MUDDYING THE WATERS? THE WATER POLLUTION CONTROL ORDINANCE AND DEFINING POLLUTION OF RIVERS AND STREAMS IN HONG KONG

Amanda Whitfort and David Dudgeon***

In this article the authors consider whether the dictionary definition of pollution adopted by the Court of First Instance in The Secretary for Justice v Flame Construction Company Limited and Others is appropriate and, in particular, whether the definition can sustain prosecutions for common types of discharges which are damaging to rivers and streams. Emphasis is placed on the difficulty of demonstrating unequivocally that ecological "harm" is caused by discharges, as this has important implications for laws that are intended to protect the environment. The authors conclude that without an amendment to the Water Pollution Control Ordinance that would provide an appropriate definition of pollution, effective prosecutions for the pollution of rivers and streams in Hong Kong cannot be pursued.

Introduction

The Water Pollution Control Ordinance[1] makes it an offence to discharge polluting matter into the waters of Hong Kong in a controlled zone. However, the Ordinance does not define "pollution". In a recent decision the Court of First Instance applied the dictionary meaning of pollution in determining whether muddy water discharged into a river had "polluted" the river. An important question is whether the dictionary meaning of pollution can sustain prosecutions for common types of discharges which are damaging to rivers and streams, given the current formulation of the Ordinance.

* Assistant Professor, Faculty of Law, The University of Hong Kong. The author would like to thank Adrian Halkes of Halkes Dundon, Solicitors, for his useful advice and assistance in the preparation of this article.

** Professor and Head, Department of Ecology and Biodiversity, The University of Hong Kong.

1 Cap 358, Laws of Hong Kong.

Secretary for Justice v Flame Construction Co Ltd and Others

This was an appeal by way of case stated[2] before Deputy Judge McMahon as he then was, brought by the Secretary for Justice, against the decision of a magistrate to acquit four construction companies of discharging "polluting matter" (muddy water) into a river running through a construction site in the Deep Bay Water Control Zone.[3] The charges against Flame Construction Company Limited, Zen Pacific Civil Contractors Limited, China State Construction Engineering Corporation, and Ngo Kee Construction Company Limited were brought by the Environmental Protection Department under s 8(1)(a) of the Ordinance.

Section 8(1)(a) of the Ordinance provides that:

> "(1) Subject to section 12, a person commits an offence who discharges-
> (a) any waste or polluting matter into the waters of Hong Kong in a water control zone."

Section 8(1A) of the Ordinance provides that:

> "Subject to section 12(1A), a person commits an offence who discharges any poisonous or noxious matter into the waters of Hong Kong."

Sections 12 and 12(1A) of the Ordinance allow such discharges into water control zones only in accordance with a licence issued by the Director of Environmental Protection or in circumstances where the discharge was made in an emergency in order to avoid danger to life and property. These defences were not relevant to the decision in *Flame*.

The magistrate who heard the case against Flame Construction (the alleged polluter) and the other defendants (the main contractors at the construction site) found that s 8(1)(a) required more proof for the offence to be made out than would be required if the discharge had been an alien (man-made) toxic substance, because mud is a natural substance occurring in rivers. In instances where the alleged pollutant was mud, the magistrate found that the prosecution needed to demonstrate:

(1) quality contrast, by sampling the quality of the water upstream and downstream, in order to prove causation;

2 Brought under s 105 of the Magistrates Ordinance (Cap 227).

3 *Secretary for Justice v Flame Construction Co Ltd, Zen Pacific Civil Contractors Ltd, China State Construction Engineering Corporation and Ngo Kee Construction Company Ltd*, High Court Magistracy Appeal No 942 of 2001.

(2) escape of the mud from the site boundary, not merely intra-site mud movements; and
(3) duration of the stated river water: mud concentration in order to prove damage to the environment.[4]

In his assessment of what the Legislature considered to be "pollutant" the magistrate considered Hansard of the Hong Kong Legislative Council proceedings dated 25 June 1980, when the Ordinance was at the Second Reading Stage. The "polluting matter" then mentioned by the Secretary for the Environment was "bacteria ... from untreated sewage ... cadmium and other toxic metals, and agricultural wastes (predominantly pig and poultry manure)." The magistrate noted that the Legislature had considered the Ordinance on at least two more occasions since 1980 – in 1985 and 1990. In 1990, the terms used were "heavy metals" and "organic pollutants". He considered that the tables attached to the Technical Memorandum,[5] which provide differing limits on suspended solids in inland waters, were dependent on the beneficial use of the waters. However, the magistrate noted that the tables referred clearly to the discharge of toxic or alien substances such as "toxic solvents, oil, grease, mercury and cyanide". He found, therefore, that the intention of the Ordinance was not to include mud as a pollutant.[6]

The magistrate also determined that he needed evidence of the polluting effects of the discharge before he could convict the defendants. Accordingly, the defendants were acquitted.

In the Court of First Instance, Deputy Judge McMahon was asked to consider two questions of law proposed by the magistrate. The questions were:

(1) whether the discharge of mud or muddy water requires more proof than the discharge of an alien toxic substance; and
(2) whether the magistrate erred in acquitting the respondents.

At the outset of the hearing, the appellant informed the court that she did not seek to vary the verdicts of acquittal in the event the magistrate was found to be in error, so the judge declined to answer the second question.

Answering the first question Deputy Judge McMahon ruled that a discharge of "mud or muddy water" does not require more proof for criminality

4 Magistrate's Statement of Findings dated 19 Mar 2001, *HKSAR v Flame Construction Co Ltd, Zen Pacific Civil Contractors Ltd, China State Construction Engineering Corporation and Ngo Kee Construction Co Ltd*, p 4, para 7.

5 Technical Memorandum for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters, Cap 358AK, Hong Kong Regulations.

6 *See* n 4 above, p 3, para 5.1.

than the discharge of an alien toxic substance. He observed that the Ordinance did not in express terms require proof of any actual effect upon, or damage occasioned to, the protected waterway for an offence to have been committed. He stated that he did not need to find evidence of the effect, even of a natural substance such as mud, on a protected waterway for a crime to have been made out.[7]

The Lack of a Definition for "Pollution" in the Ordinance

Although Deputy Judge McMahon found that no more proof is required for the offence to be made out where the polluting matter is mud, the interesting point demonstrated by the judgment is that the Ordinance contains no actual definition of "polluting matter" at all.

Deputy Judge McMahon ruled that it is immaterial that s 8(1)(a) and 8(1A) do not define "waste, polluting, poisonous or noxious matter" because these are ordinary words. The law prohibits discharge of these things but does not require any proof that the discharge has had a polluting, poisonous or noxious effect. The offence requires proof of the nature of the discharge only, and not its effect on the river. He reasoned that, presumably, this is why the term "waste" is included alongside pollutant, poisonous and noxious. Although pollutants, poisonous or noxious substances are defined by their effects on the water body that they contaminate, demonstrating their harmful effects is not a necessary element of the offence. The judge opined that, otherwise, the legislation would prohibit the actual pollution or poisoning of waterways rather than the discharging of matter into them.

In cases where the Environmental Protection Department can show harm to the river, the nature of the discharge as a pollutant is established. However, where no harm is in evidence, Deputy Judge McMahon ruled that the composition of the discharge in itself could establish the offence. If the question of whether the matter is a pollutant is not evidenced by harm caused to the river, the prosecution is required to establish that the discharge was a pollutant according to the dictionary definition of the term "pollution". The judge found no case authorities in Hong Kong that had defined pollution, and so he relied on a decision of the English Court of Appeal in *R v Dovermoss*.[8] In that case, the Court deliberated on whether animal slurry on a farm could be considered as polluting matter. The Court tested liability on the likelihood or capability of the matter to cause harm or pollute the water. The Court defined "pollution" by considering the question: "Does the substance have

[7] *See* n 3 above p 8.
[8] [1995] Env LR 258.

the intrinsic property of making other substances with which it is intermingled physically impure, foul or filthy, dirty, stained, tainted or befouled?"[9]

The Court in *Dovermoss* required likely harm or capability of harm to find a criminal offence, but in the commentary to the case a judgment of the Crown Court (the unreported decision of *R v Eggar*) is referred to.[10] In that case, the Court found the focus for liability to be what is discharged, and not what results when the discharge is mixed with water. In other words, the question is not whether the discharge is capable of causing harm to the river. If harm could be caused, the material discharged is a pollutant. Deputy Judge McMahon acknowledged the conflicting authorities and interpreted that for a prosecution under the Ordinance, Hong Kong legislation only requires a determination that waste, polluting, noxious or poisonous matter has been discharged.

In the prosecution brought against Flame Construction Company and the other defendants, a sample taken from the overflow of the filtration tank, prior to entering the river, contained 73,000 mg of suspended solids per litre of water. The court received expert evidence from one of the authors of this paper, David Dudgeon. He stated that there is an average level of 5 mg per litre of suspended solids in a natural stream, and that even after a typhoon the level would rarely go above 40 mg per litre although the highest he had seen was 100 mg per litre. If the level was sustained at 100 mg per litre for 24 hours, animals and plant life would suffer. He told the court that a suspended solids level of 73,000 mg per litre would be hugely damaging to the ecology. The judge found that the level of suspended solids in the discharge could be interpreted as having "befouled" the river.

The Inadequacy of a "Common Sense" Definition of Pollution

Whilst the judgment must be applauded for endorsing the view that "harm" to a river need not be demonstrated for an offence to have been committed under the Ordinance (and the judge's common sense definition of "pollutant" is wide), it is important to note that the offences created by the Ordinance are not adequate to protect all of the natural waters of Hong Kong. The Ordinance allows for the establishment of Water Control Zones, and 10 such zones were established between 1987 and 1996.[11] For each zone, water quality objectives have been established. However, streams and rivers do not have

[9] *Ibid.*, p 265.
[10] *Ibid.*, p 268.
[11] Cook, B., Ng, G., "Sustainable Waste Management", in Mottershead, T., (ed) *Sustainable Development in Hong Kong* (Hong Kong: Hong Kong University Press, 2004), p 492.

the benefit of the same water quality objectives as the coastal receiving waters in the same zone; the latter are more comprehensive and hence more stringent.

The decision in *Flame* has shown that a court may find that "pollution" has occurred simply by relying on evidence establishing that the pollutant entered the river or stream. However the definition of "pollutant" given by the judge, although wide, is actually not wide enough to criminalise certain discharges that place the aquatic environment at risk but which do not have the intrinsic property of making the water "impure, foul, filthy, dirty, stained or tainted". The potential for harm is there, but the pollution caused is more subtle than the definition allows and, in some circumstances, the effects may not become evident for some time. Although the judgment recognises that demonstration of a harmful effect is not necessary for an offence to have been committed under the Ordinance, the real issue is that where actual harmful effects to the environment have been caused they may go undetected and therefore unpunished.

The Nature of the Potential Damage

The types of potential damage discussed below, which are not criminalised under the *Flame* definition, include thermal pollution from industrial facilities, runoff and percolation through soil of fertilisers from agricultural activities, and increased sediment inputs due to clearance of vegetation or stream-bank channelisation. Further problems in bringing effective prosecutions under the Ordinance exist due to the problems encountered in establishing the source of the "pollutant", and significant difficulties in distinguishing natural variations in river quality from the harmful effects of pollution.

Water pollution may occur when water is piped from rivers to cool industrial facilities; the warmed water is subsequently returned to the river with no additional elements added. The returning water is not "polluted" matter under the general definition of pollution adopted in *Flame*. However, the cooling process has raised the temperature of the water and this may cause damage to the river ecosystems through "thermal pollution". Any change in the natural temperature regime will have a profound influence on the metabolic rates of fish and other aquatic organisms. Furthermore, oxygen levels in the water decrease as temperatures rise, and may subject animals and plants to respiratory stress.

Matters are further complicated by the fact that pollutants may enter water bodies in two ways – via a point source and a non-point source. When a pollutant is discharged directly into a water body (for example, from the end of a pipe), this is called point source water pollution. Thermal pollution,

as described above, is a form of point source water pollution. When pollutants contaminate a river from many diffuse sources, for instance by runoff of sediments, fertilisers or pesticides from farmland, the phenomenon is called non-point source water pollution. Pollution from a point source is more likely to be identifiable as "pollution" under the definition adopted in *Flame*, as it can be difficult to recognise or find the origin of non-point source pollutants. As a consequence, polluters are more likely to go unpunished. Unfortunately, non-point source water pollution causes considerable damage to Hong Kong's streams and rivers, and surface runoff or percolation through soil water is the main route of entry for a range of pollutants of these waters.

Additional complexity arises from the fact that substances such as nitrogen and phosphorous occur naturally at low concentrations in rivers and streams. Levels increase when river waters receive fertilisers containing these nutrients from point or non-point sources, and – as in the case of suspended sediments – they may cause harm to rivers without necessarily "befouling" them. Nutrients can enter the water as farm runoff, sewage discharge, in particulate form (such as dust), or in the acid rain that is caused by vehicle fumes and burning fossil fuels. Once in the water, nitrates and phosphorous alter biological productivity leading to eutrophication, a condition that is associated with excessive growth of cyanobacteria, algae and other plants and which can result in oxygen depletion. Again, damage to the aquatic environment has been caused but no offence under the Ordinance has been committed, even where the *Flame* definition of "pollutant" is adopted. Better agricultural practices, and minimising the runoff of nitrogen and phosphorous, could be encouraged by introducing a wide definition of "pollutant" to the Ordinance. Nevertheless, difficulties in establishing causation will remain.

Establishing Causation

The main problem in establishing causation is that changes to river water quality caused by pollution may be hard to distinguish from changes resulting from natural variability. Human impacts on aquatic ecosystems are assessed by a combination of chemical measurements and biomonitoring; that is, one or more groups of living organisms (ranging from microbes to vertebrates) are used to assess the quality of an environment and to detect environmental change. Invertebrates that dwell on the streambed (mayflies, caddisflies, shrimps, snails and so on) are a popular choice of biomonitors for assessing conditions in streams and rivers,[12] although other groups (fishes, plants) may

[12] Rosenberg, D.M., Resh, V.H., *Freshwater Biomonitoring and Benthic Macroinvertebrates* (New York: Chapman & Hall, 1993).

be used. Changes in population size of different species or other aspects of community composition (such as species richness) are used to make inferences about environmental quality or conditions.

Unfortunately, the composition of the biomonitor community will be affected by human impacts, such as pollution, and also by natural sources of variability that would exist in the absence of human activities. Such variability includes the obvious gradient of physical and biological conditions along rivers and streams, from headwaters to estuaries – well known to ecologists.[13] Despite this knowledge, many studies that purport to test for pollution effects compare conditions at an upstream "control" or unimpacted with those at a putatively-impacted site further downstream. For example, Dudgeon attempted to monitor the impacts of increased suspended-sediment loads in a Hong Kong stream by comparing a putatively-impacted site with a second site upstream.[14] The banks and stream margins between the two sites had been cleared and excavated during stream channelisation, thereby contributing soil and suspended sediments to the downstream site. Increased suspended loads and proportions of fine particles in the streambed sediments at the downstream site were associated with a dramatic decline in the species richness and abundance of aquatic invertebrates. Nonetheless, in the absence of other information, the difference between the two study sites cannot be attributed to channelisation. This uncertainty arises because we do not know if the two sites were the same prior to the "impact". Furthermore, there is good reason to believe that the longitudinal gradients in physical conditions that exist along any stream would give rise to some natural differences in the community structure of aquatic invertebrates at the two sites.[15]

Similarly, studies in the 1980s of aquatic invertebrates along the Lam Tsuen River, Hong Kong, correlated changes in the abundance of individual species and the functional organisation and structure of the community with the effects of human impacts and elevated nutrient levels.[16] Increased population densities, but lower species diversity, were associated with higher concentrations of nitrogen and phosphorus in the lower course arising from

[13] Hynes, H., *The Ecology of Running Waters* (Liverpool: Liverpool University Press, 1970).

[14] Dudgeon, D., "Environmental Impacts of Increased Sediment Loads Caused by Channelisation: A Case Study of Biomonitoring in a Small Hong Kong River" (1995) 3 *Asian Journal of Environmental Management* 69–77.

[15] Dudgeon, D., "Research Strategies for the Conservation and Management of Tropical Asian Streams and Rivers" (1994) 20 *International Journal of Ecology and Environmental Sciences* 255–285, p 260.

[16] Dudgeon, D., "Longitudinal and Temporal Changes in Macroinvertebrate Community Organisation in the Lam Tsuen River, Hong Kong" (1984) 111 *Hydrobiologia* 207–217; Dudgeon, D., "Determinants of the Distribution and Abundance of Larval Ephemeroptera (Insecta) in Hong Kong Running Waters", in Campbell, I., (ed) *Mayflies and Stoneflies: Biology and Life Histories* (Dordrecht: Kluwer Academic Publishers, 1990), pp 221–232.

waste input from pig and chicken farms. However, this downstream change in community structure cannot be unequivocally ascribed to increased nutrients because natural variations in the environment along the stream course would alter the aquatic invertebrate community in the absence of any longitudinal change in nutrient loads. The correlation between increased nutrient concentrations and a reduction in the species richness or other change in the community structure of aquatic organisms cannot, therefore, be assumed to be causal.[17] A successful prosecution requires proof that the polluter discharged the pollutant to the criminal standard – beyond a reasonable doubt. Natural variability makes it difficult to establish such causation unequivocally.

The problem of the confounding effects of natural longitudinal changes in a river on attribution of causation can be addressed if control and putatively-impacted sites are situated on different rivers or, even better, different tributaries of the same river. As long as the sampling sites are "matched" in terms of site conditions – altitude, slope and so on – then any difference in the community of biomonitors can be attributed to the harm caused by the pollutant. But care is needed here, too. Firstly, if the "matching" of sites is poor, then confounding variables will be introduced – for instance, otherwise identical streams in Hong Kong support markedly different aquatic communities that are related to the extent of shading by trees along their banks.[18] Secondly, any pair of rivers or their tributaries may support communities that differ with respect to their species composition or population densities before a pollution impact has occurred, or they may be different notwithstanding the effects of the pollutant.[19] Mere detection of difference between two sites (one of which is putatively-impacted) is not, in itself, good grounds for establishing causation. This can be shown by imagining a set of samples taken in a stream receiving point-source discharge from a factory yielded collections of aquatic invertebrates at a density of 250 individuals per square metre. A second set of samples from a nearby "matched", "control" tributary without any factory yielded many more (400 individuals per square metre). It would be unwise to assume that the disparity was caused by pollution and represented anything more than natural variability. After all, a sample from a third tributary (a second "control") might yield no more than 100 individuals per square metre – taking the average of 100 and 400 (250 individuals per square metre), we can see that the effect of the factor effluent is undetectable and the apparent impact is attributable to the effects of natural variation among tributaries

[17] *See* n 15 above, p 260.

[18] Dudgeon, D., "The Influence of Riparian Vegetation on Macroinvertebrate Community Structure in Four Hong Kong Streams" (1988) 216 *Journal of Zoology* 609–627; Dudgeon, D., "The Influence of Riparian Vegetation on the Functional Organisation of Four Hong Kong Stream Communities" (1989) 179 *Hydrobiologia* 183–194.

[19] *See* n 15 above, p 263.

or rivers. The approach needed is to include replicate control sites to take account of this natural variation. However, there is an inherent asymmetry here – replicate control sites can usually be established, but there is rarely, if ever, more than one stream or river experiencing the impacts from the same concentration or combination of pollutants. This asymmetry can be dealt with by special sampling strategies and statistic analyses that lie beyond the scope of this article, but have been considered in the ecological literature.[20] Before leaving the confounding effects that natural variation has on our ability to detect the harm caused by pollutants, it should be mentioned that such variation can be spatial (as occurs along a river among tributaries, as described above) or temporal. For instance, if samples of aquatic invertebrates collected from a river on a particular date before a factory begins discharging a potentially harmful substance are compared with samples collected at a time after the factory had discharged a potential pollutant, it is likely that some difference will be observed. That difference may result from the effects of the discharge, or could be due to something else unrelated to human activities such as changes in populations and communities of aquatic organisms that occur as a result of seasonal and inter-annual fluctuations in rainfall in Hong Kong.[21] Clearly, what would be required is some temporal replication of sampling within the strategy used to assess the environmental impact of the factory monitoring, so that the effect (if any) caused by a discharge is placed within the context of natural variability. This often means that sampling designs can become rather complex, especially when spatial and temporal variation must be taken into account.[22]

Selective Assessment and Sampling Strategies

Another issue that complicates the assessment of the effects of a pollutant is that scientists may have reasonable disagreements as to how the impacts of different pollutants should be measured. All environmental impact assessments are selective as to which biomonitors will be relied upon and which attributes of that community of biomonitors the river or stream should be measured. The approach used and attributes measured may depend on availability of

[20] Underwood, A.J., "The Mechanics of Spatially Replicated Sampling Programmes to Detect Environmental Impacts in a Variable World" (1993) 18 *Australian Journal of Ecology* 99–116.

[21] Dudgeon, D., "Patterns of Variation in Secondary Production in a Tropical Stream"(1999) 144 *Archiv für Hydrobiologie* 271–281.

[22] Stuart-Oaten, A., Murdoch, W.M., Parker, K.R., "Environmental Impact Assessment: 'Pseudoreplication' In Time" (1986) 66 *Ecology* 1176–1184; Underwood, A.J., "Beyond BACI: Experimental Designs for Detecting Human Environmental Impacts on Temporal Variation in Natural Populations" (1991) 42 *Australian Journal of Marine and Freshwater Research* 569–587.

historical data sets for the river assessed and the local expertise of the assessor, rather than being decided on the basis of which approach is likely to yield the most sensitive or reliable indication of environmental change.[23]

A further problem in bringing effective prosecutions under the Ordinance may be anticipated because there are now no large rivers in Hong Kong in sufficiently good enough condition to compare a polluted river with one in its natural pristine state.[24] One might think that if we cannot establish what a river is like in its natural state, we cannot determine whether the river has suffered impact as the result of a possible "polluting" factor. This view is mistaken. While a pollutant can harm the ecology of a pristine site along a river, it can also cause further harm to a site that is already showing some divergence from what might be regarded as conditions that are close to the ecological "optimum." It can even cause further deterioration of a degraded site. The issue here is one of comparison – have environmental conditions (be they good, bad or indifferent) worsened in the presence of the supposedly polluting substance? The question is answered by comparing conditions "before and after" or by comparing places where the pollutant is absent with one where it is present. There is no logical requirement that any of these places or occasions should represent pristine or ideal conditions, but the sampling strategy for this comparison must include appropriate levels of spatial and temporal replication to take account of natural variability.[25]

Suggested Amendment to the Ordinance

Where there is scientific uncertainty as to how to detect harm caused to the environment, disagreement as to whether the environment has been adversely affected, and what the cause of that change is, reasonable arguments can be made by both sides in the adversarial system. The arbiter of fact needs environmental expertise to fully appreciate the arguments advanced and the science argued, yet there is no specialist environmental court in Hong Kong.[26] Most prosecutions take place in the Magistrates Court and few convictions have been appealed, ensuring that the higher courts have had limited opportunities to consider environmental issues.[27] For these reasons effective prosecutions

[23] *See* n 15 above, p 258.
[24] *Ibid.*, p 257.
[25] *See* n 20 above.
[26] For a discussion of this issue *see* Bachner, B., "The Case for an Environmental Law Court in Hong Kong" (Parts 1 and 2) *Hong Kong Lawyer* Mar 2003 and Apr 2003.
[27] Mottershead, T., "Hong Kong – Expertise of Those Involved in the Environmental Protection Regime", in Mottershead, T., (ed), *Environmental Law and Enforcement in the Asia-Pacific Rim* (Hong Kong: Sweet & Maxwell, 2002), p 198.

for the pollution of Hong Kong's rivers and streams cannot take place without an amendment to the Ordinance providing a definition of "pollution".

The United States Congress claims that it is the objective of the Federal Water Pollution Control Act 1972 to restore and maintain the chemical, physical, and biological integrity of the nation's waters.[28] The Chapter (Title 33 United States Code) defines "pollutant" as:

> "dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into water."

Ecological definitions of pollution abound, and are not always consistent. Among the most widely cited authorities, one dictionary defines the term to mean:

> "the contamination of a natural ecosystem, especially with reference to the activity of man."[29]

This definition has the major shortcoming that it requires interpretation of the term "natural ecosystem". It may carry the unwarranted implication that contamination of human-modified, degraded or restored environments is acceptable, and that the term "pollution" refers only to contamination of a pristine "natural ecosystem" – that is, an environment that has not been modified in any way by humans.

According to the same reference a "pollutant" is regarded as:

> "broadly, any introduced substance that adversely affects the value, utility, or quality of a resource."[30]

This definition, although broad, fails with regard to the example of thermal pollution given above, unless the court is willing to consider heat as a "substance".

Another authority defines pollution in a way that includes thermal pollution by stating that "pollution" is:

[28] Section 1251, Congressional declaration of goals and policy.
[29] Lincoln, R., Boxhall, G., Clark, P., *A Dictionary of Ecology, Evolution and Systematics* (Cambridge: Cambridge University Press, 1998), p 238.
[30] *Ibid.*

> "The release of a by-product of human activity – chemical or physical – that causes harm to human health and/or the natural environment; contamination causing adverse effects."[31]

In this case, however, the definition hinges on the occurrence and detection of "harm" or "adverse effects", whereas the previous definition requires only the demonstration of "contamination", and not any deleterious effect upon the ecosystem.

By combining the two definitions, the authors suggest an amendment to the Ordinance providing a definition of "pollution" as:

> "the release of a by-product of human activity that contaminates the environment and has the potential to adversely affect its value, utility or quality."

Conclusion

Any definition of "pollution" must recognise that we have an incomplete understanding of the relationship between human actions (including the products that we make) and their effects on the environment. Furthermore, the scientific data that needs to be used to separate natural variation from changes caused by pollution are often inadequate and rarely allow for unequivocal conclusions (often both), and there may also be potential serious problems if the science is wrong. In such situations, the precautionary principle mandates that we impose controls to protect the environment as long as our understanding remains incomplete, and for so long as there is a perception that major problems (such as contamination of drinking water) are likely to arise as a result of our actions. One approach would be to assume the worst and assume that any potential contaminant or pollutant will have a significant effect, and the onus to prove otherwise should lie with the "polluter" – that is, anyone who stands to gain from a discharge from a point or non-point source. In practice, however, this is unworkable, due to the impossible task of demonstrating the certainty of "no effect". Responsibility for protecting the environment must therefore be placed on society and its regulators through

[31] Calow, P., *The Encyclopedia of Ecology & Environmental Management* (Oxford: Blackwell Science, 1998), p 573.

introduction of legislation that takes account of tolerability of risks from pollution and the benefits that derive from substances that may become subject to pollution control.

The Hong Kong Government first announced a commitment to sustainable development during the Chief Executive's Policy address in 1999, and has recently established a Council for Sustainable Development.[32] Local legislation should therefore reflect the precautionary principle by prohibiting discharge of substances and other activities or practices that cause adverse environmental change. The introduction of an inclusive definition of pollution under the Ordinance in accordance with the policy, would be an appropriate and timely initiative, and provide a key element of the foundations of sustainable development in Hong Kong.

[32] Available at http://www.susdev.gov.hk/html/en/council/index.htm (visited 5 Jul 2004).