

# THE EFFECTS OF CONSTRUCTION ON THE ENVIRONMENT: A CASE STUDY

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Environmental issues and concerns have recently gained importance world wide. Concerns mainly focus on atmospheric emissions; environmental deterioration; depletion of natural resources; energy issues; sustainability, in various contexts; environmental conservation versus development; the effects of the above mentioned and other factors on ecological systems; and the economic implications of environmental issues and concerns. Construction is a change agent, its nature being to alter the environment, beneficially in some respects and detrimentally in others. Construction is also an economic activity, providing facilities, while consuming energy and other resources. Tensions thus exist between construction and developmental processes *vis-à-vis* environmental and conservation issues. This paper reviews South African legislative and regulatory mechanisms and other construction-related issues concerning environmental conservation, reports on a survey on conservation and environmental issues and examines the recent development of a tourism and leisure project. Monitoring of construction processes to comply with environmental conservation mechanisms is described, and the interaction between development, construction and the environment is shown. Some lessons can be learned and proposals for the future are made.

Keywords: construction; conservation; development; environment; pollution.

## INTRODUCTION

The transformation of South Africa into a democratic, multi-faceted nation is accompanied by changes that affect every citizen. Widespread change has occurred in many spheres, including the economy, education, commerce, employment, cultural concepts, historical perceptions, national priorities and environmental issues.

South Africa is a country of contrasts, e.g. between indigenous and cosmopolitan cultures, basic and advanced education, survival and relative comfort, internal development and global competitiveness. The country is part of the developing world, exhibiting features such as subsistence farming and other basic means of survival, a large informal economy, drastic shortages of housing and other facilities, a large degree of illiteracy, considerable unemployment, etc. However, S.A. also aspires to attain global status and addresses its shortcomings through development programmes and projects. A factor beneficial to development is the availability of sophistication and skills in spheres such as the professions, sciences, technology, manufacturing processes, business and finance and a sound formal economy (McLachlan and Eksteen, 2000).

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Contemporary South Africa sets the scene for examining the effects on the environment of construction and development, as processes of economic significance. Some realities of these processes and the legislation and regulations available to align them with environmental and economic considerations are discussed. A real-life project serves to illustrate the realities and the application of the Environmental Impact Regulations.

## **OVERVIEW OF CONSERVATION AND ENVIRONMENT-RELATED ISSUES**

According to McLachlan and Eksteen (2000), underdevelopment and relatively low education levels of a large proportion of the population lead to conflicts and paradoxes. Population growth, urbanisation, scarce resources, greed, perceived economic priorities, ignorance, lack of concern, lack of awareness, competition, cavalier attitudes and other factors result in environmental pressures and deterioration and in the fact that environmental and conservation issues are often overlooked.

The Constitution of the Republic of South Africa addresses the environment and conservation in the Bill of Rights. Also relevant are legislation and regulations pertaining to forestry, hazardous substances, township development, mining, roads and traffic, pollution, water, fishery and others dedicated to environmental conservation and management. This study will consider dedicated statutory environmental mechanisms only.

The means for promoting environmental conservation and sensitivity thus exist but practical conditions and realities often predominate.

The future of built, natural and other environments in developing countries is uncertain. In developed countries the sophistication, means and resources to preserve, restore and conserve such environments exist and thrive. In the developing world, however, important natural, cultural and other resources are threatened by pressures to provide for the basic needs of rapidly growing populations and by shortages of funding. In Southern Africa, much of the built and other aspects of the environment are of European settler or Colonial origin and may be politically unfashionable to defend in the rapidly changing cities and towns, with the growth of urbanisation and changing demographics. Persons migrating from country areas to the cities may have little experience or understanding of the complex nature of urban environments. Environmental sensitivities and conservation may not be fully understood or appreciated, thus certain features may be considered to be of little value or merely an obsolete nuisance, or of greater value to use as fuel or building material. Governments in Southern Africa are also increasingly involving the private sector in stimulating development, growth, job creation and entrepreneurship. While there are many positive aspects to creating these opportunities for the private sector, competitive business conditions, market capitalism and commercial developments may lead to the neglect of environmental conservation. (McLachlan and Eksteen, 2000).

## **RESEARCH OBJECTIVES AND METHODOLOGY**

The purpose of this study was to examine the general effects of construction and physical development activities on the environment, in the current South African context, and to monitor and evaluate the execution of a major project in terms of the requirements of the relevant legislation and the previously undertaken environmental impact assessment.

The methodology includes a review of relevant literature, observations of the general environmental effects of construction and development, a survey conducted among construction industry role players to determine perceptions and opinions regarding environmental and conservation issues. Specific observations were recorded by one of the Authors, who was the Environmental Control Officer (ECO) regarding the project forming the subject of the case study, to monitor and compare the performance of the process against the criteria set in the Environmental Impact Assessment.

## **CONCEPTS**

According to Griffith (1994: 4), “environmental management encompasses those aspects of policy, strategy, procedures and practice that form the organisation’s response to its environmental situation”. “Conservation” is defined as “preservation, especially of the natural environment”, and may include such concepts as “protection, safe keeping, maintenance, upkeep, environmentalism”, etc. (Tulloch, 1994: 304).

“Environment” is defined by Tulloch (1994: 493) as “physical surroundings and conditions, especially as affecting people’s lives; conditions or circumstances of living; external conditions affecting the growth of plants and animals”. Associated terms are “surroundings, atmosphere, climate, habitat, territory, biosphere, ecosystem, nature”. The term also may include aspects such as cities, towns and villages (the urban or built environment), culture in all its manifestations, history, lifestyle and quality of life, i.e., not solely the natural environment but also previously developed and built structures or outdoor areas.

## **REGULATORY ISSUES**

The Constitution of the Republic of South Africa (1996:11) establishes the environment as a human rights issue, stating that all persons have the right to an environment that is not harmful to their health or well-being and to have the environment protected for the benefit of present and future generations. Provision is made for legislative and other measures to deal with the prevention of pollution and ecological degradation, promote conservation and “secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development”.

The National Environmental Management Act no. 107 of 1998 sets principles for decision-making on environmental matters, stresses the value of sustainable development and aims to ensure the integrated environmental management of the activities of development processes, including design and construction. Aspects directly relating to construction include compliance, enforcement and protection.

The goal of the Environment Conservation Act No 73 of 1989 is the effective protection and controlled utilisation of the environment. The Act provides for formulating an environmental conservation policy, establishes the Council for the Environment and other relevant statutory bodies, creates protective measures for the natural environment, control of pollution and environmentally detrimental activities, formulates regulations, offences, penalties and forfeitures and includes general aspects.

The Act provides for implementing the Environmental Impact Regulations. These are contained in the Guideline Document of April 1998 and include a long list of developmental, construction, land use and waste disposal activities. An Environmental Impact Assessment (EIA) is required in respect of proposed projects listed. Application

procedures, formalities, the roles and responsibilities of various role players are also prescribed. The EIA essentially forms the criteria and monitoring process for projects.

## **CONSTRUCTION AND DEVELOPMENT VS. THE ENVIRONMENT: GENERAL OBSERVATIONS**

Eksteen and Steenkamp (2000) have noted that construction and development are agents of environmental change. Construction contributes notably to and participates in the economy, creating jobs, delivering facilities and infrastructure and using other products generated by the economy, and it precedes most activities of economic value. The industry is driven by entrepreneurial opportunities or social responsibilities arising from identified needs and wants in the market, and is fiercely competitive, especially during periods of relatively low economic activity. The tendering system and awarding work to the lowest bidder adds to the competition, and can lead to excessive risk-taking and neglect of environmental issues.

involve many role players and stakeholders, e.g., professional consultants and specialists, workers with only basic education and skills and ordinary citizens. Role players are multi-disciplinary and fragmented – a characteristic which may inhibit environmental sensitivity – hence environmental and conservation issues may be ignored or neglected. The process is complex and characterised by separations between need identification, design, production and marketing.

processes involve many inter-related activities, materials and other resources and are usually subjected to considerable time constraints resulting from competitive and economic pressures. All phases of the process (concept, feasibility, design, construction, commissioning, finalisation and operating the facility) present opportunities for influencing environmental factors positively or negatively.

utilise a spectrum of materials, many (e.g. aggregates) occurring in their natural form and requiring only basic processing. Quarrying and the use of timber have direct and lasting environmental effects. Other materials undergo a variety of manufacturing processes, all consuming energy and requiring transportation. These processes contribute to the depletion of natural resources, produce waste requiring disposal and produce atmospheric emissions. Opportunities for recycling materials are limited and rare, although recycling of constructed facilities is more common, through refurbishment and adaptation of use.

Other environmental effects of construction and development include permanent, visible scars (road works, cuttings, etc.); temporary dust, noise and other pollution during operations; disposal of construction waste, some of which can be hazardous; destruction or damage to ecosystems, e.g., in rivers, estuaries, etc., and injudicious demolition of facilities or removal of trees and other vegetation.

## **SURVEY OF CONSERVATION PERCEPTIONS AND OPINIONS**

A survey on aspects of urban conservation was conducted among a sample of persons engaged in construction and development in Port Elizabeth during 1999 (McLachlan and Eksteen, 2000). 54 questionnaires were distributed and 39 were returned, 3 being incomplete, representing a return rate of 66.6%. Salient findings and comments are:

<b>Issues investigated</b>	<b>% of Respondents</b>
Conservation of the urban environment is important or extremely important	77.7
Considerable deterioration has occurred since 1990 regarding monitoring of buildings, urban cleanliness, social behaviour, vagrancy and crime. Air quality was perceived to have remained largely unchanged while conservation policies had retrogressed to some degree. This perception conflicts somewhat with the reality of legislation and regulations in effect since 1998.	Large majority
Available resources for urban conservation are inadequate	83.3
Urban conservation is an important overall influence on and not a hindrance to development.	About 60
<b>NATURAL SITE FEATURES AND SURROUNDING CONSERVATION-WORTHY BUILDINGS ARE</b>	>80
relevant or highly relevant to development.	
Is your advice on urban conservation issues readily accepted by clients ? This may indicate that other development considerations may enjoy higher priorities than conservation issues, notwithstanding respondents' convictions about the essential nature of conservation	Marginally positive
A link exists between urban conservation and tourism. The S.A. tourism industry is in a stage of relative infancy and is considered to be not only a growth industry but also a job and wealth creator.	97.2
Historical buildings and precincts, nature conservation areas within the city and cleanliness of urban areas are extremely important to tourism. This consideration can be extended to apply also to the general environment and nature conservation, scenic and leisure areas outside cities, such as national parks, trails and travel routes such as roads and railways.	Approximately 90
How do you perceive the sensitivity of the development and design professions and the advice they give to their clients concerning urban conservation issues ? This may indicate that, although the awareness of urban conservation exists, the commitment thereto may not always be present.	Neutral
Construction contractors are insensitive to urban conservation issues.	75
Construction contractors do not advise clients on the conservation impact of demolitions, alterations and refurbishment, construction operations or waste disposal, dust, noise and other constructional nuisance factors that affect conservation.	About 75

The conclusion is that urban conservation and hence conservation in general are seen as being important cultural and economic issues and are highly significant to tourism and other economic activities, but construction role players seem to lack commitment.

The active role of legislative and regulatory mechanisms, as introduced over the past few years, thus assumes great importance.

## **THE CASE STUDY**

### **Background**

Since the early nineties, S.A. Government policy has been to initiate projects aimed at socio-economic development, job creation, and equity considerations (empowerment, skills upgrading and transfer). The objectives are to expand, improve and maintain infrastructure, raise living standards and expand opportunities for economic participation. Projects include roads, health care, prisons, office and tourism facilities and are structured for private sector realisation. Generally, Government invites development bids from private sector joint ventures to conceive, finance, design, construct and operate such facilities. Projects are procured by means of strategies such as

Public/Private Partnerships (PPPs), Public/Private Funding Initiatives (PPFIs), Build, Operate and Transfer projects (BOTs) and others. Bids for such projects must conform to financial, empowerment, training, equity, environmental, land use and other criteria. To expand the country's tourism and leisure infrastructure, a number of casino and leisure developments have recently been undertaken in South Africa. One such casino was designated for Port Elizabeth, S.A. Three developers submitted bids, one being withdrawn prior to adjudication. This was one of the first major projects to be undertaken under the conditions of the National Environmental Management Act, hence it was a valuable learning experience.

### **Project description**

The site and surroundings: A land area ca. 15 ha in extent, on the beachfront road, in the tourist and leisure area. Formerly leased by the Municipality to a private operator as a caravan park and bungalow area. In the vicinity were existing single and multi-storey residential buildings, hotels, restaurants, a small shopping centre, petrol station, tennis stadium, club hall, nursery school, primary school and military base.

The development included:

Demolition: The small shopping centre and club hall.

Demolition and relocation: The petrol station, integral with project; the tennis stadium, to another suburb; the nursery school, to a site next to the primary school.

New facilities: The casino; shops; restaurants; cinemas; two new hotels; a conference centre; theatre facilities; entertainments; parking space; gardens; a man-made lake; play areas for children; reconstruction of fencing to the primary school.

Refurbishment: One existing hotel, adjoining the casino site.

Access: Roads required reconstruction to cope with higher traffic volumes.

Project team: The developer; consultants, construction design professionals, project managers, quantity surveyors for concept and detail design and cost control.

Contractual arrangements and construction team: The project went out to tender in sections. Adjudication and awards were according to the criteria (empowerment, skills development, etc.). The construction team included established and emerging contractors, in joint ventures and in collaboration with numerous sub-contractors, many being labour-only sub-contractors and / or emerging contractors.

Project duration and value: Construction started in mid-1999, for completion in October / November 2000, in time for the holiday season. The value was about R 650 million. The result was a fast-track project with extreme budget and work pressures and little time to optimise design, construction and environmental problems.

### **The Environmental Impact Assessment**

In terms of the Environment Conservation Act, an EIA was undertaken by a private firm of environmental consultants also engaged in EI Assessments for similar projects in other cities in S. A. The consultants lacked intimate knowledge of local conditions, thus a locally based Environmental Control Officer (ECO) was appointed to oversee the Environmental Management Process (EMP) during construction. The EIA included public participation and elicited opposition to the project from many local residents, mainly about the inappropriateness of a business complex of the planned size in a residential area. Residents were also worried about undesirable elements being attracted to the area because of gambling and money changing hands, the

potential for an increase in general crime and the likelihood of drugs trade in the area. In fact, the area was not solely residential, and undesirable activities, such as drugs trading and occasional violence, already occurred at some of the existing establishments. Despite residents' objections, the authorities approved the project.

During the Traffic Impact Assessment, residents were concerned that inadequate parking outside the complex might result in vehicles overflowing into normally quiet back streets. The developer undertook to provide 200-300 additional parking spaces.

### **Monitoring**

The ECO monitored the compliance of construction activities with the EIA by means of site visits, assessment of current or anticipated conditions, reporting thereon and requesting rectification or other appropriate action.

### **Design aspects**

The development bid had been based on a concept design, thus detail design of the project and all its facets largely still had to be done after the award. Considering the time and other pressures pertaining to the project, co-ordinating all project aspects was a challenge. Construction and design ran concurrently, typical of fast tracking. Design information was often not available and design decisions changed often, almost to completion of construction. In fact, the end result differed from the original concept. Disruption of the construction sequence and schedule was thus a regular feature.

During construction it became clear that the ECO should have participated in concept planning, so that local environmental factors could have been integrated at that stage, and also should have given input in the detail planning. Not having been part of the planning function, the ECO had insufficient knowledge about what was to take place at any time. Thus each visit to the site was a new experience, since roads and other features changed often and new environmental issues had to be resolved continuously.

### **Construction aspects**

**Traffic:** Construction vehicles were required to use an alternate access route to the site and strictly prohibited from using Marine Drive. The fast-track nature of the project and schedule disruptions obliged traffic later to use this road since there was no other access to certain areas on site. The EIA thus did not allow for this aspect.

**Disposal of excavated material:** Considerable excavation was done during the early stages of construction. The soil consisted of unconsolidated dune sand with underlying rock. The EIA required all spoil to be removed to the approved site, the municipal dump, some distance from the site. However, at least one of the contractors utilised an alternate site. Once discovered, it was quickly stopped, but this serves to illustrate that contractors are unaware of the purpose of an environmental management process and identifies a gap in the application of EMPs, since many of the contractors and sub-contractors accepted the environmental provisions in their contracts without realising the consequences of their actions. During construction it became clear that the EMP was not being fully implemented due either to ignorance or lack of interest. The ECO hesitated to penalise contractors who seemed to be ignorant of the requirements. Whenever the contractors' attention was drawn to a problem they 'apparently' took quick action. It also was clear that main contractors were not briefing sub-contractors fully on the provisions written into their contracts.

Next to the casino site was a disused portion of a military base, which had been used as a source of sand. The government allowed dumping of construction spoil in the

disused sand pits, provided it was levelled and fully rehabilitated, relieving local residents from a great deal of heavy traffic leaving the construction site and disrupting local traffic, and lowering the cost of the early earthworks. There seems to be no S.A. legislation requiring landfill sites to have the title deeds endorsed. This has future land use implications and is a matter requiring attention.

**Hazardous substances:** The EIA required that adequate arrangements be made for collecting paints, solvents and other substances and their removal to the municipal hazardous waste site. No evidence of such facilities was ever seen on site. The use of such substances was low level, hence they were difficult to detect by the ECO.

**Working conditions, health, safety and sanitation:** Working conditions for labour were generally good. All labour was required to undergo environmental awareness training at the start of the project but this mainly reached the labour force controlled by the main contractors. Sub-contractors, especially those arriving on site near the hectic closing months of the contract, did not receive any of this training. Safety issues were well implemented by the main contractors but poorly by many of the sub-contractors. The use of safety equipment, especially hard hats, was a constant problem. Labourers were reluctant to use them and on hot days would “lose” them to avoid wearing them. This frustrated the contractors and incurred continual replacement costs which had not been provided in the original contract. This is another example of the importance of clearly stating the environmental and safety conditions, issue by issue, before awarding contracts.

Toilets were a difficult issue. Portable latrines (of below acceptable standard) were often far from where labour was at work. The invasive Australian vegetation on the adjoining military area afforded excellent cover and labour preferred this as a toilet area. The ECO consistently pointed out that such behaviour in a residential area was unacceptable. When the construction was drawing to a close, the ECO refused to declare the military base area as environmentally acceptable.

### **Other aspects of environmental significance**

**Wind effects:** Port Elizabeth lies on Algoa Bay. The area is prone to gales, often in excess of 40 knots and winds up to 20 knots, generated by South Atlantic and South Indian Ocean low pressure systems, from the SW in winter and SE in summer. One of the layout features that caused much unpleasantness for local residents was the orientation of the main parking area. Its long axis ran down-wind and the winter SW gales blew the fine dune sand directly onto apartment buildings and private houses.

Another error was the inclusion of fountains in the complex. In windy conditions passers-by get wet, and the design could have allowed for these local conditions.

Algoa Bay is a relatively pristine area, polluted by secondary treated sewage effluent and little else. The “Dunes ‘94” international conference declared the Alexandria dune field, an area in excess of 100 km<sup>2</sup> on the northern shore of the bay, as one of the world’s best examples of a coastal dune field. It lies downwind, across the bay from the city and litter blown offshore by westerly and south-westerly winds accumulates on its beaches. Thus, an important environmental problem addressed early on was that of litter (plastic brick and other wrappings, paper, plastic containers and other buoyant material) blown off site, into the sea and finding its way to the dune field. The EIA required all litter to be collected daily and taken to the official dumpsite. This was not properly done and there was always litter on site. The main contractor said that removal was being done daily but litter accumulated faster than it could be removed.



Litter remaining in recently constructed storm water drains was carried down to the beach after a small storm, causing an outcry from local residents. The contractors collected much of the litter, but most of the low level accumulation was not an immediate problem and went unnoticed.

Water feature and garden layout: The design included a large man-made, fresh water lake as a central feature. A large filtration plant was built to keep the water clean but, during construction, the lake was polluted by dust, floodwater and fertiliser used when establishing the surrounding gardens. The sediment in the plastic base of the lake was insufficient to use plants to function as a wetland. The filtration plant could not handle the algal growth and marine mullet, which breed only in seawater, was introduced to feed on the phytoplankton. Mineral nutrients could be removed from the water by harvesting the fish. The fish are fast growing but have not been able to control the algae. The turbid water thus develops scum under windy conditions and requires skimming in order to maintain a reasonable appearance. Scum removal could have been by allowed for in the design by locating skimmers to suit wind conditions.

The gardens around the lake are well kept and species have been selected with care but the run-off into the lake from fertilising and watering the garden aggravates the algal problem. This illustrates how sound environmental management considerations at the design stage can prevent problems and save money during operation. It also illustrates that environmental management also includes sound financial management.

Potential flood effects: During the construction phase, little attention was paid to possible flood damage. The site is sloping, with run-off accumulating over several hundred metres. In the event of a heavy storm (which, statistically, was overdue), storm water would have caused erosion, flowed over Marine Drive, depositing soil on this arterial road and then flowed into the sea. The ECO advised that a berm be constructed on the seaward edge of the site, along Marine Drive, with pipes to carry water down to the road. During construction, a 50mm rainfall event occurred and the berm performed perfectly. However, it is unlikely that these measures would have handled a large storm event. When apprised of the probability of flooding, the owners responded by taking out appropriate insurance.

### **Lessons learned**

The means for sound and integrated environmental management exist but are not yet fully implemented. The concept is in its infancy in South Africa and all role players are not yet fully informed or committed to EM processes and procedures.

The ECO should participate in the overall and detail design and execution and have the authority to issue and enforce instructions and impose fines for non-compliance with stated requirements. He / she should directly inform all contractors and sub-contractors about all requirements prior to the start of construction. A set of rules, penalties and fines, an appeal procedure and how the fines will be used need to be established *ab initio* – clearly the fines cannot be returned to the developer, nor can they go to the ECO.

Projects at the concept stage should be approached from an integrated environmental management process point of view. EI Assessments should be done with full incorporation of local conditions. The future use of landfill sites and legal implications should be considered.

All development and construction project stakeholders (authorities, developers, consulting professions, construction teams, materials manufacturers, raw material

suppliers, etc.) should be comprehensively educated about the benefits of environmental management and the consequences of not doing so.

## CONCLUSION

There is much to be learned in this country about preventing nuisance and environmental damage resulting from construction and development activities. Recognition of the cumulative effects on the environment is necessary and if personal interest and gain are placed above the greater interests of society and the environment, suitable measures are required to change such attitudes. There is a need for environmental education at all levels, from schools to the general public. Specific programmes about conservation and the importance of environmental sustainability are required for construction and development role-players.

The case study demonstrated many issues identified by the survey and observations and has also shown that, despite adequate existing mechanisms, economic and time pressures, lack of attention to detail, effective procedures and monitoring measures hamper the implementation of environmental control measures in practice.

It is thus necessary to translate the EIA criteria, as contained in the regulations, into suitable, effective procedures that can be implemented on projects by developers, construction design professionals, contractors and other role players.

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