Exploring the EIA/Environmental Management Relationship

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ABSTRACT/An important measure of the effectiveness of environmental impact assessment (EIA) is the extent to which it achieves its goals for environmental protection and management. To determine this requires an examination of environmental outcomes for projects that have undergone EIA. The utility of the pre-decision stages of EIA in influencing environmental decisions has been well documented by others. It is argued here that EIA can also play a useful role in providing for ongoing adaptive environmental management. **The hypothesis of this research is that EIA does influence environmental management activities and outcomes for development projects and that this influence occurs in distinctive ways during three stages based on the principal approval decision point; pre-decision, post-decision and transitional stages. This hypothesis was tested with respect to six case studies in Western Australia (WA). The majority of management actions were proposed during the pre-decision stage along with the formulation of impact predictions, although significant environmental management activities did occur during the other stages of the EIA process. New management actions were implemented during the post-decision stage in response to the occurrence of unexpected impacts. Adaptive management activities were initiated during the transitional stage of EIA through the setting of environmental objectives in the pre-decision stage which left scope for a flexible approach to be adopted for achieving these objectives.** During project assessment in WA, strong emphasis was placed on the need for ongoing monitoring and management programmes. The implementation of these programmes was found to be central to successful

achievement of project and environmental performance objectives. The case studies demonstrate that a strong relationship exists between EIA and ongoing environmental management performance in WA.

Environmental impact assessment is a planning tool used to predict and evaluate the impacts of proposed projects in order to assist decision-making (Ortolano and Shepherd 1995). In addition to its planning role, EIA has long been considered an important tool for the environmental management of development projects (e.g. Storey 1986, Wathern 1988, Smith 1993), although relatively little attention has been given to the details of the relationship between EIA and **specific** environmental management **or mitigation** activities. However, an important development in this area is the notion of adaptive environmental assessment and management put forward by Holling (1978). Subsequently, Storey (1986) called for a greater emphasis on the environmental management aspects of projects, rather than focussing solely on the impact prediction process leading up to the decision to proceed with development projects.

In an environmental audit of artificial waterway projects in WA, Bailey and others (1992) examined the relationship between the success with which impacts were predicted and the management response to them. They found that accuracy of impact predictions had no bearing on environmental management activities with management responses to actual impacts being implemented both for inaccurately predicted impacts and for unforeseen impacts. This research led to the question: where do environmental management responses originate during EIA if not from accurate impact predictions?

Culhane (1993) suggested that the outcomes of the EIA process (i.e. the environmental impact statement and any conditions imposed by decision-makers) could be viewed as management objectives to guide subsequent project implementation and management. Framing EIA in this management context was seen to be a way of broadening EIA from a pre-decision paperwork and adversarial process into an objective-led process aligned with rational-scientific expectations (Culhane 1993).

This view of EIA was supported by Bailey (1994) who posited that EIA is a useful tool for ongoing environmental management and that this provides an important indicator of the effectiveness of the process. In subsequent work, Bailey (1997) examined the theory and practice of EIA with respect to **project based** environmental management **activities**.

Despite the wealth of experience and published accounts of EIA, Bailey (1997) noted a deficiency in the exploration of the relationship between EIA and environmental management **actvities**. He suggested that the influence of EIA beyond the decision to proceed with development projects to inform the process of ongoing environmental management was worthy of further examination. Bailey (1997) provided anecdotal examples from his own experience as a member of the Environmental Protection Authority (EPA) in WA over a nine year period during which some 500 individual impact assessments were undertaken. Some of the approaches to EIA that provide guidance for ongoing environmental management include (Bailey 1997):

- The encouragement of proponent commitments for environmental management.

- The specific incorporation of environmental management considerations in the EIA process.
- The establishment of management objectives by the EPA which proponents are legally required to comply with, but for which the means of compliance are not specified, thereby allowing flexibility in project implementation and management and encouraging proponents to continue to plan and design their project over time.
- The requirement for proponents to prepare detailed environmental management programmes (EMPs) following the approval decision, but prior to project implementation, for major or complex projects. EMPs consolidate proposed environmental management activities and put in place a system for both the monitoring of impacts and the necessary response by project managers during subsequent project implementation (Brew & Lee 1996).

It can be seen that these opportunities for environmental management **activities** are not tied to impact predictions.

The work of Bailey (1997) provided the foundation of the research reported on here. A detailed analysis of six case studies in WA was undertaken to further explore the relationship between EIA and environmental management **activities** in this jurisdiction. Some preliminary findings have previously been published in Morrison-Saunders (1996a, b, c). The full results are presented for the first time here. **An hypothesis to explain** EIA/environmental management relationship was **proposed** and subsequently tested **with results derived from** six development project **case studies** in WA. The **hypothesis and some important terminology explanations and assumptions** are outlined in the following section of this paper. The third section describes the six case studies briefly and is followed by discussion of the major findings. The paper concludes with some recommendations for future practice based on the experience with EIA and environmental management in WA.

EIA/Environmental Management **Hypothesis**

The overall process of EIA is frequently regarded as a tool for environmental management (eg. REFS....??). In this study the focus has been on discrete environmental management activities or mitigative measures undertaken during project level EIA, and hence the term 'environmental management activities' is used in this context throughout this paper.

To explore the origins of environmental management activities, and thereby enable effort to be focussed effectively, an EIA/environmental management **hypothesis** was developed and tested**. The hypothesis was derived following consideration of** the relationship between various stages of EIA and environmental management activities for projects undergoing assessment. The **hypothesis seeks** to explain the mechanisms by which the EIA process can influence subsequent environmental management activities**. The hypothesis was derived by positing two key questions**. The first question is: did EIA have an effect on project management? This question

seeks to determine from the outset whether or not EIA actually did influence environmental management activities in any way. **It involves documenting all EIA events and recording all environmental management activities related to these. Except where the influence of other legal and administrative processes are in evidence (eg. pollution control standards), it is assumed that these would not have occured in the absence of EIA**. If the answer to this question is yes, then it is important to consider which stage of the EIA process provided this influence.

The second question to consider is therefore: when were the environmental management effects of EIA initiated? The EIA process can be divided into three stages based upon the timing of events in relation to the principle decision-making point for a particular project; **the pre-decision, post-decision and transitional stages**. **The study hypothesis is that EIA does influence environmental management activities and outcomes for development projects and that this influence occurs in distinctive ways during three different stages of the process.**

The first stage occurs up to and including the approval decision itself. This incorporates the initial project planning and design activities, preparation of the environmental impact statement (EIS), public review and decision-making. Hereafter it is referred to as the pre-decision stage. This is the stage during which most, if not all, impact predictions are made and many environmental management actions proposed to manage these potential impacts. These actions may be proposed either by the proponent as environmental management commitments in EIS documents, or by decision-makers during their assessment and subsequent establishment of approval conditions. While the management actions themselves will not be implemented until the project actually proceeds, the resulting environmental benefits can be seen to originate from the pre-decision stage of the EIA process.

The second stage of EIA influence on environmental management occurs after the decision is made to proceed with a project; i.e. the post-decision stage of EIA. Given the inherent uncertainty involved in the impact prediction process, it will not always be possible to predict all project outcomes in advance and to have proposed appropriate environmental management activities. Hence some new environmental management activities can be required during project implementation in response to unexpected events. Other management activities established during the pre-decision stage of EIA may require substantial modification or refinement as new problems or issues are encountered. These also represent the influence of the post-decision stages of EIA on environmental management.

The third stage of EIA that may influence environmental management activities is a transitional one that overlaps both the pre- and post-decision stages of the process. This occurs when the EIA process establishes some important environmental management provisions during the pre-decision stage which require ongoing attention during the post-decision stage. The examples provided by Bailey (1997) of establishing management objectives (i.e. during the pre-decision stage) which proponents are bound to comply with, but not constrained in how to do so during

subsequent project implementation (i.e. post-decision stage) and the use of EMPs represent transitional stage influences.

In short the EIA/environmental management **hypothesis** seeks to differentiate between influences that originate during the pre-decision and post-decision stages of EIA plus those that can be considered to have been transitional. **In seeking these influences for the six case studies, no attempt was made to consider wider context variables outside of the EIA process itself, with the exception of clearly identified external legal and administrative factors mentioned previously.** Before presenting the key findings of the research with respect to the three stages during which the EIA process may influence environmental management activities, a brief description of the six case studies is presented.

Case Studies

Six case study projects that have undergone EIA in WA were selected for examination. These comprised two water supply dams, an offshore oil and gas production facility, an ocean wastewater outfall, a mineral sands processing plant and a chemical manufacturing plant. No attempt was made to try to select project types or numbers that could be considered to be representative of the overall experience with EIA in WA. However, some features given consideration during case study selection were to ensure that proponents representing both government and private organisations, and projects assessed under both first generation and second generation EIA legislation (in 1986, the original EIA legislation, the *Environmental Protection Act* 1971, was repealed and replaced by the *Environmental Protection Act* 1986 to provide statutory backing to the process and making decision-makers conditions of approval legally binding) were included. The EIA process in WA has been described previously in Wood and Bailey (1994) and will not be reiterated here. Salient details concerning the nature of the six case studies and assessment issues and events for each are presented in Table 1.

Methodology

For each of the case studies, information on four distinct components of EIA was collated as follows:

- the identification and prediction of potential impacts in pre-decision EIA documents **(pre-decision and transitional stages of EIA)**;
- the occurrence of actual impacts as a result of project implementation **(post decision stage)**;
- the design and implementation of project environmental management activities to address potential and actual impacts **(pre-decision and transitional stages)**; and
- the design and implementation of environmental monitoring programmes **(transitional stage).**

These four aspects are discussed in turn.

Individual impact predictions made during the pre-decision stage of EIA for each project were recorded, plus whether or not individual predictions had an associated environmental management action related to them. Predictions that **had a corresponding impact when the project was implemented** were distinguished from those that **that expected an impact to occur, but which did not actually eventuate**. For the predictions where no impact was recorded, further examination was undertaken to determine whether this was the result of good project or environmental management, an inaccurate predictive technique or some other reason. It is important to understand how impacts that were predicted to occur were avoided in practice.

The observed environmental impacts associated with the six case studies were recorded together with how these impacts were responded to by project managers in terms of any pre-planned action or ongoing adaptive management. The relationship between the occurrence of actual impacts and the content of impact predictions was recorded to enable predictive success to be determined in terms of impact outcomes.

All environmental management activities proposed and/or undertaken for the case studies were recorded. The origin of these were then examined with respect to the EIA/environmental management model discussed previously (i.e. to distinguish between individual management commitments and conditions of approval established in the pre-decision planning stages of EIA, transitional activities, and new environmental management actions originating in the post-decision stage). The relationship between impact prediction and the implementation of appropriate management actions was also examined.

Examination of environmental monitoring reports was necessary in order to identify environmental impacts for the six case studies. The nature and design of individual environmental monitoring programmes were also recorded.

Information on each of the case studies was gained from EIA documents including follow up monitoring reports, and interviews with staff representing proponents and EIA decision-makers. Owing to the complexity of the projects, a large volume of data was generated for each project. Consequently, a computerised database was utilised which enabled the data to be organised and analysed efficiently. This analysis included statistical testing for significance of association using Chi-squared analysis (χ^2). The database (formulated in FoxPro v2.5 for Macintosh) provided a useful summary of the status and outcomes of each project examined in terms of the specific EIA process experienced by that project. A complete detailed description and explanation of the database is available on request from the authors. A separate written account of each case study was also maintained to record additional textual information on the projects.

The analysis of the research findings was undertaken in two ways. Firstly, individual case study results were compared with each other in order to identify any major

similarities or differences between the projects. Reasons for these patterns in the data were explored in relation to the specific nature of individual projects or the EIA process to which each was subjected. Secondly, the results obtained in this research were compared to the findings of previous EIA research of a similar nature.

Some key findings of the research are now presented.

Research Findings

A total of 340 impact predictions, 75 observed environmental impacts, 284 management actions and 113 individual parameters for monitoring were recorded for the six case studies. In the following discussion we focus upon the important results only. These concern the nature of impact predictions and related management activities, reasons why predicted impacts did not eventuate, implementation of proposed management actions, predictive accuracy and related management activities, and nature of environmental monitoring programmes. All figures presented in the results tables are presented as percentages to enable comparison between the six case studies. No attempt was made to combine the results into a single data set for each evaluation undertaken as the case studies do not constitute a representative sample of EIA projects in WA. Within the results tables, the case studies are denoted by initials (see Table 1).

Nature of impact predictions and related management activities

The impact predictions were examined to determine the extent to which they conform with the ideal format consistent with rational-scientific notions of EIA espoused in the theoretical literature (e.g. Beanlands and Duinker 1983, Duinker and Baskerville 1986, Culhane and others 1987, Tomlinson and Atkinson 1987). Overall, there was little evidence of impact quantification or precision in predictions for the case studies with most predictions being classified as being only vague and qualitative in nature (Table 2). Similar findings have been reported by Culhane and others (1987), Luecht and others (1989), Bailey and others (1992) and Bernard and others (1993). It can be seen from Table 2 that five of the case studies were dominated by vague, qualitative impact predictions. Hence, these projects have largely failed rational-scientific expectations for ideal EIA predictions. The questions remains open as to whether these were nevertheless managed well because of the EIAs undertaken (see later). The Sodium Cyanide Plant exhibits a considerably different result, recording the highest proportion of both quantified and precise qualitative impact predictions. These categories combined account for approximately three quarters (74%) of the recorded predictions for this project. This project appears to have been the most carefully studied and planned during the pre-decision stages of EIA (i.e. a pre-feasibility study followed by a risk and hazard analysis in the lead up to preparation of the EIS document). Preliminary technical and environmental investigations were conducted for some of the other case studies (e.g. Cape Peron Ocean Outfall and Harding River Dam); however, these appear to have been relatively descriptive and general in nature (e.g. comparison of a broad range of

potential water supply options in the case of the Harding River Dam leading to selection of the preferred alternative). In comparison, the initial risk and hazard analysis for the Sodium Cyanide Plant was restricted to an identical type of project located in three very similar locations (i.e. all within a few hundred metres of each other in the Kwinana Industrial Area). It would appear that this process enabled detailed project design components to be determined and also produced quantitative data at a relatively early stage in the EIA process, thereby contributing to a high level of precision when formulating impact predictions in the subsequent EIS document. While acknowledging that some EIAs are inherently more quantifiable, the implication here is that if a high level of impact quantification and precision in predictions is desired in EIA, then greater attention needs to be given to technical studies of proposed projects prior to the preparation of EIS documents.

It is interesting to compare the nature of impact predictions in terms of rational-scientific expectations with other characteristics of EIA activities examined in this research. There was no evidence to suggest that formal impact predictions, nor those expressed in quantitative or precise terms, were any more likely to have environmental management actions associated with them or prove to be more accurate than vague, qualitative predictions and those only generally identifying potential issues of concern. In other words, the scientific basis of impact predictions had no bearing on how these were utilised in the EIA process. Proponents and decision-makers did not attach any more importance to predictions aligned with the rational-scientific ideal for EIA. Furthermore, these predictions had no special relationship with actual project outcomes; i.e. they were not found to be more accurate than other less scientific predictions. This reiterates the findings of Bailey and others (1992) for artificial waterway projects in WA. Similar findings elsewhere have also been reported by Culhane and others (1987).

While the scientific basis of the impact prediction process for most of the case studies may not have been strong in terms of the nature of impact predictions, there was evidence of other rational characteristics with respect to proposed environmental management actions. For three of the case studies (Saladin Oilfield, Narngulu Synthetic Rutile Plant and the Sodium Cyanide Plant) it was found that predictions addressing important issues identified by the EPA for each project were more likely to have a corresponding management action than the others. The sample sizes for these three projects individually were not sufficiently large enough to permit valid statistical analysis. However, the observed trend in the data for these three projects was sufficiently strong to make a statistically significant association when the results of the six case studies were analysed collectively (χ^2= 29.981; $p<0.001$; d.f. 2). As the case studies are not a representative sample of EIA projects in WA, it is inappropriate to generalise this finding. However, an implication from this result for the case studies involved is that EIA practitioners have focussed on the important environmental issues when proposing environmental management actions, while largely ignoring the issues of lesser importance. In other words, the EIA process has effectively channelled effort onto issues of concern in three of the case studies. This finding is consistent with rational expectations of the process. If **appropriate**

environmental management **action** is the most important outcome of the EIA process, then the science of impact prediction is less important than ensuring that management strategies are put in place for significant issues and impacts (Bailey and Hobbs 1990, Bailey 1994, Bailey 1997).

It is interesting to reflect upon why this result was obtained for only three of the case studies. These three were all owned and operated by private organisations whereas the proponents of the other three were operated by a government agency. However, there is no locally published evidence to suggest that private proponents would undertake EIA differently in this regard than Government proponents in WA. The three projects for which environmental management was associated with important issues were also the most recent projects examined and were all assessed (at least in part) under the terms of the *Environmental Protection Act* 1986. Hence, the finding may be a reflection of increased maturity in conducting EIA in WA compared to the other three projects which were assessed under the former legislation and related EIA procedures. This notion is supported by the work of Bailey and English (1991) who discussed the evolution of EIA in WA. They provided examples of projects assessed under the 1986 Act during which the incorporation of management measures reduced initially unacceptable impacts to acceptable levels.

Reasons why predicted impacts did not eventuate

One important measure of the success of EIA in protecting the environment used in this study concerns the implementation of environmental management strategies to avoid the occurrence of predicted impacts. Other factors can also explain why predicted impacts did not eventuate in practice. The reasons why predicted impacts did not occur for each of the case studies are summarised in Table 3.

All six case studies provided examples where the implementation of planned environmental management actions successfully avoided the occurrence of predicted impacts. These were mostly related to the construction stage of projects where proponents sought to avoid unnecessary impacts on biological and social resources in particular. Clearly an important outcome of EIA is to attempt to **reduce** the effects of projects on the environment **to acceptabel levels** and especially to avoid the occurrence of potential impacts wherever possible.

Project design changes were not found to invalidate predictions other than in several isolated cases. A similar finding was reported by Bailey and others (1992). In contrast, Bisset (1984) found that some 34% of predictions recorded in his study could not be verified for this reason.

There were numerous examples of accurate predictions of no impact for each of the case studies. Statements that indicate what will not happen as a result of project implementation are just as important to the public reviewing EIS documents and for decision-makers as those that indicate what adverse impacts are likely to occur.

Examples of predictions that expected an impact to occur but proved to be inaccurate were much less common. The relatively high proportion of these recorded for the Harding River Dam were found to be related to two suites of impact predictions on particular issues (soil erosion in the reservoir bed during low water levels and effects on downstream vegetation from reduced river flow). When the key predicted event did not eventuate (e.g. erosion upstream from the dam), the entire suite of specific impact predictions related to this event became invalid.

The number of impact predictions that could not be verified due to a lack of information represents failings or inadequacies in environmental monitoring programmes. The proportion of these for the Narngulu Synthetic Rutile and Sodium Cyanide plants were particularly low. It is likely that the industrial nature of these projects which have very specific emissions, and hence readily identifiable impacts, may have contributed to this result (i.e. the project outcomes could be determined relatively easily). In addition there were no biological component predictions recorded for either of these projects (as they were constructed on previously cleared and industrial zoned land). Most predictions that could not be verified fell into this component of the environment. Overall, the proportion of predictions that could not be verified due to a lack of data for each case study ranged from 0-24%. This was considerably less than the 35% recorded by Bailey and others (1992) in their audit of artificial waterway projects in WA, but in most cases was considerably more than the 7% reported by Bisset (1984).

Implementation of proposed management actions

Some patterns in results were apparent for all six case studies in relation to the implementation of environmental management actions for each project. The proportion of environmental management activities proposed prior to the principal approval decision point for each case study ranged from 87-100%. It is of interest to examine the implementation rate of these proposed actions during subsequent project implementation. This type of investigation is very similar to compliance auditing which has been reported on by numerous other EIA researchers (e.g. Reed and others 1983, Bisset 1984, Munro 1987, Hedstrom and Obbagy 1988, Bailey and Hobbs 1990, Thompson and Wilson 1994, Environmental Protection Department 1995). The main difference here is that where compliance auditing seeks to evaluate the extent to which environmental conditions of approval established during EIA decision-making have been complied with, this research has focussed upon any commitment or suggestions made by EIA decision-makers for environmental management activities specifically. This may extend to proposals not included in approval conditions and leave out other conditions not specifically related to management activities (e.g. the requirement for proponents to prepare annual reports on their projects). The latter would be included in a compliance audit but is not of relevance to this discussion.

The focus on proposed environmental management activities in pre-decision EIA documentation with follow-up on the implementation of these during project implementation is in keeping with the managerial model of EIA proposed by

Culhane (1993). In this model, proponents are directed to manage their projects according to the outcomes of the EIA process (i.e. management objectives established in EIS documents and by EIA decision-makers). Culhane (1993) and Bailey (1997) have suggested that this is one way in which the post-decision stage of EIA could be considered to be representative of a rational process. Hence, the implementation rate of proposed environmental management actions in this research provides a measure of the effectiveness of this model of EIA. The individual implementation status details for the six case studies are presented in Table 4.

For the Cape Peron Ocean Outfall project, all proposed environmental management actions were implemented in practice. For the Saladin Oilfield project and Stage 2 of the Narngulu Synthetic Rutile Plant there were no proposed management actions not implemented in practice, although several were not applicable at the time of the research, or there was no information available to determine implementation status. These results are exemplary and even the lowest recorded implementation rate of 83% is extremely impressive. By comparison, in their compliance audit Bailey and others (1992) found 121 environmental conditions out of a sample of 193 to be complied with (i.e. 63%). In the work of Culhane and others (1987, p233) of 35 mitigations, 23 had the highest accuracy rating and only five were not carried out. Other researchers have not quantified compliance rates and have simply indicated that most environmental conditions were complied with for their respective studies (Reed 1983, Zallen and others 1987).

What the relatively high implementation rate of management actions for this research indicates, is that projects proceeded largely as proposed during the pre-decision stage of EIA. In other words, the planning stages of projects were largely successful in establishing how the projects would be implemented in practice. This is indicative of the post-decision stage of EIA conforming with a rational process (Culhane 1993, Bailey 1997).

The implementation status of proposed environmental management actions was examined in a couple of ways with respect to other characteristics of the management records. The origin of proposed management actions was recorded to differentiate between actions proposed by proponents and those proposed by the EPA during their assessment. It was found that the origin of management proposals had no bearing on implementation status. A similar result, with respect to compliance auditing, was reported by Bailey and others (1992). The legal status of proposed management actions was recorded and it was found that this also had no bearing on implementation. In other words, voluntary commitments by the proponent and EPA recommendations for management established for projects assessed under the terms of the *Environmental Protection Act* 1971 were equally likely to be implemented as legally binding conditions established by the Minister for the Environment for projects assessed under the terms of the *Environmental Protection Act* 1986. It is particularly noteworthy that there were no legally binding management proposals for the Cape Peron Ocean Outfall project for which a 100% implementation rate was recorded.

These findings suggest that having a legal basis for EIA approval conditions is not a pre-requisite for ensuring that appropriate environmental management occurs. This result is different to that of Bailey and others (1992) who found that compliance with environmental conditions was statistically higher for those that were legally binding. It is also contrary to the work of several EIA researchers who suggest that an important determinant of the effectiveness of EIA relates to the provision for legally binding approval conditions (e.g. Gibson 1993, Ortolano and Shepherd 1995, Sadler 1995, 1996). These authors also emphasise the importance of approval conditions that explicitly provide for follow-up. Follow-up has been a feature in the EIA process for all six case studies examined in this research. Perhaps the clear expectation that proponents should account for the environmental performance of their projects is sufficient to ensure that proposed management activities are implemented in practice.

The proportion of new actions developed during the post-decision stage of EIA ranged from 0-12% of environmental management activities recorded for the six case studies. The Narngulu Synthetic Rutile Plant was the only project not to record new management actions. It is interesting to note that this is the only project out of those examined which was both assessed and implemented in separate stages. The Stage 2 plant incorporated significant modifications and upgrading of the original plant. Given the relatively poor environmental performance of the Stage 1 plant (it was closed down by the EPA until improved pollution control measures were installed) and the proponent's tendency to constantly refine management procedures over time (e.g. refinements to operating processes), it is plausible that new actions would have evolved for the Stage 1 plant in the absence of a second stage. In other words, it was during the second EIA process (which rapidly followed the first) that considerable changes to operational and management procedures at the plant were identified. Had there not been a second stage with formal EIA, and assuming that the monitoring and follow-up process would have resulted in some of the Stage 2 modifications being implemented anyway, these would have been recorded as new actions.

Predictive accuracy and related management activities

No attempt was made to classify the accuracy of the impact predictions recorded for the six case studies (e.g. in the fashion of Culhane and others 1987 or Bailey and others 1992). Instead predictive accuracy was considered only in the context of the occurrence of actual impacts. This was achieved in two ways. Firstly, where no impact was recorded in relation to a prediction (discussed previously). The second way relates to the accuracy with which observed impacts were predicted. The individual success with which impacts were predicted for the six case studies is presented in Table 5.

All six case studies were found to have some impacts that were inaccurately predicted although three of them (Big Brook Dam, Narngulu Synthetic Rutile Plant

and the Sodium Cyanide Plant) did not record any unexpected impacts. Hence the actual identification of potential impacts during the pre-decision stage of EIA was successful for these three projects even though they were not all accurately predicted. The possibility also remains that other environmental impacts have occurred for each of the case studies examined which have not been observed in practice. It was found, for example, that deficiencies in environmental monitoring programme design or the absence of certain programmes meant that some impact predictions could not be verified for most of the case study projects (see Table 3).

An important reason for documenting the accuracy with which observed impacts were predicted was to determine whether or not this had an effect on subsequent environmental management activities. A management response was not required for many of the impacts recorded in this research; ranging from 25-90% of impacts observed for individual case studies. These impacts represented a combination of beneficial outcomes of the projects for which no management was necessary, plus the inevitable and/or accepted adverse outcomes of the projects which could not be avoided or minimised in any way. Only three impacts from the six case studies were not responded to by project managers, where a response could have been implemented. This result, along with the small number of proposed environmental management actions not implemented in practice (Table 4), represents a residual deficiency in environmental management of the case studies.

It was found that a management response was instigated for the remaining impacts; ranging from 10-62% of recorded impacts for individual case studies. Many of these were inaccurately predicted to occur or were not considered in impact predictions in the first place. These impacts were found to represent one quarter of the overall number of impacts recorded for the six case studies. Hence, despite being either inaccurately predicted or not considered at all, an outcome of the EIA process has been a management response to these. This implies that the predictive process utilised during the pre-decision stage of EIA had alerted managers to the possibility of certain impacts occurring which enabled appropriate management responses to be put in place either as voluntary commitments or through EPA recommendations and decision-maker's conditions.

In addition, the fact that even unexpected impacts were also responded to suggests that by establishing environmental management activities and programmes in the first place, the EIA process also provided the opportunity to address unexpected events as they occurred. In other words, it would appear that the management regime which was predominantly established during the pre-decision stage of EIA has been extended beyond the scope of potential environmental impacts identified at this time, during the subsequent post-decision stage. Bailey and others (1992) and Bailey (1997) noted that environmental management responses can occur in relation to inaccurately predicted impacts and also in the absence of any prediction or condition. These results highlight the value of issue identification in EIA for environmental management over an emphasis on rigorous impact prediction.

Environmental monitoring programmes
Some weaknesses in the scope and rigour of environmental monitoring programmes have already been identified. Despite this a strong link between monitoring and environmental management activities was evident for the six case studies (Table 6). Similar to the previous finding regarding predictive accuracy and environmental management this result implies that the scientific rigour of environmental monitoring had little or no bearing on environmental management outcomes. In other words, environmental management activities may result in the absence of ideal rational-scientific impact predictions and monitoring programmes.

While monitoring programmes may not be scientifically rigorous, there was a strong connection between monitoring and management activities for the six case studies. It can be seen from Table 6 that with the exception of the Cape Peron Ocean Outfall, the majority of monitoring programmes were related to one or more management actions in some way. Monitoring programmes for the two industrial projects in particular were associated with environmental management activities. This probably reflects the relationship between emission monitoring and management of the respective production processes in order to minimise or control these ongoing emissions (i.e. these emissions would be environmentally unacceptable if not managed properly). Whilst the Cape Peron Ocean Outfall also is centred around ongoing wastewater emissions, the position adopted in this case was that management action would be undertaken only if monitoring demonstrated that the outfall generated unacceptable impacts on the marine environment.

The following section discusses the application of the theoretical EIA/environmental management model to the case studies.

Reflections on the EIA/Environmental Management Relationship

The research findings are now examined in the context of the **study hypothesis** surrounding the EIA/Environmental Management **relationship** posited previously.

Did the EIA process influence environmental management?
While it is not possible to determine what the environmental management outcomes of the six case studies might have been in the absence of EIA, it is reasonable to assert that the EIA process has influenced environmental management activities. Evidence of this includes activities such as:

- Selection of the preferred project alternative during initial project planning and design (e.g. site selection process at the Sodium Cyanide Plant and selection of the Harding River Dam option for a new water supply for the West Pilbara Water Supply Scheme) based largely upon environmental considerations.
- Modification of project components and operations made during assessment (e.g. addition of a fish trap to the design of the Big Brook dam and changes to transportation arrangements at the Sodium Cyanide Plant).

- Successful implementation of environmental management strategies to avoid the occurrence of predicted impacts (relevant to all case studies).
- Modification of project components and operations made during project implementation (e.g. progressive upgrading of pollution control equipment and modifications to production processes and the water recovery system for the Narngulu Synthetic Rutile Plant).
- Implementation of environmental management activities conceived during project assessment which were aimed at minimising impacts on an ongoing basis and thereby providing an opportunity for adaptive management to occur (relevant to all case studies).
- Ongoing and evolving management in response to new or unexpected impacts or to further improve environmental management performance (e.g. ongoing and refined risk management procedures for the Sodium Cyanide Plant, modifications to the marine monitoring programme for the Cape Peron Ocean Outfall and changes to produced water disposal for the Saladin Oilfield project).

It is evident from these examples that the influence of EIA on environmental planning and management activities has been realised at all steps in the process (i.e. from site and alternative selection through to project implementation and ongoing operation). While some of these influences are well reported (e.g. Ortolano and Shepherd 1995), others are less familiar; i.e. those concerning ongoing management.

When did the influence of EIA on environmental management occur?
The distribution of environmental management and monitoring activities according to the three stages of the EIA/environmental management model for each of the six case studies is now addressed.

The proportion of environmental management activities derived from the research database records falling into each of the pre-decision, post-decision and transitional categories is depicted in Table 7. It should be noted that these results do not incorporate the influence of the EIA process realised during project planning and initial design (e.g. selection of the preferred site location) which occurred prior to preparation of the EIS documents for at least two of the case studies (i.e. Harding River Dam and Sodium Cyanide Plant).

Overall, it can be seen that the majority of environmental management activities originated during the pre-decision stage of EIA. These ranged from 71-91% of management activities for each case study. These included proponent commitments to specific project design requirements, operating standards and procedures and other actions aimed at avoiding or minimising the occurrence of potential impacts. The EPA also contributed to pre-decision environmental management actions with recommendations for proponents to follow a particular course of action. The proponent commitments and EPA recommendations were a mixture of non-binding and binding activities according to the specific EIA procedures under which each project was assessed. The proportion of pre-decision environmental management activities recorded in this research is supportive of those authors who have

suggested that a major contribution of EIA is as a tool for decision-making purposes (e.g. Caldwell and others 1982, Taylor 1984, Ortolano 1993). The results clearly indicate that the greatest influence of EIA in terms of the number of environmental management activities occurs during the pre-decision stages of the process (i.e. making important information on how projects should proceed available up to the time at which the principal approval decision is made). However, the remaining environmental management activities should not be dismissed as they have also had a significant influence on project outcomes. These were a mixture of transitional and new or post-decision activities and are now discussed in more detail.

The recorded transitional environmental management activities accounted for 6-21% of the total for each of the case studies. Most of these were EPA recommendations (and subsequent legally binding conditions where applicable) that either established management objectives for the proponents to meet or required reports and EMPs to be undertaken on particular issues. In some cases though, the proponents also proposed management activities that fell into the transitional category. These mostly related to commitments to undertake ongoing EMP studies or their equivalent. The common factor linking these transitional activities was the establishment of management objectives during the pre-decision stage of EIA which required ongoing attention (including project modifications if necessary) during the post-decision stage.

Fewer new environmental management actions (0-13%) were recorded for the six case studies; i.e. which originated during the post-decision stage of EIA. Those that did occur were largely developed in response to unexpected impacts and were predominantly established by the proponents.

An interesting pattern is evident in Table 7 with respect to the proportion of pre-decision and transitional stage activities across the six case studies. In the chronologically early projects (i.e. Cape Peron Ocean Outfall and Harding River Dam), there is a greater proportion of pre-decision activities and less transitional activities than recorded for the later projects (Narngulu Synthetic Rutile plant, Sodium Cyanide plant and Saladin Oilfield project). It is possible that this finding reflects a shift in focus of EIA over time. The later three projects were all assessed under the terms of the *Environmental Protection Act* 1986 which Bailey and English (1991) characterised as providing for a great deal of flexibility in its administration in the way in which environmental management measures can be utilised. In particular, the emphasis on ongoing environmental management combined with the setting of environmental objectives for the proponent to meet has been previously discussed as a feature of EIA practice in WA under this Act. The results suggest that this objective of EIA is being achieved.

One class of management activity; i.e. environmental monitoring; displayed a considerably different distribution with respect to the three EIA timing categories (Table 8). The records in the pre-decision category ranged from 10-45%. These all represented definitive statements addressing particular parameters to be monitored

in particular ways specified in the pre-decision EIA documents. In other words, the details of these monitoring activities were fully established at this time.

Greater emphasis was placed on transitional monitoring activities which ranged from 25-76% of the individual case study records. These related to proponent commitments or EPA recommendations for particular environmental parameters to be investigated by means of an EMP approach or similar. In these cases, the particular monitoring technique to be used was not specified in the pre-decision EIA documents. In other words, these were more akin to the establishment of monitoring objectives which were subsequently addressed in the post-decision stage of the EIA process for each case study.

Many new monitoring programmes were developed in the initial EMP documents prepared during the post-decision stage of projects, but prior to project implementation (i.e. developed as final project design details became available). The requirement for an EMP to be prepared, therefore, appears to have provided the opportunity for proponents to focus monitoring effort on particular issues. These monitoring activities were classified in the post-decision stage of EIA which ranged from 10-56% for the six case studies. Apart from those established in EMP documents, there were also frequently new programmes developed in response to either actual observed impacts or otherwise in response to increased knowledge of the project and local environmental characteristics (e.g. modifications to the marine monitoring programmes for the Cape Peron Ocean Outfall and Saladin Oilfield projects).

Overall, compared to the equivalent results for environmental management activities, the emphasis of monitoring records has been on the transitional and post-decision stages of the EIA process. This means that more monitoring tends to occur in practice than originally specified in pre-decision EIA documents. A similar finding was reported by Glasson (1994) who found that EISs tend to understate rather than to overstate the actual amount of monitoring carried out. He speculated that the reason for this could be that the additional monitoring is making up for some of the limitations of the EIA, is responding to conditions and/or agreements resulting from the decision-making process, or is a response to new regulations. The results of this research have generally supported the first two of these postulations. An additional explanation for the relatively high number of transitional and post-decision monitoring activities recorded for the six case studies may relate to the general nature and purpose of monitoring in EIA. Monitoring is intended to be ongoing and with the main purpose of providing feedback on the environmental consequences of projects. The development and evolution of monitoring activities during the post-decision stage of projects could be expected as managers seek information on project performance. Furthermore, it is perhaps unreasonable to expect proponents to invest considerable time and financial resources in monitoring activities until they have been granted permission to proceed with their projects by environmental decision-makers. Making use of a transitional approach here, enables the requirement for environmental monitoring to be established during EIA decision-making, and hence

fulfil environmental protection and management expectations of the process, without any unnecessary expenditure on behalf of the proponent until approval to commence is granted. However, if this approach to environmental monitoring in EIA was widely adopted, it would significantly reduce the opportunities for baseline monitoring to be undertaken prior to project implementation. Hence the opportunities to engage in scientifically rigorous monitoring would be reduced. This risk requires attention.

Conclusions

At the outset of this research it was posited that EIA does influence environmental management activities and outcomes for development projects and that this influence occurs in distinctive ways during pre-decision, post-decision and transitional stages of the process. This hypothesis has been supported by the findings of the study. A strong relationship was found to exist between EIA and ongoing environmental management activities for six case studies in WA. The majority of management actions were proposed during the pre-decision stage along with the formulation of impact predictions. This finding highlights the importance of EIA as a planning tool. However, significant environmental management activities did occur during the other stages of the EIA process. New management actions were implemented during the post-decision stage in response to the occurrence of unexpected impacts. Adaptive management activities were initiated during the transitional stage of EIA through the setting of environmental objectives in the pre-decision stage which left scope for a flexible approach to be adopted for achieving these objectives.

Neither scientific rigour in impact prediction or prediction accuracy had any bearing on environmental management activities. Quantified impact predictions did not attract management attention more than qualitative predictions. Many inaccurately predicted impacts plus some that were not predicted at all were responded to by project managers. Hence, simple impact identification may be all that is needed in order to put in place appropriate strategies to avoid impacts outright or to manage those that cannot be completely avoided. Clearly, EIA has an important role as a management tool in this way. This role can be fostered by maintaining a focus on environmental management activities throughout the EIA process.

The research has identified a number of weaknesses and strengths of current EIA practices in WA. In response to these, a number of specific and more speculative conclusions are made, which may be equally valid in other jurisdictions, as follows:

- The apparent emphasis of management focus upon important issues represents a maturity in the EIA process in WA. This trend should be further encouraged in the future.
- A high level of scientific rigour in impact prediction may not result in more or improved environmental management. Instead issue identification during EIA

may be more important than rigorous impact prediction (i.e. to alert managers to issues requiring environmental management attention).

- Continued emphasis on environmental management performance should be encouraged to further allow project managers to respond to environmental issues irrespective of predictive accuracy.
- The planning stage of EIA was successful in identifying the vast majority of environmental management actions required. However, the benefit of adaptive and ongoing environmental management activities has been demonstrated. Hence, there should be an emphasis on environmental management during all aspects of EIA from project conception to operation.
- Establishing a clear expectation for follow-up by proponents may be sufficient to result in ongoing environmental management activities without the need for specific legal powers of enforcement.
- The onus of responsibility for management and monitoring undertakings should lie with the proponent, subject to regular review by EIA decision-makers (and the public where appropriate).
- Ongoing and adaptive management and monitoring can be encouraged by establishing environmental objectives for proponents to meet rather than prescriptive requirements.
- The strong connection between environmental management and monitoring activities should be maintained and further promoted.
- A flexible approach to EIA is needed (e.g. the use of EMPs) to enable and actively encourage ongoing refinements and improvements to management and monitoring programmes.
- A number of impact predictions were not able to be verified due to deficiencies in environmental monitoring programmes. A requirement for more monitoring is clearly desirable if all of the environmental consequences of projects are to be understood.

This research has extended beyond the scope of most previous auditing studies to focus upon environmental management activities. However, no attempt has been made to evaluate the overall effectiveness of EIA in terms of these (e.g. to evaluate the extent to which environmental management activities established by the EIA process actually protected the environment). There is scope for future research specifically aimed at evaluating EIA in this way.

This research identified a number of deficiencies in environmental monitoring programmes for the six case studies. Some programmes have not been able to determine whether or not potential environmental impacts have occurred. It would be appropriate for future research to examine the utility of environmental monitoring programmes undertaken as part of the EIA process in greater depth.

Finally, this research has **raised questions concerning the role of science in EIA.** Monitoring deficiencies and low precision in impact predictions indicate that the level of science in EIA is not as high as is desirable. **Despite this, there was evidence that appropriate environmental management outcomes were achieved. While it**

may not be possible to incorporate a high level of scietific rigour into the impact prediction process, appropriate environmental management strategies can be put in place to enable scientific rigour based around appropriate monitoring programmes to follow.

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Project Description and Proponent	Key Issues	Key EIA Events
Cape Peron Ocean Outfall (CP). Ocean disposal of primary treated wastewater by 4km offshore submarine pipeline. Managed by the Water Corporation of Western Australia.	Impacts on water quality, aquatic life and human use of marine environment	Assessed in 1982. Detailed marine monitoring programme required to confirm that water quality criteria were being met. Baseline monitoring commenced during EIS preparation, two years before ocean discharge commenced. Numerous modifications to monitoring programme since.
Harding River Dam (HD). Water supply dam in arid-tropical area built to reduce draw on the Millstream groundwater aquifer which supports a pool and riverine system of high ecological significance. Managed by the Water Corporation of Western Australia.	Water quality and quantity in the dam, impacts on downstream ecology, water level in Millstream aquifer.	Assessed in 1982. Dual monitoring and management programme. Monitoring of dam impacts and performance as well as preparation of a detailed EMP for the Millstream aquifer. Flows in Harding River are irregular so dam operates in conjunction with Millstream borefield. Dam water is used whenever possible.
Big Brook Dam (BB). Relatively small dam on a brook to provide an unrestricted water supply to the Pemberton Trout Hatchery and Pemberton townsite. Located upstream from the much smaller Pemberton Weir which did not provide a reliable source. Managed by the Water Corporation of Western Australia.	Impacts on migratory species of aquatic fauna.	Assessed in 1985. Proponent prepared an EMP to determine the effect of the dam on migratory aquatic fauna and to report on the effectiveness of the environmental management measures proposed.

Table 1. Summary of Case Studies (Part 1)

Narngulu Synthetic Rutile Plant (NG). Mineral sands processing plant located in an industrial area on the outskirts of the regional town of Geraldton. Managed by RGC Mineral Sands Limited.	Hydrogen sulphide emissions (odour), and liquid waste treatment, recovery and disposal (groundwater pollution risk).	Proceeded in stages. Stage 1 assessed in 1985. Odour emission problems led to the plant being closed down until new pollution control equipment installed. Stage 2 assessed in 1989. Doubling of plant capacity required further improvements to pollution control systems. Regular monitoring and reporting.
Sodium Cyanide Plant (SO). Sodium cyanide solution manufacturing plant located in the Kwinana Industrial Area within the greater metropolitan area of Perth. Sodium cyanide is transported to gold mining areas in Western Australia (used in gold extraction process). Managed by Australian Gold Reagents Pty Ltd.	Hazard/risk with feedstocks and manufacturing products (eg. ammonia, hydrogen cyanide gas, sodium cyanide solution). Transportation of product.	Original plant assessed in 1987 and commenced production in 1988. Numerous expansion proposals undergone EIA but yet to be built. Each required refinements to risk quantification and management procedures. Initial proposal for road transport rejected (rail requirement instead) but amended in 1995 given proponent's successful safety record and closure of several rail routes.

Table 1. Summary of Case Studies (Part 2).

Saladin Oilfield Project (SA). Offshore oil and gas extraction with processing facilities based on Thevenard Island. The island is mostly a designated nature reserve for flora and fauna conservation. Managed by West Australian Petroleum Pty Limited (WAPET).	Oil spill risk, produced water disposal (oil and treatment chemical residues) and impacts on nature reserve (weed invasion, fire, habitat loss etc.)	Assessed in 1987. Requirement for Oil Spill Contingency Plan and an EMP prior to project commencement. Produced water disposal changed from ocean discharge to injection into disposal wells in response to marine monitoring findings.

Table 1. Summary of Case Studies (Part 3).

Nature of Prediction	CP	HD	BB	NG	SO	SA
Quantitative	10	17	12	23	31	4
Qualitative - Precise*	10	13	9	24	43	31
Qualitative - Vague	80	70	79	53	26	65
Total	100	100	100	100	100	100

Table 2. Level of Prediction Precision.
*Although not quantified, the expected impact was clearly described.

Why Didn't Impact Occur?	CP	HD	BB	NG	SO	SA
Successful Environmental Management to Avoid Impact	22	8	6	19	20	13
Design Change to Avoid Impact	0	1	0	0	3	0
Accurate Prediction (i.e. a prediction of no impact was found to be correct)	25	14	15	17	14	20
Inaccurate Prediction (i.e. impact expected to occur but didn't)	0	11	0	0	0	4
Other Explanation	2	9	6	7	14	19
No Information Available to Verify	15	24	21	4	0	11
Not Applicable (i.e. the predicted impact did occur in practice)	36	33	52	53	49	33
Total	100	100	100	100	100	100

Table 3. Reason Why Predicted Impacts Did Not Occur.

Was Proposed Management Action Implemented?	CP	HD	BB	NG	SO	SA
Yes	97	90	76	92	83	88
No	0	6	6	3	3	0
Not Applicable Yet*	0	2	0	5	4	5
No Information	0	0	6	0	0	2
New Action#	3	2	12	0	10	5
Total	100	100	100	100	100	100

Table 4. Implementation of Environmental Management Actions.

*Proposed management action relates to an event that is yet to occur (e.g. rehabilitation works when project is decommissioned).
#A management action which was not recorded in the pre-decision or transitional EIA documentation (eg. a response to an unexpected impact).

Predictive Success	CP	HD	BB	NG	SO	SA
Accurate	40	74	80	80	50	25
Inaccurate	50	21	20	20	50	25
Unexpected	10	5	0	0	0	50
Total	100	100	100	100	100	100

Table 5. Success at Predicting Impacts.

Any Associated Management?	CP	HD	BB	NG	SO	SA
Yes	14	62	66	94	100	52
No	0	3	0	6	0	33
Not Required	86	35	34	0	0	15
Total	100	100	100	100	100	100

Table 6. Relationship Between Monitoring Management Activities.

Origin of Management	CP	HD	BB	NG	SO	SA
Pre-Decision Stage	91	87	74	79	71	79
Transitional Stage	6	11	13	21	19	16
Post-Decision Stage	3	2	13	0	10	5
Total	100	100	100	100	100	100

Table 7 Origin of Environmental Management Activities.

Origin of Monitoring	CP	HD	BB	NG	SO	SA
Pre-Decision Stage	10	45	11	41	19	10
Transitional Stage	76	45	33	47	25	38
Post-Decision Stage	14	10	56	12	56	52
Total	100	100	100	100	100	100

Table 8. Origin of Environmental Monitoring Activities.