Cranfield University

Professor Simon J. T. Pollard

PhD, FRSC CChem, FCIWEM CWEM, FHEA, MCIWM, SiLC

CONTRIBUTIONS TO RESOURCE AND ENVIRONMENTAL RISK MANAGEMENT

School of Applied Sciences

DSc

Academic year 2008-2009

March 2009

This thesis is submitted in partial fulfilment of the requirements for the Degree of Doctor of Science

Volume 1 of 2

ABSTRACT

This thesis charts a research journey through the disciplines of waste chemistry, environmental risk assessment, policy analysis and corporate risk governance since award of the candidate's PhD in 1990. The insights gained present a distinctive perspective on resource and environmental risk management - assessments of risk must reflect our understanding of the science and evidence that supports them; and the protection of public and environmental health, as an overarching motive, requires greater prominence if the confidence of citizens in the Government and industry handling of risk is to be secured.

Waste management *is* risk management and without an understanding of the fundamental science and engineering of wastes and how they behave in the environment, process technologies for their treatment can not be optimised, nor regulatory oversight designed properly to protect public health and the environment. The candidate's research on the chemical characterisation of complex wastes and their interaction with soils, waters and air, offers a more optimistic assessment of these risks, at least within developed nations. This said, technical assessments of risk are insufficient, in isolation, to secure the confidence of communities, investors, or the wider citizenry. The motives and values of process operators and regulators that oversee operations are as critical as technical demonstrations of environmental safety. The recent contributions in this thesis examine organisational competencies in *preventative* risk management, specifically within the water sector as it responds to international calls for improved risk governance.

In concert, the candidate's contributions and practical achievements in resource and environmental risk management reported here represent a unique and substantive body of problem-oriented research, directed at reconciling societal unease about waste with our responsibilities for its safe management. Significant insights are made on the reuse of hazardous and carbonaceous wastes, on the characterisation, fate and transport of hydrocarbons in the environment, on the practice of environmental risk assessment and the organisational competencies required to manage risk to the levels of stakeholder confidence expected in the 21st century.

DECLARATION

No part of the published or unpublished work has been presented, or is being submitted, for any other degree or other academic or professional distinction by the candidate at Cranfield or any other University. This thesis has been prepared in accordance with Regulations of Cranfield University (40.1 – 40.9 and 35.4, as amended). The general approach within the body of research presented is that the candidate was the originator of the contribution; identifying the research problem and designing the investigations, with the detailed analysis, modelling and experimental work being performed with co-investigators. Synthesis and interpretation of the research results was undertaken jointly. In the large majority of cases, these publications were edited and communicated by the candidate to the research journals.

Prof. Simon Pollard, Head of Department, Sustainable Systems
School of Applied Sciences, Cranfield University, UK
March, 2009

ACKNOWLEDGMENTS

Most of the papers presented here are jointly authored, being the result of close collaborations in a multidiscipline field. I wish to express my sincere gratitude to my various co-authors over the years, including the postgraduate students, postdoctoral fellows and colleagues who I have worked with since 1991. My thanks go to (in alphabetical order):

Dr Roland Bradshaw, Dr Kirsty Brassington, Dr Surabhin Chackiath, Dr Fred Coulon, Gareth Davies, Dr Gillian Drew, Dr Raquel Duarte-Davidson, Dr Susan Duerden, Dr Maureen Fairley, Professor John Farmer, Dr Geoff Fowler, Dr Bryan Fuhr, Dr Anurag Garg, Duncan Gray, Dr Paul Hamilton, Dr Owen Harrop, Dr Colin Hills, Larry Holloway, Dr Rupert Hough, Ibrahim Husaini, Professor Jimi Irwin, Dr Sandra Kenefick, Dr Jane Kennedy, Danielle Knight, Dr Phil Longhurst, Dr Brian MacGillivray, Gordon McConnachie, Dr Kit McLeod, Ian Meadowcroft, Dr Mohamad Pauze Taha, Tom Raffield, Graeme Risdon, Sophie Shafi, Dr Richard Smith, Dr Chris Sollars, Professor Tom Stephenson, Fiona Unett (née Thompson), Dr Michael Warhurst, Dr Martin Whittaker, Dr Roger Yearsley, Peter Young, and Mike Zemanek,

I wish especially to record my thanks to Professor Roger Perry and Professor Steve Hrudey, whose academic professionalism, generosity of spirit and commitment to environmental health have provided hugely rewarding stimulus for my career. Of course, the most important co-workers in this enterprise are the supporting cast; in this case, Rachel, Jamie, Honor and Lewis to whom I owe enormous gratitude.

CONTENTS

SUMMARY

This thesis comprises an examinable selection of eighty academic papers and eighteen additional scientific contributions from the candidate's career, conducted since completion of his PhD in 1990. The research presented has been performed by the candidate and various co-workers in the field of applied environmental science, with an emphasis on resource and environmental risk management. The publications are presented in six main sections. For each, a discussion of the distinctive contribution, its context and significance is offered. Further, in accord with University Regulations, section 7 includes an additional selection of scientific reports, guidance documents and expert judgement providing evidence of further practical achievements over and above the academic core of the thesis.

This body of papers and achievements addresses two research ambitions: one, an attempt to bring a scientific robustness to the waste and resource management agenda, through the examination and exploitation of waste chemistry; the other, a critique of environmental risk management, risk policy and risk governance. The latter, has particular significance in light of the current desire to compare risks across the environmental policy agenda to inform policy priorities and the proportionate expenditure of public funds on managing environmental risks. The themes are exemplified through a body of contributions on the assessment and management of hydrocarbon-contaminated soils. Here, the desire has been to improve analytical techniques, modelling approaches and waste characterisation to allow a more representative and evaluation of exposures to hazardous constituents in these wastes.

The regulation of risks from contaminated land and other environmental hazards leads to latter contributions on environmental decision-making in general, better regulation and risk policy. Finally, the recent work considers the organisational governance of risk within the water utility sector, reflecting one sector's attempts to embed a preventative risk management culture under a modern regulatory philosophy of risk-based regulation.

GLOSSARY

AD	Anaerobic digestion
APC	Air pollution control
ASTM	American Society for testing and materials
BNFL	British Nuclear Fuels Limited
BBSRC	Biotechnology and Biological Sciences Research Council
BSE	Bovine spongiform encephalopathy
Defra	Department for Environment, Food and Rural Affairs
DTi	Department of Trade and Industry, that was
EC	European Commission
EPSRC	Engineering and Physical Sciences Research Council
FMD	Foot and mouth disease
IWA	International Water Association
NERC	Natural Environment Research Council
ODA	Overseas Development Agency, that was
OECD	Organisation for Economic Co-operation and Development
OPC	Ordinary Portland cement
PAH	Polynuclear aromatic hydrocarbons
PFA	Pulverised fuel ash
PROMISE	Optimising biopile processes for weathered hydrocarbons within a risk management framework, project acronym
QRA	Quantitative risk assessment
REACH	Registration, evaluation, authorisation and restriction of chemicals
RBCA	Risk-based corrective action
SNIFFER	Scotland and Northern Ireland Forum for Environmental Research
S/S	Solidification/stabilisation
TIE	Toxicity identification and evaluation
TPH	Total petroleum hydrocarbons
UNECE	United Nations Economic Commission for Europe
WEEE	Waste electrical and electronic equipment
WRAP	Waste and resources action programme

PUBLISHED WORK AND PRACTICAL ACHIEVEMENTS

This chapter provides an exposition of the candidate's published work and practical achievements, and a discussion of their value and significance. Copies of the examinable papers and contributions are presented in tagged sections behind this chapter, which offers a synthesis of the contribution. Throughout, superscripts in the text refer to contributions from the candidate's published research, including the examinable material listed in the References section starting on p 27. The full listing of career communications (1990-2009[1-342]) is presented in the Appendix, forming the bibliography to which the superscripts refer.

Section 1 Overall value and significance of contribution

Four papers[38, 43, 74, 77] are presented here. They represent significant contributions to the development of an environmental risk assessment capability within Government in the UK from 1998 onwards, in which the candidate was instrumental, and subsequent development of a comparative risk assessment methodology for diverse environmental risks. The *Environmental Science and Technology* paper[38] was the first (2002) academic exposition of the development and direction of environmental risk assessment in UK Government, and describes the Environment Agency's response to its new powers under the Environmental Act, 1995, and subsequent developments in risk-based regulation, specifically on role of operator pollution risk appraisal (OPRA).

The *Risk Analysis* paper[43] describes a methodology, developed between 1999 and 2004, that has informed State of the Environment Reporting (2000) in England and Wales[90, 95, 98, 180, 186, 202] and since been the basis of the Environment Agency's forward research on comparative risk assessment. Adapted versions of the approach are expected to see use in strategic risk appraisals of Defra's policy priorities through the work programme of the newly-established Research Councils/Defra collaborative centre of excellence in understanding and managing natural and environmental risks at Cranfield University for which the candidate is the Centre Director.

The *Chemosphere* paper[74] adopts, uniquely, a fugacity approach to estimating exposures from biopiled hydrocarbons, and infers a very low availability for risk-critical compounds released during the bioremediation of hydrocarbon-contaminated soils. The research illustrates the critical role of oil-phase partitioning within

contaminated soil systems, a role to date ignored by regulatory exposure assessment methodologies and conventional contaminated land risk assessments.

The *Environment International* paper[77] by MacGillivray and Pollard (2008) presents the conclusions of the candidate's benchmarking of risk management capabilities in the international water utility sector[123, 129, 130, 140, 314, 318, 335, 339]. Building on related papers[42, 52, 58, 59], it identifies where future attention should be paid within the water utility sector on issues of risk governance; here especially for those water suppliers at low levels of risk management maturity (Pollard, S.J.T., Bradshaw R.A. *et al.*, 2009, *in press*). The paper modifies a previously published benchmarking tool[67, 123], and is now seeing application in the context of an international study on advocacy for safe drinking water among water utility leaders, funded by the International Water Association (IWA) at Cranfield University and directed by the applicant.

Section 2 Waste minimisation and resource management

The earlier research (1987-1990) performed by the candidate[1-3, 142, 166, 256] deals with a well-recognised problem of the time - the management of a self-combusting 'special waste' from the edible oil industry; spent bleaching earth. Looking forward to the eventual ban of such hazardous wastes from landfill, the first three papers in this section[5, 6, 11] build on the candidate's PhD[142] and consider the reuse of spent bleaching earth as a low-cost adsorbent; prepared through the controlled pyrolysis and activation of residual oil on the interlamellar montmorillonite surface of spent Fuller's earth. The metrology and characterisation of micropore size distributions and pore volumes in these low-cost carbons[6] is supported by evaluations of surface-specific adsorptive capacities for different reuse applications; in water and wastewater treatment (phenol removal) and the cleansing of edible oils (PAH removal from coconut oil[11]).

Building on an exhaustive review of low cost carbons for water and wastewater treatment in middle income and less-developed counties[5], the next five contributions[20, 21, 27, 30, 31] stem from Overseas Development Administration (ODA, now the Department for International Development) funded research on low-cost carbons prepared from the waste seed husks of *Moringa oleifera*, a decorative plant used widely in Africa and India, the seed extract from which has water coagulant properties. Evaluations of micropore volumes for *Moringa* carbons[31] and comparisons with

commercial analogues proved them highly competitive and capable of, for example, the uptake of considerable quantities of *Microcystin*-LR toxin from algal blooms[30], a common feature of Lake Victoria, Milawi. Working closely with the local water supplier in Blantyre, Milawi[87-88], the candidate developed a single stage steam pyrolysis activation procedure[21] for these carbons that could be implemented with ease using locally-sourced activation process plant[88].

Mixed inorganic-organic wastes from electroplating processes, for example, continue to be problematic for waste producers and demand specialist treatment. One technology, cement-based solidification/stabilisation (S/S) has seen wide application in the US for nuclear and inorganic waste streams with small (2-5 $\%^{w}/_{w}$) contributions of organic contaminant (oil, solvent) load. The technology has had a controversial operating history in the UK, but a number of high profile process failures involving incomplete set of the ordinary Portland cement (OPC) in the process mix resulted in low regulatory confidence in this technology for 20 years. In these three papers[4, 16, 24], the candidate and co-authors review the process science of S/S waste technology, the microstructural interference effects of organic contaminants on cement set, and illustrate successful S/S application for flue gas desulphurisation wastes, processed using ordinary Portland cement (OPC) and pulverised fuel ash (PFA). The papers provide S/S operating thresholds for the organic content of mixed wastes, and demonstrate a valid application of this technology for a problematic high volume waste produced from coal-fired power stations[16]. Notwithstanding a substantive research effort into these wastes over the last 20 years, the technology remains controversial in the UK. Latter attempts to present the technology as a risk management solution for problematic wastes[284, 291] have proved difficult, on account of the increased volume of the stabilised matrix and the dramatically reduced availability of hazardous waste landfill capacity in the UK.

The remaining nine papers in this section[13, 40, 46, 54, 62, 63, 68, 70, 71] represent similar examinations of the process science and technology that underpin a suite of waste treatment technologies. The waste sector has not always been forthcoming in researching the chemical, biological and engineering basis for its chosen technologies, many of which have emerged from mining and agricultural engineering practices rather than the research pilot hall (Velis *et al.*, 2009a, b, *in press*). These contributions

include a critical review of constraints on the efficiency of bioremediation[13], published at a time (mid 1990s) when unsubstantiated claims were being made among technology vendors of the capabilities of low cost bioremediation to treat hydrocarbon-contaminated soils. A further two manuscripts describe the progression toward sustainable landfill in a post Landfill Directive (1999/31/EC) policy environment[62-63].

The later contributions in this section develop a 'new waste technology' theme, being concerned with bioaersosol exposures from green waste composting sites[70], the effectiveness of the Waste Electrical and Electronic Equipment (WEEE) Directives (2002/96/EC and 2003/108/EC) to influence sustainable product design[54], market stimulation for household waste segregation[68] and resource flows within the UK economy[71]. Collectively, the candidate has been concerned here with policy appraisal, regulatory effectiveness and the market response to the new waste agenda[163]. In a policy environment aspiring to be less reliant on landfill, new hazards are generated from technologies process biological waste that require regulatory oversight if community and investor confidence in these technologies is to be secured. A particularly fruitful research thread in this regard has been the evaluation of bioaerosol exposures released from green waste composting facilities[70]. Providing a characterisation of the source term for bioaerosol hazards has proven central to their effective and proportionate regulation in the face of a rapidly expanding market for compost technology, in line with the ambitions of the Government's and devolved administrations' waste strategies. Research performed under this theme[69-70, 111, 117, 122, 127, 132, 134, 208, 221] has led to the drafting of guidance to waste operators on bioaerosol risk assessment requirements (currently underway).

Section 3 Analysis of complex environmental media

A consistent feature of environmental regulation in the 1990s was the promotion of risk-based 'Superfund' clean-ups in the United States, and the growing application of environmental risk assessments to guide contaminated site assessment and remediation. Notwithstanding the advances in analytical, and especially chromatographic science since the late 1960s, for petroleum- and creosote-contaminated sites which featured highly among cleanups in North America, the wide use of the surrogate 'oil and grease' parameter to infer contaminant load was a fundamental constraint on meaningful site evaluation. This series of papers[7, 14, 41, 28,

[15, 19, 23, 12, 8, 22, 26, 37, 50, 47, 69, 55, 76, 78] develops improved analytical methods, protocols and strategies for heavy oil and creosote residues, initially for contaminated sites in Alberta, Canada[7, 14, 41], and then more broadly[15, 19, 23]. Seeking to reveal the complexities of the weathered contaminated oil-soil matrix and improve remediation strategies, the research describes chromatographic[7, 15], mass spectroscopic[41, 12] and isotopic[23] analyses to characterise the extent of weathering, range of substituted polynuclear aromatic hydrocarbons, and the varying polarity and toxicity of components in these complex matrices. Funded by the provincial regulator, Alberta Environment[169-171], this research informed the prioritisation of Alberta's contaminated sites programme and the identification of candidate sites for detailed investigation, full risk assessment and ultimately remediation.

The fugacity approach to environmental fate and transport has had a marked influence on the development of these papers and those in the section that follow. The fundamental physicochemical properties of chemicals determine, in large part, where one can expect to find them in the multimedia environment, which analytical techniques are appropriate for their analysis, which exposure pathways will be significant for human and ecological receptors, and which media – waste[74], soil residues[22], leachate[45], off-gas[56] – should be a priority for treatment to reduce exposures and thus risk[60]. Central to these assessments is the characterisation of the waste, or 'source (of the hazard) term'. Research presented in these papers was directed towards understanding the complex composition of hydrocarbon waste residues isolated from wood-preserving waste sites and former petroleum battery sites in urban and rural Alberta, Canada[7,14, 41]. As for those papers above, without an informed analysis of the composition and fate of oils and their constituents at these sites, regulators may be drawn to cost-inefficient solutions. This work assisted directly in the prioritisation of Alberta's bioremediation programme[169].

Using a range of automated thin-layer chromatography[7, 82] and nitrous oxide chemical ionisation (soft) mass spectroscopy[41], the candidate and co-workers developed a toxicity identification and evaluation (TIE) protocol[28] for component classes in these oils, and revealed their substituted polyaromatic and polyalicyclic composition of these residues[41, 170]. The insights gained through detailed chemical examination prove to be at odds with the rudimentary chemical data used in the risk

assessments of environmental consultants at the time, which adopted single target species within coal tar creosote and petroleum, or worse, inferred their concentration from estimates of 'oil and grease' load[19]. A critical failing in the quantitative risk assessments was an absence of any recognition of where indicator (risk-critical) compounds resided at these sites – that is, within the oil matrix (the source term). In Superfund risk assessments, the assumption of human exposure to individual labile polynuclear aromatic hydrocarbon (PAH) molecules and with complete bioavailability was the norm. In contrast, the candidate's original research[41, 170] demonstrates a family of PAH and substituted analogues *comprising* the waste oil matrix, and ultimately co-solved in one another; the waste oil acting as a powerful partition medium for hydrophobic risk-critical contaminants[74], much more so even than soil organic matter. This proves pivotal to assessments of exposure because it means contaminants in these matrices are not free to transport within the environment unless accompanied by the source term itself and far from bioavailable. Revised analytical protocols using a tiered suite of analytical tools[14, 83], were recommended and the above rationale on the limited availability of PAH in waste oils applied to limit the remediation of Albertan contaminated sites to those posing greater risks.

The middle series of papers in this section[15, 19, 22, 26], co-authored with Dr Martin Whittaker, extend these studies back in the UK using North Sea crude oils. Researchers (*e.g.* Westlake and others working at the University of Alberta) in the mid 1970s demonstrated the changing chemical composition of crude oils subject to biotic and abiotic weathering and described an increasingly condensed polyaromatic structure that develops as the oil becomes more asphaltenic over time. With most hydrocarbon residues having been subject to decades of biotransformation and physical weathering at industrial sites since their original deposition to site soils, the residual oil at these sites offers an even stronger partition medium for risk critical compounds than that for freshly deposited oil. The candidate's evaluations of so-called 'refractory' (resistant to biotransformation) oils in hydrocarbon-contaminated soils[15, 23, 56, 223, 237, 238, 264] provide novel insights into the extent and nature of weathering and allowed the development of new indices[26] capable of distinguishing between oils that have experienced biotransformation and those that have not. Ultimately, this collective body of work reported in this section led to the candidate drafting the national

consultation[109, 193] and regulatory guidance[200] on the assessment of risks from hydrocarbon-contaminated soils for the Environment Agency of England and Wales, and it set the theoretical groundwork for a £1m industrial research consortium 'PROMISE'[115, 139, 313, 324] (Bioremediation-LINK funded project BIOREM_35 on optimising the biopiling of petroleum hydrocarbons within a risk management framework) addressing the risk-based bioremediation of weathered hydrocarbon wastes (2004-2008). Analytical techniques developed under this programme[78] are now set for inclusion in the UK Standing Committee of Analysts' 'blue book' of accredited analytical methods, here for petroleum hydrocarbons.

In the same way that the uptake of bioremediation technology in the US led to a wide range of new entrant technology providers during the 1990s, the rapid expansion of large scale composting in the UK has generated a concern over operator competencies and the proportionate regulation of on-farm and industrial scale compost technology. Specifically, the generation of peak releases of bioaerosols during waste shredding and windrow turning has stimulated community concerns about the environmental safety of these processes. Seeking to reassure the public, the Environment Agency (2002) issued guidance on the health risks from composting and established a 250m 'cordon' between compost plants and sensitive receptors (largely housing). Facilities planned, or operating closer than this to sensitive receptors, are subject to a quantitative assessment of bioaerosol exposure. Though effective in promoting a culture of operational risk assessment within a growing sector, this policy was, at the time, without any underpinning understanding of source term releases of actinomycetes and *Aspergillus fumigatus*, two of the key bioaerosol constituents of concern (Drew *et al.*, 2009, *in press*). The papers in this section[50, 47, 69] with Dr Mohamad Pauze Taha and Dr Gillian Drew, including the invited submission[47] to *Waste Management*, provide original contributions for a reappraisal of the 250m-rule in light of new insights into bioaerosol loads generated during compost processing. They quantify, for the first time, the relative contributions to total site load of waste shredding, windrow turning and fugitive releases at authentic compost facilities, and they have allowed revised regulatory advice to compost operators on the management of on-site exposures to workers and off-site publics[208, 221, 288, 315]. This research resulted in a collaborative NERC grant between the candidate and Cranfield

researchers with colleagues at the University of the West of England exploring bioaerosol fate and transport, post-release, with a view to generating reliable exposures and risk estimates.

Section 4 Fate and behaviour of hydrocarbons in the multimedia environment

Six submissions[25, 33, 34, 148. 161, 56] appear in this section, including two invited papers[148, 161]. Coincident with the analytical investigations above, is a stream of research on the environmental fate and partitioning of risk critical compounds[25, 56] within hydrocarbon waste matrices. The papers here represent attempts to quantify the multiphase partitioning of compounds in hydrocarbon-contaminated soil environments, together with a similar study on vinyl chloride[56], a known human carcinogen by inhalation, present in landfill gas. Related to these is the *Chemosphere* paper[74] included in Section 1.

The significance of these contributions is apparent when one considers that risk assessments supporting regulatory decisions at the time, and still, take no account of the relative availability of individual chemical species within a weathered hydrophobic matrix, as noted above. Hence the likelihood is, over and above the gross approximations that risk estimates infer because of necessary extrapolations from the baseline toxicology, that an additional overestimate of risk is incorporated because of very low contaminant availability. The practical impact of these overestimates is remediation disproportionate to the significance of the risk and potentially, the inefficient use of public and private funds. In a broader sense, this type of error reflects an over confidence in the application of quantified risk analysis to environmental issues; arguably one overly concerned with the generation of numerical risk estimates rather than the targeted application of interventions that minimise exposures[60, 107, 125, 136, 155, 157]. The candidate holds the view that the focus of these assessments should rather be in identifying opportunities for risk management and improved decision-making[80, 91].

Section 5 Environmental risk management

Environmental protection should be risk-informed, and interventions should focus on those hazards, pathways of exposure and receptors that contribute most to the risk. The development of risk-informed regulation[18, 35, 92, 177, 276] and the desire to

promote proportionate, effective environmental protection by reference to an analysis of risk led to an increasingly integrated environmental risk management capability within the UK Government and its agencies from 1995 onward[273]. With explicit requirements for environmental risk assessment within the statute, and new general powers introduced in the Environment Act of 1995, regulation of environmental risk assumed growing importance for operators and their professional advisors[17, 18] – environmental consultants and lawyers, not least because effective environmental protection (inferring a wise and proportionate use of resources) has been asserted as a central tenet of successive UK sustainable development strategies. The papers in this section[9, 10, 17, 18, 29, 32, 44, 42, 45, 48, 49, 57, 58, 52, 59, 60, 53, 65, 73, 75], including five invited submissions[42, 48, 49, 59, 60], provide a distinctive narrative on the developments in environmental risk management practice occurring at the time. They provide the link between the theoretical work above, albeit in a highly practical scientific context, and the operations of business and regulation directed towards risk management[18, 32, 42, 57, 146, 153, 155, 157, 158, 159, 162]. Increasingly, these contributions address the theme of environmental decision-making in the round[80] and lead on, in the next section, to an original evaluation of the organisational competencies for good risk governance (Pollard, S.J.T., Bradshaw, R.A. *et al.*, 2009, *in press*; Pollard, S.J.T., Lemon, M. *et al.*, 2009, *in press*; Bradshaw, R.A., and Pollard, S.J.T., 2009, *in press*) where much of the candidate's current research efforts are focused.

The UK has a successful convention of pragmatic risk assessment and management[273, 274, 278]. Nationally, we have resisted the desire to quantify risks that are not fully understood, and have relied instead on the codification of expert evidence, experience and practice, and the use of informed expert judgement as the basis for robust decision-making. However, internationalisation of the global consulting market in the mid 1990s saw the introduction of US-style quantitative risk assessments (QRAs) to environmental protection problems. The contributions here[9, 18, 29, 44, 57, 58, 59] represent a body of action-oriented research (collaborative research with practitioners) and research commentaries with the broad aim of holding dear to this UK convention that has served policy makers well. A particular concern of the candidate has been the computation of quantified risk estimates (probabilities) presented in increasingly precise terms with integers and negative exponents (10^{-7}, 10^{-15}), for which

a poor scientific basis often exists. The papers here have been made alongside the theoretical contributions in the sections above and relate to risk management for contaminated sites, as a decision tool to inform regulation and its application within the water utility sector.

The first three papers in this section address QRA and the uncertainties it embodies. Calling for a more robust, well-founded evidence base for the assessment of risks at contaminated sites and incinerators[9, 10, 17], the earlier papers pave the way for the mid-series contributions on environmental risk management practice. Here, the contributions promote a tiered approach to risk analysis, a strong focus on problem definition and risk prioritisation, and the incorporation of economic appraisal, technology assessment, social issues and management accountability to decisions on risk management.

Examples of the proportionate and targeted application of quantitative exposure assessment are provided in the incineration[17, 32], spray irrigation[45] and air pollution control (APC) residue papers[53], together in each case with discussion of uncertainty. The section then includes a series of commentaries[9, 18, 29, 44, 49, 57, 59, 65] for practitioners on the appropriate use of risk analysis in environmental protection. A recurrent theme is the application of risk tools, not in their own right, but to *inform* the management of risk which, though seemingly obvious, is a common oversight by practitioners with a strong focus on securing regulatory approvals for new developments, process modifications and the reauthorisation of long-established operations. Of note and influence in this regard is the candidate's contribution to the safety case review of the British Nuclear Fuels Limited (BNFL) low-level radioactive repository at Drigg, Cumbria, regulatory discussions on which embodied the tensions between QRA, risk-informed regulation and stakeholder confidence in risk governance[93, 175, 176, 183, 187, 190]. The insights gained from research undertaken by the candidate whilst at the Environment Agency (1998-2002) are published with his co-workers elsewhere in the open literature, and discussed in Section 7 of this thesis.

The final paper[75] in this section represents recent insights into the disposal of animal carcases and associated risks to public health, animal health and the wider environment[205]. A multidimensional problem, policy and regulatory officials must manage rapidly escalating pressures on the waste management infrastructure of

countries during animal disease outbreaks. A critical feature of these events is the safe, responsible and efficient disposal of animal carcases, which must be performed with risk reduction in the forefront of the minds of veterinary and environmental specialists. Historical disposals during the foot and mouth, bovine spongiform encephalopathy (BSE) and avian flu outbreaks tended to rely on a structured hierarchy of waste technologies (Pollard, S.J.T., 2009, *in press*). However, the need for operational agility during these crises and the practical necessity of needing to access a wider range of waste technologies prompted Defra-funded research[205] into a risk-based appraisal of disposal options. The distinctive insights gained from an exposure assessment of 28 waste process chains, communicated in the *Environmental Science and Technology* paper[75], led to a revision of the Government's contingency plan for exotic animal disease outbreaks in the UK. The methodology adopted has since informed the development of end use protocols for anaerobic digestion and compost products going to land in the UK[211] and is underpinning stakeholder confidence in the reuse of these waste residues, as 'products' within the Government's revised waste strategies.

Section 6 Environmental policy, regulation and governance

Following the promotion of explicit environmental risk assessment tools and techniques within Government from 1995 onwards, attention has turned to the development of organisational capabilities for risk management, a reappraisal of UK risk policy following the BSE and for and mouth disease (FMD) crises, and to the response of the regulated communities to risk-based regulation. In part, these developments were driven by introduction of renewed codes of corporate governance, their implementation across Government, following severe criticism of the handling of risk, and a growing recognition within organisations of the necessity to manage risks well in order to secure their 'licence to operate'.

Eleven papers[35, 36, 39, 51, 158, 160, 61, 64, 72, 66, 67] and two invited submissions[158, 160] are included in this section. The first three papers largely reflect the contributions of the candidate to the development and implementation of regulatory risk assessment, whilst within the Science function of the Environment Agency[35, 36, 39, 99, 155, 157, 177, 178, 181, 182, 184, 188], . The most recent contributions[66, 67] explore this theme within the water utility sector and return to an earlier theme (Section 2), the provision of safe drinking

water, a risk worth prioritising given its essentiality to human life and the dependence of economic growth on its continued provision.

The original insights developed here[66, 67], secured through research funded by the American Waterworks Association Research Foundation (AwwaRF) and a consortium of international water utilities[52, 61, 66, 67, 77, 112, 113, 114, 123, 129, 130, 160, 206] consider the organisational competencies required to manage risks well. Drawing on theories of high reliability organisations, mindfulness and safety culture, this body of research represents a natural progression from earlier work on risk assessment, and considers the pre-requisites for a *preventative* risk management culture within the environmental goods and service sector, specifically within water utilities. Water suppliers have become complex businesses with ageing infrastructures, outsourced functions and skills shortages. In this operating environment, managing corporate and environmental risk is a huge practical challenge but one increasingly under regulatory, investor and community scrutiny. The candidate and co-workers have explored inter- and intra-organisational competencies in risk management in the context of supplying safe drinking water. Modern water utilities have become expert at managing water quality incidents through the use of advanced control rooms and targeted workforce planning, but struggle to embed a preventative approach to managing risk. One chief risk officer interviewed in this research explained the paradox: water suppliers operate unit processes and, in effect, put these assets at risk in order to protect public health. The candidate's observations suggest that the asset management mindset and the increasing adoption of a lean management philosophy that potentially erodes inherent margins of safety (whilst maximising returns on investment for shareholders) may be contributing to latent errors in the operation of utility infrastructures– potentially building a future of increased incidents, service outages and impacts on customers. The papers co-authored with Dr Brian MacGillivray[66, 67] illustrate where improvements can be made. Investments in managing risks within a water utility's outsourced businesses, in training and educating their staff in risk management and in managing in-house on knowledge risk are singled out. Actions here are likely to reduce business exposures, improve vigilance and competencies on the front line of water and wastewater treatment, and help build a lasting legacy of organisational learning on preventative risk management (Pollard, S.J.T., Bradshaw, R.A. *et al.*, 2009, *in press*). These

insights were instrumental in establishing the Defra/Research council funded collaborative centre of excellence in understanding and managing natural and environmental risks at Cranfield University in 2008 under a £1.25m Engineering and Physical Sciences Research Council (EPSRC) awarded to the candidate.

Section 7 Additional evidence of practical achievements

The University regulations provide for the submission of further practical evidence of achievement, over an above significant academic achievement, in considering the candidacy of a DSc applicant. The contributions in this section represent additional evidence in support of ten practical achievements made over the course of a 20 year research career in academia, environmental consultancy and environmental regulation. In each case, the candidate was a central contributor to the work, the research and policy significance of which is discussed. As a whole, they represent attempts to transfer many of the research insights discussed in the papers above into practical knowledge for end user communities. They offer a mixture of practitioner guidance, expert judgement, regulatory science and research in support of new regulatory initiatives on resource and environmental risk management. The discussion of each is supported by a shortlist of publications available in the open literature, cross-referenced from the candidate's career publications in the Appendix.

7.1 GUIDANCE ON RISK COMMUNICATION FOR CONTAMINATED LAND

The SNIFFER publication[145] (1999) presented in this section, co-authored with colleagues from Dames and Moore consultants and the environment agencies in Scotland, England and Wales represents early attempts in the UK to transfer the state-of-the-art on risk communication to the developing policy context of contaminated land legislation[239,270]. The guidance presented saw very wide application in the sector among contaminated land practitioners and an update has recently (2008) been commissioned. This and the contributions below on participatory risk assessment[96, 194] (section 7.5) resulted in the candidate being asked to draft guidelines on community consultation for contaminated sites in Australia, research currently underway[120, 131], in collaboration with the University of South Australia.

7.2 GUIDANCE ON RISKS FROM TOTAL PETROLEUM HYDROCARBONS

The development of soil guideline values (SGVs) for the assessment of land contamination in the UK has been long and drawn out. One of the most common site contaminants and source of known pollution incidents has been hydrocarbon-contaminated soils. Efforts in the US to adopt risk-based corrective action (RBCA) for petroleum contaminated soils (1996-) led to the development of guidance and later recommendations for assessing exposures from total petroleum hydrocarbons, under the auspices of the US-led Total Petroleum Hydrocarbon (TPH) Criteria Working Group. These two contributions[193, 200], authored principally by the candidate, represent the national consultation[193] on the approach to assessing risks from TPH at contaminated sites in the UK, and the development of a subsequent risk management framework[200] for TPH. Drawing heavily on the research insights described in sections 3 and 4 of this thesis, the consultation uniquely sets out guidance on the assessment of weathered hydrocarbons at these sites. Ongoing research discussions with the Environment Agency on the exposure assessment model used to generate soil guideline values is informing the development of SGVs for TPH[74]. The fugacity paper referred to in section 1 of this thesis[74] will be an important input to these discussions, so that the values generated are not unnecessarily conservative.

7.3 REVIEWING THE POST-CLOSURE SAFETY CASE FOR DRIGG

The UK has a single strategic facility for the disposal of low-level radioactive waste – the repository at Drigg, in Cumbria. From 1998 onward the candidate assumed responsibility for overseeing the technical review of the then operator's (BNFL) post-closure safety case[187, 190]; that is, BNFL's assessment of the radiological risks to public health and the environment following future closure of the facility once the site's radiological capacity is met (*ca.* 2050). Working closely with front line regulatory colleagues[190], radioactive waste risk analysts within the Agency[187], policy specialists and a group of external experts[93, 175, 176, 187], the candidate provided a technical review role to the Agency on the requirements of the post-closure risk assessment and on the reasonable requirements of this assessment to inform the decision on reauthorizing disposal at Drigg[190]. These contributions reflect the intellectual inputs to this process, and in particular, the candidate's desire to move away from a single, quantitative, deterministic risk curve with time (forward in time,

from closure, 100 000 years) to a more diagnostic risk assessment illustrating key risk drivers and, therefore, engineering features and operational practices that were candidates for regulatory control in the immediate term so to protect long term safety. The 2003 document here[190] has national significance because it represents the Environment Agency's qualified approval of the post-closure safety case and risk assessment, and thus informed the reauthorisation, with permit conditions, of the Drigg facility.

7.4 RISK ASSESSMENT REQUIREMENTS FOR UNDERGROUND WASTE STORAGE

This guidance[188] and expert evidence[185] represents original thought on the regulation of underground disposal facilities for hazardous wastes in the context of the European Council Landfill Directive (1999/31/EC). The 'Minosus' development[189] is the UK's only underground, as opposed to near-surface, hazardous waste facility. Unique regulatory guidance[188] for the developer of this facility was required during the planning process and drafted by the candidate and co-authors. Expert witness evidence to the planning inquiry for this facility was provided by the candidate[185], describing in technical detail the risk assessment requirements the Environment Agency would have on the operator during the future permitting of the facility. As development of the facility progressed through the planning stage and the various appeals that ensued, these contributions required substantive innovation in regulatory process, and the application of safety case methodologies for risk assessment, previously only applied to radioactive waste repositories in the UK. The candidate drafted these requirements for the Environment Agency and subsequently reviewed the operator's submissions[189]. Potentially controversial, because of the risk of a precedent for all hazardous waste facilities, the safety case approach[189] adopted proved instrumental to the environmental permitting of this national facility and to the avoidance of judicial review by opponents of its construction. In brief, the level of rigour required of the facility developer in assessing operational and future risks built confidence within the broader community in its robust regulatory oversight. This was the first time that a safety case approach had been applied to a hazardous waste facility in the UK.

Following this evidence, the candidate incorporated the interests of the local community within Agency-funded research on participatory risk assessment[194-196];

research devised and directed by the candidate and co-authored with researchers at the University of Birmingham (7.5 below).

7.5 ON THE PRACTICE OF PARTICIPATORY RISK ASSESSMENT

The shortcomings of a technocratic approach to risk analysis, in isolation of contributions from the broader social science agenda of environmental justice, equity and trust, has long been paraded in the risk literature. Despite the pragmatism referred to earlier in this thesis, the UK has been slow to adopt the deliberative-analytic approach to risk management developed, for example under the auspices of the US Presidential Commission on Risk Management (1997). Seeking to incorporate these aspects and building on the contribution in 7.1 above, the candidate directed research on participatory risk assessment collaboratively with the University of Birmingham and consultants Pat Delbridge Associates[96, 100, 194-196,] . The contributions developed build on the sentiments of Frank Fischer's 'greening of risk assessment' (1995). Using the qualitative research methods of structured interviews with triangulation of elicited data, this research[194] sought to understand where publics would wish to be involved in the risk assessment process (problem definition – framing, and risk characterisation), and to offer guidance to regulatory staff on involving others in risk assessment. Trials of similar approaches in the Environment Agency's flood risk and waste management functions indicated the practical challenges of eliciting engagement in this sort of technically complex and often inaccessible regulatory science[196]. Nevertheless, this research was able to recruit the community objectors from the Minosus waste facility above and, with them, explore in focus groups what engagement processes might work in practice. The co-authored literature review[194] and project reports represent the first attempts in the UK to respond to this agenda by environmental regulators. Though controversial at the time because of the inferred resource requirements, the UK has since ratified the United Nations Economic Commission for Europe (UNECE) convention on access to information, public participation in decision-making and access to justice in environmental matters (the Aarhus Convention), becoming a full party to the convention in May 2005. The Convention is an important step towards environmental democracy throughout the UNECE and tools like those developed under this project are in growing demand.

7.6 TOOLS FOR STRATEGIC RISK APPRAISAL

A recurrent theme for Government and environmental regulators over the last 10 years has been a requirement in the statute to report on the state of the environment, a necessity to compare a suite of diverse risks, and an operational need to advise on the proportionate use of resources to address environmental concerns. The contributions offered here[90, 95, 186, 202] represent the Environment Agency's development and application of strategic risk assessment tools. Nationally, the techniques[43, 80, 90, 95, 98, 178, 180, 186, 197, 202] saw use in the 2000 'State of The Environment' report for England and Wales and they have since influenced thinking in Defra. Intellectually, they extend the work of the German Advisory Council on Global Change (1999), seeking to defensibly incorporate an assessment of non-monetisable values within the strategic appraisal of environmental risk, and improve the visualisation of strategic risk issues on various probability-consequence axes[43]. Their application has not been straightforward, because end users need to climb a substantive learning curve on risk characteristics before they can rank strategic risk issues[197]. Nevertheless, the original thinking developed during their design and implementation has informed comparative risk assessment in the Environment Agency and revealed some hitherto ignored aspects of environmental risk, especially latent effects, the reversibility of environmental change and the spatial heterogeneity of impacts. Research directed and co-authored by the candidate in this theme produced one of the key publications discussed in Section 1 of this thesis, and strategic risk appraisal is a key research theme of the Defra/Research councils collaborative Centre of Excellence in understanding and managing natural and environmental risks, under the direction of the candidate at Cranfield University.

7.7 EXPOSURE ASSESSMENT METHODOLOGY FOR CARCASE DISPOSAL

The research contributions to this theme are discussed in section 5 above. The candidate has made significant practical contributions to the development of risk assessments for animal disease outbreaks. These include his membership of the core intergovernmental team drafting the Department of Health's qualitative risk assessment of health effects during the 2001 foot and mouth disease (FMD) outbreak and subsequent attendance at the Government's spongiform encephalopathy advisory committee (SEAC), to advise on risks to groundwater from carcase disposal during the

2001 FMD crisis. A single report is presented in this section[205]. It describes research advice to Defra on exposures to pathogenic and chemical agents across 28 disposal options for animal carcases. The research, currently being further developed, resulted in a shift of emphasis within Animal Health (Defra), away from a focus on suitable waste management technologies and towards one concerned with the significance of exposures along various points in a process chain. This has delivered greater flexibility for Defra in its use of waste treatment options and sharpened the focus on fast, effective management of exposures at source when exotic disease outbreaks occur.

7.8 UNDERPINNING THE QUALITY PROTOCOLS FOR WASTE-DERIVED PRODUCTS

A growing dissatisfaction with the capacity of conventional regulation to provide sufficient certainty and signals to the market has spawned new approaches to encouraging the uptake of waste-derived products. Under the theme of 'wastes as resources', the contribution offered here[211] adopts the generalised exposure assessment methodology developed in 7.7 above for anaerobic digestion (AD) residues being put to end use on land. This research is now underpinning the Environment Agency/WRAP specification for AD product end use, by providing stakeholder confidence in the safe and responsible use of AD residues on land. Pivotal to the exposure assessment has been (i) the prioritisation of risks by reference to hazard potency, environmental persistence and exposure pathway availability, and (ii) the visualisation of process risks so to identify critical control points. The exposure assessment methodology and output developed by the candidate has been used in the drafting of the quality protocols for AD producers, such that specification-compliant products can be brought to market with confidence. Success with this methodology has resulted in similar research on the use of compost products funded by WRAP.

7.9 RISK GOVERNANCE IN ANIMAL HEALTH LABORATORIES

The Institute for Animal Health (IAH) is a national strategic research facility for the study into exotic animal disease transmission. The laboratories at Pirbright, Surrey were subject to a series of Government reviews in 2007 following the release of FMD virus from the multiuser site at which the laboratories are situated. This section includes one of these reviews[164]: the 'Beringer report' to BBSRC council, of which the

candidate was a co-author and key contributor. Among the terms of reference for Sir John Beringer's review of IAH was the requirement to advise on issues of risk governance. The candidate was the key advisor to the review panel on these issues, offering recommendations to the panel on corporate risk management and its relationship with issues of biosecurity, the preserve of the related review led by Dr Martin Jeggo. The Beringer panel's recommendations have had national strategic implications for IAH and the retention of a national capability in exotic animal disease prevention. The specific recommendations on risk governance are of wide application across all research facilities and point to a need for a single 'line of sight' by the executive on issues of risk management, the need for clear accountabilities on issues of risk, and the maintenance of a risk management culture among all staff. In making these recommendations, the candidate was able to draw heavily on AwwaRF-funded research referred to in section 6 of this thesis.

7.10 REGULATING ENGINEERED NANOMATERIALS

One research report is presented here[220]. Manufactured nanomaterials are now widely used in a range of industrial and consumer products. However, they remain largely unregulated at present other than through voluntary disclosure agreements with the sector. This research report co-authored with Dr Sophie Rocks and others represents guidance to Defra of the risk assessment requirements for engineered nanomaterials. The research was commissioned by Defra, via international competition and prepared for the Organisation for Economic Co-operation and Development's (OECD) working party of manufactured nanomaterials (Rocks, S.A., *et. al.*, 2009, *in press*). A key recommendation of the work, directed by the candidate, has been the need for a formal weight of evidence framework for engineered and manufactured nanomaterials that can be integrated within the European chemicals (REACH - registration, evaluation, authorisation and restriction of chemicals) legislation, thus guiding manufacturers on the regulatory requirements of nano risk assessments in support of the societal use of these materials. This work has led directly to the development of a Cranfield responsible care (nanocode) initiative for the sector now established at the University.

REFERENCES

Published work presented for examination

Section 1 Overall value and significance of contribution

[38]**Pollard, S.J.T.**, Yearsley, R., Reynard, N., Meadowcroft, I.C., Duarte-Davidson, R. and Duerden, S. (2002) Current directions in the practice of environmental risk assessment in the United Kingdom, *Environ. Sci. Technol.* 36(4): 530-538

[43]**Pollard, S.J.T.,** Kemp R.V., Crawford, M., Duarte-Davidson, R., Irwin, J.G. and Yearsley R. (2004) Characterising environmental harm: developments in an approach to strategic risk assessment and risk management, *Risk Anal.*, 24(6): 1551-1560

[74]**Pollard, S.J.T.**, Hough, R.L., Kim, K-H, Bellarby, J., Paton, G., Semple, K.T. and Coulon, F. (2008) Fugacity modelling to predict the distribution of organic contaminants in the soil : oil matrix of constructed biopiles, *Chemosphere* 71: 1432-1439.

[77]MacGillivray, B.H. and **Pollard, S.J.T.** (2008) What can water utilities do to improve risk management within their business functions? An improved tool and application of process benchmarking, *Environ. Intl.* 34: 1120-1131

Section 2 Waste minimisation and resource management

[5]**Pollard, S.J.T.**, Fowler, G.F., Sollars, C.J. and Perry, R. (1992) Low-cost adsorbents for waste and wastewater treatment: a review, *Sci. Tot. Environ.*, 116: 31-52

[6]**Pollard, S.J.T.**, Sollars, C.J. and Perry, R. (1992) A clay-carbon adsorbent derived from spent bleaching earth: surface characterisation and adsorption of chlorophenols from aqueous solution, *Carbon*, 30 (4): 639-645

[11]**Pollard, S.J.T.**, Sollars, C.J. and Perry, R. (1993) The reuse of spent bleaching earth: a feasibility study in waste minimisation for the edible oil industry, *Biores. Technol.* 45(1): 53-58

[20]**Pollard, S.J.T.**, Thompson, F.E. and McConnachie, G.L. (1995) Microporous carbons from *Moringa oleifera* husks for water purification in developing countries, *Wat. Res.* 29(1): 337-347

[21]Warhurst, A.M., McConnachie, G.L. and **Pollard, S.J.T.** (1996) The production of activated carbon for water treatment in Malawi from the waste seed husks of *Moringa oleifera*, *Wat. Sci. Technol.* 34(11): 177-184

[27]Warhurst, A.M., McConnachie, G.L. and **Pollard, S.J.T.** (1997) Characterisation and applications of activated carbon produced from *Moringa oleifera* seed husks by single-step steam pyrolysis, *Wat. Res.*, 31(4): 759-766

[30]Warhusrt, A.M., Codd, G.A., McConnachie, G.L. and **Pollard, S.J.T.** (1997) Adsorption of microcystin-LR by a low-cost activated carbon from the seeds of the pan-tropical tree *Moringa oleifera*, *Sci. Tot. Environ.*, 207: 207-211

[31]Warhurst, A.M., Fowler, G.D., McConnachie, G.L. and **Pollard, S.J.T.** (1997) Pore structure and adsorption characteristics of steam pyrolysis carbons from *Moringa oleifera*, *Carbon*, 35(8): 1039-1045

[4]**Pollard, S.J.T.**, Montgomery, D.M., Sollars, C.J. and Perry, R. (1991) Organic compounds in the cement-based stabilization / solidification of hazardous mixed wastes: mechanistic and process considerations, *J. Haz. Mat.*, 28(3): 313-327

[16]**Pollard, S.J.T.**, Hills, C.D. and Kennedy, J. (1994) Preliminary examination of mechanistic control during the cement-based solidification / stabilisation of flue gas desulphurisation waste and pulverised fuel ash, *Environ. Technol.* 15(7): 617-630

[24]Hills, C.D. and **Pollard, S.J.T.** (1997) The influence of interference effects on the mechanical, microstructural and fixation characteristics of cement-solidified hazardous waste forms, *J. Haz. Mat.*, 52: 171-191

[13]**Pollard, S.J.T.**, Hrudey, S.E. and Fedorak, P.M. (1994) Bioremediation of petroleum- and creosote-contaminated soils: a review of constraints, *Waste Manage. Res.*, 12: 173-194

[40]Stephenson, T., **Pollard, S.J.T.,** Cartmell, E. (2004) Feasibility of biological aerated filters (BAFs) for treating landfill leachate, *Environ. Technol.* 25: 349-354

[46]Hurst, C., Longhurst, P., **Pollard, S.,** Smith, R., Jefferson, B. and Gronow, J. (2005) Assessment of municipal waste compost as daily cover material for odour control at landfill sites, *Environ. Pollut.* 135: 171-177

[54]Gottberg, A., Morris, J., **Pollard, S.**, Mark-Herbert, C. and Cook, M. (2006) Producer responsibility, waste minimisation and the WEEE Directive: case

studies in eco-design from the European lighting sector, *Sci. Tot. Environ.* 359: 38-56.

[62]Hall D.H., Drury D., Gronow J.R., Rosevear A., **Pollard S.J.T.** and Smith R. (2006). Estimating pollutant removal requirements for landfills in the UK: I. Benchmark study and characteristics of waste treatment technologies. *Environ. Technol.* 27 (12): 1309-1321.

[63]Hall D.H., Drury D., Gronow J.R., Rosevear A., **Pollard S.J.T.** and Smith R. (2006). Estimating pollutant removal requirements for landfills in the UK: II. Model development. *Environ. Technol.* 27 (12): 1323-1333.

[68]Husaini, I.G., Garg, A., Kim, K.H., Marchant, J., **Pollard, S.J.T.** and Smith, R. (2007) European household waste management schemes: their effectiveness and applicability in England, *Res. Conserv. Recyl.* 51: 248-263

[70]M.P.M. Taha, G.H. Drew, A. Tamer Vestlund, D. Aldred, P.J. Longhurst, and **S.J.T Pollard** (2007) Enumerating actinomycetes in compost bioaerosols at source – use of compost agar to address plate masking, *Atmos. Environ* 41: 4759-4765 *(short communication)*

[71]Raffield, T., Herben, M., Billington, S., Longhurst, P. and **Pollard, S.** (2007) Coupling hidden flows and waste generation for enhanced materials flow accounting, *Comm. Waste Resource Manage.* 8(1): 12-18.

Section 3 Analysis of complex environmental media

[7]**Pollard, S.J.T.**, Hrudey, S.E., Fuhr, B.J., Alex, R.F., Holloway, L.R. and Tosto, F. (1992) Hydrocarbon wastes at petroleum and creosote-contaminated sites: rapid characterisation of class components by thin layer chromatography with flame ionization detection, *Environ. Sci. Technol.*, 26(12): 2528-2534

[14]**Pollard, S.J.T.**, Kenefick, S.L., Hrudey, S.E., Fuhr, B.J., Holloway, L.R. and Rawluk, M. (1994) A tiered analytical protocol for the characterisation of heavy oil residues at petroleum-contaminated hazardous waste sites. In: *Analysis of soil contaminated with petroleum constituents, ASTM STP 1221*, T. A. O'Shay and K.B. Hoddinott (Eds.), American Society for Testing and Materials, Philadelphia, 1994: 38-52

[41]**Pollard, S.J.T.,** Hrudey, S.E., Rawluk, M. and Fuhr, B.J. (2004) Characterisation of weathered hydrocarbon wastes at contaminated sites by GC-simulated distillation and nitrous oxide chemical ionisation GC/MS, with implications for bioremediation, *J. Environ. Monit.* 6(8): 713-718.

[28]Zemanek, M.G., **Pollard, S.J.T.,** Kenefick, S.L. and Hrudey, S.E. (1997) Toxicity and mutagenicity of component classes isolated from soils at petroleum- and creosote-contaminated sites, *J. Air Waste Manage. Assoc.*, 47(12): 1250-1258

[15]Whittaker, M. and **Pollard, S.J.T.** (1994) Characterisation of refractory wastes at hydrocarbon- contaminated sites I: thin layer chromatography of reference oils, *J. Planar Chromatog.* 7(5): 354-361

[19]Whittaker, M., **Pollard, S.J.T.** and Fallick, A.E. (1995) Characterisation of refractory wastes at heavy oil-contaminated sites: a review of conventional and novel analytical methods, *Environ. Technol.* 16: 1009-1033

[23]Whittaker, M., **Pollard, S.J.T.**, Fallick, A.E. and Preston, T. (1996) Characterisation of refractory wastes at hydrocarbon-contaminated sites II: screening of reference oils by stable carbon isotope fingerprinting, *Environ. Pollut.*, 94(2): 195-203

[12]Dale, M.J., Jones, A.C., **Pollard, S.J.T.** and Langridge-Smith, P.R.R. (1994) Direct determination of polycyclic aromatic hydrocarbons in environmental matrices using photoionisation time-of-flight mass spectrometry, *The Analyst*, 119: 571-578

[8]Dale, M.J., Jones, A.C., **Pollard, S.J.T.**, Langridge-Smith, P.R.R. and Rowley, A.G. (1993) Application of two-step laser mass spectrometry to the analysis of polynuclear aromatic hydrocarbons in contaminated soils, *Environ. Sci. Technol.*, 27(8): 1693-1695

[22]**Pollard, S.J.T.**, Obbard, J.P. and Farmer, J.G. (1996) Natural and anthropogenic components in soil: an examination of recent applications and future data requirements, *Geoscientist*, 6(2): 20-24

[26]Whittaker, M. and **Pollard, S.J.T.** (1997) A performance assessment of source correlation and weathering indices for petroleum hydrocarbons in the environment, *Environ. Toxicol. Chem.*, 16(6): 1149-1158

[37]**Pollard S.J.T**., Farmer, J.G., Knight, D.M. and Young, P.J. (2002) Matrix effects in applying mono- and polyclonal ELISA systems to the analysis of weathered oils in contaminated soil, *Environ. Pollut.*, 117(1): 5-8

[50]M.P.M. Taha, G.H. Drew, P.J. Longhurst, R. Smith and **S.J.T Pollard** (2006) Bioaerosol releases from compost facilities: evaluating passive and active source terms at a green waste facility for improved risk assessment, *Atmos. Environ.*, 40: 1159-1169

[47]M.P.M.Taha, **S.J.T Pollard**, U. Sarkar and P. Longhurst (2005) Estimating fugitive bioaerosol releases from static compost windrows: feasibility of a portable wind tunnel approach, *Waste Manage.* 25: 445-450 (invited)

[69]Taha, M.P.M., Drew, G.H., Tamer, A., Hewings, G., Jordinson, G.M., Longhurst, P.J. and **Pollard, S.J.T.** (2007) Improving bioaerosol exposure assessments of composting facilities – comparative modelling of emissions from different compost ages and processing activities. *Atmos. Environ.* 41: 4504-4519.

[55]R.L. Hough, M. Whittaker, **S.J.T. Pollard**, A.E. Fallick, T. Preston and J.G. Farmer (2006) Identifying source correlation parameters for hydrocarbon wastes using compound-specific isotope analysis, *Environ. Pollut.* 143(3): 489-498

[76]Koh, Y.K.K., Chiu, T.Y., Boobis, A.R., Cartmell, E., **Pollard, S.J.T.**, Scrimshaw, M.D., Lester, J.N. (2008) A sensitive and robust method for the determination of alkylphenol polyethoxylates and their carboxylic acids and their transformation in a trickling filter wastewater treatment plant, *Chemosphere* 73(4) 551-556.

[78]Risdon, G.C., **Pollard, S.J.T.**, Brassington, K.J., McEwan, J.N., Paton, G.I., Semple, K.T. and Coulon, F. (2008) Development of a novel and robust analytical procedure for weathered hydrocarbon contaminated soils within a UK risk-based framework, *Anal. Chem.* 80: 7090 -7096

Section 4 Fate and behaviour of hydrocarbons in the multimedia environment

[25]Zemanek, M.G., **Pollard, S.J.T.**, Kenefick, S.L. and Hrudey, S.E. (1997) Multiphase partitioning and co-solvent effects for polynuclear aromatic hydrocarbons (PAH) in authentic petroleum- and creosote-contaminated soils, *Environ. Pollut.*, 98(2): 239-252

[33]**Pollard, S.J.T.**, Whittaker, M. and Risdon, G.C. (1999) The fate of heavy oil in soil microcosms I: a performance assessment of biotransformation indices, *Sci. Tot. Environ.,* 226(1): 1-22

[34]Whittaker, M., **Pollard, S.J.T.** and Risdon, G.C. (1999) The fate of heavy oil in soil microcosms II: a performance assessment of source correlation indices, *Sci. Tot. Environ.,* 226(1): 23-32

[148]**Pollard, S.J.T.** and Duarte-Davidson, R. (2001) Linking pollutant transport, environmental forecasting and risk assessment: case studies from the geosphere. *Chapter 5*. In*: Forecasting the environmental fate and effects of chemicals*, Rainbow, P.S., Hopkin, S.P. and Crane, M. (eds.) John Wiley & Sons, Chichester, ISBN 0 471 49179 9: 55-70 (invited)

[161]**Pollard, S.J.T** and Kibblewhite, M.G. (2006) *Soils and land contamination. Chapter 4*. In Harrison, R.M. (ed.) *An introduction to pollution science*, RSC Publishing, Royal Society of Chemistry, Cambridge, ISBN-10: 0-85404-829-4, pp. 122-151 (invited)

[56]Shafi, S., Sweetman, A. Hough, R.L., Smith, R., Rosevear, A. and **Pollard, S.J.T.** (2006) Evaluating fugacity models for trace components in landfill gas. *Environ. Pollut.* 144: 1013-1023

[81]Coulon, F., Orsi, R., Turner, C., Walton, C., Daly, P. and **Pollard, S.J.T.** (2009) Understanding the fate and transport of petroleum hydrocarbons from coal tar within gasholders, *Environ. Intl*. 35(2): 248-252

Section 5 Environmental risk management

[9]Hrudey, S.E. and **Pollard, S.J.T.** (1993) The challenge of contaminated sites: remediation approaches in North America, *Environ. Rev.* 1(1): 55-72

[10]**Pollard, S.J.T.**, Hoffmann, R.E. and Hrudey, S.E. (1993) Screening of risk management options for abandoned wood-preserving plant sites in Alberta, Canada, *Can. J. Civ. Eng.* 20(5): 787-800

[17]Harrop, D.O. and **Pollard, S.J.T.** (1994) Environmental assessment and risk assessment of an incineration plant - a case study, *Clean Air* 24(4): 159-163

[18]**Pollard, S.J.T.**, Harrop, D.O., Crowcroft, P., Mallett, S.H., Jefferies, S.R., and Young, P.J. (1995) Risk assessment for environmental management: approaches and applications, *J. CIWEM*, 9(6): 621-628

[29]Young, P.J., **Pollard, S.J.T.** and Crowcroft, P. (1997) Overview: context, calculating risk and using consultants, *Issues in Environ. Sci. Technol.*, 7: 1-22

[32]Harrop, D.O. and **Pollard, S.J.T.** (1998) Risk assessment and waste-to-energy plants (incineration). Quantitative risk assessment for incineration: is it appropriate for the UK? *J CIWEM*, 12(1): 48-53

[44]**Pollard, S.** (2004) Human health risk assessments for contaminated sites: a retrospective view and forward look, *Land Contam. Reclam.*, 12(4): 329-337 (invited)

[42]**S.J.T. Pollard,** J.E. Strutt, B.H. MacGillivray, P.D. Hamilton and S.E. Hrudey (2004) Risk analysis and management in the water utility sector – a review of drivers, tools and techniques, *Trans. IChemE Part B: Process Saf. Environ. Protect.*, 82(B6): 453-462 (invited)

[45]Gray, D., **Pollard, S.J.T.,** Spence, L., Smith, R. and Gronow, J. (2005) Spray irrigation of landfill leachate: estimating potential exposures to workers and bystanders using a modified air box model and generalised source term, *Environ. Pollut.* 133: 587-599.

[48]**S.J.T Pollard**, R. Duarte-Davidson, K. Askari and E. Stutt (2005) Managing the risks from petroleum hydrocarbons at contaminated sites: achievements and future research directions, *Land Contam. Reclam*. 13(2): 115-122 (invited)

[49]Smith, R., **Pollard, S.J.T.,** Weeks, J.M. and Nathanial, C.P. (2005) Assessing significant harm to terrestrial ecosystems from contaminated land, *J. Soil Use Manage.* 21: 527-540 (invited).

[57]Duarte-Davidson, R. and **Pollard, S.** (2006) Guest editorial – environmental risk management: the state of the art *Environ. Intl.* 32: 931-933

[58]Hrudey, S.E., Hrudey, E. and **Pollard, S.J.T.** (2006) Risk management for assuring safe drinking water *Environ. Intl.* 32: 948-957 (invited)

[52]MacGillivray, B.H., Hamilton, P.D., Strutt, J.E. and **Pollard, S.J.T.** (2006) Risk analysis strategies in the water utility sector: an inventory of applications for

better and more credible decision making, *Crit. Rev. Environ. Sci. Technol.* 36: 85-139.

[59]Hamilton, P.D., Gale, P. and **Pollard, S.J.T.** (2006) A commentary on recent water safety initiatives in the context of water utility risk management, *Environ. Intl.* 32: 958-966 (invited)

[60]**Pollard, S.J.T.**, Smith, R., Longhurst, P.J., Eduljee, G. and Hall, D. (2006) Recent developments in the application of risk analysis to waste technologies, *Environ. Intl.* 32: 1010-1020 (invited)

[53]Macleod C., Duarte-Davidson R., Fisher B., Ng B., Willey D., Shi J.P., Martin I., Drew G. and **Pollard S**. (2006) Modelling human exposures to air pollution control (APC) residues released from landfills in England and Wales, *Environ. Intl.* 32: 500-509.

[65]Brassington, K.J., Hough, R.L., Paton, G.I., Semple, K.T., Risdon, G.C., Crossley, J., Hay, I., Askari, K. and **Pollard, S.J.T.** (2007) Weathered hydrocarbon wastes – a risk management primer, *Crit. Rev. Environ. Sci. Technol.* 37(3): 199-232

[73]Kim, K.H., Hall, M.L., Hart, A. and **Pollard, S.J.T.** (2008) A survey of green burial sites in England and Wales and an assessment of the feasibility of a groundwater vulnerability tool, *Environ. Technol.* 29(1): 1-12.

[75]**Pollard, S.J.T**., Hickman, G.A.W., Irving, P., Hough, R.L., Gauntlett, D.M., Howson, S., Hart, A., Gayford, P. and Gent, N. (2008) Exposure assessment of carcase disposal options in the event of a notifiable exotic animal disease – methodology and application to avian influenza virus, *Environ. Sci. Technol*. 42(9): 3145-3154

Section 6 Environmental policy, regulation and governance

[35]**Pollard, S.J.T.** (2001) An overview of the use of risk assessment for environmental regulation in the UK – key drivers and regulatory initiatives, *Risk, Decision & Policy* 6: 33-46

[36]**Pollard, S.J.T.,** Lythgo, M. and Duarte-Davidson, R. (2001) The extent of contaminated land problems and the scientific response. In: Hester R. and Harrison, R. (eds.) Assessment and reclamation of contaminated land, *Issues in Environ. Sci. Technol.* 16: 1-19

[39]**Pollard, S.J.T.**, Brookes, A., Earl, N., Lowe, J., Kearney, T. and Nathanail, C.P. (2004) Integrating decision tools for the sustainable management of land contamination, *Sci. Total Environ.* 325(1-3): 15-28

[51]E. Cartmell, P. Gostelow, D. Riddell-Black, N. Simms, J. Oakey, J. Morris, P. Jeffrey, P. Howsam and **S.J. Pollard** (2006) Biosolids – a fuel or a waste? An integrated appraisal of five co-combustion scenarios with policy analysis, *Environ. Sci. Technol.* 40(3): 649-658

[158]**Pollard, S.J.T.** and Young, P.J. (2006) Chapter 10. Environmental risk management. In: *The risk management universe – a guided tour*, Hillson, D. (ed.) British Standards Institution, London, ISBN 0 580 43777 9, pp.239-263 (invited)

[160]**S.J.T. Pollard,** J.E. Strutt, B.H. MacGillivray, J.V. Sharp, S.E. Hrudey and P.D. Hamilton (2006) Risk management capabilities – towards mindfulness for the international water utility sector. In: *Water contamination emergencies: enhancing our response*, Thompson, K.C. and Gray, J. (eds.), Royal Society of Chemistry Publishing, Cambridge, ISBN 0 85404 658 5, pp.70-80 (invited)

[61]MacGillivray, B.H., Hamilton, P.D., Hrudey, S.E., Reekie, L. and **Pollard, S.J.T**. (2006) Benchmarking risk analysis practice in the international water sector. *Water Practice Technol.* 1(2): doi: 10.2166/WPT.2006024 <on-line only>

[64]Hall D.H., Drury D., Gronow J.R., Rosevear A., **Pollard S.J.T.** and Smith R. (2007). Estimating pollutant removal requirements for landfills in the UK: III. Policy analysis and operational implications. *Environ. Technol.* 28 (1): 25-32.

[72]Garg A., Smith R., Hill D., Simms N. and **Pollard S**. (2007). Wastes as co-fuels: the policy framework for solid recovered fuel (SRF) in Europe, with UK implications, *Environ. Sci. Technol.* 41(14): 4868-4874

[66]B.H. MacGillivray, J.V. Sharp, J.E. Strutt, P.D. Hamilton and **S.J.T Pollard** (2007) Benchmarking risk management within the international water utility sector. Part I: design of a capability maturity methodology, *J. Risk Research* 10(1): 85-104

[67]B.H. MacGillivray, J.V. Sharp, J.E. Strutt, P.D. Hamilton and **S.J.T Pollard** (2007) Benchmarking risk management within the international water utility sector. Part II: a survey of eight water utilities, *J. Risk Research* 10(1): 105-123

Other work presented for examination - evidence of practical achievements

Section 7 Additional evidence of practical achievements

7.1 Guidance on risk communication for contaminated land

[145]Kemp, R., **Pollard, S**., Forster, V., Herbert, S. (1999) Communicating understanding of contaminated land risks, Scotland and Northern Ireland Forum for Environmental Research, Edinburgh, Scotland, 30pp.

7.2 Guidance on risks from total petroleum hydrocarbons

[193]Environment Agency (2003) *Principles for evaluating the human health risks from petroleum hydrocarbons in soils: a consultation paper*, prepared by **S J T Pollard**, Cranfield University, research report P5-080/TR1, Environment Agency, Bristol, ISBN 1 84432 016 2, 37pp.

[200]**Pollard, S.** and Askari, K. (2005) *The UK approach for evaluating the human health risks from petroleum hydrocarbons in soils,* Environment Agency science report P5-080/TR3, ISBN 1 84432 342 0, Environment Agency, Bristol, 22pp.

7.3 Reviewing the post-closure safety case for Drigg

[93]Wilmot, R., **Pollard, S.J.T**., Smith, R.E., Yearsley, R. and Galson, D.A. (1999) Transparency in risk assessments – presenting the 'expectation value' of post-closure risks from radioactive waste repositories. In : Anderson, K. (ed.) *Proc. 1st VALDOR symposium in the RISCOM programme addressing transparency in risk assessment and decision making*, Stockholm, Sweden, June 13-17, 1999: 129-136

[183]Duerden, S.L., Streatfield, I.J., **Pollard, S.J.T**., Bennett, D.G. and Galson, D.G. (2001) *Assessment of the post-closure safety case development programme for the Drigg low-level radioactive waste disposal site: Phase II – review of the status report on the development of the 2002 Drigg post closure safety case*, National Centre for Risk Analysis and Options Appraisal, position paper 25, Environment Agency, London, 72pp.

[190]R A Yearsley, I J Streatfield, S L Duerden, **S J T Pollard**, D G Bennett and D A Galson (2003) *Assessment of the post-closure safety case development programme for the Drigg low-level radioactive waste disposal site: phase II*

overview, Environment Agency, Centre for Risk and Forecasting position paper 26, Reading, 29pp.

7.4 Risk assessment requirements for underground waste storage

[185]**Pollard, S.J.T.** (2001) *Expert witness statement on environmental risk assessment on behalf of the Environment Agency* in relation to the Town and Country Planning Act 1990 (Section 77) application by Minosus Limited 4/34566, Winsford Rock Salt Mine, Jack Lane, Bostock, Middlewich, 6pp.

[188]Environment Agency (2002) *Guidance note 1: safety philosophy for underground disposal activities*. Annex to schedule 4 notice to Minosus Limited under the Pollution, Prevention and Control Act, 1999 and The Pollution Prevention and Control Regulations 2000, (prepared by **S.J.T. Pollard**, D. Newberry, R. Marshall and R. Yearsley), dated 30th August, 2002, 9 pp.

7.5 On the practice of participatory risk assessment

[96]Homan, J., Petts, J., **Pollard, S.J.T**. and Twigger-Ross, C. (2001) Participatory risk assessment for environmental decision-making. In: *Proc. VALDOR 2001 - the 2nd VALDOR symposium addressing transparency in risk assessment and decision making*, K. Anderson (ed.), 10-14 June, Stockholm, Sweden, 2001: 398-406

[194]Petts. J., Homan, J. and **Pollard, S**. (2003) *Participatory risk assessment – involving lay audiences in decisions on risk: literature review and stakeholder interviews*, Environment Agency, R&D publication E2-043/TR, Environment Agency, Bristol, UK, ISBN 1 85705 913 1, 97pp.

7.6 Tools for strategic risk appraisal

[90]Duarte-Davidson, R., **Pollard, S.J.T**., Yearsley, R., Llewllyn, G. and Steele, J. (1999) Considering 'environmental harm': qualitative and semi-quantitative treatments for strategic risk assessment. In: *Risk analysis: facing the new millennium*, (ed. L.H.J. Goossens), Proc. 9th annual conference, Rotterdam, October 10-13, 1999, Delft University Press: 231-235

[95]**Pollard, S.J.T.**, Duarte-Davidson, R., Yearsley, R., Kemp, R. and Crawford, M. (2001) Strategic risk assessment: a decision tool for complex decisions. In *Proc. VALDOR 2001 - the 2nd VALDOR symposium addressing transparency in risk assessment and decision-making*, K. Anderson (ed.), 10-14 June, Stockholm, Sweden, 2001: 296-303

[186]Kemp, R.V., Crawford, M.B., **Pollard, S.J.T.,** Twigger-Ross, C., Fisher, J. and Weatherley, N. (2002) *Strategic risk assessment: phase II*, Environment Agency R&D project E2-041/TR, Environment Agency, Bristol, ISBN 1 85705 674 4, 150pp.

[202]Environment Agency (2005) *Informing strategic decisions with comparative risk assessment: a literature review*. Science report RIS-05-01. Prepared for the Environment Agency by **S.J.T. Pollard**, Cranfield University Integrated Waste Management Centre, Environment Agency, Bristol, ISBN 1 844 325 199, 46pp.

7.7 Exposure assessment methodology for carcase disposal

[205]Department for Food, Environment and Rural Affairs (2007) *A risk-based review of carcass disposal options in the event of a notifiable exotic animal disease - methodology and application to avian influenza*, version 0.9, prepared by Prof. **S.J.T. Pollard** for the State Veterinary Service, Contingency Planning Division, Contingency Plans and Disposals Branch, Defra, London, 32pp. with appendices., published, with peer review at: http://www.defra.gov.uk/animalh/diseases/control/contingency/index.htm

7.8 Underpinning the quality protocols for waste-derived products

[211]**Pollard, S.**, Tyrrel, S., Longhurst, P., Villa, R. and Sweet, N. (2008) *A generalised exposure assessment of anaerobic digestion products in various end-use settings*, WRAP and Environment Agency project OFW002, Cranfield University, School of Applied Sciences, Centre for Resource Management and Efficiency, 38pp. + appendices.

7.9 Risk governance at the Government's animal health laboratory

[164]Beringer, J., Gull, K., Minson, A., Penman, A., **Pollard, S**., Raymond, M. and Simmons, A. (2008) Review of Institute for Animal Health funding, governance and risk management, A report for BBSRC Council, BBSRC, Swindon, 44pp. at: www.bbsrc.ac.uk/organisation/policies/reviews/operational/0804_iah_governance.html

7.10 Regulating engineering nanomaterials

[220]Rocks, S., **Pollard, S.,** Dorey, R., Levy, L., Harrison, P. and Handy, R. (2008) Comparison of risk assessment approaches for manufactured nanomaterials, Report to the Department for Environmental, Food and Rural Affairs (Project CB403), 104pp. available at: http://randd.defra.gov.uk/Document.aspx?Document=CB0403_7306_ABS.doc

APPENDIX

Full list of career communications 1990 -2009

Publications accepted and in press

K.J. Brassington, **S.J.T. Pollard** and F. Coulon (2009) Weathered hydrocarbon biotransformation: implications for bioremediation, analysis and risk assessment. In *Handbook of hydrocarbon and lipid microbiology*, Timmis, K.N. (ed.), Springer, ISBN: 978-3-540-77588-1, *in press (invited)*

Pollard, S., Lemon, M., Davies, G., Coley, F., Irving, P., White, M., Foan, C., Whitfield, A. (2009) *Evaluating and improving the effectiveness of risk based decisions*. Project record SC070055, Environment Agency, Bristol, 63pp, *in press*

Pollard, S.J.T., Bradshaw, R., Tranfield, D., Charrois, J.W.A., Cromar, N., Jalba, D., Hrudey, S.E., Abell, P. and Lloyd, R. (2009) *Developing a risk management culture – 'mindfulness' in the international water utility sector*, Awwa Research Foundation Research Report 3184, Awwa Research Foundation, American Water Works Association and IWA Publishing, Denver, CO, *in press*.

Bradshaw, R.A. and **Pollard, S.J.T.** (2009) Evaluating cause-effect relationships and impact of incidents – a learning approach for operations and asset management. In: *3rd Water Contamination Emergencies Conference – Collective Responsibility*, RSC Publishing, Cambridge, UK, *in press (invited)*

S.J.T. Pollard (2009) Disposing of diseased animals. Chapter 62. In: *Environmental Medicine*, J. Ayres, R. Harrison, G. Nichols and R. Maynard (eds.), Hodden Arnold, London, *in press (invited)*

Drew, G.H., Deacon, L.J., Pankhurst, L., **Pollard, S.J.T.** and Tyrrel, S.F. (2009) *Guidance of the evaluation of bioaerosol risk assessments for composting facilities,* Cranfield University, Centre for Resource Management and Efficiency, prepared for the Environment Agency, 35pp., in press

C.A. Velis, P.J. Longhurst, G.H. Drew, R. Smith and **S.J.T. Pollard** (2009a) Biodrying for mechanical-biological treatment of wastes: a review of process science and engineering *Bioresource Technol.* 100: 2747-2761

C.A. Velis, P.J. Longhurst, G.H. Drew, R. Smith and **S.J.T. Pollard** (2009b) Production and quality assurance of solid recovered fuels using mechanical biological treatment (MBT) of waste: a comprehensive assessment, *Crit. Rev. Environ. Sci. Technol., in press.*

S.A. Rocks, R. Owen, **S.J. Pollard,** R.A. Dorey, P.T.C. Harrison, L.S. Levy, R.D. Handy, J.F. Garrod (2009) Risk assessment of manufactured nanomaterials. In: J. Lead, E. Smith (eds) *Environmental and human health effects of nanoparticles*, Blackwell Science, *in press (invited)*

Drew, G.H., Nogami, A., Tamer Vestlund, A., Pankhurst, L., Seymour, I., Batty, W., Deacon, L.J., **Pollard, S.J.T.** and Tyrrel, S.F. (2009) Monitoring and variation of bioaerosols at composting facilities using conventional and novel samplers.. In: *Proc. Cranfield multi-strand conference: creating wealth through research and innovation (CMC 2008)*, Cranfield University, Bedfordshire UK, 6-7th May, 2008, *in press*

Garg, A., Smith, R., Hill, D., **Pollard, S**., Longhurst, P.J. and Simms, N. (2009) An integrated appraisal of energy recovery options from municipal waste derived solid recovered fuel (SRF) *Waste Management, in press*

Williams, A., Temple, T., **Pollard, S.J.T.**, Jones, R.J.A. and Ritz, K. (2008) Environmental considerations for common burial site selection after pandemic events. In: *Criminal and environmental soil forensics*, K. Ritz, L. Dawson and D. Miller (eds.), Springer, Dordrecht, Netherlands, ISBN 978-1-4020-9203-9, *in press (invited)*

Refereed journal papers

1. **Pollard, S.J.T.,** Sollars, C.J. and Perry, R. (1990) The reuse of spent bleaching earth for the stabilization / solidification of hazardous mixed wastes, *Environ. Technol.,* 11(12): 1113-1122
2. **Pollard, S.J.T.**, Sollars, C.J. and Perry, R. (1991) A low-cost adsorbent from spent bleaching earth I : the selection of an activation procedure, *J. Chem. Tech. Biotechnol.*, 50(2): 265-276
3. **Pollard, S.J.T.**, Sollars, C.J. and Perry, R. (1991) A low-cost adsorbent from spent bleaching earth II : optimization of the zinc chloride activation procedure, *J. Chem. Tech. Biotechnol.,* 50(2): 277-292
4. **Pollard, S.J.T.**, Montgomery, D.M., Sollars, C.J. and Perry, R. (1991) Organic compounds in the cement-based stabilization / solidification of hazardous mixed wastes: mechanistic and process considerations, *J. Haz. Mat.*, 28(3): 313-327
5. **Pollard, S.J.T.**, Fowler, G.F., Sollars, C.J. and Perry, R. (1992) Low-cost adsorbents for waste and wastewater treatment: a review, *Sci. Tot. Environ.,* 116: 31-52
6. **Pollard, S.J.T.**, Sollars, C.J. and Perry, R. (1992) A clay-carbon adsorbent derived from spent bleaching earth : surface characterisation and adsorption of chlorophenols from aqueous solution, *Carbon,* 30 (4) : 639-645
7. **Pollard, S.J.T.**, Hrudey, S.E., Fuhr, B.J., Alex, R.F., Holloway, L.R. and Tosto, F. (1992) Hydrocarbon wastes at petroleum and creosote-contaminated sites: rapid characterisation of class components by thin layer chromatography with flame ionization detection, *Environ. Sci. Technol.,* 26(12): 2528-2534
8. Dale, M.J., Jones, A.C., **Pollard, S.J.T.**, Langridge-Smith, P.R.R. and Rowley, A.G. (1993) Application of two-step laser mass spectrometry to the analysis of polynuclear aromatic hydrocarbons in contaminated soils, *Environ. Sci. Technol.,* 27(8): 1693-1695
9. Hrudey, S.E. and **Pollard, S.J.T.** (1993) The challenge of contaminated sites: remediation approaches in North America, *Environ. Rev.* 1(1): 55-72
10. **Pollard, S.J.T.**, Hoffmann, R.E. and Hrudey, S.E. (1993) Screening of risk management options for abandoned wood-preserving plant sites in Alberta, Canada, *Can. J. Civ. Eng.* 20(5): 787-800
11. **Pollard, S.J.T.**, Sollars, C.J. and Perry, R. (1993) The reuse of spent bleaching earth: a feasibility study in waste minimisation for the edible oil industry, *Biores. Technol.* 45(1): 53-58
12. Dale, M.J., Jones, A.C., **Pollard, S.J.T.** and Langridge-Smith, P.R.R. (1994) Direct determination of polycyclic aromatic hydrocarbons in environmental matrices using photoionisation time-of-flight mass spectrometry, *The Analyst,* 119: 571-578
13. **Pollard, S.J.T.**, Hrudey, S.E. and Fedorak, P.M. (1994) Bioremediation of petroleum- and creosote-contaminated soils: a review of constraints, *Waste Manage. Res.*, 12: 173-194
14. **Pollard, S.J.T.**, Kenefick, S.L., Hrudey, S.E., Fuhr, B.J., Holloway, L.R. and Rawluk, M. (1994) A tiered analytical protocol for the characterisation of heavy oil residues at petroleum-contaminated hazardous waste sites. In: *Analysis of soil contaminated with petroleum constituents, ASTM STP 1221*, T. A. O'Shay and K.B. Hoddinott (Eds.), American Society for Testing and Materials, Philadelphia, 1994: 38-52
15. Whittaker, M. and **Pollard, S.J.T.** (1994) Characterisation of refractory wastes at hydrocarbon- contaminated sites I: thin layer chromatography of reference oils, *J. Planar Chromatog.* 7(5): 354-361
16. **Pollard, S.J.T.**, Hills, C.D. and Kennedy, J. (1994) Preliminary examination of mechanistic control during the cement-based solidification / stabilisation of flue gas desulphurisation waste and pulverised fuel ash, *Environ. Technol.* 15(7): 617-630
17. Harrop, D.O. and **Pollard, S.J.T.** (1994) Environmental assessment and risk assessment of an incineration plant - a case study, *Clean Air* 24(4): 159-163
18. **Pollard, S.J.T.**, Harrop, D.O., Crowcroft, P., Mallett, S.H., Jefferies, S.R., and Young, P.J. (1995) Risk assessment for environmental management: approaches and applications, *J. CIWEM,* 9(6): 621-628
19. Whittaker, M., **Pollard, S.J.T.** and Fallick, A.E. (1995) Characterisation of refractory wastes at heavy oil-contaminated sites: s review of conventional and novel analytical methods, *Environ. Technol.* 16: 1009-1033

20. **Pollard, S.J.T.**, Thompson, F.E. and McConnachie, G.L. (1995) Microporous carbons from *Moringa oleifera* husks for water purification in developing countries, *Wat. Res.* 29(1): 337-347
21. Warhurst, A.M., McConnachie, G.L. and **Pollard, S.J.T.** (1996) The production of activated carbon for water treatment in Malawi from the waste seed husks of *Moringa oleifera*, *Wat. Sci. Technol.* 34(11): 177-184
22. **Pollard, S.J.T.**, Obbard, J.P. and Farmer, J.G. (1996) Natural and anthropogenic components in soil: an examination of recent applications and future data requirements, *Geoscientist*, 6(2): 20-24
23. Whittaker, M., **Pollard, S.J.T.**, Fallick, A.E. and Preston, T. (1996) Characterisation of refractory wastes at hydrocarbon-contaminated sites II: screening of reference oils by stable carbon isotope fingerprinting, *Environ. Pollut.*, 94(2): 195-203
24. Hills, C.D. and **Pollard, S.J.T.** (1997) The influence of interference effects on the mechanical, microstructural and fixation characteristics of cement-solidified hazardous waste forms, *J. Haz. Mat.,* 52: 171-191
25. Zemanek, M.G., **Pollard, S.J.T.**, Kenefick, S.L. and Hrudey, S.E. (1997) Multiphase partitioning and co-solvent effects for polynuclear aromatic hydrocarbons (PAH) in authentic petroleum- and creosote-contaminated soils, *Environ. Pollut.,* 98(2): 239-252
26. Whittaker, M. and **Pollard, S.J.T.** (1997) A performance assessment of source correlation and weathering indices for petroleum hydrocarbons in the environment, *Environ. Toxicol. Chem.,* 16(6): 1149-1158
27. Warhurst, A.M., McConnachie, G.L. and **Pollard, S.J.T.** (1997) Characterisation and applications of activated carbon produced from *Moringa oleifera* seed husks by single-step steam pyrolysis, *Wat. Res.,* 31(4): 759-766
28. Zemanek, M.G., **Pollard, S.J.T.,** Kenefick, S.L. and Hrudey, S.E. (1997) Toxicity and mutagenicity of component classes isolated from soils at petroleum- and creosote-contaminated sites*, J. Air Waste Manage. Assoc.*, 47(12): 1250-1258
29. Young, P.J., **Pollard, S.J.T.** and Crowcroft, P. (1997) Overview: context, calculating risk and using consultants, *Issues in Environ. Sci. Technol.,* 7: 1-22
30. Warhusrt, A.M., Codd, G.A., McConnachie, G.L. and **Pollard, S.J.T.** (1997) Adsorption of microcystin-LR by a low-cost activated carbon from the seeds of the pan-tropical tree *Moringa oleifera*, *Sci. Tot. Environ.,* 207: 207-211
31. Warhurst, A.M., Fowler, G.D., McConnachie, G.L. and **Pollard, S.J.T.** (1997) Pore structure and adsorption characteristics of steam pyrolysis carbons from *Moringa oleifera*, *Carbon*, 35(8): 1039-1045
32. Harrop, D.O. and **Pollard, S.J.T.** (1998) Risk assessment and waste-to-energy plants (incineration). Quantitative risk assessment for incineration: is it appropriate for the UK?, *J CIWEM*, 12(1): 48-53
33. **Pollard, S.J.T.**, Whittaker, M. and Risdon, G.C. (1999) The fate of heavy oil in soil microcosms I: a performance assessment of biotransformation indices, *Sci. Tot. Environ.,* 226(1): 1-22
34. Whittaker, M., **Pollard, S.J.T.** and Risdon, G.C. (1999) The fate of heavy oil in soil microcosms II: a performance assessment of source correlation indices, *Sci. Tot. Environ.,* 226(1): 23-32
35. **Pollard, S.J.T.** (2001) An overview of the use of risk assessment for environmental regulation in the UK – key drivers and regulatory initiatives, *Risk, Decision & Policy* 6: 33-46
36. **Pollard, S.J.T.,** Lythgo, M. and Duarte-Davidson, R. (2001) The extent of contaminated land problems and the scientific response. In: Hester R. and Harrison, R. (eds.) Assessment and reclamation of contaminated land, *Issues in Environ. Sci. Technol.* 16: 1-19
37. **Pollard S.J.T**., Farmer, J.G., Knight, D.M. and Young, P.J. (2002) Matrix effects in applying mono- and polyclonal ELISA systems to the analysis of weathered oils in contaminated soil, *Environ. Pollut.,* 117(1): 5-8
38. **Pollard, S.J.T.**, Yearsley, R., Reynard, N., Meadowcroft, I.C., Duarte-Davidson, R. and Duerden, S. (2002) Current directions in the practice of environmental risk assessment in the United Kingdom, *Environ. Sci. Technol.* 36(4): 530-538
39. **Pollard, S.J.T.**, Brookes, A., Earl, N., Lowe, J., Kearney, T. and Nathanail, C.P. (2004) Integrating decision tools for the sustainable management of land contamination, *Sci. Total Environ.* 325(1-3): 15-28

40. Stephenson, T., **Pollard, S.J.T.,** Cartmell, E. (2004) Feasibility of biological aerated filters (BAFs) for treating landfill leachate, *Environ. Technol.,* 25: 349-354
41. **Pollard, S.J.T.,** Hrudey, S.E., Rawluk, M. and Fuhr, B.J. (2004) Characterisation of weathered hydrocarbon wastes at contaminated sites by GC-simulated distillation and nitrous oxide chemical ionisation GC/MS, with implications for bioremediation, *J. Environ. Monit.* 6(8): 713-718.
42. **S.J.T. Pollard,** J.E. Strutt, B.H. MacGillivray, P.D. Hamilton and S.E. Hrudey (2004) Risk analysis and management in the water utility sector – a review of drivers, tools and techniques, *Trans. IChemE Part B: Process Saf. Environ. Protect.,* 82(B6): 453-462 (invited)
43. **Pollard, S.J.T.,** Kemp R.V., Crawford, M., Duarte-Davidson, R., Irwin, J.G. and Yearsley R. (2004) Characterising environmental harm: developments in an approach to strategic risk assessment and risk management, *Risk Anal.,* 24(6): 1551-1560
44. **Pollard, S.** (2004) Human health risk assessments for contaminated sites: a retrospective view and forward look, *Land Contam. Reclam*., 12(4): 329-337 (invited)
45. Gray, D., **Pollard, S.J.T.,** Spence, L., Smith, R. and Gronow, J. (2005) Spray irrigation of landfill leachate: estimating potential exposures to workers and bystanders using a modified air box model and generalised source term, *Environ. Pollut.* 133: 587-599.
46. Hurst, C., Longhurst, P., **Pollard, S.,** Smith, R., Jefferson, B. and Gronow, J. (2005) Assessment of municipal waste compost as daily cover material for odour control at landfill sites, *Environ. Pollut*. 135: 171-177
47. M.P.M.Taha, **S.J.T Pollard**, U. Sarkar and P. Longhurst (2005) Estimating fugitive bioaerosol releases from static compost windrows: feasibility of a portable wind tunnel approach, *Waste Manage.* 25: 445-450 (invited)
48. **S.J.T Pollard**, R. Duarte-Davidson, K. Askari and E. Stutt (2005) Managing the risks from petroleum hydrocarbons at contaminated sites: achievements and future research directions, *Land Contam. Reclam*. 13(2): 115-122 (invited)
49. Smith, R., **Pollard, S.J.T.,** Weeks, J.M. and Nathanial, C.P. (2005) Assessing significant harm to terrestrial ecosystems from contaminated land, *J. Soil Use Manage.* 21: 527-540 (invited).
50. M.P.M. Taha, G.H. Drew, P.J. Longhurst, R. Smith and **S.J.T Pollard** (2006) Bioaerosol releases from compost facilities: evaluating passive and active source terms at a green waste facility for improved risk assessment, *Atmos. Environ.,* 40: 1159-1169
51. E. Cartmell, P. Gostelow, D. Riddell-Black, N. Simms, J. Oakey, J. Morris, P. Jeffrey, P. Howsam and **S.J. Pollard** (2006) Biosolids – a fuel or a waste? An integrated appraisal of five co-combustion scenarios with policy analysis, *Environ. Sci. Technol.* 40(3): 649-658
52. MacGillivray, B.H., Hamilton, P.D., Strutt, J.E. and **Pollard, S.J.T.** (2006) Risk analysis strategies in the water utility sector: an inventory of applications for better and more credible decision making, *Crit. Rev. Environ. Sci. Technol.* 36: 85-139.
53. Macleod C., Duarte-Davidson R., Fisher B., Ng B., Willey D., Shi J.P., Martin I., Drew G. and **Pollard S**. (2006) Modelling human exposures to air pollution control (APC) residues released from landfills in England and Wales, *Environ. Intl.* 32: 500-509; and *errata Environ. Intl.* (2007) 33: 1127
54. Gottberg, A., Morris, J., **Pollard, S.**, Mark-Herbert, C. and Cook, M. (2006) Producer responsibility, waste minimisation and the WEEE Directive: case studies in eco-design from the European lighting sector, *Sci. Tot. Environ.* 359: 38-56.
55. R.L. Hough, M. Whittaker, **S.J.T. Pollard**, A.E. Fallick, T. Preston and J.G. Farmer (2006) Identifying source correlation parameters for hydrocarbon wastes using compound-specific isotope analysis, *Environ. Pollut.* 143(3): 489-498
56. Shafi, S., Sweetman, A. Hough, R.L., Smith, R., Rosevear, A. and **Pollard, S.J.T.** (2006) Evaluating fugacity models for trace components in landfill gas. *Environ. Pollut.* 144: 1013-1023
57. Duarte-Davidson, R. and **Pollard, S.** (2006) Guest editorial – environmental risk management: the state of the art *Environ. Intl.* 32: 931-933 (invited for "Special Issue on Risk Management" (eds.) Duarte-Davidson and Pollard)

58. Hrudey, S.E., Hrudey, E. and **Pollard, S.J.T.** (2006) Risk management for assuring safe drinking water *Environ. Intl.* 32: 948-957 (invited for "Special Issue on Risk Management" (eds.) Duarte-Davidson and Pollard)
59. Hamilton, P.D., Gale, P. and **Pollard, S.J.T.** (2006) A commentary on recent water safety initiatives in the context of water utility risk management, *Environ. Intl.* 32: 958-966 (invited for "Special Issue on Risk Management" (eds.) Duarte-Davidson and Pollard)
60. **Pollard, S.J.T.**, Smith, R., Longhurst, P.J., Eduljee, G. and Hall, D. (2006) Recent developments in the application of risk analysis to waste technologies, *Environ. Intl.* 32: 1010-1020 (*invited* for "Special Issue on Risk Management" (eds.) Duarte-Davidson and Pollard)
61. MacGillivray, B.H., Hamilton, P.D., Hrudey, S.E., Reekie, L. and **Pollard, S.J.T**. (2006) Benchmarking risk analysis practice in the international water sector. *Water Practice Technol.* 1(2): doi: 10.2166/WPT.2006024 <on-line only>
62. Hall D.H., Drury D., Gronow J.R., Rosevear A., **Pollard S.J.T.** and Smith R. (2006). Estimating pollutant removal requirements for landfills in the UK: I. Benchmark study and characteristics of waste treatment technologies. *Environ. Technol.* 27 (12): 1309-1321.
63. Hall D.H., Drury D., Gronow J.R., Rosevear A., **Pollard S.J.T.** and Smith R. (2006). Estimating pollutant removal requirements for landfills in the UK: II. Model development. *Environ. Technol.* 27 (12): 1323-1333.
64. Hall D.H., Drury D., Gronow J.R., Rosevear A., **Pollard S.J.T.** and Smith R. (2007). Estimating pollutant removal requirements for landfills in the UK: III. Policy analysis and operational implications. *Environ. Technol.* 28 (1): 25-32.
65. Brassington, K.J., Hough, R.L., Paton, G.I., Semple, K.T., Risdon, G.C., Crossley, J., Hay, I., Askari, K. and **Pollard, S.J.T.** (2007) Weathered hydrocarbon wastes – a risk management primer, *Crit. Rev. Environ. Sci. Technol.* 37(3): 199-232
66. B.H. MacGillivray, J.V. Sharp, J.E. Strutt, P.D. Hamilton and **S.J.T Pollard** (2007) Benchmarking risk management within the international water utility sector. Part I: design of a capability maturity methodology, *J. Risk Research* 10(1): 85-104
67. B.H. MacGillivray, J.V. Sharp, J.E. Strutt, P.D. Hamilton and **S.J.T Pollard** (2007) Benchmarking risk management within the international water utility sector. Part II: a survey of eight water utilities, *J. Risk Research* 10(1): 105-123
68. Husaini, I.G., Garg, A., Kim, K.H., Marchant, J., **Pollard, S.J.T.** and Smith, R. (2007) European household waste management schemes: their effectiveness and applicability in England, *Res. Conserv. Recyl.* 51: 248-263
69. Taha, M.P.M., Drew, G.H., Tamer, A., Hewings, G., Jordinson, G.M., Longhurst, P.J. and **Pollard, S.J.T.** (2007) Improving bioaerosol exposure assessments of composting facilities – comparative modelling of emissions from different compost ages and processing activities. *Atmos. Environ.* 41: 4504-4519.
70. M.P.M. Taha, G.H. Drew, A. Tamer Vestlund, D. Aldred, P.J. Longhurst, and **S.J.T Pollard** (2007) Enumerating actinomycetes in compost bioaerosols at source – use of compost agar to address plate masking, *Atmos. Environ* 41: 4759-4765 *(short communication)*
71. Raffield, T., Herben, M., Billington, S., Longhurst, P. and **Pollard, S.** (2007) Coupling hidden flows and waste generation for enhanced materials flow accounting, *Comm. Waste Resource Manage*. 8(1): 12-18 (*short communication*).
72. Garg A., Smith R., Hill D., Simms N. and **Pollard S**. (2007). Wastes as co-fuels: the policy framework for solid recovered fuel (SRF) in Europe, with UK implications, *Environ. Sci. Technol.* 41(14): 4868-4874
73. Kim, K.H., Hall, M.L., Hart, A. and **Pollard, S.J.T.** (2008) A survey of green burial sites in England and Wales and an assessment of the feasibility of a groundwater vulnerability tool*, Environ. Technol.* 29(1): 1-12.
74. **Pollard, S.J.T.**, Hough, R.L., Kim, K-H, Bellarby, J., Paton, G., Semple, K.T. and Coulon, F. (2008) Fugacity modelling to predict the distribution of organic contaminants in the soil : oil matrix of constructed biopiles, *Chemosphere* 71: 1432-1439.
75. **Pollard, S.J.T**., Hickman, G.A.W., Irving, P., Hough, R.L., Gauntlett, D.M., Howson, S., Hart, A., Gayford, P. and Gent, N. (2008) Exposure assessment of carcase disposal options in the event of a notifiable exotic animal disease – methodology and application to avian influenza virus, *Environ. Sci. Technol*. 42(9): 3145-3154

76. Koh, Y.K.K., Chiu, T.Y., Boobis, A.R., Cartmell, E., **Pollard, S.J.T.**, Scrimshaw, M.D., Lester, J.N. (2008) A sensitive and robust method for the determination of alkylphenol polyethoxylates and their carboxylic acids and their transformation in a trickling filter wastewater treatment plant, *Chemosphere* 73(4) 551-556.
77. MacGillivray, B.H. and **Pollard, S.J.T.** (2008) What can water utilities do to improve risk management within their business functions? An improved tool and application of process benchmarking, *Environ. Intl.* 34: 1120-1131
78. Risdon, G.C., **Pollard, S.J.T.**, Brassington, K.J., McEwan, J.N., Paton, G.I., Semple, K.T. and Coulon, F. (2008) Development of a novel and robust analytical procedure for weathered hydrocarbon contaminated soils within a UK risk-based framework, *Anal. Chem.* 80: 7090 -7096
79. Kim, K.-H., Kim, H.-J., and **Pollard, S.J.T.** (2008) Prediction of distribution for five organic contaminants in biopiles by level I fugacity model, *Korean J. Soil Sci. Fert*. 41(3): 228-234.
80. **Pollard, S.J.T.**, Davies, G.J., Coley, F. and Lemon, M. (2008) Better environmental decision-making – recent progress and future trends, *Sci. Tot. Environ*. 400: 20-31
81. Coulon, F., Orsi, R., Turner, C., Walton, C., Daly, P. and **Pollard, S.J.T.** (2009) Understanding the fate and transport of petroleum hydrocarbons from coal tar within gasholders, *Environ. Intl*. 35(2): 248-252

Refereed conference proceedings

82. **Pollard, S.J.T.**, Hrudey, S.E., Fuhr, B.J., Alex, R.F. and Holloway, L.R. (1992) The characterisation of petroleum and creosote-contaminated soils: class composition by thin layer chromatography with flame ionization detection, *Proc. Canadian Society of Civil Engineers 2nd bi-annual environmental speciality conference* , Quebec City, Quebec, Canada, May 26-31, 1992: 207-216
83. **Pollard, S.J.T.** (1994) Characterising residual saturation at hydrocarbon-contaminated sites, *Proc. 3rd international conference and exhibition on the re-use of contaminatedlLand and landfills*, Brunel University, UK, 28-30 June, 1994: 27-33
84. **Pollard, S.J.T.**, Vogt, T.C., Harrop, D.O., Crowcroft, P. and Young, P.J. (1994) Embracing uncertainty: Developing risk assessment methodologies for environmental management in Europe, *Proc. 2nd international symposium on contamination in Central and Eastern Europe*, Budapest, Hungary, 1994: 571-575
85. Fairley, M.A., Farmer, J.G., Paterson, J.E., **Pollard, S.J.T.** and Rees, R.M. (1995) The influence of sewage sludge derived organic matter on the mobility and speciation of heavy metals in colliery spoil*, Proc. 10th international conference on heavy metals in the environment*, Hamburg, Germany, 18-22 September 1995, CEP Consultants, Edinburgh: 451-454
86. **Pollard, S.J.T.**, Harrop, D.O., Crowcroft, P., Jefferies, S.R., and Young, P.J. (1995) Risk assessment for environmental management: approaches and applications, *Proc. CIWEM symposium of emergency planning and incident management in the water environment*, London and Glasgow, 21-22 March and 2-3 May, 1995, CIWEM, London: 17-30
87. Warhurst, A.M., McConnachie, G.L. and **Pollard, S.J.T.** (1996) The production of activated carbon for water treatment in Malawi from the waste seed husks of *Moringa Oleifera*, *Proc. 18th IAWQ biennial international conference*, Singapore, 24-26 June, 1996, Vol 5: 150-157
88. McConnachie, G.L., Warhurst, A.M., **Pollard, S.J.T.** and Chipofya, V. (1996) Activated carbon from *Moringa* husks, *Proc. 22nd WEDC conference: reaching the unreached: challenges for the 21st century*, New Delhi, India: 91-94
89. **Pollard, S.J.T.** and Herbert, S.M. (1998) Contaminated land regulation in the UK: the role of the Environment Agency (EA) and the Scottish Environment Protection Agency. In: *Contaminated soil '98*, *proc. 6th international FZK/TNO conference on contaminated soil*, Edinburgh, May 17-21, 1998, Thomas Telford, London, Volume 1: 33-42 (keynote)
90. Duarte-Davidson, R., **Pollard, S.J.T**., Yearsley, R., Llewllyn, G. and Steele, J. (1999) Considering 'environmental harm': qualitative and semi-quantitative treatments for strategic risk assessment. In: *Risk analysis: facing the new*

millennium, (ed. L.H.J. Goossens), Proc. 9th annual conference, Rotterdam, October 10-13, 1999, Delft University Press: 231-235

91. **Pollard, S.J.T.**, Brookes, A., Twigger-Ross, C. and Irwin, J. (1999) Fragmentation, convergence and harmonisation: where are we going with integrated decision-making? In: *Risk analysis: facing the new millennium*, (ed. L.H.J. Goossens), Proc. 9th annual conference, Rotterdam, October 10-13, 1999, Delft University Press: 559-563
92. **Pollard, S.J.T**. and Duarte-Davidson, R. (1999) The development of risk assessment capabilities in the Environment Agency. In: *Risk analysis: facing the new millennium*, (ed. L.H.J. Goossens), Proc. 9th annual conference, Rotterdam, October 10-13, 1999, Delft University Press: 314-318
93. Wilmot, R., **Pollard, S.J.T**., Smith, R.E., Yearsley, R. and Galson, D.A. (1999) Transparency in risk assessments – presenting the 'expectation value' of post-closure risks from radioactive waste repositories. In : Anderson, K. (ed.) *Proc. 1st VALDOR symposium in the RISCOM programme addressing transparency in risk assessment and decision making*, Stockholm, Sweden, June 13-17, 1999: 129-136
94. **Pollard, S.J.T.**, Farmer, J.G., Knight, D.M. and Young, P.J. (2000) Immunoassay test kits for the on-site analysis of hydrocarbon-contaminated soils: practical experience from the field. In: *Contaminated soil 2000,* proc. 7th TNO/FZK conference on contaminated soils, Thomas Telford, Leipzig 18-22 September, 2000, Volume 1: 239-246
95. **Pollard, S.J.T.**, Duarte-Davidson, R., Yearsley, R., Kemp, R. and Crawford, M. (2001) Strategic risk assessment: a decision tool for complex decisions. In *Proc. VALDOR 2001 - the 2nd VALDOR symposium addressing transparency in risk assessment and decision-making*, K. Anderson (ed.), 10-14 June, Stockholm, Sweden, 2001: 296-303
96. Homan, J., Petts, J., **Pollard, S.J.T**. and Twigger-Ross, C. (2001) Participatory risk assessment for environmental decision-making. In: *Proc. VALDOR 2001 - the 2nd VALDOR symposium addressing transparency in risk assessment and decision making*, K. Anderson (ed.), 10-14 June, Stockholm, Sweden, 2001: 398-406
97. **Pollard, S.J.T**., Duarte-Davidson, R. and Humphrey, S. (2001) Research issues for the environmental epidemiology of contaminated land. In: *Proc. CLARINET final conference on sustainable management of contaminated land*, 21-22 June, Vienna, Austria, 2001: 74-77 (invited)
98. Irwin, J.G., Duarte-Davidson, R. and **Pollard S.J.T**. (2002) Characteristics of environmental harm in the context of air pollution. In *Air pollution X*, *proc. 10th air pollution conference*, 1-3 July, Segovia, Spain, Brebbia C.A. and Martin-Duque J.F. (eds) WIT Press, Southampton, ISBN: 1-85312-916-X, pp. 191-199
99. **Pollard, S.J.T.** (2002) Overview of environmental risk assessment methodologies. In: *Risk assessment for the processing and recycling of biosolids and organic residuals*, P. Lowe (ed.), Proc. 7th European biosolids and organic residuals conference, pre-conference workshop, UKWIR and Aqua Enviro Consultancy Services, 17th November, Wakefield, 2002: 7-13 (invited)
100. Petts, J., **Pollard, S.J.T**., Gray, A-J, Orr, P., Homan, J. and Delbridge, P. (2003) Involving lay audiences in environmental risk assessments. In: ConSoil 2003, P*roc. 8th international FZK/TNO conference on contaminated land, 12-16 May 2003,* Ghent, Belgium: theme D: 2969-2978
101. **Pollard, S.J.T.** (2003) Heavy oil wastes at contaminated sites: a summary of implications for decision-makers. In: ConSoil 2003, P*roc. 8th international FZK/TNO conference on contaminated land, 12-16 May 2003*, Ghent, Belgium, theme B: 1079-1085
102. Jackman, S., Hampton, S., Nathanail, P., Guess, P., Killham, K., Paton, G., **Pollard, S**., Judd, S., Stephenson, T., Thompson, I., Bailey, M., Kalin, R., Larkin, M., Banwart, S., Lerner, D., Harris, R., Beck, P., Dalrymple, I., Pallett, I., Lethbridge, G. (2003) FIRST Faraday – a network of excellence in remediation of the polluted environment. In: ConSoil 2003, p*roc. 8th international FZK/TNO conference on contaminated Land, 12-16 May 2003*, Ghent, Belgium, theme C: 2754-2761
103. Stephenson, T., **Pollard, S.J.T.** and Cartmell, E. (2003) Feasibility of biological aerated filters (BAFs) for leachate treatment, *Sardinia 2003: Proc. 9th International Waste Management and Landfill Symposium,* Cagliari, Sardinia, 6-10th October 2003: 274-276 /CD-ROM-225, 9pp.

104. **Pollard, S.J.T**., Eduljee, G.H. and Hall, D. (2003) Rethinking risk assessment for waste management, *Sardinia 2003: Proc. 9th International Waste Management and Landfill Symposium,* Cagliari, Sardinia, 6-10th October 2003: 536-538 /CD-ROM-226, 10pp.
105. M.P.M.Taha, **S.J.T Pollard,** U. Sarkar and P. Longhurst (2004) The influence of process variables on bioaerosol emission flux and exposure - estimating fugitive bioaerosol releases from static compost windrows. In *Biodegradable and residual waste management* (K. Papadimitriou and E.I. Stentiford, Eds.), Contemporary waste management series, CalRecovery Europe Ltd., ISBN 0-9544708-1-8, pp. 268-275
106. Hurst C., Longhurst P., Pollard S., Smith R., Cartmell E. & Gronow J. (2004) Combination of olfactometry and novel analytical method TSIFT - assessment of municipal waste compost as a daily cover material for odour control at landfill sites. In: *Proc. odours 2004 - environmental odour management*, 17 November, 2004, Cologne, Germany. 12pp.
107. **S.J.T Pollard** (2004) Twenty-five years of risk assessment on contaminated sites, Proc*. international contaminated site remediation conference,* University of South Australia, Centre for Environmental Risk Assessment and Remediation, Adelaide, South Australia, 15-18 September 2004; ISBN 1 920927 16 6, pp. 94-104
108. **S.J.T Pollard** (2004) Human health risk assessment for contaminated sites: a retrospective view and forward look. *Proc. SCI/RSC conference on contaminated land: aspirations and achievements*, Loughborough University, 12-15th September, 2004, UK, EPP Publications, ISBN 1 900995 01 8, pp29-38
109. **S.J.T Pollard**, R. Duarte-Davidson, K. Askari and E. Stutt (2004) Managing the risks from petroleum hydrocarbons at contaminated sites: achievements and future research directions. *Proc. SCI/RSC conference on contaminated land: aspirations and achievements*, Loughborough University, 12-15th September, 2004, EPP Publications, ISBN 1 900995 01 8, pp.45-53
110. **Pollard, S.J.T.,** Cartmell, E.C., Riddell-Black, D., Gostelow, P., Oakey, J., Morris, J., Jeffrey, P. and Howsam, P. (2004) Sewage sludge - waste or fuel? An integrated appraisal of five co-combustion scenarios. *In Proc. waste 2004 conference*, 28-30th September, 2004, Stratford-upon-Avon, Warwickshire, UK, pp. 837-846
111. Taha, M.P.M. and **Pollard, S.J.T.** (2004) Emission and dispersal of bioaerosols during the agitation of green waste compost piles. *In Proc. waste 2004 conference*, 28-30th September, 2004, Stratford-upon-Avon, Warwickshire, UK, pp. 735-743
112. Hamilton, P.D., MacGillivray, B., Bradshaw, R., Strutt, J. and **Pollard, S.** (2005) Tools and techniques – what we need or what people think we want? In: Pollard, S.J.T., Hrudey, S.E., Reekie, L. and Hamilton, P.D. (2005) (eds.) *Proc. AwwaRF international workshop "Risk analysis strategies for better and more credible decision-making"*, Banff Centre, 6-8th April, 2005, Banff, Alberta, Canada, ISBN 1 861941 15 3, 9pp.
113. J.E. Strutt, B.H. MacGillivray, J.V. Sharp, **S.J.T. Pollard** and P.D. Hamilton (2005) Measuring risk management capabilities. In: Pollard, S.J.T., Hrudey, S.E., Reekie, L. and Hamilton, P.D. (2005) (eds.) *Proc. AwwaRF international workshop "Risk analysis strategies for better and more credible decision-making"*, Banff Centre, 6-8th April, 2005, Banff, Alberta, Canada, ISBN 1 861941 15 3, 8pp.
114. **Pollard, S.J.T.,** P.D. Hamilton, S.E. Hrudey, J.E. Strutt, B.H. MacGillivray, R. Bradshaw, J.V. Sharp, W. Leiss, L. Reekie and A. Godfree (2005) Risk analysis strategies for better and more credible utility decisions: project overview and progress. In: Pollard, S.J.T., Hrudey, S.E., Reekie, L. and Hamilton, P.D. (2005) (eds.) *Proc. AwwaRF international workshop "Risk analysis strategies for better and more credible decision-making"*, Banff Centre, 6-8th April, 2005, Banff, Alberta, Canada, ISBN 1 861941 15 3, 6pp.
115. **Pollard, S.J.T.** and Hough, R.L. (2005) Optimising biopile processes for weathered hydrocarbons within a risk management framework (PROMISE). *Proc. CL:AIRE and FIRSTFARADAY joint conference on contaminated land,* Birmingham, April 27-28, 2005, 4pp. (invited)
116. Jose S.C., Mitchell N., Little R., Longhurst P. and **Pollard S.** (2005) Modelling London's waste – policy relevant research for multi-level governance. *Proc. intl. conf. on "Waste – the social context",* Edmonton, Alberta, Canada, 11-14 May 2005, pp 6A2-1 – 6A2-8.

117. M.P.M. Taha and **S.J.T. Pollard** (2005) Characterising the bioaerosols source term at windrow composting sites for improved environmental risk assessment. In: *Proc. 3rd annual Malaysian research group conference*, Manchester Conference Centre, Manchester, 14th May, 2005, UK, 6pp.
118. **Pollard, S.J.T.** (2005) Stuff to soils: workshop overview. In: *"Raising the standard" Proc. Chartered Institution of Wastes Management annual conference and exhibition*, 14th-17th June 2005, Paignton, Torbay, UK, workshop proceedings, 2pp. (invited)
119. Jose S C, **S J T Pollard**, CG Lee, R Little, P J Longhurst (2005) Technology selection using a performance-based modelling method to treat London's residual waste. *Proc. tackling waste 2005*, University of Nottingham, Nottingham, July 13-14, 2005, 10pp.
120. **Pollard, S.J.T.** and Fowler, R. (2005) Contaminated land – risk policy issues. *Proc. UK-China "Partners in Science" workshop on remediation and risk assessment of contaminated land*, 5-7 September, 2005, Beijing, China, pp. 205-207 (invited)
121. Shafi S., **Pollard S.J.T.**, Smith R., Sweetman A. and Rosevear A. (2005). A fugacity approach for generating a landfill gas trace component source term. *Proc. Sardinia 2005, 10th international waste management and landfill symposium*. S. Margherita di Pula, Cagliari, Italy, 3-7 October 2005, paper 101, 10pp.
122. Drew G.H., Smith R., **Pollard S.J.T**., Longhurst P.J. and Kinnersley R. (2005) Amenity impacts of episodic emissions from composting facilities. In: *Proc. 10th European biosolids and organic residuals conference*, UKWIR and Aqua Enviro Consultancy Services, Wakefield, 13-16th October 2005, ISBN 1-903958-15-6, session 25, paper 84, 6pp.
123. **S.J.T. Pollard**, B.H. MacGillivray, P.D. Hamilton, S.E. Hrudey, J.E. Strutt, J.V. Sharp and L. Reekie (2006) Better utility decisions – evaluating organisational maturity in risk management within the water utility sector. In: *Proc. WEF/AWWA 2006 joint management speciality conference*, Salt Lake City, Utah, USA, February 19-22, 2006, Paper TUE6A, 9pp.
124. Longhurst P, I Black, R Seaton, D Hill, **S Pollard**, S Chackiath (2006) Appraising risk and uncertainty for procuring waste treatment technologies. *Proc. 5th international symposium on waste treatment technologies*, Paignton, UK, June 12–16, 2006, session WS2, 4pp. (presentation).
125. **Pollard, S.J.T.** (2006) Better decisions through risk-based land management (and associated lectures). *Presented at the Cranfield University, CRC-CARE, ACLCA and IPM-Net workshop: Risk-based land management – tools for practitioners*, 28-29th June, Novotel Darling Harbour, Sydney, NSW.
126. Chackiath, S., Black, I., Seaton, R., Hill, D., Lee, C., Ryan, R., **Pollard, S.** and Longhurst (2006) Risk and uncertainty analysis of MSW treatment technologies. In: *Proc. waste 2006: sustainable waste and resource management* (B. Vegh and J. Royle, eds.), The Waste Conference Ltd., Coventry, UK, pp.33-42.
127. Drew, G.H., Tamer, A., Taha, M.P.M., Smith, R., Longhurst, P.J., Kinnersley, R. and **Pollard, S.J.T.** (2006) Dispersion of bioaerosols from composting facilities. In: *Proc. waste 2006: sustainable waste and resource management* (B. Vegh and J. Royle, eds.), The Waste Conference Ltd., Coventry, UK, pp.357-365.
128. Chackiath, S., Hill, D., Lee, C., Ryan, R., **Pollard, S**., and Longhurst, P. (2006) Managing London's MSW – options appraisal. In: *Proc. waste 2006: sustainable waste and resource management* (B. Vegh and J. Royle, eds.), The Waste Conference Ltd., Coventry, UK, pp.399-408.
129. **Pollard, S.**, Tranfield, D., MacGillivray, B., Bradshaw, R., Hrudey, S.E. and Charrois, J. (2006) Organisational cultures for effective risk management in water utilities. In: Pollard, S.J.T. and Hrudey, S.E. (2006) (eds.) *Proc. AwwaRF international workshop "Risk management cultures"*, Banff Centre, 13-15th December, 2006, Banff, Alberta, Canada (invited keynote).
130. Bradshaw, R., Tranfield, D., Denyer, D. and **Pollard, S.** (2006) Creating high reliability management cultures: generating an evidence base for the water utility sector. In: Pollard, S.J.T. and Hrudey, S.E. (2006) (eds.) *Proc. AwwaRF international workshop "Risk management cultures"*, Banff Centre, 13-15th December, 2006, Banff, Alberta, Canada (invited)
131. **Pollard, S.J.T.** and Davies, G. (2007) Risk-based regulation – drivers, experiences and futures. *Proc. 2nd international contaminated site remediation conference*

(contamination cleanUp 07), Adelaide, Australia, 24-28 June, 2007, paper C7129 at: http://www.ecoforum.net.au/crccare (invited keynote).

132. Drew G.H., Tamer Vestlund A., Jordinson G., Taha M.P.M., Smith R., Tyrrel S., Longhurst P.J. and **Pollard S.J.T.** (2007). Progress towards a best practice method for modelling dispersion of bioaerosols from composting facilities. Sardinia 2007, *Proc. 11th international waste management and landfill symposium*. S. Margherita di Pula, Cagliari, Italy. 1-5 October 2007. Paper 94.
133. Garg A., Smith R., Longhurst P.J., **Pollard S.J.T**., Simms N. and Hill D. (2007). Comparative evaluation of SRF and RDF co-combustion with coal in a fluidised bed combustor. *Proc. 11th international waste management and landfill symposium.* S. Margherita di Pula, Cagliari, Italy. 1-5 October 2007. Paper 411.
134. Tamer Vestlund A., Drew G.H., Jehlickova B., Stenbro-Olsen P., Sneath R., Tyrrel S., Longhurst P.J., Jordinson G.M. and **Pollard S.J.T.** (2007). Bioaerosol and odour emissions: a comparison of three composting sites in Scotland. *Proc. 11th international waste management and landfill symposium.* S. Margherita di Pula, Cagliari, Italy. 1-5 October 2007. Paper 95.
135. **Pollard, S.J.T.** (2007) Waste management is risk management – chronology, review and forward look. *Proc. intl. conf. on risk management in production activities*, Centro de Riscos da Universidade do Porto, Alfandega Conventions Centre, Porto, Portugal, 10-12 October, 2007, paper 040, 15pp. (invited)
136. **Pollard, S.J.T.** (2008) Challenges for contaminated land assessment and management. Presented at *Contaminated land and groundwater remediation*, London Technology Network, 30th January, 2008, London (invited session Chair).
137. **Pollard, S.J.T.** (2008) Embedding a risk management culture. Presented at an Environment Agency workshop on *Innovation for efficiency*, January 23rd, 2008, Birmingham (invited)
138. **Pollard, S.J.T.** (2008) EPSRC project workshop on *Human reliability analysis in the water utility sector*, 9-10th January, 2008, Cranfield University (Chair)
139. **Pollard**, S.J.T. (2008) Hydrocarbon risk assessments in context. Presented at the *BBSRC/BERR bioremediation_LINK (BIOREM_35) dissemination event*, Melton Mowbray and Edinburgh, 5th and 11th January 2008 (invited)
140. Bradshaw, R.A. and **Pollard, S.J.T.** (2008) Evaluating cause-effect relationships and impact of incidents – a learning approach for operations and asset management. Presented at the *SCI, RSC-WSF and IWO Water contamination emergencies conference – collective responsibility*, 7-8th April 2008, London (invited)
141. Orsi, R., Turner, C., Walton, C., **Pollard, S.J.T.,** Daly, P. and Coulon, F. (2008) Evaluation of vapour emission aiming former gasholder decommissioning. In: *Proc. ConSoil 2008, 10th Intl. UFZ-Deltares/TNO Conference on Soil-water systems,* 3-6 June 2008, Milan, Italy, Theme D: pp D114-123

Additional published communications

Theses, books, book chapters / online resources / edited publications

142. **Pollard, S.J.T.** (1990) *Low-cost adsorbents from industrial wastes*, PhD thesis, Centre for Waste Management and Environmental Control, Department of Civil and Environmental Engineering, Imperial College, London, 299pp.
143. **Pollard, S.J.T.** and Whittaker, M. (1997) Heavy-oil contaminated sites: improving the environmental chemical analysis of complex sources. In: *Current trends in contaminated land research*, Society for Chemical Industry, G.D. Fowler (ed.), SCI, ISBN 0 901001 81 3, London, pp. 153-170
144. **Pollard, S.J.T.**, Timmis, R. and Robertson, S. (1999) Environmental exposure assessment in the Environment Agency. In: *Exposure assessment in the evaluation of risk to human health*, RATSC Workshop Report (cr5) Institute for Environment and Health, ISBN 1 899110 26 7, University of Leicester: 17-21
145. Kemp, R., **Pollard, S**., Forster, V., Herbert, S. (1999) Communicating understanding of contaminated land risks, Scotland and Northern Ireland Forum for Environmental Research, Edinburgh, Scotland, 30pp.

146. **Pollard, S.** and Guy, J. (eds.) (2001) *Risk assessment for environmental professionals*, Chartered Institution of Water and Environmental Management, Lavenham Press, ISBN 1 870752 71 6, Suffolk, 94pp.
147. **Pollard, S.J.T**., Fisher, J., Twigger-Ross, C. and Brookes, A. (2001) Approaches to decision support in the context of sustainable development. In: *NATO/CCMS, Evaluation of demonstrated and emerging technologies for the treatment and clean up of contaminated land and groundwater (phase III), special session: decision support tools, No.245,* United States Environmental Protection Agency, Washington DC, EPA 542-R-01-002: 105-116 (invited)
148. **Pollard, S.J.T.** and Duarte-Davidson, R. (2001) Linking pollutant transport, environmental forecasting and risk assessment: case studies from the geosphere. Chapter 5. In*: Forecasting the environmental fate and effects of chemicals*, Rainbow, P.S., Hopkin, S.P. and Crane, M. (eds.) John Wiley & Sons, Chichester, ISBN 0 471 49179 9: 55-70 (invited)
149. **Pollard, S.J.T** and G. Carroll (2001) Recent developments and new directions. Chapter 3. In: *Risk assessment for environmental professionals*, Pollard, S. and Guy, J. (eds.) Chartered Institution of Water and Environmental Management, Lavenham Press, ISBN 1 870752 71 6, Suffolk: 21-30
150. **Pollard, S.J.T** (2001) Principles, tools and techniques. Chapter 2. In: *Risk assessment for environmental professionals*, Pollard, S. and Guy, J. (eds.) Chartered Institution of Water and Environmental Management, Lavenham Press, ISBN 1 870752 71 6, Suffolk: 9-20
151. Guy, J. and **Pollard, S.J.T.** (2001) *Summary*. In: *Risk assessment for environmental professionals*, Pollard, S. and Guy, J. (eds.) Chartered Institution of Water and Environmental Management, Lavenham Press, ISBN 1 870752 71 6, Suffolk: 91-92
152. **Pollard, S.J.T**. (2002) *Environmental risk assessment & modelling*. Chapter 21. In: Environmental careers – the inside guide, Taberham, J., Chisholm, A. and Wilson, H (eds.) CIWEM, London, ISBN 1 870752 73 2, pp.150-158 (invited)
153. **Pollard, S.J.T.** (2003) *Environmental risk assessment*. In Murley, L. (ed.) Pollution handbook 2003, National Society for Clean Air and Environmental Protection, Brighton, ISBN 0903 474 57 3, UK: pp.10-14 (invited)
154. **Pollard, S.J.T.** (2004) *Ecological and public health risks – analysis and management. In: Theme 4.13. Waste management and minimisation*, Sollars C.J., Cheeseman C., Smith S. and Blakey, N. (Eds.) Encyclopedia of life support systems (EOLSS), developed under the Auspices of the UNESCO, Eolss Publishers, Oxford UK [http://www.eolss.net] (invited)
155. **Pollard, S.J.T.** (2005) Environmental risk management. Chapter 4.3. In Brady, J. (ed.) *Environmental management in organisations. The IEMA handbook*, Earthscan, London, ISBN 1-83383-976-0, pp. 212-226 (invited)
156. **Pollard, S.J.T.,** Hrudey, S.E., Reekie, L. and Hamilton, P.D. (2005) (eds.) *Proc. AwwaRF international workshop "Risk analysis strategies for better and more credible decision-making"*, Banff Centre, 6-8th April, 2005, Banff, Alberta, Canada, ISBN 1 861941 15 3.
157. **Pollard, S.J.T.** (2005) Environmental risk assessment. In Murley, L. (ed.) *Pollution handbook 2005*, National Society for Clean Air and Environmental Protection, Brighton, ISBN 0903 474 59 X, UK: pp.11-15.
158. **Pollard, S.J.T.** and Young, P.J. (2006) Chapter 10. Environmental risk management. In: *The risk management universe – a guided tour*, Hillson, D. (ed.) British Standards Institution, London, ISBN 0 580 43777 9, pp.239-263
159. **Pollard, S.J.T.** (2006) *Risk management for the environmental practitioner*, IEMA Practitioner No. 7, Best practice series, Institute of Environmental Management & Assessment, Lincoln, UK, ISSN 1473-849X, 75pp.
160. **S.J.T. Pollard,** J.E. Strutt, B.H. MacGillivray, J.V. Sharp, S.E. Hrudey and P.D. Hamilton (2006) Risk management capabilities – towards mindfulness for the international water utility sector. In: *Water contamination emergencies: enhancing our response*, Thompson, K.C. and Gray, J. (eds.), Royal Society of Chemistry Publishing, Cambridge, ISBN 0 85404 658 5, pp.70-80 (invited)
161. **Pollard, S.J.T** and Kibblewhite, M.G. (2006) *Soils and land contamination. Chapter 4*. In Harrison, R.M. (ed.) *An introduction to pollution science*, RSC Publishing,

Royal Society of Chemistry, Cambridge, ISBN-10: 0-85404-829-4, pp. 122-151 (invited).

162. **Pollard, S.J.T.** (ed.) (2008) *Risk management for water and wastewater utilities*, Water and wastewater process technologies series (ed. T. Stephenson), IWA Publishing, London, ISBN 1843391376, 159pp.
163. Longhurst, P., **Pollard, S**., Cook, M. (2008) *Memorandum by Cranfield University, Centre for Resource Efficiency and Management*. In: House of Lords Science and Technology Committee (2008) Waste reduction, 6th report of session 2007-2008, HL163, Volume II: evidence; pp.33-34, ISBN 978 0 10 401352 6; and evidence of 11th December 2007 (presented by S.J.T. Pollard at www.parliamentlive.tv/Main/VideoPlayer.aspx?meetingId=675)
164. Beringer, J., Gull, K., Minson, A., Penman, A., **Pollard, S**., Raymond, M. and Simmons, A. (2008) Review of Institute for Animal Health funding, governance and risk management, A report for BBSRC Council, BBSRC, Swindon, 44pp. at: www.bbsrc.ac.uk/organisation/policies/reviews/operational/0804_iah_governance.html
165. Naidu, R., **Pollard, S.J.T.,** Bolan, N.S., Owens, G. and Pruszinski, A.W. (2008) Bioavailability: the underlying basis for risk based land management. In: *Chemical bioavailability in terrestrial environments* (ed. Naidu, R.) *No. 32 in the Publication Series 'Developments in soil science'* Elsevier, Amsterdam, The Netherlands. ISBN 978-0-444-52, pp 53-72 (invited).

Research, consulting and expert reports, evidence and submissions

166. **Pollard, S.J.T.**, Sollars, C.J. and Perry, R. (1987-90) *Carbonaceous adsorbents for the removal of polynuclear aromatic hydrocarbons from vegetable oils*, Imperial College Adsorbents R&D Group, Widnes, UK, progress papers 1-6.
167. **Pollard, S.J.T.**, Montgomery, D.M., Sollars, C.J. and Perry, R. (1991) *An experimental investigation into the effects of organic compounds on the stabilisation / solidification of an inorganic waste stream*, Imperial College Centre for Toxic Waste Management, Consulting Report for Leigh Environmental, UK
168. **Pollard, S.J.T.** (1991) *Environmental impact assessment: terms of reference development workshop summary*, University of Alberta, Environmental Health Program, Consulting Report #0685-1 prepared for Environmental Health Services, Alberta Health, Edmonton, CANADA
169. **Pollard, S.J T.** and Hrudey, S.E. (1992) *Review of bioremediation for polynuclear aromatic hydrocarbon contaminated sites*, University of Alberta, Environmental Health Program, Consulting Report 92-0192-1 for Alberta Environment Help End Landfill Pollution Project, Edmonton, Alberta, CANADA
170. **Pollard, S.J.T.** and Hrudey, S.E. (1992) *Analytical approaches to the rapid characterisation of oily waste residues at petroleum and creosote-contaminated sites,* University of Alberta, Environmental Health Program, Consulting Report # 92-0192-2 for Alberta Environment Help End Landfill Pollution Project, Edmonton, Alberta, CANADA
171. **Pollard, S.J.T.** and Hrudey, S.E. (1992) *Site evaluation needs for the assessment of contaminated land in Alberta, Canada*, University of Alberta, Environmental Health Program, Consulting Report # 90192-3 for Alberta Environment Help End Landfill Pollution Project, Edmonton, Alberta CANADA
172. **Pollard, S.J.T.**, Farmer, J.G. and Eades, L.J. (1993) *Laboratory-scale evaluation of chemical precipitation/coagulation processes for the removal of zinc from mine wastewater*, Environmental Chemistry, Department of Chemistry, University of Edinburgh, Contract Report UE-EC/93-01/ASP for Aspinwall & Company, Water Division, Shrewsbury, UK (unpublished).
173. **Pollard, S.J.T.** (1996) *Expert statement on chemistry and remediation. Official referees business in relation to British Waterways Board vs. FINA plc* in the High Court of Justice, Queen's Bench Division, 64pp.
174. **Pollard, S.J.T.** and Meadowcroft, I.C. (1998) A *semi-quantitative risk assessment methodology for factors affecting coastal flood risk at Chiswell, Dorset*, NCRAOA guidance note 16, Environment Agency London,
175. Duerden, D.L. and **Pollard, S.J.T.** (1999) *Technical review of the post-closure safety case for the Drigg low-level radioactive waste disposal site: summary of*

progress to May 1998 and future plans, NCRAOA Internal Report, Environment Agency London, 14pp.
176. Yearsley R. and **Pollard, S.J.T.** (1999) *Radioactive waste disposal programme: summary of research 1997-1998*, NCRAOA internal report, National Centre for Risk Analysis and Options Appraisal, Environment Agency London, 30pp.
177. **Pollard, S.J.T.,** Jones, H. and Llewellyn, G. (1999) *Guiding principles for the design and implementation of risk-rating systems in the Environment Agency*, NCRAOA guidance note 17, National Centre for Risk Analysis and Options Appraisal, Environment Agency London, 34pp.
178. Duarte-Davidson, R. and **Pollard, S.J.T.** (2000) The *Environment Agency's risk portfolio volumes 1 and 2*, NCRAOA report 29, National Centre for Risk Analysis and Options Appraisal, Environment Agency London, 73pp. and Annex (15pp.)
179. Twigger-Ross, C and **Pollard, S.J.T.** (2000) *Developing integrated approaches to the management of 'contentious' sites, environment policy – risk and forecasting report No. 35*, Environment Agency, Reading, UK, 28pp.
180. **Pollard, S.J.T.**, Duarte-Davidson, R., Yearsley, R., Twigger-Ross, C., Fisher, J., Willows R. and Irwin, J. (2000) *A Strategic approach to the consideration of environmental harm,* NCRAOA report No. 36, National Centre for Risk Analysis and Options Appraisal, Environment Agency London, 24pp.
181. **Pollard, S.J.T.,** Purchase, D. and Herbert, S. (2000) *A practical guide to environmental risk assessment for waste management facilities*, Environment Agency, environmental policy – risk and forecasting guidance note 25, Environment Agency, Reading, 53pp: at http://www.environment-agency.gov.uk/commondata/105385/gn25_555333.pdf
182. Butler, B., Duarte-Davidson, R., Martin, I. and **Pollard, S**. (2000) *Investigation of byker incinerator ash disposal. Identification of potential impact on human health*, Environment Agency, National Centre for Groundwater and Contaminated Land and National Centre for Risk Analysis and Options Appraisal, Solihull, Ref: EA/02/10/02, 6pp.
183. Duerden, S.L., Streatfield, I.J., **Pollard, S.J.T**., Bennett, D.G. and Galson, D.G. (2001) *Assessment of the post-closure safety case development programme for the Drigg low-level radioactive waste disposal site: Phase II – review of the status report on the development of the 2002 Drigg post closure safety case*, National Centre for Risk Analysis and Options Appraisal, position paper 25, Environment Agency, London, 72pp.
184. Macleod, K., Duarte-Davidson, R., **Pollard, S**., Fisher, B., Larentis, P., Ng., B., Willey, D., Martin, I. and Shi, J-P (2001) *Environmental risk assessment of current disposal of air pollution control residues to licensed landfill sites – identification of potential impacts on human health*, Environment Agency, National Centre for Risk Analysis and Options Appraisal, Air Quality Modelling Unit and National Groundwater and Contaminated Land Centre, Reading, 37pp. (confidential internal report).
185. **Pollard, S.J.T.** (2001) *Expert witness statement on environmental risk assessment on behalf of the Environment Agency* in relation to the Town and Country Planning Act 1990 (Section 77) application by Minosus Limited 4/34566, Winsford Rock Salt Mine, Jack Lane, Bostock, Middlewich, 6pp.
186. Kemp, R.V., Crawford, M.B., **Pollard, S.J.T.,** Twigger-Ross, C., Fisher, J. and Weatherley, N. (2002) *Strategic risk assessment: phase II*, Environment Agency R&D project E2-041/TR, Environment Agency, Bristol, ISBN 1 85705 674 4, 150pp.
187. Yearsley, R., Duerden, S., **Pollard, S.** and Ould-Dada, Z. (2002) *Assessment of post-closure safety cases for radioactive waste disposal facilities: a summary*, Environment Agency, environmental policy – risk and forecasting guidance note 37, Environment Agency, Reading, 40pp at http://www.environment-agency.gov.uk/commondata/105385/gn37_555361.pdf
188. Environment Agency (2002) *Guidance note 1: safety philosophy for underground disposal activities*. annex to schedule 4 notice to Minosus Limited under the Pollution, Prevention and Control Act, 1999 and The Pollution Prevention and Control Regulations 2000, (prepared by **S.J.T. Pollard**, D. Newberry, R. Marshall and R. Yearsley), dated 30th August, 2002, 9 pp.
189. **Pollard, S.J.T.** (2003) *Expert evidence - Minosus waste management facility: risk assessment and safety case evaluation – technical review of schedule 4 notice response*, report for Environment Agency EA/02/01, Cranfield University, 23pp.

190. R A Yearsley, I J Streatfield, S L Duerden, **S J T Pollard**, D G Bennett and D A Galson (2003) *Assessment of the post-closure safety case development programme for the Drigg low-level radioactive waste disposal site: phase II overview*, Environment Agency, Centre for Risk and Forecasting position paper 26, Reading, 29pp.
191. **Pollard, S.J.T.** (2003) *Management of contaminated oil – best practicable environmental option, confidential peer review of strategy report*, for confidential, undisclosed client, Cranfield University, 12pp (unpublished).
192. Vivian, S., Hughes, A., Westwood, D., **Pollard, S**. and Pearce, H. (2003) *Managing corporate environmental risk - a review of guidance and selected industry practices*, Environment Agency, R&D publication E2-056/TR, ISBN 1 84432 117 7, 136pp.
193. Environment Agency (2003) *Principles for evaluating the human health risks from petroleum hydrocarbons in soils: a consultation paper*, prepared by **S J T Pollard**, Cranfield University, research report P5-080/TR1, Environment Agency, Bristol, ISBN 1 84432 016 2, 37pp.
194. Petts. J., Homan, J. and **Pollard, S**. (2003) *Participatory risk assessment – involving lay audiences in decisions on risk: literature review and stakeholder interviews*, Environment Agency, R&D publication E2-043/TR, Environment Agency, Bristol, UK, ISBN 1 85705 913 1, 97pp.
195. Gray, A.J., Petts, J., Delbridge, P. and **Pollard, S.** (2003) *Participatory risk assessment, workshop simulation: project record*, Environment Agency R&D project record E2-043/PR, Environment Agency, Bristol, UK, 27pp.
196. Petts, J. Gray, A-J., Delbridge, P. and **Pollard, S.** (2003) *Participatory risk assessment: characterising Environment Agency decisions on risk*, Environment Agency, R&D publication E2-043/TR/02, Environment Agency, Bristol, UK (unpublished)
197. **Pollard, S.J.T.,** Kemp, R.V and Crawford, M. (2004) *Agricultural strategic risk workshop report*, prepared for the Environment Agency, Cranfield University Integrated Waste Management Centre and Galson's Sciences Limited, Cranfield, Beds., 32pp. (unpublished)
198. **Pollard, S.**, Tyrrel, S. and Longhurst, P. (2004) *An environmental risk management framework for composting facilities in England and Wales,* Environment Agency internal guidance, version 1.0, October 2004, Environment Agency, Bristol, 41pp. (internal Agency guidance)
199. Cartmell, E., Gostelow, P., Jeffrey, P., Morris, J., **Pollard, S.J.T.** and Riddell-Black, D. (2004) *Sewage sludge: a fuel or a waste?,* prepared by the Integrated Waste Management Centre, Cranfield University for UKWIR Research Limited, report 04/SL/13/1, ISBN 1 84057 338 4, UKWIR Research Ltd, London, 43pp.
200. **Pollard, S.** and Askari, K. (2005) *The UK approach for evaluating the human health risks from petroleum hydrocarbons in soils,* Environment Agency science report P5-080/TR3,
ISBN 1 84432 342 0, Environment Agency, Bristol, 22pp.
201. Enviros Consulting Ltd (M Broomfield and J Davies), Resource and Environmental Consultants Ltd (P Furmston), MRC Institute for Environment and Health (L Levy), Cranfield University Integrated Waste Management Centre, (**SJT Pollard**, R Smith) (2005) *Exposure assessment of landfill sites: volume 1: main report*, prepared by Enviros for the Environment Agency, Environment Agency, Bristol, R&D project P1-396/TR1, 166pp. (unpublished).
202. Environment Agency (2005) *Informing strategic decisions with comparative risk assessment: a literature review*. Science report RIS-05-01. Prepared for the Environment Agency by **S.J.T. Pollard**, Cranfield University Integrated Waste Management Centre, Environment Agency, Bristol, ISBN 1 844 325 199, 46pp.
203. Chackiath, S., Hill, D., Seaton, R., Black, I., **Pollard, S**., Longhurst, P. (2006) *Understanding the barriers to new and emerging waste technologies*. A scoping report for the "Understanding the costs and barriers to the introduction of new waste management technologies" project. Summary report: report to Grantscape No. CU/NTech/REP/1 Jan 2006, available at http://www.cranfield.ac.uk/sas/resource.
204. Chackiath, S., Hill, D., Seaton, R., Black, I., **Pollard, S.**, Longhurst, P. (2006) *New Technologies: costs and barriers to their introduction*, Grantscape No. CU/NTech/REP/3 July 2006, available at http://www.cranfield.ac.uk/sas/resource;

205. Department for Food, Environment and Rural Affairs (2007) *A risk-based review of carcass disposal options in the event of a notifiable exotic animal disease - methodology and application to avian influenza*, version 0.9, prepared by Prof. **S.J.T. Pollard** for the State Veterinary Service, Contingency Planning Division, Contingency Plans and Disposals Branch, Defra, London, 32pp. with appendices., published, with peer review at: http://www.defra.gov.uk/animalh/diseases/control/contingency/index.htm
206. **Pollard, S**., Hrudey, S.E., Hamilton, P., MacGillivray, B., Strutt, J., Sharp, J. Bradshaw, R., Leiss, W. and Godfree, A. (2007) *Risk analysis strategies for credible and defensible utility decisions*, Awwa Research Foundation research report 91168, Awwa Research Foundation, American Water Works Association and IWA Publishing, Denver, CO, Ref 1P-3.25C-91168-02/07-NH, 88pp.
207. **Pollard, S.** and Wu, S. (2007) *Independent review of risk methodology for infrastructure and non-infrastructure assets*, prepared for an undisclosed client, November 2007, 21pp.
208. Drew, G., Tamer Vestlund, A., Tyrrel, S., Longhurst, P. and **Pollard, S**. (2007) *Measurement and modelling of emissions from three composting sites*, Final report prepared for SNIFFER (UKPIR 12) and SEPA (S684 10002), Scotland and Northern Ireland Forum for Environmental Research, Edinburgh, 50pp., available at http://www.sniffer.org.uk/results.asp?bool=OR&proposed=1&active=1&complete=1&theme=[Process%20Industries%20Regulation]&location=research_areas&refer=res_area_air_1.asp
209. **S.J.T. Pollard**, R. Smith, P. Rumsby, M. Worboys, N. Earl and S. Swift (2008) *Health risk assessments for land contamination: guidance on detailed quantitative risk assessment*, R&D publication P5-079-7, Environment Agency, Bristol (unpublished)
210. Garg, A., Smith, R., Hill, D. and **Pollard, S.J.** (2008) An integrated quantitative appraisal of options for the utilisation of solid recovered fuel (SRF) from the mechanical-biological treatment of MSW. Report to Grantscape No. 760828/1 March 2007, 57pp.
211. **Pollard, S.**, Tyrrel, S., Longhurst, P., Villa, R. and Sweet, N. (2008) *A generalised exposure assessment of anaerobic digestion products in various end-use settings*, WRAP and Environment Agency project OFW002, Cranfield University, School of Applied Sciences, Centre for Resource Management and Efficiency, 38pp. + appendices
212. Smith, R., Longhurst, P. and **Pollard S.** (2008) *The mechanical biological treatment [MBT] of municipal solid waste [MSW]: Part 1. Overview*. Cranfield University report to Grantscape No. CU/MBT/REP/1 March 2008, 26pp. available at http://www.cranfield.ac.uk/sas/resource.
213. Velis, C. Smith, R., **Pollard S**. Longhurst, P. and Drew, G. (2008) *The mechanical biological treatment [MBT] of municipal solid waste [MSW]: Part 2. Review of mechanical processing and SRF quality.* Cranfield University report to Grantscape No. CU/MBT/REP/2 March 2008, 143pp. available at http://www.cranfield.ac.uk/sas/resource.
214. Velis, C. Smith, R. Longhurst, P. and **Pollard S**. (2008) *The mechanical biological treatment [MBT] of municipal solid waste [MSW]: Part 3. Review of biodrying.* Cranfield University report to Grantscape No. CU/MBT/REP/3 March 2008, 45pp. available at http://www.cranfield.ac.uk/sas/resource.
215. Garg, A. Smith, R. Hill, D. Simms, N. Longhurst, P. and **Pollard S.** (2008) *The mechanical biological treatment [MBT] of municipal solid waste [MSW]: Part 4. Solid recovered fuel (SRF) policy framework*. Cranfield University report to Grantscape No. CU/MBT/REP/4 March 2008, 29pp. available at http://www.cranfield.ac.uk/sas/resource.
216. Garg, A. Smith, R. Simms, N. **Pollard S**. Longhurst, P. and Hill, D. (2008) *The mechanical biological treatment [MBT] of municipal solid waste [MSW]: Part 5. Options appraisal for solid recovered fuel (SRF) utilisation.* Cranfield University report to Grantscape No. CU/MBT/REP/5 March 2008, 62pp. available at http://www.cranfield.ac.uk/sas/resource.
217. Balampanis, D. Smith, R., Longhurst, P. **Pollard S.**, Villa, R. and Simms, N. (2008) *The mechanical biological treatment [MBT] of municipal solid waste [MSW]: Part 6. SRF combustion studies on fuel characteristics.* Cranfield University report to

Grantscape No. CU/MBT/REP/6 March 2008, 37pp. available at http://www.cranfield.ac.uk/sas/resource.

218. Balampanis, D. Smith, R. Simms, N. Longhurst, P. Villa, R. and **Pollard S.** (2008) *The mechanical biological treatment [MBT] of municipal solid waste [MSW]: Part 7. Chlorine behaviour in fluidised bed combustion and gasification – preliminary results*. Cranfield University report to Grantscape No. CU/MBT/REP/7 March 2008, 31pp. available at http://www.cranfield.ac.uk/sas/resource.
219. Arsand, M. Smith, R. Coulon, F. Longhurst, P. and **Pollard S.** (2008) The mechanical biological Treatment [MBT] of Municipal Solid Waste [MSW]: Part 8. Evaluation of anaerobic digestion for the treatment of MBT residues. Cranfield University report to Grantscape No. CU/MBT/REP/8 March 2008, 50pp. available at http://www.cranfield.ac.uk/sas/resource.
220. Rocks, S., **Pollard, S.,** Dorey, R., Levy, L., Harrison, P. and Handy, R. (2008) Comparison of risk assessment approaches for manufactured nanomaterials, Report to the Department for Environmental, Food and Rural Affairs (Project CB403), 104pp. available at http://randd.defra.gov.uk/Document.aspx?Document=CB0403_7306_ABS.doc
221. Drew, G.H., Longhurst, P.J., **Pollard, S.J.T**., Smith, R. and Tyrrel, S.F. (2008) *Development of amenity risk assessments at organic waste treatment facilities* (Report SC040021/SR1) ISBN 978-1-84432-778-2, 42pp. available at http://www.environment-agency.gov.uk(publications and reports).

Extended abstracts

222. **Pollard, S.J.T.**, Sollars, C.J. and Perry, R. (1990) The reuse of spent bleaching earth for the stabilization / solidification of hazardous mixed wastes, presented at the *ASTM symposium on stabilization / solidification of hazardous, radioactive and mixed wastes*, Williamsburg, VA, USA, May 29-June 1, 1990: 36
223. **Pollard, S.J.T.**, Kenefick, S.L. and Hrudey, S.E. (1992) Class composition of soil extracts from petroleum and wood-preserving waste sites in Alberta*, Proceedings of the CLRA/CSSS environmental soil science conference*, Edmonton, Alberta, Canada, August 8-15, 1992: 37-38
224. Nesbit, N.L., Mallett, S.H. and **Pollard, S.J.T.** (1995) Resolving the heterogeneity of tarry wastes during investigation of acid tar pits, *Proceedings 5th International FZK/TNO conference on contaminated soil*, Maastricht, 30 October - 3 November, 1995, Maastricht: 243
225. Fairley, M., Farmer, J.G., Paterson, J.E., **Pollard, S.J.T.** and Rees, R.M. (1998) The fate of heavy metals in materials used for land reclamation. In: *Contaminated soil '98*, proceedings 6th international FZK/TNO conference on contaminated soil, Edinburgh, May 17-21, 1998, Thomas Telford, London (poster presentation), Volume 2: 727-728
226. **Pollard, S.J.T.**, J. Gould and H. Flowers (1998) The Scottish Contaminated Land Forum (SCLF): a collaborative approach to contaminated land assessment. In: *Contaminated soil '98*, proceedings 6th international FZK/TNO conference on contaminated soil, Edinburgh, May 17-21, 1998, Thomas Telford, London (poster presentation), Volume 2: 721-722
227. M. Whittaker and **Pollard, S.J.T.** (1998) The performance of diagnostic chemical indices for oil-contaminated sites. In: *Contaminated soil* '98, proceedings 6th international FZK/TNO conference on contaminated soil, Edinburgh, May 17-21, 1998, Thomas Telford, London (poster presentation), Volume 2: 795-796
228. **Pollard, S.J.T.**, Llewellyn, G. and Brewer, M. (1998) An environmental regulator's approach to risk assessment: from corporate- to project-specific risk. In: *Risk analysis: opening the process*, proceedings 8th annual SRA-Europe conference, SRA-Europe / IPSN: volume 2, 1205
229. **Pollard, S.J.T**., Eduljee, G.H. and Hall, D. (2003) Rethinking risk assessment for waste management, submitted to *Sardinia 2003: Proc. 9th international waste management and landfill symposium,* Cagliari, Sardinia, 6-10th October 2003: 536-538
230. Stephenson, T., **Pollard, S.J.T.** and Cartmell, E. (2003) Feasibility of biological aerated filters (BAFs) for leachate treatment, submitted to *Sardinia 2003: Proc. 9th*

international waste management and landfill symposium, Cagliari, Sardinia, 6-10th October 2003: 274-276

231. **Pollard, S.J.T.,** Sweet, N., Owers, A., Longhurst, P., Tyrrel, S and Taha, M.P.H. (2003) A risk management framework for composting facilities in England and Wales, Proc. 8th European biosolids organic residuals conference and Exhibition, 23-26th November, Wakefield, UK, Volume 1: paper 14.
232. **Pollard, S.J.T.** , Hamilton, P., MacGillivray, B. and Strutt, J.E. (2004) HACCP and environmental risk management – translating experiences for water utilities from other business sectors. In *Proc. NSF/WHO workshop on risk management strategies for drinking water utilities: the role of HACCP and water safety plans*, May 4-5, 2004, Crowne Plaza, Ann Arbor, Michigan, USA, pp.10-11
233. **Pollard, S.J.T.** and Fowler, R. (2005) Contaminated land – risk policy issues. *Proc. UK-China "partners in science" workshop on remediation and risk assessment of contaminated land*, 5-7 September, 2005, Beijing, pp.19-20 (invited).
234. S. Shafi, **S.J.T. Pollard**, R. Smith, A. Sweetman and A. Rosevear (2005) A fugacity approach to generating a source term for trace components in landfill gas. In: *Proc. 10th international waste management and landfill symposium*, 3-7 October 2005, S. Margherita di Pula, Cagliari, Sardinia, Italy, pp.405-406.
235. MacGillivray, B.H., Hamilton, P.D., Hrudey, S.E., Reekie, L. and Pollard, S.J.T. (2006) Benchmarking risk analysis practice in the international water sector. *Proc. IWA world water congress and exhibition*, 10-14 September, 2006, Beijing, China. Paper ID 592972, 8pp. (on CD-ROM).

Poster presentations

236. Holloway, L.R., Alex, R.F., Fuhr, B.J., Tosto, F., Hrudey, S.E., **Pollard, S.J.T.** (1993) Development of a method for component type analysis of contaminated soil extracts using thin layer chromatography, *Proceedings 1993 Pittsburgh conference* (Pitcon '93), Atlanta, GA, USA, March 8-12, 1993
237. Whittaker, M. and **Pollard, S.J.T.** (1994) Characterisation of residual saturation at heavy oil-contaminated sites, presented at *National highlights of chemical science and technology by young scientists*, British Petroleum Britannic Tower, London, 25 November 1994 (poster presentation)
238. Whittaker, M. and **Pollard, S.J.T.** (1994) Characterisation of residual saturation at heavy oil- contaminated sites, presented at the *NATO/CCMS pilot study meeting on the evaluation of groundwat*er, September 12, 1994, Oxford, UK (poster presentation)
239. Kemp, R., Valledy, B., Quint, M., **Pollard, S.J.T.**, V. Forster, Crowther, Y., Jeffries, R. and S. Aston (1998) Risk communication for contaminated land: a framework for managing public concern. In: *Contaminated soil '98*, *Proceedings 6th international FZK/TNO conference on contaminated soil,* Edinburgh, May 17-21, 1998, Volume 2: 775-776, Thomas Telford, London (poster presentation)
240. Duarte-Davidson, R. and **Pollard, S.J.T**. (2002) A tiered approach to environmental exposure assessment in the Environment Agency, *Linking exposure and health: innovation and interactions,* 2002 Joint International Society of Exposure Analysis and International Society for Environmental Epidemiology conference, 12-15 August, 2002, Vancouver, Canada (poster presentation)
241. **S.J.T. Pollard**, J.E. Strutt, B.H. MacGillivray, P.D. Hamilton and S.E. Hrudey (2005) Risk management in the water utility sector – drivers, tools and techniques. In: Pollard, S.J.T., Hrudey, S.E., Reekie, L. and Hamilton, P.D. (2005) (eds.) *Proc. AwwaRF international workshop "Risk analysis strategies for better and more credible decision-making"*, Banff Centre, 6-8th April, 2005, Banff, Alberta, Canada, ISBN 1 861941 15 3 (poster presentation)
242. P. Hamilton, B. MacGillivray, R. Bradshaw and **S. Pollard** (2005) An integrated approach to water safety planning. In: Pollard, S.J.T., Hrudey, S.E., Reekie, L. and Hamilton, P.D. (2005) (eds.) *Proc. AwwaRF international workshop "Risk analysis strategies for better and more credible decision-making"*, Banff Centre, 6-8th April, 2005, Banff, Alberta, Canada, ISBN 1 861941 15 3 (poster presentation)
243. B. MacGillivray, R. Bradshaw, P.D. Hamilton, J.V. Sharp, **S.J.T. Pollard** and J.E. Strutt (2005) Benchmarking and improving risk management capabilities. In: Pollard, S.J.T., Hrudey, S.E., Reekie, L. and Hamilton, P.D. (2005) (eds.) *Proc.*

AwwaRF international workshop "Risk analysis strategies for better and more credible decision-making", Banff Centre, 6-8th April, 2005, Banff, Alberta, Canada, ISBN 1 861941 15 3 (poster presentation)

244. B. MacGillivray, R. Bradshaw, P.D. Hamilton, J.E. Strutt and **S.J.T. Pollard** (2005) Performnace measurement for risk management. In: Pollard, S.J.T., Hrudey, S.E., Reekie, L. and Hamilton, P.D. (2005) (eds.) *Proc. AwwaRF international workshop "Risk analysis strategies for better and more credible decision-making"*, Banff Centre, 6-8th April, 2005, Banff, Alberta, Canada, ISBN 1 861941 15 3 (poster presentation)
245. R.A. Bradshaw, B.H. MacGillivray, P.D. Hamilton and **S.J.T. Pollard** (2005) Water safety plans and the implications for asset management. In: Pollard, S.J.T., Hrudey, S.E., Reekie, L. and Hamilton, P.D. (2005) (eds.) *Proc. AwwaRF international workshop "Risk analysis strategies for better and more credible decision-making"*, Banff Centre, 6-8th April, 2005, Banff, Alberta, Canada, ISBN 1 861941 15 3 (poster presentation)
246. MacGillivray, B.H., P.D. Hamilton, J.E. Strutt, J.V. Sharp and **S.J.T. Pollard** (2005) Measuring water utilities competencies in risk management. Presented at the *2nd WEKNOW (Web-based European Knowledge Network on Water) drinking water conference, Bratislava, Slovakia*, 13-15 June 2005 (poster presentation), p.134
247. K. J. Brassington, R. L. Hough and **S. J. T. Pollard** (2005) Optimising biopile processes for weathered hydrocarbons within a risk management framework. *Presented at the CL:AIRE and FIRST Faraday joint conference on contaminated land,* 27th-28th April, 2005, International Convention Centre, Birmingham, UK (poster presentation)
248. Hough, R.L., Brassington, K., Sinke, A., Crossley, J., Paton, G.I., Semple, K., Risdon, G., Jacobson, C., Daly, P., Jackman, S., Lethbridge, G. and **Pollard, S.J.T.** (2005). Optimising the biopiling of weathered hydrocarbons within a risk management framework. ConSoil, Bordeaux, 3-7 October 2005 (poster presentation).
249. Velis C., Smith R., Garg A., **Pollard S.J.T.** and Hill D. (2005) Mechanical biological treatment of wastes: overcoming barriers and reducing risk in the UK'. In: Kühle-Weidemeier, M (ed.) *International symposium on mechanical-biological waste treatment (MBT)*, Hanover, Germany, 22-25 November, p.375 (poster presentation)
250. Bellarby, J., Al-Awadi, M., Semple, K.T., Hough, R.L., Brassington, K.J., Kim, J., Crossley, J., Risdon, G., Daley, P. **Pollard, S.J.T.** and Paton, G.I. (2006) Ecological hazard assessment of weathered hydrocarbons: justification of selected assays. *Presented at SETAC Europe 16th annual meeting: Controversies and solutions in environmental sciences*, 7-11 May, 2006, The Hague, The Netherlands (poster presentation).
251. S. Chackiath, D. Hill, C. Lee, **S. Pollard**, P. Longhurst (2006) Waste treatment technologies and policy compliance capabilities - an assessment *Presented at the 5th International symposium on waste treatment technologies*, Paignton, UK, June 12–16, 2006 (poster presentation)
252. Bradshaw, R.A. and Pollard, S.J.T. (2006) Managing highly reliable water supply systems. Presented at the *4th Engineering doctorate conference,* Cranfield University, June 22, 2006 (poster presentation)
253. Garg, A., Hill, D., Smith, R., **Pollard, S.** and Longhurst, P. (2006) Appraisal of options for solid recovered fuel (SRF) utilisation within the UK. Presented at *Venice 2006: Biomass and waste to energy symposium*, Venice, Italy, 29th Nov - 1st Dec 2006 (poster presentation).
254. Davies, G., **Pollard, S**., Kendall, G. and Soane, E. (2008) An investigation into regulatory decision-making: using automated decision makers. Presented at the *UKERC workshop – agent-based modelling: application to energy policy*, 16th January, 2008, London (poster presentation).
255. Edgar, C., Smith, J., **Pollard, S**., Breach, R. and Williams, T. (2008) Putting the Bonn Charter into practice: challenges to water suppliers. Presented at: the IWA conference on *water safety plans: global experiences and future trends*, Lisbon, Portugal, May 12-14th, 2008 (poster presentation).

Patent applications

256. Mobbs, D.B., Shaw, D. and **Pollard, S.J.T.** (1991) Adsorbents and a method for their production, *European patent application 91112290.1*

Miscellaneous communications, including trade press articles

257. **Pollard, S.J.T.** (1991) Waste management: towards a sustainable society (1990) by O.P. Kharbanda and E.A. Stallworthy, *Utilities policy,* 1(5): 435-436 (book review)
258. Coyle, A. (1994) Carbon? Lets drink to that, Science (ed. Tom Wilkie), *The Independent*, 15th November 1994. (A media commentary on activated carbon research)
259. Whittaker, M. and **Pollard, S.J.T.** (1994) Characterisation of refractory wastes at hydrocarbon-contaminated sites I: an investigation of source terms and extent of weathering, *Proceedings of the 12th European meeting of the Society for Environmental Geochemistry and Health: contaminated land*, BGS, Nottingham, UK, 6-8th April, 1994 (presentation)
260. **Pollard, S.J.T.** (1994) Embracing uncertainty: issues in quantitative risk assessment for UK environmental management, presented at Institute of Occupational Safety and Health, Aberdeen branch meeting, Aberdeen, 8 June, 1994 (presentation)
261. Harrop, D.O., and **Pollard, S.J.T.** (1994) The risk of incineration to human health, *Proceedings 61st National Society for Clean Air annual conference*, Blackpool 24-27 October 1994
262. **Pollard, S.J.T.** (1994) Effective risk management at contaminated sites: implications for the analysis of on-site contamination, *Environmental Excellence* 1(2): 23-24
263. **Pollard, S.J.T.** (1994) Screening risk management options at contaminated sites: employing meaningful site data, *5th Annual conference on contaminated land: policy, risk management and technology*, London, 24-25 January, 1994 (presentation)
264. Whittaker, M., **Pollard, S.J.T.** and Fallick, A.E. (1995) Stable carbon isotopic characterisation of hydrocarbons in contaminated soils, presented at *2nd SETAC world congress*, Vancouver, Canada, 5-9 November 1995 (presentation)
265. **Pollard, S.J.T.** (1995) The use and misuse of environmental quality criteria for the assessment of contaminated land, presented at *Partnership in land recycling*, University of Strathclyde, May 15-17th, 1995, 17pp. (presentation)
266. Harrop, D.O. and **Pollard, S.J.T.** (1996) Risk assessment and waste-to-energy plants (incineration). Quantitative risk assessment for incineration: is it appropriate for the UK?, presented at *CIWEM scientific group symposium: risk management-water, industry and environment*, May 16th 1996 (presentation)
267. **Pollard, S.J.T.** (1996) Risk assessment for improved business management. In: *'Avert'* IChemE Environmental Protection subject group newsletter, 6, pp.6-7 (*recipient of IChemE Avert paper award*)
268. **Pollard, S.J.T.** (1997) Understanding SEPA's responsibilities on contaminated land. In: *Contaminated land in Scotland: assessing the legal liabilities and wider implications of the new regime,* 11 March, 1997, IBC UK Conferences Ltd., 6pp. (presentation)
269. **Pollard, S.J.T.** (1997) Contaminated land remediation: overview and future of change, *Proceedings of the 4th IPSS annual conference: soil protection and industry - looking ahead*, Silsoe College, 24th September 1997 (presentation)
270. **Pollard, S.J.T.** and Kemp, R. (1998) Communicating risk: where it can all go wrong, Association of Geotechnical and Geo-environmental Specialists seminar: *Risk assessment for contaminated land*, Birmingham, December 9, 1997 (presentation)
271. **Pollard, S.J.T.** (1998) Linking risk assessment and environmental forecasting. *Presented at SETAC-Europe (UK Branch) 9th annual meeting, Forecasting the fate and effects of toxic chemicals*, London, UK, 7-8th September 1998 (keynote presentation)
272. **Pollard, S.J.T** and Duarte-Davidson, R. (1999) Pollutant transport processes and the road to environmental risk assessment*. Presented at Society for Environmental*

Geochemistry and Health, 17th European conference: Pollution of the urban environment and pollutant transport processes, Glasgow, 29-31 March 1999 (keynote presentation)

273. **Pollard, S.J.T.** (1999) The Environment Agency approach to risk assessment*. Presented at Risk management for contaminated land*, CIRIA conference, 6th October 1999 (presentation)
274. **Pollard, S.J.T.** (1999) The Agency's approach to risk assessment*. Presented at 'Risk assessment in waste management – a practical guide'*, ESA workshop, 22nd September 1999 (presentation)
275. **Pollard, S.J.T.** (1999) Risk assessment and the Environment Agency: approaches to the evaluation of risks and values. *Presented at 'Risk: a common currency'*, SCI Water and Environment group, London, 16th June 1999 (presentation)
276. **Pollard, S.J.T.** (1999) Risk-based inspections in the UK: steps towards a common approach*. Presented at European Union IMPEL seminar on minimum criteria for inspections*, Haarlem, Netherlands, 18-19th March, 1999 (presentation)
277. **Pollard, S.J.T.** and Willows, R. (1999) Ecological risk assessment needs in the UK and current Agency research. *Presented at 'Current Issues in ecotoxicology and ecological risk assessment'*, SCI Water and Environment group, London, 18th May 1999 (presentation)
278. **Pollard, S.J.T.** (1999) Risk assessment for environmental management – key drivers and regulatory initiatives, *Proceedings CIWEM Scottish Branch annual symposium: "Environmental risk",* Edinburgh Conference Centre, Riccarton, Edinburgh, Scotland, 16 November 1999 (keynote address).
279. **Pollard, S.J.T.** and Duerden, S.L. (1999) Safety cases in context: lessons for and from environmental risk assessment. *Presented at 'Safety cases: successes and concerns'*, London, 26-27th April 1999, IBC Conferences Limited (presentation).
280. **Pollard, S**.J.T. (2000) Environmental risk assessment in the Environment Agency, *Interdepartmental liaison group on risk assessment newsletter*, August 2000: 3-4.
281. Duarte**-**Davidson, R. and **Pollard, S.J.T.** (2002) A tiered approach to environmental exposure assessment in the Environment Agency. *Integrating environmental and human health perspectives in the 21st century*, SETAC UK conference, 16-18 September 2002 (invited presentation)
282. **Pollard, S.**J.T. (2002) Risky business? *Water services magazine*, October 2002: 2-3
283. **Pollard, S.J.T.** (2002) Keynote - overview of environmental risk assessment methodologies, 7th European biosolids and organic residuals conference, pre-conference workshop, November 17th, Wakefield, 2002. (keynote presentation)
284. Hooker, P., Tearle, M., **Pollard, S.J.T.** and Hills, C.D. (2003) *Applying risk management approaches to stabilisation/solidification technologies for improved stakeholder confidence*, remedial techniques for contaminated land clean-up, University of Greenwich, 24th June 2003 (invited presentation)
285. **Pollard, S.J.T.** and C. Brown (2003) *Integrating environmental risk assessment practice across pollution research*, British Society of Soil Science and SETAC joint meeting, University of Aberdeen, 8th-10th September, 2003 (invited keynote)
286. **Pollard, S**., Tyrrel, S., Longhurst, P. and Owers, A. (2003) Presented at the *Chartered Institution of Wastes Management South West Region new generation group meeting,* ISCA Centre, Exeter, 3rd November, 2003 (invited presentation).
287. **Pollard, S**. and Longhurst, P. (2003) Guidance through a risky business *Industrial Environmental Management 14*(6): 28-29
288. **Pollard, S.J.T.,** Sweet, N., Owers, A., Longhurst, P., Tyrrel, S and Taha, M.P.H. (2003) A risk management framework for composting facilities in England and Wales. Presented at *8th European biosolids organic residuals conference and exhibition*, 23-26th November, Wakefield, UK (presentation)
289. Naidu R, **Pollard, S**, Juhasz, A, Megharaj, M, Smith, E, Owens, G and Chen, Z (2003) Risk based management of contaminated sites: a cost effective solution to managing contamination. Presented at "Risk based management of contaminated sites: developing cost effective strategies for remediating contaminated sites" Rydges, North Sydney, 29th September, 2003 (presentation)
290. **Pollard, S.J.T.** (2004) Strategic risk assessment: what can it deliver? Presented at the *Environment Agency expert workshop: Identifying synergies between EIA/SEA and risk assessment*, Westminster, London, March 19th, 2004 (invited presentation).

291. Hills, C.D. and **Pollard, S.J.T.** (2004) Performance assessment of stabilised/solidified waste forms (PASSiFy). Presented at the *CL:AIRE annualpProject conference*, 20th April, 2004, University College, London (invited presentation).
292. **Pollard, S.** (2004) Chairman's overview. Presented at "*New technologies for cost-effective landfill compliance*", 20th April 2004, BRE Garston (conference chair)
293. **Pollard, S.J.T.** , Hamilton, P., MacGillivray, B., Strutt, J.E. and Hrudey, S.E. (2004) HACCP and environmental risk management – translating experiences for water utilities from other business sectors. Presented at *NSF/WHO workshop on risk management strategies for drinking water utilities: the role of HACCP and water safety plans*, May 4-5, 2004, Crowne Plaza, Ann Arbor, Michigan, USA (invited presentation)
294. **Pollard, S.J.T.** and Longhurst, P. (2004) Order from disorder? – science for the resource management policy agenda, Presented at the *ESRC transdiciplinary seminar series: knowledge and power: exploring the science/society interface in the urban environment context. Seminar 5: municipal waste management – policy without evidence?*, University of Birmingham, 11th May 2004 (invited presentation)
295. **Pollard, S.** (2004) Regulatory approvals and environmental risk assessment. Presented at *Materials recycling week seminar on hazardous waste regulations*, London, 13th May 2004. (invited presentation)
296. Taha, M.P.M., **Pollard, S.J.T.** and Longhurst, P.J. (2004) Source term monitoring and depletion for bioaerosols at green waste composting sites – improving regulatory risk assessments. Presented at *Tackling waste 2004*, 20-21st July 2004, University of Nottingham (presentation)
297. **S.J.T. Pollard** (2004) Connecting risk assessment and management. Presented at *the EU TRITON project course on environmental risk management, Tampere University of Technology*, Finland, 6-10 September, 2004 (invited presentation).
298. **S.J.T. Pollard** (2004) Evaluating risk assessments. Presented at *the EU TRITON project course on environmental risk management, Tampere University of Technology*, Finland, 6-10 September, 2004 (invited presentation).
299. **S.J.T. Pollard** (2004) Options appraisal. Presented at *the EU TRITON project course on environmental risk management, Tampere University of Technology,* Finland, 6-10 September, 2004 (invited presentation).
300. **S.J.T Pollard** (2004) Twenty-five years of risk assessment on contaminated sites, Proc*. international contaminatedsSite remediation conference,* University of South Australia, Centre for Environmental Risk Assessment and Remediation, Adelaide, South Australia, 15-18 September 2004 (invited keynote).
301. **S.J.T Pollard** (2004) Human health risk assessment for contaminated sites: a retrospective view and forward look. *Proc. SCI/RSC conference on contaminatedlLand: aspirations and achievements*, Loughborough University, 12-15th September, 2004, UK (invited keynote).
302. **S.J.T. Pollard** (2004) Sludge, a fuel? *UKWIR newsletter*, issue 33 (November 2004), 4.
303. **S.J.T. Pollard** (2004) Oily wastes. *Sustain magazine* 5(6) 58-61
304. **Pollard S**., Longhurst P. and Taha M.P.M. (2005) Bioaerosols: developing guidance from science, presented at the *National Society for Clean Air regional conference: air quality, fugitive emissions, future health perspectives*, Commonwealth & Empire Museum, Bristol, 27th January 2005 (invited presentation).
305. **Pollard, S.J.T**., Hough, R.L., Brassington, K., Sinke, A., Crossley J., Paton, G.I., Semple, K., Risdon, G., Jackman S.J., Bone, B., Jacobsen, C. and Lethbridge G. (2005) Optimising the biopiling of weathered hydrocarbons within a risk management framework – PROMISE, *Proc. CL:AIRE and FIRST FARADAY joint conference on contaminated land*, 27-28th April, 2005, International Convention Centre, Birmingham, UK, 2pp. (invited presentation).
306. **Pollard, S.J.T.** and Naidu, R. (2005) Risk-based land management - science for better, defensible and more credible decisions. Presented to the *Australian Contaminated Land Consultants Association*, North Sydney, Australia, 5th May, 2005 (invited presentation)
307. **Pollard, S.J.T.** and Fowler, R. (2005) Contaminated land – risk policy issues. Presented at the *EPSRC/Chinese Research Academy of Environmental Sciences*

international workshop on remediation and risk assessment of contaminatedlLand, 5-7 September 2005, Beijing, China (invited presentation).

308. **S.J.T.Pollard** (2005) Risk management comes centre stage. *UKWIR Newsletter*, Issue 36 (September 2005), 3.
309. Brassington, K. & Hough, R.L. and **Pollard, S**. (2005) Risk assessment frameworks for weathered petroleum hydrocarbons: current status and limitations, *SEESOIL winter meeting*. Reading University, 7th December 2005.
310. MacGillivray, B. and **Pollard, S.J.T**. (2006) Risk management capability in the water utility sector. *Presented at the Sensors for Water Interest Group (SWIG) workshop on "Security of water supplies"*, 25th January 2006, Cranfield, UK (invited)
311. **S.J.T. Pollard**, S.E. Hrudey, J.E. Strutt, P.D. Hamilton, B. MacGillivray and R. Bradshaw (2005) Risk analysis strategies for better and more credible utility decisions. *Presented at the AwwaRF technology transfer conference "The future of water utilities: reading the crystal ball"*, 27th September 2005, St. Louis USA (invited).
312. **S.J.T. Pollard**, S.E. Hrudey, J.E. Strutt, P.D. Hamilton, B. MacGillivray and R. Bradshaw (2005) Risk analysis strategies for better and more credible utility decisions. *Presented at the AwwaRF technology transfer conference "The future of water utilities: reading the crystal ball"*, 21st October, Detroit, USA (invited).
313. Belarby, J., Semple, K., Hough, R.L., Brassington, K., Sinke, A., Crossley, J., Risdon, G., McIntyre, G., Daly, P., Jackman, S., Lethbridge, G. and **Pollard, S**. (2006) Environmental risk assessment of weathered hydrocarbons, *SETAC Europe 16th annual meeting*, The Hague, Netherland, 7th May, 2006.
314. **S.J.T. Pollard**, S.E. Hrudey, J.E. Strutt, P.D. Hamilton, B. MacGillivray and R. Bradshaw (2005) Risk analysis strategies for better and more credible utility decisions. *Presented at the AwwaRF technology transfer conference "The future of water utilities: reading the crystal ball"*, 28th March, Portland, USA (invited).
315. Drew, G., Smith, R., **Pollard, S.J.T.** and Gronow, J. (2006) The Environment Agency's Cranfield University postdoctoral fellowship: programme and progress. Presented at *the Environment Agency bioaerosols expert workshop*, Bristol, 28th February 2006 (invited).
316. S. Chackiath, C. Lee, R. Ryan, **S. Pollard**, P. Longhurst (2006) Appraising new technology options for changing the face of waste management in London boroughs – a local authority perspective, *Presented at the 5th International symposium on waste treatment technologies*, Paignton, UK, June 12–16,
317. Hrudey, S.E., Hrudey, E.J., Charrois, J.W.A. and **Pollard, S.J.T.** (2006) A 'Swiss cheese' model analysis of the risk management failures in the fatal Walkerton outbreak. *Presented at the IWA world water congress and exhibition*, 10-14 September, 2006, Beijing, China (presentation).
318. MacGillivray, B.H., Hamilton, P.D., Hrudey, S.E., Reekie, L. and **Pollard, S.J.T.** (2006) Benchmarking risk analysis practice in the international water sector. *Presented at the IWA world water congress and exhibition*, 10-14 September, 2006, Beijing, China (presentation).
319. **Pollard, S.J.T.** (2006) Is sewage sludge a fuel or a waste? *European Commission DG Environment news alert, issue 37*, p1, 5th October, 2006.
320. **Pollard, S.J.T.** (2006) Implementing risk management – 'beyond the manual', *Water, energy & environment*, October 2006, p.2
321. Hrudey, S.E. (2006) CWN and AwwaRF sponsor unique conference in Banff, Alberta, *Canadian Water News*, annual magazine 2006, pp.16-17. (a commentary on AwwaRF collaborative work)
322. **S.J.T. Pollard** and L. Reekie (2006) Risk analysis strategies for more credible and defensible utility decisions (AwwaRF project #2939), *Drinking Water Research* 16(4): 16-17.
323. **S.J.T. Pollard**, B.H. MacGillivray, P.D. Hamilton, S.E. Hrudey, J.E. Strutt, J.V. Sharp and L. Reekie (2006) *Better utility decisions – evaluating organisational maturity in risk management within the water utility sector*, AwwaRF October live 'Webcast', 25th October 2006 (invited).
324. **Pollard S.J.T**., Hough R.L., Paton G.I., Bellarby J., Semple K.T., Risdon G., Crossley J., Bone B., Brassington K.J., J., Prebble G., Lethbridge G. (2006) Optimising biopile processes for weathered hydrocarbons within a risk management

framework – PROMISE (BIOREM_35) *2nd LINK bioremediation programme dissemination event*, London, UK, 23 November 2006 (presentation).

325. Coulon, F. and **Pollard, S.** (2007) Integrating a risk management framework to the remediation of oil wastes, *IPM-Net News*, 3, p.2.
326. **Pollard, S.J.T.** (2007) Risk management in the multi-utility sector: better regulation, red tape or cultural change. *Workshop presented at Sustainability live*, 1-3 May 2007, NEC Birmingham.
327. **Pollard, S.J.T**. (2007) Best practice techniques in environmental risk assessment. *Presented at the IEMA annual conference and exhibition*, 12th June, 2007, Manchester, UK.
328. **Pollard, S**.J.T. (2007) Involving publics in risk assessment – does it help or hinder? *Presented at the EcoForum industry summit*, 26-27th June 2007, Adelaide, Australia. Paper e7013 at: http://www.ecoforum.net.au/crccare (invited).
329. **Pollard, S**. and Smith, J. (2007) Rediscovering risk management. *Water & Sewerage Journal*, 3/2007, pp.13-14 (invited).
330. **Pollard, S**., Bradshaw, R. and Smith, J. (2007) Rediscovering risk management, *IWA Specialist Group on Systems Analysis and Integrated Assessment Newsletter* 4(3): 29-31 (September, 2007)
331. **Pollard, S**., Bradshaw, R. and Smith, J. (2007) Rediscovering risk management, *Water 21*, October 2007, pp.53-54 (invited).
332. **Pollard, S.J.T.** (2007) Rediscovering risk management for the water utility sector. *IWA Utility Leaders Forum*, 19 October 2007, Hotel Real Palacio, Lisbon, Portugal (invited)
333. **Pollard, S**., Bradshaw, R. and Smith, J. (2007) Rediscovering risk management. *Water Utility Management International* 2(3): 18-19 (invited)
334. MacGillivray, B.H. and **Pollard, S.J.T.** (2007) Implementing risk management: a study of utility practice, *Water Utility Management International,* December 2007: 13-15
335. **Pollard, S**., Carter, R., Webster, J. and Smith J. (2008) Editorial: developing a culture of water safety, *Drinking Water Safety International Newsletter* 1: 3-4 (invited)
336. Coulon F., Orsi R., Turner C., Walton C., **Pollard S.**, Daly P. 2008. Evaluation of vapour emission aiming former gasholder decommissioning, Presented at: *Consoil 2008*, Theme D: risks and impacts, lecture session D4: fate and transport, Milan, Italy, 3-6 June 2008.
337. **Pollard, S**., Smith, J., Edgar, C., Williams, T. and Breach, B (2008) Putting the Bonn Charter in practice: addressing the challenges to water suppliers, *Water & Sewerage Journal*, 3/2008, pp. 29-30 (invited).
338. **Pollard, S.J.T.** (2008) *Enterprise risk management*. Presented at the Cranfielod University short course. Safety management systems in aviation, 22-26th September 2008, Cranfield University.
339. Charrois, J.W.A., Jalba, D.I., Cromar, N.J., Bradshaw, R., **Pollard, S.J.T.** and Hrudey, S.E. (2008) Risk management cultures in water utilities and lessons for small systems, presented at *13th Canadian National Conference and 4th Policy Forum on Drinking Water: Small systems: protecting source water and improving finished water quality*, Quebec City, October 4-7, 2008 (presentation).
340. Breach, B., Bursill, D., Hrudey, S., **Pollard, S**., Veira, J. and Williams, T. (2008) The Bonn network – an international water utility initiative for safe water presented at *13th Canadian National Conference and 4th Policy Forum on Drinking Water: Small systems: protecting source water and improving finished water quality*, Quebec City, October 4-7, 2008 (presentation).
341. **Pollard, S.** (2008) *Living with environmental change – building confidence through sound risk management*. Presented at the *City of Calgary Water Resource Symposium*, Calgary, Alberta, Canada, October 28-29, 2008 (invited).
342. **Pollard, S.** (2008) *Risk management in water and wastewater utilities*. Presented at the Laboratório Nacional de Engenharia Civil (LNEC) Advanced short course on 'Risk management in civil engineering', Lisbon, Portugal, November 17-22, 2008 (invited).