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Report

Industrial Estate Identification and Development Procedure

By

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For
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SRI LANKA INDUSTRIAL ESTATE IDENTIFICATION AND DEVELOPMENT PROCEDURE

June 1997

EXECUTIVE SUMMARY

The identification and evaluation of potential sites for industrial development is a complex but necessary initial stage in the establishment of a sustainable industrial base in Sri Lanka Until recently selection of sites for industrial facilities was conducted primarily on a separate site-by-site, industry-by-industry basis This approach has frequently been time-consuming, expensive, controversial, and frustrating for both government officials and industrial applicants The Ministry of Industrial Development (M/ID) is determined to change that approach into one that is more comprehensive and more efficient A part of this effort, M/ID asked NAREPP to conduct a review of their current industrial estate siting program

To conduct this study, NAREPP assembled a multidisciplinary team of environmental and engineering professionals The team members were assigned to review current industrial development trends and policies in Sri Lanka, to assess environmental concerns and environmental management practices associated with industrial development, to conduct preliminary reviews of eleven of M/ID's candidate sites, to provide a comparative analysis of the environmental and socioeconomic characteristics of each of the sites, and, using the lessons learned from the site analyses, to derive more general conclusions regarding measures that Sri Lanka can and should take to improve its industrial siting and management processes

The main report contains the team's review of current industrial trends (in Chapter 2), the sectoral-level analysis of environmental concerns and management practices related to industrial siting (in Chapter 3), a description of the analytical methodology developed by the team to carry out its assessment of the eleven proposed industrial estates (in Chapter 4), and a synthesis of the results of both the site-specific studies and the more general review of industrial siting (in Chapter 5), as well as the team's findings and recommendations for improving the industrial siting and management process in Sri Lanka (in Chapter 6)

The Summary Environmental Reports for each of the eleven proposed industrial estates that M/ID asked the study team to evaluate have been separately printed and delivered to the Ministry The reports are presented in a standard format to facilitate site-to-site comparisons, along with maps and tables that contain the results of the on-site field evaluation part of the study These reports also contain the team's findings and recommendations with regard to the key environmental capabilities and resource constraints relative to potential industrial development activities at each of the sites

ENVIRONMENTAL CONCERNS IN INDUSTRIAL SITING IN SRI LANKA

In Sri Lanka, as in other rapidly-industrializing countries, inadequate attention to environmental concerns during industrial siting decisions may later lead to extremely costly problems There

number of projects Among these have been running disputes over paper mill discharges into the Walawe Ganga, controversies over the odors, solid wastes, and toxic chemicals associated with tannery operations, erosion and sedimentation in several rivers due to uncontrolled sand mining, and other issues associated with agricultural and urban discharges into rivers and sensitive coastal wetlands In addition to impacts from large-scale industrial plants, cumulative impacts of small- and medium-scale industrialization are major contributing factors to solid waste and drinking water problems in the Colombo District

The environmental problems illustrate the need for changes of attitude and policies for planning, operating, and monitoring of industries in Sri Lanka Fortunately, a further extension of past patterns is not the inevitable consequence of industrialization Rather, such problems reflect inefficient technologies or wasteful processes as well as carelessness and lack of appropriate legal and economic policies Through sound planning and management the problems of the past need not be perpetuated, but instead can be minimized or eliminated

SYSTEMATIC PLANNING FOR INDUSTRIAL SITING

Environmental problems associated with industrial development can be effectively managed if appropriate policies are put into place and implemented These policies must address environmental issues throughout the industrialization process, from initial siting decisions through management of industrial facilities throughout their operational lifetime Under a national Clean Industrialization policy, adverse environmental impacts from industrial estates can in most cases be avoided or greatly reduced if a three-step strategy is adopted

A **making careful siting decisions,**
B **making the appropriate selections of industry type and mix,**
C **requiring use of pollution prevention technology**

All three of these steps must be followed in sequence if clean industrial development is to be achieved This study was designed primarily to review the estate siting process in Sri Lanka and to make recommendations for improving it, however, the main report provides some advice and recommendations on implementing all three steps of the above strategy

STUDY DESIGN AND SCOPE

The technical design of this study was based on the results of initial site surveys conducted in October and November 1994 by a joint NAREPP/GOSL/World Bank study design team That team visited nine sites located in five provinces across Sri Lanka Based on the survey team's findings, NAREPP prepared a detailed Terms of Reference for this second study The analytical approach set out in the TOR was directed primarily at assessing the "environmental and socioeconomic sensitivity" of the sites, i e , the capacity of the local environment and the communities in the vicinity of each site to absorb industrial development To assess the sites' sensitivity to or compatibility with industrial development, fourteen environmental parameters were evaluated in this study

- o Surface drainage and soil stability
- o Surface water availability
- o Wastewater assimilative capacity
- o Air quality
- o Noise
- o Solid waste disposal capacity
- o Cultural/religious resources
- o Ecological resources
- o Transportation availability
- o Public utility availability
- o Local labor availability -- skilled
- o Local labor availability -- unskilled
- o Community infrastructure
- o Site expandability

These parameters were employed to compare similar types of information from each of the sites, **not** to make absolute or final judgements about the suitability of individual sites for industrial development A more detailed environmental impact assessment (EIA) will be needed for any site being seriously considered for location of specific industries with medium and high-polluting potential before a final suitability determination can be made

The M/ID asked the NAREPP review team to review and evaluate the environmental compatibility, using the designated parameters, of eleven sites that were under active consideration for possible development as industrial estates **Table 1** lists the sites and their approximate locations The team conducted the site visits in July and August 1995 During each visit, the team made detailed observations of the site and surrounding areas and conducted interviews with M/ID regional directors, local community leaders, and residents

INTERPRETATION OF SITE RATINGS FOR THE 14 PARAMETERS

The team evaluated each site for each of the parameters The sites were rated for each parameter at one of three levels High, Medium, or Low The rating given is the estimated compatibility of the site for each parameter with regard to typical industrial activities For example, surface water availability at Senapura is rated as <u>low</u>, indicating that the limited availability of surface water at or reasonably near the site makes it relatively incompatible with many proposed industrial activities This rating system is, of course, more qualitative than quantitative, however, team members made a considerable effort to be objective, and to use collectively their best professional judgement, all ratings were assigned following considerable deliberation and were based on group consensus

The team's ratings of each site for the selected parameters are provided in **Table 5-1.** The table should <u>not</u> be used to conclude that any given site is "best" or "worst" for all types of industrial development Each, site has a different combination of scores that reflect site-specific conditions However, these data <u>can</u> be used to identify the relative frequency and level of environmental constraints across all sites with respect to each of the rating factors

MINISTRY OF INDUSTRIAL DEVELOPMENT

INDUSTRIAL ESTATES SITING STUDY

PROPOSED SITES INCLUDED IN STUDY

SITE NAME	PROVINCE	DISTRICT	DIVISION
1 Bata-Atha	Southern	Hambantota	Ambalantota
2 Uragasmanhandiya (Yatagala)	Southern	Galle	Karandeniya
3 Waljapala watta	Western	Gampaha	Minuwangoda
4 Karanawan watta	N Western	Puttalam	Dankotuwa
5 Manaweriya	N Western	Puttalam	Arachchikattuwa
6 Tammanakele	N Western	Puttalam	Arachchikattuwa
7 Senapura	N Central	Anuradhapura	Ippalogama
8 Tambuttegama (Mahaweli)	N Central	Anuradhapura	Thambuttegama
9 Buttala (at Gamudawa Site)	Uva	Moneragala	Buttala
10 Mapakada (Viyanini Camp)	Uva	Badulla	Mahiyangana
11 Gemunupura	Uva	Badulla	Redimaliyadda

TABLE 1

Table 5.1 - Ranking of Parameters at Each of the 11 Sites

Parameter/ Site	BATA ATHA		BUTTALA		WALJA PAI A		DANKOTUWA		SENAPURA		YATAGALA		MAHAWELI		MANAWERIYA		TAMMAN-AKELLE		MAPAKADA		GEMUNU - PURA	
	EST	CAL	EST	CAL	ESI	CAI	ESI	CAI	EST	CAL	ESI	CAL	ESI	CAL	EST	CAL	EST	CAL	EST	CAL	EST	CAL
Liquid Waste Disposal	L	L	M	L	M	M	L	L	L	L	M	L	L	L	M	M	M	M	M	M	M	M
Solid Waste Disposal	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Site Expandability	M	M	L	L	L	L	L	M	M	M	H	M	L	M	L	M	H	H	L	L	L	M
Public Utilities	M	M	H	H	H	H	M	M	M	M	M	M	H	H	H	H	L	M	M	M	L	L
Ecological Systems	L	L	M	M	H	H	M	M	H	M	H	H	H	M	M	M	H	H	M	M	M	L
Transport Facilities	M	M	M	M	H	H	M	L	L	L	M	M	H	H	H	H	M	M	M	M	L	L
Community Infrastructure	M	M	H	M	H	H	H	M	L	L	M	M	H	H	M	M	M	L	L	M	L	L
Local Labour Skilled	L		L		L		M		L		H		M		M		M		L		L	
Local Labour Unskilled	H		M		H		H		L		H		M		H		H		M		M	
Air Quality	H		M		H		H		M		H		H		H		H		H		M	
Noise	H		M		M		M		M		L		H		L		H		H		M	
Cultural & Religious Res	H		H		H		H		H		M		H		H		H		H		M	

For example, in **Figure 5-2**, which has a separate pie-chart for each parameter (each circle is the sum of that parameter's ratings for the 11 sites) the darker portions of each 'pie' indicated lower levels of compatibility with industrial uses Surface water, wastewater, skilled labor, and solid waste were rated at either medium or low compatibility for all 11 sites, while air quality, unskilled labor, and cultural/religious factors posed relatively few problems at most sites Four of the parameters were viewed by the team as posing the most serious constraints on the establishment of industrial estates at these sites

- **Surface water availability** is a constraint or limiting factor at the majority of sites Significantly, none of the sites were considered by the review team to have "high" compatibility with industrial development in regard to available water supplies This constraint indicates that development of these sites may have to be restricted to industries with very low water use requirements The use of ground water may be an option at some sites but sustainable ground water availability cannot be determined without detailed site-specific ground water data, which currently do not exist for any of the sites

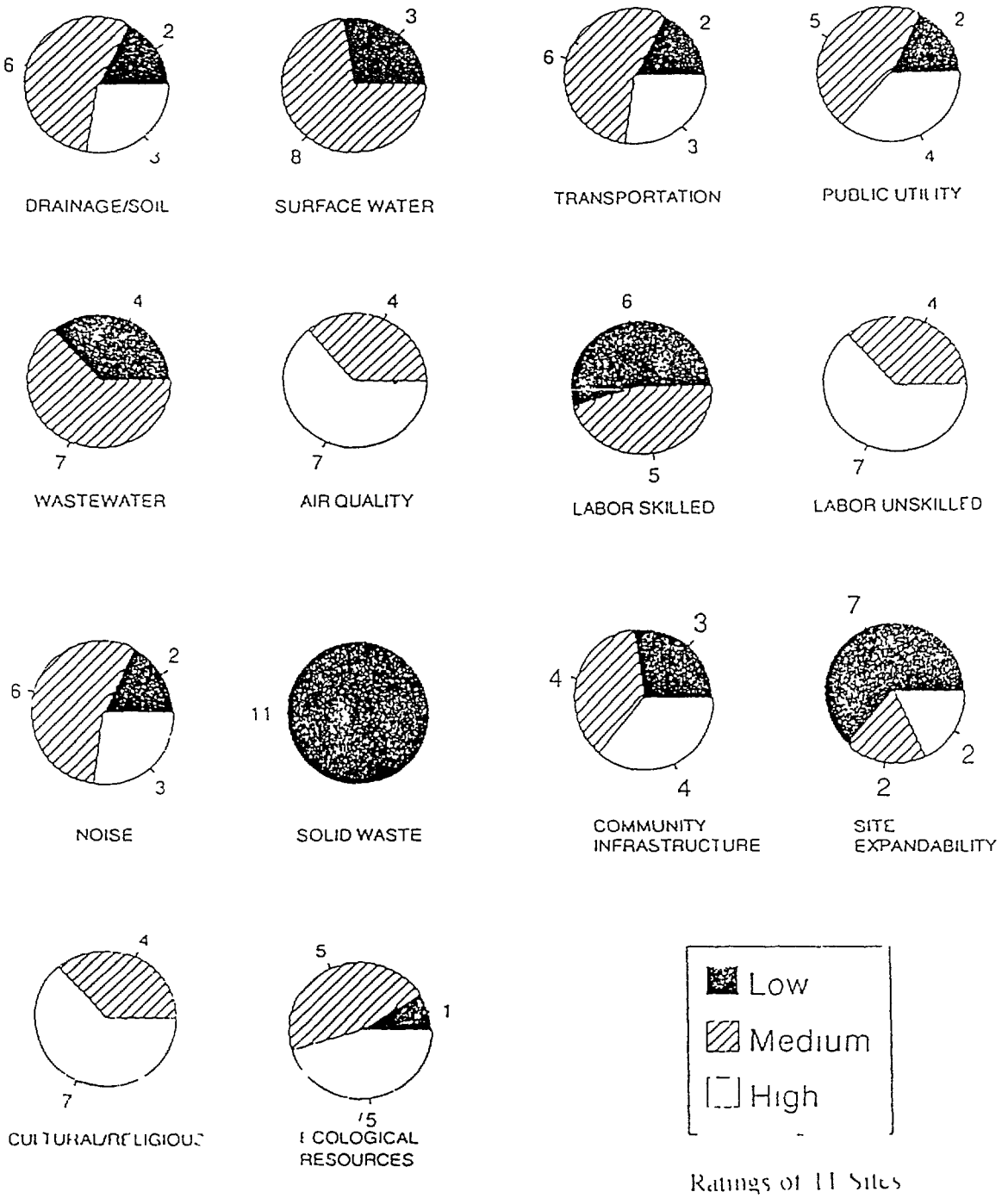
- **Limited waste-water assimilative capacity** is a constraint at the majority of the 11 sites This conclusion is based on analysis of storage and flow rates for water bodies near the sites, as well as on consideration of other current or planned competing uses of these water bodies

- **Solid waste disposal capacity** is a significant constraint at <u>every</u> site The primary reason is that there are no existing properly-constructed landfills at or near any of the sites, furthermore, on-site soil and groundwater conditions at some sites are incompatible with landfilling even if construction of such a facility were to be attempted This constraint can be alleviated to some extent by requiring that, prior to development, the site manager must approve each industry's provisions for solid waste disposal, which could include construction of a landfill <u>or</u> installation of an on-site recycling system or other solid waste treatment unit However, this requirement would add to the estate development costs and could lead to additional environmental problems In addition, residues from some waste treatment systems (such as sludge or incinerator ash) would still need to be disposed of somewhere safely after receiving on-site treatment

- **Limited space for future expansion** was a major constraint at most of the sites The review team reached this conclusion after considering the characteristics of lands immediately surrounding the sites There are physical barriers on many of these adjacent lands (e g , existing structures, natural barriers such as streams, lagoons, etc) that would make future expansion of the sites onto these lands extremely difficult and expensive, if not unfeasible

None of the sites was found to be ideally suited for high-polluting industries Some sites are highly unsuitable, while others could accommodate high-polluting industries only with a significant expenditure for additional resources and/or environmental protection measures Unfortunately, given the typically small size of the sites and the fact that most of them have very limited potential for expansion, the need to make significant capital outlays for control measures greatly diminishes the appeal of many of these sites to investors

INDUSTRIAL SITES
ENVIRONMENTAL COMPATIBILITY



Ratings of 11 Sites for each Factor

Figure: 5 1

The M/ID should consider the fact that developers of large industrial facilities will be looking carefully at ways to control their start-up costs, and are most likely to be attracted to sites where the managing entity has made substantial up-front investments in common amenities Such investments, whether by government or private parties, are not likely to be cost-effective on small sites with numerous other constraints

DEVELOPING AGGREGATE ENVIRONMENTAL INDICATORS

The 14 parameters were next sorted into one of two groups (for sites, either **pollution assimilative capacity** or **resource availability**) that each is most logically associated with Seven of the environmental parameters were used to rate assimilative capacity, and eight parameters were used to rate the second general criterion, resource availability Two parameters (cultural/religious resources and ecological resources) can be applied to both indicators and were therefore included in the estimation process for both

Once all the parameters for a site were rated, an aggregate ranking for each indicator was determined Because in most cases only general assumptions can be made about the types of industries seeking to locate at a given site, each parameter was given equal weight in the estimation of an aggregate score or classification of each site The two-part aggregate rating is determined for each site by adding up and comparing the number of H, M or L rankings separately for each of the two indicators A simple averaging method was used, whereby any single score of 'H' was matched up against any single 'L', thereby resulting in 2 ratings of 'M' This exercise produces a composite or aggregate rating for each proposed industrial estate studied with regard to the two overall indicators Thus an overall rating of 'M/ML' would mean that a site was rated medium overall for Pollution Assimilative Capacity, and medium-to-low overall for Local Resource Availability This was in fact the aggregate site rating computed for Senapura, the scores and aggregate ratings for each of the sites is given in **Table 5-2**

RATING OF SELECTED INDUSTRY TYPES BY AGGREGATE INDICATORS

The separate and aggregate ratings in **Table 5-2** were compiled for the sites themselves, not for any particular combination of industries at that site To provide some basis for matching industries to sites, the team selected 10 general types of industries found in Sri Lanka and scored them against a similar set of parameters Those scores were then used to produce aggregate ratings in the 'pollution potential' and 'resource consumption' categories The results are shown in **Table 5-3** In general terms, the table shows that different industry types vary considerably in their pollution and resource consumption impacts, which is not surprising, but the two tables taken together provide a systematic way to look for possible matches, or "fits," between a given site and a range of industries Where a site's natural resources are limited, industry types with lower resource consumption may be appropriate This rating system could be used in the preliminary stages of site development to identify which industry types should be encouraged to consider which available sites Final siting decisions should, of course, be based on more site-specific and industry-specific analysis This methodology, however, offers a short-cut in the initial screening stages

Table 5 - 3 RATING OF INDUSTRIES ACCORDING TO POLLUTION POTENTIAL AND RESOURCE CONSUMPTION

	INDUSTRIES	POLLUTION POTENTIAL							RESOURCE CONSUMPTION								
		WASTE WATER	AIR QUALITY	NOISE	SOLID WASTE	VISIBILITY	THERMAL	AGGREGATE	SURFACE WATER	ECOLOGY	TRANSPORT	PUBLIC UTILITY	LOCAL LABOUR	COMMUNITY INFRASTRUCTURE	LAND AREA	AGGREGATE
1	Textile Washing Plant	H	M	L	M	M	M	M	H	M	H	H	M	M	L	H M
2	Apparel Industry	L	L	M	M	L	L	L	L	L	H	M	H	H	M	H M
3	Manufacture of Fabricated Metal Products and Foundry	M	L	H	H	M	M	H M	L	M	M	H	L	M	L	L M
4	Manufacture of Leather (Tanning Industry)	H	H	L	H	H	M	H	H	H	M	M	M	M	M	M-H
5	Meat Processing, Curing, Preserving and Packing	H	L	M	H	L	M	M	H	L	H	H	M	M	L	M H
6	Rice Mills	L	M	L	M	M	L	M L	M	L	M	L	L	L	H	M L
7	Manufacture of Cement Products for Construction Industry	L	M	M	L	M	L	M L	M	H	H	L	M	L	H	M
8	Processing Pulp to Paper, Paper Board and Fibre Board	H	H	M	H	H	M	H M	M	H	H	H	M	M	H	H M
9	Treating and Preserving Wood	H	M	L	L	M	M	M	M	L	H	M	H	M	H	M H
10	Manufacture of Motor Vehicle Parts, Motors Brakes etc	M	M	H	H	M	M	M H	L	L	M	M	M	M	L	M L

H - High
M - Medium
L - Low

Table 5 - 2 RATING OF SITES ACCORDING TO POLLUTION ASSIMILATIVE CAPACITY AND RESOURCE AVAILABILITY

SITES	POLLUTION ASSIMILATIVE CAPACITY								LOCAL RESOURCE AVAILABILITY									
	DRAINAGE/SOILS	WASTE WATER	AIR QUALITY	NOISE	SOLID WASTE	CULTURAL RESOURCES	ECOLOGICAL RESOURCES	AGGREGATE	CULTURAL RESOURCES	ECOLOGICAL RESOURCES	SURFACE WATER	TRANSPORT	PUBLIC UTILITY	LOCAL LABOUR (SKILLED)	LOCAL LABOUR (UNSKILLED)	COMMUNITY INFRASTRUCTURE	SITE EXPANDABILITY	AGGREGATE
1 Bata Atha	M	L	H	M	L	M	L	M L	M	L	M	M	M	L	H	M	M	M L
2 Buttala	L	M	M	L	L	H	M	M L	H	M	M	M	H	M	H	H	L	M H
3 Waljapala	M	M	H	L	L	H	H	M H	H	H	M	H	H	M	H	H	L	H M
4 Karanawan watta	H	L	H	M	L	H	M	M H	H	M	L	M	M	H	H	H	L	M H
5 Senapura	H	L	M	M	L	H	H	M	H	H	L	L	M	L	M	L	M	M L
6 Uragasmanhandiya (Yatagala)	M	M	H	M	L	M	H	M	M	H	M	M	M	L	H	M	H	M H
7 Tambuttegama	H	L	H	H	L	H	H	M H	H	H	M	H	H	M	M	H	L	M H
8 Manawerıya	L	M	M	M	L	M	M	M L	M	M	M	H	H	M	H	M	L	M H
9 Tammanakele	M	M	H	H	L	H	H	M H	H	H	M	M	L	L	H	M	H	M H
10 Mapakada (Vianini Camp)	M	M	H	H	L	H	M	M H	H	M	M	M	M	L	M	L	L	ML
11 Gemunupura	M	M	M	M	L	M	M	M L	M	M	L	L	L	L	M	L	L	L M

H High
M Medium

IMPROVING SRI LANKA'S INDUSTRIAL ESTATE SITING PROCESS

Perhaps the most significant general finding of this study is that **there has not been a rational, systematic process of screening and selecting sites in Sri Lanka for industrial development.** Industrial estate site selection at present appears to be solely supply-driven, i e , tracts of land are selected without applying a consistent rationale, evaluated individually, and then offered to industrialists for whatever type of facility they are willing to develop At some point an IEE or EIA may be undertaken, sometimes rather late in the process, to determine the environmental, social, and (to some extent) economic suitability of a single site Consequently, substantial time and resources can be devoted to investigating sites that may have poor prospects for development because they have severe resource constraints, or present major environmental problems, or are otherwise unattractive to potential investors When this happens, the search for alternative sites has to begin all over again, with additional costs in time and money

A more rational strategy would be to implement an orderly siting process that begins with identifying an inventory of possible sites, based on both site characteristics **and** other considerations of industrial needs and constraints Through a systematic screening process sites could be selected from this inventory based on a variety of factors, including industry resource needs, local community acceptance of certain types of development, and consistency of the proposed development with regional land use and infrastructure Using such an inventory, it is possible to conduct an environmental assessment that allows for a systematic comparison of alternative sites, thus favoring selection of one or more sites that are the most environmentally and economically suitable The framework for such a strategy is suggested in **Figure 4-1**

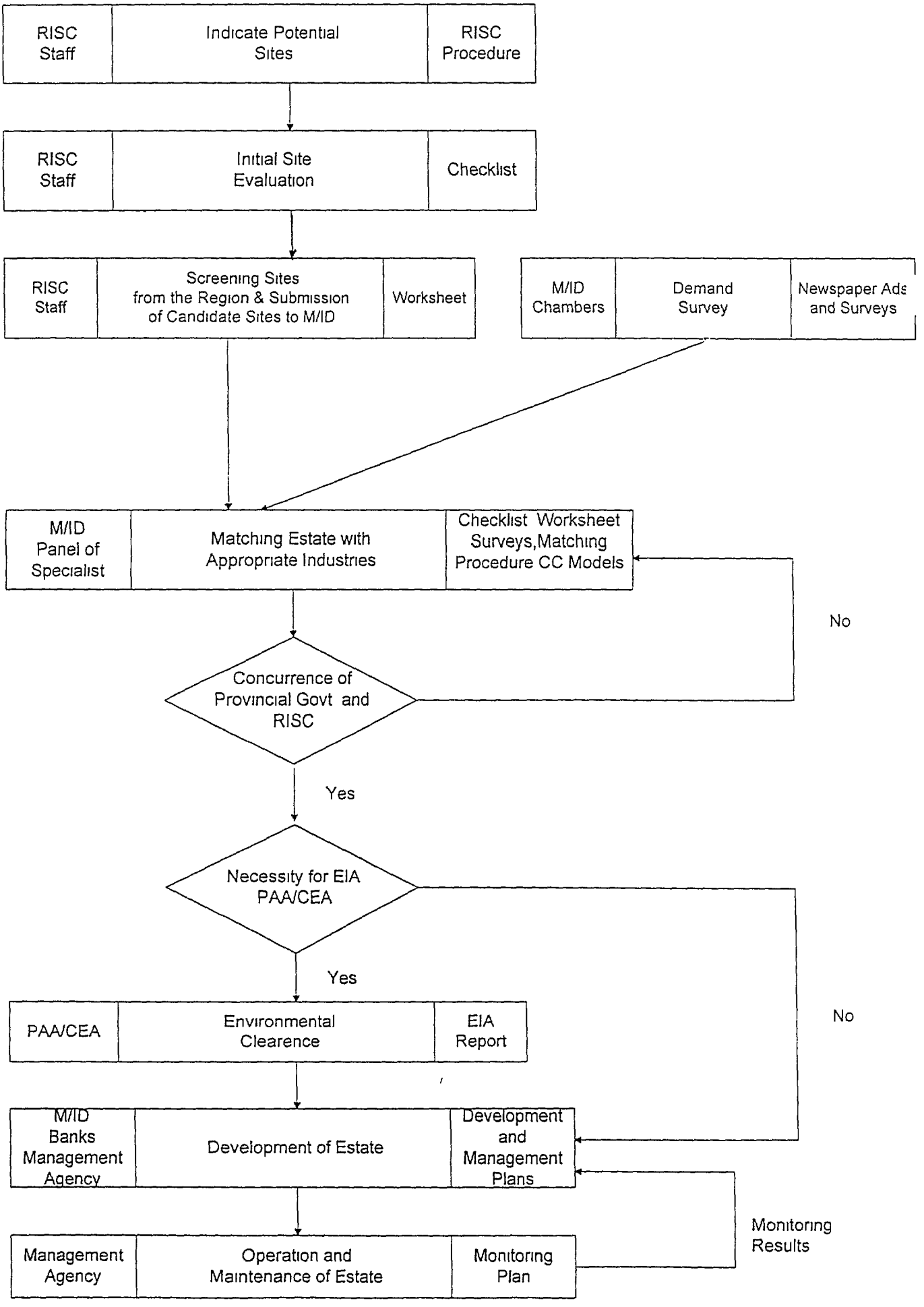
IMPROVING SRI LANKA'S INDUSTRIAL ESTATE DEVELOPMENT

In the course of this study the NAREPP team encountered several planning and management issues relating to the industrial estate siting process and other policies to develop and manage industrial estates All of these issues are manageable and can be effectively addressed with appropriate policy and institutional measures, as recommended below These issues are

1 *Improving market data indicating the level and types of industry interests* For almost all of the sites in this study M/ID lacked firm industry proposals or expressions of specific industry interests Thus, there was no solid basis for site planning and design to accommodate specific industries

2 *Improving the tract definition process* The process for siting industrial estates in Sri Lanka begins with identifying lands owned by the Government that are of appropriate size and that are not currently in use or committed to other specific uses Beyond this necessary first step, many additional measures must be taken to define and ultimately select specific tracts of land from among larger units The establishment of firm site boundaries should take place near the <u>end</u> of this process, not the beginning, as appears to have been the case with most of the sites analyzed in this study

Figure 4 1 Flow-chart describing the recommended procedure for industrial estate identification and development



3 *Improving interagency coordination and communication*: The industrial estate programs of the various industrial development agencies in Sri Lanka have not been well coordinated In particular, there has not been a multi-agency institutional mechanism for systematically assessing the need for new estates on the basis of market demand The recently-established Sectoral Committee on Industrial Estates and Projects may be the key to improving this much-needed coordination

4 *Preparing estate management plans that encourage pollution prevention and effective environmental management at the industrial estates*: Detailed plans for developing and managing most of these estates have not been completed While this is an issue of concern, it is not critical since few of the sites reviewed in this study have firm industry facility plans at this time Thus there is an opportunity to initiate policies now that incorporate sound environmental principles into estate management plans Doing so now will avoid many problems later The principles that need to be embodied in estate management plans include

- o Apply polluter-pays principles to provision of estate services such as common waste treatment and disposal facilities,
- o Reward designs that prevent pollution before it is generated,
- o Provide clear procedures and lines of authority for dealing with both planned and unplanned events

5 *Improving coordination and sharing of data on industrial needs and interests* There are several separate sources within Sri Lanka of such market data The Sectoral Committee can play an extremely valuable role in actively compiling this information and helping to ensure that it is shared among all agencies that have a stake in industrial estate planning and development

6 *Expanding the Inventory of Potential Sites* In spite of the large number of industrial estates currently proposed for Sri Lanka, our study shows that very few are likely even to be marginally suitably for medium- and high-polluting industries Of the eleven sites evaluated in this study none could be considered ideal for such industries There is a growing need to develop an inventory of sites that are suited to particular industry needs This inventory does not currently exist, largely because under the existing siting process individual tracts of land are first selected, then evaluated in terms of their economic, environmental, and social attributes As sites are eliminated from further consideration for various reasons, there is little choice but to start the process of finding sites for analysis all over again

7. *Developing Effective Industrial Estate Management Plans* When evaluating individual estate proposals, the Sectoral Committee should closely examine the arrangements that are proposed for estate management, in particular provisions for sharing environmental management and oversight responsibilities among the industrial development agencies, CEA and local environmental authorities, estate developers, and individual industrialists These provisions are extremely important, they must be spelled out in detailed form, and carefully considered

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SRI LANKA INDUSTRIAL ESTATES IDENTIFICATION AND DEVELOPMENT PROCEDURE

CHAPTER 1

INTRODUCTION

Expansion and diversification of the existing industrial base in Sri Lanka are major components of the country's economic development strategy Increased industrialization holds the promise of an improved economy It is, however also fraught with numerous environmental and social risks if improperly planned and managed The Government of Sri Lanka recognizes that one promising approach to minimizing these risks is to locate new industrial facilities in industrial estates that are designed and operated with appropriate infrastructure and environmental controls This report provides the results of a study conducted by NAREPP (a joint project of the U S Agency for International Development and the Government of Sri Lanka), the study responds to the Government's request for an evaluation of the technical, policy, and institutional issues associated with industrial estate development and operation, and a review of current siting policies in light of these issues

1 1 BACKGROUND

The Government of Sri Lanka (GOSL) has adopted a Clean Industrialization Policy, consisting of a set of measures to ensure that both existing and new industries are environmentally responsible A significant measures was a decision adopted by the Cabinet in 1994 requiring that all new industries that are classified as high-polluting (as defined by the Central Environmental Authority) be located in industrial estates Further, all new industries classified as medium-polluting must be located in industrial estates if they expect to generate large quantities of solid and liquid wastes This policy is intended to ensure that industries with the greatest pollution potential have appropriate environmental controls and are located in areas that are the most suitable with respect to their environmental and social-economic attributes

One of the first industrial development programs to be affected by this policy is a program recently initiated by the Ministry of Industrial Development (M/ID) to foster the development of industrial estates at numerous locations throughout the country Under this program, M/ID will be offering a package of incentives to encourage private investors to develop industrial estates on designated sites Depending on investor interest and specific site capabilities, some of these sites may be developed as estates to support a wide range of industries

Historically, industrial estate development planning in Sri Lanka has been carried out on a separate site-by-site basis Recognizing that M/ID's program affords an excellent opportunity to apply Sri Lanka's new industrialization policy in a more comprehensive way to an entire new industrial sector, the Government of Sri Lanka requested NAREPP's assistance in reviewing M/ID's implementation plans This activity included conducting preliminary environmental reviews of eleven of M/ID's candidate sites, comparing the environmental and socio-economic characteristics of all of the sites, and using the lessons learned from the site analyses to derive more general conclusions regarding measures that Sri Lanka should take to improve its industrial siting process

NAREPP has prepared this report in response to the Government's request The report summarizes the results of a joint NAREPP/GOSL study that was initiated in June 1995 and completed in September 1995 The study design and methodology were derived in part from a preliminary siting survey done by NAREPP in 1994, the study also drew on environmental guidelines for industrial siting developed by the Central Environmental Authority in 1993 - 94 with assistance from NAREPP NAREPP hopes that the findings provided herein will help lay the groundwork for an improved industrial siting process in Sri Lanka that will support the country's economic development objectives without compromising its environmental goals Indeed, such a process, if carefully and rigorously implemented, can demonstrate the essential compatibility of economic and environmental policies

1 2 OBJECTIVES OF THIS STUDY

This study is intended to assist the GOSL in implementing key elements of the Clean Industrialization Policy that relate to the siting and managing industrial estates There are three major objectives

A To assist M/ID in screening its candidate sites to determine which sites may be most suitable for industrial estates in terms of their environmental and socioeconomic characteristics,

B Based on the lessons learned from this screening process, to develop general recommendations for improving the overall industrial estate siting and development program and its related environmental management practices and policies,

C Develop a comprehensive policy on industrial estate siting and development, that can be institutionalized at the national and provincial levels

1 3 MAJOR ACTIVITIES OF THE STUDY

The above objectives were met by undertaking the following major activities

Field visits were made by the study team to each of the sites, where data were collected to prepare Initial Environmental Examination reports and to evaluate each site in terms of the overall industrial estate development strategy of the M/ID,

A procedure for matching an industrial estate with appropriate types of industries was developed This procedure identifies compatible industries, maximum allowance levels of industrial activiy and related sizing criteria,

An initial Site Visit Checklist and a computerised Worksheet were prepared, for use by the Regional Industrial Service Committees (RISC) This Site Evaluation Procedure allows the RISC and the M/ID to compare alternative sites in terms of several relevant parameters,

A systematic procedure for identification and development of industrial estates was developed This procedure identifies the appropriate sequence of action, along with the responsibile agencies, to facilitate effective identification, development and management of industrial estates

1 4 DISCLAIMER

Readers of this report should keep in mind that the findings and recommendations contained herein represent the best professional judgement of the study team only Views expressed do not necessarily represent those of the Government of Sri Lanka or NAREPP

CHAPTER 2

INDUSTRIAL POLICIES AND TRENDS IN SRI LANKA

This chapter focuses on the historical progression of industrialization and of national policies and programs relating to industrial estates in Sri Lanka, to provide a context for this industrial estate siting study

2 1 HISTORICAL PERSPECTIVE

In Sri Lanka, private-sector industrialization was first emphasized as a national policy during the late 1950s when the government adopted a policy of import substitution Prior to this period most industrial activity was undertaken by the government Private-sector industries were limited to a few commodities such as biscuits, aerated water, cigarettes, matches and soap [1] The government focused on setting up and managing large-scale industries Although the government actively participated as chief investor and decision maker in the industrial development process, development of small- and medium- scale industries was left to the private sector The protectionist policies adopted by the government opened up many markets for domestically-produced consumer goods

The government's policy was influenced by economic theories that justified temporary protection of domestic sectors based on the 'infant industry' argument Many financial policies of that period reflected the government's position of promoting import substitution These included licensing, high tariffs, quotas, a ban on luxury goods, foreign exchange restrictions, and extensive government intervention in industrial management

Economic policies since the 1960s have fluctuated between more liberalized, market-oriented policies and strict regimes of controls These variations have had an impact on the continuity of industrialization, and particularly on the private sector Corresponding with the prevailing economic policies, industrial development trends fluctuated as well

Broad economic reforms undertaken in 1977 led to an increase in industrial activity Protectionist policies were largely replaced with open-market policies The tariff structure was revised and a scheme of tax incentives was introduced to attract foreign investors The exchange rate was rationalized by means of devaluation, and a managed float policy was adopted to reflect market forces These open-market liberal economic policies were further supported by fiscal and monetary policies adopted by the World Bank and International Monetary Fund under the Stabilization and Structural Adjustment Programs

The period following 1977 saw a rapid expansion of industrial activity, mainly due to the availability of raw material, machinery, and spare parts Furthermore, direct foreign investment responded to the government's policy of incentives to promote industrialization

During the period 1978 - 1991 annual growth of industrial production reached an average of 8 per cent, the growth rate has declined somewhat since then

2 2 CURRENT POLICY ON INDUSTRIALIZATION AND INDUSTRIAL ESTATES

Sri Lanka's current industrial policy is based on the experience of other well-performing Asian economies [2] The Government seeks to provide a "stable and sustainable" macroeconomic environment which will tend to accelerate industrial development The Government would like to develop an "internationally competitive, export oriented diversified industrial sector," characterized by a range of high-technology 'non-polluting' industries But 'non-polluting' labor-intensive industries are also encouraged Foreign investment in the industrial sector is emphasized since it provides capital and access to modern technology and export markets

Industrial development in rural areas is now being encouraged with a view to promoting regional development and to reducing urban congestion Private-sector investment in rural areas is to be encouraged by providing infrastructure facilities Priority is to be given to agriculture-based industries and to the manufacture of finished agricultural goods

The Regional Industrial Service Committees (RISCs) serve as the regional extension of the Ministry of Industrial Development (M/ID), though other institutions also play important roles in planning and promoting industrial expansion (see below) The Ministry's 1995 Action Plan proposes measures to strengthen the ability of RISCs to execute infrastructure projects in their respective provinces Under these plans the RISCs are vested with responsibility to address several issues pertaining to promotion of industrial growth, including infrastructure, finance, and technology development

The M/ID has adopted the policy of developing industrial estates as a key component of its national industrialization strategy Due to cost as well as time constraints it is not feasible to provide infrastructure facilities necessary for industrial expansion on an island-wide scale Industrial estates are a cost-effective way to provide such infrastructure and to facilitate industrial development at specific locations This approach has also been promoted as the best way to ensure that adequate environmental controls are exerted on industrial production Two large industrial estates at Katana and Seethawaka are currently in the advanced planning stages at M/ID The M/ID is also examining several sites across the country as potential candidates for regional industrial estates Eleven such potential regional sites were analysed during this study, the principal findings and recommendations of the study team are presented in Chapter 5 of this report

In a concurrent effort, initiated by the Ministry of Transport, Environment and Women's Affairs (M/TEWA) the Cabinet in 1994 approved a decision that all high- and medium-polluting industries should be located in designated industrial estates Dispersal of polluting industries throughout the country has imposed significant difficulties for the Central Environmental Authority, which is charged with monitoring and enforcing the nation's environmental regulations The CEA's task should be made considerably easier if

all new high- and medium- polluting industries are located within designated industrial estates/parks There is, however, considerable uncertainty as to which specific industrial projects or facilities may be classified as high or medium polluting Furthermore, strong arguments can be made on the basis of the principle of economies-of-scale which suggest that pollution abatement costs can be reduced if effluent from similar industries is treated centrally

The decision to focus on industrial estates has been justified on the grounds of meeting the independent goals of both the M/ID and of the M/TEWA It constitutes a 'win-win' policy in this regard and is therefore likely to receive support from the current government While there is general consensus on the broad concept of industrial estates development, the details of a national policy must be carefully considered, addressing concerns of the relevant government agencies as well as the private-sector industries that will be subject to this policy This report is intended to support that task

2 3 INSTITUTIONAL ASPECTS OF INDUSTRIAL ESTATE DEVELOPMENT

The Ministry of Industrial Development and the Board of Investment (BOI) are the principal government agencies responsible for industrial activities in Sri Lanka These two organisations provide oversight on activities such as foreign investment tracking and promotion, export promotion, facilitating private sector growth, providing infrastructure, financing investments, and strengthening regional industrial development These activities are coordinated through a range of agencies including the, Export Development Board (EDB), Board of Infrastructure Investment (BII), the Industrial Development Board (IDB), and the Regional Industrial Service Committees (RISCs)

Several of these agencies are governed by separate laws or acts of Parliament that define their authority or jurisdiction for activities pertaining specifically to the respective agency The BOI and IDB have specific mandates to promote industrial growth, and therefore also engage in developing industrial estates The Provincial Councils (PCs) and the Urban Development Authority (UDA) promote industrial estates as well Finally, credit institutions such as the Development Finance Corporation of Ceylon (DFCC) and the National Development Bank (NDB) are also active in the development of industrial estates The specific roles of these agencies with regard to industrial estates are addressed in the following section Since these agencies tend to operate within the scope of their specific mandates, on occasion their activities may cause redundancy or duplication With respect to the siting of industrial estates, these overlapping mandates could result in the inefficient use of resources as well as in unforeseen environmental consequences if sites are located in close proximity to each other In one such instance, the BOI is developing an industrial zone directly adjacent to an industrial estate managed by IDB Industrial growth trends in the area do not appear to warrant two industrial estates Such decisions suggest the lack of a mechanism to coordinate the activities of the relevant agencies involved with developing industrial estates

In view of the need to coordinate siting of industrial estates, a Sectoral Committee has been established within the M/ID The committee is chaired by the Secretary of M/ID with representation by the Treasury, Department of National Planning (NPD), BOI, Labour Ministry, M/ID, IDB and the UDA All future proposals for industrial estates must be cleared by this committee prior to submission for cabinet approval Guidelines for establishing industrial estates have also been established by this committee According to the guidelines the first step is to conduct a demand survey of the proposed site Thereafter approval is to be obtained from the RISCs and the Sectoral Committee Clearance from the CEA must be obtained next, based on review of an acceptable Initial Environmental Examination (IEE) or Environmental Impact Assessment (EIA) Finally, the proposal must be submitted to the relevant ministry for cabinet approval

2 3 1 Ministry of Industrial Development (M/ID)

The M/ID is the primary authority responsible for developing and carrying out the industrial policy of the GOSL As stated in its Action Plan for 1995, the Ministry has proposed to develop industrial estates in several regions and two large industrial estates in the greater Colombo area The latter are targeted for large-scale industries, Katana for high-polluting industries and Seethawaka for medium- and high-polluting industries The Government of Japan is providing assistance to develop infrastructure facilities at these two sites The role of the Ministry is limited to identifying and promoting the development of industrial estates It does not play a large role in managing or monitoring the sites

The Regional Industrial Services Committees (RISCs) are responsible for developing industrial estates in the regions The Deputy Divisional Secretaries are expected to identify suitable sites within their respective divisions These proposals will be submitted to the M/ID via the respective RISCs In July 1995 the Ministry identified 15 candidate sites and requested expressions of industry interest, among those sites are the 11 included in this study (see **Table 2 3 1** below) Once the sites are approved by the sectoral committee, the M/ID is to arrange for acquisition of the required land by appealing to the Cabinet M/ID has since identified several other sites

Responsibility for managing the regional industrial estates will likely be assigned to private parties and would involve several elements First, services such as maintenance of roads and utilities and providing central security for the premises are to be undertaken centrally rather than by each individual industry Second, at industrial estates designated for high- and medium-polluting industries, waste disposal can be addressed most effectively by means of central facilities such as incinerators and centralized wastewater treatment facilities Third, each site must have a management authority to address various concerns that arise among industrialists occupying the estate These may relate to internal issues among firms or issues that industries within the park face in common These activities must be undertaken by the authority assigned responsibility for managing the estate

Initially the M/ID strategy was to provide basic infrastructure (e g , roads, telecommunication, power, and water) to the perimeter of the industrial estate site However, M/ID since decided to develop infrastructure within the estates as well

Karanawanwatte Industrial Estate in the Dankotuwa Division was the first to be so developed under the M/ID program The possibility of contracting the private sector to develop (and manage) certain infrastructure facilities such as central waste-water treatment and solid waste management on a Build-Own-Operate or Build-Operate-Transfer scheme is being considered

Table 2 3 1 below summarizes currently available information on the industrial estates proposed by the Ministry of Industrial Development Note that this study only focused on the latter 11 sites

Table 2 3 1 Potential Industrial Estates Summary information

Name of industrial estate	District	Area (ha)
Seethawaka	Avissawela	172 00
Katana	Negombo	82 00
Fullerton		12 00
Bata-Atha	Hambantota	43
Uragasmanhandiya	Galle	20
Waljapala-watta	Gampaha	6
Karanawan-watta	Puttalam	23
Manaweriya	Puttalam	21
Tammanakele	Puttalam	
Senapura	Anuradha-pura	15
Tambuttegama	Anuradha-pura	40
Buttala	Moneragala	35
Viyanini Camp	Badulla	10 7
Gemunupura	Badulla	85

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2 3 2 Board of Investment (BOI)

The BOI was created under the GCEC law No 4 of 1978 with the objective of attracting foreign capital and investors, promoting industrial development, and generating employment To this end BOI develops and manages industrial estates to facilitate export-oriented industrial growth in the country [3] At present BOI operates three industrial estates, located at Katunayake, Biyagama and Koggala Two more estates are being developed at Pallekale and Hambantota Details of these industrial estates are provided in Table 2 3 2-A

Table 2 3 2-A Industrial estates managed by the BOI

Name of industrial estate	District	Area (ha)	No of Industries in occupation	Type of industry
Katunayake	Colombo	190	105	Low and medium polluting
Biyagama	Colombo	180	38	low, medium and high polluting
Koggala	Ambalangoda	91	11	low polluting (dry)
Pallekale	Kandy	82	5	low polluting
Hambantota	Hambantota	100	-	-

BOI assumes responsibility for identifying, approving, acquiring and developing sites, approving industries, and monitoring and managing sites BOI develops infrastructure facilities within the industrial estate as well Power, water, telephone, and sewer lines are provided to the boundary of the individual lots within the estates BOI also provides services that may include maintenance of the public areas and infrastructure within the estate, providing overall security, and central treatment of solid and liquid waste

Individual industries must comply with pre-treatment water quality standards specified by the BOI These pertain to BOD and suspended solids For all other water-quality parameters the pre-treatment standards are the same as the national effluent standards established by the Central Environmental Authority (CEA) Pre-treatment standards established by the BOI are given below in **Table 2 3 2-B** of this chapter

Industries that wish to locate within BOI industrial estates are not required to conduct EIAs or IEEs for the proposed specific activity Rather they undergo an initial environmental screening by the BOI before receiving approval This screening constitutes official Clearance for the industrial activity within the guidelines set forth by the BOI agreement, and is accepted by the CEA

Table 2 3 2-B Pretreatment Standards for Water Quality Established by the BOI

Parameter	Maximum Tolerance Limit
BOD (5 days at 20°C) mg/l	200
pH	6 0 - 8 5
Suspended solids mg/l	500
Total dissolved solids (inorganic) mg/l	2100
Temperature (°C)	40
Phenolic compounds mg/l	5
Oil and grease mg/l	30
Total Chromium mg/l	2 (Chromium VI 0 5)
Copper mg/l	3
Lead mg/l	1
Mercury mg/l	0 0005
Nickel mg/l	3
Zinc mg/l	10
Arsenic mg/l	0 2
Boron mg/l	2
Percent Sodium	60
Ammoniacal Nitrogen mg/l	50
Sulphides mg/l	2
Sulphates mg/l	1000
Chlorides mg/l	900
Cyanides mg/l	0 2
Radioactive Material	
Alpha emitters mc/ml	10 -7
Beta emitters mc/ml	10 -6

Source BOI

2 3 3 Urban Development Authority (UDA)

Under the UDA Law No 41 of 1978, any area may be declared an "urban development area," at which stage the area comes under jurisdiction of the UDA Operating within its mandate to promote well-planned urban development, the UDA has established industrial estates in several regions of the country The UDA can act as a project-approving agency (PAA) in reviewing plans for proposed industrial estates UDA is also directly involved in siting industrial estates The main functions served by the UDA relating to industrial estates development are

1) acquisition of land for development as industrial estates,

2) selection of industries through a selection committee on which IDB, M/ID, BOI and the PC are also represented

The UDA assists in developing industrial estates with the support of the Ministry of Finance, Planning, Ethnic Affairs and National Integration The industrial estates implemented by the UDA are given in Table 2 3 3

Table 2 3 3 Industrial Estates of the UDA

Name of industrial estate	District	Area (ha)	No of sites available	No of industries in occupation
Peliyagoda Stage 1	Gampaha	74 5	70	28
Peliyagoda Stage 2	Gampaha	74 9	60	--
Kattuwana	Colombo	24 3	79	28
Modarawila Stage 1	Panadura	10	32	08
Modarawila Stage 2	Panadura	10	--	--

Source UDA

2 3 4 Industrial Development Board

Under the Industrial Development Act No 36 of 1969, the IDB is responsible for promoting and developing small- and medium- scale industries[4] It functions under the M/ID Prior to the creation of the UDA, the IDB held sole responsibility for providing support to industries In 1962 the IDB established the first industrial estate in Sri Lanka, at Ja-Ela Several years later two other industrial estates were established, one in Pallekale and another in Atchuvely in the Jaffna district The latter has ceased to operate due to political and economic instability in the region Basic facilities such as roads, water supply, drainage, waste disposal, electricity, and telecommunication are provided at these estates

In 1992 the IDB launched a project known as "Isuru Uyana," designed to provide land in industrial estates furnished with basic infrastructure such as roads, water and electricity Under this project several new industrial estates were established

2 3 5 Central Environmental Authority (CEA)

The CEA is vested with power to enforce the environmental regulations of Sri Lanka as stipulated in the National Environmental Act No 47 of 1980 and Amendments of 1988 The two main environmental regulations that are relevant to the industrial estates are (1) the Environmental Protection License (EPL) scheme, and (2) the requirement for the project proponent to conduct an IEE or EIA prior to siting an industry or industrial estate

Any industrial activity that will result in the discharge of industrial effluent or emission of known air pollutants is required by law to obtain an EPL prior to commencing operations The EPL is a conditional agreement to ensure that the industry meets pre-specified national water quality standards Standards for emission of air pollutants have still to be formally adopted and published Since many industries were already in existence when the EPL system was enacted in 1990, the CEA adopts a somewhat different approach in issuing EPLs to existing industries The conditional agreement upon which an EPL is issued is more tolerant for those older industries New industries, however, must provide evidence that specific measures are being adopted during the construction of facilities to assure adequate treatment of effluents and other regulated substances

The national effluent standards for water quality apply to effluent discharged from an industrial estate as well Effluent from a central treatment facility at an industrial estate is therefore expected to meet the same water quality standards as effluent discharged from a particular industry

Under the National Environmental Act N, an EIA is required if a project qualifies as a "prescribed project "[5] There are two levels to the EIA process First is an "Initial Environmental Examination" (IEE), which is a short and sometimes preliminary report specifying the possible environmental impacts of the project For many projects, an IEE-level analysis is sufficient to meet environmental concerns However, if the impacts are considered by the CEA to be significant, a more detailed "Environmental Impact Assessment" (EIA) must be conducted The EIA is more comprehensive and must suggest alternatives to the proposed project design in order to determine the feasible option that has least impact on the environment The procedure for conducting IEEs or EIAs is given in two concise publications available from the CEA

The BOI industrial estates, which are the only industrial estates now equipped with centralized wastewater treatment facilities, are subject to the EPL regulations Until recently, the BOI was authorized to issue EPLs directly to industries registered with them and located in areas outside the established zones (known as 'licensed enterprises') CEA has now assumed authority for issuing EPLs to these BOI-registered firms Industries within the BOI zones, however, are not required to have an EPL since these industries meet the pre-treatment standards established by the BOI and approved by the CEA As mentioned above, industries located within BOI industrial zones are not required to perform IEEs or EIAs, since they are subject to an approved screening process by the BOI The opportunity for industries to simplify their environmental clearances has been a clear advantage to those located in BOI's industrial estates

[1] Vidanapathirana U (1993) A Review of Industrial Policy and Industrial Potential in Sri Lanka Sri Lanka Economic Association Paper No 2

[2] The Government of Sri Lanka Policy Statement 1995

[3] BOI industries not restricted to industrial processing zones They may locate anywhere in the country if they are willing to take pollution control measures that satisfy national effluent standards BOI industries are therefore classified into two types Zone Enterprises (industries located in one of the BOI operated zones) and Licensed Enterprises (BOI industries located outside the BOI estates)

[4] Gunaratne M H (1993) "Industrial Estates of Sri Lanka" *Karmanta Souvenir Issue* Industrial Development Board

[5] The list of prescribed projects for which an EIA is normally required is established by the CEA and is published as Appendix 4 in their 1993 "Guidance for implementing the Environmental Impact Assessment (EIA) Process "

CHAPTER 3

ENVIRONMENTAL CONSIDERATIONS FOR INDUSTRIAL SITING IN SRI LANKA

Environmental problems associated with industrial development can be effectively managed if appropriate policies are put into place and implemented These policies must address environmental issues throughout the industrialization process, from initial siting decisions to management of industrial facilities throughout their operational lifetime This chapter discusses a proposed framework within which industrial siting and management policies could be implemented It includes a description of the general types of environmental impacts associated with industrial operations, followed by specific examples of industries that are most likely to locate in Sri Lanka

Adverse environmental impacts from industrial estates can in most cases be avoided or greatly reduced if a three-step strategy is adopted These steps are **A making careful siting decisions, B making the appropriate selections of industry type and mix, and C requiring use of pollution-prevention technology** All three of these steps must be carefully followed if clean industrial development is to be achieved This study has focused primarily on how to implement steps A and B, this chapter also provides some guidance on step C

3 1 LESSONS FROM PAST EXPERIENCE

As countries all over the world have learned, inadequate attention to environmental concerns in industrial siting decisions may later result in extremely costly problems The disaster that occurred at Bhopal in India is one tragic illustration of this point In Sri Lanka, pollution and waste problems have sometimes been severe enough that they have resulted in major conflicts between industry and the public Some recent examples are provided in Box 3-1 below

It is well known that industrial facilities have often severely polluted air, water, and land What should also be understood is that a further extension of past patterns is not the inevitable consequence of industrialization Rather, such problems reflect inefficient technologies or wasteful processes, as well as carelessness and lack of appropriate legal and economic policies Through sound planning and management the problems of the past need not be perpetuated, but instead can be minimized or eliminated

Box 3 1 Recent Sri Lankan Examples of Industries Facing Community Opposition

Pulp & Paper Mill at Embilipitiya	This mill discharges black liquor from the pulping process to Walawe Ganga The liquor contains a lot of chemicals from the process, it is toxic to fish and aquatic life, and is also dark in color The discharge is also upstream of the Ambalantota drinking water extraction point Due to its use of straw as the basic raw material, this process has created the special problem of preventing use of the chemical recovery section that was designed to recycle chemicals and to control effluent
Tanneries at Various Sites (Rajagiriya, Mattakkuliya)	At present numerous tanneries are located in areas that have become heavily residential, although initially the tanneries were the only occupants The practice of discharging wastewater containing highly toxic chemicals along with associated odors and solid waste without any effective control has brought strong protests and objections from nearby residents and downstream water users
Alum plant at Ranala	The facility produces sulfuric acid and alum The acid factory' as it is known locally has brought strong local objection due to the creation of acidified well water, noxious gases, etc The alum crushing process also contributes noise to the community
Textile factories at Ratmalana	Un-managed industrial development in this area has resulted in multicolored wastewater in municipal storm drains, frequently containing strong acids and other toxic chemicals and emitting noxious odors Protests in the town are very strong and numerous

Even industries that are often considered to be "low-polluting" have often caused severe environmental problems Examples include

- **Sand and Coral Mining** This activity has led to significant coastal erosion (southern coastal belt) and salinity intrusion (Kelani Ganga) affecting drinking water supplies

- **Brick and Tile industry** Raw material extraction has caused numerous environmental problems Large-scale clay mining has dotted certain villages with abandoned clay pits clogged with water weeds, providing ideal breeding grounds for mosquitoes The deep and gaping abandoned clay pits by the riverside during flood season are becoming part of the river, resulting in riverbank erosion This is a

problem in the Maha Oya valley embracing Wennappuwa, Katana, Katugampola and Divulapitiya electorates where more than 900 tile factories operate

- **Agricultural Processing** Sawdust (Moratuwa) paddy husk (Anuradhapura, Polonnaruwa districts) and coir dust (Chilaw, Kurunegala, Colombo - Coconut Triangle) are causing sedimentation and water pollution (turbidity)

These and other environmental problems illustrate the need for changes in attitudes and policies for operating and monitoring industries Cumulative impacts of small- and medium- scale industrialization are major contributing factors to solid waste and drinking water problems in the Colombo District About 80% of all small- and medium- scale industries are located in the Colombo and Gampaha Districts Because these industries were established long before the enactment of environmental laws, water discharges are often made to surrounding streams, drains, or land without any treatment Some industries generate hazardous solid wastes that are mixed with normal household waste, creating major health risks

The Kelani River is the main source of drinking water for the Colombo region and also serves as a sink for a substantial portion of Colombo's sewage and drainage Numerous industries along the Kelani River and its tributaries discharge directly into it, including small, medium, and high-polluting industries At present most of these industries are downstream of the Ambatale water intake (14 km from the river mouth) However, there is a possibility that during the drought season when the water level in the river is low, allowing increased backflows, contaminants could find their way to the water intake This realization has prompted the government to declare the area as an `environmentally sensitive zone' to prevent additional industries from relying on the Kelani River for their discharges

3 2 TYPES OF ENVIRONMENTAL CONCERNS ASSOCIATED WITH INDUSTRIAL DEVELOPMENT

Effective industrial siting and management policies must be designed to minimize environmental problems at the local and regional levels In addition, it is important to recognize that the **cumulative** impacts of industrialization can have major implications for the country as a whole and must also be considered in national policy formulation In this section, site-specific as well as industry sector-wide concerns are described

3 2 1 Site-Specific Concerns

Siting of an industrial estate can result in significant on- and off-site impacts during both the construction and operational phases Site-specific concerns can be broadly categorized as follows (a) environmental impacts, (b) socio-economic impacts, (c) infrastructure demands and impacts and (d) land use changes Evaluation of each of these four categories of potential impact, as further described below, should be performed early in the siting process

a Environmental Impacts

These types of impacts can be broadly classified as follows

- AIR QUALITY

  (i) Air emissions from stationary combustion sources
  (ii) Air emissions from mobile sources
  (iii) Air emissions from industrial processes
  (iv) Air emissions from solid waste disposal sources

  Air emissions have to be tackled at their sources with proper emission control technology and operating efficiency During the initial siting, when comparing the compatibility of several potential sites to handle air emissions, the following points should be considered

  * the circulation and air exchange characteristics of the area (e g in a valley or in an area with historically low wind dispersion)
  * whether this site is near sensitive receptors, such as hospitals, schools, and/or homes for the elderly, handicapped, etc ,
  * the possibility and the frequency of inversions

- SURFACE WATER QUALITY AND AVAILABILITY

  (i) Effluents from industrial processes
  (ii) Effluents from domestic sources
  (iii) Storm water discharges
  (iv) Water consumption

  If a discharge is necessary, it should be treated to the standards laid down by the relevant laws and regulations In determining treatment criteria the assimilative capacity of the intended receiving waters should be duly considered Some considerations are

  * Receiving water bodies, particularly those with large seasonal flow variations, may not be able to assimilate industrial discharges without exceeding CEA standards, taking into account the dilution factor provided in the standards (Generally, water bodies with high flow and high ambient water quality would be ranked higher than streams with low flow and/or poor water quality)

  * Receiving water bodies may have aquatic species (e g prawn, fish, etc) that are especially sensitive to industrial pollutants, and thus require additional protective measures

- GROUND WATER QUALITY AND AVAILABILITY

  (i) Aquifer draw-down from supply wells
  (ii) Aquifer contamination from disposal of solid and liquid wastes
  (iii) Aquifer contamination from accidental spills

  Although ground water is frequently the primary source for local drinking and household water, when industrial facilities are being sited scant attention is usually paid to the potential long-term effects on local ground-water quality or availability from proposed withdrawals and discharges These potential effects cannot be determined from casual observations, rather, site-specific quantitative hydrological testing is mandatory if such effects are to be properly assessed

- SOLID AND HAZARDOUS WASTES

  (i) Solid and hazardous wastes from industrial sources
  (ii) Solid and hazardous wastes from domestic sources

  The following examples illustrate some of the hazards associated with industrial wastes

  * Food processing produces wastes that frequently contain disease bacteria These wastes can lead to epidemics if they are not properly disposed of The same dangers are connected with pathogenic/infectious hospital wastes

  * Some materials used in factories, such as acids and mercury, can lead to acute injury and illness if people come into direct contact with them

  * Detergents and cleaning materials can aggravate allergies

  * Wastes can have airborne contaminants that may be toxic (e g , asbestos, lead, corrosive vapors or combustion by-products)

  * Even if human beings are able to avoid direct contact with hazardous materials, livestock or fish may come into contact with them and die, or pass these substances on to people who consume the meat (e g Itai-Itai and Minamata disease)

  * Hazardous wastes, if improperly disposed of, can contaminate agricultural land and pollute both surface and ground water resources over wide areas and for a very long time, some contamination is essentially permanent

  Solid and hazardous waste management has now become a critical issue worldwide In Sri Lanka the CEA has defined hazardous wastes, and all waste categories coming under that definition are listed by CEA as requiring appropriate treatment and disposal The definition was made to comply with the international Basel

Agreement The applicability of the definition to control and monitor locally-generated pollution needs further consideration, it is important to provide properly designed and managed hazardous-waste disposal facilities if industrial growth in Sri Lanka is to be achieved without further environmental degradation

Solid and hazardous waste can be managed in a number of safe ways The following examples illustrate some approaches that should be considered in locating and designing industrial estates

* Careful process design can help to separate hazardous waste from other wastes, and to reduce the volume of hazardous wastes to a minimum Hazardous waste should be stored, handled, and treated separately from other waste before being disposed of Any land filling or incineration should be performed in a facility specifically designed for such wastes

* The biodegradable fraction of solid non-hazardous wastes can frequently be separated from the non-biodegradable fraction, once separated, there may be markets for both components For example, biodegradable non-hazardous wastes might be used in anaerobic digestion producing fuel gas and digested sludge as a soil conditioner If these wastes are organic by-products from food processing, they may have value as food for animals

* Non-biodegradable solid wastes often contain recyclable metals, plastics, and glass, which can be re-used on the site or sold to other facilities to substitute for new (and often more costly) raw materials Appropriate policies to encourage such recycling and reuse are needed

- ECOLOGICAL RESOURCES

Industrial facilities may cause directly observable impacts on local flora and fauna they may also have cumulative off-site effects that degrade or threaten the existence of a sensitive area such as a wetland, park, or habitat for endangered or endemic species

In industrial siting this concern has now come to the forefront as a result of the growing awareness of man's past disastrous management of our ecological inheritance The biologist and author E O Wilson has said that "extinction is forever" Sri Lanka is fortunate to be a country rich in biodiversity, the nation's industrialization policy should not endanger this irreplaceable natural resource Hence any siting decision should incorporate protection for

* Native flora and fauna on-site or off-site that could be adversely affected by industrial development on the site,

* Important areas of natural habitat on-site or off-site such as wetlands, forests, streams, and lakes that could be adversely affected by industrial

development on the site and by off-site impacts from water withdrawals and discharges, air pollutants, or disposal of solid wastes,

* Designated environmentally sensitive areas (national sanctuaries, wildlife parks and reserves, wilderness areas, etc) that are located near the site or which could otherwise be degraded by site development and operations

- NOISE

(i) Noise from process units/residential quarters (stationary sources)
(ii) Noise from moving vehicles/loading and unloading (mobile sources)

Some industries are more prone to be noisy than others (rock crushing, metal fabricating, etc) When looking at siting a number of industries in one area, the cumulative load should be estimated In such instances the site should be evaluated to determine

* If the site is in an area where on-site noise could be amplified and thus carry over long distances, such as in a valley are on a wide water body,

* If the site adjoins residences, schools, or other occupied buildings that are near enough to be adversely affected by noise generated on-site,

* If the site adjoins areas that have high aesthetic, cultural and/or religious values that could be adversely affected by noise generated on-site,

* If the site adjoins habitat of species that are particularly sensitive to noise

Again, site layout, facility construction, and industrial processes can be designed to minimize both the generation of noise and its adverse effects if potential noise emissions are given appropriate consideration when these design steps are underway As is true for most other environmental impacts, dealing with noise as an afterthought to industrial facility development is usually less effective and more costly than considering it earlier in the siting and facility design stages

- AESTHETIC VALUES

When aesthetic values are not considered, industrial buildings and utilities frequently have unappealing appearances and/or may obstruct scenic sites, generate annoying sounds and smells, etc Once again, these values can best be protected if they are considered and addressed during the site and facility design stages

b Socio-economic Impacts

Local labour availability, the capacity of local communities to support industrial development, and potential impacts on the area's cultural and religious resources are three important socio-economic factors to consider in industrial siting decisions These factors can best be identified and addressed through advance consultation with local government officials and community leaders

c Infrastructure Demands and Impacts

Industries require physical infrastructure such as public utilities and transportation facilities The existence of a well-developed infrastructure makes it much easier to recruit industrial developers to the site and means fewer environmental impacts due to construction and upgrading of infrastructure The cost of providing necessary infrastructure need to be more fully considered in the siting process

d Effects on Adjacent Land Use

When new industrial estates are established, particularly in relatively rural areas, major changes to existing and planned uses of adjoining lands inevitably result, too often with little or no organization, management, or even prior consideration Such induced effects have caused a whole series of unanticipated adverse environmental and socio-economic impacts, some of which can interfere directly with the continued operation of the industrial estate itself These types of impacts include conversion of land from agricultural or environmental purposes to sprawling residential and commercial uses, conflicting demands on local transportation, power, and water resources traffic congestion, air and water pollution, and cultural and religious conflicts

To anticipate and minimize these induced effects, local zoning requirements and regional land-use master plans can be useful tools in assuring that industrial development plans are carried out in accordance with the overall economic and social objectives of the local community and region Such planning must, of course, be done **prior to development of the industrial estate** or it will be of little value in averting or minimizing these types of impacts It must be done with the full cooperation and participation of local government officials and community leaders, because such plans will require local acceptance and enforcement to be effective

3 2 2 Sectoral Concerns

The expansion of industrial capacity in Sri Lanka raises a number of issues which go well beyond the site-specific impacts of establishing an industrial estate These issues include concerns common to all industrial estates as well as those derived from links between the industrial and other sectors With industrial growth will come a need to better address the following concerns risks associated with industrial accidents or other emergencies, much larger volumes of hazardous wastes to be transported, stored or otherwise disposed of, and the need for systematic attention to pollution prevention and waste minimization as part of

the national environmental protection strategy Key links between industrial development and other sectors include the need for adequate infrastructure -- especially energy -- to support industrial growth, the balancing of industrial with other land uses in the context of regional development, and job creation

a Need for Land Use Planning and Zoning

Industrialisation brings about significant changes to existing land use patterns Measures to address issues such as public health, basic sanitation and housing amenities, infrastructure, and public order must be implemented in a timely manner to support industrialisation Proper land use planning and zoning can ensure that industrialisation is supported with the necessary infrastructure and facilities In the absence of such planning urban development could lead to inefficient and chaotic use of land A detailed description of land use planning and zoning as it relates to industrialisation is beyond the scope of this report However, a few salient points are addressed here

The fundamental approach to proper planning is to consider industry and its associated environs as a whole Adequate provision for infrastructure, other services, and facilities should be incorporated in the development plans

Properly planned industrialisation implies regulated growth Early experiences of industrial developement (such as in Ratmalana), where unplanned residential communities sprang up adjacent to industrial esatates, should be prevented in order to minimize conflict among competing land uses An industrial estate constitutes a concentration of industries, and its positioning should make it both economically and socially practical The tank farm fires at Kollonnawa and Orugodawatte graphically illustrate the consequences of having sensitive systems adjacent to highly populated- residential areas

It is generally considered prudent to separate the use and storage of significant quantities of hazardous materials from nearby centres of population including housing, shopping centres, schools and hospitals Guidelines have been developed for this purpose, by categorising different types of development These guidelines may be used when taking a siting decision in an already developed area or when planning development around an existing facility

One broad categorisation (ILO, 1988) which has been widely used is based on three general categories

Category A Residential, including houses, hotels, flats,

Category B Industrial, including factories (unless they have high-density employment), warehouses,

Category C Special, including schools, hospitals

Other types of development can then be added to the most appropriate of these categories, e g theaters/cinemas and shopping centres could be included in Category A Most guidelines

specify separation distances for major hazard works For instance, for LPG held at a pressure greater than 1 4 bar absolute, with a tank size of 25-40 tonnes storage capacity, the suggested distance is 300m The distance increases to 1000m when the storage capacity increases to 300 tonnes Similar values are available in the ILO publication for all other types of materials including bagged fertilizers

The separation distance given should be used as follows (as a first approximation in the decision making process)

* within the separation distance - no category C development,
* within about two-thirds of the distance - no category A development,
* no restriction of category B development

As mentioned, these criteria act as a first approximation but enable more rational decision in industrial land-use planning The distances should be regarded as tentative and would need to be considered under local circumstances to decide on their applicability

Unplanned development (including reclamation) of the low-lying areas of Sri Lanka is another concern These low-lying areas are important as flood water retention basins and also as wetland ecosystems providing habitat for a diverser biota Unplanned development of these areas would contribute to the loss of flood retention (thus contributing to flooding of adjacent communities) and destruction of wetlands, resulting in loss of diverse flora and fauna including some rare and endangered species

Finally, the institution responsible for managing an industrial estate should undertake comprehensive land use planning within the industrial estate Provision for basic infrastructure services such as water supply, waste disposal, drainage, internal roads, power lines, etc should be made in this plan Furthermore, compatibility of industrial activities should be taken into account in allocating plots to the various industrial units

b Need for Emergency Management Planning

With the national expansion of industrial capacity -- and the concentration of larger industries in estates -- comes an inherent increased risk of industrial accidents or other emergencies Depending on the type of industries which are developed in the country, the number of people (both workers and the general public) whose health and safety are at risk from industrial causes may increase substantially over the current situation The tragedy at Bhopal has demonstrated the potentially catastrophic consequences of inattention to this issue, while also illustrating vividly the need for shared private and public sector responsibilities in addressing such concerns

At present, Sri Lanka has no emergency management plan or institutional apparatus in place -- apart from some limited capability within the military -- to address and deal with such contingencies, and related guidelines for industrial facilities construction and operation

(and their enforcement) remain weak Proper emergency planning should include at least the following

(i) Training fire-fighting and police personnel (the situation may be an explosion, fire, or release of toxic substances)

(ii) Alarm system with direct lines to fire brigade or to other emergency response centers

(iii) Proper site-specific emergency response plans that include
- the organization scheme used to fight the emergency,
- the communication and evacuation routes,
- guidelines for fighting the emergency,
- information about hazardous substances (such as material or chemical safety data sheets),
- examples of possible accident sequences

(iv) Agreement with local government authorities regarding co-ordination with industry contingency plans

(v) Medical facilities nearby that are capable of handling industrial emergencies

c <u>Hazardous Waste Management</u>

Expansion of industrial activity will likely result in the generation of a much larger volume of hazardous wastes than at present These wastes -- which can include toxic chemical byproducts and low-level nuclear materials -- must be properly transported, stored and disposed of where safe and feasible While individual industrial estates can partly address such issues, generally hazardous materials must be carefully regulated and dealt with as part of a national strategy

In published reports one frequently sees the statement, *"All solid wastes generated shall be collected to a central place and disposed of periodically in an environmentally safe and nuisance-free manner in consultation with relevant local authorities "* However, this kind of statement is too often and assertion rather than a reality Local authorities do not usually possess sufficient knowledge or awareness to enforce this statement, to say nothing of dealing with hazardous waste handling, storage, and treatment Training and local institution-building is increasingly needed as the potential for mishandling of hazardous waste increases

Furthermore, there are as yet no approved hazardous waste disposal sites in the country The identification and development of a properly engineered hazardous waste disposal site is warranted if it is established that current or future industrial activities will generate significant amounts of hazardous wastes Availability of such a facility would enable off-site disposal for factories and could help to ensure safe management of hazardous wastes

The following components are necessary to support off-site disposal of hazardous wastes

- Special transport systems to cater to handling hazardous waste,
- Waste exchange facilities,
- Special hazardous industrial waste landfill sites (with controlled access at all times),
- Incineration with gas cleaning systems

These facilities could be made self-sustaining by levying of an appropriate scale of fees for waste disposal The facilities also can have secondary product lines, i e , solvent recovery lines and oil recovery lines These changes could help enhance the national economy as well as protect the environment

A waste exchange facility primarily deals with waste from multiple facilities, on the basic premise that "One industry's waste is another industry's resource " This system requires a centrally-managed register of both the wastes that are being generated and the raw or process materials that are being sought, with continuous updating of that information This system is then used to match waste producers with potential users so that waste treatment and disposal costs may be reduced

d Pollution Prevention and Waste Minimization

The concentration of industries within estates presents an important opportunity for environmental authorities to work with estate managers and investors to promote the use of pollution prevention measures in the design and operation of industrial facilities A national waste minimization program has yet to take off, but technical assistance associated with the new Pollution Control and Abatement Fund (managed by the National Development Bank) is already placing process efficiency and energy conservation efforts within their environmental context

The conventional approach to pollution control has been to use so-called "end-of-the pipe" treatment systems This approach does not find much favor among industrialists because the methods involve incurring costs to meet legal requirements that do not yield monetary returns

In "end-of-the pipe" treatment methodologies, cross-medium environmental concerns also arise During wastewater treatment, most pollutants are transferred to the sludge that is formed This process thus adds to solid waste, although the liquid effluent problem is reduced Incineration -- as a means of solid waste disposal -- transfers the pollution load to air Improperly handled incineration can even aggravate the pollution potential beyond the level that was originally present (e g , by incomplete burning of plastics, generation of heavy metal vapors etc) Thus the attractiveness of these traditional methods for pollution control has limited appeal even from an environmental protection perspective

The pollution-prevention approach is a preventive approach as opposed to a corrective approach The objective is to address waste management **before** it is generated instead of treating waste **after** it is generated In an industrial process, less waste from raw materials

means more products, resulting in higher conversion and efficiency rates More products means higher financial rewards, which should certainly be attractive to industrialists

An additional benefit of this approach from an environmental perspective is that it tackles both first-generation pollution problems -- those created in the manufacturing process -- as well as second-generation pollution problems -- those related to product use, such as packaging The conventional approach is ineffective in tackling the latter class of problems

This approach may require an initial capital outlay involving process and equipment modifications (rather than pollution treatment systems) However, the majority of measures implemented under this strategy are good housekeeping practices, which are relatively inexpensive measures

As mentioned, preliminary efforts are underway to promote pollution prevention in Sri Lanka There is an ongoing environmental program based on waste minimization supported by UNIDO, its first demonstration project was in the distillery sector Phase one of the project, involving the Distilleries Corporation of Sri Lanka Ltd (DCSL) at Seeduwa, has been completed and has shown significant fuel savings, product quality improvement, and reduction of organic load in the spent wash effluent This program demonstrates the possibilities to improve an existing industry operation

When siting a new industry, the type of process technology being proposed should be evaluated critically at the outset, to identify and encourage pollution prevention options This approach can both improve the performance capacity and reduce the need for mitigation requirements At this stage such planning and design can be done at the least cost, avoiding expensive retro-fitting and redesign efforts later on

At present, the industrial technologies being used in Sri Lanka are frequently less efficient and much more highly polluting than those employed in other more industrial countries Some examples where improved technologies could provide benefits are continuous drying in par-boiling of rice, use of centrifugal operation systems in cinnamon oil extraction, and removal of sulphur from fuels during the petroleum refining process

e <u>Energy and Industrial Growth</u>

If infrastructure bottlenecks are to be avoided in the expansion of industrial capacity and job creation, there must be close coordination among the energy, transport, and communication sectors Because energy production and use have strong environmental implications, this coordination should be a particularly important component of the national program to develop industrial estates The availability of adequate energy supplies at reasonable cost is a key assumption in the country's industrialization strategy, and the demands of industrial estates -- together with opportunities to employ energy conservation measures within them -- must be carefully considered

There is already a perception that national energy supplies are lagging behind demand This is partly due to a heavy dependence upon supply-side policy in the energy sector, which has given only limited attention to managing the demand of consumers through appropriate pricing schemes and promotion of energy efficiency Just as in the case of pollution prevention, industrial estates offer an ideal setting for the promotion of energy conservation measures In some cases (for larger or energy-intensive estates) there may also be the option of developing private power supplies -- both through the use of fossil fuels and renewable energy sources -- with the expectation that any unused capacity will be sold to the national grid Attention to such issues will obviously require close coordination and cooperation between industrial development authorities and those in the energy sector

3 3 THE ROLE OF ENVIRONMENTAL IMPACT ASSESSMENT IN INDUSTRIAL SITING AND MANAGEMENT

An EIA may be required as part of the siting process for a specific industry, a large industrial zone, or an industrial estate In the latter two cases, EIAs must assess the cumulative environmental impacts of the mix of industry types and sizes planned for the area If properly done, such EIAs remove the requirement for individual industry proponents to undertake full separate EIAs The idea is to encourage industrialists to locate in pre-studied and approved areas rather than to look for separate, independent locations that would involve the separate preparation of full EIAs to assess the potential environmental impacts at each of those separate locations

Large-scale industries are usually directed to specified industrial zones, where they would in turn have their own effluent treatment systems Medium-scale industries, including those with high and medium pollution potential, are in future to be restricted to designated industrial estates There they would usually have access to common liquid and solid waste management systems and would only require their own gaseous emissions control systems when appropriate

An EIA for such an estate should analyse the water availability (both surface and ground water resource) and the assimilative capacity for waste water It should also estimate the aggregate maximum possible water use for the entire estate and indicate the required volume and type of wastewater treatment based on maximum total flow Once the industry mix is known, the availability could be matched with the demand, and the necessity for pre-treatment by individual factories could be determined The site evaluation, along with the knowledge of the industry mix, should indicate the maximum quantities and the quality of air and solid stream wastes Waste minimization procedures should be established in the impact mitigation plan

CHAPTER 4

INDUSTRIAL ESTATE SITING AND DEVELOPMENT PROCEDURE

4 1 BACKGROUND

The iting of industrial estates is an extremely complex process requiring consideration of multiple interacting environmental, social, political, and economic factors This process requires the early involvement of government planners and decision makers, industrialists, NGOs, and the public in the site selection and development phases, working within a common framework to identify and mitigate concerns well in advance of final siting decisions

This chapter describes a study conducted by NAREPP with the assistance of the Ministry of Industrial Development (M/ID), to develop a more streamlined procedure for siting and developing industrial estates First however, it is useful to summrize previous studies that have addressed issues pertaining to industrial estate development

4 1 1 LAMSCO study

The Lanka Asia Management System Co (Pvt) Ltd conducted a study for NAREPP, titled, "Industrial Siting Guidelines" (March 1993) The study begins with an assessment of the impacts of industrial activities in Ratmalana/Moratuwa and Ekala/Ja Ela It focuses primarily on the land use issues Procedure for identifying suitable industrial estate sites is not addressed

4 1 2 JICA study

The Japan International Cooperation Agency (JICA), in collaboration with the Ministry of Industries, Science and Technology undertook a "Study on Industrial Development" (March 1993) Volume IV of the final report is titled "Development Plan of Industrial Estates", and contains a thorough assessment of the feasibility of developing five industrial estate sites The study includes a survey of investment demand, by enterprises in Sri Lanka, in Japan and by other foreign investors Basic plans, physical plans and environmental protection measures are developed for each of the sites The report also includes a financial and economic analysis based on cost estimates for developing the estates Finally, the report suggests a management plan as well as strategies for promoting the industrial estate This is a more comprehensive study of the five selected sites However, it does not propose broad guidelines for assessing industrial estates in general

4 1 3 NBRO study

A study was undertaken by the National Building Research Organization to develop a method to evaluate potential industrial estate sites This study focused mainly on the methodology of estimating the carrying capacity of a site with reference to various pollutant loads The methodology proposed in the NBRO study was adopted in part in the present study as well, and is described in more detail in the following chapter

4 1 4 NAREPP/GOSL/World Bank Study

An series of initial site surveys were conducted in October and November 1994 by a joint NAREPP/GOSL/World Bank study design team, including staff representatives of the Central Environmental Authority, Board of Investment, Secretariat of Infrastructure Development and Investment, and Metropolitan Environmental Improvement Project That team visited nine potential industrial sites located in five provinces across Sri Lanka The major objectives were to determine the types and quality of data that were available for those sites and to identify the most critical factors that must be considered in evaluating the suitability of such sites for development as industrial estates

The nine sites visited by the survey team were selected to provide a wide cross-section of environmental and socioeconomic conditions For example, one of the selection factors employed by the survey team was to include sites in the wet, dry, and intermediate zones Some of these sites were subsequently included in the list of eleven sites selected by M/ID for this study

The 1994 survey identified a number of concerns common to most or all of these initial sites, including the following

- Water availability for industrial use was a major question at all sites Surface water data (both quantitative and qualitative) were extremely limited, local ground water data did not exist for most sites
- Potential off-site impacts were just as important, or in many cases even more important, than on-site impacts
- Most sites had very limited land available for future expansion
- Most sites lacked adequate locations for discharge of liquid wastes
- Availability of solid waste management facilities was a constraint at all sites
- The capacity of local community infrastructure to absorb substantial industrial development was a major concern

4 2 DESCRIPTION OF THE CURRENT PROJECT

Based on the findings of the 1994 study, NAREPP prepared a detailed Terms of Reference for this sequential study In response to the survey team's findings that most of the sites did not have well-defined industrial proposals, the analytical approach provided in the TOR was directed primarily at assessing the "environmental and socioeconomic sensitivity" of the sites, i e , the capacity of the local environment and the communities in the vicinity of each site to absorb industrial development To assess the sites' sensitivity to or compatibility with industrial development, fourteen environmental parameters were evaluated in this study

* Water availability
* Soil stability/Surface drainage
* Site expandability
* Public utilities availability
* Transport availability
* Community infrastructure availability
* Local skilled labor availability
* Local unskilled labor availability
* Cultural and religious resources
* Liquid waste disposal capacity
* Solid waste disposal capacity
* Presence of sensitive ecological systems
* Assimilative capacity of air shed
* Noise assimilative capacity

These fourteen parameters were employed to compare similar types of information from each of the sites, **not** to make absolute or final judgements about the suitability of individual sites for industrial development A more detailed environmental impact assessment (EIA) may be needed for any site that is seriously considered for locating specific industries with medium- and high-polluting potential, before a final suitability determination can be made Such site-specific detailed assessments should also evaluate alternative facility designs and process elements that could avoid or mitigate specific environmental impacts Nevertheless, the site evaluation system employed in this study should be very useful for screening any number of proposed sites, i e , ***to systematically compare proposed sites in order to determine which ones appear most suitable for various types and levels of industrial development*** The consideration of site alternatives by this process should reduce the need to include detailed evaluations of alternative sites in subsequent EIAs for individual industrial estates

The study was conducted by a multidisciplinary team of Sri Lankan and U S -based consultants Their expertise included hydrology and water resources, water quality and environmental engineering, biology, ecology, industrial environmental management, chemical and process engineering, socioeconomics, environmental and economic policy, and environmental impact assessment A list of the study team members and their areas of expertise is included as Annex I to this report

The TOR for this study was initially developed under the assumption that the Government of Sri Lanka would seek sites specifically for industrial estates to accommodate medium and high polluting industries However, concurrent with NAREPP's initiation of the study design, the Ministry of Industrial Development (M/ID) launched a program to encourage private-sector development of industrial estates that was more generally focused on a wide range of industries, not just on those falling within the categories of medium and high-polluting industries Thus, the opportunity presented itself to further develop and apply the methodology to assist M/ID in determining which of its candidate sites might be suitable for "light" as well as "heavy" industry M/ID requested that NAREPP review eleven candidate sites for this purpose These sites are listed in Annex II of this report

The team initiated the study by contacting agencies and institutions in Sri Lanka to identify relevant environmental information that had already been collected and technical studies that had already been conducted on or near each site On July 14, 1995, the NAREPP team assisted M/ID in conducting an open meeting at the Ministry to inform Sri Lanka government agencies, private institutions, and the general public of the study and to encourage their input and involvement

The team received many valuable comments at the meeting For example, several individuals suggested that "site expandability," which was not mentioned in the TOR, be included as an indicator of site suitability As a result, this parameter was added to the list of those used in the study methodology

During the months of July and August 1995 the team conducted site visits At each site, the team made detailed visual observations of the site and surrounding areas and conducted interviews with the M/ID regional directors, local community leaders, and residents In addition, the team's hydrologist and water quality expert collected water and soil samples and took flow measurements of water bodies on or near the site The team compiled their observations and findings on the site review checklist that was provided in the TOR The checklist, [which is attached to this report as Annex III], is an adaptation of the standard environmental checklist developed by the CEA for use in conducting Initial Environmental Evaluations (IEEs)

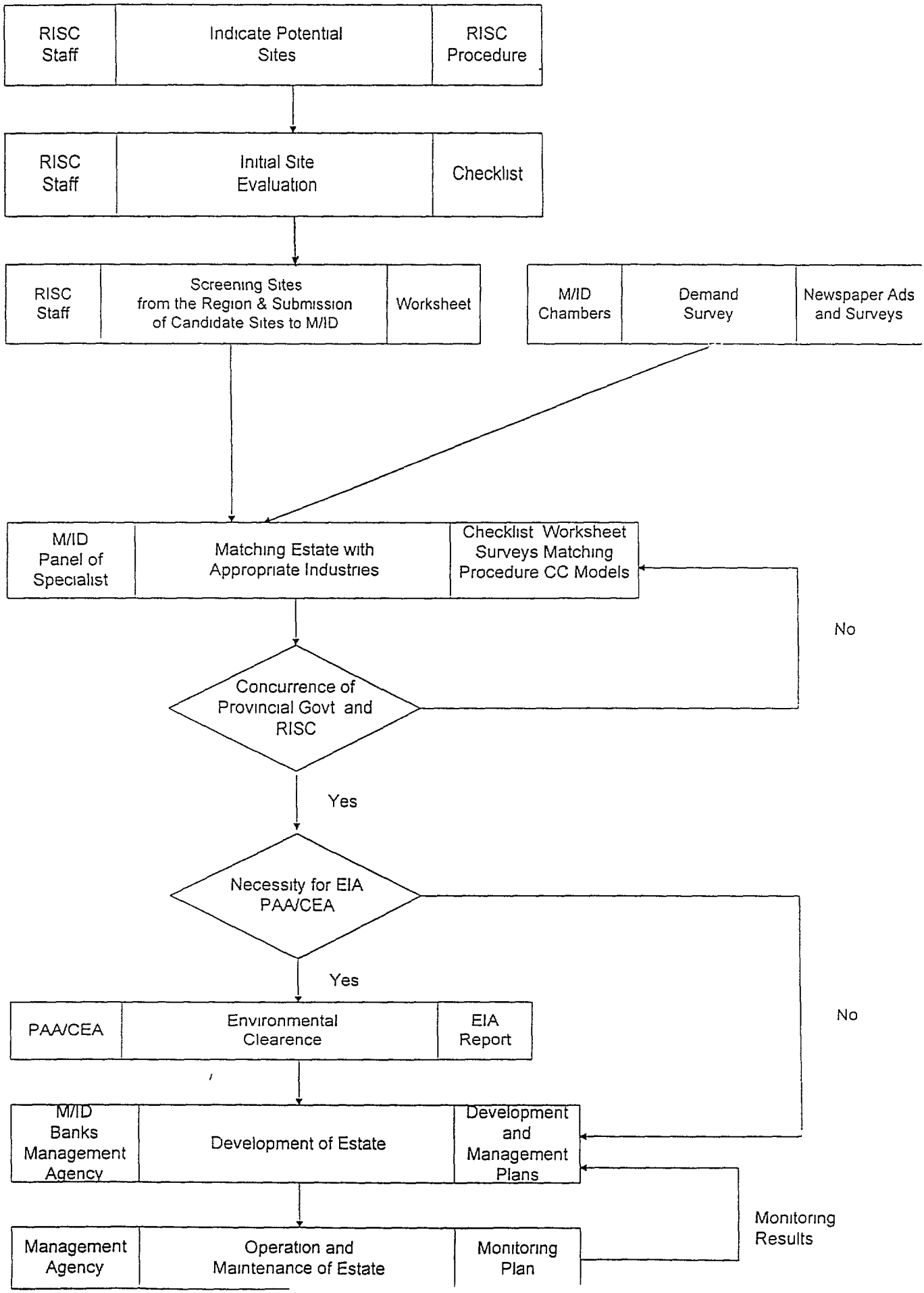
Upon completion of all eleven site visits, the NAREPP team assembled to evaluate the data for each site and to collectively derive conclusions regarding the environmental and socioeconomic suitability of these eleven proposed sites for establishment of industrial estates The team's detailed environmental evaluations of each of the eleven sites are published as a series of short reports, one per site, following a convenient format

In addition to evaluating each site individually, the team developed a comparative rating of the sites in accordance with the parameters given in the TOR The site scoring matrix and details of the criteria governing the application of these parameters to the industrial estate sites are provided in Annex IV The criteria are primarily qualitative (although ratings of surface water availability and wastewater assimilative capacity were supported by quantitative sampling and analysis conducted at each site)

In the second phase of this study, the existing industrial estate siting and developement procedure was critically evaluated and further streamlined The recommended procedure is explained in the flow-chart below

As suggested in the flow-chart below, several specific instruments were developed or further refined from the phase 1 stage of development These instruments are, a Site Evaluation Procedure based on a Checklist -- a refined version of the site visit checklist used in phase 1--, and a computerised Worksheet, and a Primary and Secondary Site-Industry Matching Procedure which includes a site industry compatibility matrix They are discussed in the following chapter Finally general findings and recommendations for improving Sri Lanka's industrial siting process, are provided in Chapter 6

Figure 4 1 Flow-chart describing the recommended procedure for industrial estate identification and development



CHAPTER 5

METHODOLOGY

This chapter provides a description of the analytical instruments that were developed by the study team to assist in evaluating and developing industrial estates

Perhaps the most significant general finding of this studyhas not been a rational, systematic process of screening, selecting and developing sites in Sri Lanka for industrial activity At present, tracts of land are selected without applying a consistent rationale, evaluated individually, and then offered to industrialists for whatever type of facility they are willing to develop An IEE or EIA may be undertaken, sometimes rather late in the process, to determine the environmental, social, and (to some extent) economic suitability of a single site Consequently, substantial time and resources can be devoted to investigating sites that may have poor prospects for development because they have severe resource constraints, or present major environmental problems, or are otherwise unattractive to potential investors When this happens, the search for alternative sites has to begin all over again, with additional costs in time and money

A more rational strategy would be to implement an orderly process (as shown in Figure 4-1) that begins with identifying an inventory of possible sites, based on both site characteristics and other considerations of industrial needs and constraints Through a systematic screening process sites could be selected from this inventory based on a variety of factors, including industry resource needs, local community acceptance of certain types of development, and consistency of the proposed development with regional land use and infrastructure Using such an inventory, it is possible to conduct an environmental assessment that allows for a systematic comparison of alternative sites, thus favoring selection of one or more sites that are the most environmentally and economically suitable This chapter discusses the instruments described above

5 1 INITIAL SCREENING

Introduction

The initial screening of candidate sites for industrial estates is important to minimize the time consumption for site selection and the expenditure of financial resources on detailed site evaluation A rational initial screening system require collection of information pertaining to a particular site and subsequent interpretation to check the matching of a site with suitable industries

A site evaluation checklist was developed by the team to provide a mode for data collection, a worksheet based on the checklist was simultaneously developed to facilitate data interpretation

The checklist and the worksheet were based on the already-identified resources and environmental parameters with respect to both the sites and industries For sites, the key parameters were Resource Availability and Pollution Assimilative Capacity, while for industries the parameters were Resource Consumption and Pollution Potential

5 1 1 Site Evaluation Checklist

In structuring the checklist, fourteen environmental and resource indicators were identified as sufficient to adequately characterise a particular site These indicators are listed in Table 5 1

Table 5 1 - Environmental and Resource Indicators in the Checklist

1	Water Availability
2	Soil Stability/Surface Drainage
3	Community Infrastructure
4	Transport Availability
5	Availability of Public Utilities
6	Sensitive Ecological Systems
7	Liquid Waste Disposal Capacity
8	Noise Assimilative Capacity
9	Cultural and Religious Resources
10	Assismilative Capacity of Airshed
11	Local Skilled Labour Availability
12	Local Unskilled Labour Availability
13	Site Expandability
14	Solid Waste Disposal Capacity

To limit both the time and the cost of this process, the Checklist should be easily understood by non-technical persons in the respective regions who would be usint it to gather the necessary information for a potential industrial estate site To facilitate collection of this information, the checklist contains questions which are easy to understand and easy to answer The questions are based on details that a non technical person could easily obtain by visiting the potential site and spending about three to four hours at the site and the vicinity

Optional answers are provided for each question so that a data collector needs only to pick one choice Each answer choice in the checklist has been carefully designed by the relevant team expert using knowledge, experience and judgement applicable to each subject area

The checklist questions are designed so as to rate the availability or the capacity of a particular indicator In ascertaining the supply of a particular resource, both quantity and quality aspects are included, to more adequately describe the nature of that resource

5 1 2 Worksheet

The Worksheet for initial site screening is also designed to enable a generalist to rate the availability or the capacity of a particular indicator at a particular location As such the worksheet takes the format of a template Each expert has designed each relevant question in the checklist so that the answers by a data collector fall into one of three categories High, Medium or Low The ratings given for each indicator are then aggregated in a step-wise manner, the template indicates the possible combination of ratings at each step Once the combination of ratings at each step is defined, an aggregate rating is entered for each combination The worksheet is designed so that a person attempting to screen a particular site would need only to pick the respective ratings and thus systematically aggregate them until the final site rating for a particular indicator is arrived at

5 1 3 Development and Validation

The checklist and worksheet were initially devloped without using the information collected at the 11 candidate sites The information and observations from the site visits were then used to modify and calibrate the checklist and worksheet as well as the subsequent aggregating of indicators This screening procedure gave rise to a systematic aggregate ranking for each indicator The aggregate ranking for each indicator, based on the checklist and worksheet, is shown in Table 5 1 This table compares rankings given by the experts based on the initial site visits, with the rankings as aggregated using the worksheet

The calibrated checklist and the worksheet were then subjected to an external validation process by by collecting information pertaining to three new candidate sites at Serapin estate near Polgahawela, Ranawana-watta near Kurunegala, and Pannala near Kurunegala

At those candidate sites, the team observed the assimilation of information by the non-expert regional staff of the M/ID The team was also able to discuss the strengths and weaknesses of the checklist with officials of the M/ID and CEA

The team then incorporated the observations done at the validation sessions to the checklist The revised checklist and worksheet are shown in the Annex V

5 2 SYNTHESIS OF SITE-SPECIFIC ANALYES

Using the qualitative rating system described above, the NAREPP team collectively conducted a comparative analysis of the 11 study sites One major objective of this exercise was to identify environmental and socioeconomic constraints that tended to occur in multiple sites, thus indicating a possible need for additional evaluation and attention to these common concerns by policy makers Several of these constraints can be alleviated by

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including specific engineering design requirements, such as those related to physical infrastructure, into the project construction permitting process However, this step could increase development costs, making sites that require additional expenditures less attractive from an economic perspective than other sites that do not have these constraints

5 2 1 Interpretation of Site Ratings for 14 Parameters and Aggregate Rating of Sites

The team's ratings of each site for the selected parameters are provided in Table 5-1 The table should not be used to conclude that any given site is "best" or "worst" for all types of industrial development Each site has a different combination of scores that reflect site-specific conditions Nor was any attempt made to weight the score for one parameter more heavily than another To do this it would be necessary to weigh separately each of the 13 criteria in the table and somehow derive a "total weighted score" for each site across all criteria This would be a difficult and questionable exercise Furthermore the relative weights assigned to different parameters would be heavily 'site dependent', thus making it impossible to derive a generalized assessment procedure

However, these data can be used to identify the relative frequency and level of environmental constraints across all sites with respect to each of the rating factors The next two figures, which graphically depict the information from Table 5-1, clearly indicate that quite a few of the sites are rated as having only Low or Medium compatibility with industrial uses for several of the same environmental factors For example, in Figure 5-1, which has a separate pie-chart for each parameter (each circle is the sum of that parameter's ratings for the 11 sites) the darker portions of each 'pie' indicate lower levels of compatibility with industrial uses Surface water, wastewater, skilled labor, and solid waste were rated at either medium or low compatibility for all 11 sites, while air quality, unskilled labor, and cultural/religious factors posed relatively few problems at most sites The same results are shown in bar-chart form in Figure 5-2 Four of the parameters were viewed by the team as posing the most serious constraints on the establishment of industrial estates at these sites

- **Surface water availability** is a constraint or limiting factor at the majority of sites Significantly, none of the sites were considered by the review team to have "high" compatibility with industrial development in regard to available water supplies This constraint indicates that development of these sites may have to be restricted to industries with very low water use requirements The use of ground water may be an option at some sites *but sustainable ground water availability cannot be determined without detailed site-specific ground water data, which currently do not exist for any of the sites*

- **Limited waste-water assimilative capacity** is a constraint at the majority of the 11 sites This conclusion is based on analysis of storage and flow rates for water bodies near the sites, as well as on consideration of other current or planned competing uses of these water bodies

Table 5.1 - Ranking of Parameters at Each of the 11 Sites

Parameter/ Site	BATA-ATHA		BUTTALA		WALJA-PALA		DANKOTUWA		SENAPURA		YATAGALA		MAHAWELI		MANAWERIYA		TAMMAN-AKELLE		MAPAKADA		GEMUNU PURA	
	EST	CAL	EST	CAL	EST	CAL	EST	CAL	EST	CAL	EST	CAL	EST	CAL	EST	CAL	EST	CAL	EST	CAL	EST	CAL
Liquid Waste Disposal	L	L	M	L	M	M	L	L	L	L	M	L	L	L	M	M	M	M	M	M	M	M
Solid Waste Disposal	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Site Expandability	M	M	L	L	L	L	L	M	M	M	H	M	L	M	L	M	H	H	L	L	L	M
Public Utilities	M	M	H	H	H	H	M	M	M	M	M	M	H	H	H	H	L	M	M	M	L	L
Ecological Systems	L	L	M	M	H	H	M	M	H	M	H	H	H	M	M	M	H	H	M	M	M	L
Transport Facilities	M	M	M	M	H	H	M	L	L	L	M	M	H	H	H	H	M	M	M	M	L	L
Community Infrastructure	M	M	H	M	H	H	H	M	L	L	M	M	H	H	M	M	M	L	L	M	L	L
Local Labour Skilled	L		L		L		M		L		H		M		M		M		L		L	
Local Labour Unskilled	H		M		H		H		L		H		M		H		H		M		M	
Air Quality	H		M		H		H		M		H		H		H		H		H		M	
Noise	H		M		M		M		M		L		H		L		H		H		M	
Cultural & Religious Res	H		H		H		H		H		M		H		H		H		H		M	

INDUSTRIAL SITES
ENVIRONMENTAL COMPATIBILITY

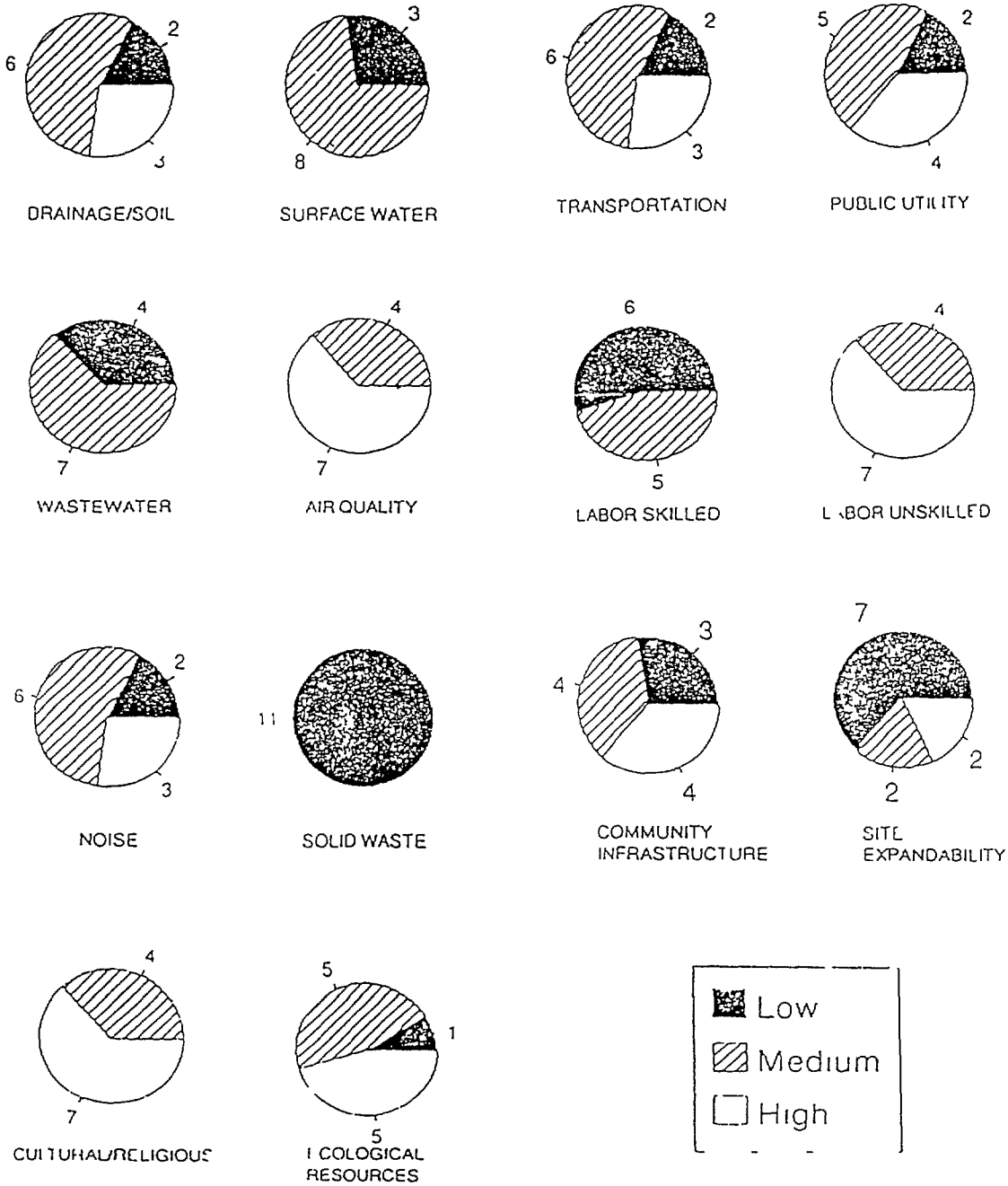

Figure 5 1

INDUSTRIAL SITES ENVIRONMENTAL COMPATIBILITY

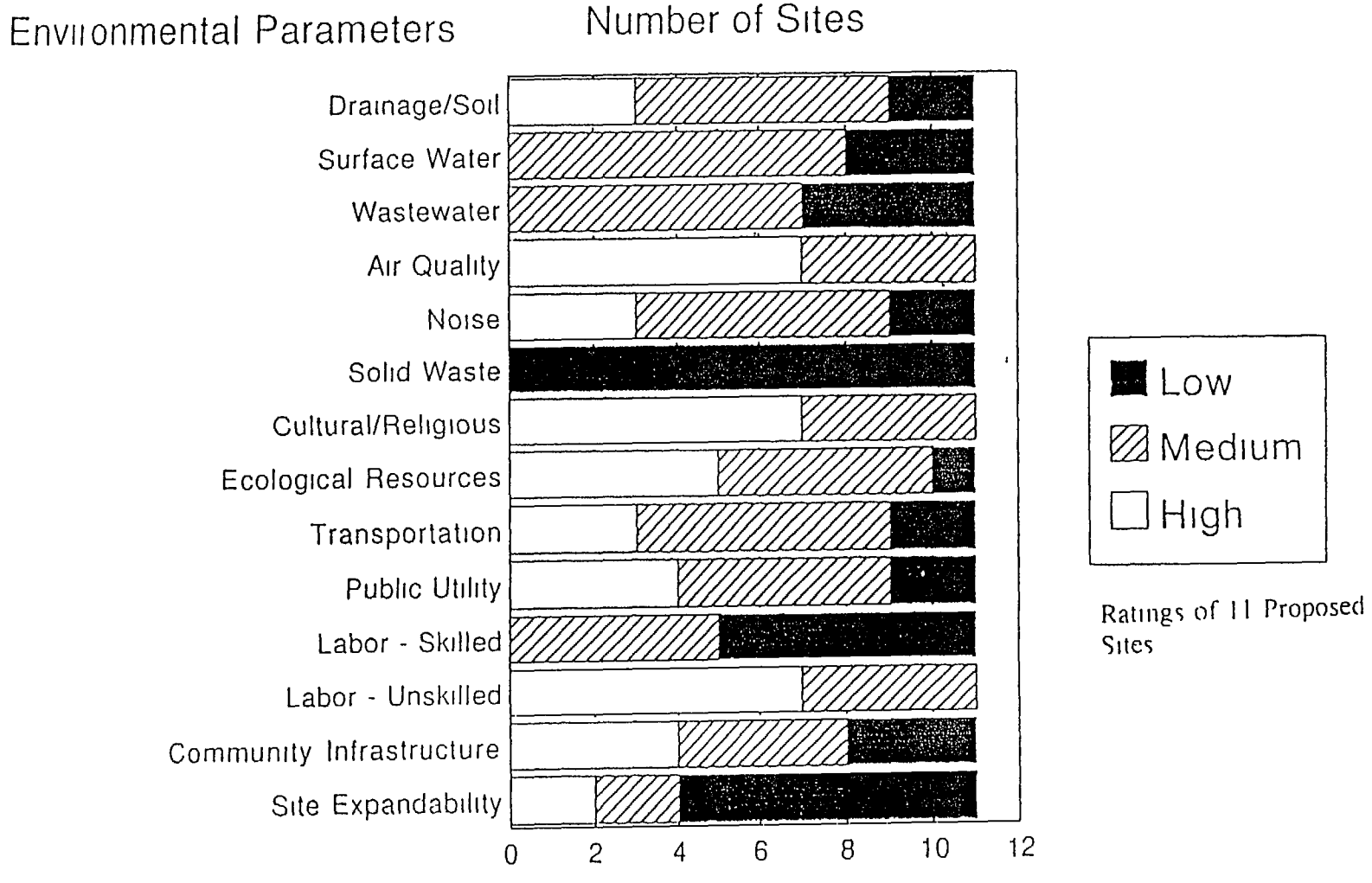

Figure 5 2

- **Solid waste disposal capacity** is a significant constraint at every site. The primary reason is that there are no existing properly-constructed landfills at or near any of the sites, furthermore, on-site soil and groundwater conditions at some sites are incompatible with landfilling even if construction of such a facility were to be attempted. This constraint can be alleviated to some extent by requiring that, prior to development, the site manager must approve each industry's provisions for solid waste disposal, which could include construction of a landfill or installation of an on-site recycling system or other solid waste treatment unit. However, this requirement would add to the estate development costs and could lead to additional environmental problems. In addition, residues from some waste treatment systems (such as sludge or incinerator ash) would still need to be disposed of somewhere safely after receiving on-site treatment.

- **Limited space for future expansion** was a major constraint at most of the sites. The review team reached this conclusion after considering the characteristics of lands immediately surrounding the sites. There are physical barriers on many of these adjacent lands (e.g., existing structures, natural barriers such as streams, lagoons, etc.) that would make future expansion of the sites onto these lands extremely difficult and expensive, if not unfeasible.

5.2.2 Aggregate Rating of Sites

The team next attempted to consolidate the separate ratings for each site into two aggregate scores, one that would give some indication of a site's overall capacity to assimilate pollutants from various sources (**pollution assimilative capacity**), and the other that would indicate the site's relative capability to provide physical and socioeconomic resources considered important for industrial development (**local resource availability**). The methodology for this step is described next.

The objective was to arrive at an aggregate ranking for each site in terms of the two criteria (i.e., **pollution assimilative capacity** and **local resource availability**). Because in most cased only general assumptions can be made about the types of industries seeking to locate at a given site, each parameter was given equal weight in the estimation of an aggregate score. The two-part aggregate rating is determined for each site by adding up and comparing the number of 'H', 'M', or 'L' ratings. A simple averaging method was used, whereby any single score of 'H, was matched up against any single score of 'L' to result in a rating of '2M'. This approach was used to aggregate all ratings to an aggregate. Thus an overall rating of 'M/ML' would mean that a site was rated medium overall in terms of pollution assimilative capacity, and medium-to-low in terms of local resource availability. The results are displayed in Table 5-2. The table shows, for example, that the site at Buttala has an aggregate rating for 'pollution assimilative capacity' of M-L, or medium-to-low, and an aggregate rating for 'local resource availability' of M-H, or medium-to-high. The reader is urged not to place any absolute value on these aggregate ratings, but they do provide a basis for comparison from one site to another of the sites relative compatibility for development as industrial estates. The ratings also give some indication of what types of industrial development may be more or less compatible with a given site's particular set of environmental resources and limitations.

Table 5 - 2 RATING OF SITES ACCORDING TO POLLUTION ASSIMILATIVE CAPACITY AND RESOURCE AVAILABILITY

SITES	POLLUTION ASSIMILATIVE CAPACITY									LOCAL RESOURCE AVAILABILITY										
	DRAINAGE/SOILS	WASTE WATER	AIR QUALITY	NOISE	SOLID WASTE	CULTURAL RESOURCES	ECOLOGICAL RESOURCES	AGGREGATE		CULTURAL RESOURCES	ECOLOGICAL RESOURCES	SURFACE WATER	TRANSPORT	PUBLIC UTILITY	LOCAL LABOUR (SKILLED)	LOCAL LABOUR (UNSKILLED)	COMMUNITY INFRASTRUCTURE	SITE EXPANDABILITY	AGGREGATE	
1 Bata Atha	M	L	H	M	L	M	L	M	L	M	L	M	M	M	L	H	M	M	M	L
2 Buttala	L	M	M	L	L	H	M	M	L	H	M	M	M	H	M	H	H	L	M	H
3 Waljapala	M	M	H	L	L	H	H	M	H	H	M	M	H	H	M	H	H	L	H	M
4 Karanawan watta	H	L	H	M	L	H	M	M	H	H	M	L	M	M	H	H	H	L	M	H
5 Senapura	H	L	M	M	L	H	H	M		H	H	L	L	M	L	M	L	M	M	L
6 Uragasmanhandiya (Yatagala)	M	M	H	M	L	M	H	M		M	H	M	M	M	L	H	M	H	M	H
7 Tambuttegama	H	L	H	H	L	H	H	M	H	H	H	M	H	H	M	M	H	L	M	H
8 Manaweriya	L	M	M	M	L	M	M	M	L	M	M	M	H	H	M	H	M	L	M	H
9 Tammanakele	M	M	H	H	L	H	H	M	H	H	H	M	M	L	L	H	M	H	M	H
10 Mapakada (Vianini Camp)	M	M	H	H	L	H	M	M	H	H	M	M	M	M	L	M	L	L	ML	
11 Gemunupura	M	M	M	M	L	M	M	M	L	M	M	L	L	L	L	M	L	L	L	M

H High
M Medium

None of the eleven sites evaluated was found to be ideally suited for high-polluting industries Some sites are highly unsuitable, while others could accommodate high-polluting industries only with a significant expenditure for environmental protection measures Unfortunately, given the typically small size of the sites and the fact that most of them have very limited potential for expansion, the need to make significant capital outlays for control measures greatly diminishes the appeal of many of these sites to investors

The M/ID should consider the fact that developers of large industrial facilities will be looking carefully at ways to control their start-up costs, and are most likely to be attracted to sites where the managing entity has made substantial up-front investments in common infrastructure such as water supply, wastewater treatment, roads, power, and other industrial amenities Such investments, whether by government or private parties, are not likely to be cost-effective on small sites with numerous other constraints

On the other hand, there are a number of positive findings in terms of the suitability of the sites for small and medium-scale industrial development

- Most of the eleven sites studied sites are served by relatively good transportation and public utility infrastructure

- With one exception, ecological factors do not pose severe constraints to on-site development or expansion

- Except at Buttala, air quality considerations do not pose a major constraint, provided sound pollution prevention and control measures are taken

- There is a reasonable good base of unskilled labor near all of the sites, and Sri Lanka's relatively high literacy level means that skilled labour can be readily trained if it is not immediately available

- There are no outstanding cultural or religious resources (e g , temples, archeological sites, etc) at or near most of the sites that would be likely to be damaged or adversely affected by industrial development on the sites

In other words, each site has certain positive and negative characteristics with respect to its compatibility with industry, these factors will affect whether and how development can occur Failure to consider these characteristics will hinder proper decision making The risk of making inappropriate decisions that have costly consequences is clear It would obviously be a very costly mistake, for example, to make substantial private and public sector investment in water supply and waste water treatment facilities to meet the needs of industries on a year-round basis at a site where there are insufficient water supplies during the dry season

Fortunately, such serious misallocations of resources can be avoided by considering all of the important economic, environmental, and social factors early in the siting process, safe and providing for sustainable industrialization

5 3 MATCHING AN INDUSTRIAL ESTATE WITH APPROPRIATE INDUSTRIES

5 3 1 Rating of Selected Industry Types by Aggregate Indicators

The aggregate ratings in Table 5-2 were compiled for the sites themselves, not for any particular combination of industries at that site To provide some basis for matching industries to sites, the team selected 10 general types of industries typically found in Sri Lanka and scored them against a similar set of parameters (i e , **pollution potential** and (local) **resource consumption**) Those scores were then used to produce aggregate ratings for these typical industries in the 'pollution potential' and 'resource consumption' categories The results are shown in **Table 5-3** In general terms, the table shows that different industry types vary considerably in their pollution and resource consumption impacts, which is not surprising, but the two tables taken together provide a systematic way to look for possible matches, or "fits," between a given site and a range of industries Where a site's natural resources are limited, industry types with lower resource consumption (but possibly with relatively high pollution potential) may be more appropriate The system could be used in the preliminary stages of site development to identify which industry types should be encouraged vis-a-vis available sites Final siting decisions should, of course, be based on more site-specific and industry-specific analysis This methodology offers a procedure for rapid assessment in the initial screening stages The strength of this rating system is that it considers environmental impact to be a combination of pollution generation and resource consumption

5 3 2 Primary Matching for Site/Industry Compatibility

The following matrix procedure may be followed to assess the compatibility of a site that has been evaluated according to the methodology described above with any industry that has been similarly evaluated The matrix contains the following main four components

1 Pollution Potential (PP)
2 Pollution Assimilative Capacity (PAC)
3 Resource Consumption (RC)
4 Local Resource Availability (LRA)

Component 1 and 3 refer to a particular manufacturing or process concern (ie the type of industry), whereas 2 and 4 refer to the capabilities of a selected site

Table 5 - 3 RATING OF INDUSTRIES ACCORDING TO POLLUTION POTENTIAL AND RESOURCE CONSUMPTION

INDUSTRIES	POLLUTION POTENTIAL							RESOURCE CONSUMPTION							
	WASTE WATER	AIR QUALITY	NOISE	SOLID WASTE	VISIBILITY	THERMAL	AGGREGATE	SURFACE WATER	ECOLOGY	TRANSPORT	PUBLIC UTILITY	LOCAL LABOUR	COMMUNITY INFRASTRUCTURE	LAND AREA	AGGREGATE
1 Textile Washing Plant	H	M	L	M	M	M	M	H	M	H	H	M	M	L	H M
2 Apparel Industry	L	L	M	M	L	L	L	L	L	H	M	H	H	M	H M
3 Manufacture of Fabricated Metal Products and Foundry	M	L	H	H	M	M	H-M	L	M	M	H	L	M	L	L M
4 Manufacture of Leather (Tanning Industry)	H	H	L	H	H	M	H	H	H	M	M	M	M	M	M-H
5 Meat Processing, Curing, Preserving and Packing	H	L	M	H	L	M	M	H	L	H	H	M	M	L	M H
6 Rice Mills	L	M	L	M	M	L	M-L	M	L	M	L	L	L	H	M L
7 Manufacture of Cement Products for Construction Industry	L	M	M	L	M	L	M-L	M	H	H	L	M	L	H	M
8 Processing Pulp to Paper, Paper Board and Fibre Board	H	H	M	H	H	M	H-M	M	H	H	H	M	M	H	H M
9 Treating and Preserving Wood	H	M	L	L	M	M	M	M	L	H	M	H	M	H	M H
10 Manufacture of Motor Vehicle Parts, Motors Brakes etc	M	M	H	H	M	M	M-H	L	L	M	M	M	M	L	M-L

- High
M Medium
L - Low

General resource/pollution profiles for each type of industry (as typically practised in Sri Lanka) can be developed independent of site For successful application of this methodology it is important that such profiles are available for industries falling into the following sectors

* Textile and leather
* Basic metal fabrication
* Chemical industries
* Food production/processing
* Machinery and equipment
* Mineral products
* Paper and pulp production
* Timber and wood
* Transport

Components 2 and 4 refer to the environmental and resource ratings for a specific site With the completion of the matrix it is possible to identify and analyse the suitability of a particular site for a particular industry If the site profile is made available to potential industrial developers early in their site selection process, significant savings in time and money may be achieved

This matrix analysis can be done in two steps as outlined below

Table 5 4 Industry/Site Compatibility Matrix

SITE	INDUSTRY
_____	_____
Pollution Assimilative Capacity Aggregate (PAC-A)	**Pollution Potential Aggregate** (PP-A)
Local Resource Availability Aggregate (LRA-A)	**Resource Consumption Aggregate** (RC-A)

The primary matching essentially identifies the correct industry type for a given site However, once the primary match has been found to be acceptable and

5 3 3 Secondary Matching

Identification of Suitable Industries

It is unlikely that all desired conditions will be met immediately A secondary matching procedure which compares the ratings of certain individual pollution and resource parameters could help an industrial develop to focus on the feasibility of upgrading the site (or of using technology improvement, or pollution abatement, or down scaling options as applicable) in order to satisfy the matching requirement

With regard to pollution assimilative capacity, it is still possible to consider siting industries with high polluting potential (H) at a site with a Low (L) aggregate rating for overall assimilative capability This is possible because a site's assimilative capacity may be compensated for by upgrading the industrial waste management system (i e advanced waste water treatment systems, superior manufacturing technology incorporating recycling and recovery, etc) This adjustment may entail high operation and maintenance (O&M) costs and monitoring costs due to the necessity to maintain O&M quality The site may have to incorporate a large buffer strip to protect the adjacent public from nuisances due to plant operations

A site with very limited resources may present more serious constraints to development A site with a "L" aggregate would likely have to be upgraded considerably to support an industry with a High RC-A rating Thus on benefit-cost grounds alone, it is unlikely that such a site will be suitable for an industry of that category

Secondary matching involves analysis of individual ratings in tabular format as shown in Table 5 5 and 5 6 below

Table 5 5

SITE		INDUSTRY	
POLLUTION ASSIMILATIVE CAPACITY (PAC)	**Individual Parameter Ratings**	**POLLUTION POTENTIAL (PP)**	**Individual Parameter Ratings**
Drainage/Soils			
Waste water		Wastewater	
Air Quality		Air Quality	
Noise		Noise	
Solid Waste		Solid Waste	
Cultural Resources			
Ecological Resources			

Table 5 6

LOCAL RESOURCE AVAILABILITY (LRA)	**Individual Parameter Ratings**	**RESOURCE CONSUMPTION (RC)**	**Individual Prameter Ratings**
Cultural Resources			
Surface Water		Surface Water	
Ecological Resources		Ecology	
Transport		Transport	
Public Utility		Public Utility	
Local labour (skilled)		Local labour (skilled)	
Local labour (unskilled)		Local Labour (Unskilled)	
Community Infrastructure		Community Infrastructure	
Site Expandability		Land area	

Note that not all individual resource and pollution parameters can be compared for matching site and industry ratings, hence some of the cells in the example below are empty An example of the Secondary Matching Procedure for one site and one industry is shown below

Table 5 7 Example of Secondary Matching

SITE	INDUSTRY
Waljapala	Textile Washing Plant

POLLUTION ASSIMILATIVE CAPACITY (PAC)	Individual Parameter Ratings	POLLUTION POTENTIAL (PP)	Individual Parameter Ratings
Drainage/Soils	M		
Waste water	M	Waste water	H
Air Quality	H	Air Quality	M
Noise	L	Noise	L
Solid Waste	L	Solid Waste	M
Cultural Resources	H		
Ecological Resources	H		

Individual Pollution Assimilative Capacity (PAC) ratings and Pollution Potential (PP) ratings contribute to the overall aggregates used in the primary matching process As seen here, an industry with a Hight (H) waste water Pollution Potential (PP), in this case a textile washing plant, is not initially appropriate for this site, sincethe site has a Medium rating (M) for Waste water assimilation This potential conflict may be resolveable if wither the site's capability to accommodate waste water is enhanced, or the textile plant's waste water load is reduced by upgrading the plant's operation from the usual or typical process

LOCAL RESOURCE AVAILABILITY (LRA)	Individual AGGREGATE	RESOURCE CONSUMPTION (RC)	Individual AGGR EGAT E
Cultural Resources	H		
Surface Water	H	Surface Water	H
Ecological Resources	M	Ecology	M
Transport	H	Transport	H
Public Utility	H	Public Utility	H
Local labour (skilled)	M	Local labour (skilled)	M
Local labour (unskilled)	H	Local Labour (Unskilled)	H
Community Infrastructure	H	Community Infrastructure	M
Site Expandability	L	Land area	L

By examining individual ratings for Local Resource Availability (LRA) and Resource Consumption (RC) aggregates, one can determine where additional infrastructure support may be needed to sustain a particular industry For this site individual requirements seems to be well balanced For example, Transport facility need and availability match at "High"to suit an industry of this type For this site the transportation infrastructure development costs that need to be undertaken to support a textile washing plant will be at a minimum

There can be situations where an industry assessed as acceptable for a site at the aggregate level fails the secondary matching process This will be due to high incompatibility at individual points of consideration For example, a Low (L) water availability (surface and/or ground) with a High (H) water resource requirement may mean significant cost to the enterprise to provide water from a distance This implies that the site may not be suitable due to high water transmission cost The same incompatibility can emerge when individual pollution potential and pollution assimilation factors are analysed Two great a difference such as L (LRA) vs H (RC) or H (PP) vs L(PAC) implies that a high financial expenditure is required to overcome this difference between the requirements and availability

5 4 COMPATIBILITY WITHIN INDUSTRIAL ACTIVITIES

Activities and operations of industrial units located within a industrial estate should be compatible with each other for a smooth and efficient functioning of the industrial estate Institutions responsible for managing the industrial estate should establish zoning within the estate so that mutually compatible industries can be located within those zones Compatibility can be assessed by taking into consideration the following examples

5 4 1 Level of compatibility between various industrial operations

(1) Very poor compatibility exists between the operations of chemical/agrochemical industries and food industries based on toxicity criteria

(2) Very poor compatibility exists between the operation of electronic industries and mineral processing industries based on "dust free environment" criteria

5 4 2 Level of treatment compatibility of wastes discharged by different industrial operations,

(1) Wastes which are refractory or toxic in character are not amenable to standard biological waste treatment processes Hence if the central treatment plant uses biological treatment, industrial units discharging toxic/refractory waste should install "pre-treatment" facilities in order to remove constituents in their waste that are toxic or refractory in character

(2) Waste treatment processes required to treat a "high strength" waste may not be compatible with the treatment process required to treat "low-strength" waste "Waste - segregation" may have to be employed to overcome this problem

It is apparent from these examples that an industrial unit producing toxic/refractory waste should not merge its wastes with an industrial unit producing bio-degradable waste Likewise,

an industrial unit producing "high - strength" waste should be separated from an industrial unit producing "low - strength" waste

A previous study of industrial estate development (NBRO, 1989) established a "compatibility matrix" based on activity compatibility and waste treatment compatibility The matrix, shown below, provides information on eight general industrial groups

Industrial Sector Compatibility Matrix
(adopted from NBRO, 1989)

	BM	CH	FD	ME	MP	TG	TW	TR
BM	1	3	3	1	2	2	1	1
CH	3	1	3	3	2	3	3	3
FD	3	3	1	3	3	1	2	3
ME	1	3	3	1	2	3	1	1
MP	2	2	3	2	1	3	3	3
TG	2	3	1	3	3	1	3	2
TW	1	3	2	1	3	3	1	2
TR	1	3	3	1	3	2	2	1

Key

1 = Very good compatibility with each other
2 = A limited compatibility with each other
3 = Incompatibility with each other

BM Basic Metal Industry
CH - Chemical Industry
FD Food Industry
ME Machinery & Equipment Industry
MP - Mineral Processing Industry
TG - Textile & Garment Industry
TG Textile & Garment Industry
TW - Timber & Wood Industry
TR - Transport Industry

5 4 3 Maximum Level of Industrial Activities

The assimilative capacity of the environment surrounding an industrial estate may be defined as the maximum emission or effluent the receiving environment can accommodate without impairing its quality to such a level as to interfere with the uses determined to be in the public interest These uses are generally defined by environmental quality objectives and resulting environmental threshold standards Hence, it is seen that both treatment and dispersal (or dilution) can contribute to the assimilation capacity of the surrounding environment In other words, by incorporating treatment facilities within the industrial estates, a higher level of industrial activities can be permitted within the estate With a higher level of treatment (viz primary treatment, secondary treatment etc), larger industrial activities (or outputs) may be accommodated within a particular estate

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

The objective of this study was to evaluate the industrial estate development program of the Ministry of Industrial Development, and to suggest ways to improve this process The findings and recommendations of the study are summarised in this Chapter

6 1 IMPROVING THE EIA/IEE PROCESS FOR INDUSTRIAL ESTATE SITING

A recurring issue found during this study was that there were significant deficiencies in available environmental information for each site and its surroundings These information deficiencies hindered a complete environmental evaluation of each site The subjects of most concern include

Information about other development plans at the regional level A thorough evaluation of the impacts of industrial development must assess commulative demands on regional resources resulting from current and planned development at the regional level

For example, in the Hambantota District, where the Bata-Atha site is located, there are several other major projects at various stages of planning that could have significant impacts on the area, including a petroleum refinery and a BOI industrial estate At the same time, the Ceylon Tourist Board has recently announced plans for further tourism development in the District Greater consideration needs to be given to the cumulative resource needs (particularly water) and to the impacts of these projects and their compatibility or incompatibility with each other

In general, the regional development plans for the Southern Province (which include development of a port in Hambantota, and construction of a highway between Colombo and Matara) will likely induce major new economic development and growth in the region While these developments will provide positive economic benefits to the region, they also present competing demands for resources that need to be considered in planning the Bata-Atha site as well as other industrial estates in the South

Due to limitations of data availability, combined with the time available to complete this study, the review team's evaluation was largely focused on environmental and social impacts at or near the sites Therefore our evaluation of these sites necessarily provides an incomplete picture of the full implications of industrial estate development In areas of Sri Lanka where development is especially high, such as the Galle and Hambantota Districts, regional planning is especially critical Development of a regional plan and strengthening of the region's planning capacity is needed EIAs for individual projects should address the compatibility of proposed projects with the overall plan for the region

Surface water availability Based on measurements taken by the review team in water bodies near each site, as well as historic flow and rainfall data available for watersheds and regions, the review team was able to derive rough estimates of water availability In addition, to the extent data were available, the team identified existing uses However,

these data were extremely limited To get an adequate picture of the impacts of industrialization on the region, water uses and needs throughout the watershed must be taken into account Unfortunately, these data are very inadequate for most of the sites

Surface water quality Very limited water quality data were available for any of the water bodies near the sites Therefore, the NAREPP team conducted a limited sampling and analysis program to support initial screening of the sites While the data are sufficient for screening purposes, a more comprehensive water quality monitoring program should be established at sites that are ultimately selected for industrial development This program should include survey monitoring to establish a statistically sound baseline prior to estate construction, and an ongoing monitoring program during estate construction and operation to ensure that (1) compliance with environmental standards is maintained and that (2) the required treatment processes are providing a sufficient level of environmental protection

Ground water resources Local hydrogeologic data were essentially nonexistent at all sites Due to the limited time and resources available for this study, the Terms of Reference did not include making assessments of ground water at the sites This does not mean that ground water information is not important -- in fact, the opposite is true If industries operating on the estates will have significant water demands, a thorough analysis of ground water resources is essential Before ground water can be considered as a resource to support industrial estates, a hydrogeological analysis of the site is essential This analysis should include a determination of the geology underlying the site, depth and thickness of aquifers, aquifer productivity, and analysis of recharge and discharge This analysis is essential in order to gain an understanding of the long-term impacts of using on-site ground water or other aquifers in the vicinity of the site

Ecological resources Baseline data for local flora and fauna, critical habitat, and wetlands were unavailable for most of the sites For a few sites, comprehensive ecological studies have been conducted in nearby regions that are very useful for assessing the off-site impacts of industrial estate development These include, for example, data provided in CEA's Wetland Site Report prepared for the Chilaw Estuary, approximately 10 kilometers from the Manawerıya site, and the Wetland Site Report for the Kalametiya and Lunuwa Lagoons, which are within one kilometer of the Bata-Atha site For the other sites, however, most baseline ecological data were absent

Removal of these significant information deficiencies requires a concerted effort to be made as part of the IEE/EIA process However, given the limitations of time and funding that are typical of many IEEs and EIAs, this process alone cannot be relied upon to provide all data needed to support effective decision making What is required is an information strategy that makes maximum possible use of available data, combined with data generated during the EIA, and places shared responsibility on both the estate developer and M/ID during the project design stage

This strategy can be implemented without placing an undue burden on the government or the potential industrial investor It consists of the following steps

1 Scoping sessions should be held by M/ID early in the EIA process to ensure the full participation of agencies and institutions with important information and of

stakeholders and others concerned citizens This participation may be enhanced if basic information about of sites under consideration is widely distributed well in advance of the initiation of individual EIAs This may be an appropriate role for the Sectoral Committee

2 M/ID should complete an IEE or EIA for each site, carrying out the analysis as far as possible within the limits of data availability and government resources If firm industry proposals are not in hand at the time of the EIA, M/ID should make reasonable assumptions about possible industries in order to complete the analysis

3 The results of M/ID's analysis should clearly indicate areas where information deficiencies have been identified, and describe very clearly the assumptions employed to complete the analysis in light of these deficiencies For example, all assumptions regarding the volume of water to be drawn from water bodies in the area need to be documented If groundwater studies are <u>not</u> conducted and documented for the site, this indicates that an assumption has been made that industries on the estate will rely on surface water supplies exclusively

4 As specific industries submit proposals to locate their facilities on the estate, these proposals should be reviewed carefully to determine whether the characteristics of their facilities as planned are consistent with the assumptions employed in the industrial estate environmental analysis In the example cited above, if the facility's proposed water use combined with the water consumption of other facilities on the estate will exceed the levels upon which the EIA analysis were based, the industrial applicant should be required to conduct a new hydrologic analysis focused on the additional impacts of his facility's water use If ground water is needed, it will be necessary for the facility sponsor to conduct a hydrogeologic assessment if such an assessment was not done as part of the EIA

The basic principle behind this process is that individual facility developers or applicants should have the burden of demonstrating that their facility is consistent with the assumptions employed in the industrial estate's EIA If the facility has potential impacts that were not fully assessed in the EIA, then the industrial applicant should be responsible for conducting a limited environmental analysis, focused on filling information gaps Under this scheme, they would not need to duplicate work already done Rather, they will only need to analyze the specific issues associated with their proposed operation that were not already adequately covered in the EIA

6 2 IMPROVING SRI LANKA'S INDUSTRIAL ESTATE PLANNING AND DEVELOPMENT

In the course of this study the NAREPP team encountered several management issues relating to policies to develop and manage industrial estates All of these issues are manageable and can be effectively addressed with appropriate policy and institutional measures, as recommended below These issues are

1 Need to improve market data indicating the level and types of industries

For almost all of the sites in this study M/ID did not have in hand of firm industry proposals or expressions of specific industry interests Thus, there was no solid basis for site planning and design to accommodate specific industries

The lack of data on industry interest poses three difficult challenges to M/ID and the Divisional Directors First, without a reasonable idea of the types of industries seeking to locate at a given site, it is not possible to plan effectively for site development, including determining the appropriate site size, layout and infrastructure needs Second, it is extremely difficult to complete a meaningful IEE or EIA since the analysis must be based on speculation concerning the types of development likely to occur Finally, a substantial amount of time and resources may be misdirected toward sites that have no reasonable prospects of development

Industry data for the Karanawan-watta (Dankotuwa) site provide a good example of the kind of information that can form a solid foundation for planning Several firm industry proposals are in hand that describe proposed activities, expected production levels, and resource needs such as water demands and expected labor requirements For most of the other sites, these data do not exist, primarily because of an absence of clearly-stated industry demand

The fact that many sites do not have firm industry proposals like those for Karanawan-watta does not mean that site planning should be put "on hold " Rather, in lieu of specific proposals a systematic market analysis and continuing monitoring of investment interest in Sri Lanka can be used to guide the industrial estate siting program The Government of Sri Lanka has recently adopted a policy of industrial estate selection based on market demand Section 6 3 outlines this policy and suggests a framework for incorporating market data into the overall estate planning process

2 Need to improve the tract definition process

The process for siting industrial estates in Sri Lanka begins with identifying lands owned by the Government that are of appropriate size and that are not currently in use or committed to other specific uses Beyond this necessary first step, many additional measures must be taken to define and ultimately select specific tracts of land from among larger units The establishment of firm site boundaries should take place near the <u>end</u> of this process, not the beginning, as appears to have been the case with most of the sites analyzed in this study

One of the concerns identified during this study is that the areas and site boundaries of these 11 proposed estates were apparently fixed by M/ID prior to undertaking a systematic evaluation to match site resources with industrial interests Thus the tracts of land being offered to investors may be too small for viable industrial estates, or may not be located in areas that are environmentally or economically optimal

Two examples may serve to illustrate this concern The St Martins Estate is a relatively large government land holding (of approximately 400 acres) that is jointly managed by

several Government agencies Within this large land parcel, three tracts have been designated for industrial estates the existing St Martins industrial estate, consisting of 17 acres, the Tammanakele site (67 acres), and the Manaweriya site

As reflected in the site evaluations, each of these small parcels, when viewed in isolation from each other, has positive and negative characteristics For example, the Tammanakele site has deficiencies in water resources, the Manaweriya site has serious drainage problems, etc These problems, combined with the small size of the separate tracts, greatly diminish their development appeal However, it is entirely possible that another larger site or combination of sites within the overall St Martins Estate might be more suitable than are the small separate pieces now being offered

Similarly the Bata-Atha site, consisting of 107 acres, is part of a much larger government-owned tract There are serious concerns regarding potential adverse impacts of industrial discharges on the nearby wetland sanctuary and associated water bodies As with St Martins, it is possible that these concerns could be alleviated by looking at alternative tracts within the larger GOSL landholding

An assessment of alternative land-used options within the larger government landholding may reveal alternative tracts, or combinations of tracts, that are more attractive from the perspectives of both economics and environment A related problem is that by establishing specific tracts too early in the process, the government may lock itself into an inventory of sites that is too restrictive to allow for consideration of alternatives Section 6 3 recommends a siting process that allows for the examination of alternative tracts and also provides for appropriate industry input

3 Need to improve interagency coordination and communication

As was pointed out in Chapter 2, the industrial estate programs of the various industrial development agencies in Sri Lanka have not been well coordinated In particular, there has not been a multi-agency institutional mechanism for systematically assessing the need for new estates on the basis of market demand The recently-established Sectoral Committee on Industrial Estates and Projects may be the key to improving this much-needed coordination

Another dimension of the coordination/communication issue that still needs improvement is in the area of environmental policy There are a number of environmental requirements and regulations that are new or under development, such as those for environmental monitoring and hazardous waste management These requirements have a major and direct bearing on industry, and may be particularly difficult to apply in the context of industrial estate operation For example, the provisions of each estate's Environmental Protection License are expected to include assignment of responsibilities and assessment of penalties for non-compliance, which may pose very difficult questions regarding legal responsibility for on and off-site enforcement of environmental laws

Just as the Sectoral Committee can improve coordination among agencies with mandates for industrial development, a central coordinating mechanism is needed to integrate environmental policy considerations into industrial estate planning For this reason, it is

recommended that CEA or other components of the Ministry of Forests and Environment should be regularly represented on the Sectoral Committee in at least an advisory capacity

4 Need to prepare estate management plans that encourage pollution prevention and effective environmental management at the industrial estates

As discussed above, detailed plans for developing and managing most of these estates have not been completed While this is an issue of concern, it is not critical since few of the sites reviewed in this study have firm industry facility plans at this time **Thus there is an opportunity to initiate policies now that incorporate sound environmental principles into estate management plans** Doing so now will avoid many problems later The principles that need to be embodied in estate management plans include

- o Apply polluter-pays principles to provision of estate services such as common waste treatment and disposal facilities,
- o Reward designs that prevent pollution before it is generated,
- o Provide clear procedures and lines of authority for dealing with both planned and unplanned events

Once individual industries are located on estates with shared treatment facilities, some plant managers may be inclined to shirk their environmental responsibilities The central management authority for the estate cannot and should not assume the full environmental liabilities associated with estate operations It must be a shared responsibility between estate managers and industries, with the obligations of all parties clearly understood

For example, central waste water and solid waste treatment and management facilities can have major advantages over individual facility treatment, such as economies of scale and more effective monitoring and control However, if the prices charged industrial users of these services do not reflect the their full cost, this is an open door to poor environmental management The pricing system established on each estate must therefore avoid providing subsidies for poor environmental performance

The assignment of responsibilities and authorities for environmental management is a critical issue Even under normal operating conditions, effective performance of a central waste-water treatment system can only be maintained if the pollutants in waste waters discharged to the system by industries on the estate are kept within the system's design limits It may be necessary for some users to pre-treat their wastes to avoid damaging the central system (e g , removal of heavy metals may be required) It is therefore essential that industrial users be closely monitored, that they maintain compliance with their pre-treatment standards, and that they take appropriate action when their standards are exceeded

Contingency planning is also essential All industries on an estate must have a clear understanding of their obligations when emergencies occur For example, malfunction of the central waste-water treatment plant can have catastrophic environmental impacts if industries on the estate are permitted to continue discharging wastes to the unit

Furthermore, individual facilities must have plans for responding to spills and leaks of hazardous materials or toxic wastes

Effective estate management policies and procedures should be reflected in each estate's environmental management plans, which should be tailored to specific estate conditions Figure 4-1 suggests the framework for such plans

6 3 INSTITUTIONAL RECOMMENDATIONS FOR IMPROVING INDUSTRIAL ESTATE SITING AND MANAGEMENT

This section provides an institutional approach to implementing the recommendations made above on ways to improve industrial estate siting and development This approach takes advantage of recent institutional changes made by the Government of Sri Lanka

The Government has recently established a Sectoral Committee, represented by M/ID, the Treasury, Department of National Planning, BOI, Labor Ministry, and the Urban Development Authority This Committee is charged with examining all newly-proposed industrial estates and industrial development projects

This central decision-making body provides an excellent mechanism to improve interagency coordination and planning, which should consequently alleviate a number of the problems described in Section 6 1 The following recommendations offer a framework for implementing an effective industrial estate planning and management program within this new institutional context

1 Improving coordination and sharing of data on industrial sector needs and interests

The lack of common or consistent information on the levels and types of industries that may be interested in locating in Sri Lanka is a serious obstacle to efficient estate planning There are a variety of sources of such market data, such as

- **Direct contact with potential investors** The most important source is information obtained through direct contacts at all levels of government with industrialists The RISCs have some of the most detailed data, but contacts between industrialists and officials at all levels of government are important The Sectoral Committee should sponsor regular industry-government forums, seminars, etc to increase such informal communication and information-sharing

- **Industry responses to investment solicitations** The responses of industry to government offers and advertisements, such as M/ID's recent requests for expressions of interest in industrial estates, constitute extremely valuable market data which should be compiled and published by the Sectoral Committee

- **Market studies** Selective surveys of industry interests and assessments of industry needs may be needed to supplement existing information Market studies may focus on particular industry sectors, specific geographic regions, or more generally on the overall business climate The Sectoral Committee should arrange for abstracts of

these surveys to be published and shared among all the government departments and agencies concerned with industrial development

Many agencies and institutions in Sri Lanka already collect and use such data These efforts should continue The Sectoral Committee can play an extremely valuable role in actively compiling this information and helping to ensure that it is shared among all agencies that have a stake in industrial estate planning and development

2 Expanding the Inventory of Potential Sites

In spite of the large number of industrial estates currently proposed for Sri Lanka, our study shows that very few are likely even to be marginally suitable for medium and high polluting industries Of the eleven sites evaluated in this study none could be considered ideal for such industries There is a growing need to develop an inventory of sites that are suited to particular industry needs This inventory does not currently exist, largely because under the existing siting process individual tracts of land are first selected, then evaluated in terms of their economic, environmental, and social attributes As sites are eliminated from further consideration for various reasons, there is little choice but to start the process of finding sites for analysis all over again

The fundamental problem with the current process is that it "puts the cart before the horse," i e , sites are selected before needs are defined The process should be carried out in reverse order, i e , define the needs and then select sites that have a reasonable likelihood of meeting these needs There are certain minimum requirements that will determine the likelihood of industrial development as well as the types of industries that will develop, including

- Size of available land,
- Access to raw materials,
- Access to markets,
- Characteristics of labor force,
- Water availability

Before individual tracts of land are selected for analysis, regional planners should conduct an initial screening process of their regions to assess how area resources mesh with industry requirements This process would not require a substantial amount of effort, and would save substantial time and resources by focusing further attention and analyses on those areas that are most likely to meet industry needs The planning activities that have been started as part of the Ministry of Finance, Planning, Ethnic Affairs, and National Integration's Southern Area Development Programme may provide a useful model

By establishing screening criteria that are fairly broad, a number of alternative candidate sites can be identified that subsequently can be evaluated and compared in an IEE or EIA By having a pool of alternative sites available for analysis, the likelihood of finding suitable sites will be greatly enhanced

The Sectoral Committee can play a valuable role by developing such a process and by facilitating discussions among regional planners who attempt to use this process In

addition, the Committee could assist regional agencies in defining and applying initial site screening criteria

3 Development of Effective Industrial Estate Management Plans

When evaluating individual estate proposals, the Sectoral Committee should closely examine the arrangements that are proposed for estate management, in particular provisions for sharing environmental management and oversight responsibilities among the industrial development agencies, CEA and local environmental authorities, estate developers, and individual industrialists These provisions are extremely important, they must be spelled out in detailed form, and carefully considered Some of the major issues that need to be addressed include

(a) How will liability for violations of the estate's Environmental Protection License be shared among the estate manager, the individual industries, any contractors, and the government?

(b) How will responsibilities for monitoring and the actual monitoring data be shared among the estate managers, individual industries, and the government?

(c) How will contingency plans for emergency response be developed and enforced?

(d) Who will bear the cost of environmental damage to the land and underlying ground water that may result from estate operations?

The study team reiterates its recommendation that the CEA or M\ETWA be included on the Sectoral Committee Through such inter-agency participation, issues can be resolved more quickly and more effectively

In conclusion, it is hoped that this industrial estates siting study has provided a constructive critique of current practices and that it also may help to improve those practices with the goal of more efficiently siting industries for economically and environmentally sustainable industrial development in Sri Lanka

ANNEX I

NAREPP STUDY TEAM MEMBERS

SRI LANKA INDUSTRIAL ESTATES SITING STUDY
1995

NAREPP TEAM MEMBERS

1	Dr Ajith de Alwis	Chemical and Industrial Process Engineer	University of Moratuwa
2	Dr S Bhuvendralingam	Water Quality Specialist and Environmental Engineer	University of Moratuwa
3	Mr John Butler	Industrial Environmental Management Specialist	Consultant to NAREPP
4	Mr M H Gunaratne	Socio-Economist	Consultant to NAREPP
5	Mr Sanath Ranawana	Environmental Economist and Planner	Consultant to NAREPP
6	Dr Robert Smythe	Ecologist and Environmental Impact Assessment Specialist	Consultant to NAREPP
7	Mr H D V S Vattala	Ecologist/Biologist	Consultant to NAREPP
8	Dr Sohan Wijesekera	Hydrologist and Water Resources Specialist	University of Moratuwa

ANNEX II

PROPOSED INDUSTRIAL ESTATE SITES INCLUDED IN THE STUDY

MINISTRY OF INDUSTRIAL DEVELOPMENT

INDUSTRIAL ESTATES SITING STUDY

PROPOSED SITES INCLUDED IN STUDY

SITE NAME	PROVINCE	DISTRICT	DIVISION
1 Bata-Atha	Southern	Hambantota	Ambalantota
2 Uragasmanhandiya (Yatagala)	Southern	Galle	Karandeniya
3 Waljapala watta	Western	Gampaha	Minuwangoda
4 Karanawan watta	N Western	Puttalam	Dankotuwa
5 Manaweriya	N Western	Puttalam	Arachchikattuwa
6 Tammanakele	N Western	Puttalam	Arachchikattuwa
7 Senapura	N Central	Anuradhapura	Ippalogama
8 Tambuttegama (Mahaweli)	N Central	Anuradhapura	Thambuttegama
9 Buttala (at Gamudawa Site)	Uva	Moneragala	Buttala
10 Mapakada (Viyanini Camp)	Uva	Badulla	Mahiyangana
11 Gemunupura	Uva	Badulla	Redimaliyadda

ANNEX III

SITE VISIT CHECKLIST USED TO EVALUATE INDUSTRIAL ESTATE SITES

II CURRENT AND PLANNED FACILITIES/SERVICES TO SUPPORT INDUSTRIAL DEVELOPMENT

Utility Sources Serving the Site:

Potential sources of electricity and existing capacity

Other energy supplies (e g , natural gas, fuel oil)

Potential water supplies and existing capacity

Potential telecommunications facilities

Refuse service

Sanitary sewer or septic system

Waste management facilities (including domestic solid waste and industrial solid waste facilities in region)

Public Services Available or Planned That Could Serve the Site

Fire protection

Police protection

Health care

Schools

Description of Transport Modes (Existing or Planned) That Could Serve the Site

Public roads

Rail service

Port facilities

Is site served by public transportation?

III PHYSICAL ENVIRONMENT

Surrounding Land Use Describe activities in areas adjacent to site, e g , housing, commercial, industrial, etc Include facilities with particular environmental sensitivity, e g , schools, hospitals, nursing homes, etc Identify significant pollutant sources in the area

Current Zoning of the Site -- Is there any? Does a Master Plan Exist?

Protected Environmental Areas Describe any National Reserve or Sanctuary, Wilderness Area, Forest Reserve, State Forest, or Village Forest, environmental protection area, botanical gardens, Man and Biosphere Reserve) located on the site or within one kilometer of its boundary

Geology/Hydrogeology Describe all available information, including stratigraphy, lithology, depth to groundwater, direction of groundwater flow, groundwater quality, locations of water supply and/or monitoring wells in area, uses of groundwater in area

Soils

Description of soils (i e , clay, sand, gravel, peat, muck)

If suitability/classification of agricultural soils is known, specify

Indications/history of unstable soils

Potential areas of erosion

Hydrology

Surface water bodies on or adjacent to site, and stream or river that it flows into (if appropriate)

Reservation area for the water bodies identified above, if any, and the act/regulation under which it is stipulated

Flow rate of water bodies (annual average, maximum, minimum)

Describe drainage patterns (attach sketch if required)

Description of available upstream/downstream water quality

Downstream water uses

On-site flood hazard potential on site

Coastal zones in vicinity of site

Noise

Qualitative assessment of ambient noise levels in vicinity of site

Current sources of noise in area

Air quality

Description of available air quality data in vicinity of site

Qualitative assessment of air quality on-site

Existing emission sources in vicinity of site

Meteorology

Precipitation (Maximum daily/monthly, seasonal average, annual average)

Predominant wind patterns (If wind rose is available, please provide)

Is area subject to frequent inversions?

Terrain features that affect local meteorology

IV BIOLOGICAL ENVIRONMENT

Flora — Identify predominant or major species of trees, shrubs, grasses, pasture, crop or grain, wet soil plants, water plants, etc)

Fauna — Identify predominant or major species of birds, mammals, fish)

Is the site part of a migration route? If so, when are migratory species present?

Is the site frequently traversed by wildlife?

Rare or Endangered Species

Briefly describe any sensitive wildlife habitats on site or within one kilometer of the site boundary, whether formally protected or not (include wetlands, forests, nature preserves)

IV. SOCIAL-CULTURAL ENVIRONMENT

Religious Sites

Religious sites that are currently in use on or in vicinity of site

Historical religious sites on-site or in vicinity of site

Historical and Cultural Resources

Archeological sites on-site or in vicinity of site

Historically significant sites on-site or in vicinity of site

Aesthetics

What is tallest structure in vicinity of site?

Note any scenic vistas that could be affected by industrial development on site

Recreational Resources

Note any designated and/or informal recreational opportunities in immediate vicinity of site

Socioeconomic Information in region affected by development on site, (existing and currently projected) Describe sources of information and suitability of data for supporting this analysis

Housing

Population (full time and seasonal)

Land Use

Planned Development Activities

Community Structure

Employment and Labor Market

Distribution of Income, Goods, and Services

Public Health Conditions

Education

Customs, Aspirations, and Attitudes of Local Populace

Land Use

Planned Development Activities

Community Structure

Employment and Labor Market

Distribution of Income, Goods, and Services

Public Health Conditions

Education

Customs, Aspirations, and Attitudes of Local Populace

V REGULATORY CONSIDERATIONS

Identify any regulatory programs in addition to GOSL requirements that could affect industrial development, e g , environmental, health and safety standards, land use controls, etc

VI OTHER COMMENTS

ANNEX IV

SITE RATING MATRIX AND RATING CRITERIA

INDUSTRIAL ESTATES COMPATIBILITY MATRIX 1995 Study Sites	Bata-atha	Buttala	Waljapala	Karanawan watta	Senapura	Yatagala	Tambuttegama	Manawerıya	Tammanakele	Mapakada	Gemunupura
ENVIRONMENTAL PARAMETERS											
Drainage/soil Stability											
Surface water availability											
Wastewater assimilative capacity											
Air quality											
Noise											
Solid waste disposal capacity											
Cultural/ religious resources											
Ecological resources											
Transportation availability											
Public utility availability											
Labor availability -- skilled											
Labor availability -- unskilled											
Community development capacity											
Site expandability											

ANNEX 4 – A

INDUSTRIAL ESTATES SITING PROJECT

CRITERIA FOR RATING PROPOSED SITES

This site rating scheme is primarily a qualitative system for comparing sites in the study, not for making absolute judgements about the merits of individual sites for industrial development Sites are rated lower in terms of their suitability for industrial development to the extent that they exhibit one or more of the properties listed under each numbered category, they are rated higher to the extent that they do not exhibit such properties

1 Drainage/soil stability

- Portions of the site are in floodplains of nearby flowing water bodies
- There is a high potential for "ponding" on site during high rainfall due to poor drainage contours combined with highly impermeable soils
- Soils do not provide a stable foundation for construction (e g, marshy, sandy, etc)
- Soils have high potential for erosion

2 Surface water availability

- Surface water supply is limited, as determined by assessing the volume of surface water available at or near the site on a daily basis during periods of low flow (net of current and planned consumption by other users in the watershed)
- Quality of water is unsuitable for sanitary or industrial process use

3 Wastewater assimilative capacity of surface waters·

- Receiving water bodies cannot assimilate industrial discharges without exceeding CEA standards, taking into account the dilution factor provided in the standards (Generally, water bodies with high flow, high ambient water quality would be rated higher than streams with low flow and/or poor water quality)
- Receiving water body has aquatic species (e g , prawns, fish, etc) that are especially sensitive to industrial pollutants

4 Air quality

- Site is in an area subject to frequent inversions
- Site is in area with poor ventilation (e g , in a valley or in an area with historically low wind dispersion
- Site is near sensitive receptors, such as hospitals, schools, and/or homes for the elderly

5 Noise

- Site is in an area where on-site noise could be amplified and thus carry over long distances, such as in a valley are on a wide water body
- Site adjoins residences, schools, or other occupied buildings that are near enough to be adversely affected by noise generated on-site
- Site adjoins areas that have high aesthetic, cultural, and/or religious values where these values could be adversely affected by noise generated on-site
- Site adjoins habitat of species that are particularly sensitive to noise

6 Solid Waste Disposal Capacity

- On-site hydrogeologic conditions are unsuitable for siting a landfill (e g , due to highly permeable soils, high water table, etc)
- Site does not have sufficient space for siting a landfill
- Existing solid waste disposal facilities in the area are unsuitable for accepting industrial solid wastes

7 Cultural/Religious Resources

- Religious, archeological, cultural, and/or tourist sites are located near enough to the site to be adversely affected by pollution and/or other effects of industrial activities on the site

8 Ecological Resources

- Flora and fauna on-site and/or off-site could be adversely affected by industrial development on the site
- Critical habitat on-site and/or off-site could be adversely affected by industrial development on the site
- Designated Environmentally Sensitive Areas (National Reserves, Wilderness Areas, etc) are located near the site

9 Transportation Availability

- Existing transportation infrastructure (i e , roads, rail lines, water ports) are insufficient to support industrial activities (i e , transportation of workers, transportation of raw materials and products)
- Existing public transportation service (i e , bus service, commuter train service) is insufficient for transporting workers to and from the site

ANNEX V

INITIAL SITE EVALUATION CHECKLIST DEVELOPED BY NAREPP TEAM

10 **Public Utility Availability**

- Existing utility infrastructure (i e , electricity, oil/natural gas, telecommunications, drinking water supply) is insufficient to support industrial activities

11 **Local Labour Availability**

- Potential base of skilled labour in the local community is insufficient to support industrial activities
- Potential base of unskilled labour is insufficient to support industrial activities

NOTE This parameter was later separated into two for site rating purposes a) Skilled Labour, b) Unskilled Labour

12 Community Infrastructure

- Existing and planned public services in the local community (e g , police protection, fire protection, health care facilities, schools) are insufficient to support additional demands from industrial development of the site
- Existing and planned housing in the local community is insufficient to support additional demands for housing that may be expected to result from industrial development of the site

13 Expandability

- Land immediately surrounding the site is unavailable for future expansion of the site, due either to natural barriers (e g , rivers and streams, mountains, etc) or manmade barriers (e g , adjoining lands are already developed, are restricted from development by zoning or special designation, etc)
- Existing and planned land use in area immediately surrounding the site is incompatible with industrial development

NOTE This parameter was added as a result of comments at a public meeting held prior to conducting the field evaluations

MINISTRY OF INDUSTRIAL DEVELOPMENT - SRI LANKA

INDUSTRIAL ESTATE SITE EVALUATION

LOCATION
DIVISION
DISTRICT
PROVINCE

	Signature	Name	Designation
PREPARED BY			

Director, RISC

Date

Developed by
USAID/Natural Resources & Environmental Policy Project
(NAREPP/IRG)

23

SURFACE WATER BODIES WITHIN FROM SITE 10KM ***RIVERS/STREAMS*** from which water is legally available for use River/Stream No				River/Stream No 1 Name	River/Stream No 2 Name	River/Stream No 3 Name	River/Stream No 4 Name	River/Stream No 5 Name
Distance from Site (in kilometers)	>5 0	1 0 5 0	<1 0	L M H	L M H	L M H	L M H	L M H
At the river/stream reach of observation (closest to site)								
Flow Characteristics	Perennial	Perennial but significant difference in seasons	Seasonal (Non Existent in one Season)	H M L	H M L	H M L	H M L	H M L
Average width (in meters)	>6	3 6	<3	H M L	H M L	H M L	H M L	H M L
Average depth of flow across a section (in millimeters)	>1 0	0 6 1 0	<0 6	H M L	H M L	H M L	H M L	H M L
Average Speed of Flow	Fast	Moderate	Slow	H M L	H M L	H M L	H M L	H M L
Down Stream Uses (amount of Usage relative to flow) Domestic (drinking washing bathing)	Large	Medium	Small	H M L	H M L	H M L	H M L	H M L
Fishery/wildlife	Large	Medium	Small	H M L	H M L	H M L	H M L	H M L
Drinking Water Supply	Large	Medium	Small	H M L	H M L	H M L	H M L	H M L
(Anicut Reservoir Pumping) Agriculture/livestock	Large	Medium	Small	H M L	H M L	H M L	H M L	H M L
Industries (including recreation)	Large	Medium	Small	H M L	H M L	H M L	H M L	H M L
Type of Water Use (Based on Water Quality)	Drinking/Cooking	Tourism/ Fishery etc	Washing/ Irrigation/No Use	H M L	H M L	H M L	H M L	H M L
Complaints about Water Quality	None	Saline Hard	Suspected to be Disease Causing/ Unsual Taste/Odour/Acidic	H M L	H M L	H M L	H M L	H M L

TANKS/LAKES/ESTUARIES from which water is legally available for use				Tank/Lake No 1 Name	Tank/Lake No 2 Name	Tank/Lake No 3 Name	Tank/Lake No 4 Name	Tank/Lake No 5 Name
Distance from Site (in kilometers)	>5 0	1 0 - 5 0	<1 0	L M H				
Water Spread Area (in Hectares)	>75	25 75	<25	H M L				
Avg Water Depth (meters)	>2 5	1 25 - 2 50	<1 25	H M L				
Maximum Water Depth (in meters)	>4 75	2 50 4 75	<2 50	H M L				
Period Reservoir Almost Dry (in Months)	0	0 6	>6	H M L				
Sufficiency of Water for Irrigation/other uses	Ample	Just enough	Inadequate	H M L				
Type of Water use (Based on Water Quality)	Drinking Cooking	Tourism Fishery etc	Only washing Irrigation No use	H M L				
Complaints about Water Quality	None	Saline Hard	Suspected to be Disease Causing/ Unusual/Taste Odour/Acidic	H M L				

GROUND WATER ACCESSIBILITY

Groundwater Aquifer (Specific Tests are required for Quantitative Assessment)				
Major type of soil at surface of site	Rocky/Gravelly	Clayey	Sandy/ Silty	L M H
Major Soil characteristic beneath the top layer of 300 millimeters	Impermeable	Moderate	Permeable	L M H
Annual Rainfall (mm)	>2000	1000-2000	<1000	H M L
Yala Rainfall (mm) (Apr - Sep)	>2000	1000-2000	<1000	H M L
Maha Rainfall (mm) (Oct - March)	>2000	1000-2000	<1000	H M L ———
Depth to groundwater from well observations at close proximity (average depth at site in meters)	0-4 5	4 5 -13 0	>13 0	H M L
Site in relation to other land	High	Similar	Low	L M H
Present Land Use	Settlements Urban/Village	Forest/Plantation Scrub/Grassland	Paddy Fields Wetlands	L M H
Type of groundwater use (Water Quality)	Drinking Cooking	Industry, etc	Washing/Irrigation/ No use	H M L
Complaints about groundwater quality	None	Saline Hard	Suspected to be Disease Causing, Unusual Taste/ Odour, Acidic	H M L
Present Groundwater use in the 2 km radius from site	High	Medium	Low	L M H

Steepest slope (rise in meters for a 100 meters distance)	>10	5-10	<5	L M H
Average slope (rise in meters for a 100 meters distance)	>10	5-10	<5	L M H
Major type of soil at surface	Rocky/ gravelly	Clayey	Sandy/Silty	H M L
Indications of soil erosion	High	Noticeable	None	L M H
Potential of erosion if land cover is removed	High	Moderate	Low	L M H
Angle of cut on a slope which may stand on its own without collapsing	$>60^0$	30^0-60^0	<30	H M L
Topography of site	Flat	Rolling	Hilly	H M L

SURFACE DRAINAGE

Steepest Slope (rise in meters in 100 meters)	>10	5-10	<5	H M L
Average Slope (rise in meters for a 100 meter distance)	>10	5-10	<5	H M L
Position of site related to other lands (elevation)	High	Similar	Low	H M L
Topography of site	Flat	Rolling	Hilly	L M H

SITE EXPANDABILITY

(Add Weightage factor specified in brackets)				
Extent of site (in ha)	>40	14-40	<14	HML
If less than 14 ha, provide additional 5L to the score				
Ownership	State/semi state/developer owned	State or semi state but encroached	Private/protected	HML
Equivalent value of land	Rural	Suburb	Town	HML
Current use of Land	Vacant	Partial use	Fully used/ Reserved area	HML
Availability of zoning/land use plan for the region	Yes	In preparation	No	HML
Existing/Planned land use of surrounding area	Not identified	Planned to be developed	Already developed/presence of sensitive systems	HML (3)
Terrain	Flat	Undulating	Hill/valley/flood plain	HML
Presence of minerals in significant quantity within 1 km of site	None	Moderate	Large	HML
			ADD	------

Infrastructure/distance from the proposed estate (km) (Add weightage specified in brackets)				
Power (from high tension line) (3)	<2	2-5	>5	HML (3)
Telecommunication	<5	5-10	>10	HML (1)
Pipe Borne Water Supply (2)	<2	2-5	>5	HML (2)
Surface Drainage (1)	<5	5-10	>10	HML (1)
Sewerage (1)	<1	1-2	>2	HML (1)
	x Weightage and Add	_____ _____		

TRANSPORT AVAILABILITY

Transport facility/distance from the proposed estate (km) (weightage)				
Roads Main(A&B or marked red on Topo sheet) (3)	<5	5 - 10	>10	HML (3)
Secondary (Marked yellow on Topo sheet)	<5	5 - 10	>10	HML
Railway line (2)	<5	5 - 10	>10	HML (2)
Airport (1)	<10	10-50	>50	HML
Port/Harbour (1)	<10	10-50	>50	HML
Bus Depots (3)	<5	5-10	>10	
Status of access roads (5)	good	moderate	poor	
		x Weightage and ADD	_____ _____	

Service/distance from the proposed estate (km weightage)				
(Up to A/L	<20	20 - 30	>30	HML (2)
Schools (Up to O/L	<5	5 - 20	>20	HML (2)
(2) (				
(Up to Grade 5	<2	2 - 10	>10	HML
Hospital Base	<20	20-30	>30	HML (3)
District	<5	5-20	>20	HML (2)
Rural	<2	2-10	>10	HML
Community Settlements (residential facilities) (2)	<5	5 - 10	>10	HML (2)
Banks (3)	< 5	5 - 10	>10	HML (3)
Police Stations (3)	<5	5 - 10	>10	HML (3)
Fire Stations (2)	<10	10-20	>20	HML (2)
Oil/Gas Storage facilities (2)	<5	5 - 10	>10	HML (2)
Hotels/Eating houses (2)	<1	1-3	>3	HML (2)
Recreational Facilities	<5	5-10	>10	HML (2)
Post Office	<2	2-5	>5	HML (2)
Communication Facilities (IDD, Fax, Photocopies)	<5	5-10	>10	HML (3)
			x Weightage and ADD ---- ----	

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LOCAL SKILLED LABOUR AVAILABILITY

In the D/S Division				
Daily wage (Rs)	>350	150-350	<150	LMH
Main occupational sector at present	Agric	Industry/ Craft	self	LMH
Unemployed Population in the age group of (16-55)	<1000	1000-2500	>2500	LMH
Unemployed Male/Female Ratio	0 9	0 9-1	<1	LMH
Level of Education				
Technical School	< 100	100-500	>500	LMH
University	< 5	5-10	>10	LMH
Post Graduate	< 2	2-5	> 5	LMH
Unemployment Condition	>12%	10-12%	<10%	HML
Apprentice training centre (within 20km)	<2	2-4	>4	LMH

In D/S Division				
Daily wage (Rs)	>200	100-200	<100	LMH
Main occupation at present	Agriculture	Industry/ craft	self	LMH
Male/female ratio of unemployment	0 9	0 9-1	>1	LMH
Population in the age group of (16-55)	<1000	1000-2500	>2500	LMH
Level of education				
Primary	<1000	1000-2500	>2500	LMH
Secondary	<700	700-1500	>1500	LMH
Unemployment Condition	>12%	10-12%	<10%	LMH

LIQUID WASTE DISPOSAL CAPACITY

SURFACE WATER BODIES WITHIN 10KM FROM SITE				River/Stream No 1 Name	River/Stream No 2 Name	River/Stream No 3 Name	River/Stream No 4 Name	River/Stream No 5 Name
Closest Distance from site (in kilometers)	<1 0	1 0 5 0	>5 0	HML	HML	HML	HML	HML
At the reach of (closest) observation during the period of flow								
Flow characteristics	Peranial	Peranial but significant difference between season	Seasonal (Almost non existent in one season)	HML	HML	HML	HML	HML
Average width (in meters)	>6 0	3 0 6 0	<3 0	HML	HML	HML	HML	HML
Average depth of flow in a across section of the river (in feet)	>1	0 6 1 0	<0 6	HML	HML	HML	HML	HML
Average speed of flow	fast	Moderate	Slow	HML	HML	HML	HML	HML
Downstream Uses (relative to flow) Domestic(drinking, washing,bathing) Fishery/wildlife Drinking water supply Ag (annicut, reservoir,pumping, livestock) Industries	 Large Large Large Large Large	 Medium Medium Medium Medium Medium	 Small Small Small Small Small Add	 HML HML HML HML HML --- ---	 HML HML HML HML HML --- ---	 HML HML HML HML HML --- ---	 HML HML HML HML HML --- ---	 HML HML HML HML HML --- ---
Type of Water Use	Irrigation and/or washing or no use at all	Tourism and/or Fishery and any other uses (except drinking and cooking)	Drinking and Cooking and any other uses	HML	HML	HML	HML	HML
Complaints	Suspected to be Disease Causing/Unusual Taste/ Ordour/Acidic	Saline/hard	None	HML	HML	HML	HML	HML

					Tank/Lake No 1 Name	Tank/Lake No 2 Name	Tank/Lake No 3 Name	Tank/Lake No 4 Name	Tank/Lake No 5 Name
Distance from site (in kilometers)	< 1 0	1 0 5 0	> 5 0	HML	HML	HML	HML	HML	HML
Water Spread area in hectares	> 75	25 - 75	< 25	HML	HML	HML	HML	HML	HML
Average water depth at centre of bund (in m)	> 2 5	1 25 2 5	< 1 25	HML	HML	HML	HML	HML	HML
Maximum water depth at centre of bund (in m)	> 4 75	2 5 4 75	< 2 5	HML	HML	HML	HML	HML	HML
Period of time when the reservoir is almost dry (in months)	0	0 6	> 6	HML	HML	HML	HML	HML	HML
Sufficiency of water for Irrigation/other uses	Ample	Just enough	Inadequate	LMH	LMH	LMH	LMH	LMH	LMH
Type of Water Use	Irrigation and/or washing or no use at all	Tourism and/or Fishery and any other uses (except drinking and cooking)	Drinking and Cooking and any other uses	HML	HML	HML	HML	HML	HML
Complaints	Suspected to be Disease Causing/Unusual Taste/Ordour/Acidic	Saline/hard	None	HML	HML	HML	HML	HML	HML

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Characteristics of land in the district (District Secretaries District)				
Characteristics of soil (general)	Impermeable	Moderate Laterite	Permeable Sand/Gravel	HML
Depth to ground water (in meters)	>5	1-5	<1	HML
Land use	No significant	Non Agric /non Food Use	Agriculture/ Food/High density groundwater use (urbanized)	HML
Utilizable Land area in the district (ha)	>160	40-160	<40	HML
Availability of Regional Solid Waste Disposal Facility	Yes	Partially	No	HML
Flooding potential	Low	Medium	High	HML

(System\distance from the proposed estate km)				
Forest reservation (in km)	> 5	1-5	<1	HML
Prime agriculture/Fertile land	>5	1-5	<1	HML
Upper catchment/recharge area	>5	1-5	<1	HML
Urban centre (town/city)	>5	1-5	<1	HML
Archeological sites	>5	1-5	<1	HML
Cultural/religious sites	>5	1-5	<1	HML
Coastal Zone as defined by CCD (including lagoons/estuaries)	>10	5-10	<5	HML
National parks/sanctuaries/botanical gardens	>5	1-5	<1	HML
Rivers/lakes/reservoirs	>5	1-5	<1	HML
Marsh/swamp/wetland (of significance)	>5	1-5	<1	HML
Tourist Resorts	>5	1-5	<1	HML

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ASSIMILATIVE CAPACITY OF AIR SHED

Geographical location	Hilly/Coastal	Flat	Valley	LMH
Cloud cover at night	Clear sky	Slightly cloudy	Cloudy	LMH
Wind speed	Strong	Moderate	Normal	LMH
Wind direction (during most of the year)	Uni-directional	change direction	No clear direction	LMH
Annual Rainfall (mm)	< 1000	1000-2000	> 2000	LMH
Average annual temperature (^{0}C)	< 30	50-30	> 25	LMH
Land use of the surrounding area (Within radius of 1km)	Forest	Open	Built up	LMH
Number of Smoke emission sources within 1 km	< 2	2-3	> 3	LMH
Position of site with respect to surroundings (elevation)	High	Similar	Low	LMH

Judicial Inst

(Within 0 5 km) of Site				
Religion, Cultural/Schools	0	1	>1	HML
School/Hospital	0	1	>1	HML
Land use of the surrounding area	Veget	Open	Residential	HML
Highways / roads	Major	Minor	Tracks	HML
Vegetation	Sparse	Bush	Thick	LMH
Geographical features surrounding the sites	Valley	Flat	Hill	LMH
Other noise generating activities	>3	1-3	0	HML

CULTURAL & RELIGIOUS RESOURCES				
Religious sites of national importance within 5 km of the site	>1	1	0	LMH
Cultural sites of national importance within 5 km	>1	1	0	LMH
Religious sites of local importance within 1 km	>3	2-3	<2	LMH
Cultural sites of local importance within 1 km	>3	2-3	<2	LMH
Any of the above on the perimeter				Yes/ No
Any of the above within the site itself				Yes/ No