then hand it over to the Council on completion.[83] By 1905 however, sewage farms were definitely out of favour and so too were chemical precipitation schemes.

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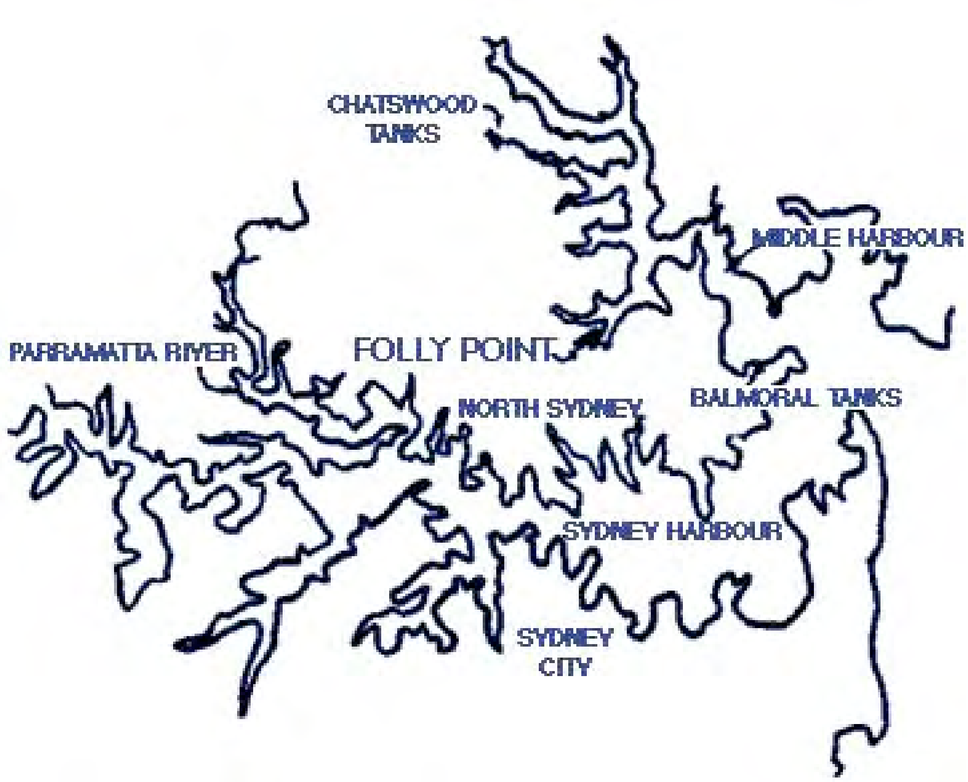
[79] ibid., p7.
[80] ibid., p8.
[81] ibid., p11.
[82] ibid., p9.
[83] W.V. Aird, The Water Supply, Sewerage and Drainage of Sydney, p161.

Although chemical precipitation was never tried at Parramatta, it was experimented with for a very short time at North Sydney. For North Shore sewage, ocean disposal was not feasible in the short term and the disposal of raw sewage into the Harbour was no longer acceptable. Chemical precipitation was first proposed in 1882 by the Public Works Department and again in a report by Stayton four years later. It was proposed that the sewage be chemically treated and discharged near Willoughby Falls at the head of Long Bay which was in Middle Harbour. The place was later named Folly Point.[84] (see figure 3.6)

Figure 3.6 Folly Point



It was intended that the sewage would be screened before having lime and sulphate of iron mixed with it. It would spend some time in settling tanks where a sludge would be precipitated out and then the clear effluent would be intermittently filtered through 6 feet of sand, on land reclaimed from tidal waters, before being discharged into the bay.[85] The sludge would be made into sludge cake using filter presses and then burnt in furnaces since "it was deemed inadvisable to rely solely for any demand for the product as a means of disposal" and because burning was the most "efficacious" method of disposal.[86]

There was some public opposition from locals concerned that a nuisance would be created and the bay polluted. A local alderman was worried that the final effluent might still pollute the harbour, that the sand might not be a very good

[84] Parliamentary Standing Committee on Public Works, Drainage Works, North Shore, 1888.

[85] ibid.

[86] J. Davis, `The North Sydney and Double Bay Sewerage Schemes', Journal of Royal Society of NSW 33, 1899, pxx.

filter, that the underlying drains might become blocked with sand and that the area chosen was too small.[87] Another witness to the hearing held by the Public Works Committee admitted that he had no professional knowledge but noted that the waters in Long Bay were very still and that any discharge into them was liable to remain there, build up and spoil the area which had been a pleasure resort for many visitors and would otherwise be one of the most beautiful areas in New South Wales.[88]

Several engineers assured the Public Works Committee that no nuisance would arise from the proposed method of treatment and that it was the best of all possible options, having given no trouble in Britain.[89] Stayton claimed that the area set aside for treatment would be sufficient for all time and that the entire sewerage system would be still thoroughly efficient in eighty or one hundred years time.[90]

Work began on the North Sydney sewerage works in 1891 and they were duly handed over to the Water Board on their completion in 1899. But in their annual report the following year the Board claimed that there were not enough tanks "to meet the requirements of the rapid expansion of the sewerage system" and that additional works had been authorised.[91] The year after that the precipitation process was abandoned.

The Board's engineer claimed that after a few months it had been found that the cost of lime for precipitation, sludge pressing and fuel for burning the sludge was too great. Various experiments for improvement had been tried such as combining the sludge with combustible materials such a sawdust and coal-dust. These had been unsuccessful and it was necessary to mix the sludge with lime to form the sludge cake.[92] There had also been trouble with the sand filtering area which "had every appearance of becoming sour and sewage sick" and this required regular harrowing to keep it aerated.[93] In a later report, the Board also admitted that there had been a number of complaints of nuisances.[94]

A British Local Government survey in 1894 of 234 towns that had or were still using chemical treatment found that none had made a profit from manufacture of fertiliser, 30 had made some income but 204 had made no income. 174 were still using chemicals.[95] When it was realised that fertiliser manufacture was not profitable the disposal of the precipitated sludge became the biggest problem facing those using chemical treatment.[96]

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[87] Parliamentary Standing Committee on Public Works, Drainage Works, North Shore, 1888, Minutes of Evidence, pp13-14.

[88] ibid., Minutes of Evidence, p16.

[89] ibid.

[90] ibid., Minutes of Evidence, pp5-6.

[91] M.W.S.&D.B., Annual Report, 1900, pp4, 86.

[92] ibid.

[93] M.W.S.&D.B., Annual Report, 1900, p86.

[94] M.W.S.&D.B., Annual Report, 1903, p21.

[95] Stanbridge, History of Sewage Treatment in Britain, part 3, p19.

[96] John Sidwick, 'A Brief History of Sewage Treatment-1', p70.

SERIOUS EXPERIMENTS WITH SEPTIC TANKS

As the precipitated sludge came to be considered to be an expensive nuisance rather than an asset, engineers searched for a means of treating the sewage which would not produce sludge.

> It has been felt for some time that any means of treating sewage without the production of sludge, would be hailed by sanitary engineers as a great advance on present methods.[97]

Purely biological methods were attractive because they held the promise of eliminating the sludge which was proving to be a nuisance with chemical precipitation. The septic tank was one such process. It was essentially a horizontal-flow primary sedimentation tank providing a very long retention period. Sewage entered and left the tank below the surface so that anaerobic microbes could operate. The sludge, which at first was not believed to accumulate, was not removed very often and never entirely removed so that there were always microbes present.[98]

Anaerobic tanks had been used as far back as 1860 but it was not until 1881 that it was found in France that organic solids liquified under such conditions and this was attributed to the anaerobic action taking place.[99] By the end of the century septic tanks were being hailed as the answer to the sludge problem and an automatic process with no accompanying nuisance and no need for expensive chemicals.[100] Although septic tanks were said to eliminate the sludge problem, at least one engineering writer has wondered in retrospect about the extent to which scientific judgement was influenced by wishful thinking.[101]

Septic tanks replaced precipitation tanks in many places but it was soon realised that they were not the panacea that had been hoped for. The reduction in sludge volume was mainly caused by consolidation in the septic tank and loss of solids with the effluent. Not only that but septic tanks were found to be smelly and the effluent, which was more unpleasant than from other tank processes, would often clog filters because of the high solids content.[102]

Septic tanks, whilst at first as popular in the U.S. as in Britain lost favour because of patent disputes arising from the original British patent of the process. Also many tanks were built as septic tanks by people who did not understand the scientific principles involved, and their subsequent failure gave septic tanks a bad name.[103]

One form of septic tank was introduced by W.D.Scott-Moncrieff in 1891. The 'cultivation tank' was a combined septic tank and upward-flow straining filter.

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97 Henry Deane, `President's Address', Journal of Royal Society of NSW 32, 1898, p17.

98 H.H.Stanbridge, History of Sewage Treatment in Britain, Part 4, Kent, 1976, p42.

99 ibid.

100 Deane, `President's Address', pp17-8; William Hamlet, `Anniversary Address', Journal of Royal Society of NSW 34, 1900, p27.

101 John Sidwick, 'A Brief History of Sewage Treatment-1', p295.

102 ibid., p296.

103 Leonard Metcalf & Harrison Eddy, American Sewerage Practice, vol III, 1st ed, McGraw-Hill, New York, 1915, p17.

The idea was that the soluble constituents of sewage would be more readily broken down by nitrifying organisms if they were first subjected to anaerobic conditions.[104] When chemical precipitation was found to be unsuitable at North Sydney it was decided to convert one of the precipitation tanks "into a bacteria bed, on the Scott-Moncrieff principle"[105] to find a less offensive, cheaper method of treatment as well as to get rid of "that gigantic nuisance-sludge."[106]

That same year, J Davis, the Engineer-in-Chief for Sewerage Construction, Public Works Department proposed a scheme of sewerage for what were then called the Illawarra Suburbs. These suburbs included Kogarah and Rockdale and were adjacent to the sewage farm but Davis recommended that the sewage of this area be treated by septic tanks and filters.[107]

The Board engineers were also keen, despite Ministerial reluctance, to make similar experiments with a view to treating the sewage from the main southern outfall "on biological principles" on the sewage farm, again with a view to saving money and because "the biological treatment of sewage is the most modern approved scientific principle". Experimental tanks had been installed at the Botany Sewage Farm in 1898 and preparations for experiments were already under way for the sewage from the Rookwood asylum.[108]

A Water Board engineer claimed that the results of experiments carried out on the sewage farm showed that the septic tank system lived up to all expectations and claims that had been made for it.[109] Added advantages were that the tanks tended to equalise an irregular flow of sewage and, where a coarse grain filter was used with the Scott-Moncrieff method, screening became unnecessary.

The precipitation tanks at North Sydney were all converted to open septic tanks in 1902 with the effluent from them still going onto the sand filter beds. The Board engineer claimed an excellent resulting effluent, no smells and a considerable cost saving. Also septic tanks were constructed at Chatswood and later Balmoral to treat the sewage from that area.[110] (see figure 3.6) The Government analyst urged in that year's Water Board report that the success of the experiments with septic tanks and with Scott-Moncrieff cultivation beds justified the whole of Sydney's sewage being treated in this way.[111] Septic tanks were also given a vote of confidence by the President of the Royal Society of N.S.W., an engineer himself, in 1903 when he claimed that septic tanks had been recognised in England as being "an essential part of modern bacterial purification processes".[112]

Along with the praise, however, there were a number of complaints about the smells arising from the North Sydney tanks. The newspapers had been reporting

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104 Stanbridge, History of Sewage Treatment in Britain, part 4, p54.

105 M.W.S.&D.B., Annual Report, 1900, p4.

106 M.W.S.&D.B., Annual Report, 1903, p21.

107 J.Davis, Report on Proposed Scheme of Sewerage for the Illawarra Suburbs, 1900.

108 ibid., p5.

109 M.W.S.&D.B., Annual Report, 1901, p71.

110 M.W.S.&D.B., Annual Report, 1902, pp21,65.

111 ibid., p73.

112 W.H.Warren, `Presidential Address', Journal of Royal Society of NSW 37, 1903, p47.

complaints about the works from nearby residents and from boating people. The local council had made representations to the Water Board in 1903 without success and the Mayor had declared conditions at Folly Point to be unsatisfactory.[113]

It was decided to cover the septic tanks up and, although the Board was sure that this would remove all nuisance from the works, it was decided to install equipment for ascertaining the rate of dilution during storm-water flows "in order to meet complaints"[114] (presumably by being able to say that the sewage was extremely diluted at times of heavy rainfall when the system was likely to become overloaded and sewage might have to flow through the tanks more quickly than was desirable.) Nevertheless the complaints continued and the Board's engineers became defensive,

> Within a year several additional dwellings have been erected in proximity to the works and find ready occupation. If the works were so bad from a sanitary standpoint as stated on several occasions, the land would be unoccupied, but the reverse is the case.[115]

The Board in fact denied any problem until the Fisheries Commission closed the area to fishing.[116] Yet even then the Water Board Chief Engineer claimed that there was no nuisance caused by the effluent being discharged into the water. He claimed that fish were to be seen playing around the outfall and that fish could be found there when they could not be found elsewhere.[117]

During a public hearing in 1905 residents of Drummoyne were invited to inspect Folly Point to see the operation of septic tanks, which were being proposed for their area. Witnesses described what they saw at Folly Point as "an abominable nuisance" and reported that many of the ladies on the wharf at the time were made sick by it.[118]

At the 1905 hearing the engineer representing the Water Board claimed that the Folly Point works did not pollute the bay in any way and he was loath to admit any fault with the works. He readily blamed the geography of the place,

> it is a peculiar place,. It is shaped like the neck of a bottle, and, when the north-easter blows, the effluvium from the tank goes up the cliff, and people on the top get a whiff of it.[119]

However, he did admit that Folly Point was not a good example of an effective treatment works and, when pressed, agreed that prejudices formed against septic tanks after visiting the works were well grounded. He made the excuse that it

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113 Daily Telegraph, 6th August 1903.

114 M.W.S.&D.B., Annual Report, 1903, p7; M.W.S.&D.B., Annual Report, 1904, p66.

115 M.W.S.&D.B., Annual Report, 1906, p91.

116 Daily Telegraph, 18th January 1904.

117 Parliamentary Standing Committee on Public Works, Scheme of Sewerage for the Municipality of Drummoyne, Report, 1906, p6.

118 ibid., pp10,12.

119 ibid., p48.

was after all set up for chemical treatment and had been adapted to septic tanks.[120]

By 1912, the sand filters at Folly Point were overloaded and "sewage sick" and had to be relieved with the addition of artificial filters and detritus tanks.[121] The nuisance continued at Folly Point until it was decided that an ocean outfall should be built at North Head and that the sewage feeding into Folly Point be rerouted. Yet before this could be accomplished the Water Board was taken to the Equity Court in 1919 by a neighbouring estate for negligence and nuisance over its conduct of the works. After several weeks the Board was found not to be negligent but was restrained from operating in a way that would cause nuisance. All extensions to the northern suburbs sewerage system had to be postponed until the Board could do something about the works, despite the outcry from residents of unsewered areas.[122]

MARKING OUT THE ENGINEER'S TERRITORY

Despite the disagreements over various treatment methods, engineers almost universally preferred ocean disposal wherever it was economically available. Clark, the English engineer who had recommended the sewage farm in Sydney, stated that he believed that sewage farming could be used as a method of treating sewage but because a loss would accompany such an operation direct discharge into deep water was preferable where it was convenient. Since it was not convenient for the south draining sewage he agreed in principle, and one supposes reluctantly, with the sewage farm.[123]

Similarly the engineering Committee of the Sydney Sewage and Health Board pointed out that the sewage farm would not be recommended if the sewage could be discharged into the sea economically. On the Board there was some argument over whether the government would be willing to cover the cost of taking the sewage all the way to the sea, given the "overflowing Treasury" at that time of national prosperity. But it was pointed out that the yearly interest payments for works which were not immediately necessary "would not be calculated to increase the prosperity of the country." [124]

Also when the sewerage of North Sydney was being considered, the top engineers from both the Public Works Department and the Water Board, Joseph Davis and Thomas Keele, supported septic tank treatment as being second only to ocean disposal, which in this case was too expensive. [125]

The engineering text books of the nineteenth century are mostly unanimous in the opinion that ocean disposal was the most preferable method of dealing with sewage. For example Baldwin Latham, a well-known author of the engineering text "Sanitary Engineering", argued that experience showed that the fertilising

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120 ibid., p50.

121 W.V. Aird, The Water Supply, Sewerage and Drainage of Sydney, pp154-5.

122 Henry, The Water Supply and Sewerage of Sydney, p195.

123 Clark, Drainage of the City of Sydney and Suburbs, p13.

124 Sewage and Health Board, Twelfth and Final Report, pp146.

125 Parliamentary Standing Committee on Public Works, Drainage Works, North Shore, 1888, Minutes of Evidence, p5.

components of the sewage could not be extracted profitably and therefore it should not be considered a great waste to put the sewage into the sea.[126]

The preference by engineers for ocean disposal was not based purely on cost-effectiveness or even the desire for minimal operating costs as can be seen by the constant reiteration of this preference even when a more cost effective alternative was available. In their drive for control, sewage treatment was unattractive because it was to a large extent unpredictable and relatively labour intensive whilst ocean disposal seemed to eliminate the need for treatment altogether. Ocean outfalls were much more controllable.

Problems such as overloading, mechanical breakdown and offensive odours were all distinct possibilities when sewage was being treated. A sewage farm, chemical precipitation or septic tanks required careful management and constant attention. An outfall on the other hand was like an environmental flush toilet with all the advantages of automatic and immediate removal and no dependence on human responsibility. Or so it seemed.

The push to utilise sewage motivated many advocates of sewage farming, both broad irrigation and downward intermittent irrigation, and later chemical precipitation. However, engineers who wrote at the end of the nineteenth century took a different perspective to the public and many other professional groups. Engineers were not necessarily against the use of sewage farms but they considered them primarily in terms of their cost effectiveness and efficiency at purifying the sewage; the waste or utilisation of manure was quite secondary. "Intermittent downward filtration" in particular was viewed simply as a cheap means of dealing with the sewage and the land was simply a medium for purification.[127]

For example, Henry Robinson, an English Professor of Civil Engineering, claimed that sewage farms were too often considered merely from an agricultural point of view rather than from a sanitary point of view.[128]

> The reason why sewage farming has been so unduly pressed and advocated is, that in the early days of sewage utilisation, those who directed public opinion on the question came to the conclusion that the full chemical value of sewage could be realised by its application to land.[129]

He pointed out that the purification of sewage and the raising of crops sometimes came into conflict. This occurred when it rained and large quantities of sewage would arrive at a farm which was already watered by the rain. On such occasions, Robinson argued, "the agricultural part of the matter must be disregarded" and the sanitary necessity alone kept in view.[130] It should be noted that this difficulty resulted from the use of water carriage technology which

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126 Baldwin Latham, Sanitary Engineering: A Guide to the Construction of Works of Sewerage and Drainage with Tables, 2nd ed, E.&F.N.Spon, London, 1878, p444.

127 ibid., pp133-4.

128 Henry Robinson, Sewerage and Sewage Disposal, E.&F.N.Spon, London, 1896, p48.

129 ibid., pp48-9.

130 ibid.

ensured that the sewage would be accompanied by a large quantity of water whether the farm required it or not.

Australian engineers also viewed sewage farming merely as one method of purifying sewage effluent rather than as a means of utilising the fertilising powers of the sewage. Benefits that came from enriching the land were merely part of the economics of the operation. W.H.Warren, Professor of Civil and Mechanical Engineering at Sydney University, like many of his contemporaries, considered that sewage farming was an appropriate option for sewage disposal when it was cheaper than disposal to sea.[131]

Chemical precipitation was another step in a process which aimed at minimising the land required for treatment rather than maximising the land which would benefit from the fertiliser. Chemical precipitation still required that the sewage be subject to downward intermittent filtration, but a smaller area was required once the sewage had much of its suspended solids filtered out. Research into artificial filters in the 1880's offered hopes that the land area required would be reduced even further by the use of materials that had a high surface area to weight ratio.[132]

Artificial filters put an end to any pretences that the sewage was being utilised as it was filtered and septic tanks heralded the end of efforts to utilise the sludge as manure. The development of septic tanks offered even more progress in this quest for processes that required less and less space. A 1917 editorial in an Australian engineering magazine recognised that septic tank treatment was "the outcome of efforts to reduce the space required for the treatment of sewage." [133]

The development of sewage treatment methods marked a steady trend away from sewage utilisation and was characterised by a search for less land intensive solutions. (see figure 3.7) Although the land pressures in Sydney in the nineteenth century were less marked than in Britain or the United States, Sydney engineers were caught up in the flow. The ocean disposal of raw sewage was a solution which required no land and offered no sewage utilisation; it was the ideal solution.

Engineers also preferred ocean disposal because sewage farming was an area less closely aligned to their traditional skills and there were pressures from other professional groups to take control of the area, especially once the biological mechanisms of the sewage farm became better understood.

In 1894 the President of the Royal Society, T.P.Anderson Stuart, M.D. who was Professor of Physiology at Sydney University explained to a meeting of fellow scientists how theories of decomposition had changed. It had previously been thought that decomposition was principally a chemical process mainly due to direct oxidation. It had been discovered, however, that organisms in the soil converted the nitrogenous components of dead organic matter into nitrites and nitrates which were harmless and dissolved in water or were taken up by the

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131 W.H.Warren, `President's Address', Australasian Association for Advancement of Science 4, 1892, p165.

132 Stanbridge, History of Sewage Treatment in Britain, Part 6, pp25-37.

133 'Septic Tank for Sewage Treatment', The Commonwealth Engineer, July 2, 1917, p307.

roots of plants. These "nitrifying organisms" were essential to the supply of food to plants.[134]

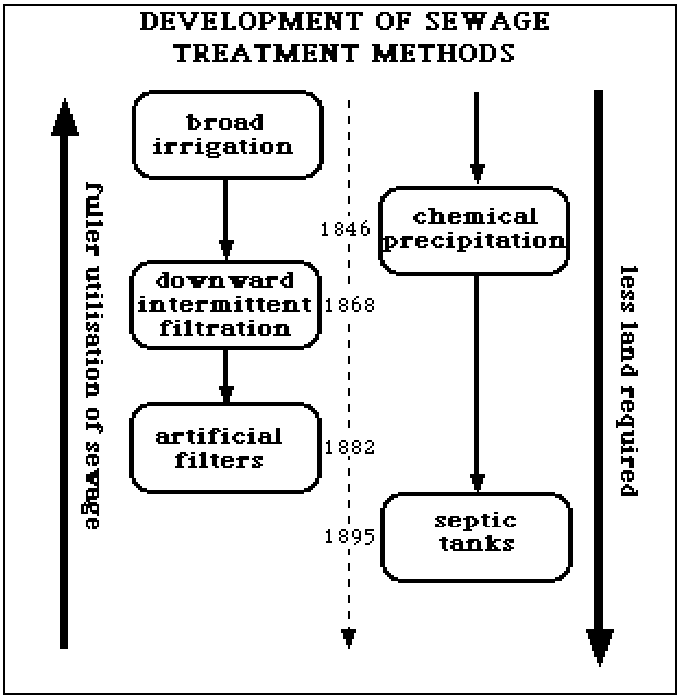

Figure 3.7

It was because of this discovery that Anderson Stuart believed that sewage farming was the most natural and efficient mode of disposing of sewage where sufficient areas of proper soil were available. [135] He felt this discovery of nitrifying organisms and their action in decomposing organic matter removed the work of disposing of sewage away from the sewerage engineer to the biologist.

> now one may say that it is the business of the engineer to collect and distribute the sewage, but that it is mainly that of the biologist or of the chemist to say how it should be disposed or destroyed.[136]

Similar arguments were made with respect to chemical precipitation and septic tank treatment. Hamlet, the government analyst, believed that

> Methods of removal are mechanical, and belong to the domain of the engineer; methods of disposal are of another order, and belong to the domain of biology and chemistry...[137]

The "naturalness" of a sewage farm, which appealed to some sections of the public, was not a desirable attribute to engineers who sought to harness and control nature with their technologies and thereby make their bid for expertise. This was why septic tank treatment appealed to engineers much more than sewage farming as a modern and scientific operation which was really "the

134 T.P.Anderson Stuart, `Anniversary Address', Royal Society of NSW 28, 1894, pp16-17.
135 ibid., pp18-19.
136 ibid., p18.
137 Hamlet, `Anniversary Address', p22.

natural method of sewage purification subject to control".[138] Sewage farms seemed to be too unpredictable. So did chemical precipitation. Septic tanks were not labour intensive and were virtually automatic. There was much more engineering consensus over septic tanks and for this reason septic tanks proliferated around Australia in places where ocean disposal was expensive and the myths associated with their operation, such as the elimination of sludge, continued long after the evidence seemed to destroy them.

Septic tanks also offered an opportunity for engineers to experiment with decentralised sewage treatment systems. The existence of the sewage farm at Webb's grant acted as a magnet for several later sewerage schemes. Stayton says he considered a proposal to convey the Western Suburbs sewage westward to the model farm at Rookwood where it could be used for irrigation. He rejected the proposal on economical grounds. The costs would included the cost of pumping the sewage to the requisite altitude and preparing about 2000 acres of land to receive it. He admitted that the proposed establishment of a sewage farm at Botany was "naturally a strong inducement to consider whether a sufficient area would be available for the purification of the sewage from the Western system".[139]

This tendency towards centralisation was a conscious one. Stayton rejected the idea of having several local systems of sewerage discharging at separate locations rather than one centralised scheme. He argued that there were few suitable sites for sewage to be treated locally and that separate management would involve extra expense.[140] However, centralisation puts huge stresses on treatment plants and Sydney's sewage farm suffered accordingly.

Septic tanks allowed sewage treatment to be far more regionalised because tanks could be small and required a minimum of supervision. In Sydney, in places which were sparsely populated, low-lying but close to waterways, septic tank treatment offered a short term, cheap solution which avoided the cost of pumping the sewage to a higher level so that it could be fed into existing sewerage systems and also the consequences of further burdening the Botany sewage farm.

The interest of engineers in septic tank treatment was a purely pragmatic one. The preference for ocean disposal remained but in situations where it was too costly they were willing to consider other options, even those that were subject to claims by other professional groups. Those claims were never accepted by engineers and so they continued to use biological treatment methods as part of their own arsenal of technologies when it suited them.

When a septic tank system was being considered for Drummoyne (see figure 3.6 for location) the engineers said that it was not fair to the people living near the sewage farm "to handicap the people there by dragging all the sewage to that place" and that if the biological system had been known before the sewage farm was laid out they may have had a far less centralised system, but rather treated the sewage at Homebush Bay and other places.[141]

138 ibid., p33.

139 Stayton, Sewerage and Drainage of the Western Suburbs, p8.

140 ibid., p7.

141 ibid., p48.

> We have a magnificent harbour, with plenty of arms; and having the biological system why should we go to the expense of taking the sewage miles away when the locality could treat it at its own door, and discharge it into a tidal river. [142]

However, septic tanks were not popular with local communities because of the likely nuisance they would cause and in the long term. The ocean outfalls offered a centralised disposal option that could not, it seemed, be overloaded.

CONCLUSION: THE ADVANTAGES OF FAILED EXPERIMENTS

To a large extent the debates between advocates of sewage farms and ocean outfalls mirrored those between dry conservancy and water-carriage enthusiasts. The desire to see sewage utilised persisted in the public mind whilst the desire of the engineers and the sewage authorities for cheap, "minimum fuss" solutions that could be controlled, as far as possible, meant that ocean disposal without treatment was seen as the ideal solution for coastal towns and cities. In Sydney, where in some places it was actually cheaper to treat the sewage on land before discharge into a waterway than to transport the sewage all the way to the sea, the ocean disposal option was reluctantly shelved but not discarded.

The ultimate preference for ocean disposal in the long term shaped the location of treatment sites and allowed the engineers to take a very experimental approach to treatment methods. They were able to try the latest methods being pioneered in Britain and contribute their findings to international engineering forums and take part in the sanitary engineering debates over treatment methods. They always had the fall back position of extending the sewers to the ocean later when populations would be larger and more rates available to repay loans. In the meantime they could play.

These experiments, particularly the Botany sewage farm, also had the additional benefit of allowing the authorities to placate the sewage utilisation lobby which had a large measure of popular support. However, because the sewage farm was always a doubtful experiment forced upon the engineers by a stubborn public and a distant sea, it was not given a fair chance of success. It was located in a low-lying sandy and swampy area with little room for expansion. This was because the engineers chose a place that the sewage could flow to by gravity, without pumping and which was on the way to the sea. (Fears of public reaction also dictated that the spot be remote from existing population centres.) The chosen method of sewage farming, downward intermittent filtration was already a compromise on full utilisation of the sewage. Full scale irrigation with the sewage would have fertilised and required far more land.

Later, Sydney Water Board engineers were able to claim that various methods of land treatment had been tried and failed and that this justified their policy of always using ocean disposal where practicable. The failure of these methods, however, was due in large part to their perceived experimental and temporary nature, which led to poor siting, overloading and poor management. The continued existence of sewage farms in Melbourne and in other countries bears testimony to this.

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[142] ibid., p49.

The overloading was an inevitable result of planning for short time spans but also the draw that existing facilities had for new sewerage schemes looking for an outlet. An existing treatment facility seemed a more economical discharge point to engineers than a new site and a new treatment facility, despite the possibility that the facility might become overloaded. Short term economics does not consider long term consequences. Moreover a centralised facility more easily facilitated any eventual extension to the ocean.

The attempts of engineers to carve out their own territory for sanitary engineering in the face of bids by biologists and chemists was also an important influence in the growing unpopularity of land based treatment and the push towards the ocean.

CHAPTER 4

OCEAN DISPOSAL AND THE EFFECTIVENESS OF PUBLIC PROTEST

It has been argued that underlying all the experiments with various forms of sewage treatment discussed in the previous chapter was an engineering preference for ocean outfalls. This chapter will cover the decisions to construct each of Sydney's three main ocean outfalls, the opposition to these decisions and the role of the engineers in having them implemented despite the opposition.

In 1936 the Sydney Water Board officially recorded its adherence to the principle of disposing of sewerage by direct discharge into the ocean where the cost of so doing was not excessive.[1] This followed reports from two chief engineers in succession which argued that the Board's experience had proved that treatment works could only be considered "a temporary expedient" and that a complete sewerage system would replace any treatment works with ocean outfalls. Sewage farming, chemical treatment and septic tank treatment had all been tried and all had been abandoned.[2]

> There can be no hesitation in accepting the principle "that disposal into the ocean should be continued, always provided that the cost of so doing is not excessive as compared with alternative methods." [3]

The various forms of land-based treatment which had become unpopular amongst engineers had also gained bad reputations amongst the public largely because of poor management and the overloading of treatment works. In the first decades of the twentieth century it was becoming exceedingly difficult to site new sewage treatment plants in Sydney because of local public opposition.

The 1936 Water Board resolution marked the culmination of years of struggle between the public and the professionals over the the siting of sewage treatment works and the fate of Sydney's beaches. The battles over land based sewage treatment were won more easily by the public because of the preference of the professionals and the authorities for ocean disposal and also because local residents were in a far weaker position with respect to ocean outfalls.

AN EARLY FIGHT BETWEEN THE EXPERTS AND THE PUBLIC

An attempt, in 1905, by the Public Works Department to install septic tanks at Five Dock Bay, Drummoyne was successfully countered by local action groups. (see figure 4.1 for location) The residents of Drummoyne were not being assailed by disease because of their lack of sewerage and the pressure to sewer their suburb was coming from the Harbour Trust because their wastes were polluting the Harbour. The Public Works Department had come up with the septic tanks proposal because the small population at Drummoyne and the sparse population

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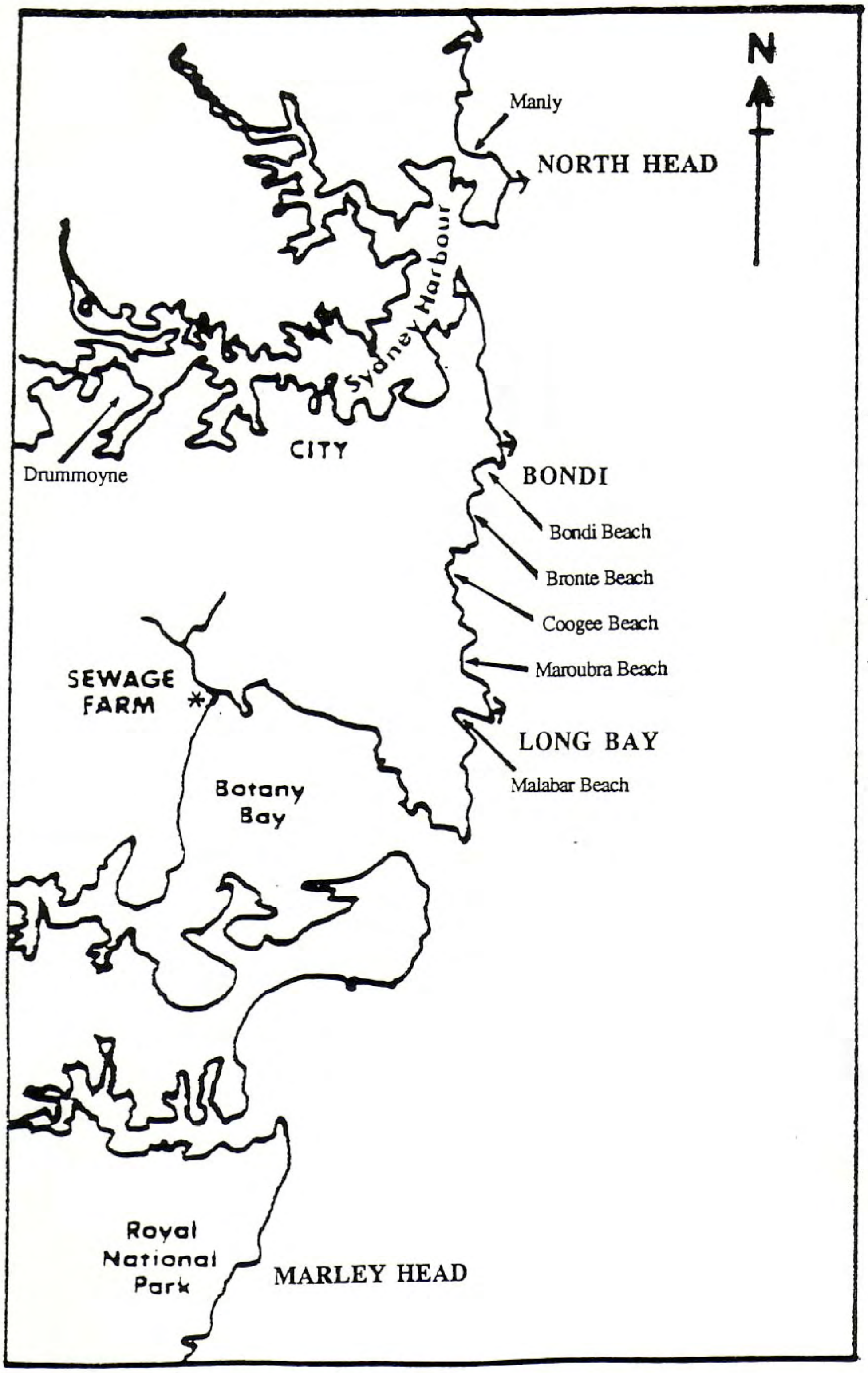
1 Water Board Minutes, 8th January 1936, p223.

2 N MacTaggart, Report on the Sewerage of Sydney, 1935, p2.

3 S.T. Farnsworth, The Major Amplification of the Sewerage System Necessary Under the Construction Programme 1936-41, 1936, p5.

between Drummoyne and the main Western Sewer did not warrant the additional expense of pumping the sewage up to the main.

Figure 4.1 Sydney Beaches



The Drummoyne residents did not like what they heard and saw of the other septic tank installations around Sydney, particularly at Folly Point. They claimed they were willing to pay higher rates to have their sewage fed into the main western system or to wait years, maintaining the old pan system, rather than have a septic tank system established in their midst. Over 1300 people in a district of little more than 3000 signed a petition protesting against the septic tanks.[4]

The engineers from both the Public Works Department and the Water Board tried using all the rhetoric and expert authority at their disposal to convince Drummoyne residents that the proposed sewage tanks would not smell or cause any nuisance. The Chief Engineer of the Water Board, J.M.Smail, accused them of having made up their minds even before visiting existing septic tank installations.

> A great many people are talking of things they know nothing about. We know that in all these cases sentiment is a very strong factor. No doubt, if you brought some of these people to Balmoral, and let them smell a lot of violets, they would swear that it was stinking sewage. You can never hope to convince people of that description.[5]

Smail argued that the installations he had visited in England had no smell, a septic tank would give absolutely no nuisance at Five Dock Bay, that even when the septic tank system was working badly it would not be dangerous and that the filter beds would never foul. The President of the Water Board, Thomas Keele was less emphatic about the absence of smell, "there is always a smell connected with sewerage works", but said it would not be objectionable and there would be no nuisance.[6]

The tendency of the authorities to label protesting locals as being somewhat ignorant and sentimental became evident in this battle. The Parliamentary Public Works Committee asked Keele if the local prejudice resulted from "a want of knowledge" and he replied,

> Exactly so. An effluent with the degree of purification of that I have referred to is turned into streams in the old country from which drinking water is obtained, so I fail to see how it can contaminate the salt water.[7]

To some extent the locals were not concerned with the facts of the case. As one alderman put it

> You must understand that it does not matter if the system is good or bad, the mere fact of the septic tank being in that locality would

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4 Parliamentary Standing Committee on Public Works, Scheme of Sewerage for the Municipality of Drummoyne, 1906.

5 ibid., p48.

6 ibid., pp3-8.

7 ibid.

> depreciate the value of property there, and prevent people from going to reside in that locality.[8]

To the engineers this obstinacy in the face of the "facts" was a show of irrationality. The Board's chief engineer claimed that the greatest thing they had to fight against was "sentiment" which accounted for 90% of the opposition to any improvement or reform.[9] Nevertheless both the Public Works Department and the Water Board showed a similar sort of sentimentality in their reasons for choosing the Five Dock Bay site. They claimed there was no suitable site along the Parramatta River because of all the fine houses fronting the river

> naturally that is the most valuable portion of the frontage. To plant a septic tank in such a situation would be very objectionable because, apart from its not being perhaps a nuisance as far as smell is concerned, it is very unsightly, and there is a sentimental objection.[10]

And when questioned about Iron Cove as a site Smail argued that if there was going to be any detriment to Five Dock Bay, the argument would apply even more so to Iron Cove Bay where there were public baths, a steamer's jetty and a popular picnicing place. [11]

This branding of the public as ignorant was not in keeping with the obvious fact that many of the witnesses had gone to a lot of trouble to inform themselves, reading up about overseas experience and reading books on the subject. Nonetheless the Committee were keen to point out to opponents of the system that they should listen to the experts, that they didn't really know what they were talking about, that they were only concerned about their own district and didn't care about forcing their sewage onto other communities.[12]

Moreover, the evidence of some experts was preferred to that of others. Dr MacKellar, a widely respected doctor, who had given evidence at the Illawarra Suburbs sewerage inquiry, was frequently referred to by witnesses at this inquiry. He had said that septic tanks were fine but should be remote from inhabited dwellings, say half a mile, to prevent a health risk. Smail's response when asked about MacKellar's comments was; "With all due respect to him, I, as a sanitary engineer, do not think I would pin much on his knowledge."[13]

Nor was the knowledge of local people about local conditions given much weight. They pointed out that the Bay into which the effluent would flow was landlocked and that there was very little movement that could carry the effluent away. Even Keele agreed that the action of the tide would be "simply up and down...there would not be any current". Nonetheless Keele argued that the works at Folly Point had a similar situation but no nuisance was caused and fish there were plentiful.[14]

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8 ibid., p15.

9 ibid., pp9,78.

10 ibid.

11 ibid., pp6, 78-9.

12 ibid., p56.

13 ibid., pp12, 50.

14 ibid., pp5-6.

When Smail made the same comment a committee member pointed out that the presence of fish could hardly be seen as a safe guide since they always gather round any offal. Smail replied that this was not so with fish in English rivers, if the fish could live in these rivers then it was not dangerous[15] and there were no impurities. "That is one of tests accepted by bacteriologists as conclusive." [16]

The final success of the Drummoyne residents lay, not in the winning of the verbal battle at the hearing. They could not win that because of the power and expert authority of the engineers who were willing to make extravagant predictions for the sake of achieving their ends. Rather they won, because the sewerage scheme had to be paid for with their rates and therefore required some sort of acquiescence. The hearing had not been an effort to adjudicate between two sides of a debate but rather it had been an attempt to get the public on side. In this it had failed.

BATTLES OVER BEACH POLLUTION

The battles over sewage outfalls were of a different nature. The outfalls were to provide not just for local residents but for a far wider section of the community, many of whom did not care very much about beach pollution, or at least put the sewering of their local neighbourhood as a higher priority than clean beaches. There was no danger of a rate-payers revolt and the representatives of beach suburbs were in a minority on the board.

The first battle was fought over Bondi Beach when it was proposed to divert the city sewage, which was at the time fouling the Harbour, to Ben Buckler, a headland on the northern end of Bondi Beach. (see figure 4.1 for location) An anonymous poet wrote of the plans to discharge sewage at Bondi in the Evening News in 1880,

> But now!
> The festering filth, that scums yon waves,
> Shall sicken health, to fatten graves!
> And when at last each beach and shore,
> Grows sewer sodden'd more and more
> Fell pestilence shall silent sow
> My unseen seeds-to sudden grow
> In one vast upas tree, whose breath
> Shall spread one brooding pall of death?[17]

The Sydney Illustrated News also took to alarmist editorialising over the proposal.

> Our beautiful beaches along the coast will become putrid, festering, fever beds, and our city will vie with New Orleans or the Savannah for the yellow fever and all the concentrated plagues which ever follow

15 ibid., pp5-8.
16 ibid., p78.
17 Evening News, 23rd March, 1880,

> Nemises-like, on open defiance of Nature's laws, and besotted disregard to the most ordinary rules of health.[18]

The News followed the "gallant knight", Sir James Martin, Chief Justice of the colony, and his Sanitary Reform League, into the fight against ocean disposal.[19] Martin believed that Sydney's beaches and harbours would be destroyed if sewage was discharged at Bondi.[20]

The local councils in the area were also aghast. A meeting of mayors of suburban municipalities was convened to consider the sewerage proposals which were roundly condemned. The Mayor of Randwick, a suburb incorporating several miles of beaches south of Bondi Beach, was concerned that disposal of sewage to sea would only rid the city of the sewage temporarily. Eventually "an enormous quantity of filth", carried by currents, would line the city foreshores from Botany Bay to Broken Bay. The Mayor of Waverley, a suburb incorporating Bondi and Bronte Beaches, agreed. He explained to the meeting that recently tons of putrid matter had been washed onto Bondi beach from the sea and this was just what could be expected to happen if the outfall plan went ahead.[21]

At this time Bondi Beach was undeveloped and considered to be fairly remote from the city. The whole of the beach right up to the low-water mark was privately owned by one man who allowed the public access "only by sufferance". Moreover, sea bathing was still considered to be somewhat improper and dangerous, and it was illegal during daylight hours. Nevertheless, the beach was a popular picnic and promenading spot and the public "assembled there in great numbers on Sundays and holidays".[22] The sea air and water was considered to be of therapeutic value and beaches were often billed as health resorts.[23]

In November 1881, prior to the construction of the sewage outfall, an area of 25 acres along the foreshore of Bondi beach was resumed for public recreation.[24] Bondi sea baths were built in 1886 for the less adventurous. However bathing during daylight hours, between 9 am and 8 pm, was officially prohibited by the Police Offences Act until the law was openly challenged in 1902.[25] It was this as well as the lack of development at Bondi beach which has always been used by the Sydney Water Board to excuse its Bondi Outfall. They would argue that there was nothing there to spoil at the time.

The Bondi Outfall at Ben Buckler was completed in 1889 and it was not long before complaints were being made. In 1904 the Water Board discussed a letter they had received about pollution of Bondi Beach by sewage from the outfall.

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18 The Illustrated Sydney News, 15th May 1880.

19 ibid.

20 Sydney Morning Herald, 9th March 1880.

21 Sydney Morning Herald, 17th March 1880.

22 Sydney Morning Herald, 17th April, 1880.

23 Lana Wells, Sunny Memories: Australians at the Seaside, Greenhouse Publications, 1982, pp43-44.

24 National Times, 6th-12th April 1980.

25 National Times, 6th-12th April 1980.

Water Board officers had inspected the beach and found sewage deposited along the length of the beach.[26]

Despite mounting evidence of pollution of Bondi Beach, it was decided in 1908 to build a second major outfall at the headland on the north side of Long Bay where the sewage from the Botany sewage farm and nearby suburbs would be discharged untreated. (see figure 4.1 for location) Pressure for the outfall had come from people living in the suburbs surrounding the sewage farm who, tired of the smells from the overloaded and "sewage sick" farm did not want any form of sewage treatment whatsoever to be carried out near them.[27]

A third major outfall was decided upon in 1916 to be sited on the northern headland of the Harbour, at North Head.(see figure 4.1 for location) This outfall would take sewage from the overloaded sewage treatment works at Folly Point, Chatswood and Balmoral and serve the northern suburbs and suburbs as far west of the city as Parramatta. Again there was no intention of treating the sewage before discharge and warnings about pollution were disregarded.

PREDICTIONS FOR PUBLIC RELATIONS PURPOSES

The engineers have always failed to predict the pollution which would result from ocean outfalls just as they always failed to publicly predict the nuisances which arose from the sewage farm (although they made provision for such a situation arising) and the septic tank installations. When the Bondi outfalls was recommended the Engineering Committee of the Sydney Sewage and Health Board wrote,

> We have examined the set of the tides at the above-mentioned point, and find that during ebb the direction of the current is well off the land, although there is somewhat of an eddy setting towards it to the southward of Benbuckler. On the flood the current sets also to the southward, but from the vast body of water with which the sewage would be mixed, and the constant wash of the waves, we do not apprehend that any nuisance would be caused in the neighbourhood.[28]

Clark also claimed that discharge at Ben Buckler would not create a nuisance. To come to this conclusion he had watched the waves and gone out by boat to inspect the sea. He had thrown a float overboard and this had "drifted a little seaward and to the north." Clarke concluded that since the mouth of the harbour was three and a half miles away there would be no danger of harbour pollution, or of beach pollution.[29]

Floats were frequently used by engineers and oceanographers to determine currents and tides and were weighted so that they were not directly influenced

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[26] Daily Telegraph, 10th March 1904.

[27] Parliamentary Standing Committee on Public Works, Scheme of Sewerage for the Illawarrra Suburbs, 1906, p5.

[28] Committee Appointed by the Sydney City and Suburban Sewage and Health Board, First Report, 1875, p15.

[29] W. Clark, Report to the Government of New South Wales, on the Drainage of the City of Sydney and Suburbs, 1877, p14.

by wind direction. Engineers sought locations for outfalls which had predominantly seaward currents. They were well aware that ocean outfalls could cause pollution.[30] It was recommended in a major engineering text of the time that the tides and currents be studied over a sufficiently long period to be able to observe the whole range of tides and to ascertain the effects of the winds on the currents and tides.[31] Clark's tossing of a float overboard hardly met this criterion.

The emphasis on ocean current allowed engineers to pronounce the outfalls at Bondi, Long Bay and North Head as well suited to sewage discharge because of a prevailing southerly current off the coast. For example the committee inquiring into the Long Bay outfall answered the objections from local property-owners and residents[32] by stating that the conditions of the ocean currents off Long Bay were "favourable for carrying floating matter clear of the coast."[33]

This was based on the evidence of Smail who argued that the current would take the sewage away and that he "would be very much surprised if any of the sewage went into Long Bay", and also the evidence of the Public Works Department's Oceanographic Surveyor, G.H.Halligan. Halligan had examined the coast and tested the direction and velocity of the ocean currents "over two separate periods of the year" (March, September and October) and decided that at the northern headland of Long Bay the current would normally carry the sewage clear of the land. He did admit, however, that putrescible matter might be deposited on the shore near the outfall in rare circumstances. He inferred this from the fact that sewage was occasionally found on Bondi Beach near the outfall there.[34]

In each case the public, especially local residents and beachgoers, was less convinced than the engineers that the southerly current would prevent pollution. The experience with the sewage in the Harbour which had been supposed to be carried off by currents made them cynical when the Bondi outfall was built. Experience with disposing of garbage and offal at sea had been that much of it made its way back to the beaches, especially at Manly.[35] Fishermen and locals who knew the sea, also knew that currents were not the only forces acting upon ocean debris. The repeated return of a dead whale which was towed out to sea in 1936 convinced many ordinary people that matter tends to make its way to shore.[36]

Even the President of the Water Board at the time of the Long Bay Ocean Outfall Inquiry, an engineer himself, admitted that he thought the sewage would drift ashore fairly often. But he allowed the experts to have the final say

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30 Baldwin Latham, Sanitary Engineering: A Guide to the Construction of Works of Sewerage and Drainage with Tables, 2nd edition, E.&F.N.Spon, London 1878, pp445-7; George Waring, Sewerage and Land Drainage, D Van Nostrand Co, 1889, p75; Henry Robinson, Sewerage and Sewage Disposal, E.&F.N.Spon, London, 1896, pp44-46.

31 Latham, Sanitary Engineering, p445.

32 Parliamentary Standing Committee on Pubic Works, Disposal of Sewage from the Western, Southern, Illawarra, and Botancy Districts, 1908, p52.

33 ibid.

34 ibid., pp52-3.

35 Sydney Morning Herald, 6th April 1880.

36 Sydney Morning Herald, 10th January 1936; Sydney Morning Herald, 15th January 1936.

claiming that he did not have any experience with sewage movements in the ocean and had only based his opinion on his observations of floating matter such as seaweed.[37]

In 1880 the newly formed N.S.W. Anti Air and Water Pollution League (founded by Sir James Martin and later renamed the Sanitary Reform League) also opposed the plans to discharge the sewage into the sea as "unscientific" and likely to render Bondi and Coogee "hotbeds of pestilence".[38] Extracts from papers by overseas experts which were read out to one of their meetings claimed that sewage had a lower specific gravity than sea-water and would rise to the surface even if discharged at a great depth and carried a long distance out to sea. Also sea water delayed the oxidation of organic matters and preserved foul constituents of sewage. Moreover, a "pickling" process (caused by the fermenting of the sewage on the sea surface) would cause the perpetual release of deadly gases, spreading epidemics as had happened on the shores of the Mediterranean.[39]

Engineers were not ignorant of the tendency of sewage to rise to the surface of the ocean since it had a higher temperature and lower specific gravity than sea water. Engineering texts pointed this out.[40] Unless the sewage was carried seaward as quickly as possible, one text warned, some of the "suspended solid impurities" would be deposited on the coast and the rest of the suspended impurities would float on the surface

> carried backwards and forwards by every tide, either decomposing and liberating offensive gases, or causing a serious annoyance to those who may have occasion, from business or recreative purposes, to be afloat.[41]

Another text admitted that the floating part of the sewage consisting of "faecal, fatty, and other matters" might be blown ashore by the winds but suggested that screening the sewage would be enough to solve this problem.[42]

Considering that the engineers of the day were well aware of the tendency of the sewage to rise to the surface, they went to extraordinary pains to minimise the influence of the wind on their floats and to ignore surface currents. The explanation lies in the fact that the engineers were more concerned about the free flow of sewage out of the outfalls than with where the sewage might flow to. They were worried about tides and currents to the extent that they might inhibit the outward flow of sewage. Latham's engineering text claims that sea and tidal currents can be greatly prejudicial, or a valuable aid, to discharge, depending on the location of the outfall.[43]

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[37] Parliamentary Standing Committee on Pubic Works, Disposal of Sewage from the Western, Southern, Illawarra, and Botancy Districts, p53.

[38] Sydney Morning Herald, 10th April 1880.

[39] Sydney Morning Herald, 15th May 1880.

[40] Robinson, Sewerage and Sewage Disposal, p45.

[41] ibid.

[42] Latham, Sanitary Engineering, p450.

[43] ibid., p449.

This overriding concern with the unhindered outpouring of sewage from the discharge point was manifest in arguments between engineers from the Water Board and the Public Works Department over the position of the Long Bay outfall. Mr Keele, President of the Water Board, did not like the idea of the sewage discharging under water as had been proposed by the Public Works Department because the flow would be retarded by wave action during storms. English experts brought in to settle this and other disputes between the two departments, suggested that the outfall be lowered from 15 feet below high-water of spring tide to 20 feet below to be sure of discharging into still water and the Public Works committee recommended this amendment.[44]

By ignoring or minimising the role of the wind in the travel of sewage in the ocean, engineers were able to play down the probability of beach pollution due to on-shore winds and to reassure the public. When, as the years went by, polluted beaches made this proposition untenable, other arguments had to be used.

By 1916 when investigations for the outfall at North Head were being carried out, the Public Works Oceanographer, Halligan, found that although there was a strong southerly current at Blue Fish point, the surface current could be retarded or even reversed by a persistent southerly wind. When the southerly wind was followed by an easterly wind, "as it invariably is", the floating matter would be blown towards Manly Beach but because the beach was at least a mile from the outfall, the sewage would be harmless by that time.[45] He claimed that his experiments with floats led him to the conclusion that floating putrescible material would not go more than one mile from the outfall before being broken up and rendered harmless by the waves.[46]

This argument that the sewage would be broken up by waves had been used for a good many years as well. The Sydney Morning Herald had defended the plan to put the sewage out at Bondi by arguing not only that the set of the current would carry the sewage out to sea but also that the "incessant churning of the waves on a rocky coast rising abruptly from the depths" was an ideal location for dispersing the sewage and rendering it innocuous.[47]

Even in 1935, after extensive public campaigning against beach pollution, the Engineer-In-Chief of the Sydney Water Board, N MacTaggart, argued that beach pollution was not a problem in Sydney because there was a prevailing southerly current. On shore easterly winds would only blow floating matter onto the beaches and since the prevailing winds were north-east in the summer and westerly in the winter this would not happen often.[48] (It could already be observed at this time that north-east winds did blow sewage on shore.[49])

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[44] Parliamentary Standing Committee on Pubic Works, Disposal of Sewage from the Western, Southern, Illawarra, and Botancy Districts, p17.

[45] Parliamentary Standing Committee on Public Works, Proposed System of Sewerage, With Ocean Outfall, for the Northern Suburbs of Sydney, 1916, p18.

[46] ibid.

[47] Sydney Morning Herald, 13th March 1880 and 26th March 1880.

[48] N MacTaggart, Report on the Sewerage of Sydney, 1935, p60.

[49] for example Sun, 4th October 1926.

An engineering report commissioned a year later admitted that the extent of beach pollution would be influenced by the wind. It cited the case of the wreck of S.S.Malabar to show that the effects of the southerly current could be dominated by the effects of the winds. The S.S.Malabar was wrecked off Long Bay in 1931 and its cargo came ashore on beaches all along the coast north of the wreck, going as far as the Harbour beach at Manly.[50] (Long Bay was renamed Malabar after this incident.)

Farnsworth, MacTaggart's successor, also argued that beach pollution was not a problem. Floating sewage, he claimed, only infrequently created a nuisance on the beaches. Also the sewage was diluted.

> It may be accepted on present knowledge that dilution by sea water, unlimited in extent, such as occurs on the Sydney Coastline, by discharge in the open Pacific Ocean, renders sewage innocuous to health.[51]

Dilution was another often quoted reason why pollution should not be feared. Dr Purdy, the Metropolitan Health Officer stated that the dilution of the Pacific Ocean was so enormous that any serious pollution would be a mere drop in the bucket.[52] The Evening News concurred

> There is commonsense, as well as scientific certainty, in that opinion, for ten thousand Bondi sewers could not pollute the immeasurable and immemorial ocean.[53]

POLLUTION PROTESTS AT COOGEE

From at least 1904 there were complaints about beach pollution reported in the newspapers. The first organised and effective campaign against beach pollution was waged against a small outfall at Coogee Beach (location of beach shown on figure 4.1) which served the Randwick district and discharged at the water's edge on the Northern end of the beach. The campaign which was carried on throughout the 1920's came at a time when Australian beach culture was blooming; sun-tans were becoming popular, sand-castle building and sand-sculpture were all the rage, gymnastics was practiced on the sand and membership of surf life-saving clubs was booming (see figure 4.2).[54]

Following consistent complaints, in particular by the Coogee and Clovelly Improvement Association to the Water Board, about the "injurious effect" of the sewage outfall at Coogee[55] and a deputation from Randwick Council and the Coogee Life Saving Club to the Board's President about the same matter,[56] the

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50 H.H.Dare & A.J.Gibson, Sewer Outfall Investigation, 1936, p9.

51 S.T. Farnsworth, The Major Amplification of the Sewerage System Necessary Under the Construction Programme 1936-41, 1936, p6.

52 Evening News, 25nd March 1929.

53 Evening News, 25nd March 1929.

54 Wells, Sunny Memories, pp49-64.

55 Water Board Minutes, 6th July 1921.

56 Water Board Minutes 21st December 1921.

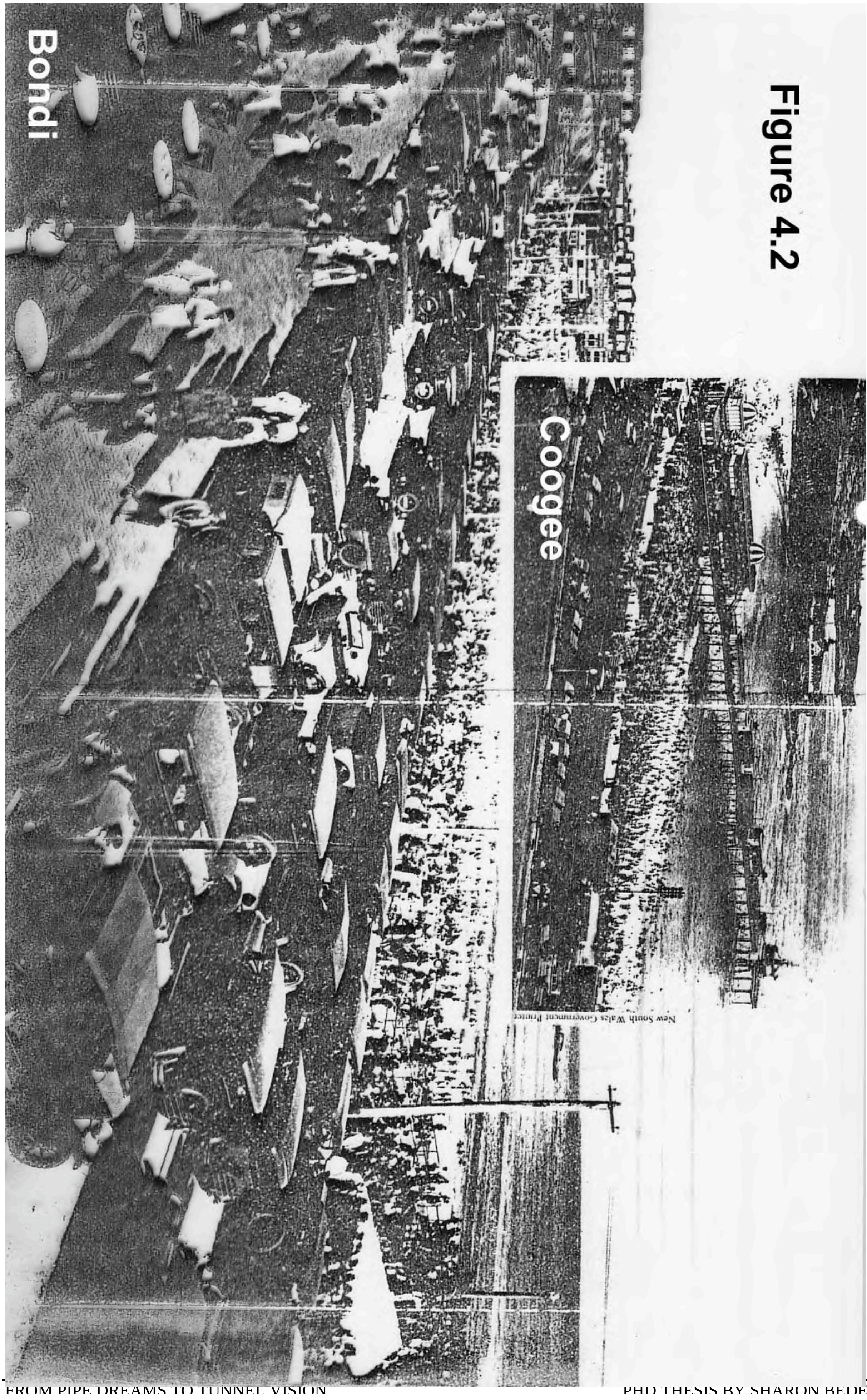

Figure 4.2

Board finally admitted, in 1923,[57] that there was a pollution problem at Coogee. They sent a report to Randwick Council stating that soundings were being taken to find out whether it would be feasible to construct a submarine pipe to take the sewage further out to sea. The Water Board claimed that the prevailing southerly current normally carried sewage clear of the beach but that on occasions, "under certain conditions of wind and tide" sewage was deposited on the beach.[58] The submarine pipe would minimise this because of the distance from shore.

At the Water Board meeting a couple of weeks later, blame for debris on the beach was placed on passing ships and the difficulties with shark nets used as a reason to seek a further report into the feasibility of laying a submarine pipe.[59] This incensed the Coogee Vigilants and Rate-payers' Association who supported the idea of a submarine pipe[60] and they became increasingly anxious as the scheme seemed to be forgotten by the Board.[61] Over a year later, following two deputations and numerous interviews with the Board the Association was still complaining that no action had been taken[62] and after yet another year and a half the Board informed an angry Randwick Council that there would have to be an inspection of the Coogee outfall sewer "before any determination to alter was arrived at."[63]

The idea of diverting the sewage to another outfall site was considered at a Board meeting in January 1924 when reports by Colonel Longley, Mr Gutteridge (Director, Division of Sanitary Engineering, Commonwealth Health Department) and the Board's Chief Engineer were discussed. The matter was deferred.[64] A few months later the Chief Engineer submitted three alternative schemes for eliminating sewage from Coogee beach, one of which was presumably the submarine outfall. [65] It is unclear why the submarine pipe idea was dropped in the end. It was reported in the press the following year that it had been said that experiments with corks had proved that even from half a mile out the northeast winds carried the corks back to to shore. [66]

A second alternative, to divert the sewage to Mistral Point between Maroubra and Coogee was also dropped for unstated reasons. Perhaps the experiments conducted showed that the sewage would pollute nearby beaches or perhaps it was the protests from Maroubra, especially the Maroubra Bay Progress Association and Randwick Council, fearing for the future of Maroubra Beach.[67] The option finally adopted was to divert the sewage to the existing outfall at Long Bay and this had the attraction of utilising existing facilities and

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57 Evening News, 18th April 1923.
58 Evening News, 18th April 1923.
59 Sun, 9th May 1923.
60 Evening News, 12th May 1923.
61 Sun, 26th February 1923.
62 Evening News, 15th April 1924.
63 Sun, 16th September 1925.
64 Water Board Minutes, 25th January 1924.
65 Water Board Minutes, 21st May 1924.
66 Sun, 4th October 1926.
67 Evening News, 30th May 1924; Labor Daily, 30th May 1924; Sun, 11th June 1924.

minimising the numbers of suburbs with an outfall in their midst. It was argued in favour of the scheme that it was better to concentrate the pollution at one point.[68]

The proposal to divert Randwick sewage from Coogee to Long Bay was not popular with locals living near Long Bay. At a council meeting an alderman said that "the filth was not required at Long Bay any more than at Coogee"[69] and there was a definite feeling that Long Bay was being sacrificed to save Coogee. Those aldermen who represented the Long Bay area were of course against the proposal but on Randwick Council, which covered both Coogee and Long Bay they were in a minority. To soothe this minority a motion was passed urging the Water Board to treat the sewage so as to render it inoffensive before it was discharged.[70]

The Board responded to allegations that the beaches near Long Bay would be adversely affected by instructing the Chief Engineer "to test the currents as he deems advisable."[71] When the Chief Engineer reported a few months later he recommended the diversion of sewage to Long Bay suggesting that more current observations be made by Halligan. He argued that the small amount of sewage from Coogee would not make much difference to the Long Bay outfall.[72]

Later that year, the Chief Engineer, maintaining that the Long Bay Outfall Sewer would have to be duplicated in the near future to provide for the sewering of additional areas, persuaded the Board to make provision in the Coogee diversion scheme for a tunnel alongside the Long Bay Outfall Sewer for that portion of the Coogee diversion pipe which followed the Long Bay Sewer of the size that would be ultimately required for the duplication.[73] Money spent on the diversion would therefore also be going towards necessary upgrading work and this gave the Board's engineer an incentive to push for this course of action.

The arguments over the Coogee diversion brought to the fore the realisation by local residents of Long Bay that their outfall was increasingly becoming a central disposal point for the city. The sewage flow was being continually augmented as more suburbs were sewered. On 25th May 1927, the Long Bay Progress Association, the Life Saving Club, the Parents and Citizens' Association and the South Ward Progress Association held an "indignation meeting" to protest against the diversion of the Coogee sewerage to Long Bay. It was said that Long Bay should not be "the dumping ground for the remainder of the city." Alderman Sautelle a member of the Water Board said that Long Bay would be doomed as a surfing beach.[74] (In fact, the beach was closed some years later for swimming and surfing because of pollution.) And an MP, Mr E Riley argued that "No Government has the right to penalise a section of the community for the benefit of another."[75]

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68 Evening News, 28th October 1925.

69 Evening News, 16th September 1925.

70 Sun, 28th October 1925.

71 Water Board Minutes, 21st October 1925.

72 Water Board Minutes, 17th February 1926.

73 Water Board Minutes, 17th November 1926.

74 Sydney Morning Herald, 26th May 1927.

75 Evening News, 26th May 1927.

The meeting resolved to request the Government to make a survey of the ocean bed to see if the sewage at Long Bay could be carried further out to sea in a tunnel under the ocean. This was suggested by Alderman Sautelle, an engineer, as the only alternative since treatment by septic tanks would require 30-50 acres and destroy everything in a five mile radius.[76] As an engineer, he could not contemplate any scheme other than dealing with the sewage at Long Bay since alternatives to this would involve the scrapping of a vast network of pipes, the physical infrastructure, which brought the sewage to Long Bay.

> The sewage system had cost millions of pounds, and could not be cavalierly brushed aside by the passing of a pious resolution - even to save Long Bay beach.[77]

Meanwhile the Randwick Council continued to complain about the lack of action by the Water Board as far as removing the Coogee outfall.[78] After reported widespread agitation the Board decided to go ahead with the diversion and put forward a proposal to extend the whole system further south. This brought further protest from Rockdale Council, claiming that Botany Bay would be threatened[79] but debate quietened down for a year or so.

In the meantime the Board had made a model of a plant for breaking up floating sewage matter and were satisfied by experiments with the model. It was decided to build such a plant at Coogee and at least some of the board members hoped that this would do away with the necessity to divert the sewage[80] although the Board later claimed that this was just a temporary measure undertaken to keep the beach clean until the diversion could be carried out.[81] The plant, which mechanically disintegrated the sewage solids was build and put into operation in 1928.

In May 1929, a further protest meeting was held by the Long Bay Progress Association, the Maroubra Chamber of Commerce, and the Maroubra Junction, Matraville and Bunnerong Progress Associations with a big attendance. Besides protesting about the Coogee diversion speakers also protested against the lack of treatment the sewage received before discharge.[82] The meeting decided that the Board should immediately investigate "modern methods of dealing with sewage to avoid possible pollution of the beaches, which are among the greatest of the city's assets."[83] A week later Botany Council joined the protest against the diversion proposal.[84]

In 1932, after the first section of work towards the diversion had been carried out and further funds were not available, the Board members representing the

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76 Sydney Morning Herald, 26th May 1927; Evening News 26th May 1927; Daily Telegraph, 27th May 1927.

77 Daily Telegraph, 27th May 1927.

78 Sun, 14th Septemer 1927; Evening News 14th September 1927.

79 Sun, 18th November 1927.

80 Water Board Minutes, 23rd November 1927.

81 Water Board Minutes, 19th October 1932.

82 Sydney Morning Herald, 1st May 1929; *Sun*, 1st May 1929; Daily Telegraph, 1st May 1929.

83 Sydney Morning Herald, 1st May 1929.

84 Sun, 9th May 1929.

Eastern suburbs, Moverley and Sautelle, proposed that the scheme be completed by applying to the Government for an Unemployed Relief Grant. The debate which followed was mainly about priorities. Moverley and Sautelle emphasised the importance of the beaches to the whole metropolitan area and the threat to health that polluted beaches posed. Other Board members suggested that the sewering of unsewered areas should have priority and that such work would at least bring a return (in the form of additional rates) since the Board already used 78% of its revenue to meet interest and other charges.[85]

One member disliked the idea of the government determining the "distribution of moneys voted" and it was decided that the priority and urgency of the diversion scheme should be reviewed by Water Board officers before government funds were sought.[86] The Chief Engineer reported back the following month giving estimated percentage revenues for money spent on various schemes, the Coogee diversion being lowest at 1.13%. But he also suggested that the Coogee diversion could be considered to be of general benefit to the community and therefore could be recommended as work to be carried out from Relief Funds.[87] He did not mention that the work on the diversion would also contribute towards the duplication of the Long Bay sewer which he foresaw would be necessary.

Advice had also been received from the Department of Labour and Industry that funds would be made available for the completion of the Coogee diversion scheme. (The Minister for this department at the time was Dunningham, Member for Coogee.) The Board decided to accept the offer if the funds could be made as a grant or with interest payment suspended until completion of the works. Various members opposed this decision because of the lack of return the expenditure would bring.[88] However, the terms were unacceptable to the Unemployment Relief Council which offered half the sum as a grant and half as a loan.[89] After trying to get them to reconsider the Board finally left negotiations up to the President.[90] Work was recommenced in October 1933, using Relief labour and the diversion was completed in 1936.

SUPPRESSING POOR PUBLICITY

The Coogee outfall was designed and constructed by the local authorities and the state authorities did not feel quite so defensive about its performance as they did about the three major outfalls which had all been declared by government engineers to be non-polluting even before they were constructed. If the Sydney Water Board had admitted that those outfalls polluted the beaches, not only would they have been discrediting their own engineers but also they would have been obliged to do something about the pollution. The Board and other government authorities therefore responded to most pollution complaints by denying the pollution existed, blaming the pollution on other sources or claiming that rare instances of pollution could not be prevented.

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85 Water Board Minutes, 19th October 1932; *Sun*, 19th October 1932.

86 Water Board Minutes, 19th October 1932.

87 Water Board Minutes, 23rd November 1932.

88 Water Board Minutes, 23rd November 1932.

89 Water Board Minutes, 30th November 1932.

90 Water Board Minutes, 14th December 1932.

In response to the 1904 complaints about the Bondi outfall, Board Inspector McKenzie claimed that all the sewage had blown into the beach on a surface drift caused by easterly winds which often brought floating matter discharged from ships onto Bondi, Bronte and Coogee beaches. Since the main ocean current was flowing south during the previous week he concluded that the sewage could not have come from the main sewage outfall.[91] The engineer-in-chief reported that since such sewage deposits occurred infrequently, they could be dealt with by maintenance men "if it could be proved that the whole deposit came from the main outfall". He admitted that the wind conditions of the previous week could have caused the light floating matter to "drift out of the current" and onto the beach. "This was unavoidable."[92]

Thirty-two years later the responses were not much different. Dr Purdy, City Health Officer blamed pollution in 1936 on night soil dumping and passing ships and claimed that diseases were contracted in dressing sheds by use of common towels and the spread of germs from one surfer to another in the water.[93]

The authorities were able to get away with unconvincing denials because public complaints were often hushed up by local councils, businessmen and property owners who were concerned that adverse publicity would drive away potential visitors and residents from the area and depress business activity, regional development and property values. Lobbying for remedies for the pollution was often carried on behind the scenes.

During the 1920s the Council had been trying to attract surfers and tourists to Coogee. An advertising campaign described Coogee as "the seaside holiday resort of NSW" and in 1928 the Coogee Pleasure Pier costing £70,000 was opened with a gala event.(see figure 4.2) The pier had a theatre seating 1,400, a ballroom for 600, a 400 seat restaurant, a nursery, a camera observer and several shops. It was lit up at night with thousands of lights. The following year the new shark net surf sheds were greeted by "Come to Coogee Week" celebrations which included a mile-long procession watched by 135,000 spectators.[94]

In the summer following the Board's decision to build the diversion to Long Bay, both Dr Thompson and Mr Stevens of the Coogee Progress Association gave statements to the press deploring the state of Coogee beach. They blamed the sewage for ill-health and shark attacks and a sickening stench.[95] In reply the president of the Water Board claimed he was unaware "of any grounds on which alarmist statements could have been made".[96] The next day, however, the reported allegations were denied and decried by the Randwick Council which claimed to be representing Coogee businessmen.

"What useful object is to be served by residents of Coogee making alarmist cries of this character" asked the Deputy Mayor, Alderman Goldstein, who had made similar statements himself in previous years, "Surely Coogee has suffered

91 Daily Telegraph, 10th March 1904.

92 Daily Telegraph, 10th March 1904.

93 Sydney Morning Herald, 5th May 1936; Daily Telegraph, 5th May 1936.

94 Weekly Courier, 7th September 1926.

95 Evening News, 4th October 1926.

96 Sun, 4th October 1926.

enough through the shark scares?"[97] At the next council meeting Mr Stevens was denied the chance to speak whilst Alderman Goldstein claimed that the sewage was in fact seaweed.[98] He did, however, contradict himself when he admitted that council had been trying for years to have the matter remedied.[99]

The Coogee Bay Progress Association immediately dissociated itself from Mr Stevens' statements and said that Coogee was perfectly clean and healthy.[100] They admitted, though, that they had resolved six months earlier to give no publicity to complaints about beach pollution since the Water Board was considering the diversion of the outfall sewer.[101]

Later Alderman Dunningham, Member for Coogee and former Mayor of Randwick admitted that the Randwick Council had hushed up publicity about pollution and for many years had dealt with the issue of Coogee Beach pollution in committee "in deference to the interests of business people." But he also stated that after trying unsuccessfully for years to get the Water Board "to remedy the trouble the council proceeded to deal openly with the question of pollution."[102]

Bondi residents also showed the same tendency towards hushing up poor publicity. On the 6th March, 1929 the Telegraph newspaper published a large aerial photograph of Ben Buckler point showing the sewage field curving around the point. The photo was headlined "Horrible Sewage-Loaded Sea Washes Bondi Surfers" and immediately set off a wave of publicity and protest about the pollution of Bondi beach.[103]

The Telegraph described the sewage field as a "sinister curve of menace to health" and the photo as "the most damning indictment of Sydney's sewerage system ever published"[104] and the Sun later that day published the outraged statements of the president of the North Bondi Surf Life-Saving Club and the Mayor of Waverley.[105] The State Premier promised to see what could be done "to remove the conditions which had been rightly described as intolerable."[106]

Immediate denials were given by the Chief Civic Commissioner, who suggested that the conditions which enable sewage to come into the beach occur "perhaps once in five years"[107], and members of the Water Board. Aldermen Moverley and Sautelle claimed that the current swept the sewage away from the beaches[108]

97 Evening News, 5th October 1926.
98 Evening News, 13th October 1926.
99 Evening News, 13th October 1926.
100 Sun, 14th October 1926.
101 Evening News, 14th October 1926.
102 Sun, 7th March 1929.
103 Daily Telegraph, 6th March 1929.
104 Daily Telegraph, 6th March 1929.
105 Sun, 6th March 1929.
106 Sun, 6th March 1929.
107 Daily Telegraph, 7th March 1929.
108 Sun, 6th March 1929; Evening News, 6th March 1929.

and the Waverley town clerk was said to have received no complaints of sewage coming onto the beach.[109]

When approached, the President of the Water Board, T.B. Cooper, said the Board would do nothing. He said that development in the Bondi area had occurred since the construction of the outfall.

> The Bondi sewer, with other ocean outfalls, was inquired into by a Parliamentary Standing Committee. Subsequently Acts of Parliament were passed authorising the construction of those works, and in due course they were carried out by the constructing authority on behalf of the Government, and then handed over to this Board to administer,....Consequently the Board proposes to do nothing. I may add, it is Sydney's unalterable system.[110]

The board unanimously agreed that it was not called upon to take any action.[111]

The day after the publication of the damning photo and the Board's refusal to take any action there was a remarkable turn around in statements and a definite attempt to suppress the idea that Bondi was polluted. The President of the North Bondi Surf Life-Saving Club retreated from previous statements. He had described the release of sewage into the sea as "criminal" and had recounted being forced to leave the surf because the beach was littered from one end to the other with "offensive matter."[112] Now he claimed that the surf was fairly free from sewage and that the stream in the photograph was "just an ocean current- not sewage matter."[113] The Mayor of Waverley who had called for the removal of the outfall which was "against all doctrines of hygiene"[114] now claimed that the photograph showed foam and not sewage and proclaimed the "remarkable clearness" of the Bondi water.[115]

The reason for this retraction emerges in the midst of the Mayor's indignation.

> It is not fair to the council and rate-payers to say it was an arc of sewage; especially after so much money has been spent to beautify the beach. I do not know of anything more harmful to the district than the publication of that photograph.[116]

Waverley Council had just spent six years planning and constructing a pavilion as part of its beach beautification program. The pavilion was claimed to be a "palatial building" with accommodation for 12,000 people to change, modern refreshment rooms, a cafe and a splendid ballroom with a jarrah floor.[117]

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109 Evening News, 6th March 1929.
110 Sun, 6th March 1929.
111 Sydney Morning Herald, 7th March 1929.
112 Sun, 6th March 1929.
113 Daily Telegraph, 7th March 1929.
114 Sun, 6th March 1929.
115 Daily Telegraph, 7th March 1929.
116 Daily Telegraph, 7th March 1929.
117 Wells, Sunny Memories, p64.

Dunningham, Member for Coogee, was informed by members of Waverley Council that "he had done wrong in giving publicity to the matter, as the interests of the shopkeepers were affected." They felt that pollution had to be put up with "until some scientific way was devised of treating the sewage before it was released into the sea" or until the outfalls could be extended far out to sea.[118]

The district and especially the businessmen and council of Bondi were said to be up in arms. There were calls to boycott the Sun and Telegraph and withdraw advertising. A "monster indignation meeting" was called against the Sun.[119] The Guardian claimed that.

> Every citizen of Bondi and Waverley who has his savings in property, or makes his living in a shop, is damaged by this sham "proof" manufactured against Bondi Beach.[120]

It was later suggested by the Guardian that the photo had been published by the Telegraph because of the discontinuation of advertising by Bondi Publicity League. The Guardian launched an attack on the Sun for attacking Bondi. Under the headline ""Sun's" Vicious Attempt to Discredit Bondi Surfing" the Guardian suggested that there was no real substance in the Sun's allegations.[121]

The League had, according to the Guardian, approached the Telegraph and arranged for them to boost the image of Bondi in return for which the League would run an advertising campaign involving half-page advertisements to be placed every Sunday in the Telegraph. The Telegraph ran two pages of complimentary photos of Bondi and the League lodged its first advertisement with the Telegraph the following Sunday. When the league failed to place further advertising as expected by the Telegraph, the photo of the sewage field was published in retribution.[122] The Sun, however, claimed that the advertising campaign had been discontinued after the publication of the damaging photo.[123]

A LAST DITCH STAND TO SAVE CITY BEACHES

The whole sewage pollution debate came out into the open properly in 1935-6 when it was proposed by MacTaggart, the Engineer-in-Chief of the Water Board, that the sewage from the southern suburbs be diverted to Marley Head in the Royal National Park south of the city and discharged there so as to relieve the overtaxed Long Bay main. The public seized upon this proposal as an opportunity to rid the eastern and southern beaches of sewage once and for all. There was heavy lobbying to have all the city's sewage, south of the Harbour, diverted away from city beaches down to Marley Head.

MacTaggart's proposal was a response to the problems that were occurring in the sewer main leading to the Long Bay outfall because of overloading, reduced capacity due to repairs and also problems that arose from connecting three sewer

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118 Sun, 7th March 1929.
119 Guardian, 22nd March 1929; Guardian, 29th March 1929.
120 Guardian, 22nd March 1929
121 Guardian, 22nd March 1929
122 Guardian, 22nd March 1929
123 Sun, 23rd March 1929.

mains that had a free outlet on the sewage farm into one inadequate channel going from the sewage farm to Long Bay. This had "converted three well designed schemes into one very defective scheme" and the Board had had to contend with continuous trouble with surcharging sewage.[124]

Marley Head was a suitable site for an outfall, MacTaggart argued, because it was the nearest suitable headland and yet was a good distance away from habitation and public beaches. A larger area could be sewered to this point and there would be no worries about possible future development around the site since it was a National Park. Because a National Park could not be alienated extra land would always be available for treatment of the sewage should it become necessary.[125]

He rejected the idea of building a duplicate sewer discharging at Long Bay because it would be too costly to cross the low-lying land between the Cooks River and the ocean and because the additional discharge at Long Bay would be undesirable in view of the complaints already received.[126] Farnsworth, his successor, disagreed and recommended that a duplicate ocean outfall carrier be constructed to discharge at Long Bay. He claimed the location of the new outfall was "a matter to be decided upon economic and technical grounds only".[127]

MacTaggart's scheme would require an unusually flat grade, an unnecessarily risky inverted syphon and a length of sewer that would allow the sewage to putrefy and destroy the concrete pipes. The scheme was a radical departure from standard practice making it of an experimental nature and overly costly.[128] On the other hand, Farnsworth argued, the duplication scheme took the shortest feasible route to the ocean, would not require further investigation as MacTaggart's scheme would, and could be built more cheaply and quickly so that inflation and changes in money market conditions would be less devastating.[129]

The Water Board considered Farnsworth's report early in 1936 and unanimously adopted his recommendation

> That the Board record its adherence to the principle of disposing of sewerage by direct discharge into the ocean where the cost of so doing is not excessive; and directs that steps shall be at once taken with a view to equipping present and future outfalls with suitable and efficient treatment works to remove matter liable to create nuisance from the sewage before discharge of same into the sea.[130]

The second recommendation to duplicate the Long Bay outfall was debated over two meetings and adopted with one dissentient, Alderman Moverley, who represented Councils covering the Eastern beaches and favoured MacTaggart's proposal to construct an outfall at Marley Head because he wished to have the

124 MacTaggart, Report on the Sewerage of Sydney, pp15-16.
125 ibid., p49.
126 ibid.
127 Farnsworth, The Major Amplification of the Sewerage System, p10.
128 ibid.
129 ibid.
130 Water Board Minutes, 8th January 1936, p223.

sewage removed from metropolitan beaches. [131] Moverley claimed that "It should not be a question of cheapness, but of what was in the best interests and health of the people." [132]

The duplication proposal was, however, attractive to the other members of the board because it was a cheaper, simpler scheme which would allow repairs to be carried out on the existing sewer and also enable sewerage provision to be extended to unsewered districts, which some of them represented, sooner. The sewage could be treated so that beach pollution would not occur, they argued.[133]

The proposal to duplicate the Long Bay outfall was immediately followed by an outcry. Complaints were made by the seaside councils which were concerned about beach pollution and claimed that "surfing had become not only a national recreation but also a health-giving exercise."[134] The Mayor of Botany felt it was "grossly unfair that the sewage of Illawarra and Bankstown [in the Western suburbs of Sydney more than 20 kilometres from Long Bay] should be directed through the Botany municipality."[135]

One thing that became clear at this time was that a number of beaches were already experiencing a degree of pollution. The threat of this situation worsening and the chance that the water board could be coerced into taking action overcame the reluctance of local people to admit to their pollution problems.[136] The Bondi Weekly proclaimed that

> To continue emptying this vile-appearing, foul-smelling abomination just over the coastline of densely-populated districts is an atrocity on the part of those responsible and a reflection on those who tamely submit to it.[137]

The Minister for Labor and Industry and Member for Coogee, Mr Dunningham, sent a letter to the Premier asking that the Board supply details so that it could be ascertained to what extent the beaches would be depreciated.

> There is widespread indignation over the proposal, not only from sea-side electorates and municipalities, but also from those thousands who indulge in surfing as a health-giving pastime.[138]

The Telegraph also reported that "seaside councils are up in arms, surfers are more than a little perturbed, and seaside property-owners are thinking gloomily of reduced land values".[139] A property owner of Malabar submitted a plea

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131 Water Board Minutes, 8th January 1936, p223.

132 Sydney Morning Herald, 21st January 1936.

133 Water Board Minutes, 8th January 1936, p223; Water Board Minutes, 15th January 1936, p233.

134 Sydney Morning Herald, 10th January 1936 & 24th January 1936; Daily Telegraph, 23rd January 1936; Labor Daily, 24th January 1936; Bondi Weekly, 6th February 1936.

135 Daily Telegraph, 16th January 1936.

136 Sydney Morning Herald, 31st January 1936.

137 Bondi Weekly, 30th January 1936.

138 Sun, 16th January 1936.

139 Daily Telegraph, 17th January 1936.

through the Telegraph pages "for protection of the unfortunates who have their life-savings similarly invested."[140]

The Surf Life-Saving Associations registered their protest and organised protest meetings.[141] And, rather belately, the North Bondi Progress Association joined in.[142] Unaffiliated young people canvassed the Eastern Suburbs to ensure a "packed house" for a public protest meeting.[143] The meeting was held on the 20th January and was "largely attended" attracting Mayors, aldermen and representatives of surf and swimming clubs.[144] The meeting, organised by Randwick council, carried a resolution against a sewerage programme which included the building or use of outfalls such as the proposed one at Long Bay. The resolution suggested that sewerage should be a "truly national project" and recommended that overseas experts be obtained to "put into operation modern treatment systems."[145]

A second meeting was organised by Waverley Council and held on the 17th February. The meeting of Bondi residents and representatives of both sides of politics decided to request the State government to "insist upon the discontinuance of the discharge of sewage into the ocean near surfing beaches."[146] There was a protest at the meeting from an alderman that publicity would adversely affect the popularity of the beaches but the Mayor of Waverley replied that the councils had "hushed up the matter" for years and now realised that publicity would achieve more.[147]

The Water Board responded throughout the campaign of protest with material from the Farnsworth report and assurances that sewage treatment would prevent beach pollution.[148] One Board Member however went so far as to say that "The trouble with Australians is that they have a hygiene complex."[149]

Support for the Water Board scheme came from Members of Parliament who argued that priority should be placed on sewering unsewered districts and that occasional beach disfigurement was a secondary consideration.[150] Nonetheless the support of those voters in unsewered districts was not enough to overcome the massive public outcry over beach pollution. The government was forced to insist that the Board bring in independent experts to review their proposals.[151] The Board agreed that the "best way to satisfy the public mind"[152] was to seek

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140 Daily Telegraph, 18th January 1936.

141 Sydney Morning Herald, 18th January 1936.

142 Labor Daily, 28th January 1936.

143 Daily Telegraph, 30th January 1936.

144 Sydney Morning Herald, 21st January 1936; Daily Telegraph, 21st January 1936.

145 Daily Telegraph, 21st January 1936.

146 Sydney Morning Herald, 18th February 1936; Bondi Weekly, 20th February 1936.

147 Daily Telegraph, 18th February 1936; Bondi Weekly, 20th February 1936.

148 Sydney Morning Herald, 9th January 1936, 10th January 1936, 18th January 1936; *Sun*, 16th January 1936; Daily Telegraph, 17th January 1936.

149 Daily Telegraph, 17th January 1936.

150 Sydney Morning Herald, 10th January 1936, 24th January 1936.

151 Sydney Morning Herald, 23rd January 1936.

152 Sydney Morning Herald, 30th January 1936.

independent opinions and Messrs. Dare and Gibson were decided upon by the Board in committee.[153]

H.H.Dare, far from being independent, had acted as a consultant to the Water Board on several previous occasions. A.J. Gibson was also a consultant engineer from the firm Julius Poole & Gibson. Dare and Gibson reported a few months later. They reaffirmed that disposal of sewage by dilution to sea was the most economical and satisfactory solution in coastal cities.[154] They therefore recommended that the duplicate sewer discharging at Long Bay be built.

They rejected the idea of sewage farming as being too expensive, full of engineering difficulties and "a retrograde step". MacTaggart's proposal to divert the sewage of the southern suburbs to Marley Beach would be too expensive and too technically difficult because of the flat grade and deep syphons required and then it would only mean another source of pollution. It would also be too expensive and quite impracticable to divert the existing outfalls elsewhere. Any extension of the outfalls further out to sea would not only be too expensive and too technically difficult but would serve little purpose since the offensive matter would still come back on shore.

THE ESSENTIAL ARGUMENTS - HEALTH RISKS AND DENIALS

The newspapers received a number of letters debating the proposed schemes, from members of parliament, aldermen, water board members and the public. The extent to which the beaches were polluted was the first point of contention.

> "Pollution of beaches" is a good and efficient political catch-cry, but as a scientific fact it ranks among the superstitions of the past like wearing a bi-metallic ring as a cure for rheumatism.[155]

Two weeks after the infamous 1929 Telegraph photo the Sun procured three samples of sea water at Bondi and had them analysed by a public analyst. The samples contained "organic matter of decomposed animal or vegetable origin" and one sample contained "the bacteria of putrefaction."[156]

In response the authorities did their own sampling. The government analyst found no nitrates in a sample procured by the Metropolitan Medical officer, which meant "the pollution of the water by sewage is negligible". Another sample procured by Waverley Council was found to have "nothing to substantiate the airy surmises so graphically depicted lately".[157]

The scope for taking unrepresentative samples on both sides was enormous. The Guardian quickly followed the Sun story with allegations that the Sun samples had all been procured by a fisherman from the same spot "in line with the sewer outfall".[158] The Sun answered these allegations by taking a further six samples

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[153] Water Board Minutes, 29th January 1936, p247.

[154] H.H.Dare & A.J.Gibson, Sewer Outfall Investigation, 1936, p4.

[155] Sydney Morning Herald, 13th January 1936.

[156] Sun, 21st March 1929.

[157] Evening News, 22nd March 1929.

[158] Guardian, 22nd March 1929.

at six different points, of which two contained organic matter. The Guardian, however, interpreted the analysis as meaning that "Bondi water is, if anything, purer that most sea water."[159]

There were numerous personal testimonials in letters to the editor of people who had seen and smelt the sewage in bathing waters.[160] Nevertheless the Government analyst, taking samples at various beaches in 1929, declared the beaches clean.[161] The difficulty lay, not only in the choice of spot from which the sample should be taken, but also in the interpretation of the analysis of such a sample. As the Board Medical Officer admitted in 1936, after returning from an overseas study tour, beach pollution had received very little scientific study and "no standards existed as to what constituted polluted water".[162]

Even where it was generally agreed that water was polluted, there was no agreement over whether polluted bathing water was a health problem. From the Coogee campaign through to the Long Bay duplication decision the newspapers reported unnamed doctors blaming ear, nose and throat diseases on bathing in polluted waters.[163] One doctor, referred to only as a well-known eye specialist, wrote in 1936 that the water had been so filthy "as to make bathing a questionable performance" and that contaminated surf water had "a very bad effect on the eyes, ears, and mucous membrane."[164] There were also personal testimonies from surfers who claimed to have suffered septic throats and blood poisoning from the polluted waters.[165] Protesters claimed that Typhoid, Mastoid growths, ear infections and "terrible diseases" could be caught in the surf.[166] The Evening News charged

> Apparently the health of the thousands of people who visit the beaches to surf is not valued by the board as highly as the estimated expenditure necessary to carry out the essential alterations.[167]

However the authorities always denied allegations that polluted water was a health threat. One metropolitan Medical Officer, Dr J.S.Purdy, in his efforts to disclaim any health threats, claimed that he induced his family and friends to sniff Bondi sea water up their noses as a prophylactic against catarrh after observing that constant surfers did not suffer from influenza. Dr Purdy had bottled his samples of Bondi sea water and called it 'hypertonic supersaturated sea salt solution'.[168]

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159 Guardian, 26th March 1929.

160 Daily Telegraph, 26th March 1929; *Sun*, 26th March 1929; *Sun*, 27th March 1929.

161 Sydney Morning Herald, 5th April 1929; Guardian, 5th April 1929; Daily Telegraph, 5th March 1929; Labor Daily, 6th April 1929.

162 Sun, 15th January 1936.

163 Daily Telegraph, 7th March 1929; Sun, 7th March 1929; Sun 26th March 1929.

164 Daily Telegraph, 18th February 1936.

165 Sun, 22nd March, 1929 and 25th March 1929.

166 Daily Telegraph, 21st January 1936, 1st February 1936, 14th February 1936; Labor Daily, 5th February 1936.

167 Evening News, 15th July 1927.

168 Evening News, 22nd March 1929.

By 1936 the Water Board was willing to admit to some pollution but not that this pollution posed a health threat. Their Medical officer said that no definite evidence existed that beach pollution had led to any epidemic of disease and he felt that ear diseases which were sometimes attributed to water pollution might be caused by "a particle of sand or of seaweed."[169]

At this time health legislation was being prepared to give the Health Department responsibility for monitoring pollution of bathing waters.[170] However health authorities also denied that pollution endangered public health. Dr Purdy, however, said that even when the surf was "grossly polluted" it did not imperil health.[171] The Director-General of Public Health concurred that there was "absolutely no evidence to favour the contention that diseases are transmitted by pollution of the surf."[172]

When Dare and Gibson reported they argued that the pollution on Sydney's beaches came from both the outfalls and from ships and dumping at sea. They quoted the American engineering text by Metcalf and Eddy to refute the idea that there was any real danger to health from polluted water. Metcalf and Eddy claimed that disease-producing organisms were present in the sewage but that these organisms were adequately dealt with by dilution in water.

Dare and Gibson also referred to a report by Dr Saunders, the Board's Medical Officer. Saunders denied that there was any danger involved in bathing at Sydney beaches. Bathing in polluted waters was dangerous if toxic industrial wastes were present but the quantities at Sydney's beaches were insignificant. There was no statistical evidence that there was any extra incidence of infections from the entrance into the bodies of swimmers of organic matter. Pathogenic bacteria, which might otherwise pose a risk, did not survive long in sewage and were scattered and dispersed in the water. Again there was no statistical evidence of disease from bacteria in the water. And bacterial counts, which did not differentiate between harmful and harmless bacteria, needed to be supported by epidemiological evidence or sanitary surveys, before being taken seriously. Dare and Gibson also referred to Dr Sydney Morris, Director General of Public Health, who was not so certain about the short life-span of organisms. Moreover he suspected epidemiological data could be distorted because many people would not swim when the water was very polluted or when the winds were on-shore.

Dare and Gibson admitted that, as the volume of sewage increased, the risk might also increase creating enough pollution to cause "septic conditions to cuts or membraneous portions of the body" which would not be on the records. They also asserted that the occasional analysis of polluted water may not have indicated pollution from the outfalls and "may even be due, in crowded areas, to the bathers themselves."[173]

The denial of health risks by the authorities was in part their solution for dealing with a situation in which difficult political choices had to be made. Which is more

169 Sun, 15th January 1936.

170 Daily Telegraph, 3rd February 1936; Sydney Morning Herald, 3rd February 1936.

171 Sunday Sun, 2nd February 1936.

172 Sunday Sun, 2nd February 1936.

173 Dare & Gibson, Sewer Outfall Investigation, p16.

important, Farnsworth asked, the public health advantages of direct disposal to sea or the public health detriment of rendering the beaches objectionable for sea bathing?[174] The reluctance of rate-payers to pay anything but a minimum meant that the Water Board, in its efforts to keep its constituents happy, was forced to choose between capital works.

The cost savings that were made available through disposing of untreated sewage into the sea allowed more money to be spent sewering new suburbs and thereby improving the healthiness of those areas. The beachside suburbs tended to be older, working class areas whilst the newer suburbs were expanding to the West, North and South and resources were being allocated towards these new developments. In other words a large backlog in sewering of new suburbs meant that the priority placed on sewage collection and removal remained even in 1936, and disposal was considered to be a far less important consideration. This meant that although the beaches provided a key recreation to all Sydney siders, the residents of seaside suburbs had a minority voice. People naturally placed their homes and neighbourhoods ahead of recreational amenities. Beach pollution could be denied, but a lack of sewerage provision was a more obvious health risk and had more serious political consequences.

Although the decision to cut corners on sewage disposal was a political and economic one, the Board and other government authorities felt that they had to justify the decision nonetheless. The claim that there was no health risk emanating from this choice was a necessary justification. There was also some attempt on the part of sewage outfall proponents to portray ocean disposal as a scientific concept and justify it that way. The Labor Daily suggested that outfall schemes were backed by "vast scientific research".[175] Concepts such as dilution, oxidation, filtration, oscillation of waves and sterilisation by sunlight were cited to make the ocean disposal seem like a scientific procedure.[176] Dare and Gibson claimed that treatment of sewage by dilution in sea water was

> not only the cheapest in first cost in most cases, but is just as well established as a truly scientific process as the most elaborate artificial treatment [177]

Dare and Gibson did however admit that the tendency, in the United States at least, was towards treatment before discharge and the recognition that nuisance and pollution should be prevented near recreational areas.[178] (England tended to be less advanced in this[179]) They therefore recommended some very rudimentary treatment in the form of screening and skimming. They suggested provision be made for progressive extension of the treatment process.

The promise of treatment at the outfalls was in the end necessary to quieten the unrest caused by the proposal to duplicate the Long Bay outfall although faith in the ability of some treatment methods to solve beach pollution was none too

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174 Farnsworth, The Major Amplification of the Sewerage System, pp6-10.

175 Labor Daily, 25th January 1936.

176 Sydney Morning Herald, 10th January 1936.

177 Dare & Gibson, Sewer Outfall Investigation, p13.

178 ibid., p4.

179 ibid., p5.

strong.[180] The Mayor of Waverley expressed his doubts about methods which claimed to pulverise the sewage.[181] A letter to the Telegraph pointed out

> Screened and pulverised matter from outfalls is only sewage transformed in character, and is still floating matter and pollution when in suspension in the sea.[182]

and Dunningham agreed

> "According to Mr Farnsworth," went on the Minister, "if you squeeze a bad egg into a glass of water and you cannot see it, it cannot be there. He apparently believes that as long as it is not visible it is not objectionable. I think it is ten times as objectionable." [183]

Nevertheless the faith that most people had in the ability of science and technology to provide the answers meant that almost everyone believed that a modern and sophisticated treatment plant could prevent beach pollution problems. The Water Board promise of treatment at the outfalls and the findings of the 'independent' experts caused media interest and general public concern to recede. The president of the Australian Surf Life-Saving Association accepted the expert opinion, and set about restoring the reputation of Australian beaches.[184] Water Board members congratulated themselves that such eminent engineers had completely endorsed their scheme. Alderman Moverley the lone dissenter, meekly agreed with the report and merely suggested that in the future the Marley Head scheme might have to be considered.[185]

CONCLUSION - EXPERT DECEPTION

There was never any disagreement amongst engineers, either in Australia or abroad, that ocean disposal of raw sewage was the preferred option when it was not too expensive in terms of initial capital costs. Ocean disposal was attractive as a low maintenance, labour free operation and certainly land treatment in the form of sewage farming, chemical precipitation and septic tank treatment had become extremely unpopular with both engineers and the public. In most places a little beach pollution was preferable to the nuisances which arose from badly managed treatment works in close proximity to residential areas.

It was convenient to ignore the possibility of environmental degradation whenever the authorities were trying to establish a sewage treatment or disposal facility. The engineers, in predicting that the ocean outfalls would not give rise to pollution, were able to defend a technological solution which achieved the political objectives of sewering the city at minimum cost. Whilst environmental considerations were secondary to the engineers they were not so secondary to beachgoers and the authorities had to show that they had considered pollution

180 Daily Telegraph, 17th January 1936.
181 Sydney Morning Herald, 18th January 1936.
182 Daily Telegraph, 25th January 1936.
183 Labor Daily, 31st January 1936.
184 Sydney Morning Herald, 1st April 1936.
185 Water Board Minutes, 8th April 1936.

possibilities and reassure the public that there were none, despite the fact that commonsense suggested that pollution would be a problem.

The "we know what's best" attitude which engineers adopted seemed to justify extravagant promises and even lies, in having their solutions implemented. They played the part of impartial experts with the community's interests at heart, trying to educate the ignorant and sentimental citizen who was really only concerned about his/her own interests. This mantle of professional impartiality, however, was not so convincing when the engineers were subsequently forced to deny that pollution was occurring once the outfalls were built. Gradually, they began to admit that pollution did occur infrequently but they still denied that this posed any health threat to swimmers.

This deception was supported by other government authorities, in particular health authorities, and often amplified by local councils and businessmen who sought to attract people to their district to live and to their beaches for recreation. Complaints of pollution were repressed and channelled quietly through official channels to the Water Board. It was only out of desperation or when there seemed to be a chance of influencing Water Board proposals that this "hush hush" policy was lifted and the extent of public feeling allowed to show itself. In this way public participation in decision-making was minimised.

Once the ocean outfalls were decided upon there was little scope for remedying the plight of the beaches. The public clamour to have the outfalls removed from city beaches was ineffective partly because it would have been a very expensive exercise. The government and Water Board preferred to spend any available money on servicing unsewered areas where the health risks were greater, the votes were more numerous and where there would be immediate financial returns from the increased number of rate-payers.

The existence of a large physical infrastructure of pipes and pumping stations with the huge amount of capital tied up with it was a definite disincentive to changes in policies of disposal and limited the alternatives available despite the public furore about the pollution of city beaches. The effect of past decisions therefore continued to shape later ones, just as money invested in the first city sewers had narrowed the options to those that would deal with the sewage once collected by those sewers. The diversion of the sewage to the coast near Bondi Beach was an obvious add on to the existing system that avoided having to start again. Similarly the sewage farm decision, based as it was on the probable extension of the system to Long Bay, meant that the decision to build the first outfall at Long Bay had been well and truly foreshadowed years before.

The narrowing of options, because of past decisions and also because of the preferences of engineering personnel, left little scope for public protests to be successful. Only those which were congruent with engineering plans and required little alteration to the general system, such as the Coogee campaign, were able to achieve what they wanted. This meant that the public was seen, by the Water Board, as just another obstacle to the implementation of necessary and non-negotiable solutions to achieve politically determined goals. Citizens had to be mollified by any effective means, be it by false claims, promises or the bringing in of outside experts.

CHAPTER 5

A SEWERAGE TREATMENT PARADIGM

By the time that engineers were forced, by public opinion, to consider installing treatment at the main ocean outfalls in Sydney, the range of possible treatments and the arguments over their relative efficiencies had been severely curtailed. Whilst sewage treatment had been the subject of fierce public debate, many letters to the editor and rivalry in the nineteenth century, the twentieth century saw the choice of treatment method reduced to a routine selection by Water Board engineers of a standard first stage process. A sewerage treatment paradigm had been set and consensus achieved by the engineering community.

Thomas Kuhn postulated in 1962 that science progresses through periods of 'normal science' and periods of scientific revolution. 'Normal science' occurs when scientists do research based upon one or more past scientific achievements which they all agree are fundamental to their work and scientific revolutions occur when that consensus is shattered and radically new theories are put forward. The scientific achievements on which 'normal science' are based serve to define the problems and methods for research and "to attract an enduring group of adherents". These scientific achievements, together with the "law, theory, application and instrumentation" that they incorporate, form the basis of a scientific paradigm. It is this paradigm which is studied in universities as preparation for students to join the scientific community.[1]

Kuhn argues that the acquisition of a paradigm "is a sign of maturity in the development of any given scientific field."[2] Before such a paradigm is formed there is a continual competition between various views of nature that are all more or less "scientific" but represent incommensurable ways of seeing the world.[3] The early developmental stages of sciences have similarities with the early developmental stage of sewerage treatment engineering. The competition between treatment technologies could not be resolved whilst there was no engineering consensus. The incommensurable ways of seeing the world that Kuhn refers to in science are similar to the differing objectives (to utilise the sewage or to minimise land usage) that occur in engineering and which arise from different ways of seeing the world.

In the nineteenth century researchers had aimed for an ideal treatment solution that would completely, or almost completely, purify the effluent leaving no awkward by-products and no smell. The existence and discovery of new treatment methods did not end the research or settle disputes since there was always a better treatment to strive for and no agreement could be reached about the efficacy of new treatment methods. The major factors in the formation of a paradigm for sewage treatment methods were the attainment of consensus amongst engineers about which treatment technologies were adequate and the discarding of the search for an ideal solution. Both of these conditions, which were interrelated, were made possible by the British Royal Commission into Sewage Disposal of 1898-1915.

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[1] Thomas Kuhn, The Structure of Scientific Revolutions, 2nd ed, University of Chicago Press, 1970, pp10-11.

[2] ibid., p11.

[3] ibid., p4.

Several major parameters for the paradigm had been set in place by the time the Royal Commission sat. The use of water carriage and the consequent reliance on waterways for disposal were significant developments. As was discussed in chapter 2, the triumph of water carriage over dry conservancy methods of sewage collection and removal gave a measure of control to the governing authorities and pushed the field of sewage management more firmly into the domain of the engineers. The competing technologies of the late nineteenth century were therefore developed to deal with a diluted waste stream carried by gravity to a waterway. The sewage treatment technologies were designed, usually by the responsible governing authorities and the engineers who worked for them, to reduce the pollution of the waterways which had become a matter of public concern. Since the ocean was much more difficult to pollute than a river, engineers and governments preferred ocean disposal and treatment methods were not developed for ocean outfalls.

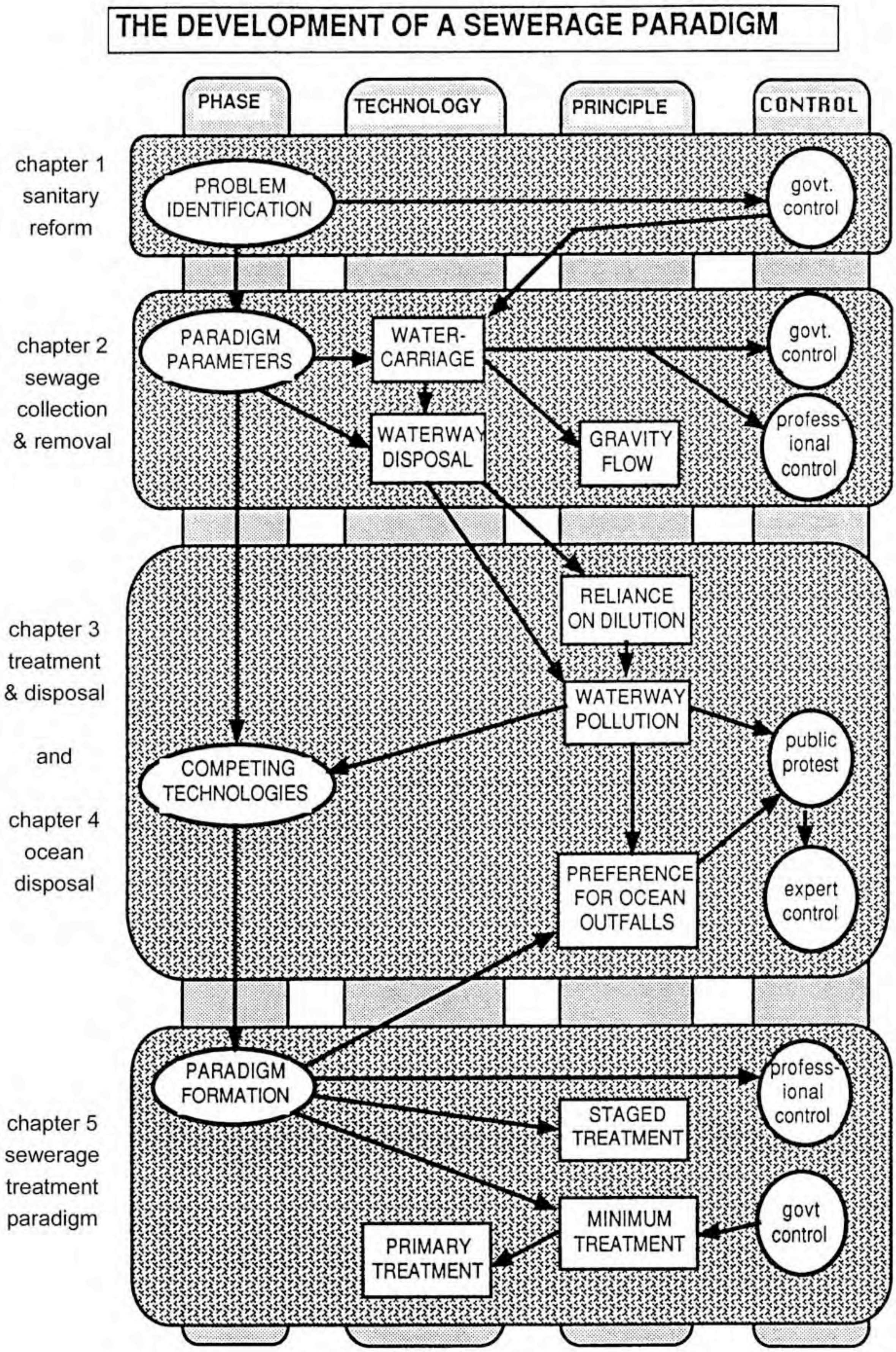
In this chapter we will be considering the role of the Royal Commission at the turn of the century in creating the conditions for paradigm formation in this area of engineering and in particular the concepts of staged treatment and minimum standards which emerged from the Commission. The paradigm ensured professional control over the range of treatment technologies that would be taken seriously and reduced government influence to that of supplying funds and defining standards.

The phases involved in reaching this point are illustrated in figure 5.1. The first phase in this process was the identification of a problem which was discussed in chapter 1 in terms of sanitary reform and the taking on of responsibility for waste disposal by the government. The next phase, which was described in chapter 2, involved the choice of water-carriage technology and the consequent reliance on waterways for sewage disposal. These decisions, which gave increased control to the engineering profession and to the governing authorities, also set the parameters which constrained the range of treatment technologies.

In chapters 3 and 4 various competing treatment technologies were considered. Despite the experimentation with competing technologies, ocean disposal continued to be preferred and this always influenced the way that those technological options were explored. The role of the public in this phase was reduced by the exertion of expert authority and rhetorical denial of problems.

This chapter describes the final stage in the formation of a sewerage engineering paradigm when a consensus emerged amongst engineers about the best treatment technologies. The paradigm gave firm control over the choice of technology to the engineering profession. Its formation depended on three major aspects which will all be discussed in this chapter. The first was the development of a notion of staged treatment, the second was the striving for minimum treatment and the third was the consensus on standards and criteria for measuring performance. The role of the British Royal Commission into Sewage Disposal in the latter was critical and so British Developments will be considered first.

Figure 5.1 The Development of a Sewerage Paradigm



BRITISH DEVELOPMENTS WHICH AFFECTED THE WORLD OF SEWAGE TREATMENT

In Britain the first Sewage Commission, appointed in 1857, reported that river pollution could only be avoided by applying sewage to the land and that this was the proper means of disposal. This was reinforced in 1875 by the Public Health Act which forbade local authorities from allowing sewage to pollute any watercourse.[4] Subsequently, chemical precipitation became a popular treatment method, pushed in large part by companies which had patented various chemicals for this purpose. However, the Royal Commission on Metropolitan Sewage Discharge, found in 1884 that although chemical precipitation removed suspended matter in solution, precipitation alone was insufficient treatment and recommended that the effluent should still be applied to the land, even after chemical precipitation.[5]

Artificial filters, using natural and patented materials, were experimented with in various parts of Britain during the 1880s, however the incentive to research along these lines was blunted when land treatment became a necessary condition imposed by the Local Government Board for any sewage disposal loan to local authorities.[6] The real breakthrough in artificial filters came in the United States where the first trickling filters were introduced. These enabled the sewage to trickle slowly through gravel filters, forming a thin film over the surfaces of the stones. The thin film, in contact with the air facilitated decomposition of the sewage by aerobic micro-organisms.[7]

The British were very interested in the U.S. experiments because these filters required much less land than conventional land treatment. As artificial filters were further developed the local authorities, keen to install them in place of land treatment, came into conflict with the Local Government Board which was still insisting on land treatment. In the face of mounting disputes, a Royal Commission was appointed in 1898 to "inquire and report what methods of treating and disposing of sewage may properly be adopted."[8]

The Royal Commission sat for seventeen years and took evidence from many engineers, scientists, doctors and other experts. It also conducted various experiments and site visits to treatment works. The Commission provided, firstly, a forum where the debates between rival processes could be played out but also enabled some of the more exaggerated and wild claims to be discredited. Not only the technical superiority of various methods was considered but also the rhetorical devices used to promote or discredit rival technologies. For example, the use of the term 'artificial' was objected to. Proponents of artificial filters preferred them to be called biological filters. It was claimed that the labelling

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[4]John Sidwick, 'A Brief History of Sewage Treatment-1', Effluent and Water Treatment Journal, February 1976, p68.

[5] H.H. Stanbridge, History of Sewage Treatment in Britain, Part 3, Institute of Water Pollution Control, Kent, 1976, p19.

[6] Sidwick, 'A Brief History of Sewage Treatment-1', p69.

[7] Stanbridge, History of Sewage Treatment in Britain, part 6, pp23-5.

[8] Sidwick, 'A Brief History of Sewage Treatment-1', p71.

'artificial' constituted an attempt to discredit them and to promote land treatment, which was considered to be a completely 'natural' process. [9]

In its Interim Report of 1901 the Royal Commission said that it was satisfied that artificial processes alone (meaning processes other than land treatment) could achieve a satisfactory standard of effluent for discharge into a stream and they found that the Local Government Board would be justified in modifying their conditions for loans.[10] This finding was confirmed in their Third report in which they stated that there was no essential difference between land treatment and artificial filters. (The essential difference, given no status by the Commission, was of course in terms of sewage utilisation.) The respectability of artificial methods grew from this time.[11]

The Royal Commission's importance was greater than the arbitration of a dispute between the British Local Government Board and local councils. It was a key event in the development of sewage treatment engineering all over the world and marked the transition between two distinctly different phases of that development. One engineering writer, commented,

> in a sense the Royal Commission marked the transition from folklore to a scientific approach to sewage treatment practices and requirements and heralded the opening of an era of rapidly developing and increasingly sophisticated technology.[12]

Although earlier sewage treatment methods were actually based in science and engineering rather than folklore, it is the perception of scientific maturity in the field that is significant here and this can be compared with Kuhn's description of the transition from a developing science to one that is governed by a paradigm. The incommensurable goals of sewerage experts were swept aside by the Royal Commission.

THE DEVELOPMENT OF STAGES AND STANDARDS - THE DEATH OF AN IDEAL

The origins of the modern concept of primary and secondary treatment arose from the division of treatment methods considered by the Commission into two stages. A number of the witnesses at the Commission hearings proposed two stage treatment for the sewage. The first stage would be to remove some of the sewage solids. The Commission reported on these methods in their fifth report under the heading of "Preliminary Processes" and they stated,

> The evidence which we have received and our own experience show that it is generally more economical to remove from the sewage, by a preliminary process, a considerable proportion of the grit and

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[9] John Sidwick, 'A Brief History of Sewage Treatment-2', Effluent and Water Treatment Journal, April 1976, p194.

[10] ibid., p197.

[11] ibid., p198.

[12] ibid., p199.

> suspended matter, before attempting to oxidize the organic matters on land or in filters.[13]

The Commissioners considered detritus tanks, plain sedimentation tanks, septic tanks and chemical precipitation as preliminary processes. The second stage of treatment consisted of biological filters, contact bed systems or land treatment and was the "real" treatment. The Commission did not consider these two stages as separable but rather as two stages, both necessary for the treatment of sewage. The very use of the term preliminary rather than primary (as came into usage later) makes clear the assumption that the first stage was only a preparatory stage.

The consideration of first stage treatment methods was therefore in terms of their use in conjunction with either filters or land treatment. The Commissioners found that chemical precipitation, sedimentation and septic tanks were all suitable forms of preliminary treatment. They dismissed many of the claims which had been made on behalf of septic tank treatment but nevertheless maintained that in certain circumstances it would be an efficient and economical preliminary process. Likewise they did not dismiss chemical precipitation although they noted that there had been a tendency for some authorities to regard it as an obsolete form of treatment. Again they felt that certain circumstances warranted the use of chemical precipitation, especially when the sewage contained trade wastes.[14]

In comparing the cost of each preliminary process the Commission found that chemical precipitation was twice as expensive as septic tanks and plain sedimentation tanks but that this difference disappeared when the cost of filtering the resulting effluent was also considered. This was because chemical precipitation tanks were more effective at removing suspended and colloidal matter and the effluent from such tanks could be treated on a filter of finer material and therefore smaller size and so the filtering operation was less expensive.[15]

Since each process, when considered in conjunction with filtering costs, had very similar annual operating costs, the Commission recommended that the choice between them be made on the basis of the means at hand for disposal of sludge, on the class of filter to be used and on the strength and character of the sewage. For example strong sewage would give less nuisance if treated by chemical precipitation and weak sewage might be more economically treated by septic tanks.[16]

The relative merits of the second stage treatments were also considered. The rivalry was not only between artificial or biological filters and land treatment but also between various types of biological filters and contact beds. The Commission found it extremely difficult to adjudicate.

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[13] Royal Commission on Sewage Disposal, Methods of Treating and Disposing of Sewage, Fifth Report, London, 1908, p18.

[14] Royal Commission, Methods of Treating and Disposing of Sewage, p21-30.

[15] ibid., pp41-3.

[16] ibid., pp43-6.

> The information obtainable from the evidence as to the cost of works on various systems was extremely scanty and altogether inadequate for purposes of comparison. This was inevitable in view of the inveterate tendency of a large section of the sanitary public to indulge in sweeping generalities on the slightest provocation [17]

The Commissioners did not pretend to fully understand the scientific workings of the various processes. For example they said of the Contact Bed process,

> The purifying agents seem to be not only bacteria, but also worms, larvae, insects, etc., and we can offer no opinion as to the respective amount of work done by each set of agents... Little is known of the kind of bacteria essential for purification, or as to their mode of action... [18]

Nevertheless they could still monitor the performance of each process. In the end, rather than recommending one method over another in absolute terms, they recognised that each had its place depending on circumstances: a biological filter could treat nearly twice as much sewage as a contact bed made from the same amount of material; that biological filters were better suited to variable flows and their effluents more aerated; but biological filters were more likely to create a nuisance from flies and from smells.[19]

Although the Commission declared no winners, they presented the rules of the game by recommending minimum quality standards for discharge of sewage into rivers and streams. In order, to work out these standards the Commission attempted to correlate the actual effects of sewage discharge with various measures of purity. These standards, commonly referred to as the 20:30 standard (Biological Oxygen Demand not more than 20mg/l and suspended solids not more than 30 mg/l), were not only accepted in Britain at the time but they are still used all over the world and refer to concentrations of suspended solids and biological oxygen demand. It was known that sewage used up oxygen dissolved in waterways when it decomposed and so it was decided that the amount of dissolved oxygen absorbed by a particular effluent in 5 days at 65 degrees Fahrenheit gave the best single test index of the polluting potential of that effluent.[20] This BOD^5 test is still used as an indicator today. In setting standards for effluents to be discharged into streams, the Commission assumed that the stream was neither very clean nor very polluted and that the sewage would be diluted by 8 times.[21]

The Commission's real achievement was in paving the way for some form of consensus amongst the engineering community. They did not do this by imposing their judgement on the engineering community. What they did was to recommend standards of effluent that should be achieved by whatever process was chosen. In so doing they made the competition between processes on the basis of technical superiority irrelevant. What use was it to achieve a higher degree of purity than was necessary?

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17 Sidwick, 'A Brief History of Sewage Treatment-2', p197.

18 Royal Commission, Methods of Treating and Disposing of Sewage, p51.

19 ibid., p119.

20 Sidwick, 'A Brief History of Sewage Treatment-2', p198

21 ibid., p199

The philosophy behind this consensus was that treatment should not be optimal but rather 'good enough'. This attitude was typified by an American text which argued that the purpose of treatment was to ensure the body of water into which the sewage would be discharged could cope with it. Any treatment beyond that which was only for the sake of making the sewage less offensive or dangerous, the text argued, would be a big waste of money.[22]

The usage of the term 'sewage purification' was gradually replaced partly because it was said to be misleading to "laymen" who supposed that once purified the sewage became pure "whereas the sanitary engineer may mean only that it is purer than it was before."[23] The skill of the engineer now lay, not in achieving a high quality effluent but rather in achieving an adequate quality of effluent for as little money as possible and letting nature do as much of the work as possible.[24]

The incorporation of economic criteria into engineering design is a crucial facet of the philosophy of engineering. Engineers repeat with pride the saying that an engineer is someone who can build for $1 what any fool can build for $2. Complex mathematical formulae replace rule of thumb methods in an effort to reduce costs. The art and science of engineering is focussed on minimising use of materials and maximising efficiency.

The experimental nature of engineering noted by Petroski[25], Blockley[26], Martin & Schinzinger[27] and Gravander[28] manifests itself in different ways in different branches of engineering. In structural engineering, innovative structures are overdesigned to begin with and as engineers gain more confidence the margin of safety is lowered.[29] In sewerage engineering, there is also a desire to reduce costs, and whilst the actual structures in the sewage plant may be overdesigned there is no analogous concern to overdesign for the environment. Rather sewerage treatment plants are underdesigned in terms of both capacity and efficacy, the experiment being to see whether they will meet the standards required. If not treatment can be upgraded.

Of the three main processes considered by the Royal Commission as a preliminary treatment, it was plain sedimentation that came to be the standard treatment used. Sedimentation tanks were simply tanks in which the sewage was left for a period of time during which some of the solids settled out. Plain sedimentation had been used with the early sewers in the nineteenth century to reduce the nuisance caused from sewage going into streams, but because the sludge was sometimes not removed allowing it to build up and occupy most of the space in the tanks, it was not considered a satisfactory method and was seldom

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22 Metcalf & Eddy, quoted in H.H.Dare & A.J. Gibson, Sewer Outfall Investigation, 1936, p13.

23 Leonard Metcalf & Harrison Eddy, American Sewerage Practice, vol III, 1st ed, McGraw-Hill, New York, 1915, p197.

24 ibid., p197.

25 Henry Petroski, To Engineer Is Human: The Role of Failure in Successful Design, St Martins Press, New York, 1985

26 D.I.Blockley, The Nature of Structural Design and Safety, Ellis Horwood, Chichester, 1980.

27 Mike Martin & Roland Schnzinger, Ethics in Engineering, McGraw-HIll, 1983.

28 Jerry Gravander, 'The Origin and Implications of Engineers' Obligations to the Public Welfare', *PSA 1980*, vol 2, pp443-55.

29 Petroski, To Engineer Is Human, p163.

seriously considered before the Royal Commission.[30] It was considered to be "a process midway between chemical precipitation and septic tank treatment, but having the advantages of neither"[31]

The claimed advantages of chemical precipitation and septic tank treatment had been exaggerated and although they were as efficient, and in the case of chemical precipitation, more efficient than plain sedimentation at removing solids (see Table 5.1) the game had changed and efficacy was no longer the primary concern.

Chemical treatment had promised large profits from the manufacture of fertiliser out of the precipitated sludge and it had been thought that this treatment would be sufficient on its own to produce an effluent free from nuisance that could be put into a stream. Instead it was found that the sludge was a nuisance, the chemicals costly and the fertiliser could not compete with artificial fertilisers. Even though the Commission gave chemical treatment a good write up, it fell into disfavour except in temporary or exceptional circumstances, for example when there was a high proportion of industrial waste in the sewage (for example an acidic trade waste might cause an acidic sewage which needed to be neutralised).[32]

Likewise septic tanks had promised to eliminate the sludge problem but failed to do this. Additionally they tended to be smelly. When separate sludge digestion was developed and biological filters took over from contact beds septic tanks ceased to be installed for sewage-treatment works. They are still, however, used for individual and small groups of houses that are too isolated to be connected to a public sewerage system.[33]

Plain sedimentation won out for municipal sewerage works, not because it was technically superior, achieved a better effluent or even because it was considered a satisfactory treatment on its own. The Royal Commission had set standards that could be met using sedimentation in conjunction with a second stage of treatment. Sedimentation therefore experienced a revival. Sedimentation was simpler, more easily controlled and cheaper if you didn't count the costs of the second stage treatment. In many places, particularly at ocean outfalls, one stage processes were installed and sedimentation was definitely cheapest if that was all you were installing. Moreover, even where two stages were planned, the first stage was often built some time in advance and the tendency was to go for the cheapest solution with respect to short-term costs.

THE PARADIGM - CONSENSUS & NARROWED OPTIONS

The narrowing of sewerage treatment research to ways of improving existing methods rather than innovative new treatments is characteristic of practice within a technological paradigm. Writers have variously referred to technological regimes, paradigms, traditions, frames and trajectories to describe the narrowed spheres of practice which are adopted by technologists.

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[30] Metcalf & Eddy, American Sewerage Practice, p5.

[31] Sidwick, 'A Brief History of Sewage Treatment-2', p195.

[32] Stanbridge, History of Sewage Treatment in Britain, Part 3, p20.

[33] Stanbridge, History of Sewage Treatment in Britain, Part 4, p44.

Constant[34], Laudan[35], Nelson and Winter[36] all describe 'normal' technology, as involving the "extension, articulation or incremental development" of existing technologies in certain directions.

Progress in sewerage treatment research since the Royal Commission has been largely of this type. Rather than radical innovations, improvements have been incremental. Screens have been mechanised, the grit removal process improved and mechanical scraping devices developed for removing the sludge from sedimentation tanks and methods for removing the scum from those tanks. A large part of the effort has concentrated on automating the process which is not only unpleasant for workers but also expensive because of the labour intensity.[37]

A comparison of engineering texts at the turn of the century and today shows that little new has been developed in the way of new treatment methods. In fact the options have considerably narrowed for primary treatment. Table 5.2 shows the major methods covered by the 1915 Metcalf and Eddy text used in Australia earlier this century and those covered by a modern Australian text for engineering students at the University of NSW.[38] The new developments which appear in Table 5.2 include comminutors, which are cutting screens that macerate the large sewage solids, oxidation and tertiary ponds which are methods of storing the sewage whilst the oxidation process goes on, and the rotating filters which use the same principle as trickling filters but have rotating discs upon which the film is formed.

Engineers today are sometimes quite defensive about the lack of original ideas that have emerged since 1915. John Sidwick, a sewerage engineer, in an article on the history of sewage treatment wrote that he was surprised how much "the earlier impetus of development" was reduced;

> improvements have largely been refinements of existing practices rather than the creation of new practices. It may, of course, be that there are no new techniques to be discovered, but this seems unlikely. A more probable explanation is that until recently effluent standards are capable of consistent achievement by conventional processes and that since research investment is always limited, those directing research preferred, quite rightly, to devote effort to improving processes of known worth rather than to investigating the unknown.[39]

and

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34 Edward Constant, 'Communities and Hierarchies: Structure in the Practice of Science and Technology' in Rachel Laudan (ed), The Nature of Technological Knowledge: Are Models of Scientific Change Relevant?, D.Reidel, 1984.

35 Rachel Laudan, 'Cognitive change in technology and science' in Rachel Laudan (ed), The Nature of Technological Knowledge: Are Models of Scientific Change Relevant?, D.Reidel, 1984, p95.

36 Richard Nelson & Sidney Winter, 'In search of useful theory of innovation', Research Policy 6, 1977, pp36-76.

37 John Sidwick, 'A Brief History of Sewage Treatment-5', October 1976, pp515-6.

38 Metcalf & Eddy, American Sewerage Practice; D. Barnes et al, Water and Wastewater Engineering Systems, Pitman, 1981.

39 Sidwick, 'A Brief History of Sewage Treatment-5', p520.

It must, however, be to the credit of earlier workers that a great deal of time and money has been devoted merely to proving the validity of their empirical judgement and that essentially little has yet been developed through central research that has significantly altered the principles of sewage treatment.[40]

TABLE 5.1 PURIFICATION EFFICIENCIES OF TREATMENTS

TREATMENT PROCESS	measured by suspended solids tests	measured by bacteriol-ogical tests	measured by B.O.D. tests
fine screening	5-20%	10-20%	5-10%
sedimentation	40-70%	35-75%	25-40%
chemical precipitation	70-90%	40-80%	50-85%
sedimentation + trickling filters	65-92%	70-95%	65-95%
sedimentation + activated sludge	65-95%	70-95%	50-90%

source: D.K.B.Thistlethwayte, 'Water Pollution and Pollution Control Methods for Reducing Pollution Levels', The Australian Health Surveyor, November 1970, p23.

TABLE 5.2 SEWAGE TREATMENT PROCESSES

METCALF & EDDY, 1915		BARNES ET AL, 1981	
Preliminary Treatment	Grit Chambers Screens	Grit Chambers Screens Comminutors	**Preliminary Treatment**
Primary Treatment	sedimentation septic tanks chemical precip travis tanks	sedimentation	**Primary Treatment**
Secondary Treatment	activated sludge trickling filters contact beds	activated sludge trickling filters rotating filters oxidation ponds	**Secondary Treatment**
	broad irrigation sand filters disinfection	grass filtration land filtration disinfection tertiary ponds	**Tertiary Treatment**

INFO FROM: Leonard Metcalf & Harrison Eddy, American Sewerage Practice, vol III, 1st ed, McGraw-Hill, New York, 1915; D Barnes et al, Water and Wastewater Engineering Systems, Pitman, 1981.

40 ibid., p520.

David Wojick concentrates more on engineering practice than research and development in his description of technological paradigms and he says that 'normal' technology involves the "artful application of well-understood and well-recognised decision-making procedures". In this way there is no ambiguity or doubt about what counts as a good solution within the engineering community.[41] The skill of the modern sewerage engineer lies in the ability to choose, from within the paradigm, the cheapest treatment process for a given situation that will perform the minimum treatment necessary to conform with local regulations and standards.

However, even engineering practice allows for technological improvement through experimentation and experience. 'Normal' engineering allows for cumulative improvement but the paradigm embodies strong prescriptions on which technological directions to go in and ensures that engineers and the organisations for which they work are "blind" to certain technological possibilities. Giovanni Dosi identifies various dimensions for a technological paradigm including the generic tasks to which it is applied, the material technology and the physical/chemical properties it exploits.[42] This latter point is emphasised by an engineer writing for an American engineering journal.

> it is indeed distressing to find "instant experts", many in the public arena, who believe the field is static because modern methods resemble those of past years. This belief demonstrates their ignorance, for the current methods of treatment are based on sound physical, chemical, and biological principles which do not change with time... The fact that the application of these basic principles has changed so little is a monumental tribute to our forebears in the field.[43]

In particular, the sewerage paradigm relies on the principles of gravity, dilution and oxidation. Gravity is utilised both in the sewers to transport the sewage and in sedimentation tanks to settle out heavier particles. The desire to utilize gravity for sewage carriage has placed constraints on the range of solutions seriously considered for any particular location which slopes in one direction. This has meant that sewage has been taken to locations that are not necessarily the most ideal for disposal but which have been chosen because the sewage can be taken there by gravity rather than by pumping. This may have been a false economy in the long run.

Water-carriage technology automatically implies some dilution of wastes. The idea that dilution of sewage should be considered as a treatment method was an American idea which was not picked up in Australia at first, because of the Australian dependence on British expertise and methods. Engineers in nineteenth Century U.S. towns resisted treating their wastes before putting them into rivers and streams because of a belief that "running water purifies itself."

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41 David Wojick, 'The Structure of Technological Revolutions' in George Bugliorello & Dean Boner (eds) The History and Philosophy of Technology, University of Illinois Press, 1979, p241.

42 ibid.

43 Ralph Fuhrman, 'History of water pollution control', Journal WPCF 56(4),`April 1984, p312.

> This hypothesis depended on chemical and physical methods of analysing water quality, which demonstrated that after sewage had been in a stream for a certain distance its physical elements dissipated.[44]

Although this practice brought many complaints from downstream users of water, sanitary engineers insisted that downstream users filter and treat their drinking water rather than forcing upstream dischargers to install wastewater treatment. Even in 1909, 88 percent of the wastewater of sewered areas in the United States was discharged into waterways untreated.[45] In 1917 an American engineer declared that the engineers' view "that the dilution power of streams should be utilized to its fullest for sewage disposal" had triumphed over the views of the "sentimentalists and medical authorities" who thought otherwise.[46]

The American engineering text by Metcalf & Eddy observes of the second British Royal Commission on River Pollution appointed in 1868, "the complete failure to recognize the dilution of sewage as a method of treatment".[47] The text complains that for many years after that the British neglected dilution as a subject of study even though the changes in sewage which took place on the land were similar to the changes which took place in the water with both the land and the water suffering if it was burdened with more sewage than either could handle.

> While the distribution of sewage over land was then a well-recognized method of sewage treatment, its dilution in water was regarded exclusively as a method of disposal, As a matter of fact, dilution is a valuable method of treatment, and a city which has a neighbouring body of water where it can be practised safely possesses an important natural resource.[48]

By 1930, the majority of American urban populations were disposing of their untreated sewage by dilution in waterways and the trend was that more towns were adopting this method than were treating their sewage before discharge.[49]

In Australia, dilution was not considered to be treatment until about 1936. A paper in The Commonwealth Engineer in 1919 stated categorically that sewage disposal into a river or sea was not sewage purification.[50] In 1936 the experts called in to investigate a Sydney sewerage scheme referred to a later edition of the Metcalf & Eddy text to put forward the case for dilution in the ocean as a treatment process that was as scientific as any of the most complex "artificial" treatment methods.[51]

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44 Joel Tarr et al, `Water and Wastes: A Retrospective Assessment of Wastewater Technology in the United States, 18001932', Technology and Culture 25(2), April 1984, p236.

45 ibid., p239.

46 ibid., p245.

47 Metcalf & Eddy, American Sewerage Practice, p3.

48 ibid., p3.

49 Tarr et al, `Water and Wastes', p246.

50 A.C.Hewitt, `The Design of Sewage Purification Works', The Commonwealth Engineer, May 1, 1919, p308.

51 Dare & Gibson, Sewer Outfall Investigation, p13.

Oxidation is another mechanism upon which the sewerage treatment paradigm depends, either in the treatment works (in secondary treatment) or in the natural environment. Waterway disposal relies on this mechanism and engineers have often overloaded waterways by overestimating their ability to continually provide the right environment for oxidation to take place. Moreover the use of oxidation in secondary treatment has led engineers in recent times to refer rhetorically to ocean disposal as secondary treatment because oxidation takes place in the ocean.

Although the sewerage engineering paradigm rests heavily on the aforementioned principles, it is not a supertheory, nor merely a set of shared beliefs, values and techniques. Nor is it easy to see what the exemplar is exactly which serves as the basis of the paradigm. Rather the paradigm is based on a set of methods and processes which the engineering community have agreed are both appropriate and sufficiently effective. These methods and processes are not superior technically but are superior in terms of the various objectives of the engineers.

PROFESSIONAL CONTROL & AUTONOMY

The importance of British engineering developments to Australian engineering arose not only from Australia's situation as a British colony. In fact, it has been argued that from the 1880s there was "little evidence of an especially 'colonial' technological dependency relationship" between Australia and Britain.[52] Rather, nations all over the world were looking to British developments in sewerage because the British were on the forefront of endeavour in this field. Moreover, British engineers travelled all over the world, particularly in the second half of the nineteenth century spreading British technology in their wake. The railway boom in the early part of the century in Britain encouraged an unprecedented expansion of the engineering profession which left it with a surplus by mid-century because of the downturn in railway work. This situation encouraged a flow of engineers to other parts of the world in search of work and to fill the gaps in expertise in other countries.[53]

In Australia, when the colony of New South Wales was first being established, engineers were recruited from the ranks of military officers and convicts and any engineers who could be persuaded to come out to the colony.[54] As the indigenous engineering profession developed, there were still plenty of opportunities for British engineers, and before any sanitary engineering profession was established, engineers of all types found themselves giving advice on, and designing, water and sewerage systems, although they had no background in the area.

An example is Robert Rowan Purdon Hickson, an engineer with railway and harbour experience in Britain, who first came to South Australia to work on the various harbour and port works. He became NSW Chief Engineer for Roads and

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52 Ian Inkster, "Intellectual Dependency and the Sources of Invention: Britain and the Australian Colonies in the 19th Century", a paper delivered at the Anglo-Australian Meeting, Royal Institution, London, 7th January 1988, p41.

53 R.A. Buchanan, 'The Diaspora of British Engineering', Technology & Culture, 27(2), 1986, pp507-509.

54 ibid.

Bridges, a member of the Water Board in 1889, and two years later Engineer-in-Chief for Roads, Bridges and Sewers. He presented papers on sewage treatment and disposal and even wrote a book on it.[55] His biographer remarked; "First harbours, then roads and bridges, and now sewage-he was certainly proving himself a man of catholic professional tastes!" [56]

Such hopping between specialisations became more difficult as Australia's engineering profession grew and became more specialised. Growth was marked by the establishment of an engineering school in Sydney but the profession drew on British engineers for lecturers.[57] Also, for many years British engineers were called upon to advise on and endorse major water and sewerage engineering works because they had the experience and the expert status that local engineers lacked. Clark, who was brought out to Australia to advice on a water supply project, also endorsed the proposed sewerage diversion from the harbour to Bondi and the Botany sewage farm and helped in getting it accepted by the electorate.(see previous chapters)

After about 1914 the "diaspora" of British engineers subsided.[58] Moreover, the sanitary engineering profession was consolidating and the growth of an indigenous sanitary engineering profession in Australia fostered local expertise in sewerage treatment methods. The formation of a paradigm overseas permitted the development of educational courses devoted to this field and united sanitary engineers in Australia against outsiders and other members of the engineering profession.

The circular argument inherent in Kuhn's scheme; that a paradigm is something that results from the consensus of a community of scientists and a community of scientists is defined by the paradigm they adhere to, also causes problems for technological paradigms. Does the paradigm define the engineering community or does the engineering community form the paradigm? Henk Van den Belt and Arie Rip argue that the development of a technology along a trajectory requires a 'cultural matrix', that is, a subculture of technical practitioners.[59] Whilst a cultural matrix may be necessary for a paradigm to exist, it may also be that a technological community cannot exist in any coherent form without some form of paradigm. Michael Callon has argued that social group formation is simultaneous with the definition of research problems and he links the struggle between social protagonists to define what is problematic and what is not with the formation of the groups which will take charge of those research problems which are defined in the struggle.[60]

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55 James Antil, 'Robert Rowan Purdon Hickson: Civil Engineer (1842-1923)', J.Royal Australian Historical Society 55(3), September 1969, pp228-244.

56 ibid., p234.

57 Buchanan, 'The Diaspora of British Engineering', p521.

58 ibid.

59 Henk Van den Belt & Arie Rip, 'The Nelson-Winter-Dosi Model and Synthetic Dye Chemistry' in Wiebe Bijker, Thomas Hughes and Trevor Pinch (eds), The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology, MIT Press, 1987, pp135-158.

60 Michel Callon, 'The state and technical innovation: a case study of the electrical vehicle in france', Research Policy 9, 1980, pp358-76.

Whilst sewage disposal methods were a matter of debate amongst engineers last century, the general public were able to take part in the debate and be taken seriously by decision-makers. Doctors, lawyers and non-professionals felt competent to comment on the theory of treatment methods and criticise proposed schemes. The formation of a paradigm has enabled sewerage engineers to consolidate their position as the 'experts' and to restrict the role of outsiders to that of an 'uninformed public' which can acquiesce with a particular proposal or protest against it but which is in no position to question the range of treatment methods available. Other professionals are particularly likely to respect the boundaries of expertise set up by the paradigm.

And although various treatments for sewage were debated in the meetings and proceedings of engineering and scientific societies in the nineteenth century, today's engineering magazines deal with the details of particular applications of an acceptable technology or improvements and refinements to existing technologies. Such discussions contain assumptions and jargon which make them uninteresting to the uninitiated and they are seldom read by those outside the field.

The sewerage engineering community perpetuates its paradigm through education and practice, which are largely determined by the engineering community. The acceptable treatment methods, classified into stages, have been taught for several decades to students training to be sewerage or public health engineers and as a result it is taken for granted by most engineers that such methods are satisfactory and appropriate to most situations.

Although earlier engineers could design and build effective sedimentation tanks, the engineering science of sedimentation has progressed to a stage where students are taught how to calculate the submerged weight of a particle of sewage, the velocity it will settle at, what drag forces it will be subject to as it settles and so on so that sedimentation tank shape and size can be optimised and detention times fine-tuned. Modern sewerage engineering students are taught exactly why and how a sedimentation tank works.

The advantage of such sophisticated knowledge is debatable, especially given that sewerage treatment works are seldom operated at optimum conditions, and flows are extremely variable. (The situation in Sydney is discussed later in this chapter.) The acquisition of this knowledge does however serve another purpose. The increased scientisation and mathematisation of these sewage treatment methods has given them an aura of precision, efficiency and certainty and conveys the impression that only engineers can understand the field of sewage treatment.

A specialised knowledge base was sought keenly by engineers as a basis for the claim for professional status during the nineteenth century. Although most engineers were employees, they believed in a social hierarchy which awarded power and influence to those with knowledge and skill and they sought to be recognised as professionals rather than workers. In particular, civil and mechanical engineers required science as part of their specialised knowledge base so that they would be differentiated from the technicians, mechanics and skilled craftsmen in the occupational hierarchy.

Demarcation disputes over the teaching of the theoretical principles of technology and jealousies on the part of science faculties forced the engineering faculties to develop an engineering science. Engineering educators, such as the Scottish engineer W.J.M. Rankine, sought to create an engineering science that would "transcend the traditional categories of theory and practice" so as not to threaten scientists or compete with on-the-job engineering training. For Rankine, a leading figure in the development of thermodynamics and applied mechanics, the answer lay in reducing the laws of actions and the properties of materials to a science. This amalgamation of theory and practice allowed a new science to be developed which could be claimed to belong to engineering.[61]

Chemical engineers also faced a demarcation problem in the early part of the twentieth century in the United States. To avoid being confused with chemists and to gain control of their field in the face of competition from other engineers they sought a scientific knowledge base that amalgamated theory and practice.[62] Similarly, for sewerage or sanitary engineers to mark out territory from within the civil engineering field it was necessary for them to develop an engineering science, a field of specialised knowledge, which they could lay claim to and which would support their bid to control the field of practice.

Although engineers could mark out their professional territory their autonomy was still limited. Gary Gutting has criticised the concept of a technological paradigm because of the difficulty of defining a technological community and attributing to it the autonomy necessary to make the term of paradigm significant. If evaluation is up to outsiders then engineers cannot be autonomous.[63] This view neglects the ability of engineers to influence the evaluation that outsiders make or impose.(This will be explored in greater depth in chapters 8 & 9) Moreover the ability of engineers to set their own objectives and constraints may be less than that of scientists but it is difficult to argue that scientists have a free choice about their goals and constraints either.

The formation of the sewerage paradigm did rely to a large extent on the official sanction of the British Royal Commission on Sewage Disposal which met at the turn of the century but the Commission based its conclusions on evidence given by the engineering community and results of experiments and projects undertaken by engineers. Moreover the Commission did not determine the paradigm but only set the standards that it should meet. The formation of the paradigm resulted from choices made by engineers working for local government authorities. Such choices were made on the basis of their search for the cheapest 'good enough' solutions.

The autonomy of the engineering community lay in its ability to dictate the range of technologies which would be taken seriously. Outside authorities might set standards and regulate the available money but the engineers decided how to meet the standards and if they could be met with the finances available. A community might demand a higher level of treatment but would not be able to ensure that alternative treatments from outside the paradigm were taken seriously.

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61 David F Channell, 'The Harmony of Theory and Practice: The Engineering Science of W.J.M.Rankine', Technology & Culture 23(1), Jan. 1982, p45.

62 Terry Reynolds, 'Defining Professional Boundaries: Chemical Engineering in the Early 20th Century', Technology & Culture, 1986, pp694-716.

63 Gary Gutting, 'Paradigms, revolutions, and technology' in Laudan, The Nature of Technological Knowledge, p57.

The infringement on engineering autonomy by employers is a different question. The difference between engineers and scientists is that career success and promotion, for engineers, is almost completely defined and controlled by employers rather than peers or professional organisations. Employers set the goals and evaluate engineers on their ability to help the organisation reach those goals.[64] Moreover engineering work takes place very obviously and directly in a context of economic and social interests and ideologies.[65] However, the identification of engineers with business interests and the existing status quo of Western industrialised countries,[66] means that these outside constraints are not so much an interference as a collaboration. The setting of goals from outside does not necessarily distort "normal" practice.

A 1971 study of American engineers found that although engineers placed great importance on having freedom to manage their own work they placed relatively little importance on being the originators of the projects they worked on.[67] The infringement on engineering autonomy posed by employers is also limited by the shared interest in the same technological system and the correlation between the engineers paradigm and the interests of the firm or authority for whom they work. Constant observed that practitioners are usually located within a few organisations that are readily identifiable with a particular technology.[68]

The paradigm was necessary for the profession of sanitary engineering to maintain a certain degree of autonomy and to help guard the boundaries of their profession against outsiders. In 1923 Colonel Longley gave a paper before the Sydney division of the newly formed Institution of Engineers, Australia, entitled "The Sanitary Engineer and His Place in Relation to Public Health in Australia" which exemplified the struggles for professional status and autonomy of the sanitary engineeer in Australia.

> Few people in Australia are qualified to bear the title. Not only is a comprehensive training in civil engineering necessary, but more vital still is a solid grounding in the special subjects of biology, bacteriology and chemistry, with considerable experience in the laboratory processes associated with the analysis of water for all purposes, sewage and garbage, and in their treatment and disposal.[69]

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64 Robert Zussman, Mechanics of the Middle Class: Work and Politics Among American Engineers, University of California Press, 1985;Peter Whalley, The Social Production of Technical Work: The Case of British Engineers, MacMillan, 1986; Edwin Layton Jr, The Revolt of the Engineers: Social Responsibility and the American Engineering Profession, Cape Western Reserve University, Cleveland and London, 1971; Robert Perrucci & Joel Gerstl, Profession Without Community: Engineers in American Society, Random House, New York, 1969.

65 Stewart Russell & Robin Williams, 'Opening the Black Box and Closing it Behind You: On Microsociology in the Social Analysis of Technology', revised version of paper to the British Sociological Association Conference Science , Technology and Society, Leeds 1987, p5.

66 for example, Layton, The Revolt of the Engineers.

67 Richard Ritti, The Engineer in the Industrial Corporation, Columbia University Press, 1971, p52.

68 Edward, Constant, 'Communities and hierarchies: structure in the practice of science and technology' in Laudan , The Nature of Technological Knowledge, p29.

69 Colonel F.F. Longley, 'The Sanitary Engineer and His Place in Relation to Public Health in Australia', I E Aust Transactions 4, 1923, pp194-5.

THE PARADIGM IN PRACTICE - PROPOSALS FOR SYDNEY

When treatment was first considered at the ocean outfalls, in the late 1930s, the philosophies of staged treatment and minimum standards ensured that there was no attempt to adopt the best, most effective treatment process. Rather the aim was to find the minimum, cheapest treatment that would suffice, with provision for more treatment if it was found necessary. Thus, Dare & Gibson recommended that treatment at the ocean outfalls be limited to removal of offensive solids and the grease. If experience showed that was not good enough, "then provision for such disinfection and sedimentation, and later, if necessary, sludge removal and treatment" could be added.[70]

In a letter to the Board of Health seeking approval for the first treatment works at Bondi the Secretary of the Water Board explained that,

> after lengthy and exhaustive deliberations the opinion has been reached that it is both unnecessary and uneconomical to submit the sewage discharged from Sydney's ocean outfalls to more than partial treatment designed to protect the beaches from floating and suspended matter.[71]

The engineers looked to the paradigm for their choice of technologies. The only two options for treatment of the effluent considered by Farnsworth, the Engineer-in-Chief of the Sydney Water Board in his 1938 report were a screening plant or a primary sedimentation plant. Septic tanks were not mentioned and chemical precipitation was only mentioned as a possible advanced treatment which would be "unnecessarily extravagant".[72] Similarly, secondary treatment was considered to be totally unnecessary. Farnsworth reported the common view "that the most efficient method of removing solid matter is to subject the sewage to a period of sedimentation". [73] Floating matter and grease would be skimmed off the surface of the sedimentation tanks with mechanical scrapers.

Farnsworth claimed that sedimentation tanks would remove 50-60% of the suspended solid matter in the form of sludge which settled out or scum which floated on the top of the tank. A screening plant would only remove less than 10% of the solids and yet would cost almost as much because the major cost was in the excavation of the headland to house the treatment plant. The screening plant would have higher operating costs than a primary sedimentation plant as well because of the requirement for cleaning the screens regularly whereas a sedimentation tank could be roofed over and would have no possibility of nuisance arising from its operation.[74]

Farnsworth's framing of the relative costs of the two treatments was deceptive. The choice between a screening plant and a sedimentation plant was really the choice between two forms of treatment that were normally installed together. Screening was a preparation process before sedimentation. The choice of

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70 Dare & Gibson, Sewer Outfall Investigation, p22.

71 S.T.Farnsworth, Elimination of Nuisance From Ocean Outfall Discharges, 1938, appendix 7.

72 ibid., p10.

73 ibid., p4.

74 ibid., pp4-5.

sedimentation over screening really represented a cost cutting exercise because Farnsworth thought he could get away with omitting preparatory treatment. His real choice was between screens and sedimentation and sedimentation on its own. Yet he was able to make his decision sound as if he was favouring the best option although it cost slightly more. In reality here was an example of the ever present desire of engineers to minimise treatment and to even cut corners on conventional treatments.

The objective of putting treatment in at Bondi was seen by the engineers as being to prevent a nuisance on the nearby beach by removing the floating matter. It was considered that it was only this floating matter which caused any problems. Although the perceived problem at the sea was therefore different from that of river disposal, the choice of treatment technologies came from the paradigm developed for waterways other than the ocean and never specifically designed to remove floatable matter. After all, sedimentation aims primarily to remove settleable solid material. The addition of scrapers to skim the surface of sedimentation tanks was an afterthought and only removed material that floated in fresh water. The fact that sewage floats in sea water because fresh water is lighter than seawater was conveniently forgotten. Nevertheless Farnsworth claimed that primary sedimentation would remove all floating sewage matter. At the same time he hedged his bets and pointed out that if the demand arose in the future for more complete treatment, then filters (i.e. secondary treatment) could be added to the treatment process so that the effluent would be of the standard required for inland waters.[75]

Farnsworth's attempts to avoid screening were not successful perhaps because it was realised that screening was necessary for the sedimentation process to work properly. Nevertheless, without the benefit of a report and supporting arguments a minimum of treatment was installed and by 1959 only the screens has been installed at Bondi and no treatment was in place at Malabar or North Head.

In May 1959 the Water Board acknowledged the growing problems of beach pollution, increased sea bathing and the accompanying complaints about pollution. It adopted a plan proposed by the Engineer-in-Chief for sewage treatment at Bondi and Malabar. The 1959 plan provided for construction in four stages at each plant:[76]

1. Provision of Screens (done at Bondi already) and Grease Removal Units (to be discussed later);

2. Provision of Sedimentation Tanks and Submarine Sludge Outfall Line;

3. Provision of Further Treatment for Sludge;

4. Provision of Submarine Effluent Outfall Line or Activated Sludge Treatment Units (secondary treatment).

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75 ibid., p9.

76 Brown and Caldwell, Design Report: Malabar Sewage Treatment Works, M.W.S.&D.B., July 1965, pp2-3.

The reasons for staged development were stated by a Board representative as follows. The level of treatment necessary could be assessed at each stage in the light of what had been achieved by the treatment already installed. Staged development also provided an opportunity to take advantage of research locally and overseas into sewage disposal. Thus pollution control could be improved as improvement was required rather than all at once. Nonetheless staged development was necessary because the Board had a policy of funding new works from current revenues and this limited the funds available at any one time for treatment works.[77] The philosophy of minimum treatment no doubt played a major part in this strategy as well.

The Board proceeded to install screens at Malabar and modified stage 1 to include a sludge treatment that could also be used to deal with screenings.[78] (Sludge treatment will be dealt with in more detail later in this chapter) However in November 1964 work was stopped on the Malabar treatment works whilst the entire program was reevaluated by a firm of American consultants, Brown & Caldwell. Brown & Caldwell say this was done because of doubts as to whether nuisance would be eliminated on the beaches and bacterial contamination controlled in bathing waters under the old plan.[79]

Brown & Caldwell, did not depart from the paradigm nor from the original plan very much. They too recommended primary sedimentation treatment with the following three stages[80];

1. Construct six of the ultimate twelve sedimentation tanks and two sludge digesters.

2. Construct a deepwater submarine outfall

3. Install additional sludge digesters and some grease removal equipment.

Other methods of treatment were not considered in the report by Brown and Caldwell and the existence of the paradigm meant that no comparisons or justifications were necessary, only predictions of performance for their proposed plant. Primary treatment, they claimed, removed 50-70% of the suspended matter, 50-70% of the grease and 25-40% of the biochemical oxygen demand. Also chlorination facilities could be provided in the long term to disinfect the effluent in case bacterial contamination levels were too high.[81]

The submarine outfalls, which were planned for a later stage would have deepwater diffusers which would meet two objectives. Firstly they would increase dispersion of effluent so that objectionable amounts of grease and debris would

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77 Conference of Professional Officers Representing the Authorities Controlling Water Supply and Sewerage Undertakings Serving the Cities and Towns of Australia, Report of the Proceedings of the Ninth Conference, 1959, paper 4; Brown & Caldwell, Design Report, p2.

78 Brown & Caldwell, Design Report, p3.

79 ibid., p1.

80 ibid., p29.

81 ibid., p10.

not accumulate. Secondly they would increase the dilution which might be necessary to keep bacterial concentrations down.[82]

Brown and Caldwell later did a similar study for the outfall at North Head. In it they reported that although screening alone would remove the nuisance caused by large solid material in the sewage, "significant improvement" could only be obtained with primary sedimentation to remove the floating and suspended solids in the sewage. Primary treatment would remove any visible evidence of sewage contamination, they claimed, but could not reduce bacteriological contamination appreciably. This would have to be done by disinfection of the sewage or by discharging the sewage through a properly designed submarine outfall.[83]

Brown and Caldwell therefore proposed the following stages for treatment of sewage at North Head;

1. Provision of Screens
2. Provision of five sedimentation tanks, screens, grit removal and sludge treatment tanks.
3. Construction of a deep water submarine outfall.
4. Additional primary sedimentation tanks.
5. Doubling the capacity of the works.

Facilities would also be constructed for intermittent chlorination (disinfection) when required.[84]

SUBMARINE OCEAN OUTFALLS - INNOVATION OR AD HOC ADJUSTMENT

Submarine ocean outfalls were not a radical departure from the paradigm but rather an augmentation of the paradigm. The concept dated back to the nineteenth century and it was not until the mid-twentieth century that submarine outfalls were referred to as a treatment method rather than just a means of disposal.

As far back as 1876 the Sydney and Suburban Sewage and Health Board recommended that some of the harbour outfalls be extended into deeper water. They argued,

> When the sewage is discharged into deeper water, and at a lower level, it will be at once mixed with a larger quantity of salt water, and be thus to a greater extent diluted and disseminated, being more exposed to the action of the tide, instead of being discharged upon the

82 ibid., p21.
83 Brown & Caldwell, Northern Suburbs Sewerage Survey 1966-1967, M.W.S.&D.B., 1967, p86.
84 ibid., p184.

> foreshore, where it festers in the sun and air, and becomes offensive; or spread over the surface of the water with almost equally bad effect.[85]

Submarine ocean outfalls were recommended in nineteenth-century texts for situations where "the influence of prevailing winds and currents" were not directly on-shore and likely to carry the sewage back to shore.[86] Other writers were more dubious about the advantages of extending the outfalls out to sea.

> In some cases, by means of long outfall sewers, the sewage is carried away from the place producing it to the sea, but they are frequently simply transferring the refuse to others, the tide carrying it so as to cause mischief and nuisance elsewhere.[87]

An early submarine outfall was built at Santa Barbara in California in 1886. It was 1,500 feet long and 12 inches in diameter and laid on the floor of the ocean. It was reported to be working well by the engineer who suggested it.[88]

The Sydney Water Board had considered constructing a submarine outfall at Coogee in 1923 when the existing outfall there had been subject to constant complaints. They informed the local Randwick Council that soundings were being taken to find out whether it would be feasible to construct a submarine pipe to take the sewage further out to sea.[89] The proposal was later dropped in favour of diverting the sewage from Coogee to the Long Bay outfall and the Sun reported rumours that experiments made with corks had proved that "even at this distance [half a mile] the northeasters carried the corks back to Coogee Bay."[90]

One of the first researchers into submarine outfalls was an American, A.M.Rawn, who investigated a number of outfalls on the Californian coast. Rawn was particularly excited at the prospect of utilising the ocean as a free means of treatment.

> To be able to relegate the entire job of secondary treatment to a few holes in the end of a submarine pipe and the final disposal of the effluent to the mass of water into which the fluid is jetted, and to accomplish this without material cost of maintenance and none for operation, presents a picture of such great allure as to capture the imagination of the dullest and justify extensive exploration into the ways and means of satisfactory accomplishment.[91]

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85 Sydney City and Suburban Sewage and Health Board, Sixth Progress Report, 1875, p5.

86 George Waring, Sewerage and Land Drainage, D.Van Nostrand, 1889, p76.

87 Henry Robinson, Sewerage and Sewage Disposal, E & F Spon, London, 1896, p45.

88 Waring, Sewerage and Land Drainage, p76.

89 Evening News, 18th April 1923.

90 Sun, 4th October 1926.

91 A.M.Rawn, `Fixed and Changing Valves in Ocean Disposal of Sewage and Wastes', in E.A.Pearson, ed, Proceedings of the First International Conference on Waste Disposal in the Marine Environment, Pergamon Press, 1959, pp6-7. (note that the title of the paper was obviously about Fixed and Changing Values rather than valves but that 'values' are such a foreign concept to engineering papers, 'valves' must have seemed more appropriate to whoever did the headlines for the papers.)

Rawn conducted many experiments, starting from the 1920s, aimed at finding out how to effect the most dispersion and dilution using diffusers at the end of submarine ocean outfalls. He considered such factors as depth, direction, quantity and velocity of discharge for the outfall. Using the results of his investigations an outfall was built in 1937 at Whites Point in Southern California. The outfall pipe was 60 inches diameter, extended a mile out to sea and its outlets were 100 feet under the sea surface. The effluent was discharged through three nozzles in a horizontal direction.[92]

A second parallel outfall was built in 1947 to cater for the extra flow caused by population growth and it was extended in 1953 from 5000 feet to 6100 feet out to sea so that it discharged at a depth of 155-165 feet. Submarine outfalls were also built at Hyperion, Los Angeles in 1959, San Diego in 1963 and Seattle in 1967. Each new outfall took advantage of the advancing investigations of researchers such as Rawn, Palmer and Brooks and their multi-port diffusers were refined and improved with the main aim of keeping the sewage field below the surface of the sea and preventing pollution of the shoreline and beaches.[93]

Rawn himself notes that the principle concern during all these years was to prevent the nearby shores being contaminated and that apart from trying to prevent the contamination of shell fish, the effects of sewage discharge on the marine environment were ignored.[94] The rational behind submarine outfalls was that the dilution would be enhanced if discharge was at greater depths, the greater distance out to sea would mean that the time for sewage to reach shore would be greater and hence time for bacterial die off would be increased, and finally attempts were made to make use of the density stratification of the sea to keep the sewage field below the surface.[95]

The idea that the sewage might be kept below the surface of the sea if density differential between top and bottom layers of sea water (the thermoclyne) was sufficient did not become accepted until 1956 after the construction of an outfall at Los Angeles when it was found that the sewage field did indeed remain submerged most of the time.[96]

When Brown and Caldwell proposed submarine outfalls as future stages of treatment at Malabar, Bondi and North Head, several groups who were concerned about beach pollution seized upon the concept as the answer to the problem of beach pollution. For example the Bondi Advancement Society was worried that "multi-million dollar plans for a glittering new Bondi could be ruined by an 80-year-old sewage problem". They pointed out the "incredible backwardness in a modern city" where the treatment works at Bondi had been commenced thirty years before and the treated effluent made its way back to the beach. The Society called for a submarine outfall or a plant to turn the sewage into fertilisers.[97]

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92 ibid., p10.

93 Paul Ryan, Submarine Ocean Outfalls, typed report for SPCC, undated.

94 Rawn, `Fixed and Changing Valves in Ocean Disposal of Sewage and Wastes', p9.

95 Ryan, Submarine Ocean Outfalls, p13.

96 Brown & Caldwell, Northern Suburbs Sewerage Survey, p146.

97 Sun-Herald, 1st September 1968.

A Water Board spokesman was reported in the media as saying that the primary treatment works would remove pollution from the beaches and all that would remain of the pollution would be a harmless stain. The only way to remove this brown stain, the Board spokesman said, in anticipation of the future plans, would be to install outfalls to carry the discharge several miles out to sea.[98]

The problem of the "huge brown stains" was taken up by the Anti-Beach Pollution Campaign Association which called for the immediate construction of the submarine outfalls which would get rid of the stains.[99] The Anti-Beach Pollution Association, according to its secretary, Bob Wurth, was concerned about the loss of business to shopkeepers and related businesses caused by pollution.[100]

In March 1971 the Water Board instructed the consultant engineering firm, Caldwell Connell Engineers P/L, to do a feasibility study into the construction of submarine outfalls for the North Head, Malabar and Bondi. Caldwell Connell Engineers were an amalgamation of engineers from the US firm of Brown and Caldwell, who had already recommended the submarine outfalls, and the Australian firm of John Connell, Mott Hay & Anderson.

Caldwell Connell presented their 288 page report in 1976 following investigations costing around one million dollars. They dismissed the alternatives to submarine outfalls in one paragraph at the beginning of their report.

> Because Sydney's major sewerage systems are already established, it would not be economically or physically feasible to consider significant changes to the basic system layouts.[101]

Given the system layout the choice, they claimed, was between providing a high degree of treatment with minimum ocean outfall facilities or a low degree of treatment with submarine outfalls. Since the "site constraints and the acquisition of the necessary land would prove very difficult" they only considered the latter alternative in their study.[102] This gives an indication of how past decisions, prior capital investment and an existing physical infrastructure all act to reinforce the paradigm.

This brushing off of alternatives may also be understood in terms of the objectives of the feasibility study, which were to study the offshore environment so as to be able to develop design parameters, prepare conceptual and preliminary designs and collect data about existing marine conditions to enable later monitoring of changes due to the submarine outfalls. The Board did not want them to consider the alternatives and Caldwell, at least had already recommended the submarine outfalls. Caldwell Connell's study concluded that not only was it feasible to construct submarine outfalls at Bondi, Malabar and North Head, but also such outfalls would "result in a marked improvement in

98 Sydney Morning Herald, 5th March 1970.

99 Sun, 23rd March 1970.

100 Mirror, 7th September 1970.

101 Caldwell Connell, Sydney Submarine Outfall Studies, M.W.S.&D.B., 1976, p1.

102 ibid., p2.

aesthetic and bacteriological conditions at many beaches now affected by shoreline discharges."[103]

Similarly, and not surprisingly after a five year, million dollar feasibility study, the Environmental Impact Statements (EIS's) for the submarine outfalls gave scant regard to alternatives. EIS's are required to cover alternatives but the discussion of alternatives was prefaced with the statement that the existing sewerage systems represented fixed investments of many hundreds of millions of dollars and serviced areas that were so highly populated that major sewer reconstruction would be very expensive because of the difficulty and the unavoidable disturbance which would be caused to normal activity.[104]

The alternatives considered in the EIS's were reduced discharge, which would involve some sort of recycling or utilisation of the sewage, shoreline discharge, nearshore discharge or deepwater discharge and each alternative was considered with regard to a range of levels of treatment from preliminary treatment through to tertiary treatment. The EIS's concluded that reuse of the effluent within the Sydney area was not feasible because of low demand and high costs. The idea of pumping the effluent over the Dividing Range to western NSW was also dismissed as being too expensive considering the demand for water there in the foreseeable future.[105]

Shoreline discharge would have required secondary treatment to meet the SPCC requirements and the long term expense in terms of energy and chemical resources were claimed to make this option impractical. One of the main objections was the difficulty of siting secondary treatment plants at existing sites. Figures 5.2 and 5.3 show a possible layout of conventional secondary treatment facilities at North Head and Bondi. At North Head the military reserve would have to be used and at Bondi the golf course. At Malabar (figure 5.4) the Rifle Range would have to be used.

Nearshore discharge was considered in conjunction with some sort of chemical primary treatment but this was also dismissed on the grounds of costs and also because the effluent field would still be visible.[106] Table 5.3 shows the alternatives considered and comparative costs for the Malabar outfall as given in the EIS. The submarine ocean outfalls are shown to be cheapest in terms of both capital costs and annual operating costs.

Nonetheless there were calls for secondary and even tertiary treatment at the outfalls. In 1975 the State Labor MP for Maroubra, Mr Haigh, argued that secondary treatment was necessary at all the ocean outfalls.[107] Whilst these demands were for more treatment within the parameters of the sewerage treatment paradigm, there were some non-engineers who suggested unconventional treatment methods.

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103 ibid., pxv.

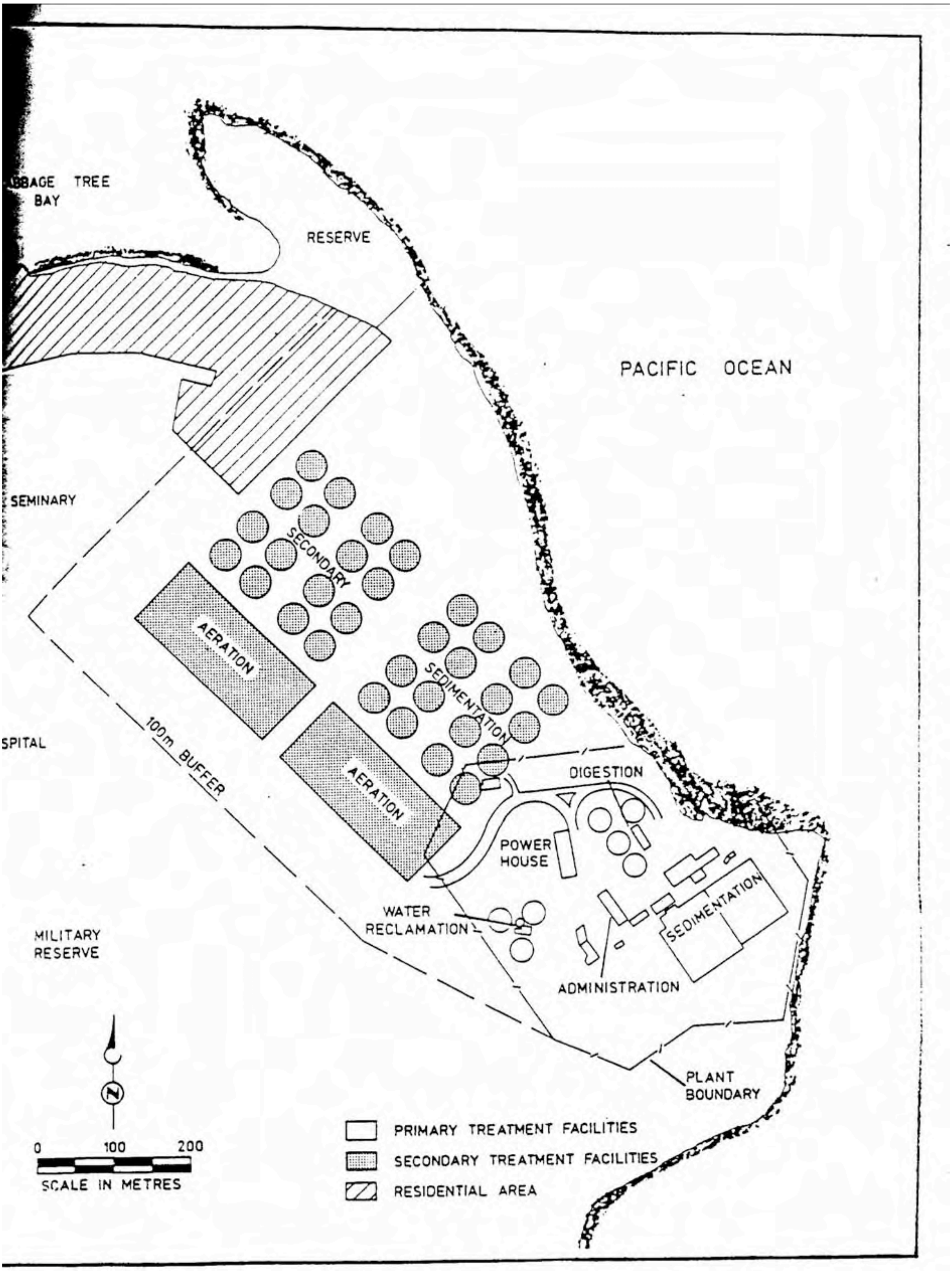
104 For example, Caldwell Connell, Environmental Impact Statements, North Head Water Pollution Control Plant, M.W.S.&D.B, 1979, p34.

105 For example Caldwell Connell, Environmental Impact Statements, Malabar Water Pollution Control Plant, M.W.S.&D.B., 1979, p46.

106 ibid., pp49-52.

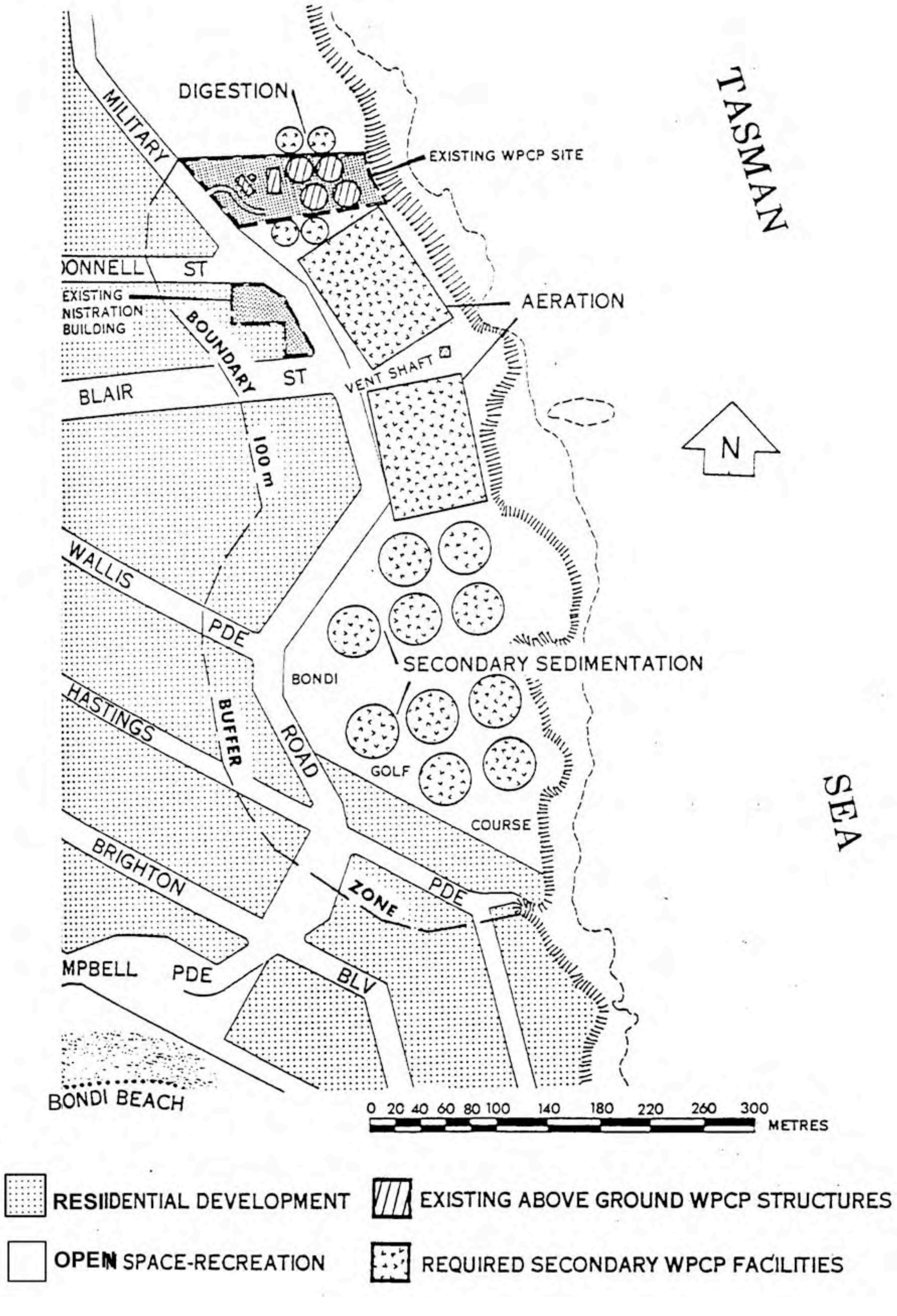
107 Mirror, 25th November 1975.

Figure 5.2 Layout of Possible Secondary Treatment Plant at North Head



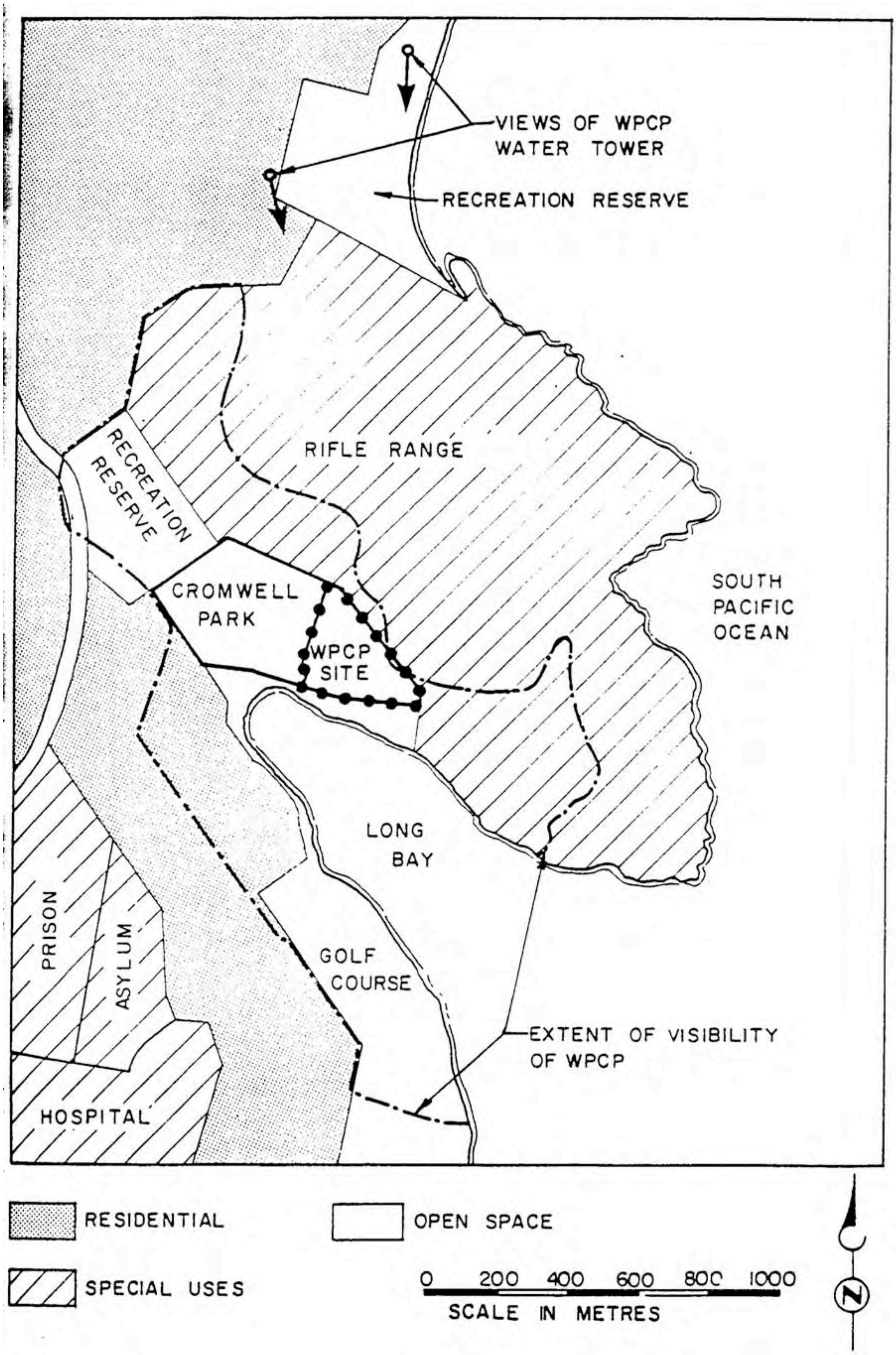
Source: Caldwell Connell, Environmental Impact Statements, North Head Water Pollution Control Plant, M.W.S.&D.B, 1979, p40.

Figure 5.3 Layout of Possible Secondary Treatment Plant at Bondi



Source: MWS&DB, Environmental Impact Statements, Bondi Water Pollution Control Plant, M.W.S.&D.B, 1979, p360.

Figure 5.4 Land Available at Malabar for Secondary Treatment Plant



Source: Caldwell Connell, Environmental Impact Statements, Malabar Water Pollution Control Plant, M.W.S.&D.B, 1979, p21.

Table 5.3 Comparison of Sewage Treatment and Disposal Options

Effluent option	Summary of major characteristics of options	Indicative 1978 costs ($ million) Capital cost	Annual operating cost	Total capitalised cost
REDUCED DISCHARGE				
Reuse within catchment	Low level of demand for effluent; possible lack of public acceptance; supplementary treatment required; conveyance of effluent through heavily populated areas.	300	8.8	410
Reuse outside catchment	Formidable physical and economic obstacles; supplementary treatment required prior to reuse. Power requirements for pumping equivalent to demand from a population of 300 000.	500	18	720
SHORELINE DISCHARGE				
Secondary treatment of primary effluent	Costs and space requirements create serious constraints; separate discharge of digested sludge will be required; may meet receiving water quality criteria but the effluent discharge would probably be noticeable.	152	5.0	215
Secondary treatment of screened sewage	Secondary treatment would have to accept screened and degritted sewage; extensive and costly modifications to main piping and open channel flow systems would be necessary; bypassing required during modifications, may meet receiving water quality criteria but the effluent discharge would probably be noticeable.	82	5.0	145
NEARSHORE DISCHARGE				
Chemical treatment with lime	Major impacts on solids handling, processing and disposal systems; lime recovery would probably be practised, and would require extensive investment in centrifuging and incineration facilities; chlorination for disinfection required.	45	5.2	110
Chemical treatment with polyelectrolyte	Discharge to approximate depth of 40 m would appoach about 35:1 average dilution; chlorination for disinfection required; needs further experimental work to determine feasibility.	45	2.4	75
DEEPWATER SUBMARINE DISCHARGE				
Primary treatment	Viable option. Will meet water quality objectives and SPCC requirements. Cost assumes construction of 2 additional sedimentation tanks after amplification of SWSOOS.	38	0.5	45

NOTES:
Total capitalised cost determined over 50 year period at 8% per annum.
Costs do not include capital or operting cost attributable to the existing Malabar WPCP or to sludge treatment facilities.
Costs for each option include provision of facilities to cater for ultimate population.
Estimates are based on December 1978 cost levels.

Source: Caldwell Connell, <u>Environmental Impact Statements, Malabar Water Pollution Control Plant</u>, M.W.S.&D.B, 1979, p54.

Tom Mullins, a marine chemist at the NSW Institute of Technology and an opponent of the submarine outfalls, criticised primary treatment as an "old fashioned" process which removed only 30% of pollution. He suggested two other methods of treatment in use in the United States - wet oxidisation process, which mixed heated sewage with air or a more advanced process combining primary treatment with reverse osmosis which could treat trade wastes as well as sewage.[108] The Board responded that wet oxidation was a process for treating sludge which had been removed by secondary treatment and that reverse osmosis was an experimental process which was extremely costly.[109]

The Sun quoted a Californian Professor who they claimed was a world authority on sewage treatment who stated that properly designed aerobic ponds could be half the cost of conventional sewage treatment methods. The article said that in the US it was mandatory to consider land disposal for sewage waste. It concluded

> However the Government has allowed conventional thinking engineers in government departments to commission consultant engineers with conventional views on the issue to give an "independent" view.
> The result was sadly predictable.[110]

Commonwealth Industrial Gases (CIG) made a major submission in response to the environmental impact statements for the submarine outfalls[111] which argued that In-Sewer Treatment, a process marketed by CIG, which involved aerating the sewers to allow oxidation to occur there, could improve Sydney's beach and in-shore conditions immediately and would be more environmentally acceptable in the long run.[112] They pointed out that the alternative of secondary treatment had been dismissed in the EIS's on the basis of cost and yet this was based on the costs of "conservative and costly secondary treatment techniques" whereas a number of new processes existed which were cheaper than conventional secondary treatment methods. In-Sewer Treatment, in particular, had not been evaluated by either the Board or their consultants.[113]

This process, they claimed, could remove 70-90% of bacteria and micro-organisms and achieve the precipitation of "dissolved and colloidal pollutants" in the sewers before reaching the treatment plant by the oxygenation of the sewage at various points along the main sewers, thus allowing the aerobic decomposition of the sewage. There would be the added advantage that Hydrogen Sulphide, which resulted from the anaerobic decomposition of the sewage, would not be formed and this would reduce odour complaints, corrosion of the sewers and the health risk to Board employees.[114]

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108 Sydney Morning Herald, 22nd February 1970.

109 Sydney Morning Herald, 26th May 1970.

110 Sun, 31st January 1977.

111 Commonwealth Industrial Gases Ltd, Oxygen Technology for Sewage Treatment and Disposal: Fast, economic alternatives to the proposed Deepwater Submarine Outfalls for Sydney, March 1980.

112 ibid., p1.

113 ibid., pp7-8.

114 ibid., pp35-6.

A trial of In-sewer treatment had been conducted at Bath in the UK and it had been found that aerobic conditions in the main were maintained giving an improved settleability of suspended solids and a reduction of about 40% of the organic load. Oxygen had also been used elsewhere in Australia to 'sweeten' sewers and aid in activated sludge treatment. CIG argued that the Water Board should take the opportunity to "follow this pioneering work to its logical conclusion. The result would be a system unique in the world." [115]

The Water Board did not quite see it that way. They criticised the process for being unproven and not used anywhere else in the world. Moreover they questioned the technical feasibility of the CIG proposal and the economics.

> The ability to achieve an effective activated sludge system in a gravity sewer is extremely doubtful,... It is clear that the system proposed by CIG is so far from a workable system that a worthwhile estimate of capital cost cannot be prepared.[116]

The initial capital outlay, they argued would not be small, as suggested by CIG, as extensive feasibility investigations would have to be carried out. Moreover the existing sedimentation tanks at Malabar would be inadequate for removing the activated sludge solids. Therefore the CIG proposal would probably be more expensive than submarine outfalls and would still not meet the SPCC criteria for ocean outfalls.[117]

The SPCC agreed that In-sewer treatment would probably not achieve the aesthetic objectives set by the Water Board (sic). Moreover one of their officers said that even if 90% faecal coliform removal was achieved, a shoreline discharge would not ensure satisfactory bacteriological quality of beaches. But the SPCC were sufficiently impressed to consider the process as an interim strategy to improve beach pollution until the extended ocean outfalls were built. The more efficient removal of grease seemed particularly attractive. However, they concluded that if the Board's estimate of the cost, which was fifteen times the CIG estimate, was correct then this would preclude its use as an interim strategy.[118]

Several other submissions made in response to the environmental impact statements suggested alternatives to the paradigm, which revolved around the utilisation of the sewage and these were also rejected by the Board. (see chapter 8) The Board was unprepared to go outside the paradigm because it involved risk, because they had already invested capital and built infrastructure that committed them to the paradigm, because its own engineers and consultants recommended a conventional solution and because they were committed to submarine ocean outfalls once they had undertaken an expensive and time intensive feasibility study.

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115 ibid., p9.

116 Chief Engineer (Investigation)'s Minute, M.W.S.&D.B., 29th April 1980.

117 Chief Engineer (Investigation)'s Minute, M.W.S.&D.B., 29th April 1980.

118 Ralph Kaye, S.P.C.C. internal report on C.I.G. submission.

HIGH-RATE TREATMENT FOR LOW QUALITY EFFLUENT

Although primary treatment facilities had been constructed at Bondi and Malabar by the mid 1970s, the North Head works were only equipped with screens although it had been intended to install sedimentation tanks and sludge digesters as recommended by Brown and Caldwell in 1967.[119] Following the Caldwell Connell study and during the preparation of the Environmental Impact Statement for the North Head submarine outfall, the Board decided that full primary treatment might not be necessary given that the sewage going to North Head was mainly domestic. A report was prepared to reevaluate the treatment options for North Head.

The idea of building the submarine outfall before the primary treatment works had been considered at least twice before. A representative of Brown & Caldwell had told the Board in 1967 that the provision of primary treatment would not remove the sewage field nor the occasional deposition of fine solids and fats on the beaches and that if the submarine outfall was built before the sedimentation tanks then all evidence of pollution would be removed, there would be less pollution and it would be cheaper. The Board decided, on the basis of this advice, to ensure that construction of the primary treatment works proceeded in such a manner that this could happen if it was so decided.[120]

Later Caldwell had "apparently changed his mind" and said that primary treatment should precede the submarine outfall but the seeds of the idea had been planted. The Board again discussed this option at the beginning of 1969. It was recognised even then that primary treatment alone would not be sufficient to prevent pollution on the beaches despite Water Board public claims to the contrary.

Whilst `in committee' the president of the Board had pointed out to other Board members that by the time the primary treatment had been built and funds had became available for a submarine outfall it could be 10 to 15 years "before worthwhile relief would be afforded" and he was worried that those who were pressing for action would not be prepared to wait that long.[121] The president thought it might be a good idea to build the submarine outfall first because

> Those people who were unhappy about sewage matter being dumped off the headland and washed onto the beaches might not be disturbed about material finding its way to these from about two miles out to sea.[122]

The president said that he was concerned that mounting pressure from Manly residents could cause the State Government, which was about to face State Elections, to make a special allocation of funds for North Head and then if the

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[119] Brown & Caldwell, Northern Suburbs Sewerage Survey, p184.

[120] `Draft Report on Investigation of NSOOSystem and North Head Sewage Treatment Works by Messres Brown & Caldwell', report of meeting of NSOOS Committee with Mr Reinsch of Brown & Caldwell, 26/6/67, appended to M.W.S.&D.B., North Head and Ocean Outfall Re-evaluation of Treatment and Disposal Options, Sept 1977.

[121] M.W.S.&D.B., minutes, 19th February 1969, p468.

[122] M.W.S.&D.B., minutes, 19th February 1969, p468.

Board admitted that nothing could be done for several years "the general reaction to this could be well imagined".[123]

The Board brought Caldwell out from the United States to discuss the matter. At a special meeting of the Board Caldwell explained to members the principles of sewage treatment. He told them that the effluent from primary treatment, although not having any solids in it which would rise to the surface, contained organic matter, fine particles of fats, etc. Secondary treatment was a biological process that effected the breakdown of the organic matter through the agency of naturally occurring bacteria. This could be achieved in the sea and in the case of North Head, if primary treatment preceded discharge, the ocean provided "the world's best secondary treatment process".[124]

Caldwell had studied and discussed the matter and "the absolute definite conclusion reached was that the primary treatment plant should be constructed prior to the submarine outfall". If it was not then floating matter, such as grease balls, pieces of rubber goods, etc, would not be removed and these would rise to the surface and blow onto the beaches if the winds were unfavourable. Primary treated effluent released at the cliff face would be merely coloured water with some dissolved salts in it and enough grease to allow the slick to be seen, but no grease balls would go to shore and the bacteria could be controlled by disinfection.[125]

Without primary treatment even fine screens would fail to remove the grease balls which would coalesce in the water after screening. With primary treatment the liquid grease might still make its way to the beach and the sewage field would be seen and even smelt. But he thought that the discolouration of the sewage field would not be noticed by the public as much as the floatables and solid materials which might result without primary treatment.[126] Another problem with not providing primary treatment but only submarine outfalls was that if bacteria needed to be controlled then disinfection, usually done with chlorine, might be necessary. This was not effective if the solids had not been removed since the chlorine would not be able to penetrate them and get to bacteria inside.[127]

The Board discussions about which form of pollution would be most acceptable to the public gives a different perspective on the promises that were being made publicly about primary treatment in the late 1960s, early 1970s and about reduced onshore treatment with submarine ocean outfalls from the late 1970s until the present. The Board clearly knew, even before construction, that primary treatment would not prevent pollution and that anything less than full primary treatment with the submarine outfalls would also cause pollution.

Caldwell argued that the cost of providing the submarine outfalls and the time taken to do so were both equivalent to the cost and time for a primary treatment plant since the pumping station would still be required. Moreover he gave a "firm

[123] M.W.S.&D.B., minutes, 5th March 1969, p504.
[124] M.W.S.&D.B., Minutes, 26th March 1969, p559.
[125] M.W.S.&D.B., Minutes, 26th March 1969, p560.
[126] M.W.S.&D.B., Minutes, 26th March 1969, p560-61.
[127] M.W.S.&D.B., Minutes, 26th March 1969, p559.

assurance" that primary treatment together with the submarine outfall would ensure that there would be no evidence of sewage on the surface of the sea "if the correct procedures were followed."[128]

The Board formally endorsed Caldwell's recommendation that a primary treatment plant should be constructed first, followed by a submarine outfall, after his visit in 1969.[129] Nonetheless this decision was reconsidered in 1977 in an internal report on treatment options for North Head.[130] Three options were considered in the report; full primary treatment with submarine outfalls and the digested sludge discharged with the effluent; reduced onshore treatment consisting of screening, grit and floating grease removal and submarine outfalls; and full primary treatment with discharge of effluent and digested sludge at the existing outfall.

In the report it was claimed that the Board was only committed to building primary treatment at the North Head outfall. The deepwater outfall was to have been considered in the light of the performance of primary treatment. Extensive excavation work was undertaken in preparation for the construction of primary treatment facilities but it was then realised, that primary treatment alone would not meet the water quality criteria set by the SPCC. The report argued that because primary treatment would not meet these criteria there was a need to go ahead with the construction of submarine outfalls immediately. This would have meant constructing submarine outfalls at the same time as primary treatment facilities and it was decided to reconsider the priority of the primary treatment facilities.[131]

The water quality criteria had been set by the SPCC at the request of the Water Board so that the submarine outfalls could be designed (see chapter 6). It is unlikely that a realisation that primary treatment would not meet these criteria was the real reason for abandoning construction of the primary treatment facilities. It is more likely that the desire to try a reduced form of onshore treatment in the hopes that it would be sufficient with the submarine outfalls prevailed here.

The 1977 report reevaluating the treatment options argued that both primary treatment with submarine outfalls, and reduced treatment with submarine outfalls would meet the criteria set by the SPCC for water quality and that both options would still produce a better quality effluent than that produced by the primary treatment at Malabar.[132] This was because, the Malabar sewage was worse to start with containing as it did a higher proportion of industrial wastes and because the primary treatment plant at Malabar was already overloaded and therefore not treating the sewage properly.

Moreover, the report claimed that the advantages of subjecting sewage to primary treatment over merely screening it and removing the grit and some of

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128 M.W.S.&D.B., Minutes, 26th March 1969, p563.

129 M.W.S.&D.B., Minutes, 9th April 1969, p586.

130 M.W.S.&D.B., North Head and Ocean Outfall Re-evaluation of Treatment and Disposal Options, Sept 1977.

131 ibid., pS-7.

132 ibid.

the grease, disappeared to a large extent when the digested sludge extracted by primary treatment was returned to the effluent before discharge. This was what happened at the existing primary treatment plants at Bondi and Malabar and what was planned for the future with the submarine outfalls. The report even went so far as to say that the effect of digesting the sludge, as at Malabar, was to stabilise the organic fraction and render the sludge more settleable, which would be a disadvantage in the sea because it would be more likely to settle out and accumulate on the ocean bottom where ocean currents were low.[133] This says a lot for the treatment that the Board had installed at great cost at Malabar and Bondi.

It is not surprising, then, that the report concluded that the extra cost of full primary treatment ($30 million in capital outlay and $5 million per year) could not be justified and that the reduced treatment option in conjunction with submarine outfalls was recommended.[134] Should additional facilities be required, the report went on, "it is likely that they may take a much simpler and more economical form than sedimentation and digestion tanks" such as enhanced capture of grease or "rotostraining" (fine screening).[135]

The Board had hesitated to take this step for several reasons. Firstly they were worried about appearances given that they had spent so much money and effort excavating for the primary treatment plant and had then changed their mind. They were also concerned that the diffusers might not work so well with less treated sewage but decided, on advice from overseas submarine outfall operators, that if they removed the floatable grease the diffuser ports would not be clogged and other precautions could be taken to prevent this.[136] They were also concerned that the SPCC approve the change in plans. The report stated

> Close liaison with senior officers of the SPCC has clearly established that the Commission favours the early provision of deepwater outfalls, at the expense of deferring or reducing onshore treatment facilities.[137]

The report referred to some of Caldwell's 1969 arguments for the necessity of primary treatment. With regard to the problems he predicted with floating material such as grease balls and rubber goods they argued that this advice had been based on the assumption that screenings would be macerated and returned to the flow and that since screenings were now to be incinerated his advice no longer stood.[138] They did not consider that the grease balls would be a problem. With regard to the problem of disinfecting solid particles of sewage, they argued that this too was outdated advice since

> the proposition that chlorination of primary effluent can effectively control bacterial pollution is not supportable. The fact is recognised in the Board's policy of not chlorinating primary effluent.[139]

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133 ibid., p2-7.
134 ibid., pS-6.
135 ibid., p5-2.
136 ibid., p5-2.
137 ibid., p5-4.
138 ibid., pp5-2,5-3.
139 ibid., p5-3.

Clearly they did not share Caldwell's concern that beaches might be polluted with high bacterial levels.

To alleviate the grease removal problem, a minimal form of primary treatment was developed in Australia whereby tanks were used, in which the sewage sat for fifteen minutes or so, giving time for some of the floating grease to rise to the surface and be skimmed off. This detention time was much shorter than for sedimentation tanks and so the treatment was named "high-rate" primary treatment. The name was ambiguous enough to confuse some members of the public into thinking that it might be a superior type of primary treatment. The cost advantage of high rate primary treatment was that only one third to one quarter of the tank capacity was required and, since the suspended solids wouldn't have time to settle out, there would very little sludge to worry about.[140] Figures 5.5 & 5.6 show schematically how a High Rate Primary Treatment Plant works and the primary treatment as installed at Bondi.

Since high-rate primary treatment was an idea developed in Australia and not tried elsewhere, experiments were carried out between 1977 and 1979 at Geelong under the direction of Caldwell Connell and at Malabar under the Board's direction. Although less suspended solids and total grease were removed and the biological oxygen demand was not lowered as much it was concluded that high-rate primary treatment was just as good as conventional primary treatment at removing the floating grease and this was what mattered to the Board as far as submarine outfalls were concerned since it was the floating grease which made the sewage fields visible and the beach sands sticky.[141]

TABLE 5.4 COMPARISON OF REMOVAL EFFICIENCIES

REMOVAL EFFICIENCIES %	CONVENTIONAL PRIMARY TREATMENT		HIGH RATE PRIMARY TREAT-MENT	BONDI PRIMARY TREATMENT PLANT		
	excluding digested sludge	including digested sludge		excluding digested sludge	including digested sludge	
					1979	predicted year 2025
BOD_5	27	20	13	12	9	12
Suspended Solids	63	20	18	36	11	18
Grease	55	45	30	40	25	30
Faecal Coliforms	17	17	NIL	NIL	NIL	NIL

INFORMATION FROM: Caldwell Connell, Environmental Impact Statement, North Head Water Pollution Control Plant, MWS&DB, 1979, p44; MWS&DB, Environmental Impact Statement, Bondi Water Pollution Control Plant, MWS&DB, 1979, p7.

Although high rate primary treatment at North Head required official approval before it was constructed, Malabar and Bondi have in recent years been operated as high rate primary treatment plants. For example, the Malabar primary treatment plant was designed to treat an average dry weather flow of 250 ML/day with a peak dry weather flow of 380 ML/day yet by 1980 the average dry weather flow was up to 400 ML/day and the peak dry weather flow up to 565 ML/day with no additional sedimentation tanks. A 1985 Water Board technical report stated that no additional sedimentation tanks were to be installed.

140 Caldwell Connell, Environmental Impact Statement North Head, p43.
141 ibid., pp43-5.

figure 5.5 FLOW DIAGRAM OF HIGH RATE PRIMARY TREATMENT

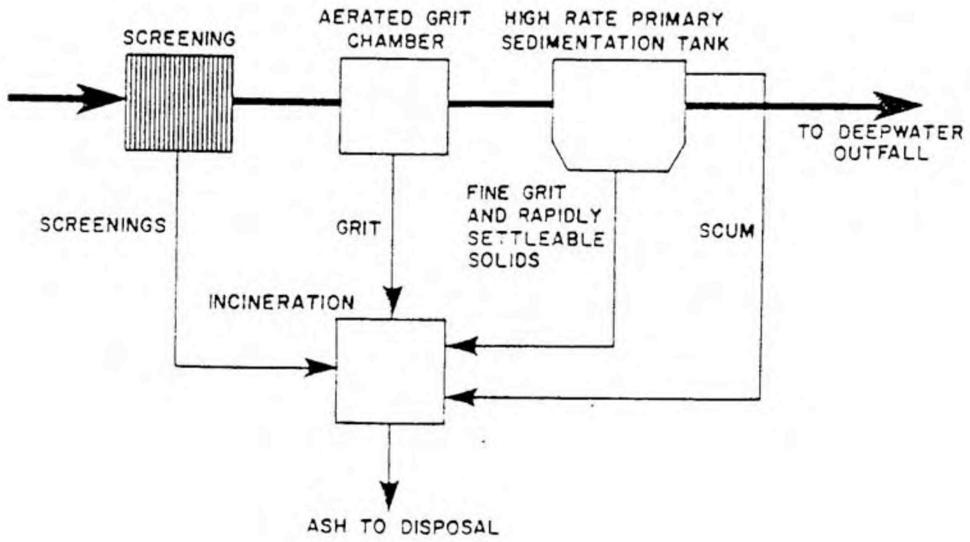
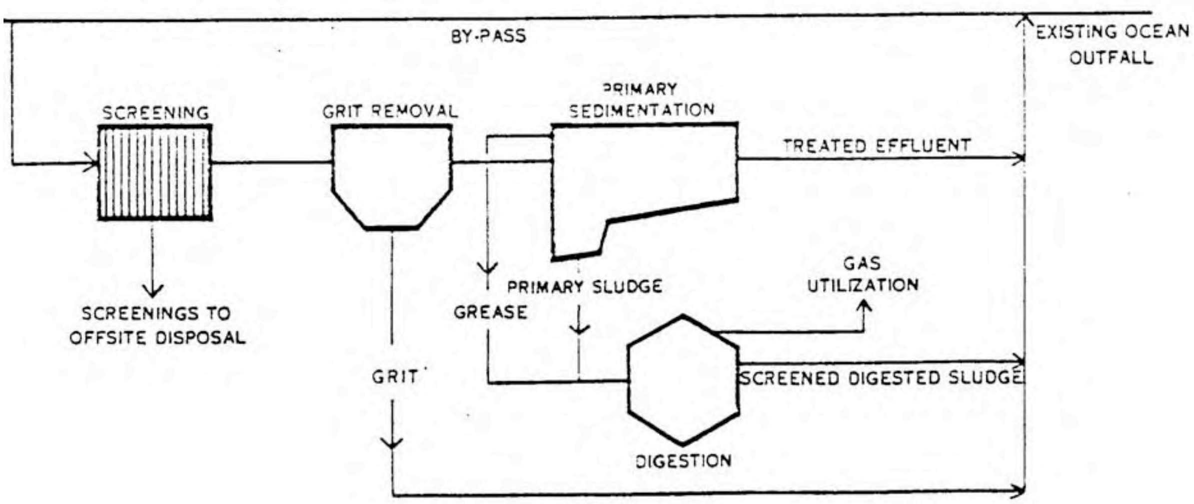


figure 5.6 FLOW DIAGRAM OF PRIMARY TREATMENT AT BONDI



Source: Caldwell Connell, Environmental Impact Statement, North Head Water Pollution Control Plant, MWS&DB, 1979, p43; MWS&DB, Environmental Impact Statement, Bondi Water Pollution Control Plant, MWS&DB, 1979, p8.

> The six (6) sedimentation tanks shall be operated at pseudo-high-rate loadings as flow to the WPCP [Water Pollution Control Plant] increases. The need for any additional tanks shall be reviewed following operational experience under the pseudo-high-rate loading mode.[142]

A comparison between the removal efficiencies expected with the High-Rate Primary Treatment plant and at the primary treatment plants also shows that the primary treatment plants are actually operating as high rate primary treatment plants and are expected to do so for many years to come. See table 5.4.

PARADIGM INADEQUACIES - GREASE, SLUDGE AND VIRUSES

High-rate primary treatment represented in essence the philosophy of staged treatment and, although disguised as an innovation, it was also a manifestation of the ever-present push towards minimising costs by minimising treatment rather than by technological innovation. In some ways high rate primary treatment was a late recognition by the Board that primary treatment was inadequate. Since primary treatment was inefficient at removing grease and bacteria, why bother with it? Primary treatment merely removed some of the solids in the sewage (and this was what is was designed to do) and therefore it ameliorated the visual and aesthetic impact on the beaches but it was thought that this same degree of amelioration could equally well be achieved by submarine ocean outfalls.

The paradigm was nevertheless retained. The grease problem was put off for later solution and provision made for the later addition of grease removal units. Air flotation was one technique suggested for this task and would involve blowing air into the sedimentation tanks to cause more grease to rise to the surface of the tank where it could be skimmed off. Air flotation constituted an adjustment to a process not primarily designed for grease removal but it allowed for the retention of the paradigm. Grease has in fact turned out to be a major problem on Sydney beaches and this will be discussed further in chapters 7 and 8. Moreover the grease and scum scraped off the sedimentation and high-rate treatment tanks has posed a problem for disposal because of the chlorinated hydrocarbons that it contains.[143]

The problem of bacterial and viral contamination was also put off to a later stage when it was hoped that either disinfection or extended ocean outfalls, further adjustments to the paradigm, might be able to solve it. The problem of bacterial contamination was not dealt with by the British Royal Commission. The standards recommended by the Royal Commission were aimed at the preventing the rivers from becoming foul and protection of downstream water supplies and so dealt with suspended solids and oxygen demand. It was considered that oxidation and dilution in the rivers would deal with the organic matter. The problem of disease-causing bacteria and viruses in the sewage will be further addressed in chapter 8.

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142 MSW&DB, "Malabar Water Pollution Control Plant, WPCP 2, Description of Existing Facilities and Upgrading Requirements, Technical Data", 14th February 1985, p14.

143 MWS&DB, "Malabar Water Pollution Control Plant No 2", internal report, March 1983.

The other major problem was with sludge disposal. By the end of the last century sludge disposal was already causing engineers headaches. Sludge is the part of the sewage which settles or precipitates out during treatment and it usually has a high water content. Little research had been done into methods of dealing with sludge because it had been hoped that the septic tank system or something like it would be able to eliminate the sludge altogether. Sludge pressing went out of fashion, partly because it was thought that it would be redundant and partly because of the expense and disappointed expectations for sale of the sludge cake as fertiliser.[144]

The idea of digesting the sludge separately from the effluent was put forward in 1899. Using the same principle as septic tanks, that is anaerobic bacteria to break down the sludge, various two-storey tanks were developed, such as the Imhoff tank in 1904 which digested the sludge in the lower chamber. The gas produced during this digestion process was mainly methane and the Parramatta treatment works was one of the first in the world to utilise this gas (from the septic tanks there) to generate power to pump the sewage.[145]

Sludge disposal problems increased in the ensuing years because of improvements in sedimentation techniques and also because there were pressures to release valuable land for uses other than sewage and sludge disposal. Moreover there was an increasing realisation of the consequences of having heavy metals and toxic chemicals in the sewage sludge.[146] Where possible the sludge was taken out to sea for dumping or disposed of on land, but engineers were forced to develop sludge digestion and dewatering techniques. At first sludge was dewatered on drying beds but the scarcity of land led to mechanical dewatering and filter presses made a come back.[147]

The alternatives for dealing with sludge discussed by Farnsworth in his 1938 report covered disposal of sludge by

1) barging raw sludge to sea.

2) chemical conditioning, vacuum filtration and incineration.

3) sludge digestion and spreading of digested sludge on land.

4) sludge digestion and discharge via the ocean outfall.

5) sludge digestion, chemical conditioning, vacuum filtration and incineration.[148]

The fourth option, disposal by sludge digestion (for 80 days) and discharge to sea via the outfall was the chosen option because it was the cheapest, it was "in

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144 John Sidwick, 'A Brief History of Sewage Treatment-3', Effluent and Water Treatment Journal, June 1976, op.cit., p301.

145 F.E.Bruce, 'Sewerage and Sewage Disposal', in Trevor Williams (ed), A History of Technology, vol VII, Part II, Clarendon Press, Oxford, 1978, p1394; Fuhrman, `History of water pollution control', p312.

146 Sidwick, 'A Brief History of Sewage Treatment-5', pp518-9.

147 ibid., pp518-9.

148 Farnsworth, Elimination of Nuisance From Ocean Outfall Discharges, p10.

accordance with most modern practice", no odour nuisance would be created, and the principles of digestion were "well understood" and "sound and safe."[149] This was also the method recommended later by Brown and Caldwell and eventually adopted at both Bondi and Malabar. The choices were again canvassed in the EIS's for the submarine ocean outfalls. The preferred option was disposal through the deepwater outfalls and this was also the cheapest in terms of operating and capital costs. For North Head the sludge problem was solved by not treating the sewage enough to obtain a significant amount of sludge. Sludge problems will be discussed further in chapters 7 & 8.

CONCLUSIONS - THE BEGINNINGS OF TUNNEL VISION

The nature of the development of sewage treatment processes has quite clearly changed since the first world war in most industrialised countries. Until that time, new ideas were rapidly forthcoming, concepts vied with each other for prominence and ascendency and various methods had ardent advocates who were willing to stake their reputations on their preferred methods. The main development impetus in the nineteenth century came from Britain where the river system, long abused as a waste disposal system, had become so obviously violated that there were public pressures to clean up the waterways. In the United States where population was sparser, rivers larger and the history of river pollution shorter there was much more willingness to rely on dilution as a form of treatment.

The debates between engineers required a different form of closure from that which operated in the public arena. The debate between water carriage and dry conservancy methods of collecting sewage were closed in Sydney because the alliance of engineers and bureaucrats was stronger and more powerful than those supporting dry conservancy methods. The debate between engineers was more of a debate amongst equals and closure required consensus. The attainment of that consensus was aided by the British Royal Commission into Sewage Disposal. There had been previous commissions and inquiries in various countries but none had the same prestige and influence. This Commission was a sufficient embodiment of expert authority to carry the day.

Although the Commission did not pronounce any method superior, it not only put an end to the factionalised fights and pushes for various methods but also to the search for new and novel approaches to the problem of dealing with sewage. It enabled engineers to reach a consensus on the range of methods which they could concentrate on, refine and use. It paved the way for the formation of a paradigm. This paradigm was written into engineering texts and education curricula. Whereas proposals for early sewage treatment works had to at least give a token mention and rebuttal of other alternative methods, modern sewage treatment proposals did not. A primary treatment plant had sedimentation tanks and that was that.

Moreover the nineteenth century search, in Britain, for the perfect method which gave a high standard of purity had yielded a number of treatment processes which were "good enough" and pronounced so by the British Royal Commission. It was considered uneconomical and extravagant to construct a treatment works

149 ibid., pp6-7.

that did more than the minimum required for the particular situation at that time, as judged by the authorities and the engineers.

This attitude gave rise to the idea of staged development whereby the degree of treatment given was upgraded as more was demanded by the public and more money became available, given that demand. In its own way the philosophy of staged treatment was a recognition by engineers that the "efficacy" of treatment methods was socially constructed and therefore variable and they were making provision for changing public perceptions of what was "good enough". But it was also a recognition that such perceptions were to some extent manipulable and that implementing sewage treatment incrementally would enable them to delay the agony of public spending and higher rates by convincing the public that what they planned to build would provide a perfect solution and insisting once it was built that it was in fact "working" as promised.

The idea of primary and secondary treatment had originally signified the order of two processes which were both considered necessary. The British Royal Commission had not evaluated the processes separately or in isolation. However, the idea of staged development and "good enough" treatment led to primary and secondary treatment being regarded as two different levels of treatment with primary treatment being sufficient on its own in many cases.

The development of high rate Primary Treatment arose from the continual quest by engineers to minimise treatment costs by reducing conventional treatment methods. The Board clearly knew, even before construction, that primary treatment would not prevent pollution and that high rate primary treatment with the submarine outfalls would also cause pollution. This is in stark contrast to the impression the public were given. The technology in this case was not chosen because it could remove sewage pollution. Rather the choice was between different technologies producing different types of pollution and the decision was based on the question of which type of pollution was least likely to cause protest and alarm and most likely to meet the rudimentary standards set by the government.

The pressure to reduce costs cannot be directly attributed to the public in this case. The continual push by the community, particularly beach users, for more treatment had been counteracted by the push by engineers for less treatment and it is as if engineers get a certain degree of pride in achieving their minimum designs. In other areas of public sector engineering there is a tendency to overdesign and oversupply commodities such as electricity because this ensures more work for the relevant bureaucratic organisations and their employees. This has not been the case with the Sydney Water Board. It is tempting to suppose that they have always been so far behind in supplying the proper facilities that the prospect of running out of work does not bother them.

The lack of impetus for new research provided by the "good enough" philosophy and the existence of an infrastructure of sewage works built on old ideas has meant that research funds are channelled into improving existing methods, and solving the problems associated with those methods. The processes are understood much more in scientific terms and the design of equipment is far more precise, standardised and reduced to formulae. There is less room for public discussion in such a climate. Whilst early sewage treatment and disposal decisions were reviewed by a parliamentary committee at a public hearing, the decisions with regard to the treatment at the main Sydney ocean outfalls in the

1950's and 60's had no public input at all and the reports involved remained internal to the Water Board.

Yet the paradigm had some inadequacies right from the beginning in terms of grease removal, removal of bacteria and viruses, and sludge disposal. As time went by more inadequacies became apparent and the conditions under which the paradigm was formed changed. These problems and the resolute adherence by engineers to the paradigm despite them will be covered in chapter 8.

The persistence of the paradigm can be partially understood when it is seen as being embedded within a technological system. Thomas Hughes defines a technological system as being a socio-technical system which includes not only physical artifacts, but also organisations, scientific components (including publications, research programs and university courses), legislative artifacts and natural resources. Technological systems attain a certain momentum as they grow.[150] In the case of sewerage technology, the system not only has momentum because of the vested interests of the engineers and authorities whose skills and practices are tied up with the paradigm but the momentum is added to by the existence of the physical structure of sewage plants. By the end of the first world war many of the larger towns and cities in Britain had established their treatment works and as time went on the same was true in many other industrialised countries. Change was therefore in terms of augmenting and improving those plants which often did a partial job. Such plants incorporated a certain amount of capital and people's reputations and it was not easy to tear them down and replace them with new plants using new processes which were not as "tried and true".

Other components of this technological system will be considered in the remaining chapters. In particular the role of legislation, regulation and government control will be considered in the next chapter and the influence of industrial interests will be considered in the following chapter.

[150] Thomas Hughes, Networks of Power: Electrification in Western Society, 1880-1930, John Hopkins University Press, 1983, chapter 6.

CHAPTER 6

LEGISLATION, COMPROMISE AND NEGOTIATION

Engineers are subject to certain constraints in their choice of treatment technologies. In the last chapter it was shown that effluent standards play a key role in defining what is good enough or sufficient treatment. Such standards can either be set down in law or regulated by some government authority or agency. In this chapter several aspects of this process will be considered; in particular the introduction of comprehensive legislation in the 1970s which followed a period of rapid and obvious degradation of Sydney's waterways that was highlighted in the media and in official reports. The new legislation set the conditions within which engineering decisions would be made. The extent to which environmental legislation sought compromise with industrial and bureaucratic interests ensured that the legislation also accommodated the engineering paradigm and ensured that engineers continued to shape and control sewerage treatment technologies.

TRADITIONAL APPROACHES TO REGULATING POLLUTION

The traditional method of dealing with pollution has been through common law. Common law is law that develops over time through precedents set in the court by judges who interpret and recognise various principles and rules in dealing with particular cases. Common law tends to protect individual and property rights and is not always appropriate for dealing with pollution.

Under common laws of nuisance a private person, usually an occupier of land, can sue for damages or be granted an injunction if the beneficial use of their land is interfered with because of the nuisance caused by their neighbour or a business in their vicinity.[1] In this case the person has to show that they have suffered "special" damage over and above what everyone else has suffered, the interference must be substantial and unreasonable and the nuisance must arise from a land use that is excessive in the context of existing uses of the area.[2] Moreover a person must show firstly that they have legal standing to take proceedings, secondly that the pollution was caused by the accused and thirdly that significant physical injury or economic loss has been sustained as a result of that pollution.[3]

The common law of 'public' nuisance can be used for personal injury suffered in public. But again the person must show that they have suffered more injury than the rest of the public. If the public is generally effected then a person can seek the assistance of the Attorney-General, as Guardian of the public interest, to put his/her name to the action and allow it to proceed. This, however, means that the action may not go ahead if it is not in the interests of the government of the day, particularly if it is the government itself which is discharging the pollution.[4]

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1 David John Haigh, 'Pollution in New South Wales-Air, Water, Noise and Waste' in Local Government, Planning and Environmental Service, Volume C-Commentary, Butterworths, 1981, p15016.

2 G.M.Bates, Environmental Law In Australia, Butterworths, 1983, p149.

3 Pamela Coward, Environmental Law in Sydney, Botany Bay Project, Canberra, 1976, p50.

4 Haigh, 'Pollution in NSW', p15016; G.M.Bates, Environmental Law in Australia, p159

Finally, an individual may take the polluter to court for negligence under common law but this too has its problems. The person has to prove that the polluter acted negligently and was able to foresee the consequences of those actions and that damage or injury resulted.[5]

All these laws offer remedies once the damage is done. They can involve legal battles that can be expensive and time consuming for private citizens who may be battling against industrial opponents who are better funded and resourced. Pollution is never easy to prove. The law of nuisance, in particular, attempts to balance competing interests in land usage and development and therefore individual cases are settled on a basis of reasonableness and findings tend to support the right of businesses to exist as long as damage to others is not too excessive.[6] For all these reasons, common law is an ineffective way of controlling pollution.

The other type of legislation that has been used for pollution control is through statute law. Early legislation of this type was aimed at protecting water supplies and prescribed penalties for nominated acts; the "don't-throw-dead-dogs-in-the-dam" approach. The effectiveness of statute law was also limited, partly because it depended on a "policeman hiding in the bushes" approach to enforcement.[7]

Statute laws tended to be included in more general legislation in areas such as public health, local government, mining, water supply and water resources and were secondary considerations to the main thrust of the legislation.[8] This meant a large number of government bodies had some power to prevent or control pollution but none of them saw this as being a top priority.[9] For example, in 1936 the Maritime Services Board was established and given responsibility for all navigable waters in NSW. The definition of 'navigable' was wide enough to include any waterway in which any craft could float and therefore covered inland rivers, streams and canals. It was therefore the Maritime Services Board which was primarily responsible for water pollution throughout NSW.[10]

The main function of the Maritime Services Board, however, was, as its name suggests, to look after shipping interests and it therefore was only really concerned with the pollution of port and harbour waters, flotsam and jetsam, which would impede shipping traffic. To cope with other water pollution the Board established the Pollution of Navigable Waters Regulations in 1941. These regulations prohibited the dumping of animals into any navigable waterways and the dumping of industrial wastes, by owners or occupants of industrial establishments, into navigable waterways near a city, town or municipality.[11]

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[5] Pamela Coward, Environmental Law in Sydney, pp50-51.

[6] Bates, Environmental Law In Australia, p148; Butlin, Sydney's Environmental Amenity, p

[7] Sandford D. Clark, 'The Philosophy of Australian Water Legislation - Part III', Water 8(1), March 1981, p14.

[8] ibid.; Bates, Environmental Law In Australia, p150.

[9] ibid.

[10] N.G. Butlin, Sydney's Environmental Amenity, Botany Bay Project, Canberra, 1976, p21.

[11] ibid., p22.

New regulations were introduced in 1955 (Navigable Waters (Anti-Pollution) Regulations) which "were a recognition of the era of chemicals".[12] These regulations prohibited the dumping of any inflammable, dangerous or toxic substance into waterways or their shores and they set maximum effluent standards for biochemical oxygen demand, acidity, alkalinity, sulphur, ammonia and heavy metal concentrations. The Board had total flexibility in the enforcement of these regulations and could vary the standards according to the state of the waterway, or the inconvenience the standards might cause an industry. This was provided that the Board considered the effect on the waters, the 'comfort, convenience or health' of water users and aquatic life.[13]

The philosophy behind the 1955 regulations shows the change in attitude towards pollution of waterways. Until then the orientation of pollution control efforts had been towards protection of human health and keeping the waterways free from obstruction. The authorities were especially concerned about the disposal of human excrement and animal products which were likely to be a source of infectious diseases. The new philosophy was oriented towards protecting the waterways so that they remained suitable for a number of uses.[14]

A second aspect of the changed philosophy towards pollution control was "an acceptance of the principle of management of the medium into which wastes were discharged".[15] Previously emphasis had been placed on the wastes and waste sources, now the emphasis was on controlling the quality of the waterways.

DETERIORATING ENVIRONMENTAL QUALITY AND IMPROVING AWARENESS

During the 1960's the public became increasingly pollution-conscious. Not only were they directly experiencing the results of pollution in the local rivers and on the beaches and reading or hearing about more distant pollution in the media but overseas concern was growing as industrialised countries faced more intolerable environmental conditions and attempts were made to legislate and control the excesses of uncontrolled growth. Moreover the new science of ecology was having its impact, environmental and conservationist groups were becoming active with the growth of the counter-culture and several key books were published at this time including Rachel Carson's "Silent Spring" (1962).[16]

It was also becoming apparent that existing mechanisms for control of pollution were inadequate. Common law was ineffective but so was ad hoc statute law. Local government bodies lacked the financial resources, the will and the geographical jurisdiction to cope with problems occurring in their areas.[17] The Health Department was only able to act after the event, in the wake of offences

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12 ibid.

13 ibid.

14 D.D.Moore & J.J.Wright, `Water and Wastewater Monitoring in the Sydney Estuaries', in Industrial Waste Water - A symposium on Recent Developments, UNSW, 1972, p1.

15 Butlin, Sydney's Environmental Amenity, p23.

16 ibid., p23.

17 ibid., p27.

committed, and then they were generally unsuccessful in catching and prosecuting the culprits.[18]

The growing public consciousness of pollution in NSW began to make itself felt at a government level from the early 1960s when the then Minister for Health, Mr Sheahan, set up a standing committee in 1961 to inquire into the causes of water pollution and ways of preventing and reducing it. The committee, comprising of representatives of the various public bodies with some responsibility for water pollution, was to compile and publish requirements for industrial waste treatment.[19]

In September 1962, the Government Analyst, Mr Ogg, caused a stir when he reported on the condition of the George's River (location shown on figure 6.1) which he said was a menace to public health. Ogg had made his investigations on instruction from the Minister for Health after river swimming pools had been closed because of pollution. Ogg found that in parts of the river even eels, notorious for their tolerance of pollution, had been killed.[20]

Five years before the river had been used for bathing, fishing, picnicing and boating but now swimming was unsafe and fish few and far between. Ogg blamed the effluent from the Fairfield sewage treatment plant particularly, but also garbage dumping and runoff from unsewered areas.[21] A year later Ogg submitted a second report on the George's River, again pointing to the pollution and health dangers. Oyster farmers also complained that their leases were being ruined by pollution and boats in Botany Bay, which the River runs into, were being coated in slime and oil. Pollution was attributed to sewage treatment works, garbage dumping, topsoil runoff and factory wastes.[22]

In 1966 it was reported that thousands of fish had been killed in the Parramatta River (location shown on figure 6.1). Industries sited on river banks were reported to be pouring their wastes directly into the waterways. In fact industries were establishing themselves next to watercourses because they offered the opportunity for no cost waste disposal. Several reports highlighted the alarming state of river and stream pollution. The Water Board chief medical officer, Dr. Flynn, described the condition of the Parramatta River at the time as "woeful". The Cooks River (location shown on figure 6.1), too, was used "just as a trade sewer"[23]

A year later the Mirror, in a major article described the Parramatta and Cooks rivers as being covered with green slime, depleted of the once plentiful scollops and littered with hundreds of dead fish floating "belly-upwards after any sudden increase in industrial effluent."[24] The paper reported that a Maritime Services Board spokesmen had emphasised the need for being realistic. He had argued that Maritime Services Board couldn't expect businesses to shut their factories

[18] ibid., p29.

[19] Sun, 13th December 1961.

[20] Mirror, 13th September 1962.

[21] ibid.

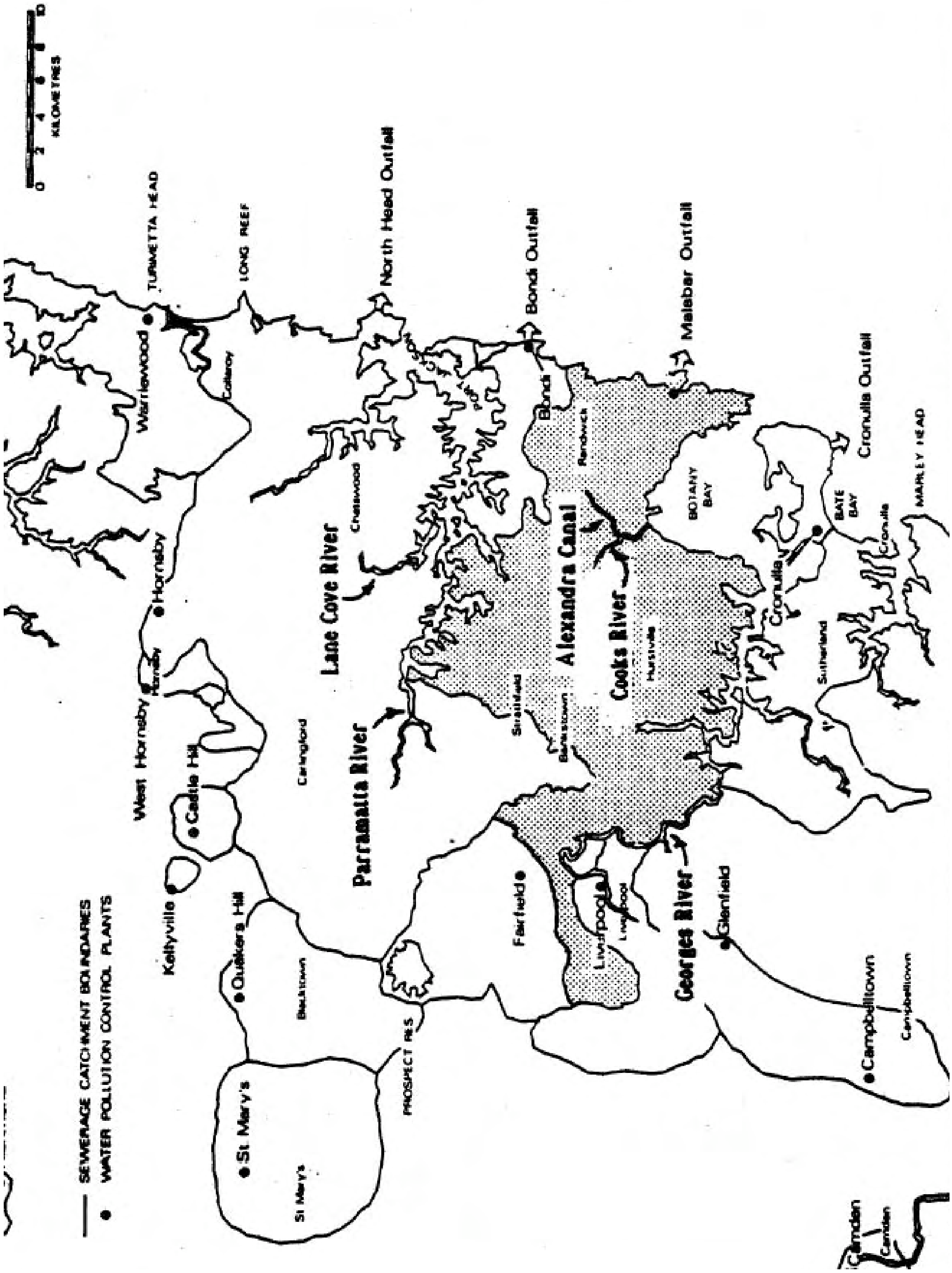
[22] Mirror, 19th September, 1963.

[23] Telegraph, 23rd May 1966, 8th June 1966.

[24] Mirror, 19th July 1967.

and send their workers home just because they were putting some pollutants in the water.[25]

Figure 6.1 Sydney Waterways



Source: Caldwell Connell, Environmental Impact Statement: Malabar Water Pollution Control Plant, MSW&DB, 1979, p2.

25 ibid.

In mid 1969 the Sun published an article about the Alexandria Canal (location shown on figure 6.1) headlined "Filthy canal makes strong men sick". They described the canal as "nothing more than a stinking industrial sullage channel", "vile smelling", with thick black water "dotted with psychedelic patterns of pink dyes, scrap metal and other industrial wastes". The Canal was lined on one side by factories and the 1000 plus people who worked in the Government-owned woolshed on the other side of the canal had held four mass meetings and elected the "Alexandria Canal Anti-Pollution Committee" in an effort to get something done about it because they believed it was a health hazard. The Canal was controlled by the Maritime Services Board (responsible for navigation and pollution) the Water Board (responsible for stormwater drains running into the canal) and the Public Works Department (responsible for dredging the canal and removing debris).[26]

The Herald described the Alexandra Canal in 1970 as "Sydney's blackest stretch of water". They quoted the Metropolitan Health Officer as saying it presented no health risk because even bacteria could not survive the degree of chemical contamination present in the Canal. The Canal had at one time been used for swimming, prawning and transport but boats became covered in a "black, oily, gluey substance" that could not be removed.[27] In a later article they described the effluent from a paperboard manufacturer which turned the water of the Alexandra Canal red, white or blue depending on the colour of the paperboard which was being milled. A sample taken by the Herald was way above limits set by the Maritime Services Board for suspended solids and biochemical oxygen demand.[28]

The Herald also described the "warm, frothy, dirty discharge" from the Australian Paper Manufacturers' mill into Botany Bay. APM had set up on Botany Bay because of the availability of cheap bore water, a never-ending supply of cooling water and because they could easily get rid of their wastes into the Bay. Both an APM spokesman and the Maritime Services Board claimed that the effluent caused no harm. The Herald took two samples and found that both were many times more than the Maritime Services Board limits for suspended solids and biochemical oxygen demand so that there was a possibility that the life on the sea bed could be stifled by paper fibre and marine life could be deprived of oxygen.[29]

The recognition by the newspapers and various public servants that water pollution was reaching crisis proportions in N.S.W. was reiterated by a Senate Select Committee on Water Pollution in Australia which tabled its report in June 1970 following two years of investigations and hearings, and over 5000 pages of evidence. The Committee found the conditions in N.S.W. were repeated throughout Australia and that pollution of waterways was so bad in some places they could no longer be used except as sewers.[30] Despite this, they argued that public awareness of the problem was very limited outside of conservation groups

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26 Sun, 27th June 1969.

27 Sydney Morning Herald, 16th April 1970.

28 Sydney Morning Herald, 22nd April 1970.

29 Sydney Morning Herald, 21st April 1970.

30 Senate Select Committee on Water Pollution, Water Pollution in Australia, Canberra, 1970, p183.

and voluntary organisations and expertise in the field of water pollution was lacking in Australia. Education of the general public and in technical fields was inadequate. Information and research was scarce.[31]

The Select Committee was particularly concerned that Australia's scarce water resources were not being protected at a time when water was becoming more valuable as population and industry grew. Water was being "squandered, by neglect or deliberate action, or by lack of administrative co-ordination," because water was considered to be free.[32] The reliance on "private conscience, rather than upon public action, to preserve our waters" had failed.[33]

The three main causes of pollution, cited by the Committee, were sewage, industrial effluents and salinity. The Committee argued that pollution had been too often justified by false economics. "Easily measured private profits had been used "as a facile argument to justify intangible and immeasurable social losses."[34] They believed that since pollution was justified in economic terms so economic arguments would be the most successful in putting the pollution abatement case. Costs and benefits had to be balanced.

The situation in N.S.W. at this time was further exacerbated by a crisis in industrial waste disposal that occurred at the end of 1969 when the last of the suburban council tips, at St.Peters, was closed to industrial waste. These council tips had been progressively closed as they became overloaded with "obnoxious industrial overflow". The tips were closed partly on the advice of the Board of Health but also in response to complaints from local people. A request by the Minister for Local Government, that 40 councils spread the industrial load between them, had been turned down.[35]

The closing of council tips to industrial waste prompted a situation which no single public authority was able to cope with. There was no body able to direct the industrial wastes to particular locations that would have a minimum impact on the environment and take charge of the crisis.[36] Before the last council dump closed its gates to industrial waste, three major and a few minor contractors collected about 300,000 gallons of industrial waste every week and disposed of it. Afterwards they were only collecting 100,000 gallons and it was assumed that the remaining 200,000 gallons per week of sludges and liquid wastes were being dumped illegally.[37]

The crisis extended into 1970 and industrial waste was being illegally dumped in bushland, into waterways and into the sewers and stormwater drains.[38] A Health Department official gave examples of trade waste abuses including a sludge carter dumping acid sludge into the Lane Cove River (see figure 6.1), a

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31 ibid., p184.

32 ibid., p183.

33 ibid., p91.

34 ibid., p184.

35 A.E.Barton, Investigations into the Problem of Waste Disposal in the Metropolitan Area of Sydney, 1970, p10; Sydney Morning Herald, 17th April 1970.

36 Butlin, Sydney's Environmental Amenity, p29.

37 Sydney Mornng Herald, 17th July 1970.

38 Sydney Morning Herald, 26th February 1970.

tanker driver splashing oil for several miles along Parramatta Road and two explosions and a death resulting from the cartage of incompatible liquids.[39] A Water Board member claimed that untreated industrial waste was polluting the harbour and beaches and causing "enormous damage and loss to the Board and ratepayers".[40]

There were plans to fall back on that old reliable dump - the sea - but this was objected to by local residents.[41] The Government responded that this waste would be small in volume compared to what already went out the outfall, and that much of this waste was already going into the sewers without treatment because of illegal dumping.[42] The Herald was also critical of the government plan to discharge selected industrial wastes, "which are often the most objectionable and difficult component to dilute", at Malabar since illegal dumping had already caused serious pollution problems on the beaches. The paper criticised the inability of the government to prepare for the situation since it should have known that the council tips were going to close down.[43]

In May 1970, twelve outer-Sydney councils agreed to consider accepting limited quantities and types of liquid industrial wastes at their garbage tips as an interim measure to help in the liquid waste disposal crisis. The local government association, however, believed that the ultimate responsibility lay with the industries that created the waste.[44]

In the meantime South Sydney Council threatened to prosecute the Minister for Public Works, Mr Davis Hughes, if he did not have the Alexandra Canal cleaned up within three months.[45] A Water Board Member, Mr Wallace, described the laws for prosecuting companies illegally discharging wastes as making "a mockery" of the board. At a meeting of the Board a "large industrial concern" which they knew was causing pollution of the beaches was discussed. The company was causing hundreds of thousands of dollars worth of damage to the beaches and the board's reputation but could only be fined a maximum of $100 if it was successfully prosecuted.[46]

COMBINED CALLS FOR COMPREHENSIVE LEGISLATION

Almost everybody who reported on or commented on the pollution problems of the 1960s called for a more comprehensive set of controls that were more centrally administered. When Ogg, the government analyst reported in the early 1960s he claimed the reason that the Georges River was so foul was the number of authorities involved in preventing its pollution and he called for a single authority with overriding control of all waterways.[47] The Telegraph supported this idea in its editorial a few days later and called for a "kind of standing body

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39 Sydney Morning Herald, 18th June 1970.

40 Sydney Morning Herald, 26th February 1970.

41 Telegraph, 10th April 1970; *Sun*, 10th April 1970.

42 Sydney Morning Herald, 14th April 1970; *Telegraph*, 14th April 1970.

43 Sydney Morning Herald, 13th April 1970.

44 Telegraph, 10th May 1970.

45 Sydney Morning Herald, 30th July 1970.

46 ibid.

47 Telegraph, 14th September 1962.

with overriding powers and a continuing responsibility for policing the disposal of factory waste, sewage and garbage in river areas."[48]The newspapers kept up their lobbying for such a body over the next few years.[49]

In May 1970 Allan Barton, an English expert brought out by the State Government to advice on the disposal of waste and garbage, completed his report. Barton argued that the formation of a single authority which would be responsible for all waste disposal was absolutely essential and urgently required. This authority would be a specialist authority "whose sole interest would be centred upon waste disposal."[50] At the time local authorities, the State Board of Health and the Department of Public Health, the Maritime Services Board and the Water Board all had powers to do with waste disposal but none of these authorities had a sole or specialised interest in it.[51] Pollution control, he said, had to be comprehensive, effective and actively enforced. Had there been a co-ordinating authority the existing "critical situation" would never have arisen.[52]

The Senate Select committee was particularly scathing about the plethora of organisations and laws concerned with pollution in all states of Australia. They described "a remarkable lack of cohesion bordering on the chaotic."[53] The consequence was that responsibility was ill defined and diffused and completely uncoordinated.[54] In NSW 5 government departments, 5 state government instrumentalities and all local government authorities were concerned with pollution prevention and control.[55] In addition legislative control of water pollution in NSW was affected by at least 30 acts.[56] They argued that there was "nothing in the present piecemeal and parochial administration of water to prevent the insidious growth of pollution excesses."[57]

Action on pollution usually only occurred in response to imminent danger from overt dumping and incidents which caused social outrage.[58] There seemed to be "a marked lack of enthusiasm in enforcing the powers to abate pollution" and anyway government instrumentalities were often exempted from the provisions of the law.[59]

Only a united, comprehensive, national approach would suffice, claimed the committee. This was necessary to ensure co-ordination between the States and the Commonwealth, to make an overall assessment of the country's resources and the threat to them, to provide and coordinate technical resources and skills,

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48 Telegraph, 17th September 1962.

49 for example Telegraph, 23rd May 1966; Sydney Morning Herald 8th June, 1966; Mirror, 19th July 1967.

50 A.E.Barton, Investigations into the Problem of Waste Disposal in the Metropolitan Area of Sydney, 1970, p21.

51 ibid., p10.

52 ibid., p19.

53 Senate Select Committee on Water Pollution, Water Pollution in Australia, p138.

54 ibid., p185.

55 ibid., p121.

56 ibid., p122.

57 ibid., p185.

58 ibid., p91.

59 ibid., p139.

to determine general standards and criteria for classifying waters for specific uses, to give financial aid, to ensure new legislation would be unified and coordinated, and to arbitrate when conflicts arose.[60]

Other reasons given, by the committee for more centralised control included the variation in attitudes and policies between local government authorities, the fact that local authorities were more subject to local pressures and the influence of local industries that were important to employment or council's revenues.[61] Also an overall pollution body would be more able to lobby for funds from the government for pollution control.[62] Pollution could not be contained within national boundaries, nor political divisions and therefore demanded national and international measures.[63]

The Select Committee therefore recommended that a National Water Commission be set up which would formulate policy, assess water resources and program conservation and development of those resources. This body would encourage, assist and co-ordinate legislation, finance, research and education. It would be assisted by "a multi-discipline administration involving specialists" in a number of fields and a voluntary advisory body which would utilise conservation groups and provide for public participation.[64] Each state should create its own central pollution authority to co-ordinate State activities. These authorities would systematically assess water quality and regularly monitor pollution in the waterways.[65]

Several attempts had been made by various N.S.W. governments throughout the 1960s to deal with water pollution legislation. In 1966 the Askin government had announced that it was introducing legislation to control water pollution throughout the state and that a Water Pollution Advisory Committee would be established. The Advisory Council would make recommendations, advise public authorities and investigate conflicts of interests between different authorities and industries.[66] In 1969 the State Government again proposed legislation to "restrict and control" pollution ("prevent" no longer used).

Mr Jago, Liberal Minister for Health, told parliament that a Water Pollution Bill had been drawn up by an interdepartmental committee. He expressed the hope that the bill would help achieve "better utilization of our existing resources" and spoke of how fine rivers had been turned into "stinking drains by what we empty into them". Legislation from overseas had been considered when the bill was drafted, especially that of New Zealand, which had had similar legislation since 1953, and of the United States.[67]

The Government allowed some time for comments and submissions to be made on the Bill and it was reintroduced at the end of October 1970 as the Clean

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60 ibid., pp186-7.

61 ibid., pp130-140.

62 ibid., p140.

63 ibid., p8.

64 ibid., pp188-9.

65 ibid., p189.

66 Sydney Morning Herald, 8th June 1966.

67 Mr. Jago, Water Pollution Bill, Second Reading, Legislative Assembly, 12th April, 1969.

Waters Bill.[68] Few revisions had been made but the name had been changed to place more emphasis on the prevention of pollution because some critics had suggested that the Water Pollution Bill would become an Act authorizing the pollution of water because of the provisions which would license organisations to discharge waste into waterways.[69]

The major public criticism of the bill had been that it was not comprehensive enough. The Telegraph criticised Jago's proposed Water Pollution bill as "patchwork legislation" and called for a "master plan" like that of President Nixon. There had been too many committees, conferences, promises to "get tough" and too little action.

> Mr Jago's projected Bill may impose harsh penalties on polluters but it will not solve the real problem of how to render harmless enormous masses of industrial waste or dispose of it in a harmless manner.[70]

In late July, 1970 a meeting of metropolitan council representatives also criticised the proposed Water Pollution Bill as being a "piecemeal approach". They called for a single authority to control land, sea and air pollution in NSW with sufficient powers to police regulations, and a "continuous program of environmental research and education". The councils also supported the idea of a National Environmental Control Council to co-ordinate State activities.[71]

The Premier immediately announced that the government would establish a State Pollution Control Authority and also a Sydney Metropolitan Regional Waste Disposal Authority. The announcement was welcomed by local government bodies.[72] In October a Commonwealth Office of the Environment was announced and welcomed in the pages of the Sydney Morning Herald, which welcomed the possibilities for uniform pollution controls across the states, financial assistance to the states in their fight against pollution and even taxation relief incentives to industry.[73]

By 1972 a new legislative approach to environmental management was in place in NSW with two new government organisations set up with responsibilities for liquid waste management. The new administrative arrangements are shown in overview in figure 6.2.

COMPROMISE - TIPPING THE BALANCE TOWARDS POLLUTERS

Although the new water pollution legislation was established to clean up the State's rivers and waterways the government was careful to ensure that the legislation would "cause minimum hardship to industries and services which need to use areas of water for waste disposal."[74] There was therefore no goal of

[68] Mr. Jago, Clean Waters Bill, Introduction, Legislative Assembly, 27th October 1970.

[69] Mr. Jago, Clean Waters Bill, Second Reading, Legislative Assembly, 4th November 1970.

[70] Telegraph, 5th March 1970.

[71] Sydney Morning Herald, 28th July 1970.

[72] Telegraph, 30th July 1970.

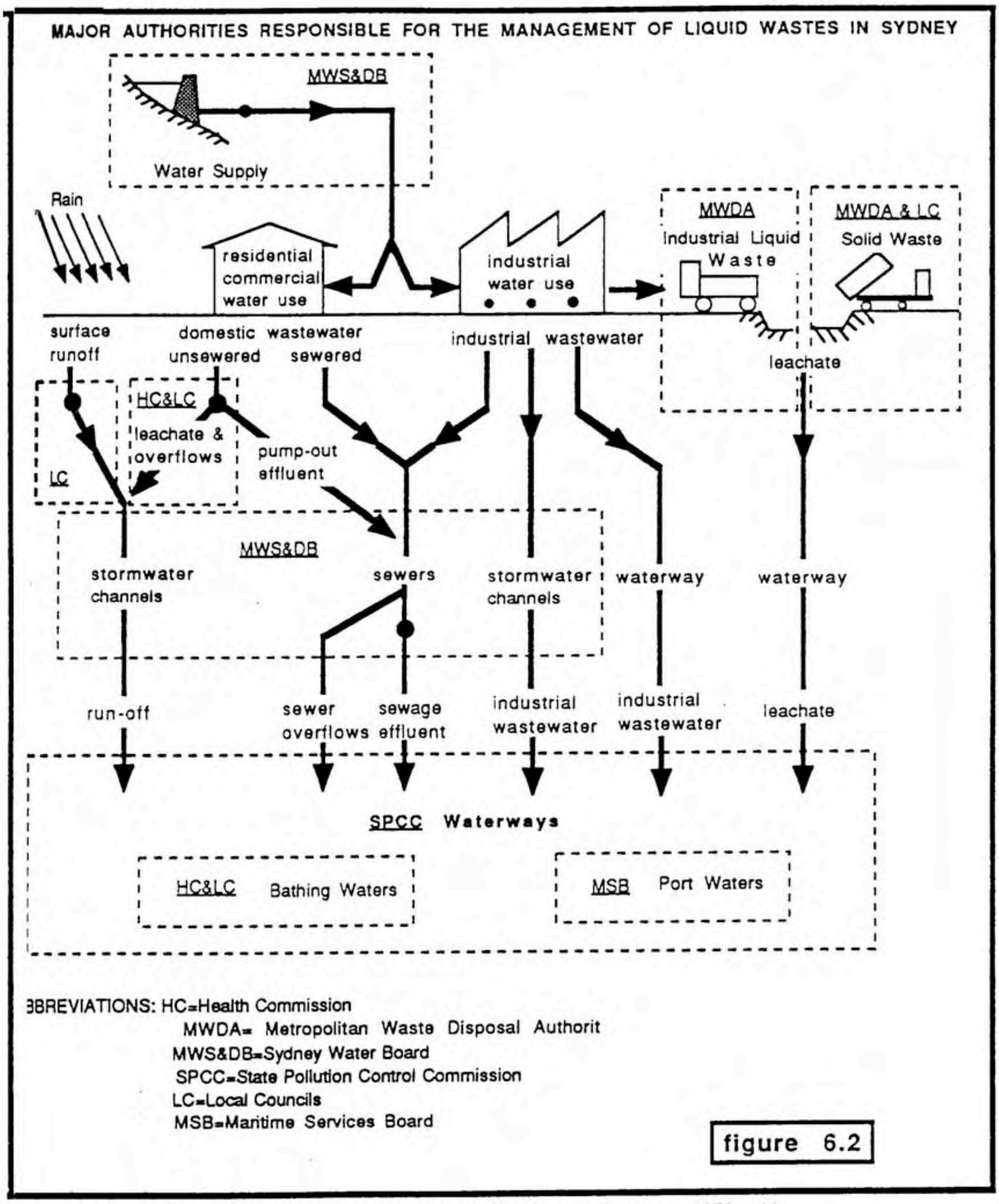
[73] Sydney Morning Herald, 24th October 1970.

[74] Sydney Morning Herald, 12th March 1969.

ridding the waterways of pollution but rather the strategy was to keep pollution "to a level where it will cause the least possible harm".

> where a degree of pollution is unavoidable because of the need to dispose of sewerage and industrial wastes, it is permitted in a controlled fashion designed to meet the needs of the community as a whole.[75]

Figure 6.2 Major Authorities Responsible



urce: C.Joy et al, Liquid Waste Management, Botany Bay Project, Canberra, 1978, p44.

[75] Mr. Jago, Water Pollution Bill, Introduction, Legislative Assembly, 27th March 1969.

Each waterway was to be classified according to its use. For each classification there would be a standard of water quality set which would imply acceptable pollution levels for that waterway. Once a waterway was classified a polluter would require a licence to discharge waste into it. Section 16(6) of the Act stated

> Notwithstanding the foregoing provisions of this section it shall not be an offence against this Act arising under these provisions for a person to pollute any waters if he holds a licence and does not pollute the waters in contravention of any of the conditions of the licence.[76]

The licence would specify the nature, quality and quantity of waste that could be discharged.[77] Classification determined the degree to which a body of water could be polluted. The philosophy behind such a system is expressed well by the Victorian Environment Protection Authority in 1975 when it said

> One has to strike a compromise in all of these matters. If industry is to exist, some degree of pollution must be permitted;... industry must be permitted to continue, and to continue to discharge waste, so long as the environment can absorb it without detriment to the quality of the environment and other characteristics.[78]

Similarly, two officers of the Water Control Branch of the Health Department in NSW told a waste water symposium that although no waters would be classified for use as an open sewer, "the reasonable and necessary use of waters in the final distribution of the community's water-borne wastes must be recognised."[79] (This attitude of compromise contrasts with the spirit of the U.S.Clean Waters Act also brought in in 1972.It aimed to eliminate all discharge of pollutants into navigable waters including the ocean by 1985.[80])

The maximum penalties for breaches of the Act provided for in the Water Pollution Bill had been criticised as inadequate and these were doubled in the Clean Waters Bill but Jago was careful to point out that the concept behind the bill was that it should be "administered with an educative and persuasive approach rather than a punitive approach." Also a distinction should be made, Jago said, between those who pollute because there is no reasonable alternative available to them and those who pollute because it is the easiest and cheapest thing to do. Education and gentle persuasion had proved to be "protracted, inefficient and demoralizing on water pollution control staff" in New Zealand and the fines would be a backup for those who fell into the second category of polluters.[81]

The Water Pollution Bill had made provision for people or companies who had been regularly discharging pollutants into waters to be given a two year period of grace during which they could continue to discharge the same wastes at the same rate. During this time they would be able to install treatment plants. Jago had

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[76] Clean Waters Act, 1972, Section 16(6).

[77] Mr. Jago, Water Pollution Bill, Second Reading, Legislative Assembly, 12th April, 1969.

[78] quoted in Bates, Environmental Law in Australia, p160.

[79] Moore & Wright, 'Water and Waste', p9.

[80] Annmarie Walsh, 'The Political Context', in Virginia Tippie & Dana Kester, eds, Impact of Marine Pollution on Society, Praeger,Mass., 1982, p3.

[81] Mr. Jago, Clean Waters Bill, second reading, Legislative Assembly, 4th November 1970.

explained that extensions to that two years would inevitably be necessary.[82] This two years or more exemption was a particular source of public complaint. The meeting of harbourside councils conservation and anti-pollution groups expressed their concern about it. This was time enough, a Bankstown Aldermen claimed, for pollution to kill the rivers.[83]

Jago argued that immediate implementation of the Act's provisions were impracticable because industry "could not possibly cease operating as suddenly as that without disrupting the economy and other problems associated with drastic action of this kind.[84] The bill was amended, however, to ensure that, where a suitable alternative to disposal into a waterway was immediately available, such as discharge into the sewers, the discharger would not be given the two years exemption. On the other hand there was still provision for some industries to be given extra time beyond the two years.[85]

The opposition, whilst not disagreeing with the general thrust of the legislation which represented a compromise between environmental protection and the protection of industrial interests nevertheless opposed the clause granting two years exemption to polluters. They pointed out that it was already nineteen months since the water pollution bill was first introduced and even before that the various laws did not permit many of the discharges that would now be given a two year exemption.[86] These polluters would not do anything about cleaning up their act till the two years had expired. The opposition wanted the blanket exemption to be replaced by individual discretionary exemptions when circumstances merited them and the details of these exemptions to be published. The opposition also did not like the escape provision in the Act which allowed the Minister to exempt people or premises from the provisions of the Act.[87]

The State Pollution Control Commission incorporated the attitude of compromise implicit in the legislation. It stated its environmental control philosophy in 1975 as being based on "balance".

> the Commission seeks to find a balance between environmental, social and economic factors. It does not demand that the environmental factors shall transcend the other factors, but it does demand that they shall receive adequate and balanced consideration[88]

The flexibility of NSW legislation can be contrasted to that of Victoria. In a 1978 case in Victoria (*Phosphate Co-operative Co of Australia Ltd v Environmental Protection Authority*) the High Court ruled that only environmental considerations could be taken into account in determining licence conditions for discharge of wastes. Technical and financial burdens of the licence holder were deemed to be irrelevant. Similarly in the case of *Tarrant v. State Electricity Commission of Victoria,* where the action involved a government authority, the

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[82] Mr. Jago, Water Pollution Bill, second reading, Legislative Assembly, 12th April 1969.
[83] Telegraph, 11th June 1970.
[84] Mr. Jago, Clean Waters Bill, second reading, Legislative Assembly, 4th November 1970.
[85] ibid.
[86] Mr. K.J.Stewart, Clean Waters Bill, second reading, Legislative Assembly, 4th Nov. 1970.
[87] Mr. K.J. Stewart, Clean Waters Bill, In Committee, Legislative Assembly, 11th Nov. 1970.
[88] SPCC, Annual Report, Year Ended 30 June 1975, p15.

Environment Protection Appeal Board rejected evidence relating to the economics and politics of the proposal. It stated that "mere financial hardship" was not a valid reason for "failure to comply with conditions designed to protect the environment against pollution..." [89]

Thus in Victoria, it is only at the stage of working out overall environmental quality objectives, that economic factors can be taken into consideration. Once those objectives are set, they must be applied to all individual licence applications.[90] The courts have ruled that the function of the Environmental Protection Authority "is not to minimise pollution to the extent consistent with maintenance of the existing or some other level of industrial and commercial activity"[91] and that the objective of their Act was to require decisions to be made on licensing of discharge waste "only from the point of view of protection of the environment". This is markedly different from the attitude adopted by the SPCC in NSW.

More recently, the NSW Environment Planning and Assessment Act, 1979, has followed a similar compromise approach to that inherent in the Clean Waters Act. The Principles in the legislation state;

> If, however, the Environmental Impact Statement suggests that the proposal should be rejected or curtailed on environmental grounds, there are other factors which must be considered. Such a decision should only be taken after it has been determined that the unavoidable detrimental considerations outweigh the beneficial considerations, after taking into account the pertinent social and political factors as well as the environmental factors.[92]

STACKED COMMITTEES AND WEAK ADMINISTRATION

The compromise with polluters, both industrial and government, was incorporated in the administrative structure of the Clean Waters Act. It was to be administered by the Minister for Health with the assistance of an advisory committee. The Clean Waters Advisory Committee would have representatives from government and industry including the Director General of Public Health or his delegate (chair) and representatives from the Department of Public Works, the Chief Secretary's Department, the Water Conservation and Irrigation Commission, the Maritime Services Board, the Sydney Water Board, the Local Government Association, the Shires Association, primary industry, secondary industry, the Hunter District Water Board, the State Planning Authority of NSW, conservation interests and recreation pursuits and also two technical experts. All members would be appointed.[93] The committee would make recommendations and advise on classifications.[94]

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[89] D.E.Fisher, Environmental Law in Australia: An Introduction, University of Queensland Press, p181.

[90] Bates, Environmental Law in Australia, pp157-8.

[91] Fisher, Environmental Law in Australia, p182.

[92] quoted in Robert J Fowler, Environmental Impact Assessment, Planning and Pollution Measures in Australia, Australian Govt Publishing Service, Canberra 1982, p55.

[93] Mr. Jago, Clean Waters Bill, second reading, Legislative Assembly, 4th November 1970.

[94] Mr. Jago, Water Pollution Bill, second reading, Legislative Assembly, 12th April, 1969.

The composition of the advisory committee ensured a conservative bias and, as the opposition argued at the time, consisted of a majority of polluters of the State's waterways.[95] The groups represented, the opposition claimed, had a vested interest in pollution. The Water Board was particularly singled out as "the greatest single polluter of our waterways and water".[96] The representatives on the Advisory Committee might be dedicated and devoted but as public servants they were bound by the terms of their employment and by ministerial directions.[97]

Despite the distortions and compromises inherent in the composition of the Advisory Committee the government ensured that the powers of the Committee remained subordinate to the government and another criticism of the Clean Waters Legislation was that the Committee would only have "fairy floss powers" and could only recommend and report.[98] It has been argued that the Committee was in fact intended merely "to act as a coordinating mechanism between government departments."[99]

Disputes were to be settled by the Premier with no right of appeal. At the time the premier was also Treasurer and ministerial head of the water board and the opposition doubted that he would be likely to take sides against the Water Board, especially if a large sum of money was required to prevent pollution from the Board's primary treatment plants.[100] The opposition had contented that the Premier was basically concerned with financial costs and therefore he should not have the final say.[101]

When the State Pollution Control Commission was set up shortly afterwards the government was again careful to maintain control. The State Pollution Bill was introduced into the State Parliament at the end of 1970 by the Liberal Premier, Mr Askin. The bill provided for the setting up of an organisation which would have a supervisory, advisory and coordinating role with respect to pollution control, waste disposal and environmental protection and would be responsible to the Premier. It would also set environmental standards to be met.[102]

Askin referred to the "growing awareness of the the serious problems posed by the contamination of the environment[103] and at the second reading quoted President Nixon and referred to the forthcoming United Nations Conference on Human Environment which was to be held in 1972. He spoke of Australia benefiting from overseas experiences in order to avoid mistakes made elsewhere. The establishment of a State Pollution Control Commission (SPCC) would be the

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95 K.J. Stewart, Clean Waters Bill, second reading, Legislative Assembly, 4th November 1970.

96 Mr. Cahill, Clean Waters Bill, second reading, Legislative Assembly, 5th November 1970.

97 Mr. Petersen, Clean Waters Bill, in committee, Legislative Assembly, 10th November 1970.

98 F.J.Walker, Clean Waters Bill, in committee, Legislative Assembly, 10th November 1970.

99 Clark, 'The Philosophy of Australian Water Legislation', p14.

100 Mr. Cahill, Clean Waters Bill, second reading, Legislative Assembly, 5th November 1970.

101 Mr. Petersen, Clean Waters Bill, in committee, Legislative Assembly, 10th November 1970.

102 Mr. Askin, State Pollution Control Commission Bill, Introduction, Legislative Assembly, 19th November 1970; Mr. Askin, State Pollution Control Commission Bill, second reading, Legislative Assembly, 24th November 1970.

103 Mr. Askin, State Pollution Control Commission Bill, Introduction, Legislative Assembly, 19th November 1970.

main feature of a "coordinated and vigorous attack on pollution in all its forms."[104]

The SPCC would not take over from any authorities already dealing with pollution but merely oversee these activities. It would achieve its purposes through cooperation with these authorities although it would have certain powers to direct them "in appropriate circumstances".[105] There were no sanctions or penalties for non-compliance with SPCC directives and it was envisaged that disputes would be settled by the Premier and enforced at ministerial or Cabinet level.[106]

The Commission would have twelve members; the under secretary of the Department of Health, the under secretary of the Department of Local Government, the President of the Water Board and nine government appointees; a chairman, director and representatives of Local Government, the Shires Association, primary industry, secondary industry, commerce, conservation and recreation.[107] As in the debate over the Clean Waters Act, the opposition argued that the members of the Commission represented the main polluters and objected to the lack of power that the Commission and its advisory committee would have as well as the "paltry" fines of $1000 for transgressors of the legislation.[108]

There was also public criticism of the SPCC, after it was set up, for being heavily weighted towards government and business interests with no representation from unions, women's groups nor conservation lobbies.[109] The Commissioners were described as being "drawn from influence-wielding sectors of society". Apart from the legislated industrial representatives on the Commission the actual choice of members by the government reinforced this tendency. The first Commission had a director who had previously been a Director of Caltex Oil Company and Manager of A.O.R. oil refinery and even the Commissioner who had been appointed to represent conservation (disowned by the conservation movement) was NSW Manager of ICI (a major multinational chemical company) and Director of other chemical and plastics manufacturers.[110]

The opposition had argued that the Advisory Committee for the Clean Waters Act should have been made up of technical experts from a variety of disciplines such as zoologists, biologists, chemical engineers, ecologists, and oceanographers.[111] It was suggested that civil and mechanical engineers should be avoided since they were the ones responsible for existing sewerage outlets.[112] The subject of water pollution was technically complex and required scientific

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104 Mr. Askin, State Pollution Control Commission Bill, second reading, Legislative Assembly, 24th November 1970.

105 ibid.

106 ibid.

107 ibid.

108 ibid.; Mr. Askin, State Pollution Control Commission Bill, Introduction, Legislative Assembly, 19th November 1970

109 Sydney Morning Herald, 25th October 1973.

110 Butlin, Sydney's Environmental Amenity, p35.

111 K.J. Stewart, Clean Waters Bill, second reading, Legislative Assembly, 4th November 1970.

112 K.J. Stewart, Clean Waters Bill, in committee, Legislative Assembly, 11th November 1970.

people rather than administrators that did not know what they were administering.[113] The government responded to this criticism by claiming that most of Australia's pollution experts were within government departments such as the Water Board[114] and that the government was following a world-wide trend in bringing the people who are principally involved into an advisory position.[115]

Nevertheless the SPCC legislation tried to combine expertise with government interests. It was to be advised by a technical advisory committee which was to be chaired by the SPCC director. The sixteen other members would be government appointees and would include officers from the Departments of Agriculture, Decentralisation and Development, Motor Transport, Public Health, Public Works, Conservation (or the Water Conservation and Irrigation Commission or the Soil Conservation Service) and the National Parks and Wildlife Service and the Chief Secretary's Department as well as representatives from the Metropolitan Waste Disposal Authority, the Water Board, the Maritime Services Board and the State Planning Authority and also a health inspector and three other persons with professional or technical qualifications.[116]

Before the SPCC was established in June of 1971 a general State election resulted in both parties promising to form a super-department to coordinate all environmental policies and activities so that when the SPCC finally got off the ground there was a Minister for Environmental Control and a Department of Environment which had similar powers of supervision and coordination as the SPCC. This not only created confusion and uncertainty but also encouraged a competitive approach to pollution control.[117]

The Minister for Environment Control made the SPCC dependent on the Department of Environment for funding and staff and the SPCC "was prevented effectively from building up its administrative arm".[118] The SPCC in turn complained publicly that it had insufficient funds to be able to carry out its responsibilities.[119] In its first annual report the SPCC argued for more centralised administration of pollution control legislation

> Legislation relating to environmental control in New South Wales is fragmented and a number of authorities administer it. The proper evaluation and control of environmental problems of significance almost always involves more than one public authority.[120]

In turn the Minister for Environmental Control, Mr Beale, complained that he was unable to recruit sufficient staff for his department and although his department was supposed to control all anti-pollution legislation, the Health Department administered the air and water pollution legislation and he had

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113 Mr Haigh, Clean Waters Bill, second reading, Legislative Assembly, 5th November 1970.

114 Mr Coleman, Clean Waters Bill, second reading, Legislative Assembly, 5th November 1970.

115 Mr Jago, Clean Waters Bill, in committee, Legislative Assembly, 10th November 1970.

116 Mr Askin, State Pollution Control Commission Bill, second reading, Legislative Assembly, 24th November 1970.

117 Butlin, <u>Sydney's Environmental Amenity</u>, p31.

118 <u>ibid.</u>, p31.

119 <u>Sydney Morning Herald</u>, 24th November 1972.

120 S.P.C.C., <u>Annual Report</u>, Year Ending 30 June 1972, p9.

been unable to get the staff of the Health Department who were engaged in this work under his control.[121]

The Telegraph took this opportunity to criticise the lack of action that had occurred with regard to water pollution by highlighting the condition of the Alexandra Canal into which, they claimed, 80 firms legally dumped 40 million gallons of waste every week including oil, acid, detergent, sludge, chemicals, tar and sewage.[122]

> because of the State Government's division of authority on pollution control between his [Beale's] department, the Health Department and the Public Works Department, Mr Beale can't do a damn thing about it.[123]

In October of 1972 the SPCC was forced, upon instructions from Beale, to limit its activities and powers.[124] This followed the appointment of the Director of the SPCC, Mr Coffey, to the head of the Department of Environment, a move which would have given the SPCC a certain amount of power over the Department. Beale claimed his directive was made because he wanted the SPCC to concentrate on its supervisory and clean-up role. Other theories put forward by the Herald are that the SPCC was regarded as a failure or that the SPCC was a threat to cabinet because of its powers to direct other departments to take action with regard to pollution.[125]

Beale had suggested the reconstitution of the SPCC into two bodies, one would be more widely representative of the community though having fewer powers and the other would be a proposed Ministry for Environment Control which would take over the advisory and regulatory functions of the SPCC.[126]

Very similar problems were being experienced in Victoria at this time which point to the problem being a general one rather than specific to the SPCC. In Victoria the Environmental Protection Agency was being being hamstrung by the Ministry of Conservation and was experiencing losses of staff, a lack of financial resources and interference from the Ministry which was usurping staff and resources. Such moves were impeding the ability of the regulatory agency to be effective in protecting the environment.[127]

In Victoria the Head of the Environmental Protection Agency (EPA), Alan Gilpin, was forced out of his position by the government of the day. In NSW Beale announced his retirement amidst rumours that he was tired of heading a department without any significant power. The Herald suggested, in an article headlined "Portfolio Without Power", that Beale was able to pressure the government into setting up a small Ministry of Environment Control by

121 Sydney Morning Herald, 25th November 1972.
122 Telegraph, 27th November 1972.
123 ibid.
124 Butlin, Sydney's Environmental Amenity, p31.
125 Sydney Morning Herald, 25th October 1973.
126 ibid.
127 Peter Russ & Lindsay Tanner, The Politics of Pollution, Visa, 1978, ch 2.

promising to go quietly at a time when the government "did not want a row over such a touchy issue as the environment with an election not far off."[128]

The Herald suggested that the Government had tried to satisfy two completely opposite political lobbies, big business and the environmentalists both of which were perceived, at the time, to be Liberal voting groups.[129] It had instituted the structure for environmental reforms to please the conservationists but had not actively utilised that structure for fear of displeasing industry.

> In an attempt to appear to reconcile the irreconcilable, the Government erected a facade of environment legislation which, in reality, was a portfolio without power.[130]

Beale was replaced by J.B.M Fuller, previously Minister for Decentralisation and Development for many years, and Fuller was given the new title of Minister for Planning and Environment. The change of title from Environmental Control to Planning and Environment signified the desire to bring economic considerations within the embrace of environmental protection.

Shortly afterwards the Planning and Environment Commission Act was passed and the Department of Environment was abolished to be replaced by the NSW Planning and Environment Commission. The Act moved the staff administering the Clean Air and Waters Acts into the SPCC, thus reinforcing the SPCC's central role in pollution control and giving it direct control over the anti-pollution legislation. The Planning and Environment Commission would plan for the future environment whilst the SPCC looked after existing environmental problems.[131]

Today the SPCC retains its centrality in pollution control whilst the Department of Environment and Planning became the Department of Planning when the new Liberal State Government gained power in 1988.

CLASSIFICATION IS SUBVERTED

When the Clean Waters Act and Regulations came into force at the end of 1972 six classifications for waterways were prescribed:[132]

S - Specially Protected Waters
: no waste discharges permitted, impounded waters for public water supply, waters in the vicinity of an intake point for potable supplies, waters originating in nature reserves and national parks and in places of scientific interest.

P - Protected Waters
: waters flowing into potable supplies, adjacent to oyster leases, tidal enclosures for public swimming, ocean-beach pools and similar recreational

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[128] Sydney Morning Herald, 25th October 1973.

[129] ibid.

[130] ibid.

[131] S.P.C.C., Annual Report, Year Ended 30 June, 1974; Butlin, Sydney's Environmental Amenity, pp31-2.

[132] S.P.C.C., An Atlas of Classified Waters in New South Wales, S.P.C.C., January 1980, pp2-3.

areas, sensitive aquatic environments, waters flowing through parks and reserves.

C - Controlled Waters
waters which may eventually flow into public water supplies, large well flushed estuarine zones.

R - Restricted Waters
waters not used for domestic water supply, waterways affected by extreme variations in flows, to be safeguarded for recreational purposes and to ensure conservation of aquatic life and water-associated wild life.

O - Ocean Outfall Waters
unconfined coastal waters into which no wastes are to be discharged that might adversely affect beaches or marine life or that contain visible grease, oil or settleable matter.

U - Underground Protected Waters

In its first report in 1973, the Clean Waters Advisory Committee stated that classification of waters was a prerequisite for the granting of licences. The function of classification was to provide guidelines for specifying licence conditions and effectively to provide "a management plan for the waters classified". The most polluted waters would therefore be classified first.[133] Another writer has put the importance of classification more bluntly;

> The classification attached to a waterbody determines, to a large extent, the degree to which it can be legally polluted.[134]

The government had argued that water classifications could be upgraded as a particular river or waterway was cleaned up. No waters, they promised, would be given over completely to waste disposal as their exclusive use.[135] New Zealand had spent 17 years classifying 18 areas and the NSW government hoped to learn from this and stated that they intended to complete classification within 5 years.[136] However this resolve gradually faded. The SPCC reported in 1974 that classification work had been delayed because priority had been given to approvals and investigations which were necessary for immediate waste control but the long term necessity of classification for determining licence conditions was reaffirmed.[137]

> efforts have been concentrated on the control of pollution sources rather than on the detailed monitoring of water quality. It was accepted that the quality of many streams required improvement, and concentration on control of sources was considered to be the most effective line of action[138]

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133 Clean Waters Advisory Committee, Annual Report , Year ended 30 June, 1973, p6.

134 C. Joy, `Management Policy and Practice' in C.Joy, W.Hickson and M.Buchanan, Liquid Waste Management, Botany Bay working paper no 2, Canberra, 1978, p60.

135 Jago, Clean Waters Act, second reading, Legislative Assembly, 11th November 1970.

136 Jago, Clean Waters Act, second reading, Legislative Assembly, 4th November 1970.

137 SPCC, Annual Report, Year Ended 30 June 1974, p32.

138 ibid., p28.

At the end of 1975 new regulations were introduced which made it an offence for anyone to discharge wastes into waters without a licence whether or not those waters were classified.[139] In their 1975 annual report the SPCC nonetheless claimed that water classification was a "fundamental concept of the Clean Waters Act". Priority was still being given to the most polluted waters and classification for polluted waters would be aimed at restoring "lost uses, such as swimming and other recreational activities."[140] The job of classifying waters was also transferred from the Clean Waters Advisory Committee to the SPCC, although the classification would still be approved by the Clean Waters Advisory Committee.

As late as 1977 the Clean Waters Advisory Committee was emphasising the importance of classification of waters as a means of "providing a statutory framework around which the Commission may formulate plans for the protection of waters".[141] Nonetheless classification was virtually abandoned in 1979. The SPCC claimed that the work of classification was labour intensive and could not be continued in the face of staff cutbacks. Classification, they said, was unnecessary since licence conditions could be and were set for unclassified waters.[142] Although the Georges River, Cooks River and Alexandra Canal were classified by this time, the Parramatta River, Botany Bay and Sydney Harbour remain unclassified despite the fact that a draft classification scheme for the Parramatta River and Sydney Harbour was presented to the Clean Waters Advisory Committee in 1978.

The labour intensity of the classification process is difficult to understand if the purpose of classification is taken literally. It would seem to be a simple matter to determine what uses a waterway was being or would be used for, whether it was used for drinking water, whether people fished or swam in it etc. In fact classification depended not just on the use of the waterway, it involved judgments regarding amenity values, costs, benefits, equity and a reconciliation of conflicting interests.[143]

Classification reflected objectives that could "realistically" be achieved in the opinion of those working out the classifications. If a waterway was polluted from sources the SPCC officers felt they could not remove or prevent then they would classify it so that the water quality standard would not require what they felt was an unrealistic task.[144] Moreover, if the effluent of a sewage plant was going into a stream and there was no where else for it to go then the classification would have to allow for this.[145]

For example a draft proposal for general guidelines for the classification of inland waters considered the implications of classification. It pointed out that

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139 SPCC, Annual Report, Year Ended 30 June 1975, p55.

140 ibid., p67.

141 Clean Waters Advisory Committee, Bacteriological Criteria for Waters Classified Under the Clean Waters Act, Business Papers, 8th September 1977, p49.

142 correspondence, W.G.Hicks, S.P.C.C., to Richard Gosden, S.T.O.P., 30th June 1987.

143 Joy, `Management Policy and Practice', p60

144 interview with Tony Farrugia, Senior Investigations Officer, Chemicals Branch, SPCC, 15th April 1987.

145 interview with Russel Cowell, Officer-in-Charge, Water Investigations & Acting Senior Scientist, Water, SPCC, 7th April, 1987.

only class P (Protected) waters could flow into class S (Special) waters and that whilst it might be desirable to classify the waters in a National Park as S this would require all waters upstream to be P. Since national parks might be downstream from a number of discharges that would preclude a P classification, then the National Park rivers affected would have to be classified P rather than S, a necessary downgrading.[146] The logic of classification had therefore been reversed in the first few years of its operation so that instead of licensing discharges to fit classifications based on usage, the classifications were being worked out to fit in with existing discharges.

A further example of the distortion of the classification process was manifest when the classification for the Sydney Harbour Drainage Basin was presented to the Clean Waters Advisory Committee in 1978. It provided for the freshwater reach of the Parramatta River to be classified C (Controlled) in recognition of the improved conditions of the river since many industrial discharges had been diverted to sewer. The rest of the river and most small watercourses draining into the estuarine waters of the Sydney Harbour basin were classified R (Restricted) which was the lowest classification available for rivers. The draft report said

> The major factors influencing the assignment of 'restricted' classification has been dry weather water quality and the capacity of waterways to assimilate wet weather discharges.... That section of the Lane Cove River that has been classified as 'restricted', receives large inputs of urban drainage as well as sewer overflows, which together cause substantial depletion of dissolved oxygen for periods of up to ten days after wet weather. Oxygen content in waters of this section of the river often fall to levels which are not capable of sustaining aquatic life. This classification makes due allowance for these occurrences, and the fact that this part of the river forms a closed-end estuary, but ensures that the waters are suitable for other beneficial uses.[147]

The report included in appendix the effects the proposed classification was likely to have on licensed discharges in the region providing an indication that the issuing of licenses without classification was not necessarily the same as the issuing of licences after classification. Each licence change was accompanied by a note about the ability of the company affected to accommodate the change. Some were diverting their wastes to sewer. [148] Although this classification scheme was drawn up by the SPCC staff and recommended by the Clean Waters Advisory Committee[149], and although the Parramatta River had been publicly given priority in 1974,[150] this classification scheme was never implemented and the area remains unclassified.

Since, according to the report, the proposed classification was not going to seriously impact on private firms discharging into the waterways, one must

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[146] Draft Proposal for the Classification of Inland Waters, presented at Clean Waters Advisory Committee Meeting, 11th August 1977.

[147] Classification of the Sydney Harbour Drainage Basin, presented at Clean Waters Advisory Committee Meeting, 9th March 1978, p25.

[148] ibid., pp29-31

[149] minutes, Clean Waters Advisory Committee Meeting, 9th March 1978.

[150] SPCC, Annual Report, Year Ended 30 June 1974, p30.

assume that it was the Water Board which objected to the proposed classification because of their sewage overflows which would not have been able to meet some of the higher classifications in the upstream areas of the drainage basin.

Similarly a proposed classification scheme for Botany Bay was drawn up for Botany Bay that made the major part of the Bay Class C (controlled) with Quibray Bay Class S (special) and Woolooware Bay as well as enclosed swimming areas Class P (protected). The Clean Waters Advisory Committee recommended that the classification be adopted, in 1979, subject to the SPCC checking with the Federal government about the classification of Weeny Bay (that included Commonwealth land) and subject to discussions with the then Planning and Environment Commission "in view of that Commission's interest in the area."[151] Botany Bay was never classified.

It appears that the will of the SPCC was not enough to get these critical waters classified, although just at what level the interference came from is not clear. Classification was not in the interests of industry, nor developers, nor government authorities who needed to use the waterways for waste disposal. In the latter category, the main Sydney authority that uses the waterways in this manner, the Sydney Water Board, has not only to dispose of treated sewage but also to use the waterways as sewer overflow points during wet weather. In 1985, for example, it was suggested at a Clean Waters Advisory Committee Meeting that the conditions for waters classified P should be relaxed to permit the installation of sewer overflows, where necessary, in developing areas.[152]

It seems that usage of the waterway was being interpreted as including usage for disposal purposes[153] and SPCC officers were spending much of their time and effort determining a compromise water quality standard that they thought could be achieved, that industries could accommodate and that didn't permit any obvious degradation of the waterway. It seems that it all proved too difficult and that it certainly wasn't possible using the given classifications. Moreover given the meandering of the classification process from its original purpose, it is little wonder that the SPCC found it to be an irrelevant process.

The SPCC claims that in the absence of classifications it nevertheless still sets standards for the water quality to be achieved in each waterway. The problem is that the process is no longer public and although polluters can object to the terms of their licence there is no longer any provision for the public to know or object to the water quality standards that are being set for various waterways. In 1977 the Clean Waters Advisory Committee had stated that classification could be interpreted as "a declaration of the Commission's intention to provide a specified degree of protection for a particular waterway".[154] By 1980 the SPCC had decided not to declare such intentions.

Classification was a way of publicly stating the maximum environmental cost that would be borne in catering for waste disposal. Each classification had to be proposed and publicly advertised before adoption. Any person was able to lodge

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151 minutes, Clean Waters Advisory Committee Meeting, 8th February 1979, pp3-4.

152 minutes, Clean Waters Advisory Committee Meeting, 12th September 1985, p10.

153 ibid.

154 Clean Waters Advisory Committee, Bacteriological Criteria, p49.

an objection to the proposed classification and the objections were to be heard by a Clean Waters Appeals Board.[155] As the classification process came to a halt the Appeals Board was dismantled.

Standards can be regulated in various ways. Standards can be incorporated in the law but this would require uniform standards and would offer minimum flexibility. Moreover it would still require a system of policing and prosecution. Alternatively the law can delegate responsibility to some institution that would create and enforce standards. "The Australian system is characterized by the conferment of discretionary controls upon public institutions".[156]

The abandonment of classification in NSW has increased the discretionary powers of the SPCC. Even with classification the SPCC had wide discretionary power in setting licence conditions. Classification merely set a minimum standard for guidance.[157] Without classification even that guidance is gone and SPCC can be completely flexible. They are able to differentiate between industries on the same waterway and change the water quality criteria rapidly and without consultation.[158]

This serves to centralise power in the SPCC. It can be argued that this is advantageous because the SPCC can then accumulate expertise in pollution control and improve standards[159] but given the lack of independence of the SPCC from government their effectiveness depends very much on policy priorities of the government of the day[160] and given the composition of its membership, their ability to be rigorous with industry is limited.

If the SPCC fails to act against a polluter a private citizen requires the consent of the relevant Minister or the Director of the administering authority or the S.P.C.C. or some authorised person before they can institute legal proceedings.[161] The role of the public in pollution control is therefore severely limited under the existing legislative system as it now operates. The two usual avenues for involvement in licensing and approval procedures are the provision for public submissions or third-party appeals but these are not available.[162] Representation on committees is limited to government, industrial and commercial interest with few exceptions and so the only opportunity to have a say is through submissions which can be made when environmental impact statements for proposed developments are displayed or by invitation, which is at the discretion of the government and issued only to selected individuals.[163]

Public participation is therefore confined to the planning of new developments. Pollution control has therefore "been implemented in a relatively closed administrative system, to which the public has been allowed either limited or no

155 ibid., p50.

156 Fisher, Environmenal Law in Australia, p170.

157 Haigh, Pollution in NSW, p15018.

158 interview with Derek Lowe, engineer, Clean Waters Branch, S.P.C.C., 15th April 1987.

159 ibid.

160 Coward, Environmental Law in Sydney, p57.

161 ibid., p58.

162 Fowler, Environmental Impact Assessment, Planning and Pollution Measures in Aust., p164.

163 Bates, Environmenal Law in Australia, p156.

access."[164] This reinforces a view that pollution control is an activity that requires specialist regulation and expert attention.

> Given also the difficulties associated with legal recourse to the courts to resolve environmental problems, it is clear that administrative action in the field of environmental protection enjoys a relative broad immunity from public scrutiny.[165]

Robert Fowler, who reported for the Federal Department of Home Affairs and Environment on environmental legislation, argued that this immunity from public scrutiny has fostered a 'co-operative' approach in the administration of environmental controls and he questions whether such an approach has been satisfactory. He argues;

> The feeling is engendered by current licensing procedures and practices that only rarely will applications be absolutely refused, and that the principle aim of the technique is to conduct negotiations on a co-operative basis concerning the conditions which may be annexed to each licence. In such cases, there is no inducement for industries to seek to reduce their emissions below the levels achieved through compliance with the licence conditions, even should this become technically feasible.[166]

This affect of this preference for a cooperative approach rather than a confrontational or strict enforcement approach is reinforced in the case of public authorities that pollute because of the provision in the legislation for directions by the SPCC to a body such as the Sydney Water Board to be subject to the overriding discretionary judgement of the Premier. In this way public authorities have "a form of political appeal in relation to public authorities which may be more sympathetic that the conventional appellate system to which private developers must resort."[167]

STANDARDS, GOOD PRACTICE AND COMMUNITY DESIRES

Varying approaches can be taken with respect to environmental and pollution control standards. One approach is to concentrate on ensuring that all polluters install the "best available" or "best practicable technology". This latter is technology that is readily available and can be economically installed, that is installed by a business without destroying its profitability. In the United States the 'best available technology economically achievable' is the approach adopted by their Environmental Protection Agency.[168] This means that in the United States controls are uniform on various industries and make no allowances for the condition of watercourses into which the effluent will be going. [169]

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164 Fowler, Environmental Impact Assessment, Planning and Pollution Measures in Aust., p212.
165 ibid., p218.
166 ibid., p218.
167 ibid., pp162-3.
168 Joy, `Management Policy and Practice', p64.
169 ibid., p60.

The other approach is to regulate by setting effluent standards and allowing polluters to meet those standards in any way they see fit. Within this approach either uniform or ambient emission standards can be set. Uniform emission standards can be set for the waste streams of all industries wherever they are located and whatever their financial position. Ambient emission standards, however, are standards that vary according to the existing environmental conditions in the local area. The existing environmental conditions may include biological properties of the area, the uses to which the waters are put, and the actual despoiling that has already been suffered; a degraded area warranting less protection than a pristine one.[170]

Classification, and de facto classification, as exists in New South Wales uses the ambient emission approach so that different industries have to conform to different standards depending on where they are located. Similarly sewage effluents on inland waterways must be of a higher standard than sewage effluents going into the sea. Such an approach is more flexible than uniform or maximum standards and allows the SPCC to take account of financial, political and technical limitations when setting licence conditions.[171]

A uniform standard is more equitable and simplest to administer but is thought to impose 'unnecessary' costs on government and industry.[172] The NSW approach by considering the "relative assimilative capacities" of different waterways allows polluters to save money and use less than the best practicable technology in some situations. Environmental protection is therefore a goal mediated by what is considered to be "realistically achievable" and "realistic" is defined by economic considerations.

The setting of ambient emission standards incorporates three levels of objectives. The first are community goals which incorporate objectives for waterways in qualitative terms such as "suitable for swimming". These community goals can be translated into water quality standards that can be expressed quantitatively in terms of concentrations of pollutants. To achieve water quality standards, emission or effluent standards need to be set which specify limits for the concentrations and quantities of pollutants for each waste stream entering the waterway.[173]

In New South Wales there is no mechanism for translation of community goals into water standards except indirectly through the political process of elected governments directing the State Pollution Control Commission. Thus, whilst the economic cost of cleaning up polluted water or preventing further deterioration of waterways is taken into consideration, they are not adequately balanced against the amenity values that various users (and future potential users) attach to a particular waterway and this means the evaluation of the benefits of clean waters can be underrated.[174]

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170 Bates, Environmental Law in Australia, p162.
171 ibid., p163.
172 Clarence Davies, The Politics of Pollution, Pegasus, 1970, p156.
173 ibid., p153.
174 Joy, `Management Policy and Practice', p64.

If the public is denied input into the legislative process, and this has certainly occurred since classification ceased, then levels of pollution that are determined to be 'acceptable' are based on judgements of public servants in negotiation with industry and government authorities. Moreover, classification (and its de facto confidential replacement) can be considered to be merely a holding operation since water quality standards tend to be based more on existing standards and their protection or slight improvement rather than on ultimate goals for water usage.

The second translation, from water quality standards to effluent standards is also problematical and is not a simple matter of mathematics or analysis. A number of assumptions and value judgements need to be made and usually what ends up happening is that effluent standards tend to be based on "good practice" rather than being directly related to water quality criteria. [175]

"Good practice" implies the use of currently available pollution control technology that can be economically installed. Effluent standards are therefore arbitrary in that they are seldom related to water quality except that in cases where the waterways have a low classification, something less that "good practice" or "best practicable technology" can be required. This is what happens in NSW and "best practicable technology" is defined as technology that is already used in other countries, particularly the U.S., Europe and N.Z.[176]

THE IMPACT OF LEGISLATION ON ENGINEERING DECISIONS

The reliance of the legislation on best practicable technology and the preponderance of engineers in the SPCC, who decide what the best practicable technology is, means that the sewerage treatment paradigm is reinforced rather than challenged by the law and its agents. In practice, when the SPCC is dealing with sewage effluents in various parts of the state, they inform the relevant authority of the water quality objectives that they would like to achieve downstream of the treatment works (generally given in terms of BOD and suspended solids concentrations) and leave it up to the authorities themselves to install the appropriate equipment to achieve the desired water quality objectives.[177]

In Sydney the licences for the Water Board's main ocean outfalls indicate required treatment technologies rather than effluent quality. For example the Malabar licence states that the Water Board may discharge up to 650 ML/day in dry weather conditions and that this flow "shall receive screening, degritting and primary treatment". The only requirements in terms of effluent quality are that non-filtrable residue in the primary treated effluent should be not less than 0.4 in 50% of samples and that samples should contain less than 40mg/l of grease and oil in 50% of samples and less than 60mg/l of grease and oil in 90% of samples. There are no limits on Biochemical oxygen demand, toxic waste, bacterial or viral concentrations set down in these licences.[178]

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[175] Clarence Davies, The Politics of Pollution, p155.

[176] interview with Derek Lowe, engineer, Clean Waters Branch, S.P.C.C., 15th April 1987.

[177] ibid.

[178] licence for Malabar S.T.P., in force until 1st May 1989.

For the North Head sewerage treatment plant, where primary treatment is not carried out, the licence conditions are relaxed accordingly. They specify only that the flow needs to receive screening, degritting and scum removal. There are no conditions on grease or non filtrable residue levels.[179] The licence conditions for Bondi are very similar to those at Malabar except that less grease and oil is allowed.[180] Presumably because there is less grease and oil in the effluent to start with.

The Board also has two other sewerage treatment plants discharging into the ocean off Sydney's coastline. At Cronulla the licence conditions do not allow sludge to be dumped and at Warriewood where secondary treatment is used, the licence conditions specify secondary treatment.[181] It is obvious that licence conditions reflect the existing levels of technology installed by the Sydney Water Board rather than water quality objectives. The SPCC are able to do this since the ocean waters have not been classified.

The power of the SPCC to act against polluters is restricted by its lack of staff. In 1987 they only had five inspectors in Sydney to check up on discharges to make sure that no one was discharging without a licence and those with licenses were keeping to their licence conditions.[182] The SPCC is increasingly forced to deal with this problem by getting polluters to monitor themselves, by putting self-monitoring conditions into the licences. In Sydney, the licence conditions for the main ocean outfalls specify what monitoring must be carried out. The Water Board has to take daily samples of primary treated effluent to check for non-filtrable residues and total oil and grease as well as quarterly samples to check for Biochemical oxygen demand, pH, hydrogen sulphide, phosphorus, faecal coliforms, Zinc, Lead, Copper and Chromium. There is no requirement for sludge to be monitored or restricted substances in sludge to be measured. Beach waters are to be checked by the Board on 5 separate days out of 30.[183]

The self-monitoring process has led to a certain amount of scepticism about this monitoring. It has been pointed out that the five samples that the Water Board is supposed to take could be taken on days of their choosing, for example when an offshore wind is blowing so that results will be good. Also readings are done during the day, whilst sludge is dumped at night.[184] The irony is, however, that the results of this monitoring do not have to meet legally enforceable standards outside of what is specified in the licences. The SPCC publishes guidelines for bathing water standards but these have no legal force. The guidelines, "Design Criteria for Ocean Discharge" are published for the benefit of polluters so that they will know the criteria the SPCC will consider in reviewing applications for licences to discharge.[185]

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179 licence for North Head S.T.P. in force until 1st May 1989.

180 licence for Bondi S.T.P. in force until 1st May 1989.

181 licences for Cronulla and Warriewood sewage treatment plants.

182 interview with Russel Cowell, Officer-in-Charge, Water Investigations & Acting Senior Scientist, Water, SPCC, 7th April, 1987.

183 for example, licence for Malabar S.T.P., in force until 1st May 1989.

184 Richard Gosden, 'Sewerside Culture', Engineering & Social Responsibility 2(2), March 1985; Sydney Morning Herald, 17th January 1989.

185 S.P.C.C., Design Criteria for Ocean Discharge, Environmental Design Guide WP-1.

The Water Board has never been keen on bacteriological standards because of the fear that they might be forced to install a higher degree of treatment than they would prefer. During 1959 when the Board was drawing up its plans for treatment at the outfalls, one of their representatives told a conference,

> In the absence of a sound basis, the arbitrary setting of a justifiably high standard for bathing water quality and/or errors of judgement in determining the form of sewage treatment required to meet the standard, could result in needless expenditure of public funds on the construction and operation of unduly elaborate sewage treatment works.[186]

Brown and Caldwell concurred a few years later when they were drawing up their own plans for treatment at Malabar, saying that the use of "unjustifiably high standards" would result in the provision of a degree of treatment which might not be necessary and this would result in an unnecessary expenditure of public funds.[187] The Board therefore did its best to ensure standards established could be met by their intended treatment and disposal technologies.

The SPCC's bathing water guidelines, often referred to as WP-1, were first drawn up after the Sydney Water Board's consultants, Caldwell Connell, requested guidelines for what conditions the proposed submarine outfalls would have to meet in order to get approval from the SPCC to go ahead. The guidelines subsequently drawn up and published in 1974 specify qualitative criteria for floatables, biochemical oxygen demand and settleable matter and quantitative levels of faecal coliforms concentrations and concentrations of several restricted substances.[188] (Faecal coliform are organisms that occur naturally in human and animal guts. The e-coli, a sub-group which is most commonly used, are usually harmless)

The faecal coliform standards were different for summer and winter. Between November and May in areas designated as bathing waters the geometric mean of at least five samples taken in a 30-day period was not to exceed 200 faecal coliform bacteria per 100ml. Also, only three samples taken during the November-May period were allowed to exceed 400/100ml. During the rest of the year the geometric mean could not be more than 1000/100ml and only three samples could exceed 2000/100ml.[189] The relaxing of standards during the winter was particularly convenient for the Water Board with their planned submarine outfalls since the submerged field could not be maintained during the winter time because of a lack of a thermoclyne when surface waters were cold. According to their own predictions pollution would inevitably be worse in the winter time.

In 1979 the Sun reported that faecal coliform tests might be out of date. Quoting "an eminent American doctor", Dr Victor Cabelli, professor of microbiology at the University of Rhode Island, and other U.S. experts they said that standard level

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186 Conference of Professional Officers Representing the Authorities Controlling Water Supply and Sewerage Undertakings Serving the Cities and Towns of Australia, Report of the Proceedings of the Ninth Conference, Melbourne, 1959, paper no 4.

187 Brown & Caldwell, Design Report: Malabar Sewerage Treatment Works, M.W.S.&D.B., July 1965, p8.

188 SPCC, Design Criteria for Ocean Discharge, Environmental Design Guide WP-1.

189 ibid.

of 200 faecal coliform/100 ml of water (the standard used for mean samples in summer in Sydney) was determined in the 1950s. Dr Victor Cabelli had conducted a study for the US Environmental Protection Agency which found that faecal coliform were not a good indicator of sewage pollution.[190]

A couple of days later the SPCC announced that it would review its testing standards for sewage pollution of Sydney's beaches after finding that faecal coliforms were not a satisfactory indicator and that health risks could not be satisfactorily evaluated in that way.[191] An SPCC report published that year as part of a study of Botany Bay on "Health Aspects of Faecal Contamination" examined the question of using faecal coliforms as an indicator. It noted that the detection of pathogens and their identification was an expensive and time consuming process and the difficulties involved had lead bacteriologists to adopt the concept of indicator organisms.[192]

An ideal indicator would be present when pathogens were present, be easily tested for, and survive longer than enteric pathogens. The e.coli bacteria, a faecal coliform bacteria, had traditionally been accepted as an indicator of faecal pollution and intestinal pathogens in water and it had been assumed that they would survive as long as or longer than pathogens. It had since been realised that e.coli might die off more quickly than some pathogens and it had been reported in 1975, for example, that the survival times for enteric viruses were far greater than faecal coliforms. Whilst it was expected that 90% of faecal coliforms died in 30 mins to 9 hours, enteric viruses survived from 2 days to 130 days in sea water.[193]

Chlorination or disinfection made the discrepancy worse so that some bacteria might be inactivated by the disinfection but viruses might not be. Moreover another study had shown Salmonella in water containing reduced numbers of e.coli. Also the variation in mortality rates because of the effect of solar radiation on faecal coliform meant that

> distributions of pathogens from ocean outfalls and calculations of dilutions will include large errors if faecal coliform measurements are only carried out during daylight and corrections are not made for varying mortality rates.[194]

The SPCC report concluded that faecal coliforms were inadequate as an indicator of pathogens because the presence of e.coli only indicated recent contamination, the absence of e.coli would not mean an absence of pathogens and finally, decreases in faecal coliform levels didn't necessarily correspond to similar decreases in levels of pathogens, particularly viruses.[195] The SPCC noted that the earliest water quality standards for bacteria were "based mostly on

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190 Sun, 21st November 1979.

191 Sun, 23rd November 1979.

192 SPCC, Health Aspects of Faecal Contamination, Environmental Control Study of Botany Bay, January 1979, p5.

193 SPCC, Health Aspects of Faecal Contamination, p7.

194 ibid., p9.

195 ibid.

engineering feasibility rather than epidemiological and scientific data" and yet these were accepted worldwide.[196] This seems to be still the case.

The WP-1 guidelines are based on 'best practicable technology' available at the time and were drawn up by the SPCC engineers.[197] The Clean Waters Act provides for the waters at ocean outfalls to be classified 'O' for ocean outfall waters and this is the only possible classification. Yet neither the licence conditions nor the guidelines for approval of sewage treatment plants seem to conform with the requirements for class 'O' waters as defined in the Act. The Clean Waters Regulations under the Act state that wastes are not to be discharged into these waters

(1) unless the wastes are visually free from grease, oil and solids and free from settleable matter; and

(ii) where the pH value of the wastes is more than 8.5 or where the discharge induces a variation of more than 0.1 in the pH value of any waters outside the mixing zone; [198]

and yet neither the licence nor the WP-1 guidelines specify conditions for pH values of the Board's discharge. The first condition that the wastes be visually free from grease, oil and solids is translated in the licence conditions into a numerical oil and grease concentration limit which (if the licence conditions are being adhered to) nevertheless causes the sewage field to be regularly visible.[199] The WP-1 guidelines translate free from settleable matter into a condition that settleable solids will not be permitted unless the applicant can demonstrate that they will not accumulate in less than 10 metres of water or within 1 km of the shoreline and that outside this area, no "significant adverse effects on the benthos" is likely to occur.[200]

The Clean Waters Regulations go on that wastes are not to be discharged if the resulting concentration of wastes in the waters-

(i) is or is likely to be harmful, whether directly or indirectly, to aquatic life or water-associated wildlife;

(ii) gives rise or is likely to give rise to abnormal concentrations of the wastes in plants or animals; or

(iii) gives rise to or is likely to give rise to abnormal plant or animal growth.[201]

yet there are no conditions in the licences that marine life should even be monitored or that concentrations of restricted substances in the wastes should be restricted. The WP-1 guidelines say that applicants should provide some relevant information such as concentrations of restricted or other deleterious substances

196 ibid., p17.

197 Minutes, Clean Waters Advisory Committee Meeting, 10th September 1987.

198 Clean Waters Regulations, 1972 under the Clean Waters Act, 1970, New South Wales, p11.

199 for example, licence for Malabar S.T.P., in force until 1st May 1989.

200 SPCC, Design Criteria for Ocean Discharge.

201 Clean Waters Regulations, p12.

and also provides a table of allowable restricted substances.[202] These allowable levels are worked out in the absence of any scientific work on the effects of these substances in Sydney's marine waters. The few studies of marine life which have been done show that the level of restrictions stated in the guidelines do not provide the protection that the legislation requires. (more about this in chapt. 7).

The lack of consistency between the WP-1 guidelines and the Clean Waters legislation reflects the ability of the engineers to remove themselves from the legislative process which is supposed to reflect the public will as interpreted by the politicians. The engineers make their own decisions which then commit the public because of the large sums of money being spent. Such a situation ensures that the existing sewerage treatment paradigm remains unchallenged and legislation is not an effective force in the decision making process.

Moreover the weakness of the SPCC, as a regulating agency, with respect to the Board is manifest. At the end of 1979 the SPCC seemed unable to get even the most essential information from the Water Board which was supposed to be monitoring itself as part of its licence conditions. An internal report observed

> The monitoring results supplied by the Board do not lend themselves to analysis to see whether they comply with WP-1 bathing area criteria. The readings are too few for any one month. . .
> Water Board monitoring results are not currently a true indication of the level of pollutants, e.g. toxicants and heavy metals, discharged to the ocean.[203]

In 1987, the SPCC attempted to revise the WP-1 guidelines to provide guidelines for new sewerage treatment works throughout the State which take account of increased community expectations and cater to criticism leveled by environmentalists.[204] The SPCC argued that the revision was necessary because ocean outfalls were being proposed by other NSW sewerage authorities, because the community was no longer happy with looser standards for winter, and because

> The criteria apply to industrial as well as municipal discharges. The schedule of restricted substances has been publicly criticised by environmental groups and is now so outdated that it cannot be scientifically justified.[205]

This move was blocked by the Sydney Water Board. The Water Board had never been happy with the new legislation introduced in early 1970s because it impinged on their autonomy, particularly with regard to discharge of sewage, industrial waste and the installation of sewer overflows.[206] At the time they had applied for an exemption from the Clean Waters Act.[207] They did not appreciate the idea of being "subservient" to another government authority that could insist

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202 SPCC, Design Criteria for Ocean Discharge.

203 SPCC, Monitoring of Ocean Beaches for Sewage Pollution, internal report, 13th Nov. 1979.

204 Clean Waters Advisory Committee Meeting, Business Papers, 10th September 1987.

205 ibid., p25.

206 M.W.S.&D.B. Minutes, 17th September 1969.

207 ibid.

that the Board undertake work without any appreciation of the Board's other activities and responsibilities. Such an authority would be only concerned with pollution and could force the Board to place greater emphasis on "anti-pollution measures" without having any idea of the Board's other problems.[208]

The proposed introduction of new WP-1 guidelines was an example of a conflict of interest between the SPCC and the Water Board that reaffirmed the Board's power. The Sydney Water Board objected to the new guidelines even though they would not be applied to the Board's outfalls and were meant merely as guidelines for new applicants for licences. The Board's representative on the Clean Waters Advisory Committee, John Browne, said that the Board would have trouble meeting the new guidelines with their proposed submarine ocean outfalls. The Board would have problems with the aesthetic criteria, the removal of settleable matter, the protection of in-shore waters and levels of restricted substances. He didn't want the guidelines to be published till after the commissioning of those outfalls (in the 1990s) because although the Board would not have to meet them, the public would use them to re-open debate about the submarine outfalls and to try and force more treatment to be installed.[209] In other words it would have been bad for the Board's public relations.

The representative of the Public Works Department, which is responsible for sewage treatment works throughout the State, also argued against the introduction of the new guidelines. He argued that the section on restricted substances should be omitted and also feared that there would be public pressure to have existing outfalls retrofitted to meet the new guidelines.[210] The Clean Waters Advisory Committee did not approve the new guidelines and the SPCC was unable to introduce them.

It shows the extent of the power of government polluters that they are able to stop SPCC actions that are not directed at them and have no legal standing, merely because they might be bad for public relations. The old standards therefore continue to be applied to new ocean outfalls and industrial polluters throughout NSW despite being out of date because of the power of Sydney based polluters.

Such instances of conflict between the Water Board and the SPCC are fairly rare however, because both organisations employ engineers who subscribe to the same paradigm. Whilst Caldwell Connell were undertaking their feasibility study for the Water Board, the SPCC got one of their consultants, Paul Ryan, a retired university engineering professor, to do a review of the engineering literature on submarine outfalls for the purposes of informing authorities who might be considering such projects and for the SPCC's own use in assessing applications made by such authorities to the SPCC for approval under the Clean Waters Act.[211]

Ryan concluded firstly that submarine ocean outfalls were the most advanced method of ocean disposal, "they are certainly the most recent development". The

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208 ibid.; MWS&DB Minutes, 16th July 1969.

209 minutes, Clean Waters Advisory Committee Meeting, 10th September 1987.

210 ibid.

211 Paul Ryan, Submarine Ocean Outfall Sewers, undated, preface

United States, particularly California, was virtually the only place to use them. The capital cost of such outfalls was usually less than that of secondary treatment (usually activated sludge plants) and the running costs were considerably less and once built secondary treatment would be unnecessary.[212] Ryan also concluded from his review that there was no evidence "that the submarine ocean outfall sewer discharges would have a deleterious effect on marine fauna and flora" provided that certain conditions of discharge were adhered to including the "rigorous source control of toxic and other deleterious wastes".[213]

Nor is the regulatory agency necessarily a force for improved standards of effluent. In 1974, the Water Pollution Control Branch, which was then part of the Health Commission and later moved to the SPCC, reported to the Clean Waters Advisory Committee on methods of discharging of wastes into the ocean. The report looked favourably upon the discharge of minimally treated sewage through a submarine ocean outfall. This would avoid the need for sedimentation tanks and sludge digesters. They suggested that the Board's plans to install primary treatment and submarine outfalls at the Malabar, Bondi and North Head, was overly extravagant.[214]

> In the selection of any of the above alternatives for ocean discharge of wastes, it is necessary, in addition to considering the many factors involved in the protection of the beneficial uses of the receiving waters, that the alternatives be subjected to economic comparisons to arrive at the most economical proposition.[215]

Ryan, as an engineer, concurred fully with the philosophy of minimum treatment. He argued that in many cases full primary treatment with sedimentation and sludge collection treatment and disposal could be eliminated.[216] He claimed that there was a recent development in use of submarine outfalls that tended towards minimal treatment of the sewage before discharge and that this trend, together with U.K. findings that there was negligible effect on health of bathing in "sewage-diluted sea water",

> indicated a return to "common sense" in these matters which may obviate the wasteful expenditure of vast sums in the provision of uneconomic and needlessly sophisticated facilities.[217]

Thus, the SPCC was amenable to the idea of High-Rate Primary Treatment well before the Water Board finally decided to install it at North Head some years later. Decisions by the regulatory authority were therefore, neither based on "best available" nor "best practicable technology". Nor were they based on legislated standards of water quality or effluent standard. The discretion available to the SPCC and its staffing by engineers combined with its lack of

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212 ibid., p216.
213 ibid., p217.
214 Business Papers, Clean Waters Advisory Committee Meeting, 18th April 1974.
215 ibid.
216 Ryan, Submarine Ocean Outfall Sewers, p216.
217 ibid., p12.

power over other government authorities has meant that it is not an effective regulatory force and that it has virtually no influence on engineering decisions.

CONCLUSION - DIVERSION OF WASTES AND RESPONSIBILITY

Despite the various calls for a comprehensive approach towards waste management and pollution and calls for a single overall authority throughout the 1960s and early 1970s the NSW government was reluctant to give the overriding power and responsibility to a single authority and much of the existing fragmented legislation and dispersed authority was maintained despite the introduction of the Clean Waters Act and establishment of the State Pollution Control Commission.

The need for the government to consider and act upon the various environmental impacts of industrial activity became clear in the face of obvious environmental degradation and increasing public concern. But this need was never allowed to overshadow the greater need to encourage and promote industrial activity and maintain political control. This was ensured by limiting the power and funding of the pollution control authorities and biasing the composition of committees and commissions in favour of those representing industrial and government interests.

Waste management was always considered in terms of disposing of wastes rather than in terms of an overall approach which considered the whole manufacturing process and ways of reducing wastes and preventing the generation of harmful and intractable or nondegradable wastes. Since 'management' meant finding a place for waste disposal the use of waterways for disposal has been a necessary part of waste management strategy. N.G Butlin described the approach taken in Sydney as "partial prohibition", an approach which aims to "regulate the impact of wastes" on the environment.

> In short, the current administrative system does not aim to prevent in a systematic way the generation of wastes; it is oriented towards 'accepting' and coping with existing volumes of wastes and shifting partially treated volumes to different parts of the environment.[218]

Classification determined the degree to which a body of water could be polluted. The degree of pollution allowed depended very much on the judgement, made by the regulating authority, about amenity values, water use, costs, benefits, equity and reconciliation of conflicting interests. Rather than controlling pollution by insisting that industries install the "best practicable technologies", the N.S.W. approach was to allow industries to take advantage of the "relative assimilative capacities" of different waterways and use lesser technologies wherever possible.

The Clean Waters Act, in aiming to clean up waterways without harming industry, was careful to minimise the economic penalty that would be suffered by industry and was unwilling to set down hard and fast standards for effluents that industries might not be able to meet using cheap and readily available technologies. By placing public standards on the water ways and negotiated, unpublished standards on each waste discharge via the licence conditions, the regulatory agencies were able to be more flexible about what they required of

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[218] Butlin, Sydney's Environmental Amenity, p67.

particular industries and could take account of what each firm and also the Water Board argued that they could or could not afford to do.

Classification had been the means of publicly applying specific standards. The discontinuation of classification of waterways has meant that the pollution licensing procedure is not based on legally set standards but is based on the judgement of officers of the relevant regulatory authority. The opportunity for the public to have a say in the setting of standards was therefore reduced and the discretion of the regulatory agency became paramount. It has reinforced a situation whereby policy decisions are kept within bureaucracies rather than being debated by the public. Moreover, there is no provision in the legislation for public participation in either the policy making processes or the enforcement of pollution controls. Pollution problems are being pushed "away from the overt political process and into the hands of the technologists, the 'neutral' experts."[219] This is despite the fact that such decisions involve social and political choices.

A characteristic of the SPCC, which is common to many regulatory bodies, is the tendency for employees to subscribe to the prevailing engineering paradigms. The regulatory body reflects in microcosm the ideas, values and professional attitudes that operate in the wider technological system which they are regulating. Typically the collective background of personnel in the regulatory body gives a shared framework of orientation and appraisal of the larger system or network.[220]

Pollution control authorities employ and are advised by engineers who inform them of what can technically be achieved and what can not; in other words pollution control authorities will usually base their standards on what can be achieved by the existing paradigm. Therefore the only mechanism that exists for evaluating the performance of the paradigm - legislation and regulation - becomes a tool for perpetuating the paradigm if standards are based on "best practicable technology" or less.

The impact of legislation on engineering decisions is also minimised by a licensing and approvals procedure which often seems to be inconsistent with the legislation and, in the case of Water Board treatment works and discharges, to be surprisingly accommodating. The whole legal process in this area involves a process of negotiation; negotiation about which parameters should be taken as measures of compliance (e.g. faecal coliform) and the levels that these parameters should be set at. This negotiation process occurs between government bodies and between government and industry and there is almost no community input. Engineers in both industry and government bureaucracies seek to redefine legislation and "practicability" to suit their own ends.

The Clean Waters Act was originally aimed at cleaning up the rivers by ridding it of point source industrial waste. Its implementation forced some industries to install rudimentary pretreatment equipment but the main accomplishment of the Clean Waters Act was the diversion of industrial wastes from Sydney's rivers to its sewerage system. Paul Landa, when Minister for Planning and

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219 Joy, 'Management Policy and Practice', p68.

220 Henk Bodewitze al, 'Regulatory science and the social management of trust in medicine', Wiebe Bijker et al (eds), The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology, MIT Press, 1987, p244.

Environment, boasted that trades wastes from over 6000 factories had been connected to the sewerage system from the commencement of the Clean Waters Act in 1972 to the end of 1978.[221]

The rivers were therefore cleaned up at the expense of the ocean and bathing beaches. Thus the pollution was transferred from the rivers to the oceans and beaches. The crisis of the late 1960s was met by "relocating discharge points and disposal responsibilities"[222] As industrial wastes increase in volume and change in composition as new chemicals are processed the contradiction between waste disposal and maintaining environmental amenity are likely to worsen under this sort of approach.[223]

The dependence on the Water Board in achieving the primary goals of the Clean Waters Act is clearly recognised by the SPCC

> The existence of a well planned major sewerage system which discharges via ocean outfalls and serves the industrial areas of the basin, and the cooperation of the Metropolitan Water Sewerage and Drainage Board in accepting increased loads of industrial wastes, has made the implementation of point source control effective from the outset.[224]

This obviously gave the Board a measure of power in its dealings with the SPCC and has made it very difficult for the SPCC to regulate the Board's discharge since then. Fowler noted that negotiations over the conditions to be imposed in approvals of new plants "would have a delicate aspect" because of the SPCC's dependence on the Board in relation to the acceptance of industrial waste. Rather than increase licence conditions and get individual firms to install more effective pollution control measures, the SPCC has taken the easy way out and diverted the pollution to other areas of the environment that are assumed to be less sensitive.[225]

The problem of industrial waste was transferred to the Sydney Water Board and so, in the next chapter, the use of the sewers for the disposal of industrial waste and the regulation of this practice will be considered.

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221 Paul Landa, Minister for Planning and Environment, letter to O.H.Miller, 21st November 1978.

222 Joy, 'Management Policy and Practice', p74.

223 ibid.

224 Classification of the Sydney Harbour Drainage Basin, Clean Waters Advisory Committee Meeting, 9th March 1978, p22.

225 Fowler, Pollution in NSW, p154.

CHAPTER 7

INDUSTRIAL WASTES IN THE OCEAN - ENVIRONMENTAL HAZARD OR ECONOMIC BENEFIT?

The compromise between environmental protection and the promotion of economic growth that was revealed in the legislation of pollution in the previous chapter was even more evident in the Water Board's policies towards industrial waste. Until the 1970s the environmental damage caused by industrial waste discharged through the sewers did not even figure in the formation of Board policy. The legislative moves of the early seventies caused environmental concerns to be part of the Board's rhetoric. The actual extent to which these concerns have affected policy has still been severely limited.

The reason that wastes have been accepted into the sewers despite their environmental consequences has been in large part based on the assumption that if industry was not provided with a cheap disposal system this would adversely affect economic and industrial growth and would pose a threat to the living standards of Sydney residents. This assumption can easily be challenged both in narrow economic terms and also in terms of the loss to the community of environmental amenity.

Industrial waste management can be approached in two different ways. One way is to concentrate on reducing the production of wastes and restricting their discharge, the other is to provide facilities for the treatment and disposal of those wastes. The emphasis in Sydney has always been towards providing disposal facilities rather than on preventing pollution at its source, for example, by changing production processes and encouraging recycling of waste materials.[1] Seen as an add on after production, pollution control is a cost that must be added to each industrial process. However, pollution controls which cause changes in the production process and increase efficiency and resource conservation can be cost-saving to industry in the long run.

The long term environmental costs of unhindered industrial discharges, via the sewers, into the sea have not figured in the cost-benefit assessments and yet there is growing evidence that toxic industrial waste is accumulating in the marine life off Sydney. This, together with the impact of pollution on bathing, surfing and fishing activities, mean that the supposed cheaper goods that arise from allowing cheap disposal methods are counterbalanced by losses in other areas.

CATERING TO INDUSTRY BEFORE THE CLEAN WATERS ACT

Having settled on water carriage as the best means of disposing of domestic waste in the nineteenth century, water carriage seemed the obvious way to dispose of industrial wastes which at the time were similar in nature to domestic wastes. Industrial wastes before the second world war were almost totally organic and biodegradable. The strength and volume of these wastes were the major problems. Nevertheless it was agreed by all Australian sewerage

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[1] W.J.Hickson, `Service and Capital Charges for Sydney's Sewer Wastes', in C.Joy et al, Liquid Waste Management, Botany Bay Project, Canberra, 1978, pp116-7.

authorities that the sewers were a proper means of disposing of industrial waste.[2]

Despite the changing composition of industrial waste because of an increasingly non-organic component, the Sydney Water Board, in 1957, affirmed the principle that the sewerage system was the "logical" means of disposal for water-borne wastes which were no longer of any value and which could not be handled by industry in an economical, convenient or inoffensive manner.[3]

The two main arguments for the use of the sewers to dispose of liquid industrial wastes centred around the provision of a service to industry and the protection of the environment from the possible irresponsibility of individual firms. It was argued that if the sewers were not available as a cheap and easy disposal method then the waste would be dumped irresponsibly in a way that would endanger waterways and natural bushland.

Although the Sydney Water Board does not legally have to accept industrial waste into its sewers, the provision of a service to industry was justified because the existing centralised public system, it was argued, could treat the wastes more cheaply than individual industries. It was also argued that industrial wastes could be "more easily treated when mixed with large volumes of domestic sewage"[4] because the domestic sewage diluted the industrial wastes and thereby reduced their toxicity, equalised the sporadic industrial flow and provided biological seeding for the decomposition of organic industrial waste.[5]

Such a system seemed to suit everyone. The government authorities would gain from having control over treatment facilities. Industry would save money. They would be able to concentrate on production whilst the specialists looked after their waste and they would be able to use their property to the full without having a treatment plant taking up room and causing complaints from neighbours.[6]

Restrictions on industrial waste going into the sewers were originally only imposed to protect the sewer system and sewerage workers. Most states were also concerned about the effect of the industrial wastes on their treatment plants in terms of the plant capacity and ability to deal with wastes which might interfere with the biological processes.[7] Sydney did not, at first, have this

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[2] Conference of Professional Officers Representing the Authorities Controlling Water Supply and Sewerage Undertakings Serving the Cities and Towns of Australia, Report of the Proceedings of the Third Conference, 1947.

[3] M.W.S.&D.B., 'Policies Respecting Trade Waste Discharges and Pre-treatment Before Discharge to Sewers', Conference of Professional Officers Representing the Authorities Controlling Water Supply and Sewerage Undertakings Serving the Cities and Towns of Australia, Report of the Proceedings of the Eighth Conference, 1957, p146.

[4] Engineering and Water Supply Department, South Australia, 'Trade Wastes Discharge to Sewers-Policy, Legislation, Pretreatment, Inspection and Charges' in Conference of Engineers Representing the Authorities Controlling Water Supply and Sewerage Undertakings Serving the Cities and Towns of Australia, Report of the Proceedings of the Fourteenth Conference, Brisbane 1969, p49.

[5] R.D.King-Scott, discussion, in Conference of Engineers, Fourteenth Conference, p83.

[6] ibid.

[7] Conference of Professional Officers, Third Conference

concern because Sydney's sewage was discharged directly into the sea without treatment. Mr Farnsworth, Chief Engineer of the Board, and a colleague told a conference of sewerage representatives in 1947 that the strength and quality of discharge was not "of immediate importance" and that they were only concerned about wastes which might damage the actual sewers.[8]

Sydney authorities had first given attention to industrial waste discharges after problems were experienced with the effluent from the NSW State Abattoirs, the CSR, pickling wastes from Lysaght's Ltd, wastes from Davis Gelatine Company, various gas works and other minor sources. Maintenance work costing thousands of pounds had been required for damage to, and blockages of, the sewers.[9]

The priority given to protecting the sewers rather than the environment was evident when the Sydney Water Board entertained the idea of reducing charges for industrial wastes going into stormwater drains. Farnsworth suggested that the discharge of industrial wastes into stormwater drains was "beneficial". The Board was only responsible for drains that passed through more than one municipality. Stormwater effluents were not treated before entering the nearest waterway so that discharge to stormwater got around the problem of damaging the sewers, sewerage workers and treatment processes. The charge for discharge of effluents into sewers and stormwater drains in 1947 was 6d per thousand gallons and the Board proposed to drop the charge for stormwater drains to 3d per thousand gallons "as an inducement to manufacturers to spend the other 3d in treatment". There were no set limits on what could be put into the stormwater drains, however, although Farnsworth said that it was hoped in the future to set standards for stormwater drains.[10]

Since most industrial waste at this time was organic, Sydney sewerage authorities were concerned with limiting the solid and fat content and the biological oxygen demand of these wastes as well as temperature and acidity in some cases.[11] Standards were set for industrial waste discharges allowed into the sewers in 1940 according to the advice of the Board's Medical Officer. These standards were based on the average composition of sewage at that time. The standards could be changed at any time by the Engineer-in-Chief but were still being used as a guide in 1957 although they were never rigidly enforced.[12]

The desire to service industry was the same in every Australian state. The Adelaide authorities, who wanted to allow as much industrial waste through the sewers as possible, lined the main sewer running through their heavy industrial district with plastic in the 1960s so that it would not be corroded by strong wastes and the treatment plant to which this sewer carried the waste was also designed to handle "strong sewage with a heavy trade component".[13]

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[8] Mr Fansworth, coment in ibid., p116.

[9] M.W.S.&D.B., 'Policies Respecting Trade Waste Discharges and Pre-treatment, p145.

[10] Mr Fansworth, coment in Conference of Professional Officers, Third Conference, p120.

[11] ibid.

[12] M.W.S.&D.B., 'Policies Respecting Trade Waste Discharges and Pre-treatment, p145.

[13] Engineering and Water Supply Department, South Australia, 'Trade Wastes Discharge to Sewers, p48.

There was also a reluctance amongst Australian sewerage authorities to have hard and fast regulations about what would and would not be accepted into the sewers. One reason for this was that some parts of the sewerage systems were more able to deal with more concentrated wastes than others depending on how much treatment the sewage would be getting at the outfall and how far from the outfall the company's discharge was.[14]

Some of the authorities actually encouraged industries to be sited at certain parts of the sewerage system.[15] For example, the Sydney Water Board encouraged industries likely to have "bad wastes" to be established in areas draining to the ocean outfalls rather than to inland treatment plants.[16] Also acid waste from one company might be balanced out by the alkaline waste from another. At the 1947 conference it was suggested that it might be expedient to accept a strong waste without pretreatment.[17] A Melbourne delegate said of one set of suggested standards

> to adopt them as a definite standard for all cases would tend to make conditions too rigid and might hence impose an unnecessary burden on industry.[18]

The decision to install primary treatment facilities at the ocean outfalls in Sydney forced the Board to tighten up somewhat on even those firms discharging to the ocean outfall systems. Previously only floating grease had been a problem in these systems because of the nuisance it caused on nearby beaches and bathing waters.[19]

A 1970 Water Board Trade Waste Committee report described how the volume and significance of industrial wastes had increased over the years till industrial wastes in 1970 "largely determined" the characteristics of the raw sewage at the main outfalls. Several times industrial wastes had "caused noxious and noisome conditions" at the Malabar treatment works and severe pollution of beaches and bathing waters.[20] The Committee also found that there were "a substantial number" of industries discharging wastes which did not comply with the standards set by the Board. This caused increased costs to the Board because of damage to sewerage structures and treatment.[21]

The Sydney Water Board had been the first Australian authority to introduce industrial waste charges in 1942 following investigations in 1940 which had revealed that industrial wastes made up about 17% of Sydney's sewage flow and yet this was not being paid for, despite the fact that this addition to the flow

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[14] Melbourne and Metropolitan Board of Works, 'Special Charges for Discharge into Sewers' in Conference of Professional Officers, Third Conference, p109.

[15] ibid.

[16] M.W.S.&D.B., comment, in Conference of Engineers, Fourteenth Conference, p68.

[17] Metropolitan Water Supply, Sewerage, and Drainage Deapartment, Perth, 'Paper No.3', in Conference of Professional Officers, Third Conference, p104.

[18] Mr Borrie, comment in Conference of Professional Officers, Third Conference, p114.

[19] M.W.S.&D.B., comment, Conference of Engineers, Fourteenth Conference, p69.

[20] A.N.Killmier, 'Charging for Trade Waste Disposal', Thirteenth Conference of Administrative Officers of Water Supply and Sewerage Authorities of Australia, 1972, p24.

[21] ibid., p25.

necessitated larger disposal facilities. Industries at that time were only paying normal sewage rates based on the value of their property.[22]

Although it was estimated that it cost 1 shilling per 1,000 gallons to dispose of sewage this was considered to be too harsh a levy on industry and the industrial waste was established at a level of 6d per 1,000 gallons.[23] Calculation of the volume of industrial waste being discharged by an individual industry was difficult to measure and gauging equipment was considered expensive so the volume charged for "became a matter for negotiation between the discharger and the board".[24]

The reasons given for imposing a charge varied. Aird, the Sydney delegate at the 1948 conference, said that in 1942 the Board needed extra revenue and had the choice of raising the sewerage rate or finding the money some other way. The industrial wastes charge would therefore cover the cost of larger sewers and additional maintenance, encourage economical use of water (there was a drought at the time) and produce extra revenue.[25] In a 1940 report Aird had said that the industrial waste charge was not to raise revenue but to "provide a more equitable distribution of the cost of the sewerage service between domestic users and manufacturers."[26]

The Board charged for industrial wastes according to volume after a certain threshold allowance. They claimed that charges that were also based on composition would be too complicated and not justified since the cost of treatment (i.e. discharge to ocean of raw sewage) was not affected by composition. It also had the advantage of not discriminating against industries which discharged into its inland secondary treatment works which were far more sensitive to strong and toxic wastes and would therefore be required to pay more for the disruption caused by high strength wastes.[27]

LEGISLATIVE REFORMS & STRENGTH CHARGES

The legislative reforms of the early 1970s did not change the basic philosophy that the sewers were, in most cases, the best means of disposal, for liquid industrial waste. In 1970 a Trade Waste Committee, under the Chairmanship of the Deputy Principle Chemist of the Sydney Water Board reaffirmed that the Board was following a world-wide practice in allowing industrial wastes into the sewers when there was adequate capacity available.[28]

In fact the efforts to clean up the environment in the 1970s directed more waste into the sewers because of the emphasis on waste removal, transfer and treatment rather than on pollution prevention and control. Not only was liquid industrial waste diverted to the sewers but air-borne wastes were converted to

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22 ibid., p4.
23 ibid.
24 ibid.
25 ibid., p7.
26 ibid., p8.
27 M.W.S.&D.B., comment in Conference of Engineers, Fourteenth Conference, p68.
28 Killmier, 'Charging for Trade Waste Disposal', p24.

liquid form for disposal to sewer. For example, in the newspaper industry, vapours are drawn off the printing machines and condensed into a liquid which is treated before going to sewer.[29] At a 1978 conference, a Sydney Water Board engineer explained that the Board had accepted "progressively heavier industrial wastes" into its system to assist the government cope with the requirements of the Clean Waters Act.[30]

A consequence of the Clean Water Act on the Board's industrial waste policy was that in 1972 stormwater drains were no longer available for industrial discharge and so standards were set for discharges going into stormwater drains and the standards for the acceptance of industrial wastes into sewers were revised. Although the costs of dealing with wastes going into stormwater channels were far less than those going to sewer because of the shorter lengths of pipe and absence of treatment, the Sydney Water Board imposed the same volumetric charge on waste going into stormwater drains as into sewers so that there would be no financial incentive for firms to use the stormwater system.

The new standards for acceptance of industrial waste into sewers covered parameters such as temperature, acidity, grease content, biochemical oxygen demand, suspended solids, sulphides and maximum concentrations for various toxic metals and compounds, including arsenic, cadmium and insecticides.[31] (see table 7.1) Despite these new restrictions the Water Board was careful to assure a meeting of the Royal Australian Chemical Institute that this did not mean the Board was reluctant to accept industrial wastes.

> Nothing is further from the truth. No enterprise, whether public or private, can operate successfully by turning away business that it might reasonably accept.[32]

The board would in fact do its utmost, the Chemical Institute was told, to find ways of placing minimum restrictions whilst protecting the sewerage system.[33]

The Water Board spokesmen did point out however, that although the Board's total policy was "aimed at providing industry with the opportunity to discharge to sewer those wastes which the Board can handle more efficiently than the owner"[34] certain wastes could be more easily and economically removed or treated at their source.[35] (After entry into the sewers the wastes became highly diluted by domestic and other industrial sewage.) Also discharges could be reduced by more efficient use of materials, recovery of by-products, better

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29 Hickson, 'Service and Capital Charges for Sydney's Sewer Wastes', p118.

30 M.W.S.&D.B., Comment in Conference of Engineers Representing the Authorities Controlling Water Supply and Sewerage Undertakings Serving the Cities and Towns of Australia, Report of the Proceedings of the Eighteenth Conference, 1977, pp76-7.

31 E.W.T.Pierce and C.S.Ralph, `Principles and Practices Relating to the Acceptance of Trade Wastes into the Sydney Water Board's Systems', in Royal Australian Chemical Institute, Process Chemistry Group, Industrial Waste Water, 1972, pp10-12.

32 ibid., p18.

33 ibid.

34 ibid., p12.

35 ibid.

Table 7.1

METROPOLITAN WATER SEWERAGE AND DRAINAGE BOARD

STANDARDS FOR ACCEPTANCE OF LIQUID TRADE WASTE TO SEWERS

Temperature	Not to exceed 37°C if the waste contains grease or fats. Otherwise not to exceed 50°C.
pH	To be in the range 6.8 to 10.
Grease	Not to exceed 200 mg/L.
Bio-chemical Oxygen Demand (5 days)	Not to exceed 600 mg/L.
Suspended Solids	Not to exceed 600 mg/L.
Sulphides	Not to exceed 10 mg/L.

Toxic Metal or Compounds (the discharge to be subject to prior approval in each case) – not to exceed:

Arsenic	100 mg/L
Cadmium	30 mg/l
Chromium	100 mg/L
Cobalt	200 mg/L
Copper	5 mg/L
Cyanide	7 mg/L
Lead	10 mg/L
Nickel	100 mg/L
Zinc	30 mg/L
Organic Herbicides	5 mg/L
Organic Insecticides	5 mg/L

Notes:

1. No discrete oil may be discharged.
2. No mercury may be discharged.
3. When two or more metals or salts of metals are discharged concurrently to the sewer in a waste, the sum of all the proportions which the concentration of each camponent metal or ion bears to the Board's limit for that metal or ion shall not exceed unity.
4. Cyanide baths are only accepted after detoxification. (The acceptable level of 7 mg/L in the table above refers to rinses only).
5. Volatile solvents shall not be discharged unless miscible with water and then only with special approval. The use of solvents in discharging the contents of grease traps to the sewer is prohibited.
6. Ferruginous pickling wastes will be accepted with pH not less than 5.5 in certain cases.

C. S. Keith
Secretary.

'housekeeping' and alternative manufacturing processes and materials as well as by pretreatment.[36]

A basic strategy that encourages the use of the 'best practicable means' available to industry to treat their waste has been preferred over any attempt to enforce general environmental standards. This has allowed the application of standards of acceptance to sewer to be flexibly applied.[37] If a waste stream was causing the Board some trouble in terms of its operations and a technology was available that the industry could install cheaply or that enabled some cost savings to the industry through recycling or added efficiency, then the Board might insist that such a technology be installed. The limits set in 1972, which were partially based on the technology available at that time, have remained the same until 1988 except for sulphide which has had its limit reduced.[38]

Despite the provisions of the Clean Waters Act the Water Board did not put environmental protection high on its agenda of priorities and was not a key factor in setting restrictions on what could go in the sewers. The four stated objectives of placing conditions on acceptance of industrial waste into the sewers were a) safety of Board's workmen and the public, b) protection and proper operation of the sewerage structures, c) proper functioning of the sewage treatment processes and d) recovery of reasonable costs for the service rendered. Increasing public concern for the environment had an indirect affect in that it influenced the criteria for the satisfactory operation of the sewers and treatment works.[39]

The standards of acceptance for industrial waste to sewer that were developed by the Board therefore represented a balance between the requirements of the Board's sewerage collection and treatment operation and the need to minimise costs to industry. A paper written in 1975 as part of the Botany Bay project concluded that effluent controls in Sydney were still oriented towards protecting Water Board facilities and workers rather than towards protecting the environment despite the 1972 anti-pollution legislation which was a response to perceived environmental threats.[40] In fact, although these standards were introduced at the time of legislative reform, the legislation seems to have had little impact on the actual content of these standards.

Another change in Board policy which followed the new NSW legislation was the introduction of strength charges but these had been foreshadowed a few years earlier. By 1969 the Sydney Water Board was becoming more amenable to what they saw as an overseas trend to charge on the basis of strength as well as quantity of industrial waste discharge "where subsequent treatment of the sewage is involved". They argued that such a charging system would allow individual industries to pay the Board to discharge high strength wastes and

[36] Melbourne and Metropolitan Board of Works, 'Quantity and Quality Charging for Acceptance of Discharge into Sewers' in Conference of Engineers, Eighteenth Conference.

[37] Hickson, 'Service and Capital Charges for Sydney's Sewer Wastes', p118.

[38] John Hitchen & Greg Klamus, `Trade Waste Discharge Limits; Current Status and Likely Trends', 1987, pp2-3.

[39] Pierce & Ralph, `Principles and Practices Relating to the Acceptance of Trade Wastes into the Sydney Water Board's Systems', p1.

[40] Hickson, 'Service and Capital Charges for Sydney's Sewer Wastes', p140.

thereby avoid "possibly expensive treatment facilities."[41] It would also have the advantage of inducing industries to try and recover their by-products where this was economical which would keep the "pollutional load" out of the sewers.[42]

In 1970 a Sydney Trade Waste Committee, set up partly in anticipation of the introduction of anti-pollution legislation[43], recommended that the basis for charging be changed so that it would be more related to costs. Strong wastes should be subject to extra charges with the maximum penalty for breach of the by-laws increasing and a bond being a condition for reconnection if a firm was ever disconnected.[44]

Two Water Board employees, an engineer and a chemist, sent on an overseas fact finding trip, also recommended that strength charges be established. The two objectives of these charges, they said, would be firstly that the discharge of strong wastes which might cause the sewerage system problems would be expensive to industry and their discharge would be discouraged. Secondly, the industry would bear the cost of treating and disposing of that waste and this was a principle accepted in Europe and the United Kingdom.[45]

That year, 1972, the Sydney Water Board established the concepts of "Basic Strength" and "Established Strength" for industrial wastes that were above limit in concentrations of grease, suspended solids and biochemical oxygen demand. Basic Strength applied to effluents assumed to comply with basic standards. These effluents would not be examined too closely and would be charged at the basic rate. For effluents that did not comply with the basic standards in one or more aspects an "agreed strength" might be established for these effluents which would be the basis of charging or, where information was lacking or in dispute, an "established strength" would be determined by sampling and testing.[46]

As in the case of the new standards for acceptance of industrial waste to sewer it seems that although the strength charges coincided with new pollution legislation, they were not brought in specifically to clean up the environment. The reason that these changes in Water Board policy were brought in had more to do with the consequences of the Clean Waters Act than the spirit or intention of the Act, that is, these changes were in response to the added load of industrial waste diverted to the sewers from the rivers because of the Act.

The fact the strength charges were not aimed at keeping high strength wastes out of the sewers but rather were part of decision to allow relatively high strength wastes into the sewers subject to charges being made for this[47] can be

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41 M.W.S.&D.B., comment in Conference of Engineers, Fourteenth Conference, p69.

42 ibid., p82.

43 Hickson, 'Service and Capital Charges for Sydney's Sewer Wastes', p123.

44 Killmier, 'Charging for Trade Waste Disposal', pp29-30.

45 E.W.T.Pierce & B. Parkes, The Control and Treatment of Trade Wastes in Sewerage Systems, Report on Visit to Europe, South Africa and Singapore, MWS&DB, 1970, p7.

46 M.W.S.&D.B., 'Pollution Control Legislation Effect on Water Supply and Sewerage Authorities' in Conference of Engineers Representing Authorities Controlling Water Suply & Sewerage Undertakings Serving Cities & Towns of Australia, Proceedings of the Fifteenth Conference, 1971, pp388-9.

47 Hickson, 'Service and Capital Charges for Sydney's Sewer Wastes', p123.

seen by the way the by-law was amended so that the Board would be able to accept any over-strength waste if the appropriate strength charge was paid. It was stated, however, that this concession was only available for wastes that were over the limits in Biochemical Oxygen Demand, grease content or suspended solids content. Wastes over the standards in temperature, pH, sulphides or toxic substances would not be accepted because of the threat they posed to workers, sewers and treatment processes.[48] Moreover there were compensations for large volume industrial dischargers because the strength charges were accompanied by a decrease in volumetric charges as quantity increased.[49]

One consequence of the strength charges in conjunction with low charges for water has been the encouragement of a heavy use of water for dilution and carriage of wastes. This has led to a situation where the proper treatment of industrial wastes in the sewage before the discharge of sewage into waterways would be extremely costly because of the additional volumes that had to be dealt with.[50]

SUBSIDIES FOR INDUSTRY - THE VELVET GLOVE APPOACH

The decision to charge industry for disposing of its wastes was not an easy one and other Australian sewerage authorities were much slower to do so. The Perth authority was not a statutory board and had a more direct relationship with government. They feared that the institution of industrial waste charges would have to be approved by the parliament where objections from the Chamber of Manufacturers and other like bodies was bound to have an influence. In addition their Department of Industrial Development, which was trying to encourage industries to establish in Western Australia, would probably oppose such a move.[51] All sewerage authorities looked at charges on industry "with a certain amount of fear and trepidation."[52]

Adelaide made no industrial waste charges for many years because special charges were a means of repressing industry[53] and because their policy of not charging industry had "considerable impact on the economic development of the city by attracting industry."[54] The Adelaide Sewerage authority still did not make any charge for industrial waste in 1972 and justified this policy in terms of the impact on industry and the environment. Some industries, which had strong and difficult wastes, Adelaide's engineer argued, would not be economically viable if they had to pay their true sewerage costs and these difficult wastes "frequently become quite amenable to treatment when mixed with large volumes of domestic sewage and other wastes."[55]

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48 Pierce & Ralph, `Principles and Practices Relating to the Acceptance of Trade Wastes into the Sydney Water Board's Systems', p13.

49 Killmier, 'Charging for Trade Waste Disposal', pp29-30.

50 Hickson, 'Service and Capital Charges for Sydney's Sewer Wastes', p115.

51 Killmier, 'Charging for Trade Waste Disposal', pp9-10.

52 ibid., p11.

53 Mr Murrell, comment in Conference of Professional Officers, Third Conference, p117.

54 Mr Hodgson, 'Policies Respecting Trade Waste Discharges and Pre-treatment Before Discharge t Sewers', in Conference of Professional Officers, Eighth Conference, p149.

55 Killmier, 'Charging for Trade Waste Disposal', p36.

The Adelaide engineer said that the absence of industrial waste charges had not led to the preponderance of 'dirty' industries in South Australia. On the contrary, the environment benefited because all wastes were discharged to the sewers since industry did not seek to avoid industrial waste charges. Also individual industry pretreatment plants, which might otherwise produce sludges and concentrated wastes that could be irresponsibly disposed of, were discouraged. Pre-treatment tended only to remove the easily treated part of waste anyway leaving the "more stable and difficult-to-treat wastes" for the city's treatment plants.[56]

In 1970 the Senate Select Committee on Water Pollution (discussed in previous chapter) raised questions about who should pay for pollution.

> The question to be answered is whether a community in which aesthetic, health and recreation expectations are rising, as its affluence, mobility and leisure opportunities increase, can afford to provide industrial waste treatment facilities free, or even to provide them at all.[57]

The Select Committee report pointed out that the community ended up paying for the pollution either indirectly through higher prices for products or directly through loss of amenity or clean up costs.[58]

Whilst taking evidence the Select committee found that industrialists assumed that "in treating their effluent they were performing an unrewarded community service." Companies felt they should be reinbursed for their efforts which had no direct financial return for the capital expended.[59]

> Treatment plants were installed to pay token respect to a by-law but in the knowledge that they would be ineffectual within a short time [because of a lack of maintenance and supervision] .[60]

(This was still happening recently in Sydney, according to an industrial waste inspector who found that firms would not maintain nor repair their pretreatment plants until a industrial waste inspector visited and directed them to do so.[61])

The Senate Committee observed that those companies that did the right thing were discouraged by seeing that other companies were not penalised for not doing it.[62] Waste-treatment obviously raised costs and situations could arise where competing firms were able to avoid these costs because of their location, their lesser degree of responsibility or variations in enforcement policies and

56 ibid., pp36-7.

57 Senate Select Committtee on Water Pollution, Water Pollution in Australia, Canberra, 1970, p80.

58 ibid., p104.

59 ibid., p81.

60 ibid.

61 interview with Nick Kenny, Trade Waste Inspector, M.W.S.&D.B., 10th March 1987.

62 Senate Select Committtee on Water Pollution, Water Pollution in Australia, p81.

supervision exercised by public authorities. Such firms would then be able to undersell a firm forced to install treatment facilities.[63]

For all these reasons, the Sydney Water Board was loath to charge industry the full cost of treatment all at once. The strength charges were introduced progressively over 5 years so as to assist industry. In the 1972/73 financial year it was estimated that Sydney industry would pay 8% of its share of the cost of treatment. It was intended that this proportion would be raised slowly until 100% was being paid by 1976/77. This would not include the costs relating to capital (including the cost of "interest, redemption and sinking fund") which the Board considered should be covered by the sewerage rates.[64] The anticipated 1976/77 charges were still well below equivalent charges for industrial wastes in Britain at the time.[65]

Grease was, however, fully charged for from the beginning because of the problems grease had caused on the beaches and it was hoped the sudden imposition of the full grease charge would induce industry to reduce that component of their wastes.[66] Clearly, the Board was prepared to be tough when the industrial waste was highly visible, even if it was less toxic than other components of industrial waste streams.

CONCESSIONS TO INDUSTRY - FAVOUR OR DISSERVICE?

Although the Sydney Water Board tried to achieve some sort of balance between industrial interests in general and its own requirements in setting standards for acceptance of waste and charges, it still retained the right to relax these in individual cases to suit particular firms. The standards were not rigidly enforced and the Board adopted a discretionary approach which involved negotiation with business interests.

Water Board officers reported that overseas authorities felt that the maintenance of good relations with industry kept illegal discharging to a minimum and ensured accidental discharges were reported. Those who reported such accidents were not prosecuted. The Water Board also fostered a close liaison with industry "at all stages of the planning construction and operation of factories and processes." Negotiation rather than prosecution was the preferred means of controlling illegal discharges in Sydney.[67]

The 1970 Sydney Trade Waste Committee report recommended that the Board be able to exercise discretion in authorising departures from standards of acceptance to the sewers.[68] The reasoning behind this was that some industries,

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63 ibid., p107.

64 Killmier, 'Charging for Trade Waste Disposal', p21.

65 Pierce & Ralph, `Principles and Practices Relating to the Acceptance of Trade Wastes into the Sydney Water Board's Systems', p15.

66 Hitchen & Klamus, `Trade Waste Discharge Limits', p2; Pierce & Ralph, `Principles and Practices Relating to the Acceptance of Trade Wastes into the Sydney Water Board's Systems', p14.

67 Pierce & Parkes, The Control and Treatment of Trade Wastes in Sewerage Systems, pp2, 18-19.

68 Killmier, 'Charging for Trade Waste Disposal', pp29-30.

having "intractable wastes" would have trouble meeting the set standards and so provision was made in the legislation to allow wastes which were stronger than the prescribed standards to be accepted if the local sewerage conditions were favourable (this would depend on the flow at that point, the ventilation and the treatment works).

> where unfavourable reaction in the sewer can be kept within acceptable limits it is clearly in the community interests that a partial relaxation of the standards be granted.[69]

After strength charges were introduced in Sydney the problem of determining the strength of a companies discharge was usually resolved by negotiation. If that failed then it was measured. Generally the company in question submitted an estimate of the strength of its wastes for the next 6 months and, if the Board considered the estimate to be reasonable, it would be the basis for charging.[70]

The negotiation approach was said to be necessary because for many firms it was most economical to treat their effluent to a certain point after which further treatment would be more expensive than putting the partly treated effluent down the sewers and paying industrial waste charges. It was therefore best not to impose arbitrary and rigid standards of acceptance since such standards might be lower than the optimum economic cutoff point for the firm.[71]

Another problem observed by the Senate Committee was that uniform standards and charges could be seen as unfair to older areas where equipment was less efficient and produced more waste and unfair to low-income areas by "forbidding them from making productive use of the very resources [e.g. a nearby river] which gave them a basis for competing with more developed areas." [72]

If an industrial waste was unacceptable for sewer disposal, the firm could be required to install treatment facilities so that the waste stream was either reduced or less concentrated before it was discharged. Most Australian authorities tried to keep these pretreatment requirements to a minimum because of complaints from industry and others who accused the authorities of "impeding or harassing industry".[73] Pretreatment was a cost to individual industries whereas treatment of the sewage as a whole was paid for by the community. It was argued that industry provided employment and therefore should be supported by the community.[74] This attitude was summed up by a delegate to the 1947 conference of professional sewerage authority officers.

> It must be realized that any costs put on to industry will be spread over the community and that it is in the interests of the community that the cheapest overall method of handling wastes should be

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69 Pierce & Ralph, `Principles and Practices Relating to the Acceptance of Trade Wastes into the Sydney Water Board's Systems', p12.

70 M.W.S.&D.B., comment in Conference of Engineers, Eighteenth Conference, p75.

71 ibid.

72 Senate Select Committtee on Water Pollution, Water Pollution in Australia, p111.

73 Engineering and Water Supply Department, Adelaide, 'Paper No.2' in Conference of Professional Officers, Third Conference, p100.

74 ibid., p102.

> adopted. It is probably more economical to treat industrial wastes with the domestic sewage than to have a lot of small plants distributed throughout industry. Some pre-treatment is necessary, but this should be kept to a minimum.[75]

In the early days the Perth sewerage authority even considered that pretreatment, where it was absolutely necessary, should be paid for, installed and operated by the sewerage authority. In this way the costs would be minimised and efficacy of the pre-treatment ensured.[76] The other sewerage authorities were not so keen on this idea. They preferred to be in a position to advise companies on what pretreatment they should install, approve their plans and inspect the pretreatment plants in operation.[77]

By 1957 the Sydney Water Board was insisting on pretreatment when it felt it was necessary to remove coarse particulate matter or oils, to neutralise acids, to reduce temperatures or to protect the sewers and sewage workers from toxic materials.[78] A spokesman told a conference that stormwater discharge was allowed if it met with Maritime Services Board requirements respecting discharge into tidal estuaries. These requirements limited toxic materials such as zinc, arsenic, and cyanides. These substances were allowed into the Board's sewers provided they were discharged at night and the Maintenance staff were previously notified.[79]

The Melbourne delegate was quite shocked that Sydney allowed toxic materials into their sewers at specified times at night. He explained that this would not be allowed in Melbourne because flows were lower at night meaning that the resulting concentration would be higher and this would be dangerous to workers. The Sydney delegate reassured him that it was only a matter of a few hundred gallons of cyanide waste every two or three months.[80] The Adelaide delegate pointed out that they had to be particularly rigid about excluding acids, heavy metals and cyanides from the sewers since their biological treatment would be destroyed.[81]

The Sydney Board was careful not to require anything of companies that they might not be able to meet.

> The levels that we put on had to be such that industry could adjust without going broke. Some industries were producing very high BOD wastes and. our levels that we intended to apply, there was just no way in the world that they could put any form of treatment plant at the site that they were at to get it down to under those levels so they

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75 Mr. Borrie, comment in Conference of Professional Officers, Third Conference, pp115-6.

76 Metropolitan Water Supply, Sewerage, and Drainage Department, Perth, 'Paper No. 3', in Conference of Professional Officers, Third Conference, p105.

77 ibid., p105.

78 M.W.S.&D.B., 'Policies Respecting Trade Waste Discharges and Pre-Treatment', p145.

79 ibid., p146.

80 Mr. Sweet, comment in Conference of Professional Officers, Eighth Conference, p151.

81 Mr. Hodgson, comment in Conference of Professional Officers, Eighth Conference, p149.

> were given more or less an open cheque book to discharge the stuff providing they paid.[82]

The argument that a business might have to close down because of the cost of treatment was answered by Stepp and Macaulay giving evidence to the 1970 Senate Committee. They pointed out that companies have to face increased costs all the time as the price of labour, materials and land rents go up and as they are forced to update their processes and equipment in the face of competition. "These are generally recognised as conditions that a firm must face and overcome". In all these cases firms which are unable to adjust go out of business. Pollution control costs may be non-productive but so, argued Stepp and Macaulay, are telephones, air conditioners, typewriters etc. [83]

The assumptions about the costs to industry and impact on economic growth inherent in all these arguments about industrial waste policy were occasionally questioned. At the end of 1970 two representatives of the Sydney Water Board travelled overseas to find out about overseas practice with regard to the control and treatment of industrial wastes in sewerage systems. In their report, they concluded that although the installation of pretreatment equipment by individual factories often involved a large capital outlay, this money was sometimes recovered very quickly by the reclamation of valuable materials from the waste. Businesses had generally been unaware of the amount of saleable product being lost to the sewer.[84] Additionally, they found experts stressing that pollution was "best and most economically dealt with at the process producing the waste, not at the final effluent from the factory."[85] At the opening address to the International Congress on Industrial Waste Water the President of the Federation of Swedish Industries, Mr Eidem, had pointed to the fact that pollution could be reduced by actually changing the industrial processes. Recovery of waste materials and production processes that created less waste were more likely to happen if industry was paying for the treatment of its own wastes to a satisfactory standard.[86]

The report of the Board representatives also concluded that the technology for adequately treating "all but the most uncommon industrial waste waters" was already existing and available.[87]

The usual argument against rigidly enforced absolute standards are that they destroy the competitiveness of industry and thereby harm the economy. This is partly because compliance costs are often exaggerated. The experience of the U.S. Environment Protection Agency (EPA) offers many examples of this. It was found that both the EPA and the industry concerned tended to overestimate compliance costs. Between 1974 and 1977 it was estimated by the EPA and the petroleum refining industry that pollution control would cost $1.4 billion. The actual cost was between $550 and $750 million. For iron and steel plants the EPA estimated they would have to spend $830 million during the same three

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[82] interview with Greg Klamus, Trade Waste Manager, M.W.S.&D.B., 2nd March 1987.

[83] Senate Select Committtee on Water Pollution, Water Pollution in Australia, pp113-4.

[84] Pierce & Parkes, The Control and Treatment of Trade Wastes in Sewerage Systems, pp2,6.

[85] ibid., p6.

[86] ibid., p5.

[87] ibid., p2.

years, and the industry estimated $1.6 billion. The actual cost was between $470 and $630 million.[88]

In 1978 the U.S. Occupational Safety and Health Administration proposed a standard to control carcinogenic beryllium dust and fumes. The industry estimated that it would cost $150 million and would close down plant vital to national security. It was later conceded by the Department of Energy that the cost was more likely to be $4.6 million. Similarly a chemical industry estimate of the cost of complying with a proposed vinyl-chloride standard turned out to be inflated by 200 times.[89]

In fact in many cases the innovations forced upon industries by legislation have benefited those industries. M.G. Royston argues that old fashioned technology leads to both low profitability and low resource utilisation efficiency. He contends that investment in low pollution technology is likely to encourage "higher technology, high skill development, lower energy and resource usage, and hence, high value added, specialization and profitability."[90]

Royston points to a French survey that showed that 70 out of 100 companies invested less in their 'clean' technology than they would have had to if the pollution had been solved by adding on pollution control equipment and in 69 cases the running costs were less than with the original "dirty plants".[91] Royston sees clean operation as being as much an indication of good management as profitability. He says

> All around the world it is being realized that pollution is a sign of wasteful inefficiency and represents a potentially valuable resource in the wrong place.[92]

And obviously the requirement for firms to install pollution control equipment benefits the companies that produce that equipment and encourage their research and development efforts. In the United States, Union Carbide told its shareholders that the tighter government standards had "significantly increased air pollution control markets".[93]

In the United States stricter standards, not based on available technologies, have resulted in new technologies. Lawsuits, regulations and the threatened ban on PCB's forced PCB users to develop product alternatives. Most of these substitutes were cheaper than the PCB's they replace.[94] Bans on CFC's in aerosols have resulted in two innovations; a non-fluorocarbon propellent was developed using carbon-dioxide and a new pumping system was introduced that

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88 Douglas Costle, 'The Decision-Makers Dilemma', Technology Review, July 1981, pp10-11.

89 ibid.

90 M.G.Royston, 'Making Pollution Prevention Pay', in Donald Huisingh & Vicki Bailey, eds, Making Pollution Prevention Pay: Ecology with Economy as Policy, Pergamon Press, 1982, p2.

91 ibid., p2.

92 ibid.

93 Dickson, The New Politics of Science, Pantheon, New York, 1984, p278.

94 Nicholas Ashford et al, 'Using Regulation to Change the Market for Innovation', Harvard Environmental Law Review 9, 1985, pp432-433; Charles Caldart & William Ryan,'Waste Generation Reduction', Hazardous Waste and Hazardous Materials 2(3), 1985, p315.

did not depend on propellents and actually turned out to be cheaper than CFC propellents.[95]

Wastewater pretreatment standards proposed for effluent from the electroplating industry were predicted to force a closure of 20% of electroplating job shops. A research and development project following this announcement produced a new rinsing method, the "Providence method" which reduced water consumption by one third and cut hazardous waste production by 50-70%.[96]

All of these cases show that constraints on industry are not necessarily detrimental to their viability. Charles Caldart, of the Centre for Technology and Industrial Development, M.I.T. and William Ryan of the Massachusetts Public Interest Research Group have expressed the conviction that regulatory approaches

> must not be bound by existing technologies and existing economic conditions. Rather, public policy must encourage the type of innovation that can spur technological breakthroughs and alter economic circumstances. In short, we believe it is possible to change production technologies. [97]

The economist, Nathan Rosenberg, suggests that most firms will direct their research efforts towards parts of their operations which seem to pose the heaviest constraints. These constraints may be created by a technical imbalance between interdependent processes so that an improvement in one part of a production line causes problems or bottle necks in other parts of the line or operation. Imbalances between rival firms is also a cause of innovation. Technical disequilibria can also be caused by the threatened withdrawal of labour which provides an impetus for research into labour replacing technology.[98]

The category of situations which may encourage innovation, which is of interest here, is the "imposition of a previously nonexistent constraint". For example, legislation can impose constraints in this way and force a search for innovations in order to comply with the legislation. Such exploratory activities, Rosenberg points out, can confer advantage on those who were constrained by the legislation. He gives the example of Swedish chemical pulp producers who were forced by a Swedish law against stream pollution to work out new ways of utilizing their waste liquors. In doing this Swedish sulphate producers gained an advantage over their Canadian and American competitors when they developed a recovery process for waste sulphite liquor. [99]

Rosenberg refers to constraints which led to innovation as inducement mechanisms or focusing devices,

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95 Ashford, 'Using Regulation to Change the Market for Innovation', pp433-4.
96 Caldart & Ryan, 'Waste Generation Reduction', p315.
97 ibid., p310.
98 Nathan Rosenberg, Perspectives on Technology, Cambridge University Press, 1976.
99 ibid., p122.

> The mechanisms examined here share the property of forcefully focusing attention in specific directions. They called attention decisively to the existence of problems the solutions to which were within the capacity of society at the time, and which had the effect of either increasing profits or preventing a decline that was anticipated with a high degree of probability.[100]

Legislation and regulation is most effective where it acts as an inducement for technological change. Environmental legislation and standards which are based on existing technologies and the economic circumstances of individual firms may impede technological advance in directions which can be both environmentally and economically beneficial. Certainly the retention of standards set in 1972 has done nothing to encourage the development of new industrial processes that produce less pollution since that time.

THE NEW TRADE WASTE POLICY - REVAMPING AN OLD APPROACH

The crisis at the end of the 1960s that followed from the closing of council tips to industrial waste caused an increasingly toxic load on the sewers. The crisis was solved in part by the opening of a landfill dump at Castlereagh for industrial waste. However this dump did not accept strong acids, cyanides, trace-metal residues nor organochlorines.[101] Sydney has not provided any disposal service for many of these wastes since then and although some intractable organochlorines are stored, little is known about the fate of the trace-metal residues and chemicals that do not find their way down the sewers. In 1988 an aqueous waste treatment plant was established to take the wastes previously going to Castlereagh but there are still various toxic wastes which will not be accepted at this facility including organochlorines, mercury and arsenic wastes and organometallics.[102] It is not expected that this facility will relieve the sewers of any of their toxic load but may in fact add to it because liquid residues from the treatment processes will be put into the sewers.[103]

Because the Water Board provides a cheap disposal service and because, in many cases, there are no alternatives to that disposal service for various waste types, most industrial liquid waste, over 99%, goes to the sewers. In 1983 153,000 million litres was estimated to be going to the sewers annually whilst only 53.5 million litres was marked down for the aqueous waste treatment plant.[104] (see figure 7.1) By July 1988 when the new Trade Waste Policy was brought in, industrial waste made up a significant proportion of the sewage flow at the three main ocean outfalls, particularly at Malabar where about 50% of the flow was industrial waste.[105]

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100 ibid., p123.

101 SPCC, Future Disposal of Industrial Liquid Wastes in Sydney, March 1983, p15.

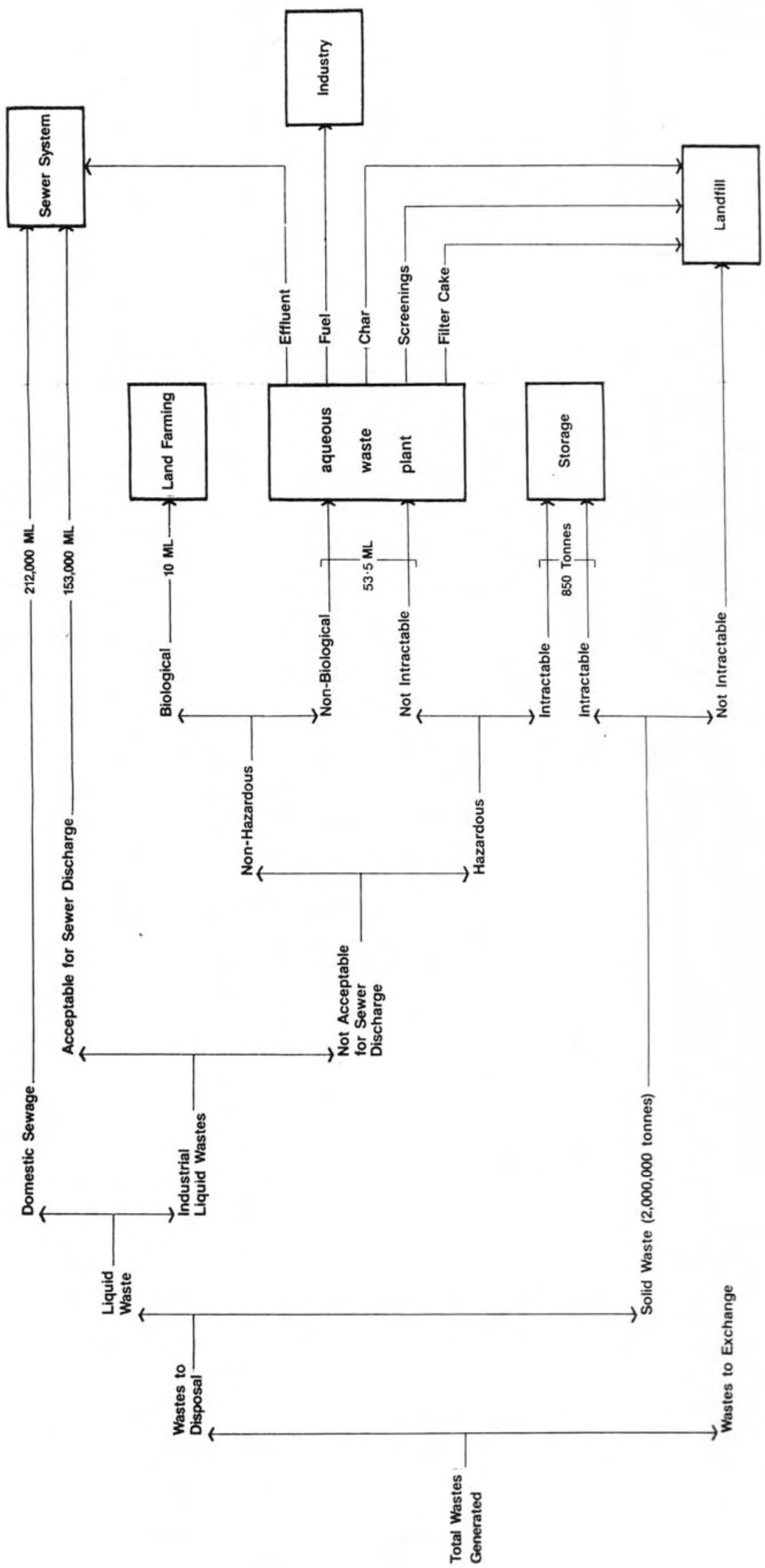
102 John Woodward & Dr Alan Gilpin, Proposed Aqueous Waste Treatment Plant, McPherson St, Banksmeadow, Municipality of Botany, Report ot Hon R.J.Carr, Minister for Planning & Environment, 1984, p23.

103 see for example, Maunsell & Partners, Submission to Public Inquiry, Banksmeadow Aqueous Waste Treatment Plant, Randwick Municipal Council, November 1984, p7.

104 Gutteridge Haskins & Davies, Environmental Impact Statement: Aqueous Waste Treatment Plant Banksmeadow, MWDA, December 1983.

105 interview with Greg Klamus, Trade Waste Manager, M.W.S.&D.B., 2nd March 1987.

Figure 7.1 Sydney's Waste Flow (Annual Quantities)



Source: Gutteridge Haskins & Davies, Environmental Impact Statement: Aqueous Waste Treatment Plant Banksmeadow, MWDA, December 1983.

Annual Quantities are shown

The Trade Waste Manager, Greg Klamus, had consulted with various people within the Board, from the State Pollution Control Commission and from industry in putting together the new Trade Waste Policy. A draft policy had been drawn up which was be circulated for comment within the board, modified, discussed with industry and other government authorities, approved by the General Manager of the Water Board and finally sent to State Cabinet for approval. The reason for consulting industry was to ensure that the standards for acceptance to sewer were not unreasonable and therefore likely to put firms out of business. The SPCC was consulted to ensure they were happy that the new policy would conform to legislative requirements.[106]

The Board claim the new policy represents a radical change in approach. However it is based on a similar philosophy. It attempts to provide a service to industry whilst limiting the contamination of discharges through strength charges rather than through absolute limits or effluent standards.

> The Policy aims to encourage industry to improve pretreatment of wastes, towards 'domestic' quality. At the same time, the Board will be providing a commercially oriented liquid waste disposal service to industry, and recovering some of the special treatment costs that the discharge of pollutants impose on the whole community.[107]

Klamus stated, in a joint paper the year before, that the sewerage system was the most appropriate method of disposing of many industrial liquid wastes. This was because the sewers offered the community an acceptable method of controlling environmental pollution from industrial waste and because disposal was cheaper than a system requiring individual industries to treat their own wastes.[108]

The new trade waste policy aims to replace the emphasis on 'control' with one of 'commitment'.[109] The monitoring and policing of industrial discharges has always been difficult. Huge variations in strength and volume of effluent are typical of industries which have certain cycles and seasonal variations. The installation of measuring apparatus could also be expensive as well as technically difficult. Understaffing has also been a problem according to Water Board inspectors, who are unable to visit firms as often as they would like.[110] In 1987 there were 34 trade waste inspectors to monitor some ten thousand properties 24 hours a day.[111] Obviously, random illegal discharges could not possibly be controlled in this way.

Inspectors were equipped with pH indicator paper and meters and field test kits to measure for concentrations of certain metals. If they discovered a breach of the standards they were expected to discuss it with the management of the company first. If the company failed to make the required permanent change then a

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106 ibid.

107 M.W.S.& D.B., Trade Waste Policy 1988, March 1988, p1.

108 John Hitchen & Greg Klamus, `Trade Waste Discharge Limits; Current Status and Likely Trends', 1987, p1.

109 Hitchen and Klamus, `Trade Waste Discharge Limits', p7.

110 interview with Nick Kenny, Trade Waste Inspector, M.W.S.& D.B., 10th March 1987.

111 interview with Greg Klamus, Trade Waste Manager, M.W.S.& D.B., 2nd March 1987.

sample of effluent would be analysed and a warning letter sent. Further breaches which were confirmed by laboratory analysis would result in prosecution. But prosecution was a long, expensive business and in the end the fines meted out could be quite trivial because judges would consider factors such as the firm's financial position.[112]

The new policy aims to achieve its ends by encouraging the cooperation of industry rather than through policing. It is hoped that businesses can be encouraged, through financial incentives, to manage their wastes as carefully as they do their production processes.[113] Each company will be required to institute its own monitoring programme of sampling and testing which will be audited by the Board or the company will be able to pay the Board to do it for them.[114] Fines for discharge over the negotiated limits will be raised and disconnection will be "seriously considered".[115]

Waste quality targets will be negotiated with each firm. Under this system, if the polluter is able to install treatment equipment for a lower cost than they would otherwise have to pay to the Water Board to discharge their untreated wastes then there is a financial incentive to do so. The question is, are financial incentives and negotiated standards as effective at inducing innovation as absolute standards?

Rosenberg notes that in a production process any change which reduces costs would be welcome, not just those changes that are associated with rising costs. One could concentrate on reducing labour costs, reducing material costs or reducing processing costs.[116] Rising waste disposal costs may be counteracted with the installation of treatment equipment if this is easy to do otherwise profits could be maintained by making savings elsewhere in the plant. For some firms profit levels may be maintained by passing the cost on to the consumer, especially where a whole industry is hit with the new charges. If a firm is going to invest $X,000 they will consider the best part of the production process to spend it in. This may be in pre-treating their waste which will save on disposal costs, or it may be in some other part of the plant where savings might be more. It may even be spent on marketing the final product with the costs of disposal being passed on to the consumer.

Moreover, such a financial incentive may act as an incentive to bypass the charges through cheating in the self-monitoring process or to do some illegal dumping or to persuade the Board that they cannot afford the charges. Whilst the extra revenue may be of use to the Water Board the financial incentive approach is not one that will force technological changes that will reduce waste generation. The charging mechanism is not specific enough. It still leaves a substantial amount of choice in the hands of individual firms who have no special interest in protecting the environment. Standards of effluent are specific and if rigidly enforced are more likely to force technological change in the right directions.

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112 ibid.

113 Hitchen and Klamus, `Trade Waste Discharge Limits', p7.

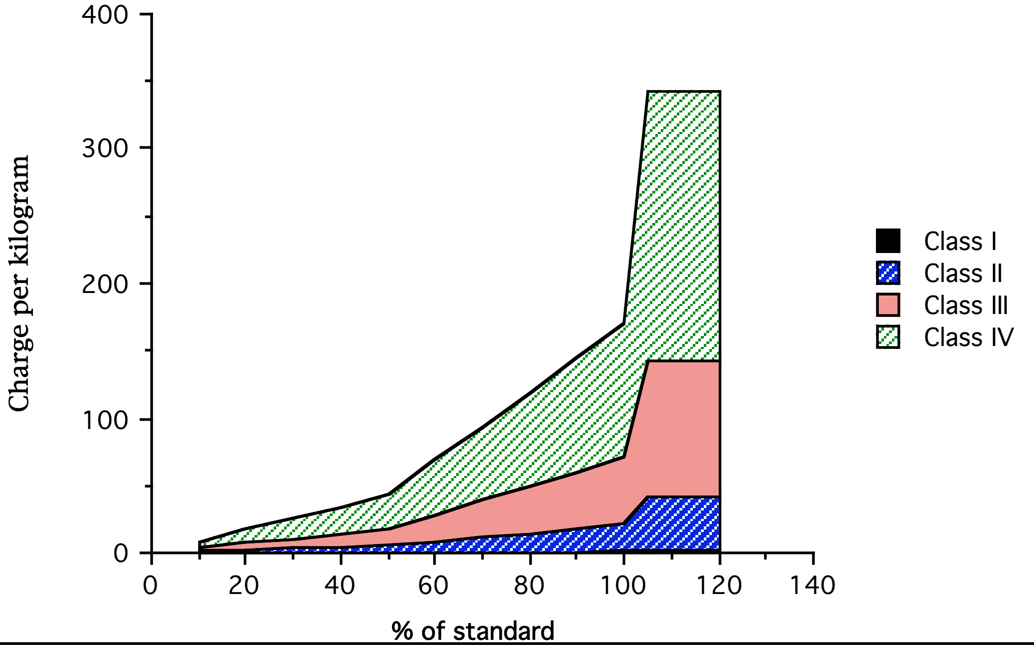
114 Draft Policy, Trade Waste Section, MWS&DB, Jan 1987, p8.

115 Draft Policy, Trade Waste Section, MWS&DB, Jan 1987, p10.

116 Rosenberg, Perspectives on Technology, p109.

Charges will still be based on concentrations of contaminants in the effluent entering the sewerage system. The more concentrated the pollutants in a firm's discharge, the more it will be charged. Strength charges will go up more steeply for higher strength waste.(see figure 7.2)

figure 7.2 CHARGES FOR NON-DOMESTIC POLLUTANTS



INFO FROM: MWS&DB, "Trade Waste Policy 1988"

As can be seen in the above figure, charges will be related to standards, set for various effluent contaminants including toxic metals and chemicals as well as biochemical oxygen demand, suspended solids and grease. (see table 7.2)

Standards, as shown table 7.2, again represent a compromise between requirements of the sewerage system (including protection of sewers, workers and treatment plants), the requirements of the SPCC and perceptions of what industry can cope with. A comparison of these standards with those elsewhere are shown in table 7.3. As Klamus said, "It is no good us setting some fancy limit that industry can't comply to."[117] Standards will be more stringent for effluents going to inland secondary treatment plants because the biological processes that treatment in those plants depends on would be disrupted by the types of waste that can go out the sewers.

As can be seen in table 7.2, many more substances are included, and the standards, in most cases, seem to have been tightened up. Nevertheless, these standards do not represent the limits in any real sense for what will be allowed into the sewers, since, as can be seen in the above figure, there is provision for charges for concentrations above the standards. These standards are little more than a pricing mechanism and whether the Board uses them as upper limits for discharge is up to their discretion at the time, presumably after negotiation with businesses concerned.

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[117] interview with Greg Klamus, Trade Waste Manager, M.W.S.& D.B., 2nd March 1987.

TABLE 7.2

STANDARDS FOR ACCEPTANCE OF LIQUID TRADE WASTE TO SEWER

POLLUTANT	1972-88	POLICY EFFECTIVE 1/7/88	
		discharge to primary plant	discharge to secondary or tertiary plant
Aluminium		200 mg/l	100 mg/l
Ammonia (as N)		200 mg/l	50 mg/l
Arsenic	100 mg/l	100 mg/l	1 mg/l
Barium		20 mg/l	20 mg/l
Boron		25 mg/l	25 mg/l
Bromine		50 mg/l	5 mg/l
Cadmium	30 mg/l	10 mg/l	5 mg/l
Chlorine (as Cl^-)		50 mg/l	50 mg/l
Chromium	100 mg/l	10 mg/l	10 mg/l
Chlorinated Hydrocarbons		10 mg/l	5 mg/l
Cobalt	200 mg/l	50 mg/l	10 mg/l
Copper	5 mg/l	10 mg/l	5 mg/l
Cyanide	7 mg/l	10 mg/l	10 mg/l
Formaldehyde		50 mg/l	50 mg/l
Herbicides	5 mg/l	0.1 mg/l	0.1 mg/l
Iron		100 mg/l	100 mg/l
Lead	10 mg/l	10 mg/l	10 mg/l
Manganese		300 mg/l	10 mg/l
Mercaptans		1 mg/l	1 mg/l
Mercury	none	0.1 mg/l	0.05 mg/l
Nickel	100 mg/l	30 mg/l	10 mg/l
Pesticides (organic)	5 mg/l	0.1 mg/l	0.1 mg/l
Phenolic compounds		100 mg/l	10 mg/l
Silver		10 mg/l	2 mg/l
Sulphide	10 mg/l	5 mg/l	5 mg/l
Sulphite		50 mg/l	10 mg/l
Tin		50 mg/l	50 mg/l
Zinc	30 mg/l	10 mg/l	5 mg/l
PARAMETERS			
Temperature	50 degrees 37 degrees with grease	38 degrees	38 degrees
pH	6.8-10	7-9	7-9
grease	200 mg/l	100 mg/l "beach grease"	n.a.
Biochemical Oxygen Dem	600 mg/l	to be determined	to be determined
Suspended Solids	600 mg/l	"	"

Source: MWS&DB, "Standards for Acceptance of Liquid Trades Waste to Sewers" & MWS&DB, "Trade Waste Policy 1988", March 1988.

TABLE 7.3

COMPARISON OF STANDARDS FOR ACCEPTANCE OF WASTES TO SEWER						
Element	Sydney 1984	Brisbane 1984	Melbourne 1984	France 1984	England 1984	Sydney * 1988
Arsenic	100	10	1			100
Cadmium	30	4	10	3		10
Chromium	100	20	10	15	10	10
Cobalt	200		10			50
Copper	5	20	10	15	10	10
Cyanide	7	3	10	1	5	10
Lead	10	20	10		10	10
Nickel	100	20	10	15	10	30
Zinc	30	20	10	15	10	10
Herbicides	5	1				0.1
Insecticide	5	0.001				0.1
Sulphides	10	1			1	5

* for sewers connected to primary treatment plants

FROM Info in: Maunsell & Partners, Submission to Public Inquiry, Banksmeadow Aqueous Waste Treatment Plant, Randwick Municipal Council, November 1984 & MWS&DB, Trade Waste Policy 1988, March 1988.

Moreover, the pricing mechanism works in such a way that industries are charged less for putting a certain volume of restricted substances down the sewer if that volume is more dilute. Mercury, for example, would cost $100 to discharge 1 kg in 0.1 mg/l concentration but it would only cost $10 to discharge the same 1 kg of mercury in the more dilute form of 0.01 mg/l although there might be a small additional volumetric cost. Moreover, charges are based on 90 percentile concentrations[118] so that 10% of the time discharges can be extremely concentrated without attracting further charges. This would conveniently allow for occasional discharges that may occur, for example, when vats or rinsing tanks are washed out.

The emphasis in the Board's trade waste policy on levels of dilution can be traced back to the SPCC guidelines which are in terms of dilution. The SPCC regulates restricted substances by stating maximum concentrations. (see figure 8.1, next chapter) Similarly, the harm posed to sewers, workers and equipment can be minimised by ensuring high levels of dilution. For these reasons the Board is more concerned about concentrations of toxic substances being discharged than total quantities.

It is interesting to note the changes between the draft trade waste policy drawn up at the end of 1986 as compared with the final policy that emerged from the consultation process with government and industry. In the draft the table of standards was in terms of "maximum allowable concentrations" and charges for discharges above these maximums were termed penalties. This terminology was dropped in the final policy document and the charges for above standard wastes was also considerably reduced in some cases.(see table 7.4)

118 Sydney Water Board, Trade Waste Policy and Management Plan 1988, M.W.S.&D.B., November 1988.

Table 7.4

STANDARDS & CHARGES FOR W ASTES GOING TO OCEAN OUTFALLS				
ELEMENT	draft maximum allowable mg/l	final standard mg/l	draft basic penalty above limits $/kg	final charges for >100% standard $/kg
Aluminium	50	200	50	2
Arsenic	10	100	100	100
Bromine	50	50	100	2
Cadmium	10	10	100	40
Chl Hydrocarbons	5	10	200	100
Chlorine	50	50	100	2
Chromium	30	10	200	40
Cobalt	50	50	100	40
Copper	10	10	200	40
Cyanide	10	10	200	100
Lead	10	10	200	40
Mercaptans	1	1	200	100
Mercury	0.1	0.1	100C	200
Nickel	30	30	100	40
Phenolic cmpds	100	100	100	100
Silver	10	10	500	100
Tin	50	50	10	2
Zinc	10	10	100	40

source: MWS&DB, Draft Trade Waste Service Policy,23rd December, 1986, pp6- 7 & MWS&DB, Trad e Waste Policy 1988, pp 9 &11.

Moreover the whole thrust of the charging system has been changed as can be seen in figures 7.3 & 7.4 which typify the new charging systems. Under the draft policy, no charge was to be made for concentrations of restricted substances below the allowable limits but heavy penalties would be imposed once those limits were breached. Under the final policy guidelines there are charges for discharges of restricted substances at all levels and the difference between charges below and above the standards are not as marked. These changes obviously offer much less incentive to industry to stay under the standards in their discharge and virtually defeats the aims of the Trade Waste Manager to establish effective financial incentives to industry to keep restricted substances out of their waste.

The Board is fairly secretive about the amount of restricted substances that enter the ocean through their ocean outfalls. Virtually the only published figures on this were given in the Caldwell Connell report in 1976 and repeated in the Environmental Impact Studies in 1979. They are shown in table 7.5. More up to date figures are difficult to find because the Water Board no longer includes the sludge in their published figures of concentrations of restricted substances in effluent.[119]

Figure 7.3

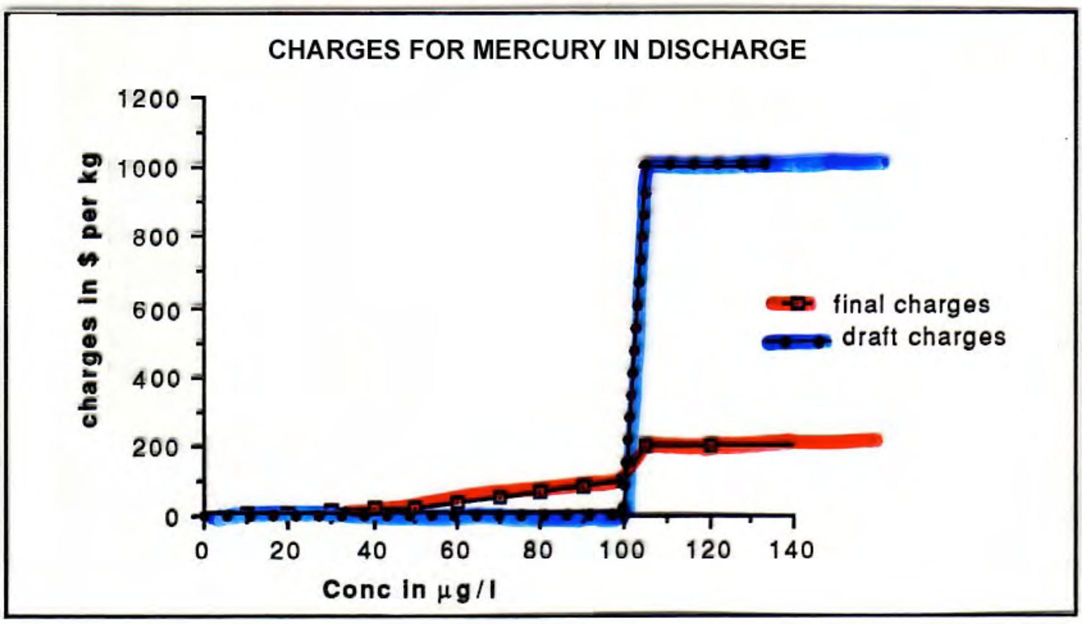
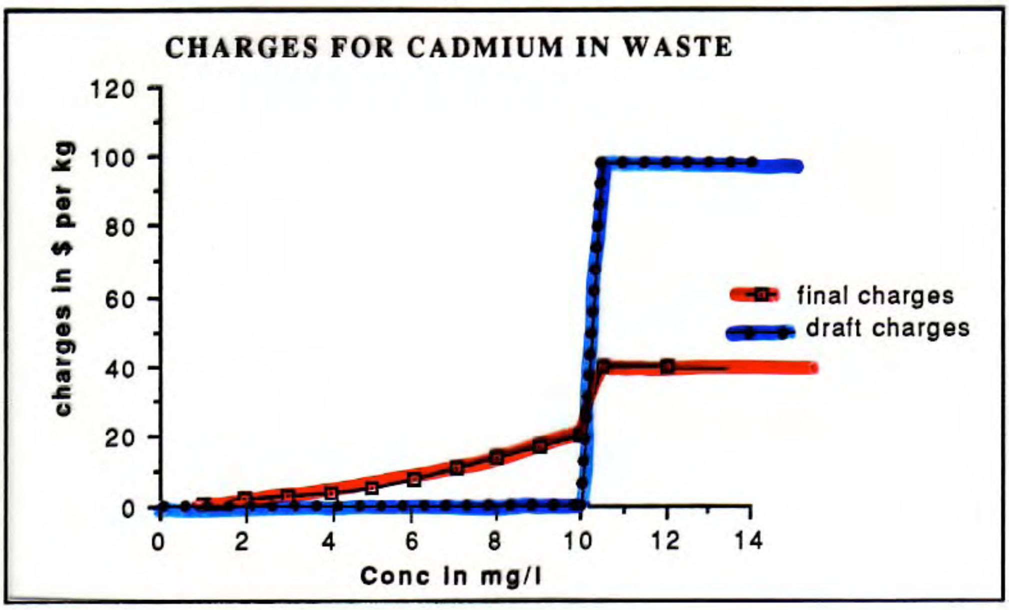


Figure 7.4



119 for example see Sydney Water Board, Sydney Deepwater Outfalls Environmental Monitoring Programme Pilot Study, vol 11 - Restricted Substances, March 1988.

TABLE 7.5

RESTRICTED SUBSTANCES IN SEWAGE EFFLUENT AT THE OUTFALLS						
	NORTH HEAD		BONDI		MALABAR	
SUBSTANCE	Effluent [a] Concent. mg/l	Total [b] Quantity t/yr	Effluent [a] Concent. mg/l	Total [b] Quantity t/yr	Effluent [a] Concent. mg/l	Total [b] Quantity t/yr
Arsenic	< 0.1	< 12.4	< 0.1	< 6.2	< 0.1	< 15.7
Cadmium	< 0.01	< 1.2	< 0.01	< 0.6	0.1	15.7
Total Chromium	0.05	6.2	0.1	6.2	0.7	109.9
Copper	0.15	18.6	0.23	14.3	0.4	62.8
Lead	0.07	8.7	0.25	15.5	0.3	47.1
Mercury	0.003	0.4	0.015	0.9	0.020	3.1
Nickel	0.05	6.2	0.05	3.1	0.2	31.4
Silver	0.02	2.5	< 0.02	< 1.2	< 0.02	< 3.1
Zinc	0.70	86.8	1.07	66.3	2.0	314
Cyanide	< 1.0	< 124	< 1.0	< 62	< 1.0	< 157
Phenolic cmpds	0.4	49.6	0.2	12.4	1.0	157
Total Chlorine	0	0	0	0	0	0
Ammonia-N	30	3720	22	1364	28	4396
Chlorinated Hydrocarbons	0.064	7.9	0.10	6.2	0.25	39.2

[a] Mean Value [b] Concentration x Aver Annual Flow

source: Caldwell Connell, Sydney Submarine Outfall Studies, 1976.

TABLE 7.6

CHANGES IN HEAVY METAL LEVELS IN MALABAR SEWAGE							
METAL	EIS RAW SEWAGE mg/l	EIS estimate [a]	1979 1 sample	1982 estimate [b]	estimated change	EIS estimate [c]	1982 estimate [d]
		SLUDGE mg/kg dry solids			EIS-1982	TOTAL tonnes/year	
Cadmium	0.1	20	40	<100	+400%	16	< 80
Copper	0.4	660	942	1000	+52%	63	95
Mercury	0.02	1.6	2	<10	+525%	3	< 19
Lead	0.3	410	412	400	-2%	47	46
Zinc	2.0	1410	1316	1400	-1%	314	312
Chromium	0.7	790	1086	--	--	110	--
Nickel	0.2	160	158	--	--	31	--

a = estimate by Caldwell Connell Engineers, b = estimate by Caldwell Connell Engineers, c = raw sewage conc given in EIS x annual flow at Malabar, d = c x % change

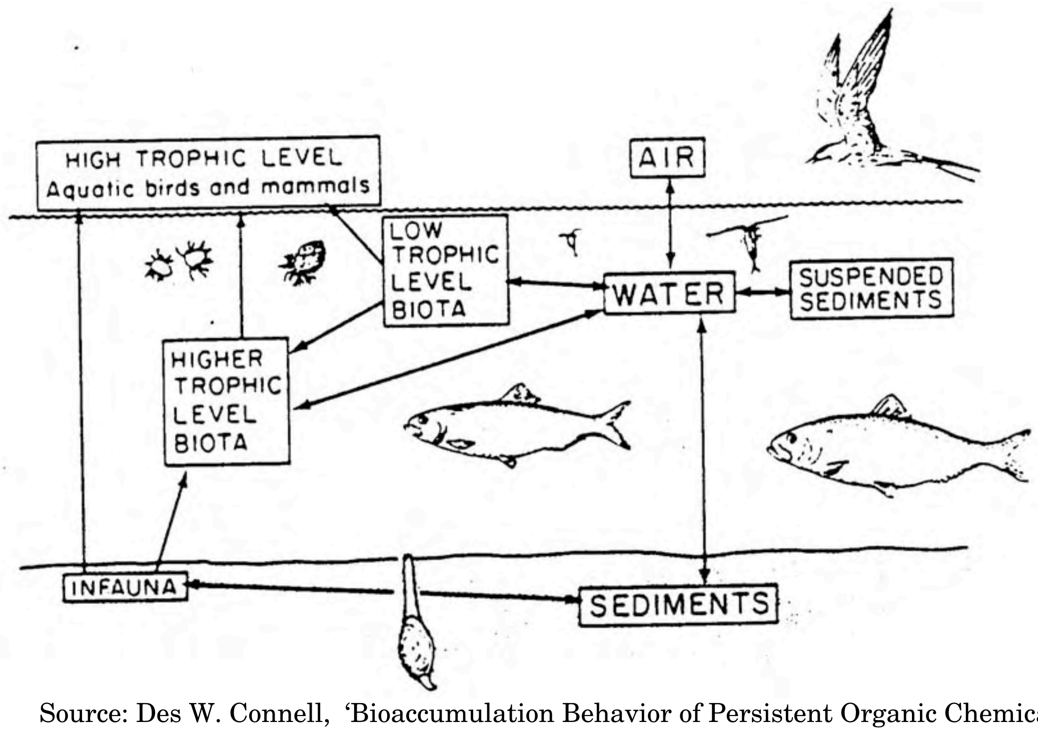
FROM: Caldwell Connell, Environmental Impact Statement North Head WPCP, MSW&DB, 1979, p47
Technical Support Paper - Sludge Disposal Policy, Clean Waters Advisory Committee, 10th September 1987, Appendix.

Table 7.6 shows estimates of more recent figures using estimates by Caldwell Connell of restricted substances in sludge and the percentage change since the first figures given in the 1976 and 1979 Caldwell Connell reports. These show a marked increase in restricted substances being discharged into Sydney waters in the years up to 1982. However figures given to the Clean Waters Advisory Committee by the Board in 1983 and 1984 claim that the restricted substances in the effluent will be slightly lower than the 1976 estimates at Commissioning and ultimately at Malabar and slightly higher at North Head.[120] Just where the truth lies is a matter of conjecture.

TOXIC FISH & EMBARRASSING SURVEYS

Industrial waste poses a threat both to the marine environment and also to human health. In particular, toxic waste can be taken up by marine vegetation and organisms and accumulated. Organic chemicals such as those in the organochlorine group are very stable and often persist in the environment for long periods. Biota can accumulate these compounds even when there are very low concentrations of the compounds in the water around them. The compounds can be transferred directly from the water to the biota, for example through the gills, (bioconcentration) or they can be consumed with food and accumulate in the tissues of the fish or other organism. The concentration of the compound up the food chain as each organism is in turn eaten by another is referred to as biomagnification or bioaccumulation in the food chain. Often there is a combination of the two processes.[121] (see figure 7.5)

Figure 7.5 Environmental Distribution of Persistent Organic Chemicals



Source: Des W. Connell, ‘Bioaccumulation Behavior of Persistent Organic Chemicals with Aquatic Organisms’, *Reviews of Environmental Contamination and Toxicology*, vol 102, 1988, p122.

120 Technical Report on Malabar Deepwater Submarine Outfall, Clean Waters Advisory Committee Meeting, 8th September 1983, p12; Technical Report on North Head Deepwater Submarine Outfall, Clean Waters Advisory Committee Meeting, 14th June 1984.

121 Des W Connell, 'Bioaccumulation Behavior of Persistent Organic Chemicals with Aquatic Organisms', Reviews of Environmental Contamination and Toxicology 102, 1988, pp118-125.

Similarly other toxic materials, in particular, trace metals, can be taken up by aquatic organisms by direct absorption from the water or by ingestion of contaminated food or polluted particulate matter or via aquatic plants. These metals can be present in the water either as colloids and as free or complex ions; they can be absorbed on the surface of particles and they can form part of waterway sediments "where conditions favour the formation of insoluble compounds or where suspended materials settle."[122]

Of the heavy metals that are discharged in industrial waste, mercury and cadmium are of particular concern because of well documented acute health effects. In Minamata, Japan more than 100 people died and 700 suffered "severe, permanent neurological damage" after consuming seafood that had been contaminated by industrial waste containing mercury. Similarly, 60 people died in Japan when rice paddies were contaminated with industrial waste containing Cadmium.[123] Nonetheless it is recognised that other heavy metals and the organic chemicals also pose a health threat if they are present in human food. Tables 7.7 and 7.8 show the properties and health effects of heavy metals and organic chemicals in the marine environment.

Table 7.7 Properties and Effects of Metals in Marine Environments

	Arsenic	Cadmium	Lead	Mercury
Bioaccumulation	Low except in some fish species	Moderate	Low or none	Significant (methylated form)
Biomagnification	Low or none	Low or none	Low or none	Significant (methylated form)
Properties	Metallic form: insoluble Readily methylated by sediment bacteria to become highly soluble, but low in toxicity	Metallic form: relatively soluble Not subject to biomethylation Less bioavailable in marine than in fresh water Long biological residence time Synergistic effects with lead	Generally insoluble Adsorption rate age-dependent, 4 to 5 times higher in children than adults Synergistic effects with cadmium	Metallic form: relatively insoluble Readily methylated by sediment bacteria to become more soluble, bioavailable, persistent, and highly toxic
Major environmental sink	Sediments	Sediments	Sediments	Sediments
Major routes of human exposure:				
Marine environments	Seafood: very minor route, except for some fish species	Seafood contributes ~10% of total for general population	Seafood comparable to other food sources	Seafood is primary source of human exposure
Other environments	Inhalation: the major route	Food, primarily grains	Diet and drinking water	Terrestrial pathways are minor sources in comparison
Health effects	Acute: gastrointestinal hemorrhage; loss of blood pressure; coma and death in extreme cases Chronic: liver and peripheral nerve damage; possibly skin and lung cancer	Emphysema and other lung damage; anemia; kidney, pancreatic, and liver impairment; bone damage; animal (and suspected human) carcinogen and mutagen	Acute: gastrointestinal disorders Chronic: anemia; neurological and blood disorders; kidney dysfunction; joint impairments; male/female reproductive effects; teratogenic	Kidney dysfunction; neurological disease; skin lesions; respiratory impairment; eye damage; animal teratogen and carcinogen
References[a]	Doull, et al., 1980 Harrington, et al., 1978 O'Connor and Kneip, 1986 Woolson, 1983	Chapman, et al., 1968 Nriagu, 1981 O'Connor and Kneip, 1986 Wiedow, et al., 1982	Callahan, et al., 1979 Heitz, et al., 1975 Kneip, 1983 NAS, 1980 O'Connor and Kneip, 1986 O'Connor and Rachlin, 1982	Greig, et al., 1979 Kay, 1984 Nriagu, 1979 Windom and Kendall, 1979

Source: US Office of Technology Assessment, Wastes in Marine Environments, 1987, p. 126.

122 S.P.C.C., Toxic Chemicals, Environmental Control Study of Botany Bay, Sydney, 1979, p6.

123 US Office of Technology Assessment, Wastes in Marine Environmnents, National Technical Information Service, 1987, pp125-6.

Table 7.8

Properties and Effects of Major Classes of Organic Chemicals in Wastes Disposed of in Marine Environments

Chemical class	Major examples	Properties	Primary routes to humans	Health effects	References[a]
Low molecular weight hydrocarbons	Benzene Toluene Xylene	Volatile Biodegradable Low bioaccumulation potential	Inhalation Drinking water	Benzene: central nervous system (CNS) effects, blood disease, leukemia Toluene: possible CNS effects, low toxicity Xylene: irritant; teratogen	Callahan, et al., 1979 Doull, et al., 1980 NAS, 1977 O'Connor and Kneip, 1986 Snyder, et al., 1984
Low molecular weight chlorinated hydrocarbons	Chloromethanes: carbon tetrachloride (CTET) chloroform methylene chloride	Volatile Lipid-insoluble Low bioaccumulation potential Some (e.g., CTET and chloroform) are persistent; others (e.g., methylene chloride) are readily biodegraded	Inhalation Drinking water	CTET and chloroform: liver, kidney, blood, and gastrointestinal disorders; liver and kidney cancer Methylene chloride: possible CNS effects	Callahan, et al., 1979 Doull, et al., 1980 O'Connor and Kneip, 1986 Thom and Agg, 1975
	Trichloroethylene, tetrachloroethylene, tetrachloroethane	Volatile Lipid-insoluble Low bioaccumulation potential	Inhalation Drinking water	All: CNS effects, liver toxicity Tri- and tetrachloroethylene: liver cancer	Callahan, et al., 1979 Doull, et al., 1980 Sittig, 1985
	Vinyl chloride	Volatile Low bioaccumulation potential	Inhalation	Animal and human carcinogen; liver toxicity	Doull, et al., 1980
	Chlorobenzenes	Range of volatilities Lipid-soluble Significant bioaccumulation potential	Food (including seafood)	Hexachlorobenzene: carcinogen	Doull, et al., 1980 O'Connor and Kneip, 1986
Chlorinated pesticides	Cyclodiene pesticides: aldrin, dieldrin, heptachlor, chlordane DDT and metabolites Chlorinated phenoxyacetic compounds (2,4,5-T; 2,4-D) Hexachlorocyclohexanes: lindane, BHC	Nonvolatile High bioaccumulation potential Moderate to high toxicity Most are highly persistent	Food (including seafood)	Known or suspected human carcinogens; neurotoxic effects; chloracne and other skin diseases	Doull, et al., 1980 Mrak, 1969 NAS, 1977 Sittig, 1985 Walker, et al., 1969
High molecular weight chlorinated hydrocarbons	Polychlorinated biphenyls (PCBs) Chlorinated dioxins (TCDD) Chlorinated dibenzofurans	Nonvolatile High bioaccumulation potential Moderate to high toxicity Highly persistent	Food (including seafood)	All: neurological, liver, and skin disorders PCBs: tumor promoters or carcinogens TCDD: highly carcinogenic	Kimbrough, et al., 1975 Kolbye and Carr, 1984 Murai and Juroiwa, 1971 Polger and Schlatter, 1983
Aromatic hydrocarbons	Phthalate esters (e.g., DEHP) Polycyclic aromatic hydrocarbons (PAHs)	Low to moderate volatility Highly insoluble Range of bioaccumulation potential Low to moderate toxicity	Food (including seafood)	Phthalates: many are teratogens DEHP: possible carcinogen PAHs: many (e.g., benzo(a)pyrene) are carcinogens; some are teratogens	FDA, 1974 Giam, et al., 1978 MacLeod, et al., 1981 NAS, 1977

[a]See list of references at end of report

Source: US Office of Technology Assessment, Wastes in Marine Environments, 1987, p.130

Sydney's coastal waters, into which the three main ocean outfalls discharge, support fish and other marine life that are fished both commercially and for recreation. Rock fishing is a popular sport and fishing directly adjacent to the sewage field is common. The area around the outfalls also provides a feeding ground for seabirds.[124] Figures 7.6 & 7.7 show the key fishing spots as identified in publications for fishermen.

Very few surveys of the affect of industrial waste discharge on marine life have been carried out in Sydney and those that have tended to concentrate on the existence and numbers of species rather than on fish disease and bioaccumulation of heavy metals and organochlorines. No comprehensive studies have been done on the latter.

When Caldwell Connell did the five year feasibility study for the submarine outfalls for example, their biological studies "concentrated on a broad community approach rather than a study of arbitrarily chosen species".[125] They described and quantified existing marine life and although they collected new organisms that had not been described before they assumed, without further investigation, that these were not unique to the area and that the outfalls therefore did not threaten marine species endemic to the mid-NSW coast.[126]

The question of fish contamination was more fully addressed in the Environmental Impact Statements for the submarine ocean outfalls. Data for concentration of restricted substances in biota came from "a brief reconnaissance study" undertaken by the Water Board in 1973 under the direction of Caldwell Connell. In this study fish were collected near the North Head and Malabar outfalls and at Marley Head which was to act as a control area. The results are shown in table 7.9.

Only one sample of each species was taken and for this reason Caldwell Connell argued that no statistical significance can be assigned to the study.[127] It is unclear what Caldwell Connell mean by this. Do they mean that no significance should be attached to the results of their survey? If so, why did they bother with the survey, or why didn't they do it properly? It would seem from the table, however, that heavy metals and/or pesticides were accumulating in nearly every species sampled and the fact that some accumulation was also taking place in the samples from the control area (Marley Head) means only that the control area was not unaffected by pollution, especially given the accumulation of DDT & DDE (which do not occur naturally) in some Marley Head fish samples.

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124 M.W.S.& D.B., Environmental Impact Statement Bondi Pollution Control Plant, M.W.S.& D.B., 1979, p17; Caldwell Connell, Environmental Impact Statement North Head Pollution Control Plant, M.W.S.& D.B., 1979, pp15-6.

125 Caldwell Connell, Sydney Submarine Ocean Outfall Studies, 1976, p93.

126 ibid., p129.

127 Caldwell Connell, Environmental Impact Statement North Head, p33.

FIGURE 7.6

SYDNEY'S TOP 20 TROLLING GROUNDS

To many bluewater anglers the idea of trolling is simply dragging a lure behind the boat in the hope that something will latch onto it.

But trolling can be more than this, it can be a carefully planned, aggressive and exciting form of productive fishing.

Even when the whole day's fishing is not to be spent trolling, results from a couple of hours with the lures can provide bait and table fish as well as some very enjoyable action.

The gear needed does not have to be fancy, any good quality geared reel or heavy threadline, combined with a good boat rod will get you involved with the fish.

If you want to do a lot of trolling, then buy a rod that will stand up to the searing runs that the hard hitting pelagics can dish out.

Any of the good 4/0 type game reels are perfect for the job especially when combined with a good jig or game rod.

The lures are simple and the techniques in using them are also easy. Basically any lure that comes through the water without spinning can be with success.

Naturally some lures are better than others and I tend to base the range I use around 3 or 4 different patterns.

For the small tuna I use ¼oz and ½oz feathers as well as small squids and pearlheads.

The colours I find best are red and white in the feathers and pink, red or white in the squids and pearlheads.

To catch the larger types of fish found off Sydney, I use a couple of small to medium sized Kona Heads and big green squids.

In this map I have attempted to show some of the main areas around Sydney where surface fish can be found in good numbers.

Naturally all areas are subject to the movement of currents and baitfish and some searching may be necessary.

This map is the first of its type and hopefully it will lead anglers to catch more and better fish.

Quality kingfish, yellowfin, wahoo, dolphin fish and marlin can be taken by trolling the bigger lures.

The Kona Heads that seem to produce best are the 350V in red or yellow with green. The big green squid is a favourite with yellowfin and marlin.

The pelagics can be found anywhere there is good bluewater but to really score you should know where good numbers of surface fish can be located.

The reason why these fish congregate in certain areas is open to conjecture, but it certainly seems to be associated with reef formations.

It is also certain that just as there are marks for catching bottom fish, areas can be pinpointed where surface fish will be found in heavy concentrations.

Sure you can hook fish anywhere in the ocean, but having some knowledge of where to look will really increase your catches dramatically.

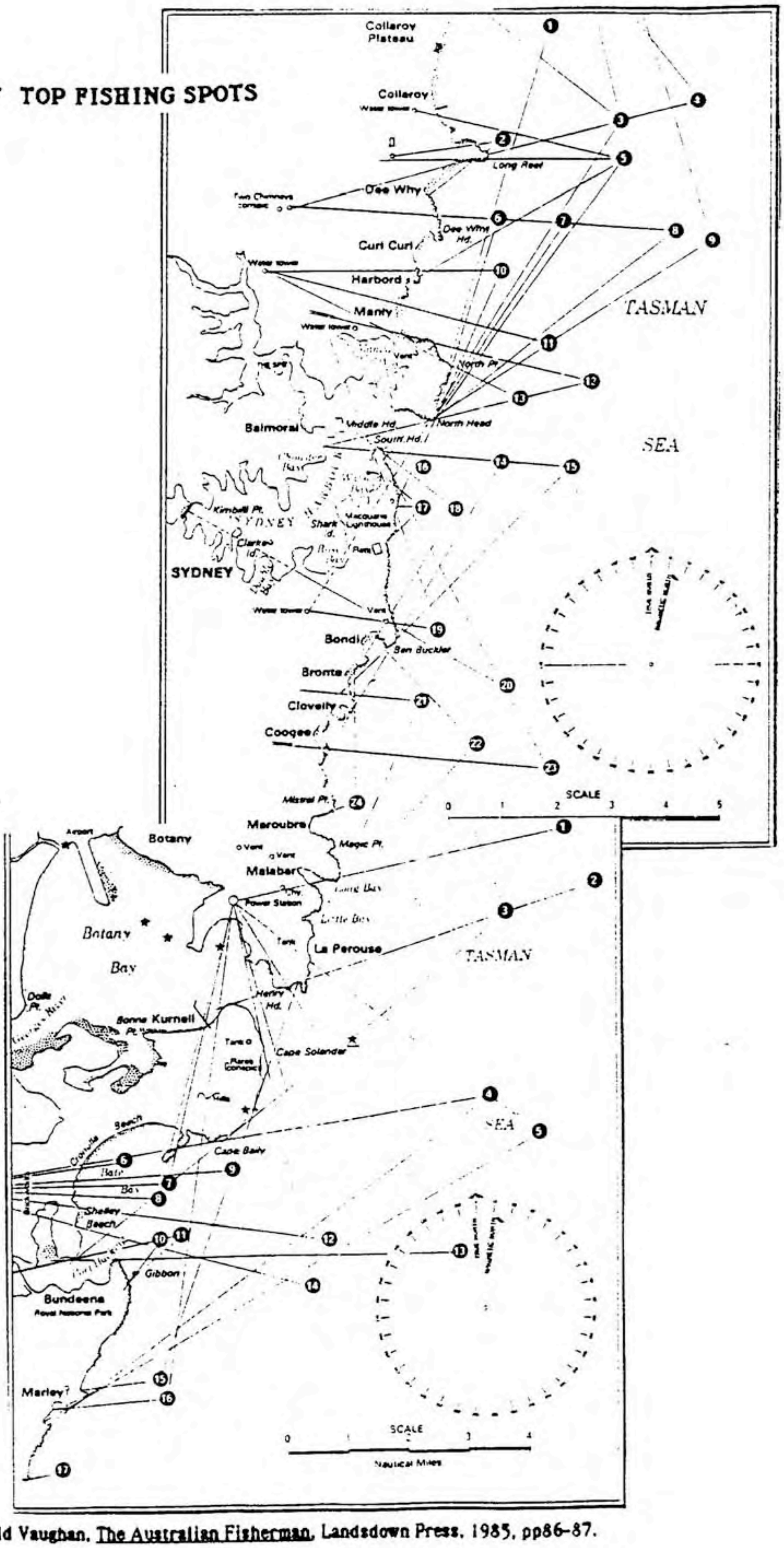
By Laurie McEnally

HOW YOU FIND THEM

1. Barrenjoey to Palm Beach holds a lot of mixed small fish, tailer, salmon, bonito, stripies and kingfish.
2. Top area on a run out tide. Strong current line forms, forcing bait fish to bunch up and mixed tuna as well as a lot of marlin are caught here.
3. Southwards from Whale Beach to Newport Reef is often a good pit-stop to get some gamefishing baits. Small tuna, tailer, salmon and kings can be trolled up on the drop-offs, with minnow lures.
4. Trolling along the 20 fathom line in this area is very productive for striped tuna.
5. Long Reef can produce anything at the right time; marlin, dolphin fish, wahoo, kingfish, yellowfin and stripies are all on the cards. Troll from the area known as Reef Wide to about the 12 fathom line.
6. White Rock: Top spot for kingfish. Also tailer, salmon and bonito at times.
7. Mixed light gamefish. Small kingfish, stripies, bonito, salmon and tailer.
8. The stretch of water between Queencliff Point and South Curl Curl often has visual schools of surface fish feeding. Troll around patches of birds no further out than moored ships.
9. North head seems to be extremely good at times for big fish. Yellowfin and marlin are often taken in this area. School yellowfin from 5 to 18kg are a good bet in this area.
10. South Head is good for mixed small tuna, kingfish, bonito, tailer and salmon.
11. Ben Buckler: Trolling along the murk line is tops for stripies.
12. The Four Mile is a good area for stripies and small yellowfin.
13. Wedding Cake Island: Small kingfish school in big numbers around the island, especially in summer. Bonito also move around the island in good sized schools.
14. South Maroubra is a very productive little spot, particularly for tailer, salmon, bonito and small kingies.
15. Trolling around the Peak can produce anything that takes lures. Kingfish, tuna, marlin, wahoo and dolphin fish can all be taken here. It is one spot that can produce fish in both winter and summer.
16. & 17. North and South of Botany Bay are good for most small light gamefish as well as the odd yellowfin and marlin.
18. The area around Bate Bay and Shelley Beach is a top area for small kings, salmon and tailer.
19. Jibbon: This area is famous for the huge numbers of kingfish.
20. South of Port Hacking and down to Marley is a good area for stripies and small yellowfin.

SOURCE: <u>Fishing Giant Map Book</u>, Neptune Press, p62.

FIGURE 7.7 TOP FISHING SPOTS



SOURCE: Harold Vaughan, The Australian Fisherman, Landsdown Press, 1985, pp86–87.

Table 7.9

CONCENTRATIONS OF RESTRICTED SUBSTANCES IN MARINE LIFE 1973										
SAMPLE		HEAVY METALS mg/l or parts/million					PESICIDES parts/billion			
SPECIES	LOCATION	Mer-cury	Cad-mium	Copper	Lead	Zinc	DDT & DDE	Lindane	Aldrin	Di-eldrin
Yellow Tail	Malabar	0.04	0.05	1.4	1.1	26	5.6	0.9	0.3	0.9
	Marley	0.04	0	0.8	0.22	3.4	4	0	0	0
Flat Head	Malabar	0.3	0	1.1	0	3.0	2	0.6	0	0
	Marley	0.11	0	0.2	0	0.3	0	0.9	0.4	0
Crested	Malabar	0.12	0.02	0.43	1.1	4.3	14	1.0	0.4	0
Flounder	Marley	0.22	0.05	0.49	0.79	3.4	13	0.6	0.2	0
	Malabar	0.34	0.02	1.9	0.22	4.5	15	4	0.09	0
John Dory	North Head	0.21	0.2	1.24	0.46	3.0	102	0	0.08	0
	Marley	0.40	0	0.79	0.11	2.1	1.6	0.2	0	0
Blue Groper	North Head	0.43	0	0.32	0	3.0	430	30	0.8	80
	Marley	0.53	0	0.14	0.19	5.8	150	1	0	0
Brown Groper	North Head	0.54	0	1.44	0.33	3.5	102	0	100	9
	Marley	0.31	0	0.14	0	1.8	120	2.5	0	0
Black Drummer	Malabar	0.14	0.02	2.54	0.38	9.6	70	10	0	30
Black Fish	Malabar	2.64	0.02	0.34	0.22	4.8	200	20	0	30
Tuna	Malabar	0.4	0	0.86	2.4	7.1	5	0	0	0
Bream	Malabar	0.43	0	0.28	0.19	2.8	620	30	0	0
Tailor	Malabar	0.16	0.06	0.27	0.22	6.2	300	6	0	20
Trevally	Malabar	0.08	0.07	0.42	0.19	4.45	280	20	0	20
Worm	Malabar	0.12	0.38	4.8	3.5	98	220	50	0	30
mussel	North Head	0.30	0.36	6.6	3.0	75	17	0	0	0
ascidian 1	North Head	0.26	0	2.5	2.5	10.4	250	0	20	0
	Marley	0.17	0.02	1.6	0	8.8	-	-	-	-
ascidian 2	North Head	0.15	0.03	1.9	0.25	25.2	100	0	0	0
mollusc 1	North Head	0.08	0.92	33	1.48	310	-	-	-	-
mollusc 2	North Head	0.28	0.27	2.2	0.22	13.7	220	0	0	5
NH&MRC max levels	1972	0.5	5.5	30	2	40	1000	1000	200	200
	1987 fish	0.5	0.2	10	1.5	150	1000	1000	200	100
	" shellfish	0.5	0.2	70	2.5	1000	1000	1000	200	100

worm - Torebellidae
ascidian 1 - Pyura pachyddermatins
acidian 2 - Pyura Praeputiallis
mollusc 1 - Agnewia tritoniforis
mollusc 2 - Cebastans spengleri

information compiles from:
Caldwell Connell Engineers, Environmental Impact Statement: North Head WPCP, MWS&DB, Dec 1979, pp32 -33 & Caldwell Connell Engineers, Environmental Impact Statement: Malabar WPCP, MWS&DB, Dec 1979, p42.

In Australia the NH&MRC recommends maximum levels of various toxic substances for food stuffs, including fish. These figures are based on Australian dietary habits and what little is known about the toxicology of the substances in question. For example, for mercury, it has been estimated that an "average" human of 70 kg (which seems to imply an average adult male more than an average human) can consume 0.3 mg of mercury each day and just be on the borderline of showing clinical symptoms of toxicity. It is assumed that such a person would eat no more than 59 g of fish a day or 410 g per week and the theoretical blood levels are calculated. A safety factor of ten is applied (and these safety factors vary for each toxic substance) and the maximum concentration of mercury in fish is thereby worked out.[128]

The guidelines put out by the NH&MRC are therefore based on assumptions that may be wrong, particularly for the children of amateur rock fishermen. Moreover the maximum levels are based on partial ignorance and a good deal of uncertainty and they are frequently changed as new information comes to hand. Nevertheless they are the only Australian standards available. In the 1973 study, 16 species caught at Malabar, 5 (that is 33%) were above the NH&MRC maximum allowable levels set in 1972 for one or more of heavy metals and seven (that is 47%-almost half) were at or above the 1987 NH&MRC levels for heavy metals. Moreover these levels recommended by the NH&MRC do not seem to take account of the possible synergistic effects of more than one heavy metal or organochlorine being present in seafood.

Despite these astounding results Caldwell Connell argued that the findings should cause no concern and say that although a blackfish had more than five times the level of mercury allowed for food by the NH&MRC guidelines, they subsequently caught six more to check them and found that they had mercury levels below the guidelines and so they assumed the first blackfish (which by this time still represented 14% of the blackfish samples) was of dubious validity. The Water Board cheerily accepted Caldwell Connell's interpretation of the results of the survey. In what some might see as an unduly optimistic conclusion the Board stated

> Whilst the statistical significance of the 1973 survey is not able to be clearly established the results are encouraging in that they indicate that no serious environmental problem existed even prior to the full implementation of source control of restricted substances... [129]

A later SPCC report argued that the Board's conclusions were open to question because very few samples were collected and because the validity of the species selected as indicators of pollutants have not been established. They point out that only muscle tissue was analysed although many metals accumulate in the liver and other organs and that microanalytical techniques for metals were not well developed at the time the study was done.[130]

Recently an ex-Water Board employee, Ron Snape, a marine biologist, has told the press that whilst he was conducting a survey of marine life off Sydney's outfalls for the Board, he carried out tests for concentrations of heavy metals and organochlorines although this was not part of his brief. He claims that he found concentrations of mercury, zinc, cadmium and dieldrin in the samples found near the Malabar outfall and the Blackfish had concentrations of mercury up to six times the NH&MRC maximum levels. He says the Water Board did not want to know and he was forced to resign over it. He was coaxed back into their

128 S.P.C.C., Toxic Chemicals, p10.

129 M.W.S.& D.B., Environmental Impact Statement Bondi, pp30-321.

130 Ralph Kaye, 'Technical Support Paper - Sludge Disposal Policy', Clean Waters Advisory Committee, 10th September 1987, p14.

employment and completed the report in 1975 but claims that the report was heavily rewritten and distorted. He again resigned from the Board.[131]

Another study undertaken by the Fisheries Research Institute of fish in the vicinity of the ocean outfall sites was not mentioned in the environmental impact statements. The results were not published because it was argued they were not scientifically significant.[132] It was a study of heavy metal content of fish in 1974 and 1979. The results of this very small survey are shown in table 7.10. In this study all eight Blue Groper sampled from Manly waters were above the NH&MRC maximum allowable levels for mercury and one Red Morwong out of eight was also over.[133]

Table 7.10

HEAVY METAL CONTENT OF FISH 1974/78
mg/l or parts/million

SPECIES	location		Cadmium	Copper	Lead	Zinc	Mercury
Bream	Malabar	one only	0.07			27.5	0.36
	Manly	mean	0.10			12.6	0.10
		range	0.05-0.15			4.0-41.0	0.06-0.18
Black drummer	Malabar	one only	0.07			24.5	0.09
Luderick	Malabar	mean	0.07			22.4	0.33
		range	0.07-0.07			13.5-30	0.29-0.37
	Bondi	mean	0.10			31.4	0.04
		range	0.05-0.20			4.0-180.0	0.03-0.07
Trevally	Manly	one only	0.10			9.0	0.06
Sweep	Manly	mean	0.08			65.3	0.05
		range	0.05-0.10			15.0-144.0	0.04-0.05
	Bondi	mean	0.10			46.3	0.05
		range	0.10-0.15			9.0-130.0	0.04-0.06
Tarwhine	Bondi	one only	0.10			59.0	0.06
Blue Groper	Malabar	one only	0.01	0.59	0.4	1.9	0.46
	Manly	mean	0.01	0.55	0.15	2.4	0.67
		range	0.01-0.01	0.31-0.71	0.1-0.2	1.6-5.0	0.51-1.06
Red Morwong	Manly	mean	0.01	0.57	0.2	2.9	0.35
		range	0.01-0.01	0.35-0.85	0.1-0.5	2.2-3.9	0.21-0.54
NH&MRC maximum levels		1972	5.5	30	2	40	0.5
		1987	0.2	10	1.5	150	0.5

FROM: correspondence between R.Chvojka, Fisheries Research Institute to Ralph Kaye, SPCC, 16th December 1985.

A further study by the Fisheries Research Institute has been kept secret for years. Attempts by Stop the Ocean Pollution, the Australian Conservation

131 Sydney Morning Herald, 4th February 1989; Daily Telegraph, 4th February 1989.

132 interview with R.Chvojka, Senior Technical Officer, Fisheries Research Institute, 16th December 1988.

133 correspondence, R Chvojka, Fisheries Research Institute, to Ralph Kaye, SPCC, 16th December 1985.

Foundation[134] and by the then shadow minister for environment, Tim Moore, to find out the results of the study were unsuccessful.[135] The Senior Technical Officer of the Fisheries Research Institute now has no memory of the survey.[136] However the results are mentioned in an SPCC report. In the study Blue Groper and Red Morwong were collected between 1977 and 1979 near the ocean outfalls and tested for pesticides. Three of forty blue groper specimens exceeded NH&MRC maximum levels (0.1 mg/kg) for Dieldrin. Ten of 58 Red Morwong exceeded the same levels for Dieldrin and five had DDT body burdens in excess of NH&MRC maximum levels (1 mg/l) for total DDT. PCB's were also detected.[137]

A study by the NSW Health Commission of PCB's (Polychlorinated Biphenyls) in fish in Sydney waters, including Malabar sewage outfall waters, was done for the Australian Environment Council in the early 1970s but even experts in the field found interpretation of the results difficult because of the way the data were presented. It was possible to say, however, that large quantities of PCB's had been detected in Bream and Mullet and smaller amounts in Blackfish and oysters.[138]

The comments made in 1982 on how little work had been done on the amounts of PCBs in the Australian marine environment could be equally well applied to other toxic material.

> Most surveys seem to have been the result of sporadic, poorly planned and documented spot tests on the various localities thought to have been contaminated as a result of local industrial activity. At present it would seem that a pattern of PCB contamination similar to that of the Northern Hemisphere is occurring in Australia, in that the aquatic environment, particularly in the vicinity of industrial centres, is at greatest risk.[139]

Two recent studies of both pesticides and heavy metals in fish in the vicinity of the ocean outfalls have been done recently. One was published by the Water Board as part of a pilot study for an ongoing monitoring program. Organochlorines were found in all the fish species and the mean levels for the livers of the Stingray and of the Wobbegong shark were above the NH&MRC guidelines. Cadmium levels were also above NH&MRC guidelines in Balmain Bug and the Giant Hermit Crab.[140]

The other study, "The Malabar Bioaccumulation Study", came up with much more serious levels of both organochlorines and heavy metals (results shown in

134 correspondence, Jane Elix, NSW Campaign Officer, ACF, to Richard Gosden, undated.

135 correspondence, Alderman Ray Collins, Waverley Council to Richard Gosden, STOP, 9th September 1986.

136 interview with R.Chvojka, Senior Technical Officer, Fisheries Research Institute, 16th December 1988.

137 Kaye, 'Sludge Disposal Policy', p15.

138 B.J. Richardson & J.S. Waid, 'Polychlorinated Biphenyls (PCBs): An Australian Viewpoint on a Global Problem', Search 13(1-2), Feb/March 1982, p22.

139 ibid., p24,

140 Sydney Water Board, Sydney Deepwater Outfalls, Environmental Monitoring Programme Pilot Study, vol 11, March 1988, pp6-10.

table 7.11 & 7.12) but the results were not published. In that study all three fish species (the Red Morwong, the Blue Groper and the Rock Cale) sampled had average levels above the NH&MRC guidelines for several heavy metals in the livers of the fish and arsenic seemed to have been at high levels throughout the fish and invertebrates sampled. The Red Morwong and the Blue Groper also had average levels of organochlorines above NH&MRC guidelines. The eight Red Morwong taken at Malabar, in fact, had average levels of Benzene Hexachloride over 120 times the NH&MRC maximum levels, Heptachlor Epoxide over 50 times the levels as well as Dieldrin and arsenic in the muscle tissue that was above NH&MRC levels and above guideline levels of Lead, Cadmium, Arsenic, Selenium and Mercury in their livers.[141]

When part of this report was first leaked to the media[142], the SPCC, which had carried out the study on the Water Board's behalf, responded that the results were not significant because it was merely a preliminary study and a further broader study was to take place. The study had consisted of 8 samples of three fish species (24 samples) and 3 species of invertebrates (24 samples) taken off Malabar. The broader study was to consist of eight samples of 1 species, the Red Morwong, to be taken at various studies up and down the coast.[143] In effect the second more extensive study would be less extensive as far as fish off Malabar were concerned.

When more specific results from the first study were leaked to the Herald a few months later the official response was that a second set of tests had been conducted and the results would be due in another month. It was argued that the second set of tests had been conducted to test the results of the first survey. The Board stated that the original survey was considered too limited and "never intended to be used as a basis for public discussion."[144]

The extent to which organisms will accumulate toxic materials of various kinds depends on a number of factors including the species, the age of the organism, the season, the feeding habits and even the presence or absence of other toxic chemicals in the organism.[145] The purpose of the Malabar Bioaccumulation study was to provide data that would assist the Board in selecting organisms as part of their ocean outfall monitoring study.[146] From the studies which have been done in Sydney it is clear that of the fish species which have been sampled, those which accumulate toxic substances the most include the Blackfish, the Red Morwong, the Blue Groper and the Wobbegong Shark. The principle species of game and commercial fish taken in Sydney ocean waters are the Mullet, Tuna, Morwong, Flat-Head, Australian Salmon and Snapper.[147]

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141 'Malabar Bioaccumulation Study', Business Papers, Clean Waters Advisory Committee Meeting, 10th December, 1987.

142 Sydney Morning Herald, 27th September 1988.

143 interview with Bob Rothwell, S.P.C.C., Lidcombe, 27th September 1988.

144 Sydney Morning Herald, 7th January 1989.

145 S.P.C.C., Toxic Chemicals, p1.

146 ibid.

147 Caldwell Connell, Environmental Impact Statement North Head, p15.

TABLE 7.11

HEAVY METALS IN MARINE LIFE 1987 mg/l or parts per million								
SPECIES	LOCATION	Copper	Zinc	Lead	Cadmium	Arsenic	Selenium	Mercury
RED MORWONG muscle	Malabar	0.28	4.6	0.26	--	2.0	0.10	0.36
	Pt Hacking	0.26	4.0	0.18	--	2.0	0.18	0.28
	Terrigal	0.62	4.6	0.07	--	3.0	0.18	0.31
liver	Malabar	6	32	8.4	1.3	3.2	3.0	1.1
	Pt Hacking	17	46	3.8	5.0	4.2	2.8	0.84
	Terrigal	17	54	2.2	8.2	7	4.1	1.0
BLUE GROPER muscle	Malabar	0.29	4.1	0.04	0.01	0.8	0.23	0.55
	Pt Hacking	0.22	4.6	--	--	0.8	0.03	0.26
	Terrigal	0.54	6.4	0.15	--	1.3	0.25	0.30
liver	Malabar	3	34	2.8	1.4	1.8	1.0	1.45
	Pt Hacking	6	38	2.8	3.2	3.0	1.4	0.46
	Terrigal	6	44	1.8	4.4	3.8	2.2	0.54
ROCK CALE muscle	Malabar	0.27	8.4	0.04	--	0.5	0.05	0.04
	Pt Hacking	0.58	8.4	0.04	--	0.4	--	0.03
	Terrigal	0.55	12	0.10	--	1.0	--	0.06
liver	Malabar	520	60	0.5	1.0	1.7	5.4	0.32
	Pt Hacking	620	104	0.2	2.2	2.7	11.4	0.12
	Terrigal	600	98	0.1	3.2	6.2	11.4	0.24
RED BAIT CRAB	Malabar	32	25	0.38	0.04	6.1	0.84	0.065
	Pt Hacking	23	26	0.45	0.06	13	0.78	0.070
	Terrigal	26	28	0.02	0.08	8.1	0.68	0.054
ABALONE	Malabar	7	17	0.29	0.02	4.1	0.08	0.04
	Pt Hacking	7	15	0.02	--	12	0.20	0.058
	Terrigal	5	15	0.06	--	5.0	0.02	0.035
CUNJEVOI	Malabar	2	7	0.39	0.03	0.8	0.42	0.018
	Pt Hacking	3	6	0.28	0.01	0.6	0.42	0.038
	Terrigal	3	6	0.29	0.15	0.6	0.32	0.034
NH&MRC GUIDELINES	FISH	10	150	1.5	0.2	1.0	1.0	0.5
	SHELLFISH	70	1000	2.5	0.2	1.0	1.0	0.5

FROM: information supplied in business papers, Clean Waters Advisory Committee Meeting, 10th December 1987.

The Board has subsequently decided not to monitor any of the species that have gone above NH&MRC recommended levels in the past. Rather they are going to concentrate on the Snapper, with some monitoring of the Stingray, the Nannygai, the Tarwhine and the Leatherjacket.[148] The invertebrates that they have chosen to monitor are not the mussel or the ascidian or the mollusc that went over NH&MRC levels in 1973, nor the Red Bait Crab or Abalone that had elevated levels of copper and arsenic in the 1987 SPCC study but the Balmain Bug, the prawn and the squid. The Snapper has been chosen as the main focus of the monitoring study because it is a valuable commercial and recreational species, whose biology is well known, that accumulates a range of restricted

[148] Sydney Water Board, Pilot Study, vol 11, pp15-6.

substances, occurs at all depths over soft and hard substrates and which can be easily caught. [149]

TABLE 7.12

ORGANOCHLORINES IN FISH 1987 parts per billion							
SPECIES	LOCATION	TISSUE	BHC	HPTE	DDT (total)	Dieldrin	TOTAL OC'S
Red Morwong	Malabar	muscle	1220	2600	300	105	4230
		liver	160	320	--	--	480
	Pt Hacking	muscle	10	60	20	--	100
		liver	--	30	--	--	30
Blue Groper	Malabar	muscle	200	250	20	20	500
		liver	80	100	--	--	220
	Pt Hacking	muscle	--	--	--	--	--
		liver	--	--	--	--	--
Rock Cale	Malabar	muscle	--	20	--	5	50
		liver	--	30	--	--	30
	Pt Hacking	muscle	--	10	--	--	10
		liver	--	10	--	--	10
NH&MRC maximum levels			10	50	1000	100	

BHC - Benzene Hezachloride
HPTE - Heptachlor Epoxide
TOTAL OC'S - sum of all organochlorines detected.

FROM: Information supplied in business papers, Clean Waters Advisory Committee Meeting, 10th December 1987.

There is a tendency in NSW to limit discussion of industrial waste impacts on marine life to the possible health effects that may accrue to humans through consumption of seafood rather than considering effects on the marine life itself.[150] In 1976 Caldwell Connell argued that a detailed investigation of levels of pesticides and heavy metals in the marine environment was beyond the scope of the study. They assumed that as long as they met the SPCC guidelines for concentrations of restricted substances in ocean waters it would be okay.[151] (These guidelines are discussed further in chapter 8)

Caldwell Connell were unable to dismiss the problem of fish contamination so easily in the Environmental Impact Statements although they did allow themselves such statements as "The abundance of fish observed near the outfall discharge indicates that the discharge does not have an adverse impact on fish."[152] Moreover, they judged the obvious accumulation of restricted substances in the marine biota as acceptable, partly because the criterion they used were NH&MRC guidelines for food.

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149 ibid.

150 for example, S.P.C.C., Toxic Chemicals, pp1-2.

151 Caldwell Connell, Sydney Submarine Outfall Studies, p129.

152 Caldwell Connell, Environmental Impact Statement North Head, p32.

There are no Australian standards for what levels of bioaccumulation of restricted substances will not cause an adverse impact on fish. Often the level which is considered safe for human consumption purposes is higher than the level considered safe for protection of fish eating mammals and birds. For example the US Food and Drug Administration recommends a maximum level of 2 mg/l of PCB's for fish for consumption whereas the US Fish and Wildlife Service recommends a limit of 0.5 mg/kg.[153]

In 1987 a U.S. Office of Technology Assessment Report argued that despite the problems of documenting a relationship between waste disposal and marine impacts, "a strong overall case can be established that waste disposal activities are contributing significantly to substantial declines in the quality of marine waters and harming marine organisms."[154] The report noted that some organisms are more vulnerable than others, especially bottom-dwelling (benthic) organisms and those which spend all or part of their lives in coastal waters, as well as those that inhabit polluted waters during sensitive parts of their life cycles. Also marine birds and mammals which are at the top of the food chain can suffer because of biomagnification of pollutants. Such biomagnification has led to impaired reproduction in the animals. For example. in California, the decline of the brown pelican population and that of several other bird species has been directly linked to DDT-contaminated fish.[155]

Actual deaths of organisms due to pollution are difficult to detect, unless there is a mass killing that cause fish to be washed up in numbers on a beach or shore, because very sick or dead organisms don't last very long. Nevertheless other symptoms such as behavioural and physiological effects, as well as changes in abundance and distribution of organisms and fish have been detected in various polluted coastal waters in the United States and the US Office of Technology Assessment report states that

> a growing body of evidence links these effects to exposure to pollutants that sometimes are present at very low concentrations or to environmental changes induced by pollutants... The effects are concentrated in estuaries and coastal waters, but detectable effects also have been found in fish far from shore in the open ocean. . . considerable circumstantial evidence indicates that pollutants from waste disposal activities have contributed to declines of major fish populations in the United States.[156]

Noticeable physiological effects include fin erosion (fin rot), ulcers, shell disease or erosion, tumors and skeletal anomalies. Resistance to infection, growth and reproductive ability can also be affected and although these effects may not be immediately fatal they can lead to a premature death. Moreover submerged aquatic vegetation, which is an important part of the ecosystem that not only provides shelter and food but also sediment stabilising functions, seems to have been generally decreasing in the United States coastal areas and benthic

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153 S.P.C.C., Toxic Chemicals, p10.

154 US Office of Technology Assessment, Wastes in Marine Environmnents, p99.

155 ibid., p104.

156 ibid., pp110-2.

communities "have been affected by waste disposal in every region of the country"[157]

THE INTERNATIONAL DIMENSIONS OF SLUDGE

When sewage is primary treated it is the sludge which contains the highest proportion of toxic substances. At present, at the North Head outfall very little sludge is produced because there is only a minimal sedimentation process, therefore any toxic substances are retained in the effluent and enter the sea with the effluent. At both Bondi and Malabar, where some sedimentation takes place, sludge is collected and digested to allow some break down of organic matter. The sludge is then sent out the outfalls after dark. The sludge creates a dark slick and is discharged at night so it won't be observed.[158] Any resulting deposits on the beaches can be cleaned up early the next morning before most beachgoers arrive. (Randwick Council estimated that it cost them $23,000 during the 1983/84 year to clean up the sewage debris from the beaches in their municipality.[159]) The routine sampling that is done during the day time as part of the licence conditions misses the bulk of the sludge as well.

This practice of adding the sludge back into the effluent defeats much of the effect of primary treatment. An internal Water Board report stated that the advantages of treating sewage with primary treatment as compared to merely screening it and removing the grit and some of the grease disappeared to a large extent when the digested sludge extracted by primary treatment was added back into the effluent before discharge.[160]

Even digested sludge can cause problems in the marine environment. An SPCC report noted that digested sludge still contained significant amounts of grease and oil as well as other organic matter, trace metals synthetic organic compounds such as organochlorines and pathogenic organisms.[161] Table 7.6 gives an indication of the concentrations of metals in sludge as compared to raw sewage and shows that many of these substances aggregate in the sludge after treatment. The Board has not published any figures about concentrations of organochlorine pesticides and PCBs in sludge but the SPCC estimates that the .002 mg/litre in the raw sewage translates to about 6700 parts per billion in the sludge which would give about 3000-4000 milligrams per litre (wet basis) with higher values occasionally recorded.[162]

The SPCC report notes that the grease in the sludge creates an aesthetic problem but that problems are created for the marine life because of its nature and toxic content. The SPCC has observed changes to ecosystems in the immediate vicinity of the existing outfalls but argue that whether such changes are undesirable is really a value judgement. WP-1 guidelines in fact state that

157 ibid., p112.

158 Sun-Herald, 18th December 1988.

159 Randwick Municipal Council, Minutes, date unknown.

160 M.W.S.&D.B., North Head and Ocean Outfall Re-evaluation of Treatment and Disposal Options, Sept 1977, p2-7.

161 Kaye, 'Sludge Disposal Policy', p3.

162 ibid., p3.

the ocean waters should be protected "to retain a natural and diverse, but not necessarily unchanged, variety of marine life."[163]

Changes can occur because of the smothering of benthic organisms, alteration of sediment type from silty/sand or rock-reef to organically rich silt.[164] Sludge may contaminate the sediments with metals and organic chemicals as well as pathogens.[165] These sediments form part of the food chain and provide a pathway for these toxic substances into the food chain.

The ocean disposal of sewage sludge is controversial in many parts of the world. Two Water Board engineers noted after an overseas study tour

> Some countries regard all forms of sea dumping as reflecting the practices of an unsavoury past or as a last resort if no alternative land disposal options can be found; other countries regard it as an option, the merits of which should be considered alongside those of alternative options on the basis of science and of economics.[166]

In Europe only 7% of all sludge generated is disposed of in the sea and only the United Kingdom, Ireland, Netherlands and Spain use the ocean for sludge disposal with the UK contributing 90% of the sludge going to sea.(see table 7.13) In the U.K. 95% of sludge disposed of to sea was deposited from vessels and ocean disposal represented 29% of all sludge disposal there whilst in the U.S. it represented only 15%. In Japan, all sludge is either incinerated or composted and ocean disposal is prohibited because of public pressure. All over the world the trend is towards increased restriction of sludge being discharged into the sea.[167]

The global nature of marine environmental problems associated with sludge dumping was recognised in the early 1970s when a number of countries got together to negotiate terms of a global dumping convention in London. The London Convention on Dumping necessarily represented political compromises amongst the various interests and was not very rigorous, but this was necessary to maximise the number of countries that would be a party to it. Like NSW environmental law it allows for a certain amount of flexibility and discretion in its implementation and does not establish rigid standards. "The agreement implicitly recognizes that economic or policy considerations should be allowed to influence national decisions."[168]

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163 ibid., p6.

164 ibid.

165 US Office of Technology Assessment, Wastes in Marine Environmnents, p103.

166 W.R.Hazell & J.H.Browne, Report on IAWPR London Conference on Disposal of Sewage Sludge to Sea and Study Tour in U.K. and U.S.A., M.W.S.&D.B., 1981, p3 & p8.

167 ibid., p6; Kaye, 'Sludge Disposal Policy', p17; Clean Waters Advisory Committee Meeting 10th December 1987.

168 Marc Zeppetello, 'National and International Regulation of Ocean Dumping: The Mandate to Terminate Marine Disposal of Contaminated Sewage Sludge', Ecology Law Quarterly 12(3), 1985, p647.

Table 7.13

European Sludge Disposal Practices

Country	Sludge Prodn (1000 tds/yr)	Ag Land	Disposal Method (%) Other Land	Incin	Sea	Unspec
Austria	140	small	large	30	0	0
Belgium	70	15	83	2	0	0
Denmark	130	45	45	10	0	0
Finland	130	40	45	0	0	15
France	840	30	50	20	0	0
Germany	2200	39	49	8	2	2
Greece	3	0	100	0	0	0
Holland	230	60	27	2	11	0
Ireland	20	4	51	0	45	0
Italy*	1200	20	55	0	0	20
Luxem.*	11	90	10	10	0	0
Norway	55	18	82	0	0	0
Spain	45	60	......20......		20	0
Sweden	210	60	......30......		0	10
Switz.	50	80	10	10	0	0
UK	1200	39	27	4	30	0
Europe	6934	37	43	8	7	5

* Indicates percentages do not total 100

Source: Ralph Kaye, Technical Support Paper – Sludge Disposal Policy, CWAC, 10th September 1987, p. 73.

What the London Convention did recognise was the desire for many nations to control marine pollution. The Convention states

> Contracting Parties shall individually and collectively promote the effective control of all sources of pollution of the marine environment, and pledge themselves especially to take all practicable steps to prevent the pollution of the sea by the dumping of waste and other matter that is liable to create hazards to human health, to harm living resources and marine life, to damage amenities or to interfere with other legitimate uses of the sea.[169]

The Convention prohibits the dumping of substances such as organohalogen compounds (which include organochlorine pesticides), mercury and mercury compounds, cadmium and cadmium compounds and requires special permits for wastes containing substances such as arsenic, lead, copper, zinc, cyanides, fluorides, nickel and chromium and their compounds. Other wastes require general permits. Permits must consider the impact the wastes will have and the aspects which must be considered are specified.[170]

169 Environmental Protection (Sea Dumping) Act 1981, Commonwealth of Australia, Schedule 1.
170 ibid.

The prohibition of dumping of wastes such as mercury is regardless of the need for a disposal method or the cost of alternative disposal methods. These prohibited substances are only allowed to be dumped as trace contaminants or if they were rapidly rendered harmless. At the time the term "trace contaminants" was not defined. Interim guidelines were therefore adopted in 1978 which stated that material could not be defined as "trace contaminants" if it had been added to otherwise acceptable wastes for dumping, if it occurred in such amounts as could cause undesirable effects on marine organisms or human health, or if it was practical to reduce the concentration further by technical means.[171]

Australia was a signatory to the London Convention in 1972 but did not ratify it till 1985. The Environmental Protection (Sea Dumping) Act 1981 represents the conventions provisions in Australian law. Although the Convention was clearly aimed at all sludge dumping in the ocean the Australian Act has changed the wording slightly in a way which makes it inapplicable to the disposal of sludge from outfalls and pipelines despite the noting of outfalls and pipelines as a source of marine pollution in the Convention's preamble.[172]

Whether or not the Act applies to sewage sludge discharged through pipes or only that which is barged out to sea, the discharge of sludge through pipes close to shore is obviously no better than dumping from vessels. The U.S. Environmental Protection Agency noted in 1979 with respect to its own laws

> It would be incongruous for Congress to ban dumping of such sewage sludge at dumpsites anywhere from twelve to more than one hundred miles from shore, while, at the same time, to allow it to be discharged through outfalls in nearshore coastal waters. [173]

Nevertheless the Water Board is able to legally discharge organochlorines, mercury and cadmium through its outfall in quantities large enough to show accumulation in marine life and to accumulate to the extent that some fish species have shown levels above health guidelines for consumption. This clearly breaches the intention of the London Convention for these substances do not meet the definition of "trace contaminants" given above and are obviously not "rapidly rendered harmless".

The problems in meeting the provisions of the London Dumping Convention have been felt in other countries too. In the United States, which drafted the original document that formed a basis for negotiation for the Convention, attempts by the Environmental Protection Agency to phase out sludge dumping have not been very successful. The EPA introduced revised regulations in 1977 which were aimed at incorporating the requirements of the London Convention. Special permits were issued for some sludges whilst others received interim permits for limited periods. The EPA set a 1981 deadline for full compliance with the provisions of the Convention.[174]

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171 Zeppetello, 'National and International Regulation of Ocean Dumping', p640.

172 Environmental Protection (Sea Dumping) Act 1981, Commonwealth of Australia.

173 Environmental Protection Agency, 'Modification of Secondary Treatment Requirements for Discharges into Marine Waters', Federal Register 44(11), June 15 1979, p34797.

174 Zeppetello, 'National and International Regulation of Ocean Dumping', p629.

These interim permits could only be issued if there was sufficient need or if the denial of such a permit would cause worse environmental affects because of alternatives that would be used. Concerned that the EPA was issuing these interim permits too liberally without determining need but rather in response to pleas of economic hardship from municipalities, the US Congress directed the EPA to end sewage sludge dumping by the end of 1981. Sewage sludge was defined as waste generated by a municipal sewerage treatment plant which might "unreasonably degrade or endanger human health, welfare, or amenities or the marine environment, ecological systems, and economic potentialities" if it was dumped in the ocean.[175]

Some States willingly acquiesced to the Federal restrictions on sludge dumping. In California the impact of sludge dumping had been extensively monitored and the marine environment had been "significantly degraded" at two sites where they had been dumping sewage sludge. The Californian government therefore explicitly banned sewage sludge discharges in ocean waters.[176]

When the 1981 deadline came up, both New Jersey and New York municipal authorities challenged the EPA in the court. The New Jersey authority lost in a New Jersey district court but the New York authority won in a New York district court. New York city argued that the environmental consequences of land disposal outweighed the environmental consequences of ocean dumping 12 miles out in the New York Bight.[177] The ruling which the EPA did not appeal against weakened the EPA resolve and it decided to "be more flexible".[178] The EPA was successful however in getting the sludge dumping site shifted from 12 miles out to sea to 106 miles out.

Another attempt by the EPA to formulate a policy which stated that ocean dumping should only be allowed if it was considered "environmentally preferable" to other alternatives was squashed by the Office of Management and Budget (OMB) which ordered the EPA to abandon efforts to issue the policy because it wanted the EPA to consider all disposal media to be equally appropriate.[179]

Even the US House of Representatives which has been strongly opposed to ocean dumping has been unsuccessful at getting laws implemented to restrict ocean dumping. A 1984 bill (H.R.4829) for example which contained no deadline for stopping ocean disposal of sewage sludge but rather sought a reduction in contaminant levels after 1986 was not passed by the Senate. If these bills had been passed by the Senate they would probably not have been passed by the Reagan Administration.[180]

More recently the 1988 summer in New York has brought huge publicity about beach pollution and closures and rumours that sludge from the old 12 mile dump

175 ibid., p630.

176 Environmental Protection Agency, 'Modification of Secondary Treatment Requirements', p34797.

177 Zeppetello, 'National and International Regulation of Ocean Dumping', p631-4.

178 ibid., p650.

179 ibid., p651.

180 ibid., pp656-8

is breaking away and coming on shore.[181] As the Congress was debating a bill to end sludge dumping within four years, New York promised it would stop dumping within a decade.[182]

Ocean disposal is more attractive to the municipal authorities than land disposal because it is cheaper and because available land is becoming scarce. At the same time the amount of sewage sludge being generated is increasing. Moreover, no option is environmentally beneficial whilst sewage sludge is contaminated with toxic substances and pathogens. Sewage sludge will remain a problem whilst the authorities are unwilling to enforce strict controls on what industries are allowed to put down the sewers and thereby ensure that measures such as waste minimisation, process changes, recycling and pretreatment are encouraged.

In Australia where the Federal Government has chosen to interpret the London Dumping Convention as applying to sludge dumped through pipes and where environmental regulation is left to a state level, there is no body such as the EPA pushing to stop sludge dumping. In NSW the SPCC decided in the 1980s that it had better put together a sludge policy. An attempt in 1985 to get a draft sludge policy approved by the Clean Waters Advisory Committee met with opposition from the Water Board's representative despite the fact that the policy was careful to make provision for the Board to continue to discharge sludge through its three main shoreline outfalls and to dispose of sludge through the extended ocean outfalls when they were built.[183]

The Board's representative, John Browne, argued that the Board's research had not shown any detrimental effects accrued from dumping sludge in the ocean. He suggested that the SPCC had no scientific basis for rejecting ocean sludge disposal as a legitimate option. The Draft Policy was not approved by the Committee and sent away to have more work done on it.[184] The SPCC subsequently consulted with the Sydney Water Board, as well as the Hunter District Water Board and the Fisheries Research Institute on its draft sludge policy which became a draft "interim policy."[185]

The Board refused to acknowledge that adverse environmental impacts made sludge disposal undesirable and adopted its own policy that it would only select land treatment where "present worth cost difference" was equivalent to ocean disposal or where the cost of land utilisation was only marginally greater.[186] Costs for sludge disposal at Bondi and Malabar are shown in table 7.14. The negligible cost of ocean disposal is hard to beat.

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181 see for example, New York Times throughout July/August 1988.

182 New York Times, 4th August 1988.

183 Clean Waters Advisory Committee Meeting Minutes, 14th November 1985.

184 Clean Waters Advisory Committee Meeting Minutes, 14th November 1985.

185 Clean Waters Advisory Committee Meeting Business Papers, Agenda Item 5, 10th September 1987,p36.

186 Clean Waters Advisory Committee Meeting Minutes, 11th June 1986.

TABLE 7.14

COMPARATIVE COST OF SLUDGE DISPOSAL OPTIONS				
Sludge Disposal Option	location	Capital Cost $M	Operating Cost $M	Total Capitalised Cost $M @ 10% p..a.
ocean via outfall	Malabar Bondi	negligible negligible	negligible negligible	negligible negligible
Incineration	Malabar Bondi	19 8	2.4 1.0	43 18
Landfill	Malabar Bondi	28 14	2.3 1.3	51 27

Source: Disposal of Digested Sludge to the Ocean: Malabar & Bondi Water Pollution Control Plants, MWS&DB, December 1982.

The SPCC interim policy on sewage sludge disposal was presented to the Clean Waters Advisory Committee towards the end of 1987. It emphasised that its objective was not to prohibit existing discharges of sludge to the ocean but only to restrict the growth of quantity of sludge being discharged till the results of environmental studies could be evaluated, particularly in other parts of NSW. The policy stated that ocean discharge would normally only be approved if the sludge was digested and discharged through approved submarine outfalls and then only if no significant environmental effects were detected and that land treatment of sludge would be encouraged because it was generally beneficial.[187]

A SPCC representative at the meeting noted that a visitor from the "influential US Congress Appropriations Committee" thought that the US EPA was unlikely to relax its policy of prohibiting new sludge discharges to the ocean. He also pointed out that Japan had to abandon plans to dump sludge at sea because "popular and political pressure against the move was so strong that it has been abandoned as an option" and a similar trend could be observed amongst the Scandinavian countries with respect to the Baltic Sea.[188]

The Water Board and the Public Works Department opposed the policy although the Public Works Department, which was responsible for all treatment works in NSW aside from those operated by the Hunter District and Sydney Water Boards, in fact, did not use the ocean for disposal at any of its treatment plants but rather used land treatment already and although the Sydney Water Board's three main ocean outfalls were exempted whilst the submarine ocean outfalls were built. The interim sludge policy was therefore not approved by the Clean Waters Advisory Committee. Rather they recommended that a Sludge Sub-Committee consisting of representatives from the SPCC, the Sydney Water Board, the Hunter District Water Board, the Public Works Department, the

187 Clean Waters Advisory Committee Meeting Business Papers, Agenda Item 5, 10th September 1987, pp36-38.

188 Clean Waters Advisory Committee Meeting Minutes, 10th December 1987.

Health Department, the Department of Agriculture and the Metropolitan Waste Disposal Authority, be formed to investigate and report.[189]

CONCLUSION - THE HIDDEN COSTS OF INDUSTRIAL POLLUTION

The responsibility for disposing of industrial wastes has become a public one because of the desire to encourage industrial growth and also because of the lack of responsibility shown by industries when left to their own devices in this respect. The use of the sewers for this purpose seemed a logical idea at a time when the composition, and therefore the treatment, of domestic and industrial liquid wastes was basically similar. The changing composition of liquid industrial wastes brought that logic into doubt and has given rise to the need for restrictions, pricing mechanisms, inspections and prosecutions just to ensure that the sewerage system can continue to function as it was originally designed to.

The growing environmental awareness of the late 1960s and 1970s forced a crisis during which the environmental consequences of the use of water carriage for industrial waste disposal and especially the use of stormwater drains, canal, creeks and rivers for this purpose became unacceptable. The response was to divert most of Sydney's liquid wastes east of Prospect into the sewer system. Consequently, the Water Board, rather than changing its criteria for acceptance of industrial waste into the sewers to cover environmental damage that might occur at the ocean outfalls, was forced to accept a heavier industrial waste load to cater for the political desire to clean up the rivers.

Strength charges allowed a degree of flexibility in applying acceptance to sewer standards and were supposed to act as a financial incentive to industries to install on-site treatment facilities. Standards had been enforced where these facilities could be economically installed. The term "economically" seems to be a negotiated one with the result that most pre-treatment, today, is very rudimentary and is limited to dilution, neutralisation, settlement and precipitation. The philosophy of 'Best practicable technology' overrides environmental standards in control of industrial waste.

The desire to maintain good relations with industry together with staff cutbacks has led to a situation where these standards are increasingly self-monitored and self-policed. It seems that industry can be trusted to do this although they would not be trusted to completely deal with the waste themselves. Moreover, the encouragement of industrial waste into a system that was never designed for it has not only diminished the effectiveness of the treatment of domestic sewage but acted as a disincentive for the development of any form of waste management that reduces the generation of waste during production or recovers or recycles waste products. It has literally inhibited the development of waste treatment and disposal technology.

Experience overseas has shown that the assumption that regulation inhibits industrial growth and that tight pollution control in particular makes an

[189] Clean Waters Advisory Committee Meeting Business Papers, Agenda Item 5, 10th September 1987, p37; Clean Waters Advisory Committee Meeting Minutes, 10th December 1987.

industry less profitable cannot be maintained. Dirty industries are often inefficient and badly managed and process changes and innovations forced by regulation can in fact reduce costs and help industries to be more productive and more profitable.

Moreover, the costs to the environment of allowing the sewers to be a cheap disposal system for industry are unknown. Despite the assurances by the Water Board and their consultants, there is growing evidence that benthic life is disturbed and that heavy metals and organochlorines are accumulating in the marine life, posing a threat to both humans and the ecosystem. This situation is exacerbated by the continued insistence that sludge be disposed of to sea despite international law and trends to the contrary and despite some attempts by the SPCC to curb this practice.

The growing body of evidence in Sydney and abroad that the use of sewers for the disposal of toxic industrial waste is having a detrimental effect on the marine ecosystem is studiously ignored by the Water Board. The presence of this toxic industrial waste in the sewage means that sewage sludge cannot be safely incinerated nor treated on land, and that more advanced, biological treatment is not possible. The choice of submarine ocean outfalls reflects a decision made given these constraints. This decision and its defence will be discussed further in the next two chapters.

CHAPTER 8

THE 'SCIENCE' AND 'METAPHYSICS' OF SUBMARINE OUTFALLS

In previous chapters we have considered the engineering and legal contexts in which the decisions were made to construct submarine ocean outfalls at Sydney's three major sewage outfall sites. In this chapter the criterion used in the design of these new outfalls and the physical, chemical, biological mechanisms upon which their performance depends will be considered. But more importantly this chapter is concerned with the way in which knowledge of these mechanisms, their importance and their role in outfall performance, is socially constructed and manipulated.

The ocean outfalls were purportedly designed to meet water quality criteria which were set down in the SPCC WP-1 guidelines. Caldwell Connell identified four aspects of the guidelines which directly influenced their design. These were maximum concentrations of restricted substances, maximum allowable variations of dissolved oxygen and pH, bacteriological standards for bathing waters and aesthetic impact. The performance of the submarine outfalls depended on four mechanisms; the initial dilution which would take place as the effluent rose from the sea bottom, subsequent dilution or dispersion once the effluent-seawater mixture reached equilibrium, movement of the effluent field under the influence of water currents and reduction of sewage organisms in the sea.[1] These principles have been used in the Board's public advertising campaign. An example is shown in figure 8.1.

DILUTION - IS IT THE POLLUTION SOLUTION?

The rationale behind extended ocean outfalls rests heavily upon dilution as a mechanism for reducing health risks and damage to the environment. Yet the design calculations and computer models for predicting dilution have been severely criticised and it had been argued that dilution was in fact overemphasised at the expense of natural mechanisms that cause an opposite effect of accumulation, including bioaccumulation of toxins, sedimentation of sludge particles and agglomeration of sewage particles with grease.

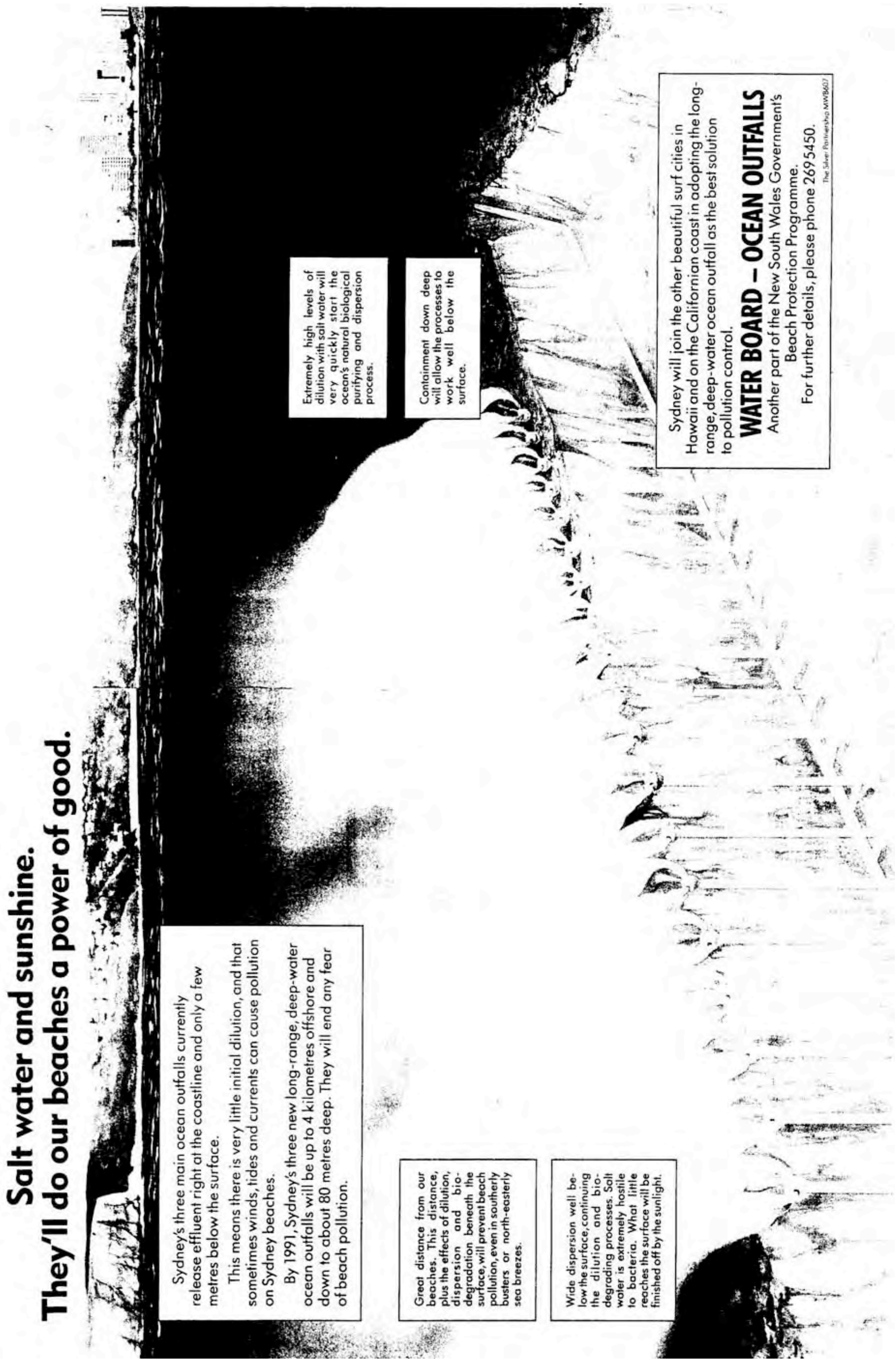
When the Environmental Impact Statements for the submarine outfalls went on display the SPCC undertook a detailed assessment of the oceanographic and hydraulic study and Robert Brain, an SPCC engineer, was recommended for this task as he was one of only two SPCC officers thought to have the necessary expertise to undertake the assessment of such highly technical and mathematically complex material.[2]

Brain made some fairly damaging criticisms of the theory used to predict the performance of the outfalls. Brain suggested that the sewage plumes would be very persistent and that the Malabar plumes would take a month to diffuse to quarter strength. As a result, he claimed, there would be permanent dead water

[1] Caldwell Connell, Sydney Submarine Outfall Studies, M.W.S.&D.B., 1976, pp10-12, p165.

[2] Internal memo by Principle Engineer-Water, Wastes & Chemicals, S.P.C.C., 31st January 1980.

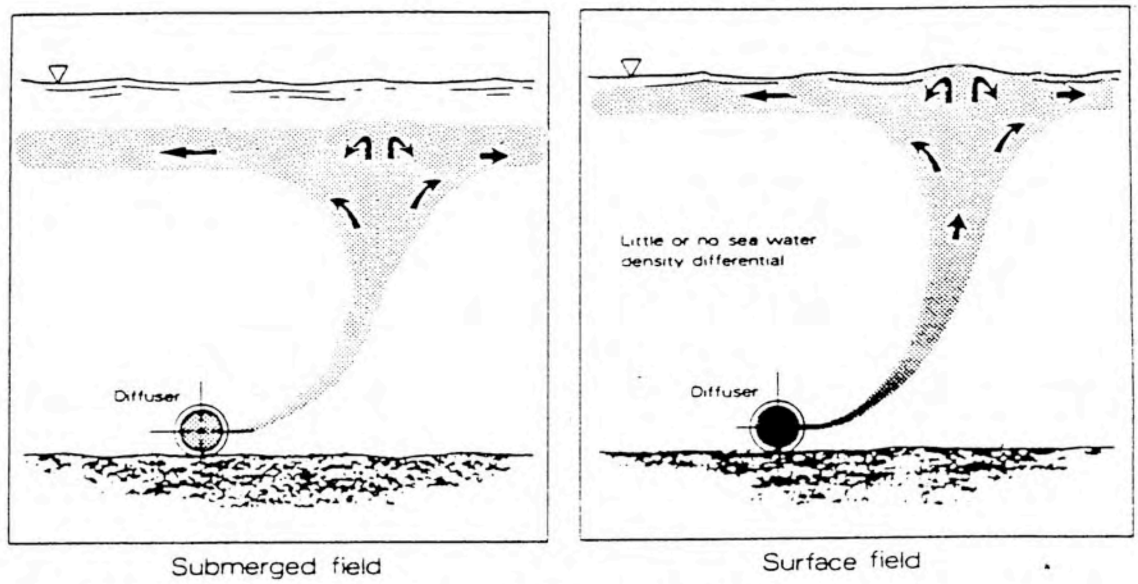
Figure 8.1 Sydney Water Board Advertisement (SMH 9/12/86)



behind the outfall possibly extending for several kilometres down current, which would be heavily contaminated with sewage and possibly anaerobic.[3]

Caldwell Connell had explained in their report that the sewage would be subject to two phases of dilution. The initial dilution phase would occur when the plume of sewage came out of the outlets of the submarine outfalls under pressure and rose towards the surface because it was lighter than the sea water. (see figure 8.2) This sewage plume would then reach an equilibrium which might be on the surface of the sea or below the surface. Subsequent dilution would occur as the seawater mass moved away from the outfall.[4] Thus calculations of how much dilution would take place were worked out in two stages and Brain criticised the theory used for both predictions.

Figure 8.2 Schematic Representation of Submarine Outfall



SOURCE: Caldwell Connell, Sydney Submarine Outfall Studies, MWS&DB, 1976, p41.

Caldwell Connell had calculated the initial dilution which would be achieved by the outfalls using a computer analysis based on traditional theories built upon the work of several researchers. These researchers had built up mathematical models of flow conditions achieved under laboratory conditions. For example, the theory of mixing of a turbulent jet discharging into a fluid of similar density, which had been developed in 1950 and shown to be a poor assumption, had been used by most investigators since that date. Similarly, the results of experiments carried out in 1956 with a circular jet discharging vertically into a stratified stagnant fluid of greater density had been used to predict the bounds of a submerged field of effluent under all conditions of current flow.[5]

3 R.Brain, internal report to S.P.C.C., 1980.

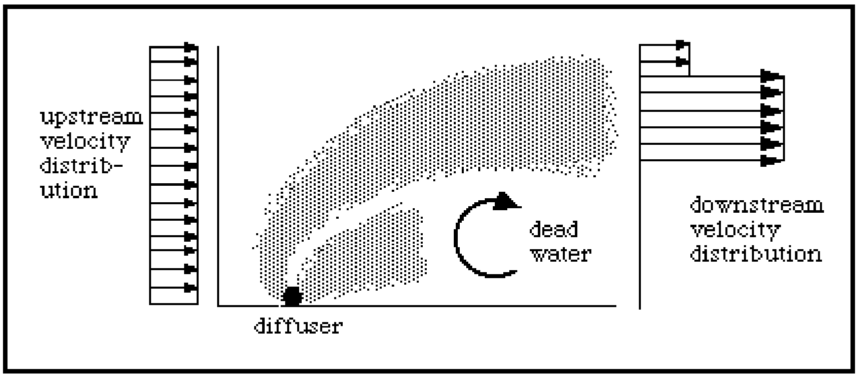
4 Caldwell Connell, Sydney Submarine Outfall Studies, pp10-11.

5 R.Brain, `Recent Developments in Ocean Outfall Diffuser Theory', Conference on Environmental Engineering. Townsville, 8-10 July 1981, pp113-4.

Caldwell Connell had admitted that their analysis did not consider the effect of currents in receiving waters but they assumed that subsurface currents would improve the mixing and dilution that they had predicted using `still water' results.[6] They stated that there was "no satisfactory mathematical basis for calculating the effect of current on a buoyant jet".[7] Brain placed far more significance on the effect of current on calculations of achievable dilution, arguing that the coastal currents of NSW were too large to assume them to be inconsequential. Such currents resulted in an asymmetric plume whereas traditional theory assumed a symmetrical plume and the Caldwell Connell report had in fact depicted a symmetrical plume in their report which would imply that dilution water had to be coming into both sides of the plume.[8]

In actual practice, Brain argued, while a current was flowing the plume from the upstream orifice would intercept all the diluting water whilst the downstream orifice would be left to discharge effluent without dilution into a dead zone of water where there was no flow. (see figure 8.3) Dilution would only occur if there was water available to dilute the effluent and this was not the case on the downstream side of the orifice.

Figure 8.3 Schematic Representation of Diffuser Operation



SOURCE: R.Brain, internal report to SPCC, 1980.

As a result of the SPCC repudiation of Caldwell Connell's first dilution model, the consultants put forward a modified dilution formulation which Brain insisted was even less applicable than the original one. The problem was that other SPCC staff were unable to assess Brain's reports properly. The principal engineer for his section wrote,

> While there may well be a flaw or flaws in the alternative theory proposed by Mr Brain, I am unable to find same in the argument presented by him in his report. Further, I believe the issue is of such importance, alleging as it does that the proposed extended outfall will not result in compliance with the ocean discharge criteria specified by the Commission in Environmental Design Guide WP-1, that we must either have Mr Brain's theory confirmed or refuted by competent

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6 Caldwell Connell, Sydney Submarine Outfall Studies, p13

7 ibid., p13

8 ibid., figure 2.3, p16.

> mathematical assessors or, alternatively, submit his report (edited if necessary) to the Board and its consultants for their comments...[9]

Later, after he had retired, Brain publicly stated that the dilution provided by the submarine outfalls would only be about three times that already provided and that the sewage would reach the beaches almost as often as with the existing outfalls.[10] He tried to show that the Water board claim that the treated effluent would be diluted hundreds of times more than at the existing outfalls was impossible unless the average discharge velocity was over 500 metres per second, "or about the same speed as a Concorde aircraft".

> Why must the board persist in claims which any sixth form science student can show to be manifestly incorrect-is the case for the outfalls so poor that it dare not tell the truth? [11]

Whilst Brain raises doubts about the amount of dilution that will actually be achieved by the submarine outfalls, others have raised more fundamental doubts about the adequacy of dilution as a mechanism to deal with pathogenic or toxic material. Dilution is not the only mechanism that operates in ocean waters and some materials actually agglomerate. Between 1976 and 1981 the Australian Atomic Energy Commission (AAEC) carried out work for the Water Board to study the processes of ocean dispersion of sewage. Using a radioisotope, gold-198, the AAEC was able to label sewage solids before discharge into the ocean and then monitor their progress. They found that this isotope was an ideal label for grease and oil of sewage origin as well.[12]

The AAEC scientists differentiated between `conservative materials' in the sewage, which dispersed and moved similarly to water, and `non-conservative' materials such as grease, wax, scum, bacteria and other particulate matter which might be subject to several accumulative mechanisms such as slick formation, windrow formation, flocculates formation and agglomerated formation.[13]

It was found that most of the grease contaminating beach sands was of mineral origin and that about 20% of the grease entering the Malabar treatment plant was of mineral origin and could not be treated by a primary treatment plant. In fact primary treatment at Malabar only removed about 45% of the total grease arriving at the plant and most of that was the scum or floatable grease, and the sludge fraction or settleable grease. The dispersable grease was not removed at all and the sludge fraction which was not amenable to digestion (ie that of mineral origin) was added back into the effluent with the rest of the sludge.[14]

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9 P.Yates, Principle Engineer-Water, Wastes & Chemicals, internal S.P.C.C. memo, 10/6/80.

10 Manly Daily, 3rd May 1985.

11 Manly Daily, 21st November 1986.

12 A Davison et al, `Radioisotope Studies on the Paradox in Dispersion and Agglomeration of Sewage Greases Discharged from Ocean Outfalls', Proceedings of the Ninth Federal Convention of the Australian Waste-Water Association, Perth 1981, p23-8.

13 ibid., pp23-9.

14 A.Davison et al, `Investigations into Sewage Grease Behaviour in Coastal Waters', Water Science Technology 13(1), 1980, p501.

The study found that grease was extremely persistent in the ocean and did not dilute much even 5km from the discharge point and could even concentrate so that seven days later the tracer would still be found in the same concentration as at the beginning.[15] They noted, in particular, that wax or grease could interfere with the dispersion and purification of enteric bacteria which could be adsorbed into particulate matter and survive in grease accumulations where predators could not get to them, nor could the oxygen nor sunlight. There was, for this reason, a strong correlation between the grease content of beach sands and the bacteria count in adjacent waters and therefore the presence of grease was not just an aesthetic problem but also indicated a health problem.[16]

In this way bacteria and viruses could be carried to remote locations where the concentration of bacterial predators would be low and the die off rate much lower. For this reason, they suggested the extended submarine outfalls might have little benefit, especially since diffusion often decreases further from shore. Moreover, offshore outfalls might have the added disadvantage that

> offshore, outfalls may cause more beach pollution since the initial dispersion of the sewage before it meets the coast will allow deposition over a wide range of beaches many of which will not contain significant amounts of bacterial predators.[17]

Microbiologists have pointed out that faecal bacteria and human enteric viruses "tend to clump together in the water attached to particles and to each other". Also viruses are naturally embedded in faecal matter and remain associated with the solids even after treatment. Not only do these particles tend to protect the viruses and bacteria and thereby enhance their survival but particles tend to "collect" viruses and bacteria on their surfaces. Whilst viruses are unlikely to multiply without a host, bacteria can replicate and increase their numbers in ocean waters and sediments. Moreover viruses and bacteria can accumulate in sediments several kilometres from an outfall. Concentrations of enteroviruses in sediments may be 10 to 10,000 times greater than in the overlying waters. These can then be released when sediments are resuspended by wind or currents or when they are disturbed and can be taken up by marine organisms such as shellfish.[18]

It only takes as few as 10 to 100 bacteria, or a single virus to induce an infection or disease under appropriate conditions. A single ingested particle can contain a large dose of microorganisms because of the tendency for particles to attract

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[15] Anon, `Tracking Sewage-Where do the Grease Balls go?', Nuclear News 24, 1986.

[16] A Davison et al, `Radioisotope Studies', p23-10; Anon, `Tracking Sewage-Where do the Grease Balls go?'

[17] Davison et al, `Radioisotope Studies', p23-12.

[18] V.A.Cooper & T.J.Lack, 'Environmental Effects of Discharges', The Public Health Engineer 14(5), January 1987, p22; U.S.Office of Technology Assessment, Wastes in Marine Environments, National Technical Information Service, 1987, p135; Margaret Loutit, 'The Fate of Certain Bacteria and Heavy Metals in Sewage Discharged Through an Ocean Outfall', 1985 Australasian Conference on Coastal and Ocean Engineering, Preprints of Papers - vol. 1, IEAust, IPENZ, NWSCO, 1985, pp211-220; C.D. Lewis, 'Fate Of Human Enteroviruses in Sewage Discharged into New Zealand Coastal Waters' in 1985 Australasian Conference on Coastal and Ocean Engineering, pp221-228; F.J.Austin, 'Pollution of the Coastal Environment by Human Enteric Viruses' in 1985 Australasian Conference on Coastal and Ocean Engineering, pp229-234.

viruses and bacteria on their surfaces. It is of no consolation to a swimmer who swallows such a particle that there are few such particles per ml of water. For all of these reasons the dilution mechanism is not adequate for dealing with water-borne disease.

> Adsorption to particles and sedimentation appears to remove much of the effectiveness of effluent dilution for reducing viral pollution in the vicinity of marine sewage outfalls.[19]

Already, in the United States, the authorities fear that routine discharge of sewage effluent and the dumping of sewage sludge are introducing large numbers of viable microorganisms, including pathogens, into the coastal waters and oceans and that their densities in both the water and the sediments may be increasing.[20]

Assumptions of dilution are also central to the argument that industrial waste will be rendered harmless in the ocean. The SPCC WP-1 guidelines specify concentrations of restricted substances allowed at the boundary of an initial dilution zone. This zone is generally taken to be about 500 metres radius around the outfall and is the area of water in which the sewage is initially diluted. The guidelines assume that this mixing zone will be sacrificed and environmental standards do not have to be applied within this zone. The specified limits on concentrations of restricted substances (shown in the first colum of table 8.1) only apply to water beyond this zone where it is assumed the wastes have undergone some dilution.[21]

The setting of boundaries to this zone is fairly arbitrary and one commentator has noted that mixing zones were defined "to accomodate whatever level of performance that was going to be installed before discharge."[22] This setting aside of an area of sacrifice in which the guidelines do not apply, is of dubious wisdom, given that its boundaries are not netted and fish may still pass through and feed in this region and probably do given its nutrient richness.

The Board's consultants, Caldwell Connell, estimated that a dilution of 40:1 in this mixing zone would be needed to ensure that the SPCC requirements were met for all restricted substances except chlorinated hydrocarbons at Malabar.(see table 8.2) Their design of the submarine outfalls was therefore done to ensure that a 40:1 dilution at the boundary of the initial dilution zone could be met even in the worst circumstances (short of bypass of the submarine outfalls). Using this figure of 40:1, it is possible to see that the SPCC guidelines in fact allow huge amounts of restricted substances to be discharged into the ocean each year (see table 8.1 column 2)

It was estimated that a dilution of 125:1 would be required to meet the WP-1 Guidelines for chlorinated hydrocarbons but Caldwell Connell assumed that

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[19] Lewis, 'Fate Of Human Enteroviruses', p226.

[20] Office of Technology Assessment, Wastes in Marine Environments, p139.

[21] S.P.C.C., Design Criteria for Ocean Discharge, WP-1.

[22] Thomas C.Jorling, 'The Southern California Bight-Municipal Sewage Discharges: A Study in Ocean Pollution Management', in Virginia Tippie & Dana Kester, eds, Impact of Marine Pollution on Society, Praeger, Mass., 1982, p252.

TABLE 8.1

SPCC SCHEDULE OF RESTRICTED SUBSTANCES FOR OCEAN OUTFALL WATERS			
	EXISTING WP-1		PROPOSED
Substance	max. conc. at boundary of i.d.z. in mg/l	max. allowed in Malabar effluent in tonnes/yr *	50%ile conc at boundary of i.d.z. in mg/l
Arsenic	0.1	700	0.004
Cadmium	0.2	1400	0.0009
Total Chromium	0.02	140	0.008
Copper	0.2	1400	0.001
Lead	0.1	700	0.0018
Mercury	0.001	7	0.0001
Nickel	0.1	700	0.015
Silver	0.02	140	0.0001
Zinc	0.3	2100	0.007
Cyanide	0.2	1400	0.0003
Phenolic Compds	0.5	3500	0.003
Total Chlorine	1.0	7000	0.001
Ammonia (N)	5.0	35000	0.4
Total identifiable Chlorinated Hydrocarbons	0.002	14	n.a.

* assuming a dilution of 40:1 and a flow of 480 Ml/day

information from: SPCC, Design Criteria for Ocean Discharge & draft of proposed new

most of these chlorinated hydrocarbons were commercial solvents rather than pesticides and PCBs. They also argued that source control would be difficult because so many industries used these chlorinated solvents and that chlorinated solvents were less significant "from a biological standpoint" than pesticides and PCB's (they gave no evidence for this however).[23] By the time the Environmental Impact Statements came out in 1979, although the same estimates of concentrations were shown for all other restricted substances, chlorinated hydrocarbons had been replaced by "Total identifiable chlorinated hydrocarbons"

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[23] Caldwell Connell, Sydney Submarine Outfall Studies, p166.

and the concentrations had miraculously fallen by more than eighty times so that a dilution of only 2:1 was required to keep chlorinated hydrocarbons within WP-1 limits.[24](see table 8.2)

TABLE 8.2

REQUIRED DILUTIONS OF RESTRICTED SUSTANCES IN MALABAR DISCHARGE						
CALDWELL CONNELL 1976				CALDWELL CONNELL 1979		
substance	Maximum allowable conc. mg/l	Effluent Conc. mg/l	minimum required dilution	minimum required dilution	Effluent Conc. mg/l	substance
Arsenic	0.1	< 0.1	1	1	< 0.1	Arsenic
Cadmium	0.2	0.1	1	1	0.1	Cadmium
Total Chromium	0.02	0.7	35	35	0.7	Total Chromium
Copper	0.2	0.4	2	2	0.4	Copper
Lead	0.1	0.3	3	3	0.3	Lead
Mercury	0.001	0.020	20	20	0.020	Mercury
Nickel	0.1	0.2	2	2	0.2	Nickel
Silver	0.02	< 0.02	1	1	< 0.02	Silver
Zinc	0.3	2.0	7	7	2.0	Zinc
Cyanide	0.2	< 1.0	5	5	< 1.0	Cyanide
Phenolic Cmpds	0.5	1.0	2	2	1.0	Phenolic Cmpds
Total Chlorine	1.0	0.00	0	0	0.00	Total Chlorine
Ammonia-N	5.0	28	6	6	28	Ammonia-N
Chlorinated hydrocarbons	0.002	0.25	125	2	0.003	Total Identifiable Chlorinated hydrocarbons

INFO FROM: Caldwell Connell Engineers, Sydney Submarine Outfall Studies, MWS&DB, 1976, p166 &
Caldwell Connell Engineers, Environmental Impact Statement Malabar Water Pollution Control Plant, MWS&DB, 1979, p83.

Although WP-1 refers to maximum levels of restricted substances, Caldwell Connell uses mean figures for concentrations of restricted substances in the sewage effluent. This is somewhat misleading since the effluent is extremely variable and the mean is unlikely to bear much resemblence to maximum concentrations, particularly when the sludge is discharged during a few hours at night.

Table 8.1 also shows (column 3) just how much more restrictive the proposed changes to the WP-1 guidelines would have been. The levels were 50 percentile concentrations rather than maximum figures but the 90 percentile figure was not allowed to be more than twice the average concentration. The levels in the revised guidelines, were supposed to be based on "the best toxicological data available to the Commission" and were worked out so that there would be no

24 Caldwell Connell, Environmental Impact Statement Malabar Water Pollution Control Plant, M.W.S.&D.B., p83.

effects at the boundary of the initial dilution zone.[25] As explained in chapter 6 these proposed guidelines were not approved by the Clean Waters Advisory Committee after the Sydney Water Board and the Public Works Department expressed concerns that their installations and the proposed submarine outfalls would not be able to meet them.

Despite the SPCC desire to update WP-1 because the maximum levels of restricted substances are "so outdated that it cannot be scientifically justified"[26] the Board continues to use the old WP-1 guidelines to publicly justify the amount of toxic waste it discharges into the ocean. Moreover the old WP-1 was used as a basic design parameter for the design of the submarine outfalls although it is not based on the latest toxicological data but rather 1974 standards set for the convenience of the Water Board at the time.

There is some controversy over whether dilution is an adequate mechanism for dealing with wastes that can be accumulated and concentrated biologically in the ocean. The regulation of restricted substances in terms of concentrations reinforces this dependence on dilution. It is argued that total amounts of restricted substances being discharged into the sea might be a more meaningful measure of potential harm. Dr Tom Mullins, a marine chemist and previously director of pollution studies at the NSW Institute of Technology, was an early critic of the submarine ocean outfalls. One of his main criticisms was that insufficient research had been undertaken by the real experts in the area, the marine biologists, ecologists and oceanographers.

> Much has been said about the dilution and dispersal characteristics of sea water, but a third function is continually overlooked; that of concentration by both biological and physical-chemical means. The most common and well-documented examples of this are the selective absorption capabilities of fish, crustaceans, seaweeds and phytoplankton.[27]

He claimed that reports from California where a similar submarine ocean outfall was located had shown that the biological productivity around the outfall discharges had changed and that if the ability for the polluted water to mix with unpolluted water was restricted such change could be severe enough to "adversely affect the ecological balance, resulting in the destruction of, for example, shellfish beds." He pointed out that the ocean was not "a world-wide homogenous system" where everything was mixed and spread evenly, but rather that local effects predominated. This was shown in the case of New York Harbour where there was a 20 square mile path of "dead water" where marine life could not live.[28]

Moreover, Mullins was concerned that the oxygen demand of sewage decomposition in the sea had not been given sufficient attention although it "could result in fish and other ocean life smothering from lack of oxygen". His

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[25] S.P.C.C., Design Criteria for Ocean Discharge, draft, 1987.

[26] S.P.C.C., Design Criteria for Ocean Discharge, Clean Waters Advisory Committee Meeting, 10th September 1987, p25.

[27] Sydney Morning Herald, 3rd June 1970.

[28] ibid.

own research into oxygen concentrations in the ocean had been restricted because there was a lack of interest in the problem, and therefore a lack of facilities. He claimed that he had already found that fish life was being forced farther out from the coast.[29]

DISPERSAL - AND WHAT HAPPENS TO THE SLUDGE?

Caldwell Connell argue that after the sewage is initially diluted as it rises toward the surface of the sea it is diffused as the seawater mass moves along. Brain criticised the basis on which Caldwell Connell worked out the coefficient for their diffusion equations. Caldwell Connell had used six die experiments. The first two had been somewhat unsatisfactory so they had changed the dye type for the subsequent four experiments. The dye had been released in three different shapes and under different conditions and monitored for some hours.[30] (see figure 8.4) Brain expressed grave doubts as to whether dye experiments could predict the movement of sewage fields.

> There appears to be a complete unawareness that there will be a profound velocity difference at the edges of the surfaced plume and that, in the case of the submerged plume, there will also be the same profound velocity difference between the upper face of the plume and the ocean water layers above.[31]

According to the traditional diffusion theory, which was used by Caldwell Connell, the plume would be expected to bleed away at the edges and the centre would remain highly persistent. In practice the edges of the sewage field could be observed to be sharp and the plume tended to break up into sharp-edged patches. Brain argued that in fact there was little evidence of subsequent dilution and that the initial dilution be assumed to be the final dilution for the purposes of calculating beach pollution levels.[32]

Dispersion is the primary mechanism which Caldwell Connell rely on to deal with contaminated particles of sludge likely to settle out of the sewage field and the ocean waters. With reference to the disposal of sludge, the 1976 Caldwell Connell report had advised that if the Board selected ocean disposal for the sludge then they recommended that it be disposed of via a separate sludge outfall pipeline in preference to using the effluent outfall.[33] The Board decided to discharge the sludge with the effluent, despite this advice, but just to be on the safe side they are constructing the effluent outfall pipes to have smaller sludge pipes embedded in them so that the sludge can be discharged separately if necessary. The disposal of sludge with primary effluent via a deep water diffuser is unique in the world. Elsewhere the preferred method of disposal to sea is by

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[29] Telegraph, 22nd May 1970.

[30] Caldwell Connell, Sydney Submarine Outfall Studies, pp72-3.

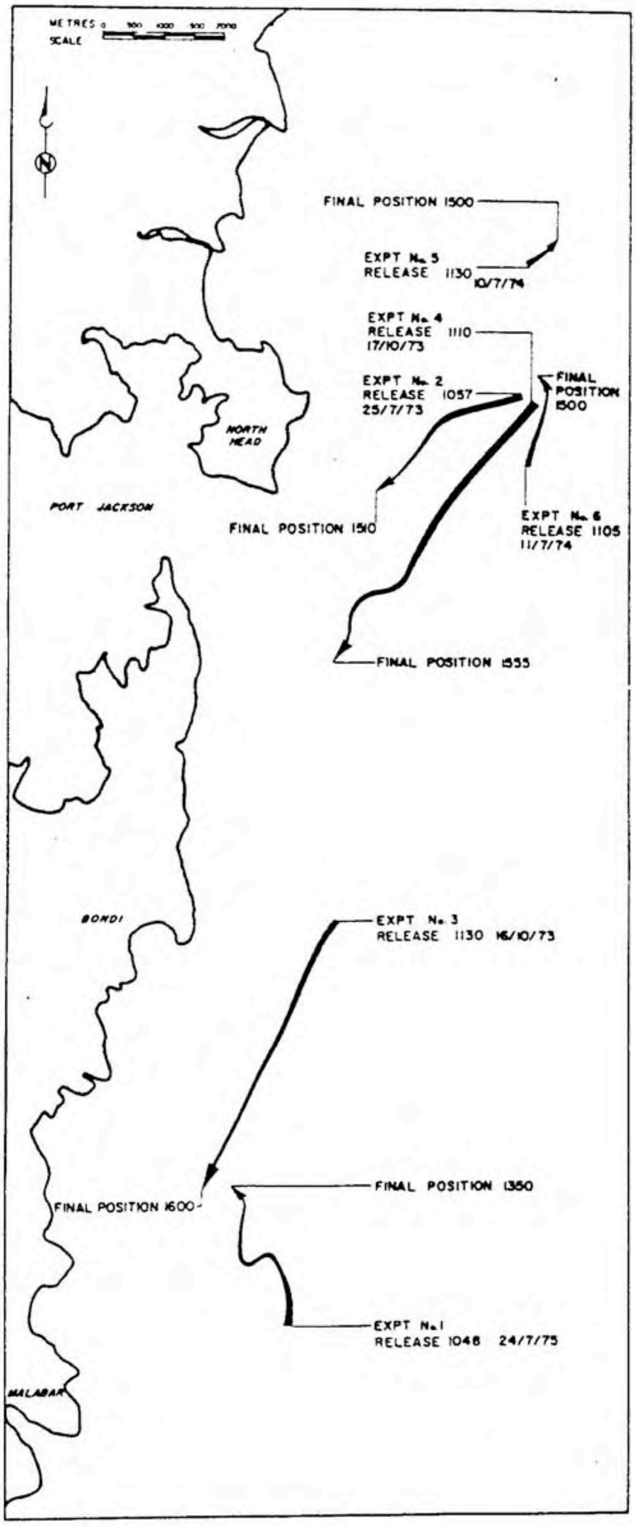
[31] R.Brain, internal report to S.P.C.C., 1980.

[32] R.Brain, `Sludge Disposal and Design Criteria for Ocean Outfall Discharge', Symposium on Sludge Management and Disposal, Surfers Paradise, 30 June-2nd July 1982, p9-5; Brain, `Recent Developments in Ocean Outfall Diffuser Theory', p116

[33] Caldwell Connell, Sydney Submarine Outfall Studies, px.

barging it out some miles although in some places separate sludge pipelines are used.[34]

Figure 8.4 Location of Dye Diffusion Experiments



Source: Caldwell Connell, Sydney Submarine Outfall Studies, MSW&DB, 1976, p. 72.

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34 Ralph Kaye, 'Technical Support Paper-Sludge Disposal Policy', presented at Clean Waters Advisory Committee Meeting, 10th September 1987, p11.

In the Environmental Impact Statements for the submarine outfalls it was noted that benthic organisms were impoverished and altered in composition close to the existing outfalls.[35] Nevertheless the possibility of toxic substances such as heavy metals, pesticides and PCB's in the sediments being concentrated up the food chain was dismissed as unlikely since no serious accumulation of these toxic materials had been observed in sediments near the existing outfalls.[36]

Sediment samples were taken using a Shipek Grab Sampler in the vicinity of the outfalls and measured for concentrations of heavy metals and pesticides. The location of sediment sampling is shown in figure 8.5. Only three locations for sediment samples are indicated and, especially at North Head, they are taken quite a distance away from the existing outfalls. No rationale is given for why these spots are chosen and whether they were likely places for sedimentation. In a confidential report the SPCC noted

> The statistical significance of single samples and the validity of a sampling technique which does not segregate undisturbed surface material must be brought into question.[37]

Nevertheless, the sample taken off Malabar contained elevated levels of heavy metals and elevated levels of DDT and DDE further out to sea.[38] (The content of the other two samples is not disclosed.) Caldwell Connell assigned no importance to this finding and argued that although "the presence of transient sludge layers" on the ocean floor were noted by SCUBA divers, this material "appeared to be deposited only during periods of low current velocities and was dispersed under the normal current regime."[39]

Jump Camera photographs taken at 45m of depth and deeper off the North Head outfall, and therefore at some distance from the shoreline discharge, also failed to show any accumulation of sediments which could be likened in particle size to digested sludge. This together with the observation that benthic organisms were abundant (a meaningless observation considering the earlier observation in the same document that they were impoverished near the outfall), were sufficient justification for Caldwell Connell to assume that sludge did not accumulate.[40]

It was argued that the discharge of sludge with the effluent would facilitate the dispersion of the particulate matter and the dilution achieved would mean the effect of the sludge on the receiving water would be minimal. Any particles which might settle on the bottom would be swept away very quickly by bottom currents and "a significant portion of the digested sludge particles would be consumed by marine organisms" (not necessarily a preferred outcome!) thus minimising

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[35] Caldwell Connell, Environmental Impact Statement North Head Water Pollution Control Plant, M.W.S.&D.B., p31.

[36] Caldwell Connell, Environmental Impact Statement Malabar, p72.

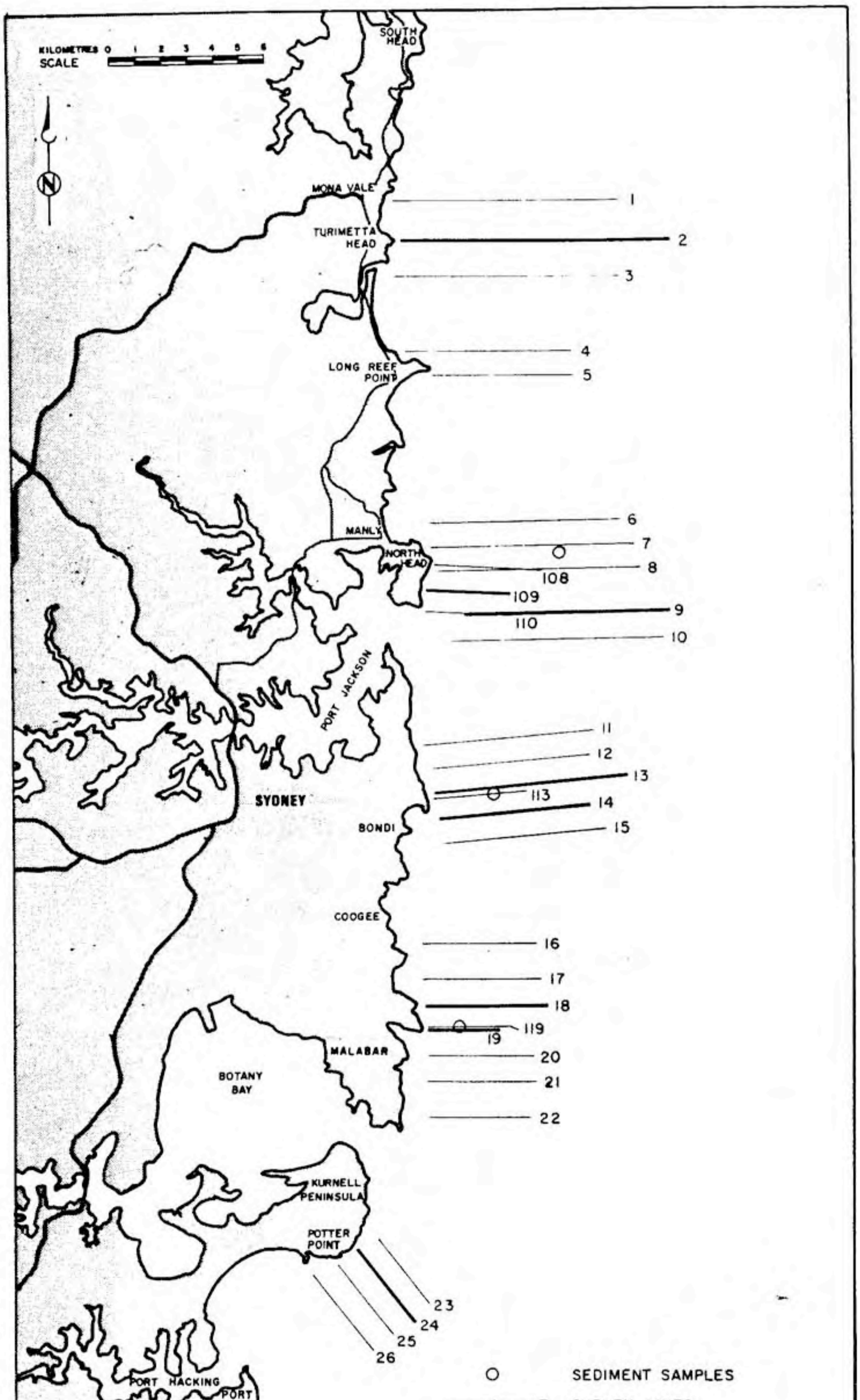
[37] Kaye, 'Sludge Disposal Policy', p13.

[38] Caldwell Connell, Environmental Impact Statement Malabar, p43.

[39] Caldwell Connell, Environmental Impact Statement North Head, pp31-32.

[40] ibid., p53.

Figure 8.5 Location of Sediment Samples



Source: Caldwell Connell, Sydney Submarine Outfall Studies, MWS&DB, 1976, p. 138.

localised sedimentation of small particles or reduction of phytoplankton productivity because of turbidity.[41]

Others who read the environmental impact statements were less optimistic. A major concern of the Department of Mineral Resources was the potential accumulation of deposits of solid particles which might in turn lead to a concentration of heavy metals and toxic chemicals in the fine fractions of sediments (the "muds and oozes"). They were sceptical of the claims that ocean current velocities/settling times/particle sizes, were such that wide dispersion of solid particles would occur. "It is difficult to understand that these particles do not go somewhere specific where they accumulate."[42]

The Board countered that it had calculated that the fastest settling particles would travel 14km before settling and that bottom currents would generally be strong enough to re-suspend most particles of sewage origin (other than sand and soil particles). They did not expect any significant accumulations and this was born out by observation made near the existing outfalls where raw and partially treated sewage had been discharged for 60 years. By their own calculations it seeems they might have been looking in the wrong place if they were looking near the outfalls and yet expected the particles to travel 14km before settling.

Mullins, also criticised the dubious reasoning of the Board in this case. What happens to sludge at the existing outfalls, he pointed out, may be quite different from what will happen in deeper and stiller water where the submarine outfalls will discharge. Caldwell Connell admit themselves, in seeming self-contradiction to other parts of their 1976 report, that

> Transitory solids deposits of variable thickness and extent were noted. No conclusions can be drawn from this existing condition, however, regarding the impact which digested sludge would have if it were discharged through a long submarine outfall into deep offshore waters.[43]

Even an internal Water Board report went so far as to say that the effect of digesting the sludge, as at Malabar, was to stabilise the organic fraction and render the sludge more settleable, which would be a disadvantage in the sea because it would be more likely to settle out and accumulate on the ocean bottom where ocean currents were low.[44] But this was a report arguing that full primary treatment should not be installed at North Head and it suited their purposes at that time.

The Australian Museum had conducted ecological surveys of nearshore waters during the 1970s. They claimed that particles from the diffuser which fell into the mud/clay range would be likely to be deposited in a relatively stable region of mud and that heavy metals and other industrial wastes which might behave like

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41 ibid., p53.

42 Dept of Mineral Resources, submission on Submarine Outfall Environmental Impact Statements, 1980.

43 Caldwell Connell, Sydney Submarine Outfall Studies, p152.

44 MWS&DB, North Head and Ocean Outfall Re-evaluation of Treatment and Disposal Options, September 1977, pp2-7.

mud or clay sized particles were likely to also be deposited in this stable zone of muddy sediment. Such materials could then be assimilated by benthic organisms and enter the tissue of fish passing through the area. "Such a situation could be harmful since the professional fishing grounds of Sydney are located in this region."[45]

Dr A Jones, marine ecologist with the Australian Museum, was more guarded in the Museum's submission on the EIS. It should perhaps be pointed out that the director of the Museum, Dr F H Talbot had been appointed to be a member of the Board (a new position was created at the time) in 1972.[46] Nonetheless their carefully worded submission did not inspire confidence. It started off

> it seems unlikely that any severe ecological damage will ensue although there will certainly be changes, especially in benthic feeding type. Intense sedimentation and low dissolved oxygen levels are likely to stress the fauna but this is expected to be transitory and not severe.[47]

His submission went on to say that the major ecological effect would be an increase in productivity because of the discharge of nutrients and that this was not a problem but that potential difficulties arose from consideration of the ecosystem. Some toxins were concentrated along food chains and this had caused the closure of some fisheries elsewhere where samples of fish have had high levels of toxins in their tissues or have suffered pollution related diseases. Moreover, Jones explained, the maintenance of benthic communities "is highly dependent on the successful settlement of pelagic larvae which may be more susceptible to pollution".

Despite all these criticisms, Caldwell Connell again concluded in 1982 that there would not be any long-term accumulation of sludge on the seabed. Caldwell Connell had done very little investigation into the actual presence of sludge accumulation and had relied instead on a computer model to tell them where sludge from the new outfalls would go to rather than conducting any empirical experiments with sludge in the ocean. They again argued that it would be widely dispersed, mostly in suspension and the sludge that was deposited would be resuspended during severe storms or taken up by marine organisms. So although they rejected the idea that the sludge accumulated they did not reject the idea that the sludge particles provided a pathway into the food chain for toxic metals.

The Board used the Caldwell Connell data to argue, in 1982, that the potential annual increases in sediment heavy metal concentrations represented only one to three percent of the average natural background concentrations which themselves varied over a wide range.[48] However, Caldwell Connell had measured concentrations of heavy metals in sea water at Palm Beach, Shelly Beach and North Head to get "typical" background levels of metals in the ocean offshore

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45 Kaye, 'Sludge Disposal Policy', p14.

46 Sydney Morning Herald, 27th July 1972.

47 Australian Museum, submission on Submarine Outfall Environmental Impact Statements, 1980.

48 MWS&DB, Disposal of Digested Sludge to the Ocean: Malabar & Bondi Water Pollution Control Plants, December 1982, p27.

from Sydney.[49] At least two and probably all three of these locations would have background levels affected by previous sewage discharges.

The Board also admitted that potential existed for the concentration of metals through the food chain but argued that available evidence indicated that this would not occur "to an extent likely to cause a hazard to humans or marine animals",[50]

> Furthermore, monitoring of diposal options in the U.K. and the west coast of the USA have failed to show any serious environmental or public health consequences.[51]

This contrasts with an SPCC finding that adverse impacts of sludge disposal to the ocean have been observed all over the world. The SPCC report cited reports, most of which predated the Board's report, that showed that in the New York Bight many benthic invertebrates seemed to have disappeared, in particular the crustacea and molluscs which are an important food organism for fish. At the Hyperion outfall in Los Angeles it was found that even when diluted by 600 times sludge was slightly toxic to the development of sea urchin embryos. Numerous diseases in marine organisms had been associated with sludge discharges in the States and in Germany.[52]

Even the model which Caldwell Connel used to reject the idea of accumulation was criticised and the same SPCC report as mentioned above noted that the predictions were based on laboratory conditions that might not be relevant to actual conditions.[53] The report also noted that "the accumulation of trace metals and organics in the vicintiy of sludge disposal areas" was well documented and Sydney oceanographic conditions similar to those off Los Angeles and elsewhere where accumulation had taken place.[54] They observed that

> None of the studies undertaken off Sydney thus far have attempted to account for the fate of the sludge which has been discharged through the existing shoreline outfalls.[55]

THE SURFACING OF THE SEWAGE FIELD - DOES IT MATTER?

Another important mechanism which the submarine outfalls were designed to achieve is a submerged field. This mechanism is important, according to Caldwell Connell, so that aesthetic nuisances can be minimised and to prevent sewage from reaching bathing waters.[56] As discussed in chapter 5, if the ocean waters are stratified so that the top layers are warmer and therefore less dense

49 Caldwell Connell, Analysis of Oceanographic Data and Review of Ocean Outfall Design Concepts, MWS&DB, July 1980, p5.

50 MWS&DB, Disposal of Digested Sludge to the Ocean: Malabar & Bondi Water Pollution Control Plants, December 1982, p27.

51 ibid., p29.

52 Kaye, 'Sludge Disposal Policy', pp7-9.

53 ibid., p12.

54 ibid., pp5,11.

55 ibid., p25.

56 Caldwell Connell, Sydney Submarine Outfall Studies, p168.

than the bottom layers, and if the sewage is released so that it is mixed with the cooler, denser layers at the bottom of the ocean before it reaches the ocean surface then the sewage field will be trapped below the top warmed layers of water.

This phenomenon, which was shown diagramatically in figure 8.1, was first observed to occur on the West Coast of the United States. However, the conditions there differ significantly from those off Sydney and there is some speculation that a submerged field is less likely to occur off Sydney. In particular, the waters off California have the top layers warmed by the sun and the bottom layers cooled by a cold current coming down from the North whereas in Sydney, as Brain has argued, stratification would be far more "trivial" because

> The East Australia Current is warm and inhibits stratification; further in the vicinity of Sydney it tends to form back-eddies which may recirculate sewage. It does not follow, therefore, that a successful Californian design will transplant to Australia with equally good results.[57]

Caldwell Connell had defended their assumptions about currents by comparing the predictions of their computer model with actual flows at existing outfalls in the United States. At West Point submarine outfall the position of the submerged field was measured with its upper boundary at 21m depth and its lower boundary at 42m depth. The model had predicted an upper boundary at 26m depth and a lower boundary at 38m. Caldwell Connell concluded that

> Considering the computer program does not include the effects of currents, the correspondence between the measured and the predicted boundaries of the field is considered to be very good.[58]

Brain did not agree. He argued that actual field thickness was 21m as compared to a predicted thickness of 12m and that such an error over a total depth of 50m was significant. With an error of that size, he pointed out, only the March/April period could be counted on for producing a submerged field with any reliability.[59]

Brain also suspected that adequate consideration had not been given to the turbulence generated between the submerged plume and the layer of seawater above it. This would cause, claimed Brain, rapid entrainment and the probable emergence of a surface plume. Brain also felt that the Malabar diffuser had been underdesigned. His first report suggested that, if all his criticisms were supported, there would be "massive increases in beach faecal bacterial densities above those given in the EIS's".[60]

Brain argued that a submerged field would only be achieved for short periods during the summer months and even then grease and floatables would surface and be subject to on-shore surface currents.[61] When there was a surface field

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[57] Brain, `Sludge Disposal and Design Criteria for Ocean Outfall Discharge', p9-9.

[58] Caldwell Connell, Sydney Submarine Outfall Studies, p14.

[59] R.Brain, internal report to S.P.C.C., 1980.

[60] ibid.

[61] For example, Manly Daily, 14th December 1985.

conditions at the beaches would be even worse than existing conditions. The Board themselves admit that the field would not be submerged for much of the time in winter.(see table 8.3) They state for example that in the worst winter months the field will not be submerged any of the time and at North Head during the winter period as a whole the field will only be submerged 9% of the time, and in the worst summer month it will be submerged 76% of the time.[62]

TABLE 8.3

WATER BOARD PREDICTIONS OF PROPORTION OF SUBMERGED FIELDS				
Time Period	Water quality Criterion	Performance North Head	Performance Bondi	Performance Malabar
Summer Period	>90%	91%	96%	96%
Worst month in summer	--	76%	94%	94%
Winter Period	--	9%	31%	36%
Worst month in winter	--	0%	0%	0%

M: Caldwell Connell, Environment Impact Statement, North Head WPCP, MWS&DB, 1979, p64 &
MWS&DB, Environment Impact Statement, Bondi WPCP, MWS&DB, 1979, p52 &
Caldwell Connell, Environment Impact Statement, Malabar WPCP, MWS&DB, 1979, p82.

As has been discussed in chapter 4 when the sewage comes to the surface it is blown on the wind for many kilometres and when the wind is onshore the beaches are easily polluted. Many swimmers and surfers are aware of this and realise that the actual distance the outfalls are from the coast provide insignificant protection. Richard Gosden from Stop the Ocean Pollution (STOP) pointed out, in 1985, that the sewage already travels much further than the proposed 2 to 4 km that the outfalls will extend. Beaches such as Long Reef had been closed several times that summer because of pollution, although the Manly outfall was 7.5km away.[63]

STOP also criticised the practice of separating the sludge from the effluent and then discharging it with the effluent. They noted that Caldwell Connell had based their design and predictions of a submerged field occuring on the separate discharge of sludge which had led to an initial design with many more finer diffusers. The later decision to add sludge to the effluent had necessitated fewer dispersal points with larger openings. This, STOP argued, would probably reduce the diffusion possible and lessen the chances of achieving a submerged field.[64]

STOP likened the submarine outfalls to the strategy used in Europe some years before where smoke stacks from coal burning power stations were made higher because of local pollution. This facilitated the further spread of acid rain throughout the whole continent and STOP argued that the submarine outfalls would, likewise ensure the further spreading of sewage pollution up and down

62 Caldwell Connell, Environmental Impact Statement North Head, p64.
63 Richard Gosden, `Sewerside Culture', Engineering and Social Responsibility 2(2), March 1985, pp6-7.
64 Richard Gosden, 'Truth Surfacing on Submerged Field', Engineering and Social Responsibility 2(7), August 1985, p5; Southern Courier, 25th June 1986.

the coast.[65] A surface field arising from the extended ocean outfalls offered no improvement over the existing outfalls in terms of sewage field reaching bathing waters.

Drogue experiments were carried out by engineers between 1958 and 1978 to predict the movement of surface fields. The trajectories of these drogues were plotted and are shown in figures 8.6, 8.7 & 8.8. Those trajectories with an arrow represented the number of occasions on which an effluent field reached shore. In other words, the drogue experiments purported to show that 43% of the time at North Head, 23% of the time at Bondi and 39% of the time at Malabar the sewage field would have reached shore and affected nearby beaches.[66]

However there is some doubt that the drogues were indicative of a surface field. The drogues were submerged at depths of about 2 metres below the surface of the water so as to minimise wind influence[67] in the time honoured way that early engineers carefully avoided the affect of the winds (as explained in chapter 4). This refusal to acknowledge the role of the wind on a surface sewage field in drogue experiments was despite the common knowledge amongst surfers and admissions from engineers from as far back as 1936 (see chapter 4) that the wind is a primary influence on the movement of a sewage field. In fact Caldwell Connell observed that currents at 2 m depth do not correlate with wind speed and direction and that "wind driven currents are confined to a surface layer less than 2 m deep." [68] Therefore their drogue experiments are not relevant to the movement of the top 2m of water nor any surface field within that water.

If wind directions had been considered as the prime movers of the floating sewage field then the prevailing onshore winds during summer would have ensured that the estimate of shoreward travelling surface fields, at least those in the top metre of so of ocean, was at least 50%. when winds are onshore for 50% of the time in Summer. This is the figure that is in fact used by the Water Board in 1983 in its application to the SPCC.[69] (see table 8.4)

Caldwell Connell argued that when the sewage field was submerged that it would be carried southwards by the current. The Department of Mineral Resources pointed out that the East Australian Current was not a single feature and that it was the eddys generated by that "current", which came close inshore, which were the prime cause of the "episodic southwards water movement".[70] Mullins claimed that it was wrong to consider masses of water as so large that they were well mixed and homogeneous.[71] Similarly a letter writer to the Herald argued that the "holy" east Australian current was not a simple north/south current "but a series of giant eddies , tens to hundreds of kilmetres in diameter,

65 S.T.O.P., `Sydney's Toxic Waste Dump: the Pacific', submission to Waverley Municipal Council, June 1986, p1.

66 Caldwell Connell, Analysis of Oceanographic Data, p23.

67 ibid., p23.

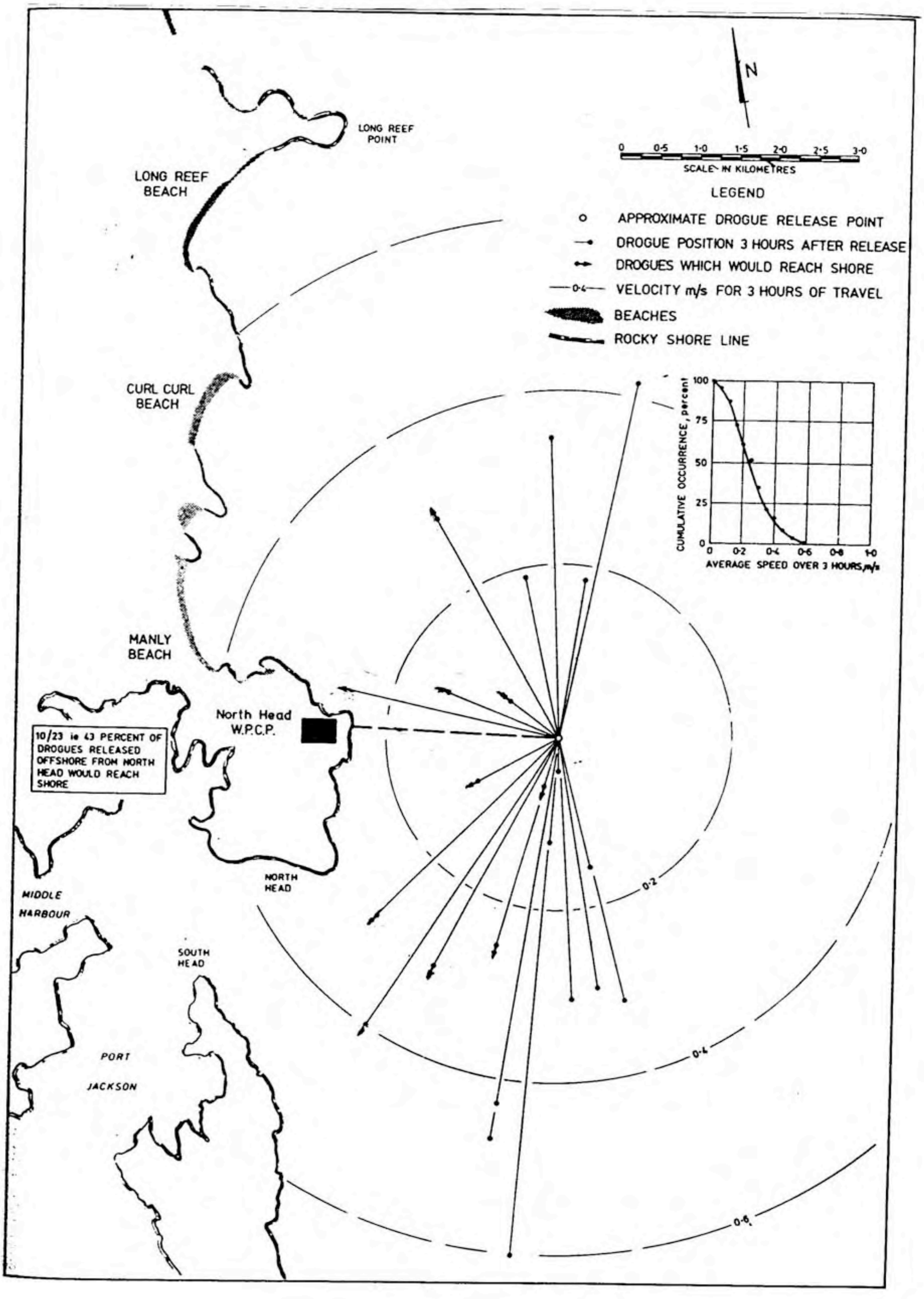
68 Caldwell Connell, Sydney Submarine Outfall Studies, p47.

69 Clean Waters Advisory Committee meeting, business papers, 8th September 1983, p18.

70 Dept of Mineral Resources, submission on Submarine Outfall Environmental Impact Statements, 1980.

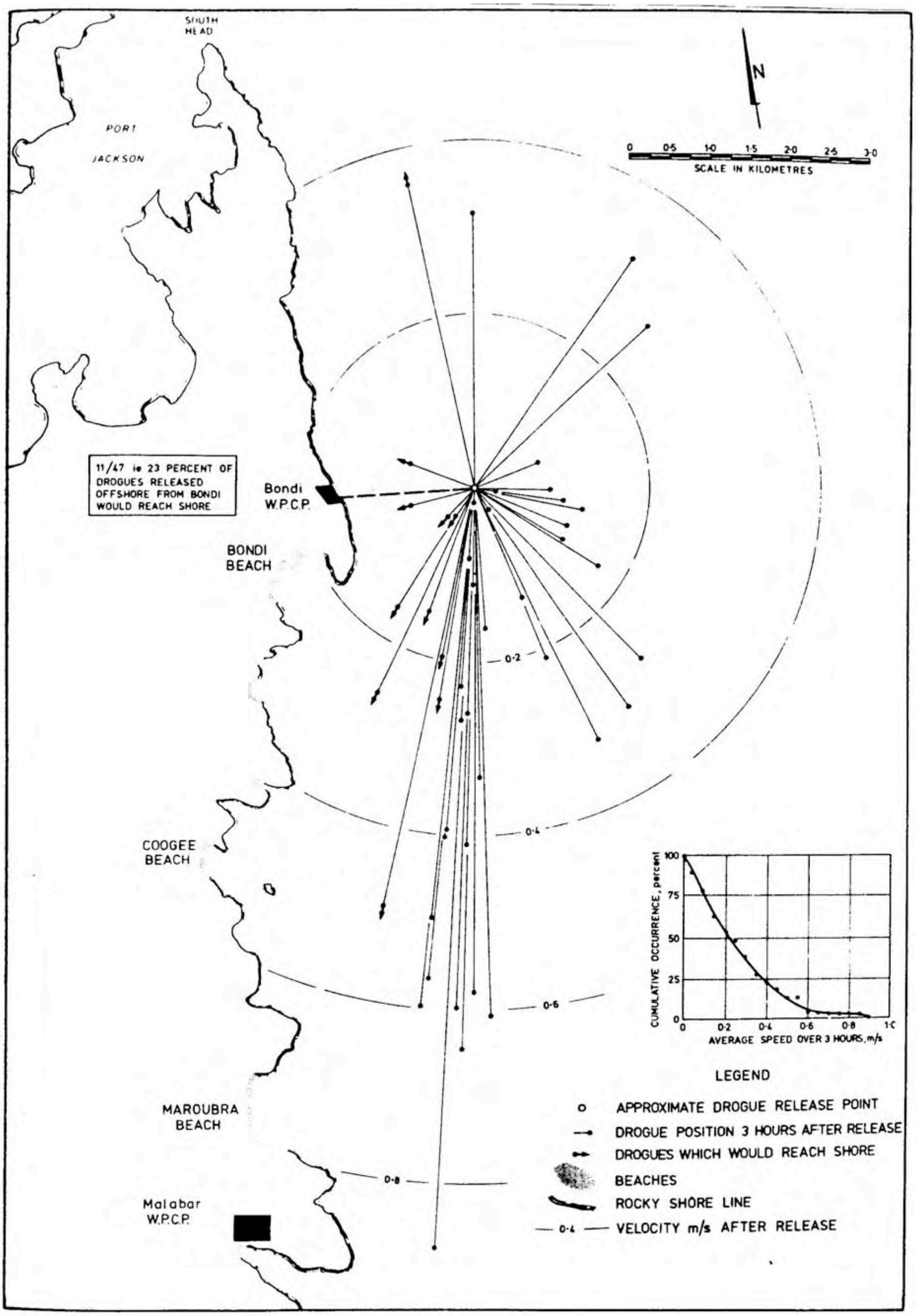
71 Weekly Courier, 15th July 1981.

Figure 8.6 Path of Free Floating Drogues Released from North Head



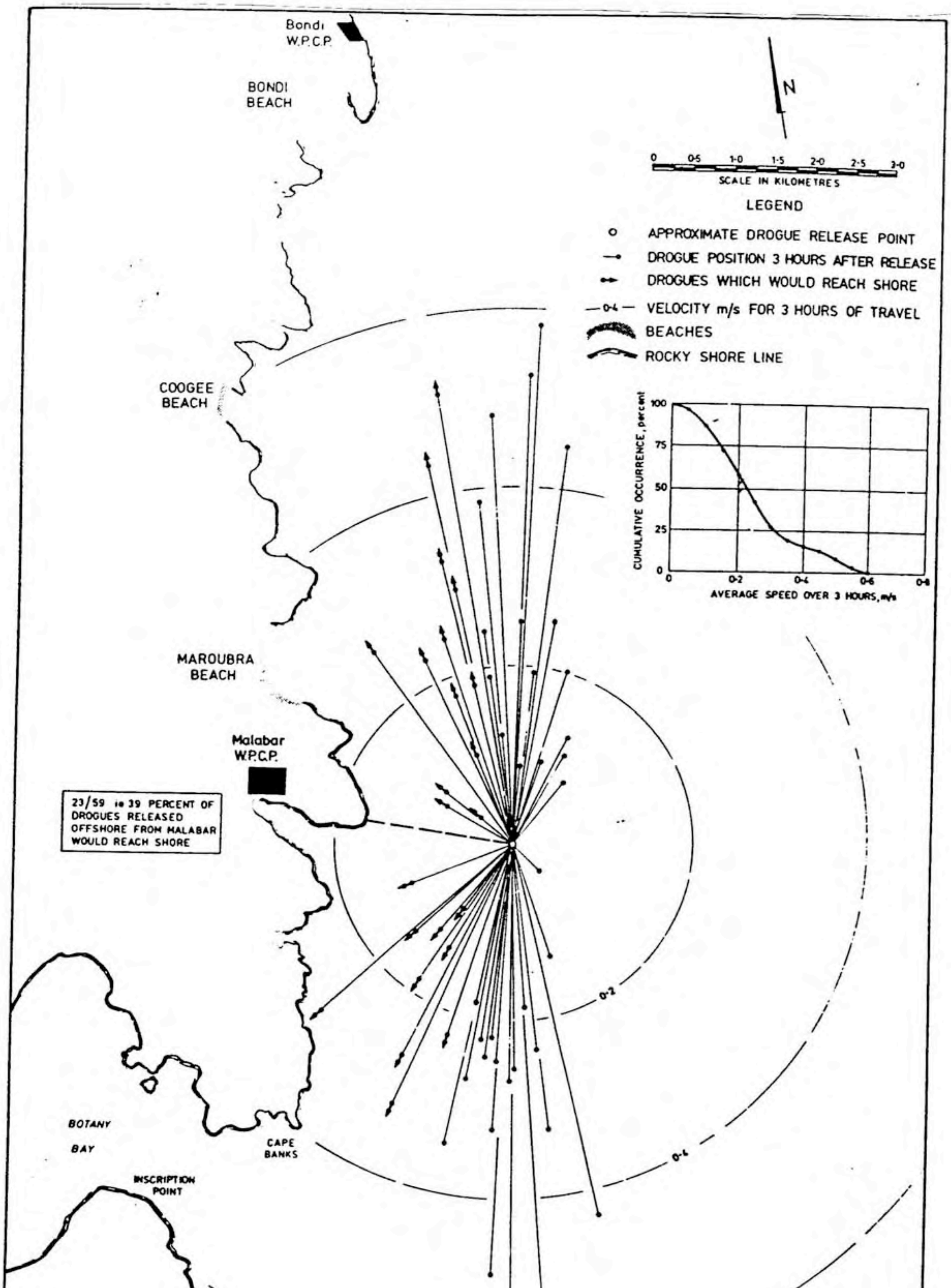
Source: Caldwell Connell, Analysis of Oceanographic Data and Review of Ocean Outfall Design Concepts, MWS&DB, 1980, p24.

Figure 8.7 Path of Free Floating Drogues Released Offshore from Bondi



Source: Caldwell Connell, Analysis of Oceanographic Data and Review of Ocean Outfall Design Concepts, MWS&DB, 1980, p25.

Figure 8.8 Path of Free Floating Drogues Released from Malabar



Source: Caldwell Connell, Analysis of Oceanographic Data and Review of Ocean Outfall Design Concepts, MWS&DB, 1980, p25.

which actually hold shore waters against the coast." He cited CSIRO research which he claimed showed that eddy pressure counteracted any dispersal mechanism.[72] Brain has also pointed out that, whilst the waters off California have a strong constant ocean current going down the coast, the Sydney currents are not constant, rather they "whirl around and form giant eddies, sometimes they stop altogether for days at a time."[73]

TABLE 8.4

SEASONAL BEHAVIOUR OF THE SEWAGE FIELD

Season	Prob. of Surface Field	Prob. of Onshore Current	Prob. of Reaching Shore	Prob. that Shore is a Beach	Prob. of Reaching Any Beach
Summer	4%	50%	2%	100%	2%
Winter	80%	50%	40%	100%	40%

SOURCE: Clean Waters Advisory Committee Meeting, Business Papers, 8th September 1983, p18

TABLE 8.5

SEASONAL BEHAVIOUR OF THE SEWAGE FIELD

Season	Prob. of Surface or Submerged Field	Prob. of Onshore Movement	Prob. of Reaching Shore	Prob. that Shore is a Beach	Prob. of Reaching Any Beach
Summer	surface 4% submerged 96%	50% 42%	2% 40%	100%	42%
Winter	surface 80% submerged 20%	50% 42%	40% 8%	100%	48%

The reliance of the Board and Caldwell Connell on the East Australian Current is not even supported by their own research. In the 1976 Caldwell Connell study, currents were measured and observed and it was noted that at Bondi onshore currents were observed a significant percentage of the time throughout the year and that at North Head and Malabar they were observed in all seasons except spring.[74] For summer when the submerged field is supposed to be working best,

72 Sydney Morning Herald, 21st December 1988.
73 Sun-Herald, 23rd October 1988.
74 Caldwell Connell, Sydney Submarine Outfall Studies, p59.

Caldwell Connell show 35% of currents going onshore at the mid-depths of the sea at North Head, 50% at Bondi and 50% at Malabar.[75]

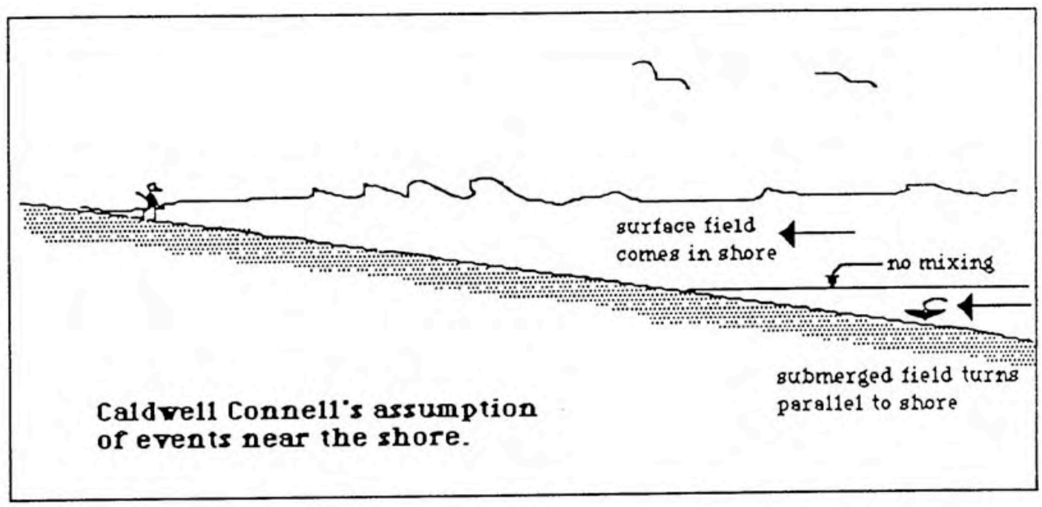
In a later Caldwell Connell study in 1980 it was found that the frequency of onshore currents throughout the year was 40% for North Head, 30% for Bondi and 42% for Malabar. Current meters had been installed in the vicinity of the proposed outfall diffusers at 30 metres depth.[76] However it seems that Caldwell Connell was determined not to interpret the results as reflecting poorly on their prediction of the field being carried away by a southerly current. The conclusion of I.G.Wallis, Principal Investigations Engineer of Caldwell Connell, was that long term discharges were carried south although his own investigations showed that up to 42% of currents would carry sewage toward shore.[77]

In the report tendered by the Water Board to the SPCC as part of its application for approval for the Malabar submarine ocean outfall in 1983[78] the following table was given.

Although the Board may have overestimated onshore winds for the winter time, table 8.4 incorporates an assumption that the submerged fields will not come on shore at all yet Caldwell Connell have found that 30-40% of submerged fields will travel shoreward. The following table, table 8.5, is a modification of the above table showing that the affect of the shoreward travelling submerged field coming onshore inflates the probability of sewage reaching any beach quite considerably.

However Caldwell Connell assumed that submerged fields which travelled towards the shore would remain submerged and turn parallel to the shore before coming in. (see figure 8.9)

Figure 8.9



[75] ibid., pp51-56.

[76] Caldwell Connell, Analysis of Oceanographic Data, pp15,20.

[77] I.G.Wallis, 'Ocean Currents Offshore from Sydney', Sixth Australian Conference on Coastal & Ocean Engineering, IEAust, 1983, p210.

[78] Clean Waters Advisory Committee meeting, business papers, 8th September 1983, p18.

Caldwell Connell based this supposition on their studies of the density contours in the ocean which they found did not slope up towards the shore "to any significant degree" and they assumed, therefore, that the top boundary of the submerged field would remain horizontal and not mix with the overlying layers of seawater even as the waters become shallower and stratification was not sustained.[79] However their density contours were done in water that was between 30 and 65 metres deep[80] and these results cannot be sensibly extrapolated to the much shallower water near the beach.

They said that "upward mixing could occur in the surf zone, where the stratification is broken down"[81] but contended,

> For the purposes of this report, we have considered that the surf zone extends to a water depth of 7m. A submerged field therefore, is defined as one whose top boundary is at least 7m from the water surface. Taking all factors into account, it is considered that submerged fields could become surface fields and be carried to the shore very infrequently and that this possibility need not be considered in preliminary design.[82]

This statement is less than convincing and there does not seem to be any good reason why the submerged field would turn away rather than come on into shallower waters where it would be mixed with the surf zone. This possibility was not investigated by Caldwell Connell or by the Water Board and no research was undertaken to support their assumptions.

Submerged fields are not necessarily preferrable to surface fields if sewage can still reach shore. Brain contended that submerged fields would hang around for a long time, the bacteria in them protected from the sunlight in the deeper water, and occasionally remixing with beach waters. The SPCC were also worried about the inhibited die-off of bacteria in deep water where sunlight could not penetrate. Caldwell Connell claimed, in 1983, that they had based the die-off rates on "the most extensive set of field experiments carried out, to date, in the world" and that since ultra violet light was not the major cause of the observed die-off rates it was not appropriate to allow for the effect of attenuation of ultra violet light with depth.[83] Nevertheless Caldwell Connell had themselves calculated that there was a 28% increase in die-off times if account was taken for "the effect of light extinction within the top 7m".[84] Moreover Caldwell Connell have found that there is far less die-off at night because of the lack of sunlight.[85]

The Department of Mineral Resources suggested that if a submerged field was maintained then this might lead to an increase in the tainting of fish due to detergents and that the existing problem of the tainting of trevally and bream in the waters around Sydney had been ignored in the EIS's. Furthermore a

79 Caldwell Connell, Sydney Submarine Outfall Studies, p170.
80 ibid., p69.
81 ibid., p71.
82 ibid., p170.
83 S.P.C.C., Questions Relating to Proposed Malabar Outfall, M.W.S.&D.B., Sydney, June 1983.
84 Caldwell Connell, Sydney Submarine Outfall Studies, p174.
85 Caldwell Connell, Analysis of Oceanographic Data, p36.

submerged field would keep detergents under the surface and could lead to a decrease in the decay rate of biodegradable detergents, "hence ensuring a wider and more dilute distribution of the grease released during degradation of the detergents."

If the submerged field is of disputable and unpredictable benefit in terms of preventing sewage from coming into bathing waters and may even hinder the decomposition of sewage why did Caldwell Connell try so hard to achieve it? The answer seems to be that a submerged field would not be visible. Caldwell Connell say it is essential that the sewage discharges do not cause aesthetic nuisances and that this can be achieved firstly by dilution and secondly by maintaining a submerged field for as much of the year as possible.[86]

The SPCC has been particularly concerned about the visibility of surface sewage fields and they have emphasised it in meetings with the Board.[87] The SPCC wanted to know at what dilution would the surface field cease to be visible to a layperson from the shore, a boat and an aircraft and under what circumstances would surface slicks of floatable material become visible.[88] They were concerned that in experiments carried out at the Board's Paddington Laboratory that effluent/sea water mixtures at dilutions of up to 150:1 didn't have the same appearance as seawater alone and also that field studies in California had found `visible' slicks of floatable material above diffusers off Los Angeles even though the effluent discharging from those outfalls were less concentrated than what would be discharged at Malabar.[89]

Caldwell Connell assured the SPCC that the Malabar sewage field would generally not be visible from the shore, boat or air and that on the rare occasion when there was a malfunction, illegal or uncontrolled discharged or a rare combination of climatic conditions such as no current, wind or waves, only a person with keen eyesight would be able to see it.

Brooks and Harremoes, the experts brought in to assess the submarine outfall designs (more about them next chapter), also reassured the SPCC that submarine ocean outfalls would effect a vast improvement to water quality along the coast. They said that the sewage field would only be visible when it came to the surface but it would not be aesthetically offensive. They did warn that "excellent removal or source control of oil and grease and other floatables" was essential to minimise visibility.[90] This was because whether or not a submerged field can be achieved it would be likely that oil and grease would still go to the surface and form a slick. This is why the Board has been so tough on grease discharge into the sewers by householders, commercial premises and industry.

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[86] Caldwell Connell, Sydney Submarine Outfall Studies, p167.

[87] Caldwell Connell, Analysis of Oceanographic Data, p9.

[88] S.P.C.C., Questions Relating to Proposed Malabar Outfall.

[89] ibid.

[90] M.W.S.&D.B., 'Technical Report in support of Application for Approval under Section 19 for the Malabar Extended Ocean Outfall' presented at Clean Waters Advisory Committee meeting, 8th September, 1983, p25.

PATHOGENIC ORGANISMS - DO THEY DIE OFF?

Caldwell Connell stated in their 1976 report that reduction of organisms such as bacteria and viruses would occur mainly because of the dilution, but they would also die in the hostile seawater environment, be consumed by protozoans and other small animals and be reduced due to sedimentation, adsorption, normal biological mortality and sunlight.[91] In a later report the Water Board state that die-off rates have a significant effect on concentrations at shore.[92] However, in their report Caldwell Connell only consider the die-off rates of faecal coliform because the SPCC WP-1 guidelines are in terms of concentrations of faecal coliforms in bathing waters.

The experts brought to Sydney to evaluate the submarine outfalls were uncertain whether even the existing WP-1 guidelines would be met in the winter despite the looser standards prescribed for winter. Both men believed that coliform requirements would be met in the summer period "provided the sewage field is kept submerged by the density stratification in the ocean for well over 90 percent of the time". They referred to Caldwell Connell's prediction that this would happen 96% of the time but were not prepared to back that prediction up.

> With the data presented, we are unable to judge whether the consultants' predictions of frequency of shoreline impact are conservative or not. To demonstrate compliance with the 90% requirement, more careful attention to infrequent events is required.[93]

But in winter, Brooks in particular, believed that when the sewage field surfaced faecal coliform counts on shore would exceed 400/100ml (the SPCC summer 90 percentile standard) and probably 2000/100ml (the SPCC winter 90 percentile standard). Moreover, they both thought it was possible that unusual situations such as following storms or during transition seasons could cause high readings of feacal coliforms (>400/100ml) for more than 10% of the time during the summer bathing season.[94]

Brooks felt that disinfection on an intermittent basis might be required, judging by his experience of other outfalls which also required intermittent disinfection. When the Clean Waters Advisory Committee considered the approval of the Malabar submarine ocean outfall in September 1983 the possible need for disinfection by chlorination of the sewage was discussed. The problem with chlorination was said to be that it took some time to become effective in bathing waters and that it might be "intrinsically undesirable in terms of acute environmental toxicity and production of persistent organochlorine compounds." The Committee decided that chlorination should only be used as a last resort.[95]

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[91] Caldwell Connell, Sydney Submarine Outfall Studies, pp10-12.

[92] M.W.S.&D.B., 'Technical Report in support of Application', p19.

[93] ibid., pp25-6.

[94] ibid., p27.

[95] Clean Waters Advisory Committee meeting, 8th September, 1983.

It should be noted in this regard that chlorination had long been considered a poor option for dealing with bacteria and viruses in sewage. In 1977 a Water Board report stated that

> the proposition that chlorination of primary treatment can effectively control bacterial pollution is not supportable. The fact is recognised in the Board's policy of not chlorinating primary effluent.[96]

In addition, a 1979 SPCC report had concluded that there were few, if any, benefits arising from chlorination and that those were "outweighed by many disadvantages". The report stated that underchlorination would not reduce pathogen numbers by more than a factor of ten and that chloramines produced through underchlorination were toxic compounds which were hazardous to many fish. Overchlorination could also result in fish kills. Even with optimum amounts of chlorine, toxic chlorinated compounds besides chloramines could be formed. Chlorinated compounds could bioaccumulate, especially in shellfish. Moreover, chlorination could interfere with the natural purification processes.[97]

At the time of writing their report Caldwell Connell were well aware of the inadequacies of faecal coliforms as a measure of health risk. They admitted that there was very little evidence that related "faecal coliform concentration to the incidence of water borne disease"[98] and recognised that a specific faecal coliform limit did not define the line between a safe and hazardous water. However they defended the use of faecal coliforms as an indicator of pollution of sewage origin because it was not 'practicable' to routinely monitor pathogenic organisms directly.[99]

Caldwell Connell, however, used faecal coliform, in their study, not as an indicator of the presence of sewage, which was what it was supposed to be used for, but as the focus of their study into the die-off rates of pathogenic organisms in the ocean. They did this "as a matter of convenience,"[100] although they admitted that different organisms, including those of sewage origin, could be expected to have different die-off rates. Another implicitly stated reason was that the submarine outfalls had to conform with WP-1 guidelines and these were in terms of faecal coliform.

However their use of faecal coliform in die-off experiments was ironic. Their findings that faecal coliform die off fairly rapidly tells us little about the fate of other organisms which can be health threatening. Their experiments serve only to discredit faecal coliforms as an indicator of sewage since they die-off so quickly. Low faecal coliform concentrations do not mean the water is not polluted. The Water Board found that ninety percent of faecal coliform die off in 1 to 7 hours during the daytime.[101] Low concentrations in bathing waters mean

96 MWS&DB, North Head WPCP and Ocean Outfall Re-evaluation of Treatment and Disposal Options, Sept 1977, p5-3.

97 S.P.C.C., Health Aspects of Faecal Contamination, Botany Bay Study 4, Sydney 1979, p14.

98 Caldwell Connell, Sydney Submarine Outfall Studies, p34.

99 ibid., p12.

100 ibid., p149.

101 Malabar & Bondi W.P.C.P. Submarine Ocean Outfall Technical Data, Data Pack Item 6(4), September 1981.

only that sewage pollution that might be present has been in the sea for more than an hour.

Viruses, Caldwell Connell said, were difficult and costly to test for and could not be carried out without specialist assistance[102] so they were not investigated at all and the possibility of viruses surviving long was dismissed with a statement that "viruses can only multiply in living host cells" and their numbers "diminish rapidly through treatment, dilution and natural die-off."[103]

Such conclusions don't seem to be supported in the scientific literature. Primary treatment does not remove any viruses[104] and viruses can survive if they are associated with solid material. This association protects them from inactivation and also provides a transport mechanism for them.[105] A recent U.S. Office of Technology Assessment report points to "a growing body of evidence" that human pathogens may persist in the marine environment for periods of many months and longer "in a nonculturable, but virulent form".[106] Viable human pathogenic viruses have been discovered in water, crabs and bottom sediments of an old sludge dump site[107] that had been disused for 17 months and an outbreak of cholera along the Gulf coast of Texas has been traced back to agents which survived in the coastal waters for at least five years.[108]

Some viruses and parasites are very resistant to environmental degradation or destruction. Sometimes the colder temperature towards the bottom of the sea can help them survive whilst inhibiting their growth.[109] As well as being protected by sludge or suspended sewage particles, viruses and bacteria can also be protected in grease balls as discussed earlier in this chapter. Because some of these viruses are inactivated they cannot be cultured in the laboratory and they cannot be detected with traditional tests yet they can be reactivated in a human host.[110]

Although these are recent findings, Caldwell Connell don't seem to have conducted any literature search in this area despite their own admitted lack of expertise with viruses, nor have they made any efforts to back up their assumptions about viruses being shortlived. Moreover, they do not supply any evidence that the die-off will be greater with the new ocean outfalls than it was with the existing ocean outfalls. The extra distance the sewage has to travel only adds a few hours, if that, to the travel time of the sewage field and if that field is submerged the reduced exposure to sunlight could well counteract this small advantage. It seems their primary concern is not with ensuring that the submarine outfalls pose no health threat to bathers but rather with whether the

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102 Caldwell Connell, Sydney Submarine Outfall Studies, p149.

103 ibid., p12.

104 Otis J. Sproul, 'Removal of Viruses by Treatment Processes' in Gerald Berg et al (eds), Viruses in Water, American Public Health Association, 1976, p175.

105 Lewis, 'Fate Of Human Enteroviruses in Sewage', p226.

106 U.S. Office of Technology, Wastes in Marine Environments, p135.

107 Sagar Goyal et al, 'Human Pathogenic Viruses at Sewage Sludge Disposal Sites in the Middle Atlantic Region', Applied Environmental Microbiology, Oct 1984, pp758-763.

108 Office of Technology, Wastes in Marine Environments, p135.

109 ibid., p135.

110 ibid., p138.

new outfalls will comply with WP-1 guidelines, which set standards in terms of faecal coliform.

The attitude which the authorities have towards health risks has always differed from that of bathers and surfers who know by first hand and second hand experience that swimming in sewage polluted water is not a healthy occupation. The SPCC and the Water Board do not want to know about this because a solution could be expensive and 'inpracticable' so despite the on-going debate and widespread interest there has still been very little investigation into the health dangers of bathing in contaminated sea-water in Australia.[111]

The difficulty in determining what the health effects are of swimming in polluted water include the problems that the symptoms of the disease might not occur till some time after exposure, many diseases which could be transmitted in this way were neither fatal nor notifiable and many of those disease are transmitted in other ways.[112] Nevertheless the SPCC still held the view at the end of 1979 that coastal waters could be presumed to be bacteriologically safe for swimming if aesthetic criteria were met and they claimed that this view was endorsed by the NSW Health Commission.[113]

This view was based on a 1959 study undertaken in the U.K which is still referred to in Britain, Australia and New Zealand as the classic paper on the subject[114] despite the continuing debate amongst experts, new research and developments in the field of virology and the various papers reaching contrary conclusions being published since that date. This report emphasised diseases such as typhoid and paratyphoid fevers which have been traditionally associated with sewage and relatively minor diseases, such as viral gastro-enteritis, which do not require the health authorities to be notified were ignored.[115]

The UK study was based on five years of investigation of 43 U.K beaches. It concluded that there was only a "negligible risk to health" of bathing in sewage polluted sea water even when beaches were "aesthetically very unsatisfactory" and that a serious risk would only exist if the water was so fouled as to be revolting to the senses. It insisted that pathogenic bacteria which were isolated from sewage contaminated sea water was more important as an indicator of the disease in the population than as evidence of a health risk in the waters.[116]

Moore believed that bathing was "an unnatural activity in man" and he ascribed the prevalence of upper respiratory infections in bathers to the mechanical effect of bacteria being forced up the nose and into the middle ear when diving or to close personal contact with fellow bathers in overcrowded swimming pools. He dismissed without further investigation the idea that such infections arose from

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111 Paul Ryan, Submarine Ocean Outfall Sewers, typescript, undated, p13.

112 S.P.C.C., Health Aspects of Faecal Contamination, p17.

113 S.P.C.C., Monitoring of Ocean Beaches for Sewage Pollution, internal report, 13th November 1979.

114 for example N.A.Smith & W.J.Speir, 'Ocean Discharge of Sewage is a Treatment Option', in 1985 Australasian Conference on Coastal and Ocean Engineering, p36; Observer, 7th August 1988; N.R.Achuthan et al, 'Development of a Beach Pollution Index for Sydney Coastal Beaches', Water, September 1985, p15.

115 Dave Wheeler, 'Sea Fever: UK's Polluted Beaches', Science for People 52, undated, p9.

116 Paul Ryan, Submarine Ocean Outfall Sewers, p14.

the ingestion or inhalation of pathogens from contaminated waters. For this reason his working group did not concern itself with upper respiratory infections but confined their investigations to "diseases the causal agents of which are known to be present in sewage" particularly paratyphoid or typhoid fever and poliomyelitis."[117]

Moore's criteria for attributing paratyphoid or typhoid fever to bathing in sewage-polluted seawater were

1. The patient must have bathed in seawater known to have been contaminated at the time with enteric organisms of the same type as caused the illness.

2. The case must not be otherwise explicable, for example, if there were other cases in the same neighbourhood.

3. The case was stronger if it was known that the patient swallowed a good deal of sea-water, for example, through being a poor swimmer or having fallen out of a boat into deep water.

4. The case was stronger if the bathing waters in question had been heavily polluted, or if it was known that the patient had had direct contact with unmacerated faecal matter while bathing on the day of presumed infection.

5. Credibility was lost if a single bathing episode, say 10 to 11 days before the onset of illness could not be pointed to.[118]

The criteria therefore included various assumptions by Moore about what he expected his conclusions would be. The most obvious being that he was more likely to believe a case was caused by bathing in sewage polluted water if the bather came in contact with faeces. He then concluded from his study that the negligible risk of contracting disease was probably from chance contact with intact aggregates of faecal matter from an infected person.[119] Cases that occurred when the beaches weren't grossly polluted were not attributed to bathing and not surprisingly he concluded that disease would not be contracted unless the bathing waters were grossly polluted.

Moore used a different methodology to study the incidence of poliomyelitis. He focused on children and asked local medical officers to pick a suitable healthy child to be compared to each child that was diagnosed to have poliomyelitis. The bathing records of each child in the previous three weeks to the onset of illness were recorded and a comparison made. The results are shown in Table 8.6.

It was concluded that since the bathing histories of children with poliomyelitis were similar to the bathing histories of healthy children then "the history of bathing is probably irrelevant".[120]

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[117] B.Moore, 'The Risk of Infection Through Bathing in Sewage-Polluted Water', in E.A.Pearson, Waste Disposal in the Marine Environment, Pergamon Press, 1959, p32.

[118] ibid., p35.

[119] Paul Ryan, Submarine Ocean Outfall Sewers, p14.

[120] Moore, 'The Risk of Infection Through Bathing in Sewage-Polluted Water', p37.

Moore's results show that bathing is not the main way to catch poliomyelitis but small incidences due to bathing would not show up using this method. Overall Moore's study proved nothing about the health risks of swimming in sewage polluted water other than those related to poliomyelitis, paratyphoid and typhoid fever. Even then the evidence is far from convincing, yet this study has continued to be referred to for decades.

TABLE 8.6

Quarter of year	Patients			Controls		
	Bathed	Did not bathe	Total	Bathed	Did not bathe	Total
2nd	3	4	7	4	3	7
3rd	40	61	101	38	63	101
4th	2	40	42	2	40	42
All Quarters	45	105	150	44	106	150

Bathing History of 150 poliomyelitis pathients aged 0-15 years and of paired controls of the same age and sex, three weeks before the onset of symptoms in the patients.

SOURCE: B. Moore, 'The Risk of Infection Through Bathing in Sewage-Polluted Water', in E.A.Pearson, Waste Disposal in the Marine Environment, Pergamon Press, 1959, p37.

The British reliance on this report has enabled British authorities to avoid treatment altogether at many of their ocean outfalls and British beaches are notorious for their pollution. European Common Market Directives from the 1970s that beaches meet a standard of not exceeding 2000 faecal coliform per 100 ml of water could not be met by many British beaches and so they bypassed the requirement by only designating 27 beaches out of over 600 as bathing beaches. This compared to France which designated 1,500 and Italy with 3,000. British authorities accomplished this by making the criterion for a designated beach 1000 bathers/kilometre during their wet dreary summer of 1979. This enabled many of their major seaside resorts, such as Blackpool, which have long lengths of beach, to be missed out.[121] After heavy criticism for this, Britain increased its number of designated beaches to 391 in 1986.[122]

In contrast, epidemiological studies in the U.S. since the early 1950s have considered minor diseases and have demonstrated "significant risks of bathing associated disease, particularly gastro-enteritis, in recreational waters even mildly contaminated with sewage."[123] Apart from stomach illness, ear, eye, nose and throat infections, hepatitis and cystitis have all been linked with swimming in sewage polluted waters.[124]

A 1975 British study which also considered more minor illnesses also showed no differences between swimmers and non-swimmers and Britain has maintained

121 Fred Pearce, 'The Unspeakable Beaches of Britain', New Scientist, 16th July 1981, pp139-143; Anon, 'Ministers call for survey of beach sewage', New Scientist, 25th July 1985, p21; Graham Ridout, 'Sewage: Why are we Getting a Raw Deal', Windsurf Magazine, March 1987.

122 Observer, 7th August 1988.

123 Wheeler, 'Sea Fever', p9.

124 Observer, 7th August 1988.

that since there is no epidemiological evidence of any significant health threat they would not set standards. They did, however, recognise that in other countries immersion or swimming times might be longer and the risks higher. The U.S. Environmental Protection Authority has also noted a "paucity of valid epidemiological data" but in contrast to British Authorities has not taken this to mean that there are no problems.[125]

A 1979 SPCC report concluded that although studies had not been done in NSW, increased illness amongst swimmers had not been observed and experience confirmed overseas findings that there was a "low probability of persons becoming infected" after bathing in sewage polluted waters. For this reason, public health could adequately be protected if aesthetic considerations were met; in other words, no undisintegrated faecal matter or other materials "clearly of sewage origin" should be allowed into bathing areas and also no "noticeable" turbidity or discolouration of bathing water attributable to sewage and no "perceptible smell". There was no evidence in the Australian context, the report went on, to support a numerical standard. [126] There is no evidence because the proper epidemiological studies have not been done in Australia.

However in 1980 a US EPA spokesman claimed that

> surveys of 30,000 bathers and non-bathers contacted on beaches in New York and Boston revealed statistically significant increases in cases of vomiting, diarrhoea, nausea, fever and stomach aches among swimmers who had bathed in polluted waters....The results show a strong link between bacteria counts in the water at the time of bathing and subsequent health of the swimmers.[127]

He went on to suggest that 4% of swimmers would get severe cases of fever and stomach upset if they swam in waters less polluted that 2000 faecal coliform/100 ml and that if there were an epidemic in the population this risk to swimmers of getting other diseases would be greater.[128]

A later US report from the Office of Technology Assessment found that sewage polluted bathing waters were responsible for relatively high rates of gastro-intestinal disease and that the outbreaks of water-borne diseases, particularly viral diseases including hepatitis, had been steadily increasing in the past decades.[129]

In 1982 a group of staff and students from the NSW Institute of Technology found in a study they were undertaking that large amounts of bacteria were breeding off Sydney's beaches whether or not the sewage workers were on strike. Jerry Jackson, the environmental engineer in charge of the project said that there was no difference in levels of disease-causing micro-organisms in the sea whether or not the sewage underwent primary treatment or was discharged raw, since primary treatment only removed large particles. The dangers to health

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125 S.P.C.C., Health Aspects of Faecal Contamination, pp16-23.
126 ibid., pp66-7,75.
127 Pearce, 'The Unspeakable Beaches of Britain', p143.
128 ibid., p143.
129 US Technology Assessmen Office, Wastes in Marine Environments, p137.

depended on the general health of the community and what diseases were spreading through the sewage.[130]

In 1987 a leaked confidential Department of Health Report was passed on to Tracks magazine and the Sydney Morning Herald. The report said

> Salmonella serotypes continue to be recovered from water samples from beaches in the Waverley and Randwick municipalities. In the last 3 years Salmonella Paratyphi B has been isolated on 2 previous occasions. However, on 6 out of 9 sampling occasions between 20 October and 15 December, 1986, S. Paratyphi B was positively identified in water samples from Maroubra, Coogee, Malabar and McMahon's Pool. [131]

According to Professor Clem Boughton, head of the Infectious Diseases Department at Prince Henry Hospital, Salmonella serotypes could cause diseases similar to Gastro-enteritis and Salmonella Paratyphi B could cause paratyphoid fever. He said that other infectious diseases such as polio and hepatitis A, particularly, but also hepatitis B, typhoid, rotavirus and other enteroviruses were likely to be in beach waters, given the presence of salmonella.[132] Dr Nancy Millis of the School of Microbiology at Melbourne University warned in the 1970s that the presence of even one salmonella in a sample indicated a definite health risk. The numbers of salmonella organisms necessary to cause disease differed according to the strain of salmonella and susceptibility of individual people.[133]

The leaked report showed results of a much longer study undertaken by the NSW Department of Health. A paper published in 1988 summarises data collected by the Department between October 1983 and April 1987. Salmonella was detected in 183 out of 1058 (17%) samples tested at Eastern suburbs swimming spots and beaches (including Malabar which is closed for swimming) over the three and a half years.[134] Unfortunately there is no breakdown of percentages over time or individual beaches and the data for the Northern beaches covers several miles of beaches including those that are often not affected by sewage pollution.

The Department study also monitored the beach for faecal coliform, faecal streptococci and P.aeruginosa. These results are summarised in table 8.7. The Department's bacteriological standard for bathing waters differs significantly from that of the SPCC. It is as follows:

> Water should be considered to be unsuitable for bathing where the faecal coliform count, calculated as the geometric mean of the number of organisms in 3 water samples taken at the one time from the area

[130] Southern Courier, 19th March 1982.

[131] Department of Health, `Public Health Report', January- February 1987.

[132] Eastern Herald, 2nd April 1987.

[133] Peter Russ & Lindsay Tanner, The Politics of Pollution, Visa, 1978, p81.

[134] A.G.Bernard, The Bacteriological Quality of Sydney's Tidal Bathing Waters', in Proceedings of Water Quality & Management for Recreation & Tourism, International Confernece, IAWPRC &I AWWA, July 1988, p50.

> being examined, exceeds 300 organisms per 100 mL, with an upper limit of 2,000 organisms per 100 mL (in any one sample). [135]

Using this standard, as can be seen in table 8.7, the Eastern suburbs beaches were found to be unsatisfactory for between 29 and 83% of the time. This is in marked contrast to the results of the Water Boards self monitoring which, using geometric means over 30 day periods that had to be less than 200 faecal coliforms per 100 ml, and could only exceed 1000 per 100 ml in more than 10% of samples for summer (and looser standards for winter) managed to balance out high readings with low readings and show much better results. (see figure 8.10)

Table 8.7

DEPT OF HEALTH BACTERIOLOGICAL SURVEY OF BEACHES 1983-1987						
BATHING AREAS	Percentage of Samples Unsatis-factory [a]		F.coliform Maximum organisms/100ml		F.Coliform Median orgs/100m.	
	dry [b]	wet [c]	dry [b]	wet [c]	dry [b]	wet [c]
Bondi, Bronte, Clovelly	31	38	7500	4500	59	160
Coogee, Tamarama	29	53	9300	10000	91	230
Malabar, Maroubra, Little Bay	57	83	26000	46000	440	2700
Mahon Pool	30	60	11000	14000	71	100
Sydney Harbour	36	62	30000	20000	100	710
Northern Surfing Beaches	14	71	3900	10000	99	650
Botany Bay	0	50	370	20000	2	320

[a] Unsatisfactory samples = those where faecal coliform geometric mean of three samples is greater than 300 per 100ml

[b] dry weather - no rainfall within 24 hours prior to sampling

[c] wet weather - rainfall within 24 hours prior to sampling

INFO FROM: A.G.Bernard, 'The Bacteriological Quality of Sydney's Tidal Bathing Waters' in Water Quality & Management for Recreation & Tourism, Proceedings of an International Conference, IAWPRC & AWWA, Brisbane 1988.

The median Health Dept results also correlate much better with the Water Department results (table 8.8). Clearly the use of a geometric mean (the multiplication of all sample results and the calculation of the appropriate root of that product) is preferred by the SPCC and the Water Board because it tends to be less distorted by high readings and because the use of such a mean over a month long period enables a large proportion of samples to be unsatisfactory and yet yield a satisfactory geometric mean. Nevertheless this use of statistics is inappropriate in a situation where health threats are being monitored. If 30-50% of the time the beaches are unsuitable for swimming then a mean that shows that the averaged beach conditions are safe, is meaningless and serves only to cover up the health risk.

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135 ibid., p46.

Figure 8.10 RESULTS OF WATER BOARD BEACH MONITORING FOR BACTERIAL INDICATORS OF SEWAGE POLLUTION

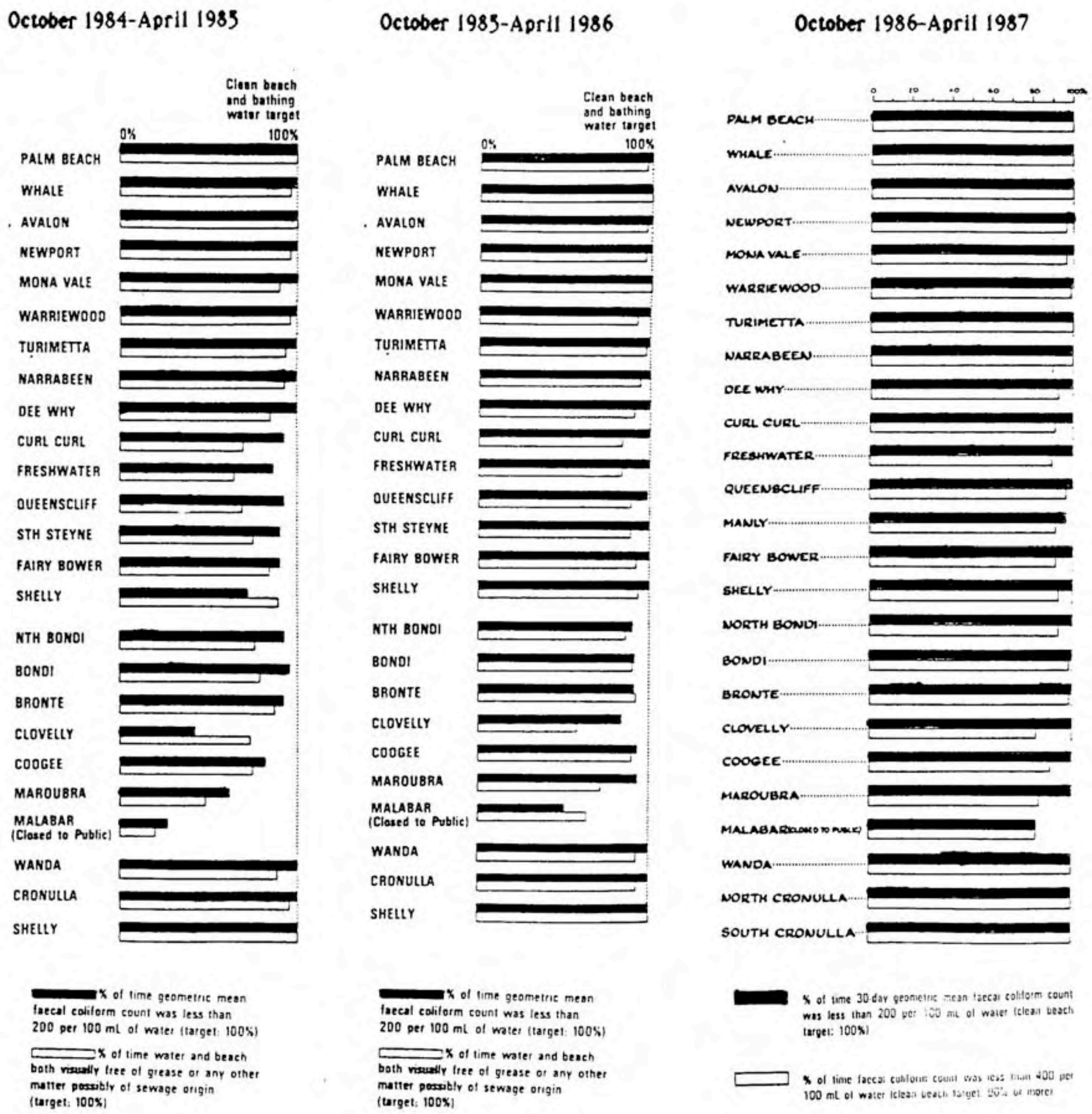


Table 8.8 shows the results of recent monitoring of beaches in the Waverley Municipal area conducted by the Health Department for the Council. The Table shows the geometric mean of 5 samples in 30 days (in the way the SPCC requires) and also the average of the same 5 samples to show how the geometric mean tends to be much lower. The results are also shown visually in figures 8.11 & 8.12 with the Health Department 300 faecal organisms/100 ml level shown.

These beaches were unsatisfactory in terms of both SPCC guidelines and Health Department guidelines according to the Health Department readings and yet the Water Board claimed that the "geometric mean coliform level during the same period complied with SPCC guidelines. The beaches were not closed during this period and the Board only issued warnings on two occasions, once for Bronte and

TABLE 8.8

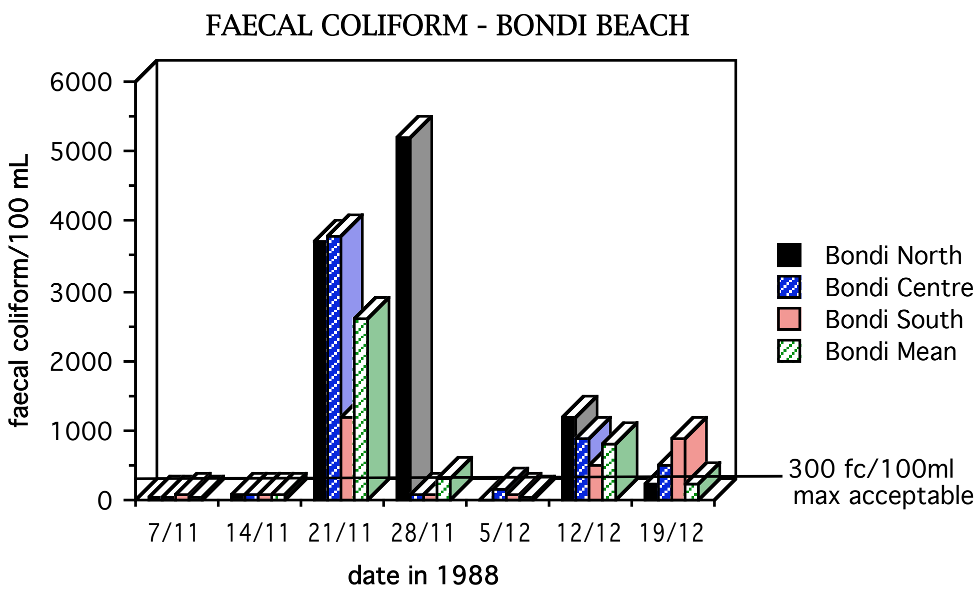
FAECAL COLIFORM LEVELS AT BONDI AND TAMATARAMA- NOV & DEC 1988

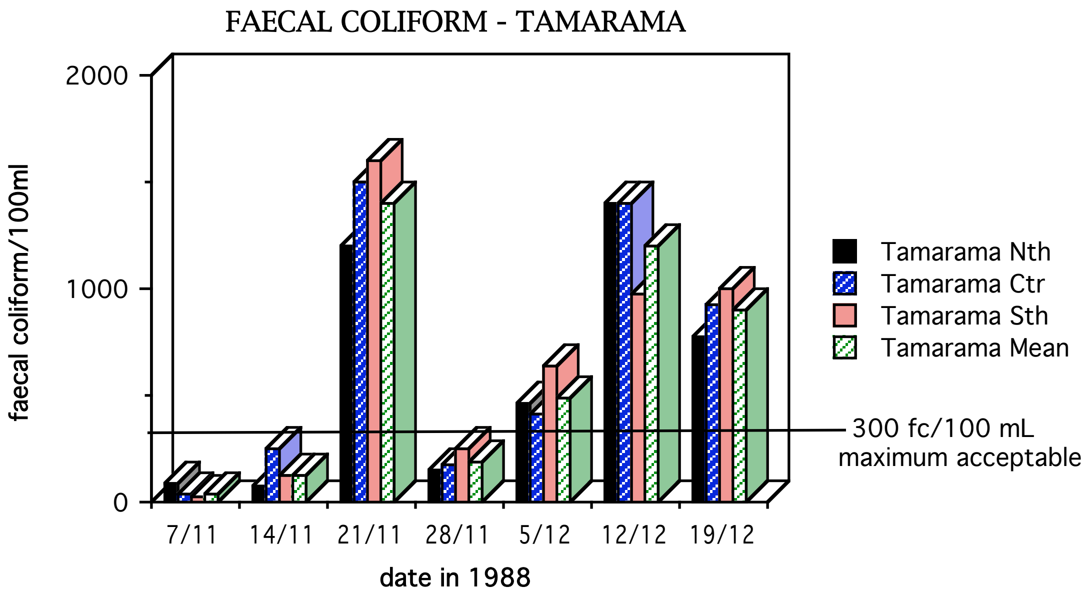
LOCATION	BEACH	WIND	FAECAL COLIFORM/ 100ML	GEOMETRIC MEAN OF 5 SAMPLES IN 30 DAYS	AVERAGE OF 5 SAMPLES IN 30 DAYS
BONDI NORTH	19/12/88	NIL	230		
	12/12/88	S-E	1200	881	2068
	5/12/88	NIL	10		
	28/11/88	S-E	5200		
	21/11/88	NIL	3700	244	1810
	14/11/88	N-E	90		
	7/11/88	E	50		
BONDI CENTRE	19/12/88	NIL	510		
	12/12/88	S-E	890	460	1086
	5/12/88	NIL	150		
	28/11/88	S-E	80		
	21/11/88	NIL	3800	161	828
	14/11/88	N-E	80		
	7/11/88	E	30		
BONDI SOUTH	19/12/88	NIL	870		
	12/12/88	S-E	510	320	548
	5/12/88	NIL	90		
	28/11/88	S-E	70		
	21/11/88	NIL	1200	133	302
	14/11/88	N-E	80		
	7/11/88	E	70		
TAMARAMA NORTH	19/12/88	NIL	780		
	12/12/88	S-E	1400	618	1894
	5/12/88	NIL	460		
	28/11/88	S-E	150		
	21/11/88	NIL	1200	220	394
	14/11/88	N-E	70		
	7/11/88	E	90		
TAMARAMA CENTRE	19/12/88	NIL	920		
	12/12/88	S-E	1400	671	798
	5/12/88	NIL	410		
	28/11/88	S-E	170		
	21/11/88	NIL	1500	253	474
	14/11/88	N-E	250		
	7/11/88	E	40		
TAMARAMA SOUTH	19/12/88	NIL	1000		
	12/12/88	S-E	980	758	880
	5/12/88	NIL	640		
	28/11/88	S-E	250		
	21/11/88	NIL	1600	228	526
	14/11/88	N-E	120		
	7/11/88	E	20		

INFO FROM NSW Department of Health Analysis of Tests Taken by Waverley Municipal Council.

once for Tamarama and Bronte.[136] On the day on which Health Department and Water Board readings coincided, November 28th the findings of the Water Board were substantially lower. For example the Health Department found 310 faecal coliform/100 ml at Bondi whereas the Board found 60-80 faecal coliform/100 ml at Bondi.[137]

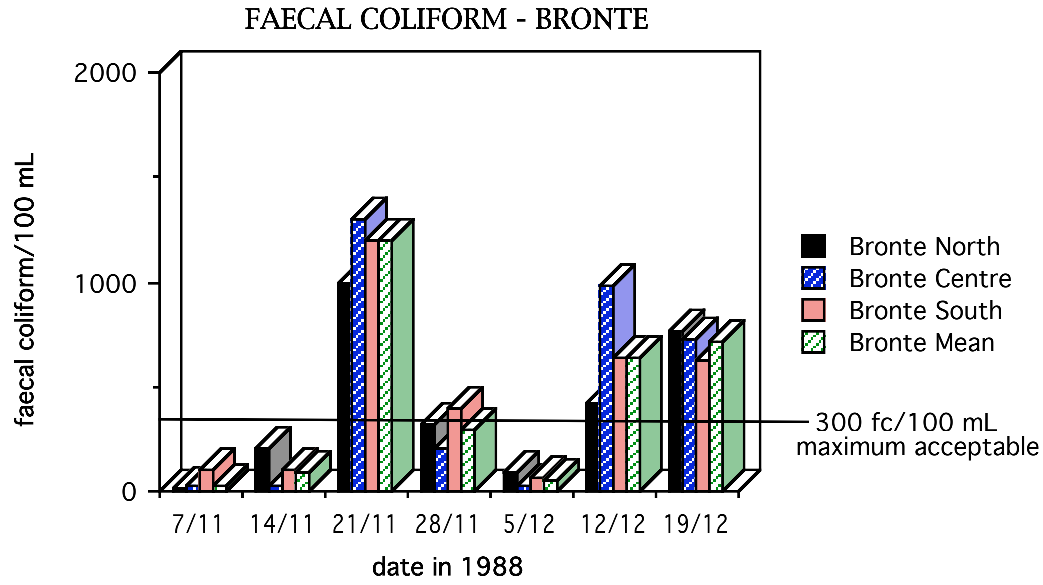
Figure 8.11

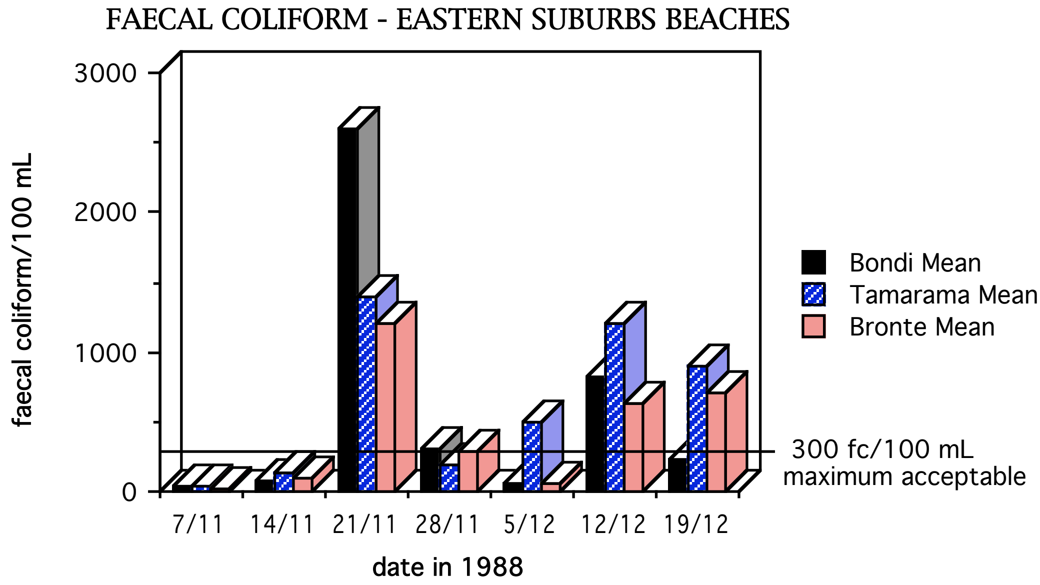




136 Eastern Herald, 12th January 1989.
137 ibid.

Figure 8.12





OUTFALLS - ARE WE FOLLOWING THE U.S. EXAMPLE OR NOT?

In a submission on the Environmental Impact Statements for the submarine ocean outfalls, the firm Commonwealth Industrial Gases (CIG), which was proposing an alternative form of treatment, had argued that with the exception of Sydney and Geelong (another Caldwell Connell job), all of the other major population centres in Australia where effluent was discharged to coastal waters either achieved or were committed to achieving secondary effluent standards and had listed them all in a table.[138] (see table 8.9)

[138] Commonwealth Industrial Gases, Oxygen Technology for Sewage Treatment and Disposal: Fast Economic Alternatives to the Proposed Deepwater Submarine Outfalls for Sydney, C.I.G., March 1980, pp18-9.

Table 8.9

Summary of Treatment Standards on Australia's Coasts

	AUTHORITY	PRESENT DEGREE OF TREATMENT	RECEIVING WATERS	LONG TERM POLICY	DEGREE OF IMPLEMENTATION
NEW SOUTH WALES					
Sydney	MWS & DB	RAW SCREENED OR PRIMARY	Pacific Ocean	UNDECIDED	Impact Statement
Newcastle	HDWB	RAW SCREENED OR PRIMARY	Pacific Ocean	SECONDARY	Commenced
Wollongong	MWS & DB	PRIMARY/SECONDARY	Pacific Ocean	SECONDARY	Part Completed
Other	LOCAL COUNCILS/PWD	SECONDARY	Pacific Ocean	SECONDARY	Mostly Completed
VICTORIA					
Melbourne	MMBW	SECONDARY	Bass Strait/Pt. Phillip Bay	SECONDARY	Completed
Geelong	GW & ST	RAW SCREENED	Bass Strait		
QUEENSLAND					
Brisbane	B.C.C.	PRIMARY/SECONDARY	Moreton Bay	SECONDARY	Under Construction
Gold Coast	G.C.C.C.	SECONDARY	Pacific Ocean	SECONDARY	Under Construction
Cairns	C.C.C.	SECONDARY	Pacific Ocean	SECONDARY	Completed
Townsville	T.C.C.	SECONDARY	Pacific Ocean	SECONDARY	Completed
Rockhampton	R.C.C.	SECONDARY	Pacific Ocean	SECONDARY	Completed
Mackay	M.C.C.	SECONDARY	Pacific Ocean	SECONDARY	Completed
SOUTH AUSTRALIA					
Adelaide	E & WS	SECONDARY	Great Australian Bight	SECONDARY	Completed
WESTERN AUSTRALIA					
Perth	MWSS & DB	PRIMARY/SECONDARY	Cockburn Sound	SECONDARY	Part Completed
TASMANIA	VARIOUS COUNCILS	PRIMARY/SECONDARY	Estuaries/Bass Strait	SECONDARY	Part Completed
NORTHERN TERRITORY					
Darwin	D.C.C.	SECONDARY	Timor Sea	SECONDARY	Completed

SOURCE: CIG, Oxygen Technology For Sewage Treatment and Disposal, Submission to SPCC, March 1980, p19.

The CIG proposal also highlighted US legislation which had in 1972 required all publicly owned treatment works to achieve secondary treatment by July 1 1977. Despite Caldwell Connell's argument that submarine outfalls facilitated a form of secondary treatment that took place in the ocean, the United States legislation was quite clear that such a concept was not acceptable. Secondary treatment was defined in terms of four pre-discharge effluent parameters - biochemical oxygen demand, suspended solids, pH and faecal coliform bacteria.[139]

Following the enactment of this legislation in the United States, several municipalities, mainly from the West Coast of the US had complained that secondary treatment was not necessary "to protect the marine environment or to assure the attainment and maintenance of water quality in ocean waters." They argued that pollution parameters that were important for freshwater ecosystems were not significant in ocean waters where there was plenty of oxygen, and where wastes would be rapidly assimilated and dispersed.[140]

Because of the testimony of these municipal authorities, the Act was amended with the addition of a section 301(h) which allowed for a municipal marine discharger to present its case to the Federal Environmental Protection Agency (EPA) and obtain a waiver to the requirement for secondary treatment if it is demonstrated to the satisfaction of the EPA administrator that the receiving waters would not be impaired because of that waiver and the discharge of toxic pollutants would not be increased.[141]

CIG argued that such waivers were difficult to get and that the intention of the US legislation was obviously to maintain secondary standards for ocean outfalls.[142] The Board in response, contended that its ocean outfall proposals would meet the requirements for a waiver, whereas CIG's proposal would not.[143]

In fact the Water Board proposals would have failed to obtain a waiver on at least two major points. Firstly, section 301(h) applicants had to demonstrate that they would provide a minimum of full primary treatment and that an applicant providing only primary treatment would bear a particularly heavy burden in demonstrating to the EPA that the treatment provided would be adequate. The EPA believed that primary treatment, which removed up to 40% of suspended solids, plus floatables and grease, was an absolute minimum level of treatment for adequate protection of water quality. In fact, the State of California required 75% removal of suspended solids as well as floatables and grease.[144]

For the North Head proposal where something less than primary treatment was being planned, (i.e. high rate primary treatment) it was predicted in the EIS that 18% of suspended solids would be removed.[145] At Bondi, where the sludge was

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139 Environmental Protection Agency, 'Modification of Secondary Treatment Requirements for Discharges into Marine Waters', Federal Register 4(117), 15 June 1979, p34784.

140 ibid., p34784.

141 ibid., p34784.

142 C.I.G., Oxygen Technology for Sewage Treatment and Disposal, p23.

143 Chief Engineer, Investigation, M.W.S.&D.B., internal report, 29th April, 1980.

144 E.P.A., 'Modification of Secondary Treatment Requirements', pp34796-7.

145 Caldwell Connell, Environmental Impact Statement North Head, p44.

added back into the effluent before discharge the suspended solids removal was 11% with an predicted ultimate performance of 18% in the year 2025.[146]

The second reason why the Board's proposals would fail to get permission in the United States was because they planned to discharge the sludge with the effluent into the sea. In the US the disposal of sludge, digested or not, into the ocean was illegal and there were to be no waivers on this account. The EPA explained that the Congress had specifically prohibited the discharge of untreated sewage and,

> Since sewage sludge is, basically the material which is removed from raw sewage during the treatment process, allowing a POTW [Publicly Owned Treatment Works] to discharge both treated effluent and sewage sludge, or sewage sludge alone, would be equivalent to allowing it to discharge untreated sewage.[147]

Another requirement for a waiver in the US was that the discharger be able to prove that a balanced, indigenous marine population would be maintained at the site of discharge. This required a comparison of the ecological characteristics between sites of no pollution and those with current or planned discharge. Variation beyond what was found naturally between habitats would be unacceptable. The bioaccumulation of toxic materials was one of the several aspects which the legislation was concerned with.[148]

Finally, the regulations for obtaining a waiver in the US specifically called for the applicable standards to be met under assumed worst case conditions which might include low current velocities in the ocean and maximum waste flow and the worst possible ambient density stratification. The reasoning behind this was that the initial dilution achieved at a discharge site was likely to be highly variable and

> measuring compliance with water quality standards on the basis of average initial dilution would mean that those standards might be exceeded 50% of the time. Furthermore, this formulation would be inconsistent with Congress' intent that water uses and marine life be protected under "assumed worst conditions".[149]

Caldwell Connell and the Water Board often cited the outfall at Hyperion, California as the model for the Sydney outfalls, because of similarities in its design. Caldwell Connell told the SPCC that the Hyperion outfall met the required health standards (<20% of samples exceeded 100 total coliforms/100ml) in 1981 and only 3.5% exceeded the 100 coliform/100 ml standards in summer and 2.0% in winter with occasional chlorination of the effluent. The standards were also met at Whites Point and at Orange County except on rainy days when stormwater runoff discharged into the ocean.[150]

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146 M.W.S.&D.B., Environmental Impact Statement Bondi Water Pollution Control Plant, M.W.S.&D.B., p7.

147 E.P.A., 'Modification of Secondary Treatment Requirements', p34797.

148 ibid., p34788.

149 ibid., p34800.

150 S.P.C.C., Questions Relating to Proposed Malabar Outfall.

However there were important differences between the proposed Malabar outfall and those which existed in California. The Malabar outfall was closer to shore (thus providing less time for bacteria, particularly coliforms, in a surface field to die off before hitting the beach) but also deeper. The effluent going through the Hyperion outfall was better quality because part of it was secondary treated and the rest given full primary treatment. All California outfalls "have, or soon will have effluents with suspended solids and BOD concentrations only about half of the values at Malabar, and oil and grease concentrations only one-third." [151]

Moreover, the success of the Hyperion outfall is disputed. Reports have been reaching Australia, via surfing magazines, that the El Segundo/El Porto area, where the Hyperion outfall is sited, has been nicknamed "El Stinko" by surfers and residents because of the continuous stench in the area which intensifies during onshore winds and during storms. As a result of complaints and Federal legislation (local groups were able to get Los Angeles section 301(h) waiver rescinded after a successful federal suit) the State authorities have ordered the local council, Los Angeles City Council, to give all their sewage secondary treatment before discharge to ocean. It is estimated that this would cost $528 million.[152] In 1987 Los Angeles had still not improved the quality of sewage treatment and was fined $625,000. It must institute full secondary treatment by 1998.[153]

Similarly Caldwell Connell used the Hyperion outfall to justify their conclusions that the disposal of digested sludge to sea through the Sydney outfalls would be safe and innocuous. They argued that sludge had been discharged through the Hyperion outfall for seventeen years and a 1973 study had shown that although there were some localized effects there was "no scientific basis for concluding that the marine disposal of digested sludge had been harmful to the marine biology."[154]

In fact the Hyperion sludge line is 11km from shore (rather than the 2.2 to 3.8 km proposed for Sydney) and it discharges off the edge of a natural canyon in the ocean floor (no such features off Sydney's coast).[155] More significantly, studies have found that the sludge discharged there is not as harmless as Caldwell Connell would have liked to have believed and fish disease attributed to pollution has been discovered in the vicinity of the outfall.[156] Los Angeles City Council was ordered to stop dumping sludge through its Hyperion Outfall by the end of 1987.[157]

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151 M.W.S.&D.B., 'Technical Report in support of Application for Approval', pp27-8.

152 for example Mike Balzer, 'Taking the Stink Out of El Stinko', Surfing , June 1986, p36.

153 Michael Moreau, Santa Monica Bay: Spills of Indifference', Surfer, December 1987, p36; Mike Balzer, 'Brown Water', Surfing, August 1987, p52.

154 Caldwell Connel, Sydney Submarine Outfall Studies, p153.

155 Willard Bascom, 'The Effects of Sludge Disposal in Santa Monica Bay' in Virginia Tippie & Dana Kester, Impact of Marine Pollution on Society, Praeger, Mass., 1982, p223.

156 ibid.

157 Mike Balzer, 'Brown Water', p52.

ENGINEERING THE FACTS

The work of the Water Board and their consultants, Caldwell Connell Engineers, clearly displays a use of science in engineering which clearly contrasts with the traditional view of engineering as being simply the application of science to real problems.

The relationship between science and technology is a complex one which has been much debated. In 1974 Edwin Layton put forward the proposition that technology should be considered as knowledge in its own right.[158] Layton points out that technological knowledge is different from scientific knowledge because although science purports to understand nature and the universe, engineering knowledge is developed to "provide a rational basis for design".[159] Henry Skolimowski had made a similar distinction earlier. He said that "in science we investigate the reality that is given; in technology we create a reality according to our designs."[160]

It is this different approach that seems to give engineers much more freedom than scientists to manipulate their data to fit their goals. The social construction of engineering knowledge is much more obvious and crude than the construction of scientific knowledge. As one engineering writer has pointed out, engineers are less concerned about accuracy than scientists are and require only that their theories be adequate for their purposes.[161] The "norms" of science; the need to back up every assumption with evidence, the testing of hypotheses and the testing of other scientists work, do not apply in engineering. The only test for technology is whether it "works" and the meaning of "works" is also socially negotiated.

In engineering, knowledge serves not only as a basis for design but also as a tool of legitimation and justification. The 1976 Caldwell Connell feasibility study, which followed the decision to build the submarine ocean outfall, served both these purposes. It provided the data necessary for the design of the outfalls but also played a role in advocating those outfalls as an environmentally sound solution to the problems of ocean pollution. The study seemed on the face of it to be a comprehensive, well documented scientific study and in areas where information was needed for the purposes of design, it was.

However, the parts of the study which were aimed at proving that the performance of the outfalls would be environmentally beneficial were poorly documented and contained little relevant data. The key assumptions upon which the conclusions about environmental performance depended were unsupported. In particular, the claimed performance of the submarine outfalls depended heavily on at least three key assumptions; firstly the assumption that sludge would not accumulate in the sediments, secondly the assumption that the

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[158] Edwin Layton, 'Technology as Knowledge', Technology and Culture 15(1), 1974, pp31-41.

[159] ibid., p40.

[160] Henry Skolimowski, 'The Structure of Thinking in Technology', Technology and Culture 7(3), 1966, p374.

[161] G.F.C.Rogers, The Nature of Engineering: A Philosophy of Technology, MacMillan 1983, p54.

submerged field would not come on shore and thirdly the assumption that water-borne pathogenic organisms would die-off rapidly in the ocean. None of these assumptions were investigated.

This report and those that followed it were clearly attempts to construct and shape knowledge for political and social ends. The scientific experiments and computer modelling gave the veneer of a scientific approach but did not address the key questions. Yet the scientific packaging was necessary to give the report the aura of objectivity and truth which are usually associated with scientific reports.

The report was not unique in its use of and emphasis on scientific trappings as part of the presentation of a case. It follows in a long tradition of engineering reports, from the nineteenth century onwards, which have sought to present and define knowledge that accords with the political and social goals of the engineers themselves and their employers.

In the nineteenth century, however, the lack of consensus amongst engineers meant that various engineers used various "scientific findings" to support various systems and their subsequent knowledge claims were seen to be a resource for combatants rather than any statement of truth. Since the formation of a sewerage treatment paradigm, the engineers have got their act together and are careful not contradict each other. Rather they support each other's knowledge claims and these are presented to the public as factual, truthful, objective findings about reality.

Apart from the role of justification and advocacy, a science-like approach is also used by engineers generally to enhance their prestige and standing in the community. Practicing engineers and professional engineering societies have always seen an emphasis on science as a means of gaining status. Engineers came to define themselves by their ability to apply scientific laws to achieve their ends.

> The cement binding the engineer to his profession was scientific knowledge. All the themes leading towards a closer identification of the engineer with his [sic] profession rested on the assumption that the engineer was an applied scientist.[162]

Engineering educators increasingly emphasised and added to the scientific content of the education of university trained engineers in the nineteenth century as a way of improving their status and thereby "capitalize on the growing respectability of science". Scientific education carried a certain amount of prestige because of "a small but prominent and growing profession, that of the scientific researcher"[163] and this prestige had its effect on engineering education. The educators in early engineering schools, operating within

[162] Edwin Layton, The Revolt of the Engineers, Press of Case Western Reserve University, 1971, p58.

[163] Randall Collins, The Credential Society: An Historical Sociology of Education and Stratification, Academic Press, 1979, p124.

universities, were highly conscious of their second-class status and even the newly esteemed scientists looked down upon them.[164]

The scientific approach has, of course, yielded solutions to engineering problems which the old trial and error methods never could but the need to teach science in engineering schools has been grossly inflated by the needs of the engineering profession for esoteric knowledge and of engineering educators for academic respectability.[165] And in many cases complex abstract methods have replaced simple empirical methods without any gain in the final engineering product.

This phenomenon was observed in a case study of American highway research by Bruce Seely. An increased scientisation of engineering had resulted from an effort to reap the higher status accorded to scientists after World War I. As part of this trend the Bureau of Public Roads concentrated on getting "precise quantitative data and the expression of results in mathematical terms". They also attempted to replace the knowledge they had gained through experience, observation and empirical methods with a more theoretical understanding of road construction. Seely concluded from his study that the embracing of scientific methodology and attitudes actually hindered the development of practical solutions.[166]

The new science of submarine outfalls seems to fit this pattern. The attempts to model real life situations mathematically tend to oversimplify the very complex action of the ocean and the heterogeneous nature of the sewage discharged into it. The preference for computer modelling over empirical experiments is marked in all of Caldwell Connell's studies, although very little evidence for the veracity of such models is given in their reports. Yet while computer modelling may seem to offer little gain over empirical methods in terms of power to predict the impact of the outfalls, it does have other advantages. Not only do the engineers and the study gain from the prestige associated with complex analytical methods (the engineers must have much esoteric knowledge and expertise and the study must be comprehensive, objective and true) but also the interpretation of results and assumptions inherent in such modelling and simulation exercises are less obvious and accessible to the lay reader than empirical tests such as drogue and dye experiments. These, as can be seen in this and previous chapters, are more obvious attempts to shape knowledge by specifically arranging experiments to give the required evidence and carefully minimising factors which may be known to be significant.

Michael Mulkay has pointed out the many flaws in arguments which treat the success of science in manipulating and controlling nature as proof of the validity of scientific conclusions[167] and a similar claim could be made about technological knowledge. The engineering knowledge of submarine outfalls and their predicted performance can be tested once they are built by how well they work. Yet the

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[164] David Noble, America By Design: Science, Technology and the Rise of Corporate Capitalism, New York, Alfred A Knopf, 1977, p26.

[165] ibid.

[166] Bruce Seely, 'The Scientific Mystique in Engineering: Highway Research at the Bureau of Public Roads, 1918 -1940', Technology and Culture 25(4), 1984, pp 798-831.

[167] Michael Mulkay, 'Knowledge and Utility: Implications for the Sociology of Knowledge', Social Studies of Science 9, 1979, p68.

definition of "working" is a negotiated one in terms of both the parameters which are defined to be important and the measures of those parameters which define success.

When the outfalls are built and operating, and if the engineers succeed in making the sewage field less visible, there may be no obvious signs of their impact. In the past, obvious signs of pollution have been denied, evidence of ill-health has been disputed, fish survey results have been labelled insignificant. The only measurable parameters which are officially endorsed are the limits on concentrations of restricted substances at the boundary of the initial dilution zone and concentrations of faecal coliform in bathing waters.

It is debatable whether the concentrations of restricted substances at the boundary of the initial dilution zone provide a satisfactory criterion of performance. Moreover these concentrations are not measured directly. Rather concentrations in the effluent are measured. This is not a simple matter of dipping a test tube into the flow. The Board is careful to get a composite sample which they say is representative of the flow which will vary at various places in the cross-section of the pipeline, with heavier material being towards the bottom etc. (Clearly there is ample opportunity here for sampling procedures that minimise the peaks of toxic metal concentration especially since the Board does not really want to know but is only satisfying SPCC requirements in taking the measurements.) The contents of this composite sample is then multiplied by an assumed dilution factor and it is this final manipulated result which can be compared to SPCC WP-1 criteria which are themselves negotiated.

Similarly, the concentration of faecal coliform is agreed by almost everyone to be an unsatisfactory indicator of bacteria and viruses in sewage and a dubious indicator of the presence of sewage because of short die-off rates. Moreover the monitoring process is manipulated to ensure that a large number of unsatisfactory readings are hidden within a mean figure. Evidence of this manipulation process is given in a recent Water Board report which observes that the chance of the worst 10% of samples being significantly over limits is increased if samples are taken less often.

> If a 6-daily strategy were adopted there would be a 35% chance that the measured 90 percentile from one season's monitoring would exceed the present value of 1000 cfu/100ml - i.e. we would be incorrectly deducing that the new outfalls had worsened the situation... For a 3-daily and daily sampling this chance reduces to 15 and 5% respectively.[168]

The report therefore recommends that sampling for the first year after the outfalls are commissioned should be at least once every 3 days with the possibility of reducing to 6 daily "if levels prove to be less than expected."[169]

There are numerous other examples where the monitoring programme for the new submarine ocean outfalls, which is supposed to assess their performance, is

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168 Sydney Water Board, Sydney Deepwater Outfalls, Environmental Monitoring Programme: Pilot Study, vol 3, March 1988, p17.

169 ibid., p18.

being manipulated in advance. During pre-commissioning beaches will be monitored at several locations, purportedly to establish the influence of alternate sources of pollution, and then after commissioning only one location[170], chosen by the Board on the basis of their pre-commissioning results, will be monitored on seven selected beaches (Avalon, Turimetta, Dee Why, Freshwater, Bondi, Malabar, Cronulla), not including Maroubra, Queenscliffe or Clovelly which are some of the most polluted at present.[171] Since 25 beaches are monitored routinely by the Board[172] it is hard to understand this selectivity.

These beaches will be monitored for faecal coliform and faecal streptococci, neither of which are pathogenic although faecal Streptococci bacteria survive longer in seawater than coliforms. Although the Board admitted that human viruses were generally more infectious and survived longer in the environment than most bacteria, they argued that they are hard to detect and may not supply "significant additional information". Salmonella will not be monitored, although it is tested for by the Department of Health, because the Board claim that it does not survive outside the body and is only found in sewage if there are carriers in the population, because salmonella can result from pollution by animals and birds and because it is unlikely that people would become infected by it from swimming. [173]

Similarly, as was discussed in chapter 7, the fish which are going to be monitored are fish which have not given too much trouble in terms of accumulation of organochlorines and heavy metals, unlike, for example, the Red Morwong, the Blackfish or the Blue Groper.[174] In fact the first volume of the Water Board's pilot study (preceding the full monitoring programme) indicated that the bioaccumulation studies were only going to be undertaken at Bondi and North Head[175], although I was told that it was later decided that Malabar would also be monitored and a later volume of the pilot study also indicated this.[176]

The use, in the earlier Caldwell Connell reports, of sediment samples obtained with a Shipek Grab Sampler, which was questioned by the SPCC does not seem to be improved upon much in recent investigations. In the pilot study, two sediment samples were collected using a Smith-McIntyre grab and no restricted substances were detected in either sample. The Board did admit, however that "this may have been due to "washing" of the sample during retrieval".[177] Moreover, sediments will be sampled in the initial dilution zone, close to the submarine diffusers (thereby assuming no travel of the sediments) and the control sites (off Long Reef and Port Hacking) will be easily within the 14 km that the Board previously argued the sludge particles would travel. Initial

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170 ibid., pp16-18.
171 ibid., p9.
172 Sydney Water Board, Annual Report, Year ended 30 June 1988, p34.
173 Sydney Water Board, Pilot Study, vol 3, pp7-9.
174 ibid., vol 11, p16.
175 ibid., vol 1, tables 8a &b.
176 ibid., vol 11, figure 10.
177 ibid., vol 11, p12.

sampling will be reviewed after six months and the sampling strategy modified if necessary.[178]

Another important difference between the construction of scientific knowledge and the construction of technological knowledge lies in the difference of approach. Technologists assume that nature can be modified and manipulated.[179] Not only do they seek to dominate nature but they are also insensitive to the complexities and delicate balances that ecosystems rely on. Engineers see oceans in terms of their assimilative capacities. They assume that matter and energy move in linear pathways unlike "the ecologists notion of keeping matter and energy within as tight as possible circles or cycles."[180]

Sewerage engineers think primarily in terms of oxygen demand, suspended solids and faecal coliform, as they have done for years but these are crude measures of the impact of sewage on an ecosystem which is more complex than we can know and has evolved subtle balances over millions of years. Engineers are used to avoiding major easily detectable impacts, yet more subtle impacts on ecosystems can be just as devastating in the long term.[181] In particular, engineers have not been concerned about the eventual fate of the sewage discharged. They seem to consider that if they can prove that the sewage will not build up or form a nuisance near the outfalls and nearby beaches then it doesn't matter where it goes to.

Engineers do call on the work of people in other fields of expertise but they do this selectively and according to what will be useful or will support their goals. This is clearly shown in the area of health risks arising from swimming in sewage polluted waters and the continued reference by engineers in the SPCC and the Water Board to the findings of a 1959 report despite all the research and evidence that has been done since that time. They are similarly selective about citing overseas experience of environmental impacts associated with engineering projects similar to their own. Nor are engineers the only ones to shape knowledge to suit their purposes. Moore's study also clearly shows how medical knowledge can be shaped to suit social and political ends and shows the folly of relying on one study to ascertain health risks unless that study suits your purposes.

And whilst engineers must necessarily draw upon the knowledge of other professions, particularly scientists and medical experts, they are not willing to take criticism from those whose areas of expertise they encroach on. There is no reason for them to since the knowledge they desire is just enough to be able to construct lasting, low maintenance structures and convince others that they are adequate. The knowledge of others who do not share their paradigm is not only seen as superfluous but also counterproductive.

For example, Mullins, as a marine chemist, found the engineering simplifications of the behaviour of the ocean as one homogeneous mass and the interaction of a changeable sewage effluent with it, to be almost incomprehensible. Moreover his priorities were quite different from those of the sewerage engineers. He wanted

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178 ibid., vol 11, pp17-18.

179 Rogers, The Nature of Engineering, p30.

180 Jorling,'The Southern California Bight', p252.

181 ibid., pp252-5.

to see the marine life protected and the sewage recycled.[182] His criticisms were described by the Water Board as "unsubstantial and irresponsible" and a board spokesman asserted that Mullins had not understood the Board's "extensive" EIS's.[183]

What Mullins failed to understand, from the Board's point of view, was the extent to which political ends and cost considerations shaped the choice of submarine outfalls and the way the scientific data had to fit in with that. It was irresponsible not to consider such things. What was called for was "unemotional consideration of the subject by those qualified and experienced in this field."[184] Clearly only engineers, who were willing to consider political and economical aspects of the situation, were properly qualified to comment.

Brain, who as an engineer should have known better, took the request to assess the Caldwell Connell study seriously. He later admitted that he had misunderstood the situation; that the SPCC had made a policy decision in favour of the submarine outfalls and that he was supposed to support the report. He had not and he was very unpopular because of it. He claimed that he had been "crucified" and that he was pushed into other work. It was the end of his career in the SPCC.[185]

CONCLUSIONS - AND ARE THEY NEGOTIABLE?

The advantages which submarine ocean outfalls are supposed to have over shoreline discharges are firstly the greater dilution and dispersion they will effect, secondly the ability to keep the sewage field submerged because of the depth at which the sewage is released and thirdly the greater die-off of water borne disease-causing organisms due to the greater distance they have to travel before reaching shore.

The faith in dilution has its roots in the faith of early American engineers in the almost infinite ability of running water in rivers to purify effluent. Yet dilution is not the only mechanism that operates in ocean waters and various materials in the sewage tend to accumulate and agglomerate rather than disperse in the ocean or are bio-accumulated in the marine food chain. Moreover a narrow emphasis on dilution ignores the effect that continual discharge may eventually have on a finite body of water. There is evidence that sewage and sludge disposal to sea are causing a build up of pathogenic microorganisms and toxins in various parts of the world.

Similarly the role of the submerged field and die-off factors are open to question. Even if a submerged field can be maintained most of the time in summer, as Caldwell Connell hope it will, the bacterial die-off rate will be reduced and the submerged field may still come in shore. Faecal coliforms may die-off quickly but bacteria and viruses can live for months.

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182 T. Mullins, 'Submarine Sewerage Out-Fall', Communique 2, August 1981.

183 Southern News, 21st July 1981.

184 Sydney Morning Herald, 8th June 1970.

185 Robert Brain, personal communication, July 1987.

Engineering knowledge is not about truth nor does it describe reality, past, present or future. It is a special blend of know-how, ideology and representation aimed at achieving ends. It mimics science, takes on the trappings of science, utilises science selectively, but also ends up being a parody of science. This tendency is heightened in public sector technology where the evaluation of a technology is endlessly manipulable and the criteria for performance socially negotiated.

In the case of sewerage technology and, in particular, the submarine ocean outfalls, the only means of evaluation is through legislated standards and guidelines. Yet the standards and guidelines reflect the same engineering knowledge that the technology is based upon with the same inconsistencies and the same selective use of scientific findings. These standards are also subject to social construction and manipulation. The WP-1 guidelines were put together in 1974, upon request from the Water Board. Many of the provisions within them are open to interpretation and the numeric standards they contain are based on principles that were at the time and are increasingly questioned.

In particular, the bacterial standards are based on measures of faecal coliform, which bear little behavioural relation to pathogens and the levels of restricted substances are based on concepts of a zone of sacrifice and the efficacy of dilution for dealing with toxics. It has been argued, moreover that the focus by sewerage authorities and regulatory agencies on faecal coliforms "is a public relations exercise aimed at distracting attention from the very serious, long-term water pollution problems which are not being tackled." Other indicators of water quality such as levels of heavy metals in fish are not publicised and "the public is mistakenly led to believe that 'all is well' if most beaches are given the all clear in terms of faecal pollution.[186]

The proposed monitoring programme for the new ocean outfalls is being worked out on the basis of a pilot study which allows the Water Board to choose and shape its methods, criteria and locations for monitoring in advance and because the monitoring programme have a pre-commissioning stage, this process will be refined as results come in. This provides for ample opportunity to shape the results and ensure that the Board only discovers what it wants to discover.

The Water Board and Caldwell Connell Engineers have spent over a decade putting together a knowledge base that supports their submarine ocean outfalls, presently being constructed. This was not only to convince the community and their politicians that the outfalls would "work" but also to convince the SPCC as regulatory authority so that approval would be granted. The next chapter will consider, the social context of their work, the debates over their knowledge claims and the preparations being made to ensure that the submarine ocean outfalls are defined as "working" after they are commissioned.

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[186] Russ & Tanner, The Politics of Pollution, pp79-80.

CHAPTER 9

DEFENCE OF THE SUBMARINE OUTFALLS: PUBLIC RELATIONS ASSISTED TECHNOLOGY

The engineering of Sydney's submarine outfalls began with the first conception of the idea, followed by firm proposals and plans for the outfalls in the 1960s. By the time the firm Caldwell Connell Engineers was formed to do the feasibility study and initial design and the money had been allocated for this purpose the decision had been made that submarine ocean outfalls would be the next step in the development of Sydney's sewerage system. The previous chapter has concentrated on the Caldwell Connell studies and their social construction of knowledge. This chapter will consider further the defence and implementation of this decision to build the submarine ocean outfalls, particularly following the display of the environmental impact statements at the end of 1979.

Figure 9.1 shows these events in a chronological frame with relevant regulatory, political and public relations activities indicated. It will be noted that the decision to install submarine ocean outfalls preceded legislative reforms and in fact preceded the growth of environmental concern that bloomed at the end of the 1960s and throughout the 1970s. (see figure 9.2) These events may have hastened the plans but did not alter them.

The display of the Environmental Impact Statements followed closely after legislation (the Environmental Planning and Assessment Act 1979) which aimed at allowing more public input into the urban development process. It marked the culmination of a decade of resident protest actions and union green bans against unwanted developments, and the consequent political recognition that the public was increasingly demanding a say in the shaping of the urban environment.

Caldwell Connell prepared environmental impact studies for the Malabar and North Head submarine outfalls at the request of the Water Board and these were displayed for the public at the end of 1979. The Board prepared the EIS for the Bondi submarine outfall itself, along the same lines as the others and it was displayed with the other two EIS's at the end of 1979. The submissions received in response to the public display of the Environmental Impact Statements ranged from one or two page handwritten letters from residents of beachside suburbs to more weighty submissions from environmental groups. Ten government authorities and five councils responded. About forty six submissions were made altogether.

The general thrust of each submission is shown in table 9.1. Whilst a few individuals used the opportunity to protest against beach pollution, most of those who were opposed to the submarine outfalls were opposed to the principle of disposing of the wastes into the ocean. The submarine outfalls were repeatedly referred to as a "short-sighted solution" or a "stop-gap measure". Many submissions called for the return of sewage to the land, utilisation of the sewage as fertiliser for urban tree plantations or crop production further west and the reuse of the water.

In its assessment of the EIS's and submissions the newly formed Department of Environment and Planning (DEP) concluded that there were no environmental

Figure 9.1 EVENTS RELEVANT TO THE SUBMARINE OCEAN OUTFALLS

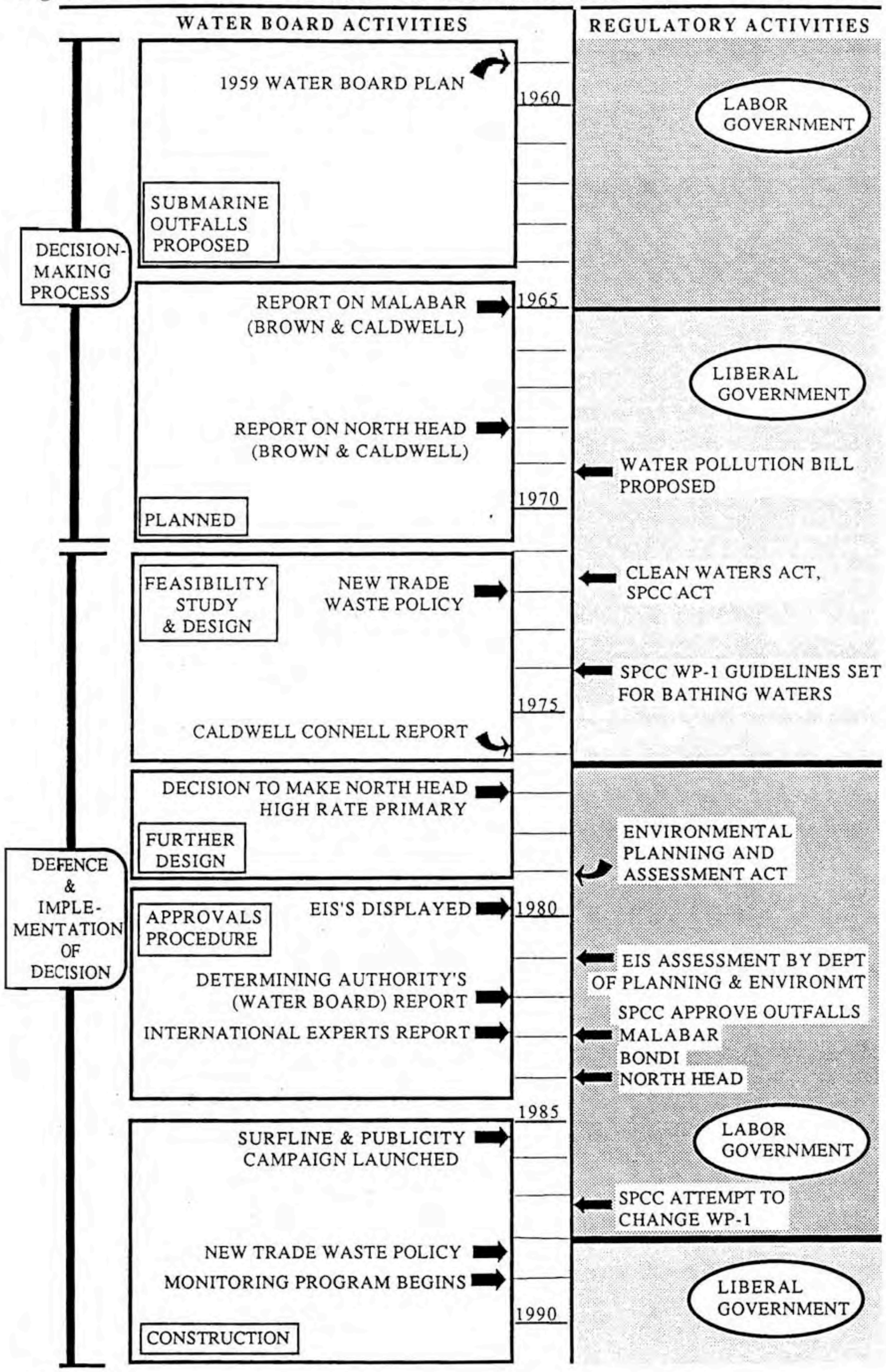

Figure 9.2

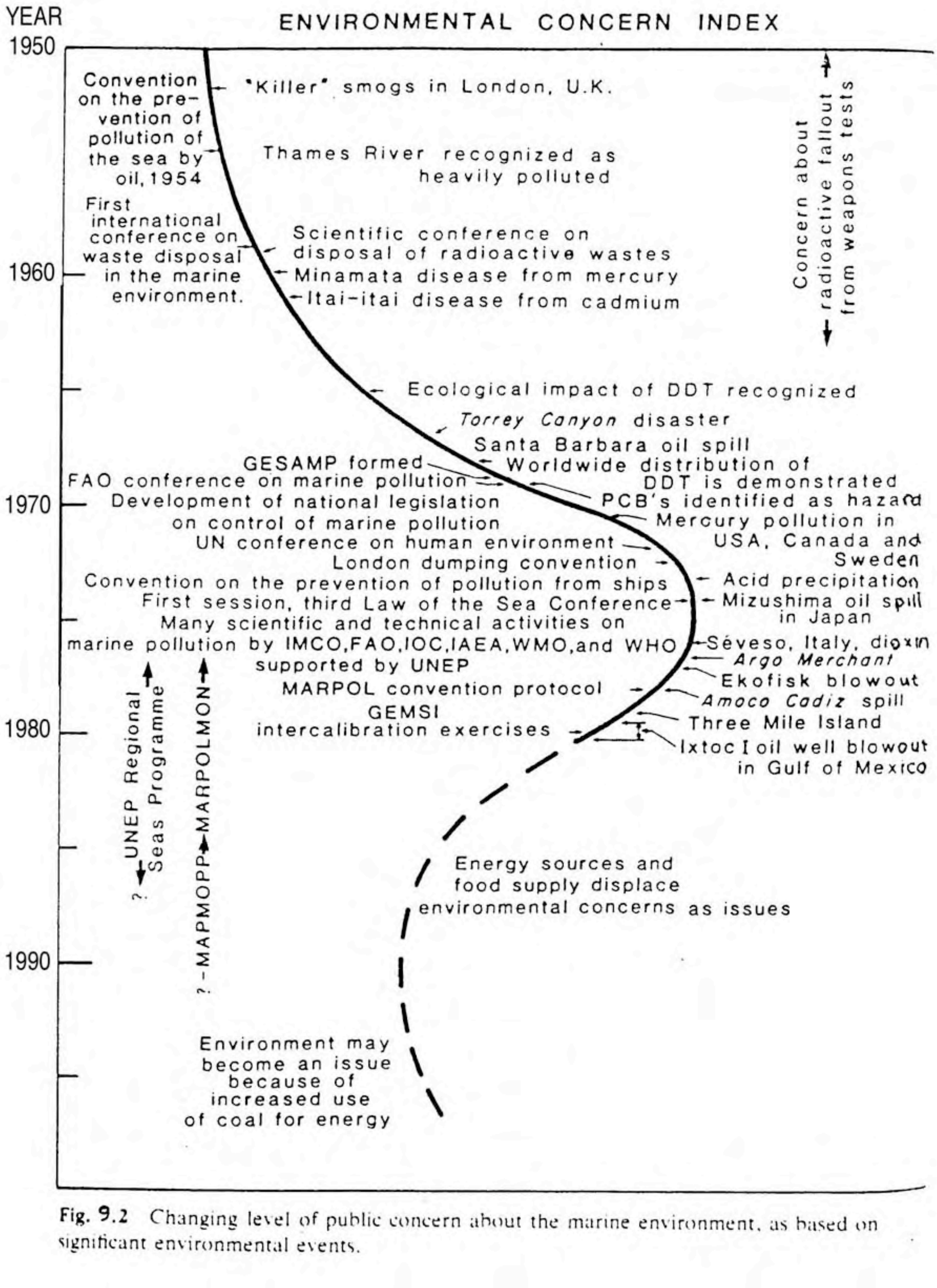

Fig. 9.2 Changing level of public concern about the marine environment, as based on significant environmental events.

SOURCE: Michael Waldichuk, 'International Perspective on Global Marine Pollution' in Virginia Tippie & Dana Kester, eds, Impact of Marine Polution on Society, Praeger, 1982, p72.

TABLE 9.1

SUBMISSIONS ON EIS'S	approve decisions	qualified approval	oppose decision		other
			reuse/ recycle	more treatment	
GOVT AUTHORITIES					
Dept of Sport & Recreation					desire less pollutn
NSW State Fisheries	✔				
Maritime Services Board	✔				
Met Waste Disposal Authority					prob-sludge reuse
Dept of Public Works					prob-spoildisposal
Water Resources Commission					against reuse
Australian Museum		✔	✔		monitor ocean life
Dept of Mineral Resources					concern- impact
State Pollution Control Comm		✔			need more details
National Parks & Wildlife				✔	
LOCAL COUNCILS					
Botany Municipal Council	✔				fear-overloading
Manly Municipal Council	✔				
Randwick Municipal Council		✔			interim measures
Warringah Shire Council	✔				
Waverley Municipal Council	✔				
INTERESTED GROUPS					
Total Environment Centre			✔		
Nature Conservation Council			✔		
Randwick Beach Polltn Comm		✔			
ALP, Windsor Branch			✔		
Environment Defence Council			✔		
Engineered Australia Plan					anti ocean disposal
Opposition Committee					critical of design
PRIVATE SUBMISSIONS					
W.H.Haigh, M.P	✔				
Commonwealth Industl Gases				✔	
O.Miller			✔		
N Blakes					concern-pollution
Chapman & Chapman					general protest
F.M.Brooks	✔				
H Humel					need urgent action
J Shearman					disgust with W/Bd
J Rodgers				✔	
A Strom			✔		
W Solomons					ship it further out
W Wilkin			✔		
P.A.Yeomans			✔		
G Jarjoura			✔		
L Cruise			✔		
J Crossley			✔		
G Bartley			✔		
Arnot & Poole			✔		
Seabridge Australia P/L			✔		
R Niblack				✔	
J.Oakden			✔		
R.D.Evans			✔		
Beverley Haas			✔		
Cathy Phillips			✔		

reasons why the submarine outfalls should not be built.[1] The DEP did however impose a number of conditions on the Board. These included the implementation of monitoring programmes for levels of grease, oil, floating particles, suspended solids, settleable solids, turbidity, pH, restricted substances, toxic materials in sediments, beach pollution and for effects on benthic organisms and fish. Moreover the Board had to submit to the DEP a feasibility study and economic analysis of the cost and benefits of short term measures to alleviate existing problems with shoreline discharge of sewage.[2]

In April 1982, the Board completed its Determining Authority's report in which it formally considered the submissions and the DEP's report and announced its final decision to go ahead with the detailed design and construction of submarine outfalls.[3] The outfalls were subsequently approved by the Clean Water Advisory Committee in 1983 and 1984 and construction began in October 1984. The outfalls are expected to be completed in the early 1990s.

This chapter is essentially about how the Water Board and its employees have defended the submarine outfall decision against a number of groups and individuals who have criticised it. Figure 9.3 attempts to show the various groups that have had an interest in the Board's decision, many of which have sought to influence or support that decision. The Board has been purposely placed at the centre of this constellation of groups to indicate its power and importance as well as its central role in the decision making process.

EARLY ENVIRONMENTAL CONCERNS - MANURE AND COMPOST

The nineteenth century debates over water carriage and ocean disposal had first highlighted that a section of the community viewed sewage as a resource rather than as a disposal problem and these concerns, repressed for seventy or eighty years during which the public had no say about sewage disposal, again came to the fore when the public were invited to comment on the EIS's for the submarine ocean outfalls. Recycling was a concern all the established environmental groups took up as an environmentally sound option but a number of individuals also took the opportunity to oppose ocean dumping and record their preference for a recycling option of some sort. Most of the individual submissions made in response to the EIS's favoured some form of reuse. They cited damage to the ocean ecosystem, threats to human health and the further entrenchment of a system that was wasteful of resources and unnecessarily polluting.

One of those individuals at the forefront of the push for sewage reuse was Francis Sutton. In 1974 the National Times had featured Sutton, a "man who can't stop", and that same year a film had been made about Sutton similarly entitled "The Man Who Can't Stop". Sutton had been trying for years to get public authorities on the NSW coast to utilise sewage rather than dump it in the sea to spoil the beaches. Sutton had designed fairly detailed schemes for using

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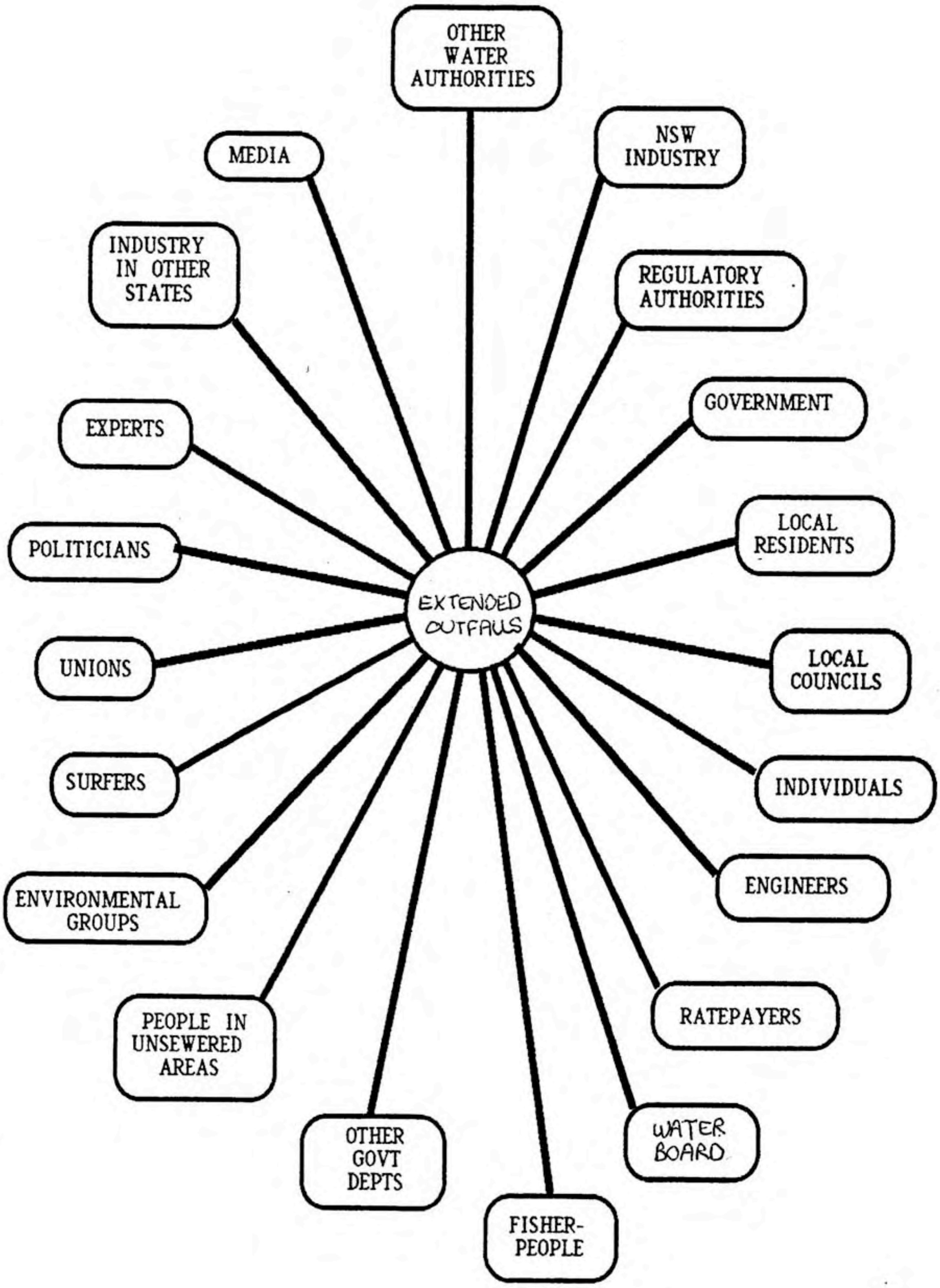
[1] Department of Environment and Planning, Proposed Upgrading of Ocean Outfalls for Disposal of Sewage Effluent at North Head, Bondi and Malabar: Environmental Impact Assessment, Sydney, January 1981, p20.

[2] ibid., pp21-2.

[3] M..W.S.&D.B., Determining Authorities Report on Deepwater Submarine Outfalls for the Disposal of Sewage Effluent at North Head, Bondi and Malabar, April 1982.

Figure 9.3 People and Social Groupings with an Interest in Sydney's Submarine Ocean Outfalls



sewage effluent for irrigation and cooling water. The National Times portrayed Sutton as a bit of a fanatic,

> Mr Sutton now spends most of his waking hours trying to persuade the authorities and the public to consider the scheme. His savings are dwindling, his family and social life neglected, but he is determined to continue until the scheme is given fair consideration.[4]

But Sutton was not without his supporters. The Central Coast Trades and Labour Council placed a green ban on Gosford Council's planned outfalls in an effort to ensure that the Sutton scheme was fully examined[5] and later the Commonwealth government provided a grant for the development of Sutton's inland sewerage treatment scheme for the Central Coast of NSW.[6]

In response to the Sydney Water Board's EIS's, Francis Sutton, representing the Environment Defense Council, recommended "full scale improved multi-stage lagoon and irrigation systems". Sewage could be diverted to such systems inland.[7] In more recent years Sutton has given up on Sydney and now devotes his time to getting other NSW communities to reuse their sewage.

Another campaigner for the reuse of sewage effluent was P.A.Yeomans, an agricultural engineer who argued that partly treated sewage could fertilise specially planted forests.[8] Mullins was also a strong advocate of reuse arguing that Sydney's water supply was finite and would run out by the year 2000.[9] Dr Nancy Millis, a reader in microbiology at Melbourne University, also argued that Australian water was not used enough and should be recycled for industrial, irrigation and domestic uses and that the treatment involved would be cheaper than building dams.[10] And an emeritus Professor at the University of NSW, C.J.Milner, wrote to the Herald arguing that the eastward push of the sewage should be reversed so that the sewage could be used constructively and giving references to papers that backed up his case.[11]

Len Williams of the Nature Conservation Council of NSW argued for the progressive recycling of sewage effluent and against new urban subdivisions being "plugged in" to existing systems when they could go into urban forest or similar land disposal schemes as outlined by Professor Elias Duek Cohen, Town Planner, Sydney University. They argued that the large expenditure on submarine outfalls would effectively close off recycling avenues.[12]

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4 National Times, July 8-13, 1974.

5 ibid.

6 Francis Sutton, submission on the Environmental Impact Statements for the submarine outfalls, 1980.

7 Environment Defense Council, submission on the Environmental Impact Statements for the submarine outfalls, 1/3/80.

8 Sydney Morning Herald, 7th September 1974.

9 Australian, 24th August 1974.

10 Mirror, 27th October 1974.

11 Sydney Morning Herald, 3rd January 1979.

12 Nature Conservation Council of NSW, submission on the Environmental Impact Statements for the submarine outfalls, 1980.

Dr A. Jones, from the Australian Museum also argued that the although recycling disposal methods were uneconomic at that time, changes in technology, supply and demand were all likely to favour re-use in the future but by then Sydney might be "locked into a totally non-recycling system." Jones argued that re-cycling was not only more sustainable and environmentally desirable but also it was the way that natural ecosystems operated.[13]

The Total Environment Centre argued that the project should not go ahead until all alternatives had been properly considered and called for the SPCC to present a parliamentary white paper which fully presented the alternative disposal options. They argued that the EIS's had given poor consideration to the Sydney water supply which had been assumed to be infinite and had presented costings which did not include the benefits which land applications would have in terms of crop productivity, the aesthetic value of urban forests and such like. Nor did the cost estimates include the cost of augmenting existing sewers although the EIS's had said that this was necessary.[14]

The main argument against reuse was the cost argument but the cost estimates made by Caldwell Connell were never detailed. The costing included taking all the sewage from the three major outfalls and piping it across the dividing range. This would include heavy annual pumping costs and more treatment. Such an option was obviously more expensive than piping it out to sea but if considered as a long term option might have compared more favourably since it was argued that secondary treatment would have to be installed at the outfalls in the future and that the sewerage system would have to be renewed. Caldwell Connell, in their 1976 report, had covered two alternatives for expanding the inadequate sewerage systems. One was to expand each main outfall sewer independently and the other was to divert part of the sewage flow from the Bondi and Malabar outfalls and reroute it to Marley Head, in the Royal National Park, south of Sydney and also augment the North Head system independently.[15] The cost of doing either of these was not included when comparisons were made with recycling alternatives.

Moreover the gains from the additional irrigation water and fertiliser had not been included in the cost estimates. These gains were instead considered separately and compared to the cost of water from dams in the western valleys.[16] The Water Board claimed that there was no need to recycle water since the Shoalhaven Scheme would meet Sydney's water demand until after the year 2020 if current population and usage trends continued and that further potential existed for water storage by damming other rivers that were relatively close to Sydney.[17]

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13 Australian Museum, submission on the Environmental Impact Statements for the submarine outfalls, 1980.

14 Total Environment Centre, submission on the Environmental Impact Statements for the submarine outfalls, 1980.

15 Caldwell Connell, Sydney Submarine Ocean Outfall Studies, M.W.S.&D.B., 1976, p20.

16 Water Resources Commission, submission on the Environmental Impact Statements for the submarine outfalls, 1980.

17 Acting Secretary, Water Board, letter to Secretary, NSW Planning and Environment Commission, 14/8/80; also D.E.P., Environmental Impact Assessment, p12.

As for using the recycled effluent closer to the city, for the irrigation of trees, the Board claimed that there was insufficient land for this purpose "within an economically feasible distance from Sydney".[18] The Board also claimed that new urban subdivisions would not "plug in" to the existing systems, in fact most would be beyond the ocean outfall catchment areas and would be connected to sophisticated treatment plants which would discharge into the Georges and Hawkesbury Rivers.[19] Their argument that putting sewage into various rivers (which discharge into the sea of course) ignored the point that Conservation Council was making that sewage should be progressively reused where possible. Moreover the later episode, when the effluent from the Glenfield effluent works was found to be creating problems in the Georges River and was diverted to the Malabar outfall, showed a trend in the opposite direction.

The Department of Planning and Environment, in its assessment of the EIS's and the submissions, accepted the Board's claim that ocean disposal was the only feasible disposal alternative because of the impracticability of disposing of all effluent from the three main ocean outfalls by agricultural use within the Sydney metropolitan area. However, recognising the support amongst the public for the recycling of sewage they recommended that the Board continue to investigate the matter so that some sewage might be beneficially used[20] and asserted that the submarine outfalls would "in no way prejudice future selection" of recycling alternatives should the need arise.[21]

It might be noted here that before public display, the EIS's were shown to the Deputy Premier and Minister for Public Works, L.J.Ferguson, who requested that, for public relations purposes, the EIS's be adjusted to place greater emphasis on the potential for increased utilisation of digester gas and the possible energy recovery potential of the treatment works as well as on the monitoring and control of heavy metals in effluents.[22]

The public airing of the Total Environment Centre's views on recycling sewage received a savage Water Board reaction in a local paper. In an official statement that was heavy on rhetoric and light on information the Board chairman claimed that "any qualified person" could see that land treatment of sewage was "only superficially attractive" and, far from acceptable, was not viable.

> The environment centre apparently wants these exhaustively-researched impact studies cast aside in favour of a scheme which is totally inappropriate to the Sydney region...Is the board to abandon the coastal treatment plants, which have already cost more than $100 million...? [23]

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[18] M..W.S.&D.B., Determining Authorities Report.

[19] Acting Secretary, Water Board, letter to Secretary, NSW Planning and Environment Commission, 14/8/80.

[20] D.E.P., Environmental Impact Assessment, p13.

[21] ibid., p20.

[22] L.J.Ferguson to Water Board, 17th August 1979.

[23] Southern News, 15th April 1980.

Letters continued to be sent to the papers advocating the reuse of sewage, especially for fertiliser.[24] The Secretary of the Water Board wrote in to counter these calls. He said that the .03% of sewage which was solid had little or no value as fertiliser, it would be very expensive to process and it was doubtful whether there was a market for the final product. The liquid, he said, would still have to be disposed of to sea because it would take an area larger than the Royal National Park to soak it up. To pump it over the mountains would be extremely energy and cost intensive and environmentally undesirable.[25]

The United Nations Association of Australia also promoted the idea of turning garbage and sewage into hygienic compost which would decrease beach pollution and provide natural fertiliser for Australia's depleted soils.[26] And two Wollongong researchers, Chris Illert and Daniella Reverberi, criticised the Water Board's submarine outfall plans in a book they wrote on Botany Bay's Seagrass Meadows. They argued that sewage would kill sea plants and annihilate the fisheries and they advocated the recycling of sewage, claiming that the Board had tested sewage fertiliser at Glenfield and found that it increased the yield of vegetables six times on an untreated plot of ground and gave twice the yield of conventional fertilisers.[27]

A series of letters at the beginning of 1984 also advocated reuse of sewage. A farmer testified to the poverty of Australia's soil and Elizabeth Kirkby of the Australian Democrats had raised the issue in the Legislative Council. She called for the conversion of 750,000 tonnes per annum of sewage sludge to compost, the elimination of 862 tonnes per annum of toxic heavy metals from the sewage flow, secondary treatment, recycling of some effluent for irrigation and some effluent to be pumped below ground into existing aquifers at Botany for purification and recycling.[28]

Kirkby's reference to the toxic heavy metals in the sewage flow was a point that most advocates of reuse largely missed and the one which the Board was not anxious to point to. But it was the major problem, apart from cost, in reusing sewage. This became clearer when the Metropolitan Waste Disposal Authority were asked to comment on Owen Millers' submissions in 1980 that the sewage sludge should be mixed with garbage to make compost. They agreed that the scheme had some potential and said that it was practiced overseas to produce a soil conditioner or compost.

> However, some concern has been expressed in the literature as to the health risks that may result from the continued application of such compost to agricultural land, particularly with regard to the levels of pathogens and heavy metals.[29]

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24 For example Sydney Morning Herald, 7th April 1981.

25 ibid.

26 Manly Daily, 7th March 1984.

27 Illawarra Mercury, 12th March 1986.

28 Sydney Morning Herald, 10th February 1984.

29 M.W.D.A., letter to Water Board, 29/2/80.

In a letter to the editor, A.D.Brown from the Department of Biology at Wollongong University also posed the problem of heavy metals which are often found in urban sewage and which can accumulate in the soil and contaminate crops.[30]

The strength of public support for recycling of sewage did not go unnoticed by the Board who announced that they would run a public seminar in June 1984 on the "re-use of sewage by-products". Mr Paul Whelan, Minister for Water Resources, Forests and Aboriginal Affairs, explained that the seminar would try to identify "the most practical and cost efficient re-uses" for effluent, sludge and digester gas.[31] In July, the new Minister for Natural Resources, Janice Crosio, made the same announcement but this time for a seminar in August. She pointed out that the Board already used some tertiary treated effluent from inland plants for irrigation of crops and golf courses.[32] Prominent advocates of recycling were invited to speak including Tom Mullins and Owen Miller.[33]

The Seminar was held, the recyclers had their say and the Board drew their trump card; a recycling scheme would cost about $1500 million dollars with annual running costs of $84 million. "This would have to be financed by a massive increase in water rates."[34] A local Eastern Suburbs paper which reported the seminar hoped that work on the submarine outfalls would not be delayed by investigations into recycling.[35]

Nevertheless the Board sought ways to pacify the reuse lobby. A scheme to use sludge for fertiliser at the Bellambi Sewerage Treatment Works near Wollongong, which had been initiated by sewage workers, was achieving good results and this was supported by the Board. The Board was reported to be seriously considering marketing the processed sludge under the name of `Orgo-Natural' for large scale use in agriculture, landscaping and vegetation regeneration as well as for the domestic consumer. Research showed that 12,000 tonnes of topsoil had been bought on the South Coast during the previous year for $16 a tonne and `Orgo-Natural' top soil could be produced for about $10 a tonne.[36]

The Board has carefully promoted and exaggerated the tiny amount of reuse that it does undertake at its inland plants to give the impression that the Board too aims to recycle sewage where possible. One advertisement headlined, "People like to tell us what we can do with our effluent", claimed that the Board had investigated a number of uses for treated effluent "scientifically" including the irrigation of Australia's "Red Centre" which would be enormously expensive for only a small irrigated area and environmentally destructive to the Blue Mountains. They boasted that they already irrigated two golf courses, agricultural land at Camden, Castle Hill Country Club, the Hawkesbury

30 Sydney Morning Herald, 13th February 1986.

31 Macarthur Advertiser, 3rd April 1984.

32 Macarthur Advertiser, 17th July 1984.

33 Messenger, 18th July 1984.

34 Sydney Morning Herald, 13th August 1984.

35 Messenger, 15th August 1984.

36 Sydney Morning Herald, 8th February 1986; Illawarra Mercury, 8th February 1986.

Agricultural College and Warwick Farm racecourse. They were only at the experimental stage and any extension of the programme could only happen when they were sure that bacteria levels could be kept down. (There was no mention of heavy metals or toxic substances of course)[37]

Another advertisement featured a pile of sludge superimposed on a scene of Farm Cove in the city. The advertisement said that sludge was digested, incinerated or burned but there was no mention of ocean disposal although the great majority of Sydney's sludge was disposed of that way. The text of the advertisement said that the Board was experimenting with turning sludge into fertiliser with some good results and that they already sold 300 tonnes of composted sludge per month from the St. Marys plant (an inland plant) to local landscapers. Their `Orgo-Natural' produced better results than chemical fertilisers.[38] Although the Boards experiments were not aimed at the sludge that was planned to be dumped out the submarine ocean outfalls the setting of the pile of sludge with the Opera House and the Harbour Bridge in the background clearly gave the impression that the Board's "Sludge Recycling Project" was for the whole of Sydney.

The Board has not only aimed advertisements directly at the reuse lobby but market research has also led them to use key words like "natural" and "recycle" in their more general advertisements. For example, an advertisement featuring a deep blue ocean says,

> Introducing the world's most efficient purification plant. This is also the world's largest and most <u>natural</u> treatment plant, and it has some of the most experienced employees as well. Hundreds of species of fish and other marine organisms exist here to do little more than thrive on breaking down the pre-treated effluent discharged into the ocean off Sydney. What they don't <u>recycle</u>, the salt water and sunshine purify <u>naturally</u>. Its the most <u>natural</u> process in the world. [39] *(my emphasis)*

The impression that is attempted to be given here is that no harm is being done to the marine ecosystem and that in fact the sewage is being treated as God and Nature meant it to be and the discharge of sewage is actually beneficial to marine life. The reference to marine life existing only to breakdown sewage effluent gives and insight into the Board's attitude toward nature and the differences in value systems between technocrats and environmentalists.

GOVERNMENT AUTHORITIES - SOLIDARITY AND CONFIDENTIAL CRITICISM

As was shown in Table 9.1, ten government authorities responded to the display of the Environmental Impact Statement. Only the NSW State Fisheries and the Maritime Services supported the proposal unconditionally. The Department of Sport and Recreation, the Metropolitan Waste Disposal Authority, the

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[37] For example, Sydney Morning Herald, 21st February 1987.

[38] For example, Sydney Morning Herald, 2nd January 1987.

[39] Sydney Morning Herald, Weekend Magazine, 12th December 1987.

Department of Public Works and the Water Resources Commission were all non-committal about the scheme. The Australian Museum expressed some concerns about marine life and the need to continue monitoring it.

The National Parks and Wildlife Service were concerned that more consideration had not been given to secondary treatment in conjunction with the submarine ocean outfalls and they questioned whether the discharge would come under the aegis of the London Dumping Convention and whether the discharge would meet this criteria. This question seems to have remained unanswered and is completely ignored in the Department of Environment and Planning's Assessment.[40]

The Department of Mineral Resources expressed a number of concerns about the impact of the submarine ocean outfalls. They were concerned about the accumulation of sludge deposits containing heavy metals and also the affect on fish of having sewage including detergents submerged in the ocean. They argued it was unwise not to consider the discharges in conjunction with the other existing and planned ocean discharges up and down the NSW coast since it was intended that the ocean currents carry all the material southward. If the currents were all simultaneously going in one direction then the total nutrients and sediments in the downdrift areas would be considerable.

The Board countered that there was not any cause for concern about the combination of residual pollutants since the closest outfalls were still 9 kilometres apart and the submarine outfalls would provide high levels of dilution. Moreover, the longshore currents carried an average of about 920 tonnes of nitrogen and 66 tonnes of phosphorous through the outfall areas each day and the additional 48 tonnes of nitrogen and 11 tonnes of phosphorous that would ultimately be discharged from those outfalls would not result in any undesirable phytoplankton growth in the discharge region.

The SPCC gave the EIS's most attention as the regulatory body responsible for pollution of the ocean waters. Despite Brain's grave reservations (see chapter 8) the SPCC made its submission on the EIS's stating that it considered the provision of the submarine outfalls to be "the most practicable solution" to beach pollution problems. It noted that detailed design had not begun and advised that this would require more geological and oceanographic studies.[41]

Although the SPCC submission didn't express the concerns that Robert Brain had over the performance of the submarine outfalls, the submission made by the Opposition (Liberal) committee covered many of those concerns and one can only suppose that Brain was in contact with them. Their submission covered the misleading information in the EIS's, the oversimplified computer model which had neglected to take into account the effect of currents and the faulty diffusion calculations. The submission also criticised the Board for not having carried out studies which had been recommended in the 1976 Caldwell Connell report.[42]

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[40] D.E.P., Environmental Impact Assessment, p6.

[41] ibid., p5.

[42] Opposition Committee, submission on the Environmental Impact Statements for the submarine outfalls, 11/3/80.

The SPCC still had its private doubts about the submarine outfalls, fed by Brain's objections. They persuaded the Board that it would be desirable to obtain 'independent' advice from "a panel of acknowledged international experts" since the extreme complexity of the ocean environment meant that outfall processes might be "subject to alternative technical interpretation" and that these interpretations had to be resolved prior to statutory approval being given for any specific design.

A set of SPCC questions and Caldwell Connell answers, together with the various reports, were sent to Professor Norman Brooks of the United States and Professor Poul Harremoes of Denmark for their evaluation. Both men were said to be recognised as experts in the field and to have considerable experience in outfall design. They came to Sydney for a week during which they inspected oceanographic records, viewed the outfall sites from the air and spoke to Water Board and SPCC officers.[43]

The SPCC officers maintain that after meeting with the experts Brain recanted and that was the end of his criticisms. Brain himself denies this. He says that Brooks and Harremoes agreed with his criticisms but argued that the extended ocean outfalls would still be an improvement on the existing shoreline discharges. Brain agreed with this, and said no more, since as far as he was concerned he had done his job in pointing out the faults in the Caldwell Connell calculations.[44]

The Health Department made no submission on the Environmental Impact Statement although the matter was directly linked to health concerns. NSW Health authorities seem to have consistently supported the Sydney Water Board and the SPCC in downplaying health risks from swimming in sewage polluted bathing waters. However they continued to use the threat of a health risk as a political weapon against striking sewage workers despite the need to make contradictory statements in order to do so.[45] Dr Ian Hay, Health Department spokesman, during a sewage workers strike in 1971, advised people not to swim at affected beaches "although it has never been proven that polluted beaches cause disease."

> I'm not saying there is a danger - but it would be most unwise to swim at any beach affected by this sort of pollution [46]

The implication that a strike, when raw sewage was discharged might be more of a health danger than at other times was also a controversial point since, as Mullins pointed out, primary treatment was ineffective at removing "disease carrying agencies including viruses".[47] Dr W.A. Lopez, deputy director of epidemiology at the State Health Department, admitted that primary treatment did not kill viruses but claimed that it dispersed the sewage more easily and this

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43 M.W.S.&D.B., 'Technical Report in support of Application for Approval under Section 19 for the Malabar Extended Ocean Outfall' presented at Clean Waters Advisory Committee meeting, 8th September, 1983, p24.

44 Robert Brain, personal communication, July 1987.

45 Sydney Morning Herald, 30th December 1980.

46 Sunday Telegraph, 4th April 1971.

47 Sydney Morning Herald, 14th December 1972.

removed the health hazard.[48] Lopez made a similar statement a few years later, that untreated sewage (which was being discharged during a sewage workers strike) was not a health hazard because it was "broken into tiny pieces and diluted considerably."[49]

And whilst Lopez maintained his line on the health hazards of sewage pollution, Hay, now State Director of Health Services, changed his tone during a 1975 sewage workers strike and warned of the "grave risk" of catching diseases such as gastro-enteritis or hepatitis in an effort to get the strikers back to work.[50] During the 1981 strike the Health Commission's adviser on infectious diseases, Dr Peter Christopher, warned the public that people swimming in the surf "ran a serious risk of contracting hepatitis or gastro-enteritis."[51]

Early in 1985, rumours of breakdowns at the newly completed North Head treatment works created some public alarm, although the Board claimed that the bits of plastic in the surf was just picnic rubbish.[52] The alarm grew to such an extent that the Department of Health began emergency testing even though the chief health officer argued that there was no evidence that the beaches were unsafe and the Water Board claimed there was no sewage in the water.[53] A few days later the Department reported that tests had shown a higher than expected quantity of two organisms, but both were considered "unreliable indicators" and did not cause disease.[54] One wonders why they bothered to measure them if that were so.

In September, however, the Health Department recommended that it reduce the number of tests it was taking after salmonella organisms were detected in samples taken from Manly's waterways and the surrounding ocean. The Department said that the number of tests should be halved because of the work load on their laboratory and staff but the Council and the local State MP were incensed and called for more rather than less tests.[55]

It now also appears that the Health Department monitoring of the beaches from 1983 through to 1987 was finding that many of the eastern suburbs beaches were unsuitable for swimming by their own definition for 30-80% of the time and yet they did not make this public in any way. Moreover they were turning up salmonella in samples from bathing areas.[56] (see chapter 8) In early 1987 a Health Department Report was leaked to surfing writer, Kirk Wilcox, which showed that 6 out of 9 samples taken at Eastern suburbs bathing spots during that summer had contained salmonella organisms. Wilcox noted that the

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[48] Sydney Morning Herald, 14th December 1972.

[49] Sun, 13th February 1975.

[50] Mirror, 4th April 1975.

[51] Daily Telegraph, 21st March 1981.

[52] Manly Daily, 4th January 1985; 9th January 1984.

[53] Manly Daily, 12th January 1985.

[54] Manly Daily, 15th January 1985.

[55] Manly Daily, 13th and 17th September 1985.

[56] A.G.Bernard, 'The Bacteriological Quality of Sydney's Tidal Bathing Waters', Water Quality & Management for Recreation & Tourism, Procedings of an International Conference, IAWPRC & AWWA, 1988, pp46-50.

findings had not been made public, nor had any warnings been given to the public, either by the media or signs on the beach, even though the period October through to December was at the height of the "official" surfing season. Anyone contracting a salmonella related disease at that time would have been more likely to attribute to something they ate than to swimming.[57]

SURFERS & LOCALS - HEALTH HAZARDS AND SPOILT PASTTIMES

Surfers, particularly, were aware of the health problems associated with polluted waters. Each new summer brought a fresh batch of allegations. In the Summer of 1969/70, before the Caldwell Connell study commenced, the president of the Maroubra Surf Life Saving Club blamed pollution for six of his club members becoming ill in two months with ear, eye, throat and bowel infections.[58] Randwick Council Health Inspector, Brian Kelly, pointed to a rising incidence of hepatitis and other notifiable diseases in Clovelly, Coogee, Maroubra and Malabar and argued that many surfers and swimmers got ear, nose, throat and bowel infections and glandular fever.[59] He was backed up by Aldermen, one of whom quoted figures to show that the rate of increase of hepatitis was far greater in their area than in other parts of the state.[60]

When the submarine outfalls were first proposed, the main reaction in beachside suburbs was a hooray that at last something was to be done about the pollution and the main pressure was that they should be hurried up. Beach pollution, once a reason to criticise the Board, became the incentive to push for the submarine outfalls. The Councils, local MPs and community groups, formed to do something about the pollution, all pushed for the submarine outfalls.[61] When, at the end of 1978, a report on the board's operations by US management consultants McKinsey & Co recommended that the outfalls be deferred because they would not be income earning, there was much protest and the Board had to reassure the public that pollution control works would continue.[62]

Following the release of the environmental impact statements the public continued to lobby for the speedy cleaning up of the beaches. The Randwick Beach Pollution Committee which had collected 12,000 signatures on a petition for this purpose presented it to the State government.[63] Randwick council made attempts to see the Deputy Premier and Minister for Public Works, Mr Jack Ferguson.[64] Threats were made about supporting only candidates in the coming State Election willing to take immediate action on beach pollution or even nominating candidates for that purpose.[65]

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57 Kirk Wilcox, `Australia a Turd World Country', Tracks, May 1987, p68.

58 Mirror, 15th January 1970.

59 Mirror, 16th January 1970.

60 Sydney Morning Herald, 21st January 1970.

61 for example Southern News, 1st August 1978; Messenger, 15th November 1978; Daily Telegraph, 22nd December, 1978.

62 Sydney Morning Herald, 28th December 1978.

63 Messenger, 20th February 1980, 21st May 1980.

64 Southern News, 1st April 1980.

65 Messenger, 2nd April 1980; Messenger, 3rd December 1980.

But not all those who used the beach rejoiced at the idea of the submarine ocean outfalls. Many people who actually used the beaches felt intuitively that the outfalls would not achieve the results promised. In particular surfers and regular bathers were well aware of the way the sewage field moved with the wind and of the long distances the field could travel. They argued that discharging the sewage 2 or 3 kilometres further out to sea would make no difference since the sewage travelled that far anyway.

At the beginning of 1985 a group of Manly surfers got together and organised a protest march. Supported by various big name surfers and iron men, the March against Pooh made its way along the beach promenade and up to the treatment works. Surfers and others, numbering several hundred according to the local paper, carried buckets of "nasties" collected from the surf to dump back at the works.[66]

The Board did its best to capitalise on this event despite the obvious hostility of the crowd. Surfers were invited to tour the treatment works after the march and a Water Board press release said that organisers of the march had been invited to discuss improved liaison with surfers on pollution issues at a later meeting with Board's officers. Crawford claimed that they were all working towards the same goal of cleaner beaches.[67] In fact the Board at first welcomed the raising of awareness of pollution caused by the surfers because it justified the money that was being spent on the new outfalls.

In April the following year the Manly Surfers, now organised as People Opposed to Ocean Outfalls (POOO), organised their second annual protest march. By coincidence the Water Board had an open day organised for the same day and had an information campaign conducted from a marquee next to the local surf club buildings, tours of the treatment plant, and engineers and scientists on hand to answer questions. Peter Crawford, the general manager of the Board, said the open day was to "encourage informed discussion and debate on environmental issues."[68]

Despite the rain, it was reported that four or five hundred people turned up for the march, including several well known surfers. The crowd were addressed by David Hay, local MP, Richard Gosden, from Stop the Ocean Pollution (STOP) and Peter Garrett from the band Midnight Oil. The march organiser said that their campaign was to get the Board to consider other alternatives to the submarine outfalls which would "use the sea as a sewer".[69]

The main concerns of surfers were the aesthetics and health risks of surfing in polluted waters. They experienced these problems personally and so were more aware than anyone that Water Board denials of pollution had very little foundation. However epidemiological studies have not been carried out in Australia so there was little hard evidence besides the experience of individual beachgoers and the unsourced evidence of beachside doctors and chemists. What evidence that did exist was played down. One such investigation followed an

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66 Manly Daily, 26th February 1985.

67 M..W.S.&D.B., News Release, 23rd February 1985.

68 Manly Daily, 10th April 1986.

69 Manly Daily, 15th April 1986.

incident in Perth where eight cases of typhoid (an unusually high number) were notified in a very short space of time early in 1958. The usual sources were investigated, such as contact with carriers and food eaten, but these did not seem to account for the outbreak.

It was found that five of the eight victims had spend a lot of time bathing at Perth's City Beach which was close to a leaking outfall from an uncompleted sewage plant. High levels of faecal coliforms had been found at the time. Following closure of the beach there were seven more notifications of typhoid, five of whom had bathed at the beach and one of whom had been in contact with a carrier.

The causative organisms from the victims were found to be of five different types and therefore ruled out the possibility that they had all been infected by one or two carriers or a common foodstuff and strengthened the case that the sea-water had been the source of infection. Moreover, it was known that the infective dose of typhoid bacteria is very small and that they are capable of surviving in sea water for long periods of time.[70]

In 1964 an investigation was carried out by Flynn and Thistlethwayte of the Sydney Water Board. Flynn and Thistlethwayte refer to the Perth incident saying that although ten cases were claimed, they were never definitely proven, to be due to swimming. Flynn and Thistlethwayte freely admitted that typhoid and paratyphoid organisms were commonly present in Sydney's sewage and that "it may be assumed that sewage discharges commonly contain pathogenic bacteria" but they stated that in NSW none of the health authorities had received "specific claims of such disease" from swimming in sewage polluted sea water.

Moreover, questionnaires of doctors, pharmacists, surveys of schools and of hospitals had not revealed any more of an increase in typhoid, paratyphoid, infective hepatitis or poliomyelitis amongst coastal populations than inland groups.[71] The researchers also dismissed claims of eye, ear, nose and throat infections from sewage pollution, arguing that such infections could result from swimming in any water and there was just as much risk from swimming in chlorinated freshwater pools.[72]

Flynn and Thistlethwayte noted back in 1964 that measures of coliform organisms, especially faecal coliforms, gave some indication of the degree of contamination from sewage but were not a measure of health risk. They argued that a coliform standard could not be set on health grounds until a thorough epidemiological study was done and that until then bathing water quality was a matter of public relations and aesthetic considerations.[73] Such an epidemiological study seems to have been carefully avoided in the intervening years whilst public relations has been stepped up.

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[70] Paul Ryan, Submarine Ocean Outfall Sewers, typescript, undated, p30.

[71] Michael Flynn & D.K.B.Thistlethwayte, `Sewage Pollution and Sea Bathing', International Journal of Air and Water Pollution 9, 1965, p641.

[72] ibid., p642.

[73] ibid., pp650-1.

For many years the Board would not even admit that their outfalls were responsible for more than a rare instance of pollution occurred. When the papers reported particularly bad instances of pollution the Board was always ready with an excuse. In 1976, for example, the Secretary of the Board claimed that samples of suspect sewage pollution had been analysed and "found to consist of marine animal life pulverised by heavy seas." [74]

At the beginning of 1979 the Board admitted publicly for the first time (aside from mention in the 1976 Caldwell Connell report) that the existing outfall systems did not always meet the standards laid down in the Clean Waters Act because of the visible trail of effluent which could, at times, "extend several kilometres from the outfalls" and that the SPCC faecal coliform guidelines were also not being met.[75] This admission of pollution was possible and even necessary because of the plans to build the submarine ocean outfalls which would have seemed a waste of money, if pollution didn't occur.

The Board continued to deny the health risks however. In March 1979 it was claimed that a 71 year old bather died as a result of bathing in polluted water when septicaemia caused his lung and kidney to fail.[76] Later that year there were scares of a hepatitis epidemic after thirteen or more suspected cases amongst swimmers in the eastern suburbs. The State health authorities insisted that there was no way that the hepatitis could be linked positively with the beach pollution."[77] The Board responded that there were 3000 cases of hepatitis in Sydney every year and that thirteen possible cases were not statistically significant.[78]

The Board made full use of the way the standards were based on a geometric mean and claimed it was right that occasional high readings could be disregarded:

> individual readings mean nothing because they may have been taken from water fouled by a seagull or "dog moments" before the test, or contaminated by effluent from a ship moored off the beach.[79]

Such a disclaimer was thought necessary because the newspapers and the councils kept taking their own readings and coming up with very high readings. In February 1981 readings of over 200,000 faecal coliform/100 ml were found at Maroubra beach and over 3000/100ml at Coogee. The high readings were blamed on heavy rainfall and the additional load of stormwater pollution which had washed accumulated street rubbish into the sea.[80] (Faecal coliforms in stormwater drains came from animal droppings and sewage overflows rather than rubbish.) The Board claimed at the end of the month that inspite of some unusually high faecal coliform counts on some days the SPCC criteria for that

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[74] Sunday Mirror, 5th December 1976.

[75] Telegraph, 1st January 1979.

[76] Sydney Morning Herald, 30th March 1979.

[77] Mirror, 31st October 1979.

[78] Telegraph, 23rd November 1979.

[79] Sydney Morning Herald, 30th December 1980.

[80] Sun, 17th February 1981; *Mirror*, 17th February 1981.

month had been met at all eastern suburbs beaches except at Clovelly where the geometric mean had been marginally exceeded.[81]

The Board was more willing, by 1980 to admit that swimming in very polluted water might be a health risk, especially during a strike, but still denied that Sydney's beaches posed any real threat. Dr Bruce Fraser the Board's chief medical officer argued that there was more risk of infection in a crowded backyard swimming pool than at a Sydney beach and that by the time a beach was so contaminated by faecal coliform that it was a health hazard, most swimmers would have left the water for aesthetic reasons.[82] (clearly reminiscent of Moore 1959) The Board was helped in maintaining this line by the Health Department as could be seen earlier in this chapter.

The surfers and beachgoers didn't tend to be organised except into surf life saving clubs and associations. The NSW Surf Life Saving Association was reluctant to speak out against the government because they depended on government funding. However in January 1989, the conservative National body, the Surf Life Saving Association of Australia (SLSAA) threatened to withdraw their beach patrols and force the closure of beaches unless there was immediate action to provide money to solve Sydney's beach pollution problems. Ian Macleod, the Association's spokesman said that they were concerned about the health risks of polluted beaches and that the submarine outfalls would not solve the problem. He claimed that three members of the Maroubra surf club had serious gastric illnesses in the previous week alone.[83]

The Tourism commission also made a statement in response that Sydney's beaches were an integral element in the marketing of NSW and Australia overseas and that they "could not afford to have any doubt cast over our beaches." The Minister for Environment, Tim Moore, also responded saying that nothing could be done quickly just by throwing money around and that secondary treatment would cost $3 billion and mean that rates would be tripled.[84] This is more than double the Board's own estimate of November 1987.[85]

AN ALLIANCE OF SURFERS AND ENVIRONMENTALISTS

Stop the Ocean Pollution (STOP), a group representing surfers, swimmers and fishing people, was formed in 1984. It aimed to get the community involved in the issue of ocean pollution and to educate the media on the issue.[86] STOP's approach differed significantly from that of environmental groups which took an interest in the issue in the 1970s. Realising that alternatives, such as recycling, were easily dismissed on cost grounds STOP undertook a detailed critique of Water Board reports and claims, lobbied politicians and supplied research material to various interested groups and individuals. This approach has been far more successful at raising public conciousness and keeping the media

81 Southern News, 10th March 1981.

82 Sydney Morning Herald, 30th December 1980.

83 Sydney Morning Herald, 21st January 1989; Telegraph, 21st January 1989.

84 Sydney Morning Herald, 21st January 1989.

85 Sydney Water Board, Background Briefing 8, November 1987.

86 Sydney Morning Herald, 9th February 1989.

informed, although sometimes the debate has been too complex for the media to use.

STOP had three main concerns. They argued that the submarine outfalls would not keep pollution off the beaches, that toxic waste posed a threat to marine life and people who ate fish caught in the vicinity of the outfalls, and that viruses and bacteria posed a health threat to swimmers and surfers. In May 1986 a local paper reported on STOP's research under the shock headlines, "New Sewer Won't Work!". STOP pointed out that a similar treatment plant and submarine outfall in Los Angeles had not worked satisfactorily and that Los Angeles City Council was being forced to install secondary treatment before discharge via the submarine outfall.[87] It was also claimed by STOP that sewage reaching the surface would be blown directly onto the beaches by easterly winds. On the same page the paper had a story about a whale which had been killed in 1934 when it was accidentally hit by a Manly ferry. The whale was towed out to sea several times, the last time 14 miles out, but it still floated back inshore. Finally it was taken out 20 miles and was never seen again.[88]

STOP also directed the paper to Brain and the following week the paper reported his views, and the responses by Sandy Thomas, spokesman for the Board (previously spokesman for the SPCC). Thomas said that Brain had been a "minority of one" at the SPCC with his views about the efficacy of the submarine outfalls. He said that the Board was "completely and utterly confident that these outfalls will work."[89]

The two articles in the local papers prompted such concern amongst local residents that the Waverley Council asked its chief engineer to investigate the outfall project and report "as to any deleterious effects that might be experienced".[90] After a meeting with the engineer, three members of STOP were invited to a committee meeting of the Waverley Council to put their case. Several aldermen were persuaded that there was reason for concern and the council decided to invite representatives of the Board and the SPCC to respond to the matters raised.

The Board and the SPCC sent seven officials to the Council with several display boards and a three metre long model of one of the submarine outfalls and, as the local paper put it, flooded the meeting with facts, figures, charts, diagrams and models. They attempted to discredit STOP by labelling their submission as being unscientific and an attempt to scare the public.[91] This is a situation that Brian Martin has described as fairly typical of such controversies. Proponents attribute their own stand to science and attribute opposition to personal or political factors.[92]

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87 Wentworth Courier, 7th May 1986.

88 ibid.

89 Wentworth Courier, 14th May 1986.

90 Southern Courier, 4th June 1986.

91 Southern Courier, 6th August 1986.

92 Brian Martin, 'Analyzing the Fluoridation Controversy: Resources and Structures', Social Studies of Science 18, 1988, p335.

In their submission to the Waverley Council the Board defended their outfalls, arguing that independent overseas experts had reviewed the Board's calculations and confirmed their accuracy. They also claimed that their own estimate that sewage would reach the shore 40% of the time in the winter was an extremely conservative estimate and that the latest estimates were more like 5-10% of the time.[93]

STOP argued that the real reason that the submarine outfalls were being built, since their performance was in doubt, was to dispose of industrial waste.They claimed that the sewerage system had become Sydney's major toxic waste dump. With the submarine outfall proposals toxic substances would be dumped further offshore where they couldn't be easily identified. Alternatives such as recycling and secondary treatment would necessitate the removal of industrial waste and this would cause extra expense to industry.[94]

The local paper, in its editorial a month or so after the confrontation at Waverley Council chambers, said that the Water Board's public relations team had "failed to allay the fears of at least some aldermen". It noted that whilst the Board had criticised STOP's submission, the Board had itself appeared to "have taken liberties with the truth". They referred to an incident at the Council meeting when Board representatives claimed that the primary treatment process could remove 60% of the solid matter, implying that this was what was achieved at Sydney's outfalls. They had been embarrassed and forced to admit this was misleading when Kirk Wilcox of STOP had put to them that the Bondi plant in fact only removed 11% of suspended solids.[95]

The main government funded environmental groups did not involve themselves in the issue of Sydney's beach or ocean pollution once they had made their submissions in 1980. Richard Gosden presented STOP's case to the Total Environment Centre's Toxic and Hazardous Chemicals Committee in 1986 and although they were interested the committee decided that the Water Board was just too big and powerful for them to tackle.[96]

STOP did manage to interest Greenpeace in the industrial waste aspect of the sewage question and Greenpeace, using information supplied by STOP, ran a short 'Clean Seas Campaign' against the use of the sewers as a major toxic waste dump at the beginning of 1987. At the end of January, they delivered thousands of leaflets to homes in beachside suburbs.[97] The leaflets, entitled "Sun, Surf and Cyanide" began;

> The Water Board is asking you not to pour oils down your sink. Fine. What you may not know is that half of Sydney's sewage is wastewater

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93 M.W.S.&D.B., `The Sydney Water Board's Beach Protection Programme', submission to Waverley Municipal Council, July 1986, pp13-4.

94 Richard Gosden, 'Truth Surfacing on Submerged Field', Engineering and Social Responsibility 2(7), August 1985, p5.

95 Wentworth Courier, 10th September 1987.

96 Interview with Richard Gosden, S.T.O.P., 18th January 1989.

97 Greenpeace, media release, January 1987; Wentworth Courier, 21st January 1987; Daily Telegraph, 2nd February 1987.

> from industry. The things they pour down the sink tend to be a little nastier....[98]

Greenpeace made use of STOP figures on the quantities of toxic chemicals going into the sea with the sewage. These figures were based on those reported in the Caldwell Connell reports and showed that of the 1500 tonnes of heavy metal waste generated in Sydney every year over 600 tonnes were going through the sewers and that the waste being discharged into the sea included 5 tonnes of arsenic, 19 tonnes of organochlorines, 38 tonnes of lead, 190 tonnes of cyanide etc.[99]

The Water Board argued that domestic waste, especially domestic grease, was a more significant problem than industrial waste.[100] They disputed the quantities of toxic chemicals as being "dramatic overstatements" although they were simple extrapolations from their own reports. Clearly the Board realised that when the information was presented as total tonnages it was bad for public relations and they preferred that it be presented as concentrations.

> It cannot be emphasised too heavily that when considering the effects of toxic wastes such as these on a part of the environment such as ocean waters off Sydney, the significant parameter is concentration rather than total mass. This is because...discharges to the ocean off Sydney are known to be dispersed very rapidly over very, very large volumes of water through the natural movement of ocean currents, tides, etc. Although the ocean clearly is not an infinite sink for pollutants such as heavy metals, it does have, in this case, an exceptionally large assimilative capacity. [101]

The Board tries to ensure that the public considers pollution in terms of dilution by recording and always referring to quantities of substances being discharged in terms of concentrations rather than total quantities. When these figures were given by STOP the Board denied them outright and accused STOP of fraud but when the same figures were brought up in parliament they were unable to get away with this and suggested the concentrations they had given were mainly upper limits because of the inability of their equipment to detect lower levels. The Board claimed that 1987 monitoring results were unable to detect arsenic, organochlorine pesticides or lead but it is now known that the concentrations in the sludge were not included in these measurements although this was not made clear at the time.[102]

The Board insisted that a "series of publicly released studies" since 1972 (which this researcher has not been unable to locate) had consistently found that concentrations of potentially hazardous chemicals were well below the limits set by health authorities and that whilst some elevated results had been found in the case of DDT and Dieldrin (both chlorinated hydrocarbons and used as

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98 Greenpeace, Sun, Surf and Cyanide, pamphlet, 1987.

99 STOP, submission to Waverly Council, July 1986.

100 M.W.S.&D.B., `The Sydney Water Board's Beach Protection Programme', pp3-4.

101 ibid., p17.

102 Sydney Water Board, Background Briefing 5, Nov 1987.

pesticides) residues in fish, "the levels observed have not been sufficiently high to cause immediate health concern."[103]

The Board's General Manager and publicity material also tried to downplay the significance of the toxic chemicals in the ocean by saying that concentrations of these toxic substances (such as cadmium, arsenic and zinc) were already found naturally in the ocean in large quantities and that the concentrations being discharged were well within the SPCC limits specified under the Clean Waters Act. They argued that even if the total tonnages that STOP worked out were correct, they were "infinitesimal in comparison with the quantities of the chemicals already in the ocean, due entirely to natural causes, off Sydney."[104] These are arguments that do not fit well with surveys of fish near the outfalls. (see chapter 7)

At the annual POOO protest march at Manly in 1987 the Board handed out to the press kits containing a range of their glossy brochures and a six page handout on industrial wastes. It stated that the Board shared the concern of some environmental groups that adverse environmental and health impacts might arise from the disposal of industrial waste. The handout claimed that errors in the Greenpeace leaflet, which had also been distributed at the POOO rally, had arisen from incorrect advice given to Greenpeace by another organisation.[105] It is not clear whether the Board was attempting to drive a wedge of misunderstanding between Greenpeace and STOP or whether they were just trying not to be insulting to Greenpeace in an attempt to keep them on side.

MEDIA MANIPULATORS AND CAMERA SHY DISSIDENTS

The sewage issue seems to be one readily taken up by the media. It is controversial, is of concern to a large number of people and can be easily illustrated. Shocking pollution stories sell papers. The tabloids, in particular, have often revelled in the shock headlines such as "Filth Left on Beach"[106], "Beach Filth-New Scandal"[107], "Hepatitis from a Day in the Surf"[108], "Muck Rolls on Beaches"[109], "Typhoid Peril at Bondi Beach"[110], "Filth Closes Beaches"[111] etc.

However, newspapers are not always ready to take up such a stance. A newspapers policy towards pollution may be affected by its advertisers or its readership as well. Dorothy Nelkin, in her study of how the press covers science and technology has observed that newspapers need to make a profit and to do this they must maintain circulation and attract advertisers, without offending

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103 M.W.S.&D.B., `The Sydney Water Board's Beach Protection Programme', p9.
104 M.W.S.&D.B., `Control of Industrial Wastes Discharged to Sewers'.
105 M.W.S.&D.B., `Control of Industrial Wastes Discharged to Sewers', pamphlet, 1987.
106 Mirror, 16th February 1966.
107 Telegraph, 18th December 1969.
108 Mirror, 16th January 1970.
109 Sunday Telegraph, 4th April 1971.
110 Mirror, 24th November 1972.
111 Sun, 25th November 1975.

their owners or advertisers. "Newspapers must operate according to the commercial realities imposed by their dependence on advertising."[112]

The incident in 1929 (chapter 4) is an alleged example of this where it was argued that the the Telegraph ran a pollution photo and the Sun a follow up series of articles after the Bondi Publicity League cancelled advertising campaign.[113] An indirect affect of the Water Boards huge publicity campaign from 1985-87 may well have been the suppression of anti-submarine outfall stories in papers and magazines which ran their double page colour advertisements.

Similarly, local newspapers can be affected by the perceived affect a story may have on the development, businesses and real estate in the local area.[114] Beachside newspapers can be reluctant to publish pollution stories that turn people away from the local beaches. Often local papers are dominated by political interests. For example a Liberal aligned paper in Bondi may emphasise problems associated with the proposed outfalls whilst the Liberal Party is in opposition but after they win State government, the paper may no longer be interested in such stories.

Certainly the newspapers are not concerned with consistency. For example the Sun, which had published many shock headlines about pollution, published a series of articles in 1972 in favour of the Board's new scheme, the first of which was headlined, "It's Time the Sewerage Whingers Faced the Facts, We're Better Off Than You Think". The article argued that Sydney siders were better off than others in comparable cities overseas and that ocean disposal was the most economically and practically preferred option by engineers all over the world.[115] The second article, headlined "The Wonderful Thermoclyne" explained how, once the submarine outfalls were built, the sewage would remain submerged beneath the thermoclyne.[116]

Yet a few years later the Sun published its own pollution readings under the headline 'The Alarming Truth About Pollution' and reported that despite the slump in trade on dirty beach days there were new sales because "Some die-hard board riders wanted drinks to take their penicillin tablets!". In 1985 the Sun editorial said

> Nowhere else would such pollution be tolerated to anything like the extent and duration of that endured here.
> Yet here we are for the umpteenth year in succession forced to splash around in a cesspool.
> The attitudes of the Water Board and the State Pollution Commission are a constant source of amazement.[117]

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112 Nelkin, op.cit., p121.

113 Guardian, 22nd March 1929.

114 Dorothy Nelkin, Selling Science: How the Press Covers Science and Technology, W.H.Freeman & Co, New York, 1987, p122.

115 Sun, 5th December 1972.

116 Sun, 6th December 1972.

117 Sun, 14th January 1985.

This readiness of the newspapers to take up the pollution issue, whilst being a bonus for the Board's detractors, has not always meant automatic publication however. Firstly, the papers usually need some sort of event upon which to hang their stories so that they are defined as news. Each story competes for priority and an emphasis on "breaking news" does not encourage any coverage of long-term issues. Not only must the story be newsworthy but it has to attract and hold the attention of readers.[118]

An environmental group which makes claims is often not considered to be news nor interesting unless their claims are judged to be astounding. STOP has often had the experience of spending hours with a reporter who was enthusiastic about the story only to find that the story had been cut by an editor who thought it was boring.[119] Reporters, in fact try to get opponents to make exaggerated and unqualified statements because this is more newsworthy.[120] For this reason groups and individuals opposing a government decision are forced to either sound an alarm or otherwise to stage "actions" or demonstrations.

Eric Ashby has written about the dilemma that environmentalists face in this situation.

> Since the public will not respond to anything that is not news, the would-be protector of the environment is faced with an ethical problem: Is it legitimate to dramatize some potential environmental hazard in order to overcome indifference among the public?... [121]

For some groups the choice has been clear. For example, Greenpeace engaged in a publicity stunt when three members, dressed in contamination suits and gas masks arrived at Bondi beach in an inflated motor boat and proceeded onto the beach, erecting signs warning of toxic waste in the water.[122] Similarly, Ian Cohen, when candidate for the Senate, staged an action to draw attention to the sewage pollution by climbing down the cliff above the Bondi outfall, paddling out on his surfboard into the murk, collecting a jar full of sewage, and them paddling round to Bondi beach where he showered ("decontamination") and after speaking to reporters delivered the jar to a local Federal Ministers office).[123]

Although alarming statements and "actions" or "stunts" can be successful at getting media attention they can also be counterproductive in that such groups are tainted with a less than respectable image which may damage their credibility and turn away middle class membership. Ashby has noted that the influence a group has as a public interest lobby often depends on the reputation they gain for integrity.[124] Fearing the loss of this, some of the more institutionalised environmental groups in Australia, such as the Australian

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118 Dorothy Nelkin, Selling Science, p111.

119 interview with Richard Gosden.

120 personal experience with reporter from Mirror, January 1987.

121 Eric Ashby, Reconciling Man with the Environment, Stanford University Press, 1978, pp29-30.

122 Sydney Morning Herald, 16th February 1987; On the Street, 18th February 1987.

123 Eastern Herald, 9th July 1987.

124 Ashby, Reconciling Man with the Environment, p26.

Conservation Foundation, avoid "actions" and dramatic statements. Recently Stuart White of Friends of the Earth (FOE) found an innovative way to organise an event that would attract media attention in a respectable way. He organised a "crap walk" along part of the coastline. Those who took part were able to hear speakers and talk to members of STOP and FOE about the sewage and beach pollution problems.

In contrast, the Water Board is able to centre its press releases around each new stage in the submarine ocean outfall development, which can then be classed as news. Although the Board and associated Ministers are not averse to their own publicity stunts. Numerous public swims have been taken for example. In 1979, the Environment Minister, Mr Paul Landa, was photographed in the surf and quoted as saying that the only answer to pollution was to extend the outfalls.[125] In November 1983 Crawford, the Board's new General Manager, was pictured in the Sun coming out of the surf, as a regular swimmer at Manly. Crawford was reported as saying that if the water looks clean its okay to swim in.[126] Janice Crosio, Minister for Natural Resources, was the next one to be photographed in the Bondi surf to show that it was safe. Mrs Crosio declared the water "crystal clear". The beach pollution level over the last few days had been "the same pollution as if a child went to the toilet in a swimming pool". She suggested that people who said they had got ear and throat infections had picked them up from swimming pools or from sitting on the sand.[127] The tactics of the politicians were satirised in the Sun-Herald (see figure 9.4).

The Leader of the Opposition, Nick Greiner took a boat load of journalists on a sight seeing tour through the murk.[128] This was just one example of how those with financial resources, particularly government authorities, can use them to woo the media. The Board can and do offer boat rides, helicopter trips and tours of sewage works and sewers, the latter perhaps not so desirable, that help to make the journalists feel important and give good picture opportunities to camera crews and photographers.

Another advantage that the Board has in its dealings with the media is its near monopoly on information and authorised experts. Reporters often rely on the authorised experts for their information, having little time or incentive to seek out conflicting views. Public relations people, in particular, can often provide information in a suitably packaged form, that can be easily used by a reporter working to a deadline.[129]

Environmentalists, no matter how much research they may have carried out, find it difficult to compete with the authorised experts and public relations personnel for credibility. Credibility is especially important when dealing with the media. Reporters seldom have the ability or confidence to know who can be trusted when it comes to technical information and will usually just accept the 'official' version rather than be caught out believing a "crackpot" or extremist.

[125] Mirror, 11th November 1979.

[126] Sun, 23rd November 1983.

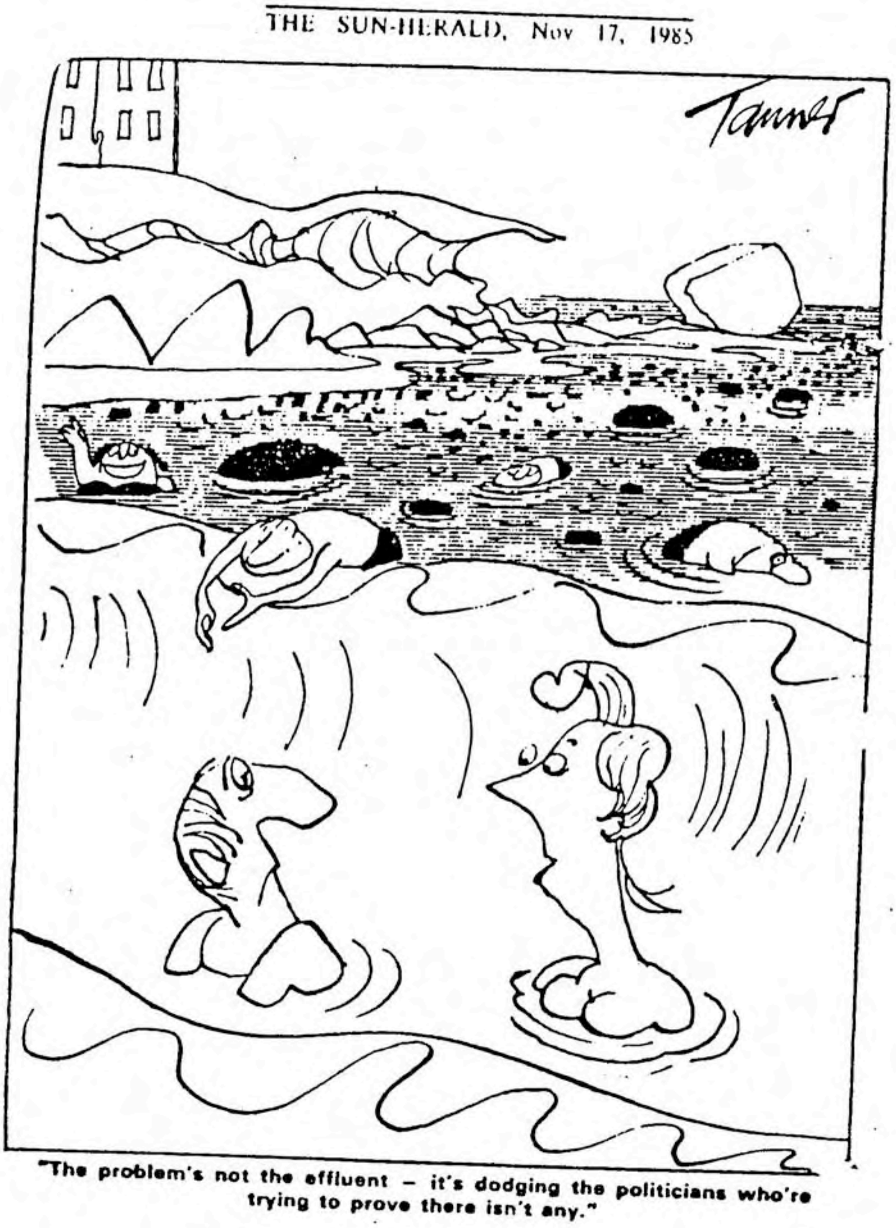
[127] Sun, 20th and 21st Decemer 1984; Sydney Morning Herald, 21st December 1984; Telegraph 21st December 1984.

[128] Telegraph, 21st December 1984; Sydney Morning Herald, 20th December 1984.

[129] Nelkin, Selling Science, p113.

This is easier than taking the time to check out either the official versions or the opposing versions.[130]

Figure 9.4



The Board began releasing a series of press releases in 1984 which announced every small step forward in the progress of the ocean outfalls and each press release put forward the case for the submarine outfalls. Local papers happily reprinted the releases almost word for word. Every milestone in the construction was marked with pictures of politicians and local dignitaries happily standing over spades with hard hats on. For example in March 1984, local headlines

130 Joel Primack & Frank von Hippel, Advice and Dissent: Scientists in the Political Arena, Basic Books, New York, 1974, pp244-5.

announced that work would start "soon".[131] Every article carried the Board's claim that

> Environmental studies have demonstrated conclusively that, under local oceanographic conditions, beach and marine pollution of sewage origin will be eliminated by the discharge of primary treated effluent through deepwater submarine outfalls three to four kilometres off-shore.[132]

A further press release in May announced that the work would begin on June 8th and claimed the submarine outfall tunnels would eliminate "occasional high pollution levels in swimming waters, the visible effluent in near shore waters, the occasional deposits of grease and sewage on beaches and reduce the concentration of chemicals and other "restricted substances" to acceptable levels.[133] Another press release at the beginning of October put forward the same claims when construction finally began.[134]

Most larger papers make some attempt to get both sides of a story which is controversial rather than merely relying on a press release. Rather than checking out the claims of each side these papers will often overcome the problem by merely quoting the views of each side without analysis or judgement. Some papers such as the Sydney Morning Herald are much more careful about what they will print and like to check out the claims of uncredentialed spokespeople.

Nor is it easy for reporters to find independent "experts". Medical people, scientists and engineers are often loath to be named by newspapers or to commit themselves in a public dispute. Criticism of the submarine outfalls by engineers, if it existed, was fairly well suppressed. The Telegraph reported that "private and government civil engineers" had criticised the proposed submarine outfall plan arguing that it would do little to solve the pollution problem.[135] Such critics were not willing to put their names to their criticisms, however. Indeed it is an unwritten part of the engineering ethos, not to criticise engineering works designed by other engineers.

When the Institution of Engineers, Australia was first established just after the first World War the proposed code of ethics, which was modelled on that of the American Society of Civil Engineers, had two provisions out of six which was related to criticism of other engineers. These were

> It shall be considered unprofessional and inconsistent with honourable and dignified bearing for any member...
>
> To attempt to injure falsely or maliciously, directly or indirectly, the professional reputation, prospects, or business of another engineer.

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131 for example Messenger, 28th March 1984; Weekly Courier, 28th March 1984.
132 ibid.
133 For example, Sydney Morning Herald, 21st May 1984; Weekly Courier, 23rd May 1984.
134 For example Southern Courier, 3rd October 1984; Bondi Spectator, 4th October 1984.
135 Telegraph, 17th January 1977.

> To review the work of another engineer for the same client, except with the knowledge and consent of such engineer, or unless the connection of such engineer with the work has been terminated.[136]

The President of the Institution, claimed at the time that "the development of the spirit of loyalty among engineers" was essential to raising the status of the profession and that it should be taught to all new engineers. He noted that it happened that engineers sometimes gave opposing evidence as expert witnesses in court and that this tended "to lower the dignity of the profession and bring it into contempt."[137]

Today this ethos is not so clearly stated but is nonetheless still felt. The 1988 Code of Ethics states that engineers shall act "so as to uphold and enhance the honour, integrity and dignity of the profession" and even exhorts engineers to contribute to public discussion on engineering matters in their areas of competence if they consider that this can constructively advance the well-being of the community. [138] Nevertheless engineers do tend to avoid public criticism of each other for fear of downgrading the status of engineers. When the author of this work made some public statements about the submarine ocean outfalls and the nature of engineering work, she received a phone call from a senior member of the Institution of Engineers. This man questioned her competence, referred her to the code of ethics and threatened to take her before an Institution tribunal for breaching the code of ethics by being disloyal to the profession.[139] Shortly afterwards the President of the Institution made a public statement supporting the submarine outfalls and deploring "the denigration of Australian engineering endeavours which seems to occur all to frequently these days."[140]

The other problem is that engineers feel only able to comment on their own areas of competence which means that, in general, only sewerage engineers would feel able to comment on the submarine ocean outfalls. Since most sewerage engineers are employed by government departments or organisations and those that don't are employed by, or are consultants, dependent on those government departments for work, a potential critic faces the possibility of severely limiting their career prospects by making such criticism. Moreover, such engineers will subscribe to the paradigm and be less likely to find fault with a scheme that emerges from that paradigm.

The one major exception in the case of Sydney Submarine Ocean Outfalls has been Robert Brain, a retired SPCC engineer. His retired status has given him the freedom to speak out and his treatment within the SPCC seems to have given him the moral justification to. His role within the SPCC make him uniquely qualified and competent to do so. Yet even Brain did not speak to the media whilst employed by the SPCC. This is indicative of the constraints on employees who don't have to work for a private firm to be classed as whistleblowers if they divulge information to the media.

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[136] W.H.Warren, Presidential Address, Transactions of IEAust, vol I, 1920, p165.

[137] ibid., p166.

[138] I.E.Aust, Code of Ethics, 1988.

[139] phone call from E.C.Fox, 12th January 1987.

[140] Sydney Morning Herald, 21st January 1987.

Public authorities, like private industry, attempt to control the flow of information to the public by confining it to certain approved channels. In the case of the Water Board, a public relations department plays this role and outside of this department there are attempts to restrict liaison with the media. Public statements are limited to certain high ranking engineers who understand the sensitivities of the Board. The Board does not like journalists interviewing employees that have not been specially selected for this role.[141]

Whilst engineers are loath to publicly criticise engineering projects, scientists too, are discouraged by their peers from speaking to the media. Rae Goodell argues that the high profile scientists who get media attention "are typically outsiders, sometimes even outcasts among established scientists,... seen by their colleagues almost as a pollution in the scientific community".[142] Often the scientists who are conversant with the issues are employed by government departments or authorities and are restricted, like engineers, by their employers.

Similarly, medical people have been loath to speak out about the health risks involved with swimming and the fact that the health authorities have always downplayed those risks does nothing to encourage them. As in the case of engineers, unnamed medical people have been quoted in the papers but, whilst the doctors in seaside suburbs may admit privately that they see many cases of people with infections resulting from bathing in polluted waters, they are unwilling to stake their reputation on it.

Some enterprising papers have attempted to by-pass the need to depend on the authorities for information by taking their own samples of sea water and having it analysed. This occurred as far back as 1929 (see chapter 4) but then and now the papers have not been too successful at it. Firstly, the papers have often confused total numbers of coliforms with faecal coliforms (most commonly e-coli) which came from the human and animal gut. This enabled the Board and health officials to dismiss high levels of total coliforms as marine pollution and pollution from vegetable matter and soil.[143]

Moreover, the occasional sampling by newspapers can easily be shown to be less significant than the regular sampling undertaken by the authorities and where the authorities argue that their findings are less, the paper can suffer from a credibility problem. Moreover, the officials are always able to deny any connection between coliform levels (faecal coliform or not) and proven health risks and use this to their advantage in denying that high coliform levels are meaningful.

The reporting of the new submarine outfalls has tended to be rather simplified. The arguments over whether the outfalls will perform as claimed can be complex and are not readily seen as media material, especially on the radio or television where there are only a few minutes allotted to each item. Both sides are forced in such situations to make simplistic claims that cannot be supported by detailed argument and which are, in the end, judged according to such factors as strength of personality, confidence and the authority which the person carries.

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141 interview with journalist, Sydney Morning Herald, 29th December 1988.

142 quoted in Nelkin, Selling Science, p160.

143 for example, Telegraph, 18th December 1969; Sun 19th November 1979.

Even in the newspapers there are similar constraints. Journalists have limited time and incentive to become fully immersed and well versed in a subject. The complexities of just how contrived the official claims are, is not only difficult to show but considered to be boring to readers. In an area such as health risks, for example, journalists want to know if it is safe to swim at Bondi or not; they are seldom interested in whether faecal coliforms are a poor indicator of health risk. Moreover they will need to check claims with medical experts even though environmentalists may have read more scientific papers on the subject of health risks from bathing in sewage polluted sea-water.

Powerful organisations with government backing are often able to exert considerable pressure on newspapers and journalists, particularly when they think that they are not getting favourable coverage. In such circumstances, journalists need to be convinced of their information and sources if they are critical of these organisations and they also need to be sure of editorial support. This isn't always possible but if a journalist is courageous enough to take a chance on partly verified information or a sceptical editor, other media reporters may quickly follow him/her into an unfolding story.

Alan Tate, a Sydney Morning Herald journalist wrote a series of investigative articles commencing on the 7th January 1989 which successfully turned the tide on the Water Board. Throughout the first week of his series he was subject to verbal abuse from Water Board officers, accusations of taking uninformed advice and also accusations of not printing Water Board statements.[144] Two days after a full page Water Board advertisement was published in the Herald, the following letter to the editor from Bob Wilson appeared.

> The Water Board has responded to these articles by way of a number of press releases and statements. In my view, the Herald has not adequately published this information. Nor has it so far published information provided in response to these claims by the State Pollution Control Commission (SPCC), the Department of Fisheries or the Department of Health.[145]

However, despite these protests, the Board did not accuse the Herald of printing anything that was untrue and other media soon took up the story. Successive waves of embarrassing revelations of the Board's activities continued for weeks.

POLITICIANS - ELECTION PROMISES AND EMPTY RHETORIC

Beach pollution and its solutions have always been a highly politicised affair partly because of the media coverage it gets and voter interest in the subject. Politicians have sought media attention by making public statements about pollution and, whilst in opposition, by criticising the Board's proposals for dealing with it. Yet it is also one issue on which the two main parties have very little differences in approach. Politicians in government have tended to downplay the pollution and deny the health risks whilst politicians in opposition have played it up and criticised the Water Board's proposals. As can be seen in figure

144 Alan Tate, Sydney Morning Herald, personal communication, January 1989.
145 Sydney Morning Herald, 19th January 1989.

9.1, the various changes of government seem to have had little influence on the development of the submarine ocean outfalls.

Whilst in government various politicians have attempted to speed up progress on the outfalls and to get extra funds for it. After a concerted campaign against the pollution by the Telegraph in the 1969-70 swimming season and taken up by the Mirror, the Premier, Mr Askin, approached the Prime Minister, Mr Gorton for loan funds to combat beach pollution.[146] Early the next year the opposition (Labour) state member for Maroubra, W.H.Haigh, unsuccessfully tried to put an Urgency Motion calling on the government to provide special grants to the Water Board to enable it to complete sewage works to "stop the destruction of the beaches and foreshores by sewage pollution". He said that the discharge of partially treated sewage was a health hazard, damaged the tourist industry, lost sales for beaches businesses and affected property values at beachside locations.[147]

The Daily Mirror featured a photo a few days later headlined "Revolting! The filth that pours out on to Sydney beaches" and suggested that the pollution "menace" was causing an uproar in State and Federal parliaments, council meetings and among surfers.[148] A week later it was announced, in response to an Opposition no confidence motion in the NSW Legislative Assembly that the Federal government would be making $17 million available over five years toward the completion of the Board's sewerage treatment works.[149]

Whilst in opposition, Lionel Bowen, a Federal MP for an electorate with beachside suburbs, spoke out strongly in parliament against the proposed submarine outfalls. He argued that overseas investigations had shown that no matter how far off-shore the effluent was disposed of it would still pollute the water and end up "virtually destroying whatever marine environment we have left there. He argued that the matter should be taken up by the Federal government because otherwise it would be left in the hands of the Water Board Engineers.

> The biggest problem with sanitary engineers, if we may use that expression, is that they are interested only in the disposal of the effluent. They have no real knowledge, nor is it their duty to have any knowledge, of the problems associated with disposing of that sewage, effluent or industrial waste onto the marine floor and the dangers it is causing.[150]

Both Bowen and his fellow MP Tom Uren called for a closer examination of the recycling option.[151]

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146 Mirror, 21st January 1970.

147 Telegraph, 19th February 1970.

148 Mirror, 24th February 1970.

149 Sydney Morning Herald, 4th March 1970.

150 Lionel Bowen, House of Representatives, 8th May 1970, p1936.

151 Lionel Bowen, House of Representatives, 21st May 1970, p2572; Tom Uren, House of Representatives, 9 June 1970, p3134.

The change of State Government in 1976 from Liberal to Labour did not change the plans for submarine outfalls and although the deputy premier, Mr Ferguson, argued that the neglect of the previous government had left his with a massive task, denials about the extent of pollution continued to be put out by the Labor government as they had been by the Liberal government. For example, at the end of 1976, newspaper reports that several beaches had been closed because of pollution by beach inspectors who realised a potential health threat were accompanied by denials from deputy premier and the Minister for the Environment, Mr Landa.[152]

The State Opposition Leader, Mr Mason (Lib), also got involved. He argued that sewage pollution of beaches was not only threatening health but also causing "huge financial losses for hundreds of small local businesses reliant on tourist trade".[153] Predictably the State MP for Coogee, Mr Cleary (Lab), said the current campaign against beach pollution had "greatly exaggerated the danger of the situation" and he quoted the director of the Health Commission of NSW that hepatitis could not be contracted from swimming in polluted water and that the worst swimmers might get would be minor infections of the ear, eye and skin.[154]

Rosemary Foot, the member for Vaucluse, argued for secondary treatment at the outfalls as used in other Western countries and she pointed out that there would be no relief from sewage pollution for seven to nine years under the existing Water Board plans. Even when the submarine outfalls were built, she claimed, the "future of some of Australia's finest beaches" would depend on which way the wind blew and they would still be at the mercy of union strikes.[155] The President of the Water Board attacked Mrs Foot saying that he was astounded that she "should seek publicity by making "ridiculous" statements which suggested experts were incompetent fools." Her statements proved "how sadly uninformed she was".[156]

The Democrats also got involved in the argument, tending to favour the recycling options. Tom Mullins spoke to a branch meeting of the Democrats in Bondi[157] and later Dr Jim Boow of the Democrats supported Mullins in an argument in the print media.[158] Elisabeth Kirkby, the State leader of the Democrats accused Wran of squandering the State's most precious resource by not recycling waste water. She promised that her party would introduce legislation to recycle waste for industrial use.[159]

The run up to the 1984 State elections produced a whole spate of political offerings. The Herald suggested that 'muck' might bring down Labor in the key

[152] Telegraph, 25th and 26th November 1976.

[153] Sun, 13th November 1979.

[154] Southern News, 20th November 1979.

[155] Messenger, 11th June 1980; Southern News, 7th October 1980; Telegraph, 14th February 1981.

[156] Telegraph, 17th February 1981.

[157] Messenger, 10th June 1981.

[158] Messenger, 29th November 1981.

[159] Bondi Spectator, 17th September 1981.

marginal seat of Manly.[160] The Liberal Candidate for Manly, David Hay, bemoaned the failure to clean up Manly Beach which risked investment in the area, their tourist trade and their enjoyment.[161] The sitting Labor member, Alan Stewart, told Manly residents that he "shared their frustration and anger" at the delays in the submarine outfall project, deliberately spoke of the treatment at North Head as primary treatment and made an announcement that construction of North Head submarine outfall would begin in four months.[162]

To aid State Labor candidates in beleaguered beachside electorates, the Commonwealth Government announced, in the week before the election, that it would consider funding "a multi-million dollar program" to clean up the beaches, especially Bondi, Malabar and Manly and that it would certainly look favourably at a request by the NSW government for a special Loan Council borrowing to help finance sewage works.[163]

Not to be outdone, Nick Greiner, Leader of the State Opposition, took a helicopter flight to inspect sewage at the three major outfalls from the air. He stated after his flight that much of the water around the cliffs was murky brown and "it was unthinkable" that the Government allowed the beaches to be threatened like that. He described Manly beach as an "open sewer" and condemned the "unbelievable bungling and waste of public money" that had occurred in regard to North Head sewerage treatment works.[164]

Both parties promised to clean up the beaches.[165] Max Smith, Liberal MP for Pittwater accused the State Government of "blatant pork barrelling" over sewerage.[166] The Labor Member for Maroubra, Bob Carr, claimed that the Liberals would not have spent the money that they were spending on the submarine outfall project with the only return being health and cleaner beaches.[167] The election caused the sitting Labor member, Alan Stewart, to lose the marginal seat of Manly whilst Bob Carr, the sitting Labor member for the safe seat of Maroubra retained his.

The debate did not finish after the election however. Max Smith, Liberal Member for Pittwater, took a two month "study tour of sewerage systems in Holland, England and Scandinavia" and came back to report that the Water Board's plans were outdated and "governed by penny-pinching seeking to cheapen possible solutions instead of planning for the best".[168] Smith, trained as an engineer himself although not a sewerage engineer, criticised the submarine outfalls pointing out that the EIS's showed that 82% of the solid material in sewage would go into the sea. He said that the Government should have considered more seriously alternative methods of sewage treatment such as deep shaft

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160 Sydney Morning Herald, 12th March 1984.
161 Manly Daily, 21st February 1984.
162 Sydney Morning Herald, 12th March 1984; Manly Daily, 23rd March 1984.
163 Sunday Telegraph, 18th March 1984.
164 Sydney Morning Herald, 19th March 1984; Manly Daily, 22nd March 1984.
165 Telegraph, 19th March 1984.
166 Manly Daily, 22nd March 1984.
167 Maroubra Magazine, 21st March 1984.
168 Manly Daily, 7th July 1984.

technology.[169] He quoted the Dutch authorities he had visited on an overseas trip to argue that dilution was not the solution. Smith cited the case of a high rate primary treatment plant at The Hague where a 2.5 km submarine outfall had been installed ten years before and where secondary treatment was now being installed because of the unsatisfactory results.[170]

The Opposition raised the matter in State Parliament, arguing that the government had not only been guilty of allowing pollution to reach this stage but also of neglecting to warn people of the possible dangers. Crosio, Minister for Local Government and Water Resources, replied that pollution occurred only occasionally.[171]

In mid 1986 a bi-election was held for the State seat of Pittwater which was such a safe Liberal seat that the Labor Party decided not to contest it. However, a well-known surfer, Nat Young, stood as an independent and one of his main platforms was the sewage question. He said that he had decided to run when he was competing in a surf competition and sitting is a sea of detergent with foreign material floating around him.[172]

Young campaigned against the proposed submarine outfalls with the help of STOP, arguing that the Pittwater Beaches, less affected by pollution than those closer to the outfall, would be worse off when the outfalls protruded further out to sea and spread their load further.[173] The final result was extremely close and whilst preferences were being counted, Nick Greiner, Leader of the Liberals, admitted that the result could go either way.[174] Nat Young lost, but only just and the Liberals were badly shaken.

That same year, Tim Moore, the Liberal State Shadow Minister for the Environment began criticising the submarine ocean outfalls. He argued that effluent should be recycled for such purposes as watering sports grounds and for industrial purposes whilst the solids removed could be used as fertiliser.[175] He had returned from an overseas "fact-finding mission" into sewage treatment systems around the world. Moore said that in Germany secondary treatment was adapted to small land areas so that instead of having very wide shallow ponds they had narrow deep ponds that took only one tenth of the space of conventional secondary treatment. He argued that since an engineering solution existed the only other difficulty was cost and that involved a political consideration which would determine how fast secondary treatment was installed but should not determine whether it was installed. Most of the cities he visited, he said, either had secondary treatment or were moving towards it.[176]

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169 Manly Daily, 10th December 1983.

170 Manly Daily, 12th January 1985.

171 Sydney Morning Herald, 29th May 1987; Weekly Courier, 3rd June 1987.

172 Sun, 9th May 1986.

173 Nat Young, election pamphlet, 1986.

174 Sun, 2nd June 1986.

175 Mirror, 7th February 1986.

176 Sun Herald, 5th October 1986.

He argued that the submarine outfalls would provide,"at best, medium-term cosmetic solutions to Sydney's sewerage problems".[177]

> The blind insistence that the deepwater ocean outfalls are the solution to the problem represent a stubborn refusal to face the reality, revealed from the Water Board's own documents, that there will still be visible pollution in summer, at Sydney's beaches, on a minimum of one day in every twenty.[178]

The Liberals came to power in 1988 and although construction of the submarine ocean outfalls continued, Tim Moore was left with a problem, given his earlier statements. Towards the end of October Moore announced that he had ordered his senior policy adviser to review all Water Board and State Pollution Control Commission documents on the submarine outfalls. It was reported that Moore was sceptical about the accuracy of the Board's claims that the outfalls would clean up the beaches completely but that there was not much he could do if he found the claims were untrue because the project was almost half finished.[179]

Moore also took advantage of the planned monitoring programme that was being carried out as part of the approval conditions imposed by the SPCC. Moore announced the start of this monitoring programme as if it was his own initiative and was a response to growing doubts about the likely effectiveness of the submarine outfalls.[180]

MUNICIPAL COUNCILS - PROTECTING LOCAL INTERESTS

Councils have played a variable role in debates over pollution. On the one hand, they have sought to suppress publicity that would reflect badly on their area (see chapter 4) but on the other hand they have consistently lobbied the Board to do something about the pollution and have occasionally used publicity when they have felt it might be effective in putting pressure on the Board. Moreover, local aldermen, like the politicians have used the issue to promote themselves and their parties, especially at election time.

In April 1966 Randwick Council, which covers Malabar, Maroubra, Coogee and Clovelly beaches, threatened to take the Board to court and sue for compensation for residents who had paid high prices for property in the area so that they could be near the beaches which were not able to be used because of pollution.[181] The Telegraph supported the Randwick Council and in its editorial forecast the ruin of Sydney's "priceless assets".

> The ancient - many say outmoded - method of disposing of sewage by flushing it into the sea might have been tolerable when Sydney was a small city.

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[177] Tim Moore, 'Labor Sewerage Priorities Misguided', Environment Newsletter, June 1987, p1.
[178] Tim Moore, 'Pollution', Environment Newsletter, August 1987, p7..
[179] Sun-Herald, 23 October 1988.
[180] Sydney Morning Herald, 18th November 1988.
[181] Sun, 6th April 1966; Telegraph, 7th April 1966.

> With the growth of population and waste producing industry it could become a serious health hazard... [182]

The pollution testing of the beaches has always been a sore point with the councils and they have sought to control it themselves. In 1979 Manly Council was going to do its own tests of beach waters, warning signs were erected and warnings were broadcast over loudspeakers.[183] Randwick Council also complained about the Board's testing procedures. The taking of only five samples per month could be used to show the water was polluted or clear, depending on the choice of days and the morning readings avoided the onshore winds that usually came up on summer afternoons.[184]

The desire for control of pollution testing was not necessarily to protect the interests of beachusers however. In 1981 when local residents had complained about the lack of warning signs at Randwick beaches when the water was very polluted, the Council's chief engineer had responded that surf pollution received a lot of publicity "without council erecting signs on the beach."[185]

When the Board instituted Surfline in 1985, a service to inform surfers which beaches were polluted (more about this in the next section) Randwick Council retaliated, accusing the Board of "squandering money on publicity" rather than cleaning up the beaches. The Council's questioned the accuracy of Surfline reports. The Mayor, John Scullion, said the reports were misleading and that the council's own beach inspectors provided more accurate and up-to-date reports. Beach inspectors, themselves argued that they were able to determine when beaches should be closed since they were there all day and every day. Scullion said that the public would be better informed if they contacted the council and that the council erected warning signs and notified the public through a public address system, "in a responsible manner", when beach pollution was detected.[186]

The Manly Council was also reported to be "irate". The concern of the beachside councils was that bad reports turned people away from their beaches and this affected local businesses particularly badly. Randwick Council superintendent of beaches, Brad Burke, estimated that about 20,000 beachgoers had gone swimming elsewhere because of the bad publicity for Maroubra. Scullion estimated a fall of 10% in small business in the area and other areas were also concerned.[187]

In a column in the local Bondi paper, Wally Glover, a well known beach identity also tried to downplay pollution because of its effects on local businesses. He claimed that pollution had always been used as a political weapon and that media alerts about blue bottles, sharks and pollution only hurt those they

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182 Telegraph, 7th April 1966.

183 Sun, 13th November 1979.

184 Sun 17th February 1981; *Weekly Courier,* 8th April 1981.

185 Messenger, 1st April 1981.

186 Telegraph, 7th January 1987; Sydney Morning Herald, 9th January 1987; Southern Courier, 14th January 1987.

187 Sydney Morning Herald, 9th January 1987; Maroubra Magazine, 21st January 1987, Sydney Morning Herald, 24th January 1987.

claimed to be helping. He called upon the recently revived Bondi Beach Chamber of Commerce to set up a "virile public relations campaign to destroy these mischievous stories which do so much harm to local business."[188]

The proposals for submarine outfalls were welcomed by all the beachside councils and their support was enlisted in a series of special joint meetings of the Eastern suburbs councils during 1979 leading up to the display of the EIS's. Randwick, Woollahra, Botany and Waverley Municipal Council representatives were present at the first meeting held in April of that year which was addressed by Marshall Whyte, Investigative Engineer, Sewerage, from the Water Board. Whyte explained to the meeting what would be in the environmental impact statements and put forward the case for the submarine ocean outfalls. He emphasised that the submarine outfalls would not be built unless the State government allocated money for them and as a result the meeting resolved to form a Joint Council Action Committee to do whatever was necessary to ensure that money would be quickly allocated to the project.[189]

Michael Cleary, M.P. for the Coogee area, spoke to the joint council meeting in November 1979 shortly before the release of the EIS's using background information prepared by the Board for him. He spoke of the benefits of submarine outfalls.[190] Having been sold on the concept all the councils (except Woollahra which made no submission) supported the EIS's (see table 9.1) with Randwick making a plea that some interim measures be instituted to deal with the sewage until the new outfalls were built and Botany asking that no more sewage be directed to Malabar whilst the plant was so overloaded. However the support seems to have been less than unanimous amongst the Councillors and the Mayor of Randwick, Ken Finn (Lib), argued that even when the submarine outfalls were built, the sewage would still be washed back to the beach given the right tides and winds. The answer he said was to treat the sewage to a higher degree with secondary and even tertiary treatment.[191]

When STOP representatives gave their presentation to the Liberal dominated Waverley Council in 1986, Councillors seemed to be shocked to find that there was some doubt that the submarine ocean outfalls would work and angry that they had been sold the scheme so easily. Alderman Collins threatened to get the beachside councils to sponsor a scientific investigation of the entire issue.

There can be no doubt that the response of the Board, which sent along five of its senior people and three SPCC experts as well as a three metre long model and posters full of charts and diagrams to cover the council chamber walls, overwhelmed the councillors. The public relations barrage left the council, as the local paper reported, "scratching their heads". Alderman Collins was reported as saying that this was "an enormous scientific and technical question which is very difficult to comprehend".[192]

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188 Spectator, 2nd and 16th October, 1986.

189 Minutes of the Special Joint Conference of Eastern Suburbs Councils on Beach Pollution, 19th April 1974.

190 M.W.S.&D.B., "Pollution of Beaches", information prepared for M.Cleary to joint meeting of eastern suburbs councils, 15th Novebember 1979.

191 Southern News, 13th November 1979.

192 Southern Courier, 6th August 1986.

THE WATER BOARD DEFENCE

The public relations effort at Waverley Council was an example of the new public relations strategy of the Board adopted after organisational and management changes. At the end of 1983 Dr Peter Crawford (previously of SPCC) was appointed General Manager and Dr Rhonda McIver chair of the Water Board after a major reorganisation of the Board following recommendations from a task force headed by McIver. The Board was, at this time, placed under the direction and control of the Minister to ensure greater government control.

Amongst the favourable findings of the task force was that the SPCC was "relatively happy" with the standard of effluent coming from the Board's sewage plants and that the cost of services in Sydney were relatively cheap compared to other cities.[193] The task force noted that there was an increasing community concern with environmental protection as well as increasing governmental control and scrutiny and community pressure for the Board to be more accountable, accessible, efficient and effective.[194]

In recommending against having local government representatives on the Board as had happened prior to 1972, the task force argued that the benefits of having such representatives on the board could be met by encouraging community participation and the systematic canvassing of community opinion and the opinion of interest groups such as local government to ensure their views were taken into account in decision making.[195]

In a section on 'areas of concern' the task force included the lack of public participation and the fact that the Board was seen by the public as secretive. To overcome this they suggested that financial aspects of large projects should be published "to permit informed debate", that the Board communicate more openly with the media and the public, that more effort be put into "selling" the Board and that senior managers and Board members attend media courses. Additionally the Public Relations and Publicity Sections should merge and report directly to the General Manager.[196]

In the summer of 1985/6 the Board began its submarine outfalls propaganda campaign in ernest. 'Surfline' was launched-a telephone line which swimmers and surfers could call to find out which beaches were polluted and which were clean. Also education kits were made available and an advertising campaign begun with a stated budget of $500,000 for that year.[197]

The Board's annual report stated that the Board's public relations programs were aimed at

> developing and maintaining perceptions of the Board as a modern, customer-oriented and innovative organisation that effectively and

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[193] Dr. R. McIver, Report of the Ministerial Task Force to Review Sydney Water Board, 31 August 1983, p20.

[194] ibid., p35.

[195] ibid., p47.

[196] ibid., ppp84-6.

[197] Manly Daily, 12th November 1985; *Sydney Morning Herald*, 9th and 12th November 1985.

> efficiently provides water, health and environmental protection services to the community.[198]

The report noted that there was significant dissatisfaction with the "Board's perceived performance" with regard to sewage pollution of the ocean beaches in Sydney and their major public relations campaign for the year had been the first phase of their "beach protection program". As well as advertising the submarine outfalls the campaign, the report said, also sought to encourage the use of the Surfline beach inspection service and to educate householders and industry on the steps they could take to reduce beach pollution.[199]

The Water Board has become particularly adept at public relations and the presentation of information in the most favourable light. Because the impact of technological projects must be done in the face of technical uncertainties, and this is particularly so with a unique and untried project such as submarine ocean outfalls off the Sydney coastline, there is no conclusive data and almost no "accepted theoretical framework from which to draw definitive quantitative conclusions".[200] Given this atmosphere of uncertainty there is scope for various interpretations, predictions and conclusions to be drawn from available data.[201]

Yet the Board has put their case more strongly than can be supported by the evidence so that the results seem decisive when in fact they are uncertain.[202] When uncertainties exist the degree to which a firm conclusion can be reached is debatable at the best of times[203] but in advocating a particular proposal, engineers tend to ignore the uncertainties or keep them from the public view. In this way the Sydney Water Board has always claimed that there is no doubt about the efficacy of their various sewerage treatment and disposal schemes. The submarine outfalls would, they said, end sewage pollution of the beaches totally and forever and this was the message put across by the brochures and the advertisements.

An example of deliberate removal of all reference to uncertainties in an environmental impact statement can be shown in the case of the proposed sewerage scheme for Byron Bay. The draft impact statement prepared by Byron Shire Council at the end of 1987 and given to me the week before publication contained the sentences;

> There should be little, if any, impact from the development, upon the S.E.P.P. 14 wetland within the site.
> A less than satisfactory result in the performance of the works and associated artificial wetlands would result in a forced abandonment of the wetlands disposal option and cause Council to again pursue the

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198 M.W.S.&D.B., 98th Annual Report, Year Ended 30th June 1986, p27.

199 M.W.S.&D.B., 98th Annual Report, Year Ended 30th June 1986, pp27-8.

200 This sort of situation is described by Dorothy Nelkin, `Scientists in an environmental controversy', Science Studies 1, 1971, p253.

201 This sort of situation is described by Dorothy Nelkin, `The political impact of technical expertise', Social Studies of Science, vol 5, 1975, p48.

202 This device is covered by R.V. Jones, 'Temptations and Risks of the Scientific Adviser', Minerva x(3), July 1972, pp442-3.

203 Allan Mazur, `Opposition to technological innovation', Minerva xiii(1), Spring 1975, p252.

> ocean outfall option with its inherent high cost and public opposition.[204]

These sentences were omitted from the final version of the EIS as published and the following inserted

> Monitoring results indicate no effect on the adjoining wetland areas.
> A close monitoring programme will enable Council to assess the performance of the proposed ponds and to determine the need for additional wetland areas.[205]

Similarly the Sydney Water Board has eliminated all mention of uncertainty in its television advertisements which featured majestic aerial views of the beaches and its series of double page colour ads in the Sydney Morning Herald, weekend magazine and in various other magazines. The first of these newspaper advertisements featured a view of a pristine and unpopulated beach was headlined `We're spending millions and there'll be nothing to show for it.' The text of the advertisement said that it had become "more than a little apparent" that the outfall sewerage works needed serious upgrading and that the Board was spending "the $450 million it will take to do the job properly". ($300 million for the submarine outfalls and $150 million that included completion of the North Head treatment works.) It claimed the submarine outfalls would allow the salt, the depth and the movement of the ocean to naturally bio-degrade the treated sewage.

> In the future neither winds nor currents will be able to wash partly treated sewage onto our beaches.[206]

Other advertisements were worded in a similar vein. All were visually beautiful. Sparkling clean beaches alluded to what the future held. The amount being spent was repeated over and over as if just spending this amount of money must guarantee good results. They emphasised how the beaches and bathing waters would be absolutely clean and clear after the submarine outfalls were built and that this would be achieved by natural means in the ocean. The radio advertisements won the Gold Medal in the Utilities (Products and Services) category of the International Radio Festival of New York in June 1986.[207]

Uncertainties were often denied by emphasising the scope of the study or investigation that had been undertaken.[208] For example, the oceanographic study of Sydney's coastal waters was said to be one of the most comprehensive ever carried out, taking five years and cost one million dollars to do. It was implied that after all this investigation there could be nothing left to uncover and no uncertainties remaining.

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204 Byron Shire Council, Byron Bay Sewerage Augmentation Environmental Impact Statement, draft, December 1987, pp5,12.

205 Byron Shire Council, Byron Bay Sewerage Augmentation Environmental Impact Statement, December 1987.

206 For example Good Weekend, Sydney Morning Herald, 21st December 1985, pp2-3.

207 M.W.S.&D.B., 98th Annual Report, p28.

208 Mazur, `Opposition to technological innovation', p247.

In fact a lack of evidence, rather than putting the experts conclusions in doubt, can be used to reinforce them by using the phrase, "there is no evidence to show that" or something like it.[209] In this way the lack of fish and sediment studies carried out in Sydney was used by the Water Board to assure the public that there was no evidence of a problem with toxic substances accumulating in the food chain. Similarly the lack of studies into the health of Sydney swimmers allowed them to argue that there was no evidence that swimming in sewage is damaging to the health.

Exaggeration has also been used effectively whilst details are glossed over. One advertisement headlined, "The Water Board's commitment to clean beaches is 4 kilometres long and 80 metres deep",[210] gave the impression that the outfalls were 4 kilometres off-shore even though the Bondi outfall was 2.2 kilometres from the shore with effluent coming up from 1.5 kilometres out, where the diffuser section begins, and the longest outfall was North Head at 3.85 kilometres from the shore, at the end of the diffuser. The most recent advertisement says that the outfalls will go between 3 and 5 kilometres off the coast and will discharge effluent into between 60 and 80 metres of water.[211]

Earlier Water Board brochures mentioned that ocean currents were not normally directed onshore in summer. For example a brochure defined "Subsequent Dispersion" as follows

> This occurs as the effluent/seawater mixture moves away from the initial dilution zone under the influence of ocean currents. In Sydney, these currents are not normally directed onshore during the summer months.[212]

A reprint of the same brochure defined the same term as follows

> This occurs as the effluent/seawater mixture moves away from the initial dilution zone under the influence of strong offshore ocean currents during the summer months.[213]

The Water Board press releases and the advertisements stressed that the treatment works would be upgraded as well as submarine outfalls constructed. This upgrading was never spelt out in these public announcements but in the annual report reference was made to more efficient screening, grit and grease removal and the amplification of facilities at Bondi to provide greater capacity.[214] This seemed a bit different from the impression given by Crosio's statement that the submarine outfalls "will be releasing a more highly treated effluent at a concentration hundreds of times less than it is released at present." [215]

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209 ibid., p248.

210 For example, Sydney Morning Herald, 8th November 1986.

211 Sydney Morning Herald, 16th January 1989.

212 M.W.S.&D.B., Deepwater Submarine Outfalls for Sydney, brochure, undated.

213 M.W.S.&D.B., Deepwater Submarine Outfalls to Protect Sydney's Beaches, brochure, undated.

214 M.W.S.&D.B., 98th Annual Report, p 45.

215 Weekly Courier, 27th November 1985.

Problems can be variously interpreted by defining them differently.[216] Much of the disagreement about the health risks of bathing in polluted water resulted from the Board's focus on acute or chronic or serious illness which does not take into consideration the public's experience with more minor infections and stomach upsets which are not fatal but nevertheless not considered to be a tolerable consequence of ocean bathing or surfing. Official surveys concentrate on statistics that only record the more serious notifiable disease.

Similarly, the official concern with an obvious accumulation of pollutants locally allows them to argue that the ability of the submarine outfalls to dilute and diffuse pollutants will solve beach pollution problems. The different perspective of environmentalists who are concerned with a build-up of pollutants in the environment means that they are not comforted that pollutants might be discharged in a more dilute form.

The Board can obviously bias the picture by suppressing awkward evidence[217] or selectively using favourable evidence. For example, overseas studies and papers, especially those done by Moore in England, which minimised the health risk were cited and those which pointed towards possible health risks were ignored or quickly dismissed. When opponents have then quoted those awkward studies that the Board would prefer to ignore, the Board has accused those opponents of misleading the public through selective quotation.

As for the impact of the submarine outfalls on the marine environment, the EIS's conveniently ignored evidence to the contrary when they argued that

> Experience overseas has shown that effluent and digested sludge may be discharged through a deepwater outfall without any significant adverse effects where ocean conditions are favourable. Most constituents of sewage are in fact beneficial to marine life, providing that the assimilative capacity of the waters for the additional organic nutrient load is not exceeded.[218]

Argumentum ad Hominem is a favourite of the Board and they have happily accused opponents, be they politicians, dissident experts or members of protest groups of being self-appointed, misunderstanding the facts, alarmist, pseudo-scientific etc.

The concept of comparative risk was also one that the Board utilised by considering natural and common risks which people were regularly exposed to.[219] The health risks of swimming in sewage polluted water were compared to those of swimming in a community or neighbour's swimming pool or travelling on public transport. The discharge of heavy metals into the ocean was juxtaposed against the presence of natural levels of heavy metals in the marine

216 Mazur, `Opposition to technological innovation', p251.

217 Jones, 'Temptations and Risks of the Scientific Adviser', p444

218 Caldwell Connell, Environmental Impact Statement Malabar Water Pollution Control Plant, M.W.S.&D.B., 1979, pviii.

219 Mazur, `Opposition to technological innovation', p247

environment. And a favourite Water Board comparison is to cite the massive faecal pollution by anchovies off California.[220]

The Water Board campaign was also at pains to make the submarine outfalls appear to be scientifically sound and technologically sophisticated. The second summer of advertisements became more technical following the onslaught of criticism and the popular notion that all the outfalls would achieve would be to take the effluent further out to sea from where it would blow back inshore. Several advertisements featured pictures of the diffusers operating. The text put forward the idea of dilution, dispersion and underwater biodegradation arguing that salt water was extremely hostile to bacteria. The little sewage that might actually get to the surface would "get the sunshine cure".[221]

They argued that the ocean actually provided secondary treatment and so the calls for secondary treatment facilities were superfluous.

> These on-shore treatment facilities would, by and large, be merely duplicating what the ocean's own natural biological purification and dispersion processes will be able to do, free of cost, once the deepwater outfalls are commissioned.[222]

Another technical looking advertisement appeared in Billy Blue, a free magazine that appeared in trendy restaurants. Headlined "The Debate About Sewage Treatment is Getting Cilia and Cilia", the advertisement argued that the sewage was simply inserted into the natural cycle. But by talking about treatment at inland treatment plants as well as ocean outfalls in the advertisement text the impression was put forward that all sewage treatment was very scientifically complex and technologically advanced. It ended saying

> The next time someone starts moaning about effluent treatment and beaches covered in !*#* you can raise the standard of public debate and put them straight...Naturally we prefer to talk to people who like facts rather than whinging or idle gossip.[223]

The Water Board also avoided mention of industrial waste in their advertisements apart from one advertisement that was replete with hyperbole. It stated

> We are revolutionising the way industry disposes of its waste products, so that the environment will never suffer as a result of industrial pollution in our waste water.[224]

The advertisement referred to "an army of inspectors" (30 or so in reality for the whole of metropolitan Sydney) and also to the role Greenpeace was playing in "helping us objectively review our control measures to make sure they continue

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220 Sydney Water Board, Background Briefing 3, 1987, p1.

221 for example, Sydney Morning Herald, 6th December 1986; Mosman Daily, 27th November 1986; Weekly Courier, 26th November 1986.

222 Sun-Herald, 19th October 1986.

223 Billy Blue 92, Summer 1986.

224 Good Weekend, Sydney Morning Herald, January? 1987.

to be effective" (Greenpeace attended one or two meetings at which nothing significant was decided before dropping the issue.) The advertisement also used the term "up to" in a purposely misleading way. The chemicals were said to be in sewage effluent in concentrations "up to 10 times less than is already present in the natural ocean environment" and chemical concentrations would be "up to 100 times less than the SPCC's current limits."[225] One might be forgiven for interpreting these statements as saying that the worst case concentrations were 1/10 of natural background levels and 1/100 SPCC levels but the Board was referring to the best case.

The reference to industrial wastes was otherwise downplayed. In fact until STOP and Greenpeace campaigns brought the matter of industrial waste to the attention of the public, people were generally unaware of the extent to which the sewage contained industrial waste. The SPCC received a number of Ministerial enquiries concerning the discharge of toxic waste to sewers after the Greenpeace campaign.[226]

By ensuring the problems of beach and marine pollution are sourced back to the public rather than to industry, then public criticism is headed off. The Board aimed a set of advertisements at the domestic kitchen virtually putting the blame for grease and oil pollution onto the housewife, ignoring in the ads the contribution industry made to this problem. Readers were told not to pour grease or oil down the sink because their detergents caused grease and oil to mix "so thoroughly with the water" that the Board were unable to separate them again in the treatment plants and this was what caused the millions of tiny grease balls in the ocean, "Yuk!".[227]

Similarly, when the results of the Malabar Accumulation Study were leaked to the Herald after being kept secret for over a year and it was reported that the Red Morwong caught had average concentrations of Benzene Hexachloride (BHC) 120 times the NH&MRC recommended maximum, Keith Mullette, Manager of Scientific Services of the Water Board, claimed that since such the dumping of such chemicals by industry was "effectively prohibited", the problem lay with private individuals who were disposing of pesticides and household chemicals down the toilet.[228]

This theme was repeated in a new style advertisement put out by the Board in January 1989. A full page advertisement, that consisted mainly of text with the picture of Bob Wilson, Managing Director of the Board, was headlined "We are committed to ending sewage pollution of Sydney's beaches." It told the story of a woman who had "rung up the other day" because she had found 50 kg of Cyanide in her garage and wanted to know if she could put it down the toilet.[229] This was a blatant attempt to blame householders for toxic waste in the sewers.

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225 ibid.

226 SPCC, Internal Report on Concerns Expressed by Greenpeace, 12th March 1987.

227 for example, Sydney Morning Herald, 13th December 1986 and 17th January 1987; Southern Courier, 10th December 1986;

228 SBS.TV News Broadcast, 7th January 1989; 2BL 7pm News, 7th January 1989.

229 Sydney Morning Herald, 16th January 1989.

The "effective prohibition" of toxic chemicals was another myth the Board liked to put out. In its "fact" sheets the Board claimed that "only the lower strength/least toxic of industrial wastes are permitted to be discharged to the Sydney sewerage system"[230] and Bob Wilson claimed on radio that the Board had told industry that they would not receive wastes with toxic materials in them.[231] This is despite the Board's policy that quite plainly does allow toxic materials into the sewers and charges industry to dispose of these substances per kilogram.(see chapter 7)

SURFLINE - RESTORING THE WATER BOARD'S CREDIBITILITY

Surfline was an idea which first took shape in the SPCC. The authorities, following Moore, maintained that water was safe to swim in unless it was aesthetically revolting. Sydney bathers were told throughout the 1960s and 1970s that if the water looked dirty then it should be avoided[232] despite the claims by various people that "typhoid-carrying pollution" and viruses were not necessarily visible to the naked eye.[233] Judgements about whether to post warning signs on beaches were made by council beach inspectors who made a subjective evaluation, after considering the extent of grease and debris on the beach, and the presence of floating scum and turbidity in the water.

In 1984 the SPCC decided that if this judgement could be quantified to a certain degree it would make the judgement less subjective and more consistent[234] (and seem to be more scientific). They tried to develop a beach pollution index, (BPI) a numerical measure similar to the air pollution index, which could be a ready reference for beach goers. The SPCC noted all the problems with using faecal coliforms and said that in recent years there had been a move away from using such measures as a direct and immediate measure of beach pollution and towards the use of visual indicators and aesthetic judgement in deciding whether a beach should be closed.[235]

The SPCC failed to find any single mathematical equation to relate faecal coliform densities with visual indicators because the relationship was so complex, nonetheless they argued the BPI should be based solely on visual parameters since there were no other established and rapidly determined chemical measures of sewage pollution. "The BPI concept is related to public perception of pollution, namely aesthetics."[236]

The SPCC researchers came up with a formulation that had a correlation coefficient of 0.55 as follows:

$BPI=I1+I2-1$ where $I1=\{(G+1)_5(MB+1)_2(T+1)_2(MWT+1)\}_{1/10}$

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[230] Sydney Water Board, Background Briefing 5, 1987.

[231] Radio 2GB, 8.10 am, 17th January 1989.

[232] for example, Telegraph, 18th December 1969.

[233] Mirror, 24th November 1970.

[234] N.R.Achuthan, et al, `Development of a Beach Pollution Index for Sydney Coastal Beaches', Water, September 1985, p15.

[235] ibid.

[236] ibid., p17.

and I2=Maximum {G,MB,T,MWT}

G : Code for number of grease particles on beach.

MB: Code for materials of sewage origin on beach.

T: Code for turbidity beyond breakers

MWT: Code for materials of sewage origin in water. [237]

That year Sandy Thomas, spokesperson for the SPCC, told the Sydney Morning Herald that they were trying to refine a system of forecasting beach pollution so that daily beach pollution reports could be issued for the following summer. The SPCC had found that there was a "definite relationship between the severity of visual sewage pollution and the possible risks to health."[238]

Both Sandy Thomas and the idea of daily beach reports moved to the Water Board shortly afterwards and Surfline was born. Surfline was aimed at getting surfers on side and it was advertised to them in the local papers. One pictured a surfer in a phone box on the beach with the headline 'If there's *!?# in the swell, give us a bell' and used surfing idiom in the text to assure surfers that they could ring up and report polluted beaches and the Surfline inspectors would come and take samples, get them analysed and "make a full report about what they find."[239]

A second advertisement showed a beach inspector from 1958 holding up a bikini (and referring to the way beach inspectors used to enforce dress standards at the beach) and a modern Surfline 'beach inspector' holding up a test tube and a clip board and looking 'scientific'. The headline: 'Our beach inspectors aren't interested in cover-ups.'[240]

Surfline was vehemently attacked by the Manly State MP, David Hay (Lib) as "nothing but a costly propaganda machine for the NSW Government". He claimed that he had rung Surfline after he had received several complaints about a five by one kilometre slick of sewage and found that Surfline employees were not aware of the problem and they suggested the pollution was oil and not from the nearby sewage works.[241]

Hay argued that the stain began at the outfall and that the thousands of seagulls proved that the slick was sewage and not oil. The Board denied this and stated that the problem was caused by the illegal dumping of grease near North Head. Hay was accused by the Minister for Natural Resources, John Aquilina, of having "a callous disregard for the truth". He asserted that Surfline's reports on the days in question were 100% accurate.[242]

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237 ibid., p17.

238 Sydney Morning Herald, 20th December 1984.

239 for example, Weekly-Courier, 8th January 1986, p8.

240 for example, Weekly-Courier, 4th December 1985, p27.

241 Manly Daily, 15th February 1986.

242 Manly Daily, 15th February 1986; Manly Daily, 22nd February 1986.

Some surfers also viewed Surfline as a "publicity stunt" according to Kirk Wilcox a surf reporter for an ABC radio station and editor of Waves, a surfing magazine.[243] The surfers in POOO argued along with Hay and Water Board Union officials that the money would be better spent on treating the sewage. As Hay pointed out, any surfer could tell when the water would be polluted, from their experience of wind and tides.[244]

In the face of all this criticism the Board sent out press releases about Surfline. The ensuing newspaper articles said that members of Surfline were experienced Water Board employees who were "active members of beach communities" who swam, surfed or sailed every day themselves and who had a "proven record of concern for protecting and improving Sydney's beach environment". They checked the beaches several times a day and, in case anyone thought that it was enough just to observe conditions as any surfer was able to do, they were equipped with binoculars, sextants, wind gauges and maritime charts.[245] Members of Surfline also wrote into the Manly Daily protesting their honesty and their commitment to clean water.[246]

Under pressure to be seen as honest and independent the Surfline inspectors occasionally reported gross pollution such as plastic nappies, condoms and plastic bags at Cronulla during the 1986 Australia Day weekend and slabs of decaying meat at South Curl Curl beach on the north shore a week or so later.[247]At the end of 1986 the Sun newspaper claimed that its reporters had found rats "gorging themselves on piles of litter along the water's edge" at Maroubra beach at the same time as Surfline was reporting the beaches to be clean and clear of all serious sewage contamination.[248]

A week later a public argument between the councils and Surfline hit the headlines. The manager of Surfline, Leigh Richardson, accused local councils of putting bathers at risk by ignoring Surfline's advise to close beaches on several occasions. Maroubra beach had been ruled, by Surfline, unfit for swimming 14 times between October and the new year because of high pollution levels and on each occasion Randwick council had refused to close the beach.[249] (It should be noted here that the Board reported in its Annual Report that 100% of samples at Maroubra for that summer complied with a monthly geometric mean of 200 faecal coliforms per 100 ml.[250]) The next day the Surfline report warned that there were maggots on the beach and in the water at Maroubra. The Board later stated that the "land-based fly maggots" had been washed down stormwater drains onto the beach but did not pose any health risk.[251]

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243 Eastern Herald, 9th October 1986.

244 Manly Daily, 14th October 1986.

245 Southern Courier, 15th October 1986.

246 Manly Daily, 1st November 1986.

247 St.George and Sutherland Shire, 4th February 1986; Daily Telegraph 12th February 1986.

248 Sun, 30th December 1986.

249 Sun, 5th January 1987.

250 Sydney Water Board, Annual Report, Year ending 30 June 1988, p34.

251 Telegraph, 7th January 1987.

The leaked Health Department report of Salmonella on the beaches in early 1987 (see chapter 8) was followed a few days later the Mirror, with the headline "Aids Alarm Sounded at Beaches". It reported that the Health Department was carrying out emergency tests for AIDS in seawater off some of Sydney's beaches. The reporter went to another member of the Infectious Diseases Unit, Dr Phillip Jones, who said that the AIDS virus could be found with blood in faeces and that if mixed with blood the AIDS virus could persist for hours.[252]

Sandy Thomas, spokesman for the Water Board, said that he was not surprised that salmonella had been found and that was why they had established Surfline and that this "confirmed the wisdom" of daily pollution reports which advised bathers when it was safe to swim. However a check of dates made by the Eastern Herald claimed that Maroubra beach had only been closed on 3 of the occasions and Coogee beach had only been closed on two of the occasions on which the Department of Health took samples.[253] Thomas also argued that it was the Department of Health's responsibility to test for viruses, not the Water Board's.

Surfline achieved a number of public relations objectives. One of those objectives has been to highlight the pollution so as to justify the enormous amount of money being spent on the submarine outfalls.[254] The Board attempted to tread a fine line between denying that their discharges created gross pollution and yet also admitting that there was a problem which justified the $450 million dollars they were spending. They would say that "even though most beaches are clean most of the time, sewage-related beach pollution is at unacceptable levels." [255]

It was reported that the Board had been embarrassed by Surfline reports which had shown up a level of pollution which they were ignorant of. By mid January, 1987 it was estimated that Surfline had recommended that swimmers not swim or swim at their own risk 62 times that summer.[256] In an article headlined, "Has Surfline too much dirt on our polluted beaches?", the Herald reported rumours that Surfline inspectors were being too honest and had been told to "tone it down".[257]

But Surfline had other objectives as well. The Herald argued that Surfline's creation had been "an ingenious move by a government department traditionally perceived as secretive and hostile."[258] The campaign ($700,000 for that summer for television and magazine advertising) had been a success according to an opinion poll which found a 95% awareness and approval rating for Surfline which was receiving 200-300 calls a day during the week and far more on weekends.[259]

Surfline also serves the purpose of reestablishing Water board employees as experts in analysing whether a particular beach is polluted. Although Surfline

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252 Mirror, 7th April 1987.

253 ibid.; Eastern Herald, 2nd April 1987.

254 Wentworth Courier, 21st January 1987.

255 M.W.S.&D.B., `Clear Water. Clean Sand.', Fact Sheet 2, 1986.

256 Sun-Herald, 18th January 1987.

257 Sydney Morning Herald, 24th January 1987.

258 Sydney Morning Herald, 24th January 1987.

259 ibid.

inspectors rely mainly on visual indicators for doing this, the Water Board literature and advertisements emphasise the sampling and measurements they make and give them an aura of scientific expertise. (They are usually depicted with beakers or test tubes of liquid and clipboards as shown in figure 9.5. although the containers of liquid are more often assessed visually for tubidity rather than sent to the laboratory for analysis.) This downplays the ability of the ordinary person to judge whether a beach is polluted or not.

When the new submarine ocean outfalls are built the sewage is likely to be less visible, especially when there is a submerged field. This means that the traditional association between visual indicators and health risks will be broken and people will not be able to tell whether the beach is polluted just by looking. It will be interesting to see whether Surfline continues to do its reports according to visual indicators and whether it serves as a new mechanism for denying beach pollution.

The Board also seems to be preparing to meet the possibility that beach pollution is obvious after the outfalls are built. Already Surfline has restored the credibility of the Water Board's determinations of whether a beach is polluted or not and the Board's claims that the sewage outfalls are not the only source of pollution will enable them to blame any pollution on other sources as they have in the past. Crawford, the Board's previous general manager, argued that the first flush of stormwater had "an incredibly high bacterial count" and although this was not the Board's responsibility, it did not want to remove sewage pollution "for all time" with its submarine outfalls only to find that there was still an unacceptable level of pollution on the beaches from other sources.[260]

Other sources of beach pollution which the Board has pointed to include beach litter, marine pollution, ship spills, algae that looked like a sewage field and even gave rise to the same health complaints such as ear and eye infections, and dark-coloured pumice from volcanic eruptions in the Pacific Ocean which was frequently mistaken for grease from sewage discharges.[261] For example a Board fact sheet stated

> it has been estimated that anchovies off the coast of southern California produce as much faecal matter each year as 90 million people - and anchovies are only one of hundreds of species of marine life in this part of the ocean. [262]

Such claims have also been made by the SPCC, which is supposed to regulate the Board's activities. The director of the SPCC, Mr Jenson, said in 1979 that

> it has been reported that a school of salmon off the US coast is responsible for more sewage than the whole population of California.[263]

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260 Sunday Telegraph, 25th January 1987.

261 M.W.S.&D.B., `Clear Water. Clean Sand.', Fact Sheet 2, 1986; Southern Courier, 15th October 1986.

262 M.W.S.&D.B., `Clear Water. Clean Sand.', Background Briefing 3, 1987.

263 Sun, 14th November 1979.

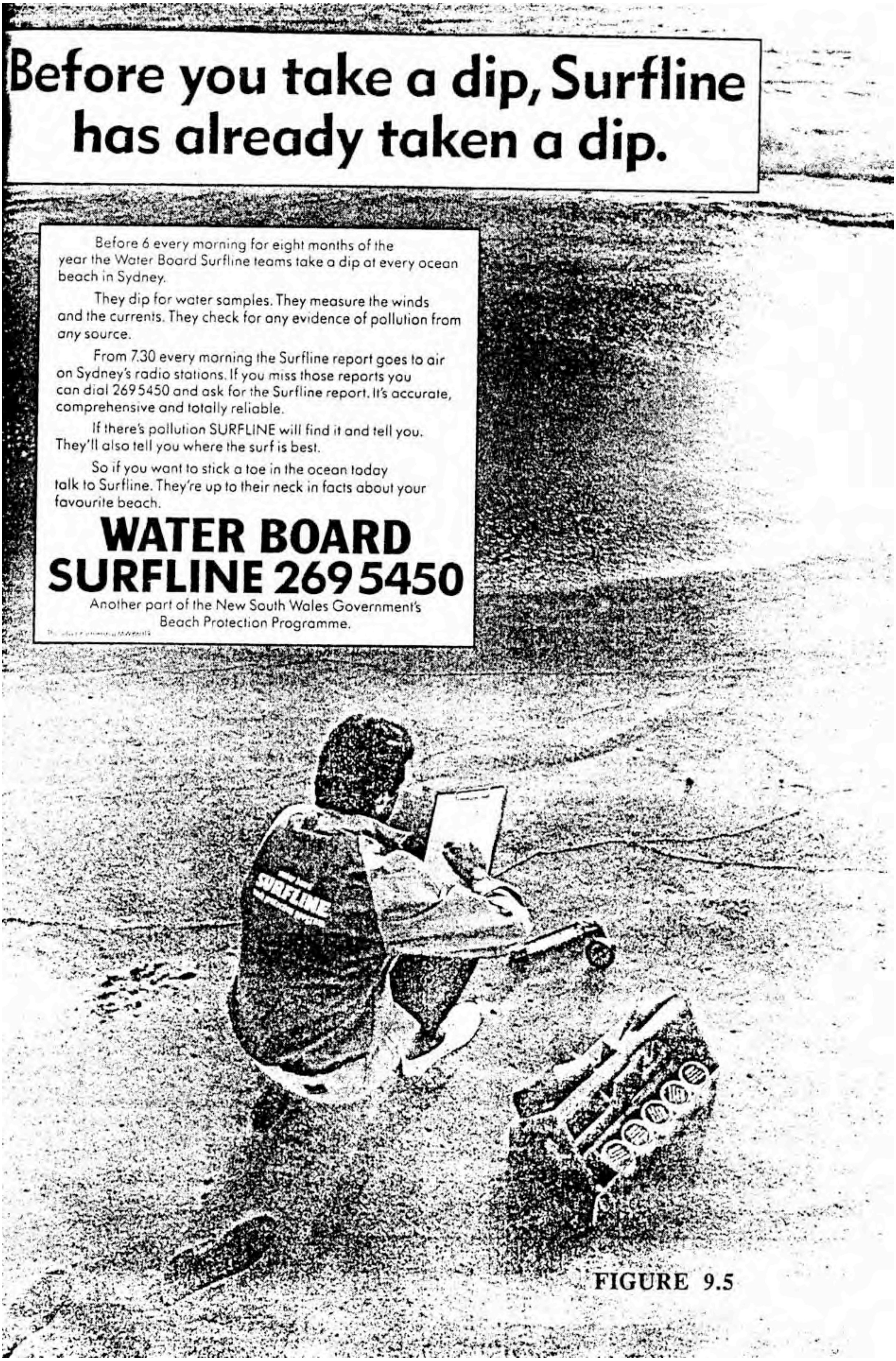
Before you take a dip, Surfline has already taken a dip.
Before 6 every morning for eight months of the year the Water Board Surfline teams take a dip at every ocean beach in Sydney.
They dip for water samples. They measure the winds and the currents. They check for any evidence of pollution from any source.
From 7.30 every morning the Surfline report goes to air on Sydney's radio stations. If you miss those reports you can dial 269 5450 and ask for the Surfline report. It's accurate, comprehensive and totally reliable.
If there's pollution SURFLINE will find it and tell you. They'll also tell you where the surf is best.
So if you want to stick a toe in the ocean today talk to Surfline. They're up to their neck in facts about your favourite beach.
WATER BOARD
SURFLINE 269 5450
Another part of the New South Wales Government's Beach Protection Programme.
SURFLINE

FIGURE 9.5

And despite the Board's assurances that the submarine outfalls would solve pollution problems once and for all, a leaked document, a letter from the Board to the Department of Planning and Environment, gave a hint of the Board's long term plans.

> While there are no proposals to provide a higher degree of onshore treatment at Malabar after the outfall is completed, increasing community expectations could require the Government to construct such further treatment facilities in the future.[264]

More recently since the Liberal Government has come to power, the Board's advertising campaign has been cut back sharply and under the Ministership of Tim Moore,who has expressed doubts about the Board's promises, the Board no longer states that the submarine outfalls will end beach pollution forever. The most recent advertisement only claims that there will be no visual pollution.[265] It seems that already the way is being opened for a new stage of treatment (probably some form of secondary treatment) to be implemented in more distant future.

CONCLUSIONS - PUBLIC PARTICIPATION VS PUBLIC RELATIONS

It is clear that the public had very little say in the decision making process that surrounded the submarine ocean outfalls. The decision was made well before public comment was invited and the Board defended itself against all forms of opposition through a well orchestrated public relations effort.

Sherry Arnstein has described various types of public participation and 'non-participation' in terms of a hierarchy based on the degree of participation involved. On the bottom of her ladder are two forms of non participation; manipulation and therapy. Therapy pretends to involve people in planning in order to help those people feel better about themselves; manipulation is also a facade of participation and is concerned to 'educate' people or get them on side.[266]

The next three levels, Arnstein describes as degrees of tokenism. 'Informing' involves the use of the media, pamphlets and posters to provide a one-way flow of information. 'Consultation' allows citizens to express their views but there is no guarantee that those views will be considered or taken into account. 'Placation' allows some influence to citizens through token membership of committees or boards. The three highest levels which involve real participation involve a redistribution of power.[267] (see figure 9.6)

Much of the Board's activities have taken place at the level of manipulation. Thousands of glossy brochures have been distributed at protest meetings, to school children for projects and are available to anyone who is interested. However this "information" is in the same form as the advertisements and in the

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264 Southern Courier, 18th February 1987.

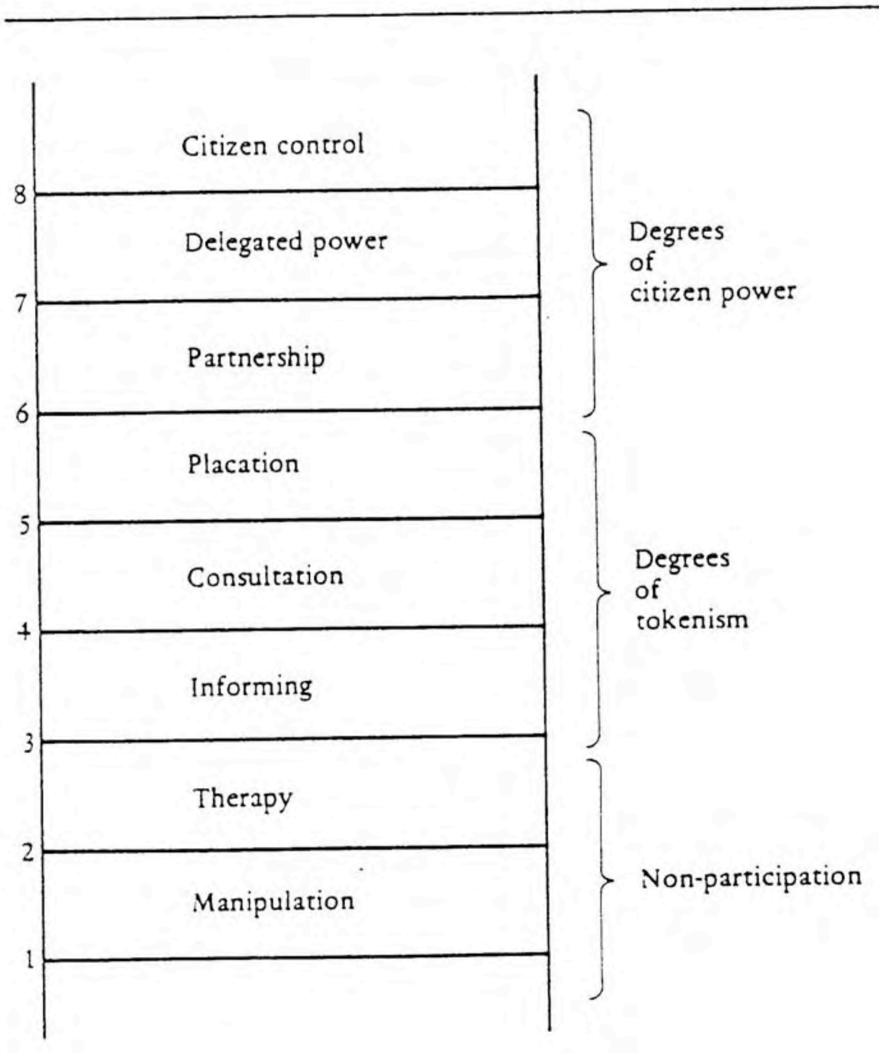
265 Sydney Morning Herald, 16th January 1989.

266 Sherry Arnstein, `A ladder of citizen participation', in Godfrey Boyle, David Elliot & Robin Roy, The Politics of Technology, Longman & Open University Press, 1977, p242.

267 ibid., pp243-4.

tradition of all good advertisements, the Board's advertisements have not sought to inform but rather to create an impression. Visually attractive pictures and text that stresses the good job that the Board is doing are accompanied by a careful use of language that emphasises key phrases designed to subtly reassure doubts that people might have and ensures an association with science and natural processes. Public relations employees carefully monitor the activities of opposition spokespersons and quickly repair any damage done through their superior access to the media. Their usual line is that there is obviously no cause for concern and those who suggest there is are portrayed as trouble makers, or well-meaning people mislead by the trouble makers.

Figure 9.6 EIGHT RUNGS ON A LADDER OF CITIZEN PARTICIPATION



Source: Sherry Arnstein, 'A ladder of citizen participation' in Godfrey Boyle et al., eds, The Politics of Technology, Longman & Open University Press, 1977, p. 240.

Recently the smooth operation of the Water Board's publicity machine has not been able to cope with a series of leaked documents and public airings of Board secrecy and coverups, as well as raised community consciousness of environmental matters. The new line of public response has been that, yes the Board has been remiss in the past but that has all changed now.

Many of the institutionalised avenues for consultation are of dubious strength and value. These include making submissions on Environmental Impact Statements and public hearings or inquiries. In each case there is no guarantee that real consideration will be given to members of the public putting forward their views in such cases.

> Mechanisms for public involvement may increase direct public influence on the formation of policy, or may merely inform policy makers about public concerns. More often they are a means to manipulate public opinion, to win acceptance of decisions already made, and to facilitate the implementation of these decisions. [268]

All this was true of the EIS's for the submarine outfalls. The public submissions were quickly dismissed since they could not hope to compete with the million dollar study carried out by Caldwell Connell and all seemed puny in comparison. The Board was able to gauge the concerns of the public by the submissions and hone in on them in their public relations efforts, particularly in the advertising campaign.

It is clear that the Sydney Water Board has, throughout its history, largely avoided consultation with and placation of the public. It has shown an obstinate face and relied on local business interests to quell any unrest over pollution. Recently the Board has resorted to a measure of placation because of the increased public pressure for participation. In 1987 they invited Greenpeace to to be on a committee that would have input into the Board's trade waste policy, although the Trade Waste Manager assured me that there was no committee, and that he, as the sole decision maker would be consulting various parties.[269] The Greenpeace representative found himself invited to meetings at which he was at a bit of a loss to follow what was going on and unable to exert any influence over the Board's trade waste policy. The Board, however, was able to publicise the fact that it was consulting with environmental groups.

At the end of 1988 the Board wrote to the Nature Conservation Council (a group which has not been involved in the issue since it made a submission on the EIS's in 1980) to invite representation on a committee that would advise on the submarine ocean outfall monitoring programme. Moreover, Judy Messer, president of the Nature Conservation Council, was appointed to the Water Board by the Minister, Tim Moore, during 1988. Whilst such representation is unlikely to affect decisions since in all cases the environmental representative only has one vote amongst several, the Board can claim that it consults with environmentalists. Recently Tim Moore has, in fact defended the Board's environmental credentials by referring to Messer's appointment.[270]

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268 Dorothy Nelkin & Michael Pollack, `The politics of participation and the nuclear debate in Sweden, the Netherlands, and Austria', Public Policy 25(3), Summer 1977, p334.

269 interview with Greg Klamus, Trade Waste Manager, M.W.S.&D.B., 2nd March 1987.

270 Sydney Morning Herald, 10th January 1989.

The SPCC has similar representation on its Clean Waters Advisory Committee with little effect. Nor does the SPCC seem any more willing than the Board to have the public participate in its decisions. In chapter 6 we saw how the classification process which allowed for some public input was abandoned. More recently when the criteria for quality of ocean bathing waters was revised, supposedly because of public pressure, there was no public consultation. In an attempt to stall its implementation it was suggested by the Clean Waters Advisory Committee that public comment be sought.[271]

The courts seem to be the only institutionalised setting that can effectively force action but legal action is expensive and the courts give a distinct advantage to those with best access to financial resources and information. Legal action is only effective if legislation is adequate to start with and courts tend to judge a case on legal technicalities rather than the environmental merits. This is definitely not a forum where values and priorities can be discussed. Moreover, as was discussed in chapter 6, the Clean Waters Act is not written so as to give the public a role in its implementation.

The media is really the only avenue open to groups with poor financial resources and even then the media reports events and is not inclined to report opinions unless they are the opinions of politicians or superstars. Credibility, as was mentioned previously, is a problem for the uncredentialled and the unaligned.[272] Informal activities, including protest activities that gain media attention, and pamphlets, which communicate directly with other members of the community, have some effect in mobilising concern in the community. Media attention seems to be fairly effective at pressuring the government to pressure the Board to implement their plans more quickly but seems to have very little role to play in deciding what it is that will be done, that is, what technology will be used.

The public has very little say in what technologies are used to collect, treat and dispose of sewage. At most they can complain, prompt politicians to promise improvements and get sums of money allocated to the problem. In general, the engineers get to pick the 'suitable' technology and will consider no interference with this decision which they feel only they have the expertise to make. Even the government seems unable or unwilling to interfere with the decision-making process. Government ministers and local government representatives are, like the public, manipulated by the propaganda and, lacking the ability or incentive to evaluate them, are too often taken in by the promises.

[271] Clean Waters Advisory Committee Meeting Minutes, September 10th 1987.
[272] Primack & von Hippel, Advice and Dissent, p244-246

CONCLUSION

The popular view of technological decision-making as a process in which decisions are made by experts using technical data[1] is not supported by the case study of the development of Sydney's sewerage system. Clearly, experts are not the only ones involved in the decision-making process and 'technical factors' are only part of a range of considerations. In addition it has been repeatedly shown that the term 'technical factors' is misleading since so-called technical issues and criteria of technical evaluation are themselves constructions. This study has clearly shown that an interactive and constructivist model of technological development is far more appropriate than a linear objectivist model because of the interweaving of social, political, economic and technical factors in the decision making process from the first conception of a technological project through to its implementation and operation.

Sydney's sewerage system was conceived within a social context which shaped its physical form. It was not constructed simply to improve the public health of those who lived in insanitary conditions. The push for sewers came from professional groups, bureaucrats and middle class people who were concerned about the economic and moral costs of dirt and disease, as well as the health risks to themselves. Heavily influenced by what was happening in Britain, the newspapers emphasised an association between sewage and drunkenness, prostitution, crime and vice. City slums became the focus of fears about radical political movements and revolution. The economic costs of lowered productivity from ill-health, charity to families made into paupers by the death of working parents, unpaid rents and vandalism were weighed against the heavy cost of sewers in a new city and the necessary increases in rates, which ratepayers were ever reluctant to pay. The advantages of government control and the imposition of order on the masses were balanced against *laissez-faire* principles of minimal government intervention popular at the time.

The argument for control and order reigned supreme in the end and the government took over responsibility for managing the city's waste products. The choice of technologies for this task was heavily influenced by the objectives set in the previous public debate over sanitary reform. Sewers were far more amenable to public control than dry conservancy schemes and achieved the goal of rapid and automatic removal of wastes from homes.

COMPETING TECHNOLOGIES AND THE PROBLEM OF CLOSURE OF DEBATE

The debate between water-carriage technology and dry conservancy methods is an example of competing technologies where artifacts were perceived differently by different social groups and therefore exhibited an "interpretative flexibility" as described by Pinch & Bijker.[2] It was the interpretation of water-carriage technology as modern, healthy and problem free which triumphed over an

[1] Ronald N.Giere, 'Controversies Involving Science and Technology: A Theoretical Perspective', in H.Tristram Engelhardt, Jr & Arthur L.Caplan, eds, Scientific Controversies, Cambridge University Press, 1987, P142.

[2] Wiebe Bijker & Trevor Pinch, 'The social construction of facts and artifacts: or how the sociology of science and sociology of technology might benefit each other', Social Studies of Science 14, 1984, pp 399-441.

alternative interpretation of water-carriage as polluting, unhealthy and wasteful of natural resources. Engineers also preferred water carriage technology which involved large scale excavation and construction of sewers as well as the centralization of sewage for disposal.

The dry conservancy enthusiasts were concerned that the nutrients in sewage be utilized to fertilise the land rather than pollute the waterways. This could be done more effectively if the wastes were not diluted in water and transported to a centralized point for disposal but were rather retained in their pure or in an improved form that could be more easily taken to where manure was most needed.

Some authors, including Pinch & Bijker, have sought to understand the choice of technology through understanding the different interpretations that various social groups attached to an artifact and the enrolment of opposing social groups by rhetoric and problem redefinition. In this case the closure of the debate cannot be so simply explained. The different value system which the dry conservancy advocates adhered to was not compatible with that of the water carriage advocates and closure never really occurred as far as they were concerned. The desire for utilisation of sewage remains strong in sections of the population more than one hundred years later despite the supposed closure of the debate by those in power. For many people the debate goes on today. Their approval or enrollment was, however, unnecessary to the implementation of water carriage technology.

The problem is that the power relationship is underplayed in many analyses of technological choice and this can lead to erroneous perceptions. Although the implementation of water carriage technology in Sydney was accompanied by rhetoric and attempts to enroll the public and redefine the problem, these do not seem to have been decisive in the final outcome. In fact these tactics were used by people advocating water carriage and people advocating dry conservancy. Similarly both sides were able to put forward experts and give statistics and figures to support their favourite schemes.

Timing was a significant factor in this dispute. Dry conservancy methods did not reach their peak of popularity until many sewerage systems had been constructed. Their popularity was a result, in fact, of the pollution of waterways that was perceived to accompany water-carriage methods. This lateness on the scene was an immediate drawback since sewers had been installed and had proven statistically to achieve immediate results in decreasing the mortality rate in areas where they were installed. Moreover, the existence of a physical infrastructure of pipes encouraged the continued use of pipes rather than the scrapping of an expensive and proven system in favour of a relatively unproven one.

Although Pinch and Bijker concentrate on varying interpretations of artifacts in terms of problems associated with them, artifacts can also be interpreted in terms of the opportunities which the artifact offers for control or power. This interpretation of an artifact may well be hidden behind rhetorical interpretations which are expressed. The government and public service engineers preferred a system that could be controlled and that was compatible with a centralised government bureaucracy staffed by experts. Water carriage brought sewage disposal within the engineering domain and gave them professional control over the field. Engineers also saw an opportunity to establish themselves as experts in the new field of sanitary engineering and to increase their role in city management.

The coalition of politicians, public officials and engineers was a powerful one. The debate which took place in the newspapers was peripheral and those with power did not bother to take part in it. Engineering reports and texts touched on alternatives to water-carriage in a dutiful but cursory manner in a token of respect for the notion of a pluralist, democratic society that allowed all voices to be heard. The engineers continued to design water-carriage schemes and the government continued to fund them. By the end of the century sewers were so clearly entrenched that the word "sewerage" had come to define human waste products.

Tristran Engelhardt and Arthur Caplan have nominated five categories of closure in scientific controversies by amalgamating those put forward by Tom Beauchamp and Ernan McMullin. The first is "closure through loss of interest" which corresponds to Beauchamp's "natural death closure" and McMullin's "abandonment".[3] This type of closure implies that a controversy ends because participants lose interest. No resolution or concensus has been reached but the issue has lost its importance or is no longer the focus of interest or controversy.[4]

A second category of closure is "closure through force". The controversy is ended although there is no rational basis for resolution. This may occur when an external authority declares a decision, or by the use of state power, or even the loss of funding.[5] Everett Mendelsohn also pointed out that closure is sometimes achieved when those who are weaker in political strength can be driven from the scene and, although they still maintain their position, they are unable to continue the open confrontation.[6]

These authors were dealing with scientific controversy but their analysis is relevant to technological controversy as well. In the case of the debate over sewage collection methods both these means of closure have occurred. A decision was imposed through the power of the state by the construction of sewers and the diversion of sewage from the harbour to Bondi and thereafter debate died. Dry conservancy methods lost their popular appeal because they were no longer seen to be attainable, but also because sewage farming seemed to offer an alternative way of utilising sewage.

The choice between sewage farms and ocean outfalls was very similar to that between water carriage and dry conservancy technology. Again the different objectives, utilisation of sewage or quick and easily controlled disposal, were involved. Sydney's sewage farm was seen by those in power as a short-term

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3 H.Tristram Engelhardt, Jr & Arthur Caplan, 'Patterns of Controversy and Closure: the Interplay of Knowledge, Values, and Political Forces' in Engelhardt & Caplan, Scientific Controversies, pp1-26.

4 Tom L Beauchamp, 'Ethical Theory and the Problem of Closure', in Engelhardt & Caplan, Scientific Controversies, p32.

5 Ernan McMullin, 'Scientific Controversy and its Termination' in Engelhardt & Caplan, Scientific Controversies, p78.

6 Everett Mendelsohn, 'Political Anatomy of Controversy in the Sciences' in Engelhardt & Caplan, Scientific Controversies, p101.

measure which would satisfy the public's desire for sewage utilization. It was argued that should the sewage farm be unsuccessful, the public would then readily accept the preferred option of the engineers and public officials. In this way the opposition could be enrolled. Their interpretation of water-carriage as wasteful needed expression before that enrollment could take place.

Nonetheless the sewage farm was also the cheapest option in the short-term and the infrastructure needed could mostly be used for the preferred scheme which it was envisaged would later be implemented. Had the sewage farm been uneconomical and inconvenient, the authorities would almost certainly have been less ready to go to such lengths to enrol the opposition. Nonetheless the sewage farm experiment was unsuccessful in achieving enrollment and closure in the long term. In a very real sense this debate goes on today and closure has never occurred and this fits McMullin's observation that the original disagreement still persists to some extent when closure is forced.[7]

The solidarity of the engineers on the issue of ocean outfalls was increasingly supported by evidence of failed land-based treatment experiments that had been poorly sited and quickly overloaded because of long term plans for ocean disposal. Moreover, as the years went by, a momentum was built up of a sewerage system directed towards the sea with a growing infrastructure and capital investment. In this way past decisions shaped later ones and all that concerted protest was able to achieve was diversions from one polluted spot to another. The power of the coalition of engineers and bureaucrats was cemented in the form of pipes and pumping stations.

PARADIGMS, SYSTEMS AND THE PROBLEM OF CHANGE

The three other categories of closure that Engelhardt & Caplan outlined are more relevant to scientific and technical communities; "Closure through sound argument", "closure through negotiation" and "closure through consensus". The two latter depend on social processes that occur between participants.[8] Beauchamp observes of consensus closure,

> Here it does not matter whether a correct or fair position has been reached. It does not matter whether, as a matter of justification and method, some point of view is well defended. Nor need principals believe that a permanent solution has been found, or even a definitive one. It only matters that there is consensus agreement that the force of one position has overwhelmed others. . . the weight of evidence might play no role at all in bringing about the consensus.[9]

The authority and control of engineers as experts in the field of sewerage management was assured through closure by consensus following the British Royal Commission into Sewage Disposal. The debates between engineers over sewage treatment technologies required a different form of closure from that which operated in the public arena because the relationships between opposing sides were different. Consensus occurred after the Royal Commission

7 McMullin, 'Scientific Controversy and its Termination', p79.

8 Engelhardt & Caplan, 'Patterns of Controversy and Closure', pp14-15.

9 Beauchamp, 'Ethical Theory and the Problem of Closure', p30.

recommended standards of effluent to be met and put an end to the search for ever better treatment methods. The Commission, with its prestige and influence, was able to define evaluative criteria that enabled sewerage engineers to work out an agreed paradigm of practice.

For many decades engineers have chosen sewage treatment solutions from a small range of technologies that are consistent with the water-carriage of sewage (in pipes) to a point adjacent to a waterway where the sewage effluent will be discharged. Alternative technologies which are decentralized, land intensive or based on utilization of sewage products have been ignored. The paradigm relied on dilution and gravity as primary mechanisms for dealing with sewage. It incorporated a philosophy of staged treatment, whereby treatment was to be installed stage by stage so that at any one time only a minimum amount of treatment would be installed. As public complaints and political pressure increased, then a bit more treatment would be done. This delayed the agony of public spending.

Engineers minimise their designs as part of an inbuilt engineering philosophy but the incorporation, in engineering design, of economic priorities that enable engineering projects to be built with a minimum of materials, labour and capital and so ensure profits are maximised may be misplaced in this sort of application where other goals are supposed to be paramount. In other fields of technological development the search for reduced costs can promote technological innovation but in the field of sewerage engineering the temptation is to reduce costs by reducing efficiency rather than by innovating.

In its own way the philosophy of staged treatment was a recognition by engineers that the "efficacy" of treatment methods was socially constructed and therefore variable and they were making provision for changing public perceptions of what was "good enough". The skill of the engineer lay in being able to choose a minimum form of treatment from the paradigm and convincing the public that this was all they required.

Sedimentation came to dominate as a primary treatment. Although chemical precipitation was more effective at removing suspended solids and sedimentation was no cheaper when full treatment was considered, sedimentation was adequate as a treatment when combined with a secondary biological treatment to satisfy the standards recommended by the Royal Commission for disposal to rivers and it was cheapest as a single stage treatment. Therefore sedimentation became the accepted primary treatment although it was also used without further treatment for ocean disposal. More recently the Sydney Water Board together with its consultants have come up with a way of reducing primary treatment even further as part of the continual engineering quest for minimising treatment technologies.

Because of staged treatment, sewerage technology exhibits what has been referred to by some writers[10] as a 'trajectory' which is particularly persistent. The trajectory projects into the future the socially constructed characteristics of the system acquired in the past when the physical

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10 Giovanni Dosi, 'Technological paradigms and technological trajectories', Research Policy 11, 1982, pp147-162; Richard Nelson & Sidney Winter, 'In search of useful theory of innovation', Research Policy 6, 1977, pp56-60.

components were designed.[11] At present Sydney's sewerage system has a physical and figurative trajectory out to sea. Nelson and Winter also suggest there are more general trajectories common to a wide range of technologies. Two which they mention are latent scale economies and increasing mechanisation of operations.[12] Both of these can be observed in Sydney's sewerage system.

The general trajectory of mechanisation or automation was noted earlier in this chapter to have influenced the choice of water-carriage technology. The increasing centralisation of Sydney's sewerage, which has been perceived to be the cheapest option not directly because of economies of scale but because it has always been cheaper in the short term to use the existing facilities. This has caused massive overloading of the three main sewage treatment plants in Sydney, a resultant sewage flow which is too large and too heterogeneous to be able to treat properly and the discharge of raw sewage into all of Sydney's waterways through sewage overflows every time it rains heavily.

The engineering paradigm has played a key part in the larger technological system, which includes legislation, bureaucracies, industrial interests, health authorities etc. The commitment of both organisations and their experts to existing systems can also be found in other social groups such as educational institutions and manufacturing companies. Moreover vested interests are compounded by fixed assets and sunk costs. All these factors add to the momentum which a system accumulates.

The sewerage system in Sydney, like other systems, has grown to have its own considerable momentum. The Metropolitan Water Sewerage & Drainage Board is a very large organization dedicated to the system and its engineers are skilled in the sewage collection, treatment and disposal methods that have been in use most of this century in Sydney. The relevant professional associations support current sewerage engineering practice. Australian universities teach these methods and radical alternative methods are not researched either in government or private industry, except where firms outside the system can see some profitable use can be made of their own products and skills. (for example CIG and its in-sewer oxygen treatment).

Moreover the fixed assets and sunk costs, the physical infrastructure is a powerful conservative force. Because engineering practice incorporates cost minimisation, engineers are always keen to make use of whatever is available to them in terms of natural and 'man-made' resources in their efforts to minimize costs. There is a great reluctance to tear down existing treatment plants and start again. An old treatment plant will have involved a large capital input when it was first built and will probably be achieving some results, even if those results are unsatisfactory. Even if new methods were developed engineers would in most cases prefer to improve or upgrade or augment the existing facility.

The role of engineers in the technological system has been a decisive one. The autonomy of the engineering community lies in its ability to dictate the range

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[11] Thomas Hughes, Networks of Power: Electrification in Western Society, 1880-1930. John Hopkins University Press, 1983, p140.

[12] Nelson & Winter, 'In search of useful theory of innovation', p58.

of technologies which will be taken seriously. Outside authorities may set standards and regulate the available money but the engineers decide how to meet the standards and if they can be met with the finances available. The community may demand a higher level of treatment but they would have great difficulty in getting alternative treatments from outside of the paradigm accepted.

The dependence of standards on concepts of "best practicable technology" also gives a great deal of autonomy to the engineering profession in determining appropriate technology and thereby supports the existing paradigm. Moreover, measures of efficacy and evaluative criteria are largely shaped by engineers, both overseas and in the major sewerage authorities in Australia. On top of this the Sydney Water Board has a great deal of power and political influence because of alliances with other polluting organisations and because of the dependence of the SPCC on the Board's acceptance of industrial waste to protect more sensitive parts of the environment.

Engineers are clearly powerful when aligned with powerful organisations. They are nevertheless employees and subordinate in every sense of that word; dependent on their employers for continued employment and promotion. Whilst they are loyal they are rewarded and given influence, and their commitment to the technological system is assured. In return they remain anonymous and must pass their technical advice upwards, in confidentiality, "to separate decision makers, foregoing any explicit rights in policy making".[13]

However, engineers are able to implicitly influence policies through the advice they give. They have the ability to manipulate non-engineers through their construction of engineering knowledge. As much of the work in the social studies of science has shown, scientific knowledge embodies social objectives, values and ideologies. Similarly, and perhaps even more so, engineering knowledge is shaped by social choices as to what data should be collected and how the results should be interpreted. Sewerage engineers have from the beginning purposely put together studies with end purposes in mind, being careful to gather only information that helped to promote their projects and justify them. In recent years, using computer models and complex scientific-like investigations, they have been able to put together a knowledge base that lay people find difficult to challenge. Where, in the case of the Sydney Water Board, policy makers are politicians or Board members, who are not appointed for their ability to understand engineering knowledge, engineers are able to control the options that are considered and present their preferred option as the most favourable.

The sewerage engineering paradigm and accompanying knowledge base not only allow engineers to make overly optimistic predictions about whether their projects will "work", but they are able to manipulate the definition of the term to support their later claims that they do "work" once they are built. The "testability tradition" which Edward Constant has referred to[14] in the case of sewage disposal is based on suspended solids, biological oxygen demand and more recently faecal coliform levels but these do not take account of more

[13] Barry Barnes, About Science, Basil Blackwell, 1985, p100.

[14] Edward Constant, 'Scientific theory and technological testability: science, dynometers, and water turbines in the 19th century', Technology and Culture 24(2), April, 1983; 183-198.

recent developments in scientific knowledge or more recent dangers posed by sewage disposal.

The problems associated with sewage disposal, such as those created by toxic chemicals and viruses are hard to prove, invisible, and their effects are long-term. Environmentalists have a difficult job convincing the public that problems, which are not visually obvious, do exist. Even if they achieve this the public, like the authorities, tends to readily accept the bounds of technological possibility that the 'experts' put forward. The experts believe these bounds themselves.

Sewerage engineers and the authorities which regulate them only recognise certain problems. Hughes has utilized the term "reverse salients" to describe the situation when components of a system fall behind or out of line.[15] These reverse salients may be observed by engineers or the organisations for which they work, and they are redefined as a set of critical problems which the engineers believe they can solve, without radically altering the system. Constant identified "presumptive anomalies" which are presumed to exist when it is predicted by the engineer that a conventional technology will fail under certain future conditions or it is predicted that an alternative technology will do a better job. The second type of anomaly which Constant identified is the "functional-failure" when the technology does not work very well because conditions have changed, allied technologies have changed or other parts of the system have advanced more quickly.[16]

The recognition of a reverse salient or an anomaly, however, depends on the willingness of the technological community or the regulating authority to recognise problems which can be just as subject to interpretative flexibility as artifacts. In other words, reverse salients, functional failures and presumptive anomalies are social constructions rather than realities which emerge and force change.

David Wojick argued that anomalies occurred when standard procedures repeatedly "fail to eliminate known ills" or when knowledge shows up the importance of factors which have previously been incorrectly evaluated. Those contesting the evaluation policy may be outside the paradigm community and their view may be disputed. They can then, Wojick says, turn to the government for a ruling.[17] The question is, does the government listen to them or to the engineers?

Sydney's sewerage system has been perceived by various social groups to be suffering from both functional failure and presumptive anomalies, despite the engineers' faith in the paradigm. In the decades since the system was established the composition of the sewage has changed substantially with the growth of industry and the increased use of inorganic and artificial materials in industrial processes. Conventional sewage treatment methods are

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[15] Thomas Hughes, Networks of Power, chapter 4.

[16] Edward, Constant, 'Communities and hierarchies: structure in the practice of science and technology' in Rachel Laudan (ed). The Nature of Technological Knowledge: Are Models of Scientific Change Relevant?. D.Reidel, 1984, p31.

[17] David, Wojick, 'The structure of technological revolutions' in George Bugliarello & Dean Boner (eds), The History and Philosophy of Technology, University of Illinois Press, 1979, pp244-6..

aimed at removing suspended solids which will settle out of the effluent and breaking down organic material with the use of naturally occurring microorganisms contained within the sewage and in the environment. These methods do not remove or treat viruses, toxic chemicals, heavy metals, organochlorines or most of the grease and oil that is contained in the sewage. In fact some of these substances actually interfere with the microorganisms necessary for secondary and tertiary treatment, killing them off and turning whole batches of sewage 'off'.

Conventional treatment methods were not designed to eliminate pathogens from the sewage, but rather to prevent the waterways becoming a nuisance after the treated effluent was discharged into them. The paradigm was set before viruses were discovered. As a result, although sewage may contain as many as 110 different types of virus, conventional sewage treatment processes cannot be counted on to remove them.[18] Primary sedimentation does not remove viruses or pathogenic bacteria at all. A representative of the World Health Organisation remarked over a decade ago that

> The sanitary engineer who built the early community sewage and water systems did not know about viruses; which is understandable, but many modern sanitary engineers still do not know about viruses; which is neither understandable nor excusable.[19]

Changing community expectations have also created problems for the paradigm on two levels. The public is far less tolerant of the degradation of recreational facilities and more willing to pay for higher degrees of treatment but many treatment plants built when sewage flows were smaller and public expectations lower do not have the space available nearby to expand and incorporate, for example, secondary treatment. This has lead to a solution for ocean outfalls of extending the outfalls under the sea for a few kilometres. Such an ad hoc solution aims at keeping the sewage from view by discharging it at greater depths where it will be more dispersed and may be kept beneath the surface some of the time.

The other change in community expectations arises from the greater environmental awareness that has been manifest since the 1960's and 70's. This awareness has meant that the public is not only concerned with their own health but also with the preservation of river and marine environments and the species that live in them. Very little research has been done into the effects of sewage, especially industrial wastes, on such ecosystems and the consequences of bioaccumulation of certain substances up the food chain.

Sewerage engineers have refused to recognise the full implications of all these problems for their paradigm and have hidden any evidence of environmental problems, such as the accumulation of heavy metals and organochlorines in fish. To the extent that public lobbying of environmentalists have forced them to take notice of these problems they have sought solutions which do not require any radical innovations or changes to the system. They cope with changed situations

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18 Sagar Goyal et al, 'Human pathogenic viruses at sewage sludge disposal sites in the Middle Atlantic Region', Applied and Environmental Microbiology 48(4), 1984, p758.

19 Joseph Melnick, 'Viruses in water: An Introduction' in Gerald Berg et al (eds). Viruses in Water, American Public Health Assoc, 1976, p4.

as best they can by upgrading existing treatment plants, moving points of discharge and adding further stages of treatment to the paradigm.

The problem of industrial wastes is denied by engineers to be a major problem. On the other hand grease is admitted by engineers to be a major problem for swimming beaches near sewage outfalls because the grease, which forms a floating slick on the surface of the sea, makes the sewage field highly visible and leaves obvious traces in the form of grease balls on the sand. Some grease is removed from the sewage during sedimentation treatment by skimming the floating grease from the surface of the sewage in the tank. This has caused engineers to note the inappropriateness of the treatment paradigm,

> most primary treatment plants do a much better job of removing settleables than removing floatables. It would be much better if this were the other way around.[20]

The concern with visibility of the sewage field is substantial because the engineers recognise that performance will be judged by the lay public mainly on what they can see. Without visual indicators, the public has to rely on accepted testing or evaluation procedures for sewerage technology. These, rather than pointing up any functional failure, tend to hide it. Because the paradigm does not specifically deal with viruses or pathogenic bacteria, their presence is not monitored. Authorities, who will not set standards that cannot be met by the available technology, set standards for bathing waters in terms of concentrations of these faecal coliforms which are generally agreed not to correlate statistically with viral counts.

Engineers, as system builders, are able to prevent the system from being radically changed, partly, as Law[21] and Callon[22] have described, by the way they view these systems as being constituted of a number of components which may be animate and inanimate ranging from people, to skills, to artifacts, to natural phenomena. The engineer puts up no barriers between the social, the economic and the political. The engineer, as system builder associates these disparate elements into a form that holds together. Law and Callon argue that engineers treat these various components or elements in the same way, always seeking to change the most malleable and adapting to take advantage of the most durable, in an effort to sustain and hold together the system and achieve the system goals. One thing that Law & Callon do not make clear is that the system goals may become related more to preserving the system than to the original goals that it was set up to achieve.

When faced with a problem that threatens the stability of the system, the engineer, rather than considering building a new system, tries to rearrange or manipulate the system components or perhaps to incorporate a hostile

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[20] Paul Ryan, <u>Submarine Ocean Outfall Sewers</u>, internal SPCC report, undated, p11.

[21] John Law, 'Technology and heterogeneous engineering: the case of Portuguese Expansion' in Wiebe Bijker, Thomas Hughes and Trevor Pinch (eds), <u>The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology</u>. MIT Press, 1987, pp111-134.

[22] Michael Callon, 'Society in the making: the study of technology as a tool for sociological analysis' in Bijker et al, <u>The Social Construction of Technological Systems</u>, pp83-106.

environment.[23] If certain social groups are placing importance on problems that are not perceived to be soluble within the system, the engineers may be more likely to concentrate on manipulating or enrolling or discrediting those social groups or reducing their impact rather than coming up with a radical solution to the problem.

In the case of the sewerage system, laws can become, rather than implacable constraints to be heeded, rules that can be variously interpreted and full of loopholes to be utilised; regulatory bodies become open to persuasion and education; and the public becomes an element in the system to be manipulated. For this reason, it is not surprising that the Sydney Water Board is spending massive sums of money on public relations. The compromises built into the legislation and the lack of public input give it enough flexibility to allow its administration to become a negotiation process that can be manipulated by powerful organisations like the Sydney Water Board. Moreover the staffing of the SPCC by engineers and the composition of advisory committees and the Commission with people who adhere to the system have ensured that the legislative process has become part of the system rather than part of the environment of the system.

EXPERT ADVICE AND THE PROBLEM OF POLITICAL AND PROFESSIONAL BIAS

The efforts of engineers to predict and mould public opinion is part of engineering activity and clearly this activity makes any separation of the social and technical unrealistic. Callon, for this reason, has described engineers as sociologists. This is particularly true of sewerage engineers who aim, not so much at being able to predict the acutal performance of the technology they are designing as the perceived performance of that technology. But they also try and control that public perception as well through their predictions and later denials. Engineers treat people like the inanimate parts of their system, as elements to be shaped rather than influences to be listened to. They generally don't like unpredicability and prefer order and control.[24] They attempt to manage public reactions just as they attempt to control nature and various other unpredictable parts of their systems.

The notion of public participation in decision-making and the idea that everyone has a legitimate right to influence public engineering decisions are anathema to the engineer's professional self identity and a threat to expert status. The self-image of engineers as having superior knowledge, being logical thinkers and having a special ability to combine practical matters, such as economics, with theoretical scientific principles means that they see themselves as uniquely able to control public works and solve social problems through the application of scientific principles.

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23 Thomas Hughes, 'The evolution of large technological systems' in Bijker et al, The Social Construction of Technological Systems, p53.

24 A.J.Kirkman, 'The Communication of Technical Thought' in E.G.Semler, ed, The Engineer and Society, Institution of Mechanical Engineers, London, 1973, p182; Robert Perrucci & Joel Gerstl, Profession Without Community: Engineers in American Society, Random House, New York, 1969, pp51-52; William Davenport & Daniel Rosenthal, Engineering: Its Role and Function in Human Society, Pergamon Press, 1967, p73.

Engineers have opposed increased public participation arguing that it would lead to worse decisions. Good decisions are seen as those that lead to more cost-effective solutions. Alternatives can be considered and impacts appraised by weighing the facts, making calculations and predictions and quantifying the benefits and risks. This, it is argued, takes special education, information and experience which the public do not possess.[25] The "ordinary consumer is not generally deemed to be able to appreciate what goes on in science and technology".[26]

Most engineers work in large organisations or bureaucracies. By having control of the intellectual resources and often the organisational resources within those bureaucracies they hold a good deal of power.[27] They are able to filter information reaching the top management or boards and to define the range of options from which those in charge can select, being careful to present the options os that their preferred option is most attractive.[28]

The tendency towards elitism in decision making that engineers have is reinforced by the bureaucratic mode.

> Bureaucracies tend to be secretive, self-serving, non- imaginative, non-risk taking, and susceptible to functional lying....In their relationships with the public, bureaucracies withhold certain kinds of unpalatable information or deliver information in such a way that it distorts facts.[29]

Over the years bureaucracies establish operating procedures and solidify relationships with other institutions which constrain the flexibility of the organisation and limit the options that the bureaucracy will consider.[30] Public bureaucracies in particular can become concerned with maintaining and expanding their control and power rather than achieving specific objectives in serving the public.

Most of the population respect and acquiesce to those who claim to have specialised knowledge. [31] In a complex society with a division of intellectual labour, such relationships are necessary. The abstraction and generalisation that are characteristic of scientific knowledge are necessary in dynamic societies where social and technological change occurs rapidly. Social relationships require trust and the granting of authority to those with specialised knowledge is

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[25] Stuart Umpleby, `Is greater citizen participation in planning possible and desirable?', in Godfrey Boyle, David Elliot & Robin Roy, The Politics of Technology, Longman & Open University Press, 1977, p234.

[26] Leslie, Sklair, `Science, technology and democracy' in Godfrey Boyle, David Elliot & Robin Roy, The Politics of Technology, Longman & Open University Press, 1977, p173.

[27] Joseph, Coates, `Why Public participation is essential in technology assessment', in Boyle et al, The Politics of Technology, p186.

[28] Joel Primack & Frank von Hippel, Advice and Dissent: Scientists in the Political Arena, Basic Books, New York, 1974, p38.

[29] Coates, `Why Public participation is essential in technology assessment', p186.

[30] Primack & von Hippel, Advice and Dissent, pp38-9.

[31] Lauriston King & Philip Melanson, `Knowledge and Politics: Some experiences from the 1960s', Public Policy xx, Winter, 1972, p84.

necessary for such society to function.[32] The boundary between granting experts sufficient authority and too much is a fine one however.

It is not only knowledge but also assumptions of rationality and objectivity which lead the public to look to experts for advice and solutions.[33] The public increasingly judges claims to expertise in terms of credentials; academic qualifications and those granted by professional societies. Often however, education is a socialisation process concerned with producing compliant and diligent employees who possess the required middle class values and can be trusted in positions of responsibility.[34]

Membership of professional engineering societies is also based on academic qualifications, references, usually from employers, and responsible work experience, which is dependent on the degree of trust placed in the employee by the employer. This trust has as much to do with loyalty and willing subordination to the employer as with competence and specialised knowledge[35] and these are qualities which do not lead to objective non-partisan advice.

More importantly, credentials may not be specific to the subject area in question and engineering knowledge in particular may not be specific to the problem being publicly discussed. In terms of sewage disposal, commonsense and observation have often proved to have been every bit as valid and accurate (if not more so) in predicting where sewage would go once discharged to the ocean as the knowledge gleaned by engineers from their specially constructed scientific models, float experiments and specialist observations. It has recently been admitted by the authorities in Sydney that common observation is the best way of telling whether the sea is polluted. This comes after years of experts denying the validity of such public observations and will probably disappear once Surfline has gained control over expertise in this area.

Moreover, the technical aspects are only one part of the decision-making process which inevitably involves a weighing up of benefits, costs, values and priorities. There is no reason why technically trained people would be the best at making the final decision, in fact the very specialisation of an expert could well ensure that he or she has a far too narrow view to be able to make good, broad ranging, far seeing decisions.[36]

Whilst credentials may indicate a certain level of education and work experience, they are no guarantee of rationality or objectivity. Engineers, like scientists, have sought to portray themselves as non-political, non-partisan, neutral

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[32] Randall Albury, The Politics of Objectivity, Deakin University Press, 1983, p44; Barry Barnes, About Science, Basil Blackwell, 1985, pp82-3.

[33] Dorothy Nelkin, `The political impact of technical expertise', Social Studies of Science 5, 1975, p36.

[34] Randall Collins, The Credential Society: An Historical Sociology of Education and Stratification, Academic Press, 1979.

[35] Robert Zussman, Mechanics of the Middle Class: Work and Politics Among American Engineers, University of California Press, 1985, p158; Peter Whalley, The Social Production of Technical Work: The Case of British Engineers, MacMillan, 1986, pp58-9.

[36] Leslie Sklair, `Science, technology and democracy' in Boyle et al, The Politics of Technology, pp173-4.

experts.[37] Nevertheless engineers on public works have necessarily had a close association with those in government. As employees, engineers have sought to fulfil the goals and objectives of those in power and they act openly as advocates of particular engineering schemes.

The dependability and truth of what experts say rests partly on the perceived norms of science, which include the search for truth, honesty and peer review. Such norms, even if they work well when it comes to research work and publication of results, are often not operative for scientists in a public arenas where different conventions and rules can "require them to adopt and defend firm conclusions" despite the existence of uncertainties.[38]

> The layman however is not usually aware that the scientist in such a situation is speaking without that control over his statements. The setting of the courtroom or public hearing of a legislative committee in which scientists speak to laymen, and in which expert witnesses do not criticise one another as they would in the scientific community, permits recommendations made by persons who claim scientific expertise to go unchecked by other experts.[39]

For engineers, there is no norm of truth seeking or peer review, in fact commenting on another engineer's work is considered to be unethical. The solidarity of engineers in the public arena is quite marked, when compared with scientists, for this very reason. Engineers are concerned firstly about their individual status and then about the collective status of engineers and it is often more important not to tarnish that status in the public eye with criticism of other engineers or open disputes between engineers, than to ensure that the truth is revealed.

Moreover engineering work is judged by its effectiveness or ability to achieve the desired goals of employers rather than by professional standards. Publication is not the route to recognition and the details of an engineers work are not usually made public. Engineering codes of ethics, unlike the norms of science, are not part of the self identity of practitioners and they are notoriously loose and difficult to enforce.[40]

The difficulty with enforcing any peer pressure is that engineers give their first allegiance to their employers, to whom they look for career advancement and recognition. Professional control over behaviour is displaced by control in the

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[37] David Noble, The Forces of Production: A Social History of Industrial Automation, Knopf, New York, 1984, p42; Stanley Schultz & Clay McShane, `To Engineer the metropolis: Sewers, sanitation and city planning in late- nineteenth century America', Journal of American History LXV(2), Sept 1987, p399.

[38] Arie Rip, 'Experts in Public Arenas', in Harry Otway & Malcolm Peltu, eds, Regulating Industrial Risks, Butterworths, 1985, p95.

[39] Duncan MacRae, Jr, `Technical communities and political Choice', Minerva xiv(2), Summer 1976, p173.

[40] A.M.Stretton, `Questioning professionalism', in The Engineering Conference, Proceedings of Institution of Engineers, Australia conference, Hobart, 22-26 February 1982, p14; Kenneth Prandy, Professional Employees: A Study of Scientists and Engineers, Faber & Faber, London, 1965, p82.

workplace[41] and this involves quite a different set of behavioural rules, directed at achieving the goals and objectives of the employer rather than displaying objectivity and rationality.

A study of American engineers in the late 1960s found that

> regardless of the extent of administrative duties, level of technical responsibility, and level of supervisory responsibility, engineers are most likely to select "immediate superiors" as the group whose judgement should count most in evaluating the professional performance of engineers.[42]

Preferences after immediate superiors went to fellow engineers, then consumers, then leaders of professional associations with community leaders in last position. The community therefore cannot expect to get objective, truthful nor non-partisan advice from experts employed by private companies or public authorities. It has been observed

> Where particular policy areas become intensely polarized, the "knowledge" drawn into the conflict is likely to mirror the contending positions in the conflict rather than transcending the values at stake.[43]

Not only is expert advice likely to be biased because it is bought but also because the expert will have professional predispositions and biases and also their own personal political views, values and priorities which will be reflected in the advice given.[44] Advisory committees or independent experts might be able to overcome the problem of individual personal biases and the problems of loyalty to a particular organisation but the professional biases of experts still predominate.

> People used to working and thinking in a certain discipline, and who thus tend to see issues in the context of that discipline, inevitably base their advice on a certain set of implicit technological, social and political assumptions.[45]

It is not surprising that on the occasions when the NSW government have called in independent engineers to assess decisions, be they the Sewage and Health Board engineers' decisions or the Water Board engineers' decisions, they have been supportive of the positions taken by the partisan engineers since the choices dictated by an engineering training are necessarily narrow and the economic constraints are universally applied. Similarly, a separate organisation such as the SPCC, set up to regulate the Board's activities, will have very few points of difference with the Board because of its similar reliance on engineering expertise.

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[41] William Rothstein, 'Engineers and the Functionalist Model of Professions' in Robert Perrucci & Joel Gerstl (eds), The Engineers and the Social System, John Wiley & Sons, 1969, p89; Edwin Layton Jr, The Revolt of the Engineers: Social Responsibility and the American Engineering Profession, Cape Western Reserve University, Cleveland and London, 1971; Prandy, Professional Employees, p123.

[42] Perrucci & Gerstl, Profession Without Community, p118.

[43] King & Melanson, `Knowledge and Politics', p93.

[44] Barnes, About Science, pp106-7.

[45] Primack & Von Hippel, Advice and Dissent, p121.

Advisory committees are often set up to reflect appropriate biases by careful selection of members. The setting up of the Clean Waters Advisory Committee is one example which promoted lively parliamentary debate over the extent of government department and industrial representation. Token representation of unions and environmentalists does not provide any real say to these groups and the appointment of these representatives can further subvert the voice of potentially threatening groups. For example the first conservation representative of the SPCC also happened to be on the Board of ICI and was disowned by the environment movement.

A further bias in the setting up of advisory committees can occur because of the avoidance of any experts who have taken a strong public stand on an issue. This also can result in a bias towards the status quo since experts who have never taken a public stand will generally be those who agree with the status quo or who are too frightened to speak out against it.[46]

Government decisions are often defined as technical decisions and the issues at stake also as primarily technical. This is more comfortable for the policy makers.[47] In this way, the decision appears to be subject to objective criteria that can be evaluated by the experts using economic and scientific models, calculations and statistics.[48] Difficult issues such as conflicting interests do not have to be resolved and the alternatives can be compared solely on the basis of cost and effectiveness in solving the immediate problem.[49] It has also been argued that by focussing increasingly on technical issues "we are diverted from more significant and fundamental issues and even start to lose our capacity to deal with them." [50] Expertise in ethics, morals and values is not recognised and these aspects of life are considered to be a matter of opinion.[51]

Moreover, people have in the past treated technological change as inevitable and irresistible to a far greater extent than any other sort of change,[52] especially since technological change has been synonymous with progress. Certainly, Sydney's first sewers were greeted as a step towards greater civilisation and in rural towns all over Australia, people without sewerage systems regard their septic tanks as backward and primitive.

Defining a problem as technical also conveniently hides the political choice and priorities involved and reduces the arguments to arguments over technical details.[53] Those who control "certified expertise" hope that by defining the issue as non-political they can avoid being embroiled in a public debate.[54] Proposals

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46 ibid., p121.

47 Dorothy Nelkin, `The political impact of technical expertise', Social Studies of Science 5, 1975, p36.

48 Dorothy Nelkin (ed), Controversy: Politics of Technical Decisions, Sage Publications, 1984, p18.

49 Nelkin, `The political impact of technical expertise', p36.

50 Barnes, About Science, p101.

51 ibid.

52 James Carroll, `Participatory technology', Science 171, 19 February 1971, p648.

53 Harvey Brooks, `Scientific concepts and cultural change', Daedalus 94(1), Winter 1965, p68.

54 Brian Martin, 'Analyzing the Fluoridation Controversy: Resources and Structures', Social Studies of Science 18, 1988, p337.

can be "thrust upon the public as if they were noncontroversial technical decisions" and without policy makers appearing to be arrogant or undemocratic in doing so without open debate.[55] The justification of major policy decisions in terms of "some purportedly objective knowledge" is seen to be necessary in representative systems.[56] Unspoken objectives such as maximising economic growth and priorities afforded to industrial concerns do not become explicit. Opposition can then be labelled emotional or politically biased, ignorant or irrational.[57]

In this way the debate over sewage reuse can be contained by arguments over the economic value of sewage as fertiliser or water and the philosophical debate over use of resources and sustainability can be avoided. The use of the sewers for trade waste can be discussed in terms of what concentrations of which chemicals the sewerage system can cope with and thereby the debate over the provision of cheap disposal facilities to industry can be by-passed.

It is not to be assumed that experts are fooled by the pretensions that a problem is totally technical. Most engineers are fully aware of the political dimensions of the decisions they make and the advice they give but they cannot make those political dimensions obvious for fear of undermining the faith others have in expertise.[58] They must appear to be apolitical for after all they are not elected and it is their perceived neutrality which allows them to have power.

> a principle function of the apolitical definition of the policy expert's role is the exact opposite of the definition: it provides access to social power without political election.[59]

Decision-makers can make use of the esteem given to expert knowledge and the status given to science in order to justify, legitimise and gain acceptance for their decisions and to give the impression that their decisions have a sound and certain basis.[60] This does not mean that the technical considerations were foremost in making the decision. Rather "specialised knowledge merely becomes another weapon in the decision-maker's political arsenal"[61].

By keeping issues confined to technical discussion, not only do policy makers avoid making their objectives and priorities explicit but they ensure that any argument is confined to an arena in which experts have authority. If it is admitted that a decision has social and political dimensions then it is much more difficult to maintain that only scientists and technologists should discuss and influence it.[62] In this way policy makers are able to use expert judgement to

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[55] Dorothy Nelkin & Michael Pollack, `The politics of participation and the nuclear debate in Sweden, the Netherlands, and Austria', Public Policy 25(3), Summer 1977, p355; Martin, 'Analyzing the Fluoridation Controversy', p337.

[56] Randall Albury, The Politics of Objectivity, Deakin University Press, 1983, pp6-7.

[57] Dorothy Nelkin, `Scientists in an environmental controversy', Science Studies 1, 1971, p254.

[58] Guy Benveniste, The Politics of Expertise, Croom Helm, London, 1972, p62.

[59] ibid., p65

[60] Rip, 'Experts in Public Arenas', p96; King & Melanson, `Knowledge and Politics', pp88-9

[61] King & Melanson, `Knowledge and Politics', p100.

[62] Sklair, `Science, technology and democracy', p174.

justify their decisions and in any dispute they have an advantage because of their superior access to experts and technical information.

Organisations are able to consolidate a monopolistic position by either acquiring widespread external professional consensus on their proposals or by "creating a large integrated research team whose advice cannot easily be dismissed".[63] The Water Board acquires widespread external professional concensus by using consultants with a good reputation who are unlikely to be questioned by fellow engineers. The use of people with international reputations in the field of submarine ocean outfalls to support the Sydney Water Board proposal has made it virtually impossible for other engineers with lesser reputations or reputations in other areas to credibly question the proposal and they are unlikely to do so, whilst adhering to the whole concept of specialist expertise.

Public access to debate is further limited by the use of specialist jargon and making reports overbearingly and unnecessarily technical and esoteric.[64] Popularisers of scientific and technological fields inevitably meet with displeasure and have low status within expert communities because they are opening up fields which the experts would prefer to be incomprehensible to the public.

By hiring their own experts opponents can either question the evidence put forward by government experts or point to evidence that has been ignored. Debate, however, tends to remain focussed on technical issues rather than the conflicts over values and priorities which are really at the heart of any disagreement.

> Thus power hinges on the ability to manipulate knowledge, to challenge the evidence presented to support particular policies, and technical expertise becomes a resource exploited by all parties to justify their political and economic views.[65]

When the Sanitary Reform League was formed in 1880 to oppose water carriage and ocean discharge of sewage it utilised expertise in the form of written papers and texts, mainly from overseas sources. The members were thus able to inform themselves and use the authority of selected experts to counter the experts quoted and retained by the government. This was easier before engineers took over the field and formed their consensus. Since the formation of a sewerage treatment paradigm it is difficult to find alternative experts in the field.

Occasionally engineers have anonymously voiced their doubts about a particular sewerage proposal but any public expert opposition, and it has been rare, has come from outsiders. Most recently, public expert opposition to the extended ocean outfalls has come from a retired engineer, Bob Brain, who felt he was badly treated by his previous employer but nonetheless had much confidence in his competence in the area in question,Tom Mullins, a marine chemist with the NSW Institute of Technology, and most recently John Easey, a scientist with the Australian Nuclear Science and Technology Organisation. Stop the Ocean

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63 Benveniste, The Politics of Expertise, p126.

64 Sklair, `Science, technology and democracy', p173

65 Nelkin, Controversy, p17

Pollution, the main opposition group to the extended outfalls, has mainly had to draw on expert opinion from written sources, especially overseas sources. Even so they have had difficulty in acquiring the credibility that is accorded to those with qualifications.

The formation of the paradigm has ensured that engineers have become the 'endorsed' group when it comes to sewerage technology. Brian Martin has pointed out that extent of official endorsement a group has will effect their strategy in a controversy. The 'endorsed' group relies on their authority, preferring to avoid or deny any scientific disputes, whereas challenging groups uses the existence of any scientific disagreement to argue for an examination of the evidence.[66] In the sewage treatment debate, the Sydney Water Board has presented knowledge claims about health risks of swimming in polluted water, for example, as uncontroversial whereas opponents such as STOP have highlighted the debate between scientists over the issue and called for epidemiological studies to be carried out in Sydney.

It is useful for policy makers to have controversial decisions legitimised by prestigious experts. In NSW in the nineteenth century when a proposal to put the sewage out at Ben Buckler Point, Bondi, was met with public opposition, an eminent English engineer, W.Clark, was called in to supply expertise and authority to support the proposal, which was opposed because of fears that the outfall would pollute nearby beaches. Clark reported, after very rudimentary experiments, that the point of discharge at Bondi was well chosen and nuisance would not arise[67] but it is clear that the specialised skill and experience of such an eminent engineer were wasted on such an exercise which could have been performed more competently by a local fisherman. Moreover, Clark relied for his conclusions on the evidence of one float thrown overboard and deliberately ignored the possibility of sewage being driven into the Bondi Bay even though this was an important factor in rejecting an alternative proposal.

Legitimation may merely involve invoking an authority as a substitute for evidence[68] or informing the public that the policy maker has consulted eminent experts, even if in fact the experts did not whole-heartedly support the proposal but reported confidentially so no one knows the difference. In the face of public controversy and internal questioning of the 1976 Caldwell Connell report, overseas experts were called in to give the prestigious expert support that would allow the proposal to go ahead. These experts spent less that a week in Sydney and had to give their support with some reservations based on the data supplied to them by the proponents of the scheme. Instances have been reported where officials have selectively published expert reports, have summarised expert reports in a misleading way, have lied about expert reports, have suppressed information available only to them or have manipulated their advisers to ensure a favourable report.[69] The Water Board used Brooks and Harremoes in a way that caused the Board severe embarrassment when the reservations expressed by the experts were later made public.

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66 Martin, 'Analyzing the Fluoridation Controversy', p336.

67 W. Clark, Report to the Government of NSW on the Drainage of the City of Sydney and Suburbs, 1877, pp13-14.

68 Primack & von Hippel, Advice and Dissent, p72

69 ibid., pp34-5.

As media attention has focussed on beach pollution and the new submarine outfalls the Board has claimed that all stages of the project have been reviewed by an overseeing panel of leading international scientists and engineers.[70] This overseeing panel has never been mentioned before and one can only suppose that they were referring to their own consultants, Caldwell Connell.[71] Most recently the NSW government announced a inquiry into submarine outfalls to be undertaken by international experts.[72] The tender advertisement invites inquiries from experts in sewage treatment and diposal technology.[73] This is clearly a move designed to calm public agitation over beach pollution and the performance of the new ocean outfalls by calling in the technical experts although the issues are clearly wider than can be dealt with adequately by specialists subscribing to the sewerage treatment paradigm.

Expertise is not equally available to all those who might wish to use it to support their case and it thus becomes an "instrument of power and privilege".[74] Modern environmentalists often hire their own experts these days but government authorities are always able to hire more experts, more prestigious experts and to limit information about the proposed project to the opposition. Experts, especially engineers, have been reluctant to speak on behalf of government opponents, not only because it would mean opposing other engineers and breaking solidarity but also because, in Australia, such a large proportion of engineers are dependent on the government for either direct employment, consultant work or grants. It is just not worth it to an engineer to jeopardise his/her future in this way.

Those in power not only have better access to the experts but also to information. Organisations can limit outside interference by resorting to secrecy or by not allowing the public enough time to study the huge amount of research data that it has come up with before the decision is made.[75] Secrecy is certainly used by Sydney authorities to limit information available to potential opponents. Without key information opponents can be fairly effectively disabled. The Board's engineers themselves may have some knowledge through education but, more importantly, they have access to the information they obtain and generate in the course of their job. Engineers, by exchanging such information informally with other engineers in other parts of the public service, are able to form an "informal professional network of information exchange" as a "defence against emerging pressure groups with few resources". It becomes a simple matter to expose such groups as poorly informed.[76]

In the absence of Freedom of Information legislation in NSW the public authorities such as the Water Board and the State Pollution Control Commission are able to limit the amount of information that they make available to the public and also to keep internal reports, memos and debates confidential. Moreover there are clauses built into various NSW government acts, including

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70 Sydney Morning Herald, 16th January 1989.

71 Sydney Morning Herald, 28th January 1989.

72 Sydney Morning Herald, 2nd February 1989.

73 Sydney Morning Herald, 8th February 1989.

74 King & Melanson, `Knowledge and Politics', p100

75 Benveniste, The Politics of Expertise, p128.

76 ibid., pp123,130.

the Clean Waters Act,[77] that provide for financial penalties to any person disclosing information obtained by them in connection with their duties in administering and executing the act.

This secrecy enables government authorities to have a better command of the facts and to appear far more knowledgeable to the public but also helps them to suppress embarrassing information and hide internal differences of opinion. It has been suggested that such confidentiality is necessary to protect those experts from outside pressure or retaliation, ensure that internal discussions are frank and open and keep commercial trade secrets or matters of personal privacy from public view.[78] It does seem, however, that the greatest pressure on experts comes from within the organisation for which they work.

Whilst confidentiality is maintained it is therefore fairly easy to create the image that policy decisions and technological proposals are the direct result of an objective analysis of the facts provided by the experts[79] and any disagreement between the experts is kept hidden from the public. Moreover the policy maker remains free not to accept the experts' advice if that advice is not made publicly.[80]

Often a decision about a proposal will precede the detailed investigations, feasibility studies and environmental impact statements which are supposed to be enquiring into that proposal and engineers may be required to prepare a case in favour of a particular project or to argue that it is safe and environmentally sound.[81]

> It is common for heads of organisations and their advisers to accept that their task is to authenticate or justify the policies previously chosen and to deny the validity of the arguments introduced in support of the alternative recommendations made by others. [82]

This requires that investigations be selective and damaging evidence be suppressed.[83] Technical advice can be slanted by using different criteria for collecting data and interpretations. Studies based on diverse premises require different sampling techniques.[84] Detailed studies can be done into areas where the advisers are confident no harmful impacts will be found whilst areas where major problems are likely can be glossed over. The distortions inherent in the resulting large volumes of data will not be visible to those who do not have the time, skill or inclination to examine the reports in detail.

When each of the Sydney ocean outfalls was decided upon the investigations done were careful to prove that the sewage would not return to shore. A million dollars was spent on a feasibility study that took five years to complete. The

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77 Clean Waters Act, 1970, Section 30.

78 Primack & von Hippel, Advice and Dissent, p112.

79 ibid., p112.

80 ibid., p33.

81 Barnes, About Science, p108.

82 Duncan MacRae Jr, `Technical communities and political Choice', p177.

83 ibid., p177.

84 Nelkin, `The political impact of technical expertise', p45

resulting volume was proclaimed as "one of the most intensive oceanographic and marine biology studies ever undertaken in Australia".[85] Tides and major currents were studied meticulously whilst winds were all but ignored. Floats were carefully kept submerged so as not to be influenced by the wind. This was all despite the knowledge, available in engineering texts at the time, that sewage would float and that surface currents were determined by wind direction. The direction of deeper currents was studied but not what happened to those currents as they approached the surf zone.

The impact of toxic sediments on the marine food chain was given almost no serious investigation apart from having a diver looking around some distance from the existing shoreline outfall, a few jump camera observations and a very small sample of fish being tested, the results of which do not inspire confidence. No efforts were made to find out the eventual fate of sewage sludge discharged into the ocean. Similarly the die-off of faecal coliforms was studies meticulously but viruses and pathogenic bacteria were ignored.

The State Pollution Control Commission made a policy decision in favour of submarine ocean outfalls prior to receiving the environmental impact statements for comment. They passed them on to one of their experts, Bob Brain, an engineer. When, instead of giving them the nod, he raised serious objections to the whole study and raised significant doubts about the performance predictions for the outfalls the SPCC ended up exerting considerable pressure on Brain to withdraw his objections and in the end he was put on to other work. Brain's objections were not made public and his reports were not available to myself as a researcher. It is only since Brain has retired that he has made some of his objections public and has agreed to talk about his experience in the SPCC.

The ideology that leads engineers to be contemptuous of public participation in decision making, the lack of access that the public have to expertise and the use, by the government and public authorities, of expertise to legitimate policy decisions all lead to a less than honest and open approach when it comes to dealing with the public.

PUBLIC DECISION MAKING AND THE QUESTION OF ITS BENEFITS

The degree to which public decisions draw upon expertise and the imbalance of access to that expertise has caused several writers to raise questions about the extent to which democracy is viable in a society dependent on experts, given that experts are not usually directly accountable to electorates.[86]

> The power afforded to those who control technical information can threaten democratic principles, reducing public control over many public policy choices.[87]

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[85] Caldwell Connell, Sydney Submarine Outfall Studies, M.W.S.&D.B., 1976, letter at front.

[86] Nelkin & Pollack,`The politics of participation and the nuclear debate in Sweden, the Netherlands, and Austria', p334; MacRae, `Technical communities and political Choice', p169; Carroll, `Participatory technology', p652.

[87] Nelkin, Controversy, p14.

There are three ways in which decisions made by bureaucratic organisations employing experts can be influenced by the public; through accountability, representation and participation. Accountability is the usual way and implies that the organisation's policies and actions are open to public scrutiny and regulatory investigation. This form of control is quite indirect and weak and totally dependent on the degree of secrecy practiced by the bureaucracy.[88]

Accountability can be reinforced by regulatory agencies which are supposed to monitor the activities of the organisation, be it public or private, and ensure that it abides by existing legislation and standards in its operations.

> One problem is that these agencies can take on a life of their own - they do not necessarily reflect the interests of the citizens. And once again the citizen is reduced to a state of helpless dependence on 'experts'.[89]

Representation, whereby citizens are able to elect representatives to make decisions on their behalf, is a more powerful form of control in that such representatives can be voted out periodically if they do not perform well. But such control does not extend to experts and officials appointed rather than elected to serve the public interest. Such appointees may be responsible to an elected representative but control is far less direct.[90]

Representation has been the chief mechanism for democratic control of sewerage authorities in Sydney but there has also been a tendency to try and remove these authorities from direct democratic control. The history of sewerage development in Sydney typifies the attitude that public authorities and the engineers employed by them should be able to make decisions without interference from the public. Public protests were viewed with annoyance and concessions to popular demands made reluctantly. The Sydney and Suburban Sewage and Health Board discussions were not open to the public nor did they elicit public opinion. The Sewage and Health Board in fact recommended that a permanent and independent central body be established to administer sewerage matters which had tenured members who would not be directly subject to popular control. It was feared that any body which feared unpopularity would not apply sanitary laws stringently.[91]

Between 1888 and 1924 the Public Works Department constructed new sewerage schemes and the Water Board maintained and operated them, doing some ongoing augmentation work. The parliamentary standing committee on public works which approved these schemes held inquiries to which members of the public, especially representatives such as local council aldermen, were invited to give evidence. These parliamentary committees were made up of members of parliament rather than appointed experts and although they gave more weight to expert evidence, they were also sensitive to the opinion of voters in these

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88 David Elliot & Ruth Elliot, `Social control of technology' in Godfrey Boyle, David Elliot & Robin Roy, The Politics of Technology, Longman & Open University Press, 1977, pp20-21.

89 ibid., p21.

90 ibid., pp21-22.

91 The Sydney City and Suburban Sewage and Health Board, Eleventh Progress Report, 1876, p4 and Twelfth and Final Report, 1877, p8.

matters. During this period some proposed sewerage schemes were actually stopped because of local community opposition.

When the Board became totally responsible for sewerage schemes in 1924, the public hearings ceased and the opportunity for local residents to have a say became limited to lobbying in the form of letter writing and deputations to the Board, as well as going to the media. The Water Board was an organisation whose higher strata were almost all engineers and the Board, which had representatives from various regional areas, had the power to authorise sewerage proposals but this was usually a financial consideration and they usually bowed to the expertise of the engineers when it came to which technology should be used. In this way the choice of technology became an internal matter for the engineers to decide without interference from the public who only objected when an already installed technology gave rise to a nuisance.

When the public complained in this way, the nuisance was routinely denied, blamed on other sources or shrugged off as only happened infrequently. Proposals that were unpopular because of a fear that a nuisance would be created, often only affected a local area (with perhaps one representative on the Board) and the other members of the Board could be relied on to push it through, whilst the public was reassured and 'educated'. Treatment was kept to a minimum whilst representatives of beachside suburbs remained a minority on the Board.

Being a semi-autonomous public authority the Board was not directly responsible to the parliament and, because of its make up, was far less responsive to public opinion than a government department or municipal council. This autonomy enabled the Board to be fairly contemptuous of public complaints, either dismissing their validity out of hand or responding with the arrogance of one beyond reach or accountability. In 1929 when the media spread the scandal of polluted beaches across their pages, the Board responded that it would do nothing and that nothing needed to be done. Even the Eastern suburbs representative on the Board denied the pollution on the beaches, probably because he realised that nothing was going to be achieved by complaints and local businesses resented bad publicity.

It is ironic, in fact, that the Board was created as a statutory body to remove it from direct public pressure so that it could carry out the unpopular work of sanitary reform and yet that very remoteness from public pressure meant that when environmental concerns became more popular, the Board could retain old fashioned attitudes toward the environment with relative impunity.The State Pollution Control Commission was established in 1972 and provided the opportunity for the Board's activities to be more closely regulated. In practice however, the liaison between the two organisations was very close with interchange of personnel and no real independent stance.

In 1983 the state government moved to bring the Board more closely within its control, making it directly responsible to the Minister for Resources and with a government appointed general manager. Local government representatives were not put on the Board as had happened prior to 1972 because it was argued that the benefits of having such representatives on the board could be met by encouraging community participation and the systematic canvassing of community opinion and the opinion of interest groups such as local government to ensure their views were taken into account in decision making.[92] But rather than consulting with the public, except where it was required to under the provisions of the Environmental Planning Legislation, the Board chose to deal with the public through massive public relations and propaganda campaigns. It was a policy of persuading the public that the experts knew best.

> Those in favor of rapid applications of technological development often believe that opposition comes from the 'irrational worries' of 'poorly informed' people. To overcome this, many governments and large companies have launched information campaigns and tried to improve the dissemination of information, intending to counteract the appeal of arguments against certain technological developments and to enhance trust in official decisions.[93]

However, the presentation of such information, because it is designed to persuade, is often presented by public relations people in a way that can easily be perceived as mere propaganda.[94]

The Minister responsible for the Board and his/her government are susceptible to public pressure as elected representatives, but the State body represents a wide range of interests and many people who have no interest in Sydney's sewerage system or the cleanliness of Sydney beaches. In places where sewerage is under the control of local government authorities, local people have more say. In Wellington, New Zealand, for example, the Wellington City Council lost office because they intended to install a sewerage disposal system that citizens felt was not good enough.[95]

A State government is most unlikely to lose office over such an issue unless it can be made to assume wider importance, through its effect on NSW's tourist industry for example. Moreover, there seems to be a defacto bipartisan policy on sewerage treatment despite the rhetoric, given that both major parties have presided over the submarine ocean outfalls project which has been almost twenty years in the making. Voters therefore do not really have a ballot box choice on this issue.

Representative democracy has therefore not been effective in Sydney for allowing citizen's views to directly influence technological decisions to do with sewerage treatment and disposal, nor in other areas of public policy that impact on local environments. For this reason there have been calls for more direct participation in technological and development decisions. Mechanisms such as consultation on environmental impact statements, public enquiries and membership of community spokespeople on committees have all been used in Sydney to meet the public demand for greater participation.

Ann Richardson in her book on "Participation" differentiates three main arguments for advocating increased participation in government decision, firstly

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92 Dr. R. McIver, Report of the Ministerial Task Force to Review Sydney Water Board, 31 August 1983, p47.

93 Michael Pollack, 'Public Participation', in Otway & Peltu, Regulating Industrial Risks, p78.

94 ibid., p78.

95 Interviews with Ian Lawrence, former Wellington Mayor & John Blincoe, new Councillor, Wellington City Council, Wellington, February 1988.

that it is the fairest system of government, secondly that it is important to the well-being of participants and thirdly that it leads to better decisions. The first argument rests on the idea that those who will be affected by decisions should have a right to influence those decisions. She points out that it can also be argued that those who bear the costs of these decisions should have the sole right to determine them.[96] In the case of public sector technology, the two arguments are not necessarily contradictory because there is considerable overlay between the people who pay for the technology through rates and taxes and the people who are affected by it. This is certainly the case with Sydney's sewerage system.

Another reason to improve participatory processes, as outlined by Richardson, is that they give dignity to those involved and affected, they help in the development of individual capability and awareness and help to create a well informed, responsive, involved citizenry. However the ability of participatory processes to achieve these ends may be questioned.[97]

Of more interest to this thesis is whether greater public participation would affect public sector engineering decisions and whether such effects would be desirable. There are two ways of looking at this. Firstly one could see increased participation as an aid to policy makers who would have more information about what services were required, the limits of public tolerance, and various other forms of feedback.[98] At first, some governments believed public participation "would lead to a smoother acceptance of controversial technologies and to the restoration of confidence in official decision-making institutions."[99] Certainly engineers, generally, do not seem to view participation to be beneficial. Rather they see it as being a time consuming, expensive and extremely difficult, if not impossible procedure. How do they know who represents community opinions, how do they survey everyone, what about the very different opinions that people hold?

Another way of viewing increased participation is in terms of the redistribution of power that would be effected.[100] This is more likely to be the reason that engineers, and those who presently have power in public policy making dislike the idea; it infringes on their autonomy and threatens to reduce their power. Here it is assumed that there is some conflict of interest between those who are affected by a decision and those who make it. This may be disputed when policy makers are elected. In the case of Sydney's sewerage system however the interests of wider State electorate may well differ from the interests of Sydney beach users for example. Certainly, the priorities of sewerage engineers as a tight knit professional group that is well entrenched in a technological system and paradigm differ from the interests of beach users and environmentalists.

The claims by the Water Board that they are acting in the interests of the community have a very paternalistic ring to them when they will not make vital

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96 Ann Richardson, Participation, Routledge & Kegan Paul, 1983, pp52-53.

97 ibid., pp54-60.

98 ibid., p61.

99 Pollack, 'Public Participation', p77.

100 Richardson, Participation, p63.

information available to community groups and the media. Despite the recent admissions by a Board's spokesman of past secrecy, little has changed since.

> In the past, there were problems. The board was run by engineers. That is no longer the situation. Yes, perhaps there was too much secrecy. No, not secrecy. It just never occurred to them to let the public know. All of that has changed now.[101]

Nevertheless the Board will not divulge to journalists important information such as the total concentrations of restricted substances in sewage discharged (including sludge) and the removal efficiencies of the treatment plants. It is rumoured that a second bioaccumulation study has been done but the results of that have not been made public either.

Another argument against participation is that most people do not really want it. They simply don't have the time or inclination to inform themselves sufficiently to be able to assess the situation and they would prefer to delegate the responsibility to others. Relatively few people read the environmental impact statements for the submarine ocean outfalls and even fewer made submissions. The current dissatisfaction with the performance of the Water Board is not necessarily a dissatisfaction with institutionalised control of sewerage but rather with the particular incumbents of the Board. This attitude was reflected in the recent calls by the Australian Democrats to sack the sitting members of the Board.[102]

Yet this may well reflect a popular misunderstanding of the process of engineering decision-making. The current situation is more the result of social structures, professional ideologies and previous practice than individual choices. Whilst influence on decision-making is confined to an alliance of engineers and bureaucrats, and whilst those decisions and the relevant information remains confidential, there is danger that the shortcomings of the technological system will not be recognised by the decision-makers.

It is only when the decision-making process is opened up to scrutiny, that those outside the system, in particular environmentalists and community groups acting on behalf of the wider community, can alert the general public of the problems and pressure can be applied for change. Michael Pollack has observed that "relatively open, adversarial systems" combined with "public and intervenor-group lobbying" tends to be more effective than the establishment of consultative procedures.[103]

Mechanisms for public participation and consultative procedures that are controlled by policy makers may not achieve this opening up. Those in power are able to control the structure of the decision-making agenda, lay down the boundary conditions for participation, define the scope of discussion, determine which types of argument will be considered, and generally determine the limits

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101 Sydney Morning Herald, 7th January 1989.

102 Sydney Morning Herald, 10th January 1989.

103 Pollack, 'Public Participation', p82.

of legitimacy.[104] Moreover, where participation is introduced as an attempt to obtain approval for decisions or to aid policy makers rather than redistribute power, the impact of participation is carefully limited.

The question remains, whether the Sydney community would chose a different form of sewage treatment and disposal if they were fully informed of the uncertainties and consequences and disputes associated with each option and whether widespread dissatisfaction with the range of options offered by the sewerage treatment paradigm would force a revolution in sewerage treatment. Recent events suggest it might. The coverage in the media of the issue in recent weeks has been heavier than in the past and the issue seems to have captured public attention in a way that has not happened since the 1930s when it was proposed to duplicate the Malabar outfall. This follows similar media attention to ocean pollution issues overseas following a very hot North American summer accompanied by heavily polluted beaches and the death of thousands of seals in the North Sea that were believed to be weakened by industrial pollution of the oceans. Already novel sewerage treatment processes have been coming out of the woodwork,[105] Although these particular treatments may not be promising they are indicative that research may once again be directed towards innovation in sewerage treatment methods.

Increased public involvement in other areas has led to the growth of governmental regulation, changes in industrial strategies as well as the establishment of new research and development priorities.[106] Certainly public involvement provides a counter to narrow professional viewpoints and allows for input on environmental and social impacts of technological projects that involved engineers may be prone to ignore or give secondary importance to.

CONTROVERSY, CHANGE AND CONTROL OF TECHNOLOGY

At the beginning of this thesis I set out to answer some fundamental questions about the nature of technological change and its control. Firstly, is technological change self-perpetuating? Certainly not in the case of sewerage technology. If technological change means innovations in technology, then it can be seen that such change is carefully controlled within a paradigm that directs and paces innovation. If technological change is taken in a broader sense to embrace all new technological projects then the only way in which sewerage technology can be seen to be self-perpetuating is in terms of the way past decisions shape later ones because of the momentum created by physical infrastructure, vested interests, and committed organisations and people.

Are the adverse consequences of technologies inevitable? In this case study, most of the adverse consequences were predicted in advance. Decision-makers chose to ignore or not believe warnings of environmental consequences because they had other priorities. The environmental degradation that has accompanied ocean outfalls has resulted from conscious decisions by policy makers to use the ocean

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[104] David Dickson, The New Politics of Science, Pantheon Books, New York, 1984, p220; Pollack, 'Public Participation', pp80-81.

[105] Telegraph, 21st January 1989; Telegraph, 24th January 1989; Australian, 24th January 1989.

[106] Pollack, 'Public Participation', p83.

for disposal because it was cheapest and most convenient to do so. Environmental costs which are usually long-term were not included in the cost calculations because shorter term objectives were given priority.

Who controls technology? This is the most difficult question. Who actually makes the decisions, determines the outcomes? Is it the engineers, the politicians, the public? In public sector engineering technology an alliance of politicians, engineers and bureaucrats hold power but this alliance is not all powerful. The delicate balance between them can easily be upset by massive public discontent. Whilst voters are disinterested, politicians tend to be disinterested as well. In this situation, engineers are able to determine public policy in the area of sewerage technology, provided they minimise costs and work in the interests of their employers. They have learnt during such times that their autonomy depends on the thriftiness of their projects, and they have sought to protect politicians from voter backlash by manipulating public opinion about the consequences of this thriftiness, which is inevitably pollution. Their autonomy has depended on this too. For in times of widespread public agitation, politicians step in and assert their authority.

Nor is the public, one amorphous mass but rather various groups have various interests. Capital and those who represent industry have influence because their interests are identified as interests of the State. The provision of a cheap industrial waste disposal system is provided because of the perceived economic benefits. The Water Board's workforce finds that its interests lie with more treatment because of the construction, maintenance and operating work that would be involved. Women have very little influence because of their minimal role in the engineering profession, as elected representatives and in higher levels of government bureaucracy but as beach users, residents, parents, and ratepayers they have interests.

Sydney beach users have in the past conflicted with residents of unsewered suburbs, but as the proportion of unsewered suburbs has decreased, so has the counter lobby in Sydney. The willingness of ratepayers to pay more for environmental protection is also increasing although there have been recent attempts to inflate the costs of secondary treatment in order to deflate the demands for it. NSW voters outside the Sydney area can be enrolled in the debate by references to the state's fishing and tourist industry.

The control of technology is therefore shared in a way that is fluid and changeable. Each party seeks to consolidate its own power, and the engineers as a constant, cohesive group with a certain amount of expert authority have been the most successful at this, because of the key positions at the design and conception stage and through their ability to socially construct a knowledge base that will support their preferences. Yet their very success has occurred at the expense of the environment and in the end it could be their undoing. Their standing in the community is dependent on their good works but they are increasingly identified with environmentally damaging works. The solidarity which has effectively prevented alternative engineering views from being put may also mean that all engineers are branded as environmentally insensitive. And their manipulation of both politicians and public may be becoming too obvious and cause them to lose their image as impartial, objective experts.

It remains to be seen, as the current battle between beach users and the Water Board reaches a head, just who will win. Is the strength of mass indignation, fed by the media, enough to force the politicians to overrule the engineers in the Board? A recent poll showed that 64% of Sydney-siders were willing to pay higher taxes in order to prevent pollution.[107] How will closure be attained in this latest stage of a controversy that has been waxing and waning for over one hundred years? History stands on the side of the engineers and bureaucrats at the Board but the future is never predictable.

107 Sydney Morning Herald, 13th February 1989.

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