Best Practices in Coastal Tourism Development
Red Sea, Egypt

PN-ADA-935

Compiled Summary Version

ENERGY MANAGEMENT

LANDSCAPE ARCHITECTURE

PLANTING

WATER & SANITATION

SOLID WASTE MANAGEMENT

Environmental Best Practices

RED SEA TOURISM DEVELOPMENT

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Comments and suggestions regarding this document are welcomed. Please bring any errors or omissions to the attention of the Tourism Development Authority/Red Sea Sustainable Tourism Initiative.

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Foreword

The Egyptian Tourism Development Authority (TDA) recognizes that the Red Sea natural environment is the main asset upon which all tourism activities rely. Understanding that any development or human activity may have negative impacts if not properly managed, TDA has developed regulations and legal requirements intended to prevent degradation of the natural environment. It is however TDA's policy when dealing with developers to encourage rather than discourage, provide incentives rather than penalize and guide rather than command.

In view of this policy and the advisory role we play, TDA, with funding from the US Agency for International Development (USAID) introduced the "Best Practices for Tourism Center Development along the Red Sea Coast" for the first time in 1998. That document introduced the main concepts of Best Practices in environmental planning and design of tourism destinations. It touched upon many topics of environmental concern and introduced the framework for tourism development and environmental protection.

Six years later, greater environmental awareness has emerged and more practitioners are seeking guidance. To fulfill these needs, TDA, through the Red Sea Sustainable Tourism Initiative (RSSTI), is introducing the ***updated version*** of the ***Best Practices Manual***.

The new Best Practices Manual, which is extracted from the comprehensive set of Best Practice manuals, is addressing key issues of environmental concern in the Red Sea region such as: Solid Waste Management, Water & Sanitation, Landscape Architecture, Landscape Planting and Energy Efficiency.

The ***new updated Best Practices Manual*** contains practical information to guide developers as well as practitioners in the field of tourism development during the development process of a tourism center or resort from the planning phase to design, construction and operational phases.

Finally, while TDA is introducing ***this updated version*** of the ***Best Practices Manual,*** is also committed to continually introduce and disseminate new technologies and best practices according to the new needs of developers and to cope with the latest innovations in the field of sustainable tourism. It is hoped that by issuing and publishing this manual, greater environmental awareness will be created encouraging all of us to protect the unique Red Sea environment.

Eng. Mohamed Magdy Kobaicy
Chief Executive Officer
Tourism Development Authority

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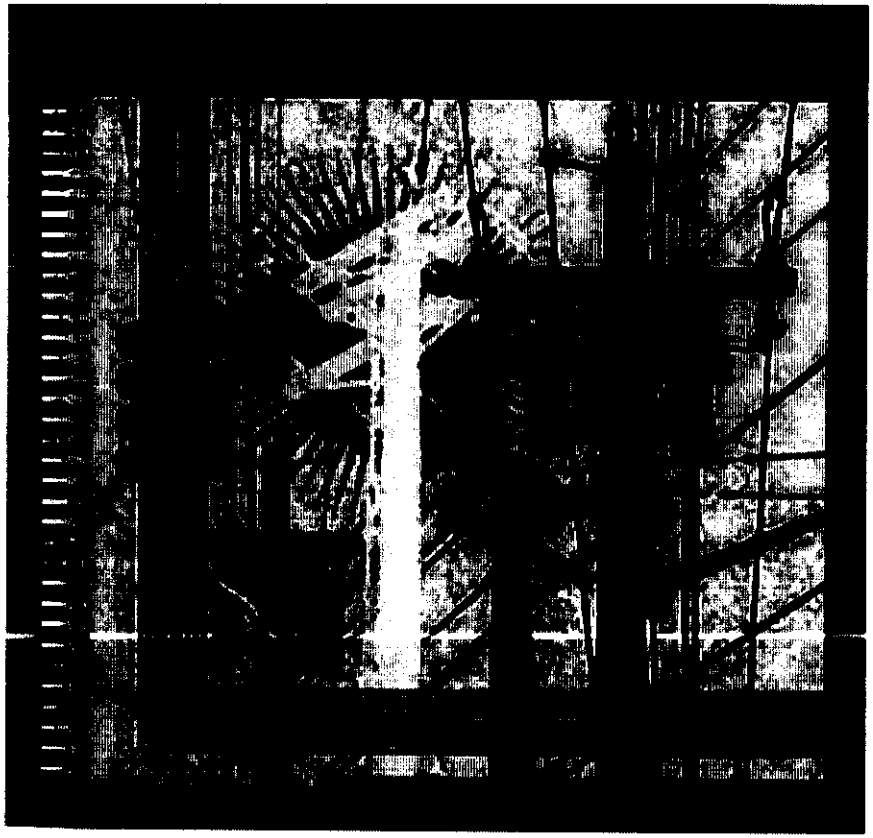
Environmental Best Practice For Red Sea Tourism Development

Executive Summary



PART A

A. Energy Management

B. Landscape Architecture

C. Landscape Planting

D. Solid Waste Management

E. Water and Sanitation Systems

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A

Energy Management

A-1 Introduction

A-2 Energy Efficient Buildings

A-3 Active Design Process Checklist

A-4 Rehabilitation Guide For Existing Buildings

A-5 Standards For High Energy Efficiency Equipment

A-6 Efficient HVAC systems and energy management Systems

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A-8 High-Efficiency Steam and Hot Water Systems

A-9 Energy Efficiency Benchmarking for Hotels and Resorts

A-1 Introduction

1-1 Background

Tourism on the Red Sea coast and Sinai represents one of the most active sectors in the tourism industry. According to the Tourism Development Authority (TDA), around 400 projects will be established in these two areas within the next three to four years. The estimated investment cost of these projects is around US$8 billion. The expected electricity demand will be above 1000 MVA and potable water demand will exceed 200 thousand cubic meters per day.

Since most of these new tourist establishments are away from the national electricity grid as well as potable water supply, they will rely on their own generation and desalination facilities. This represents an added investment and additional operating costs for these projects. Also these facilities will have an adverse impact on the environment due to their harmful emissions and discharges.

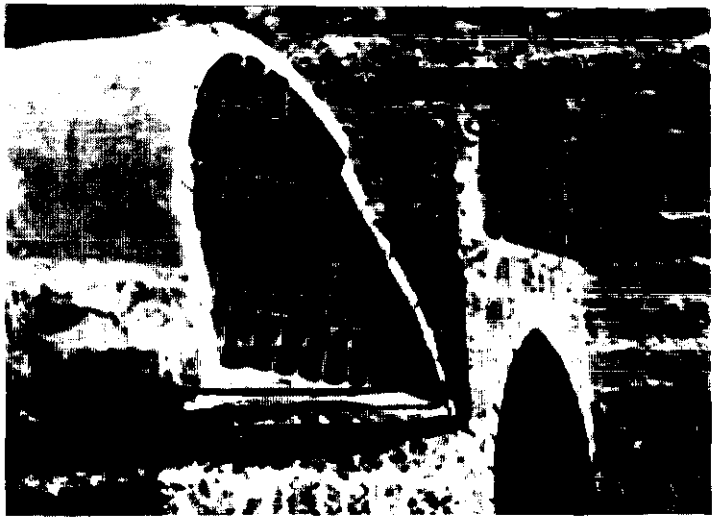
1-2 Benefits of Improved Energy and Environmental Management

There are multiple benefits from improving energy and environmental management in tourism establishments:

- Reduced consumption and reduced costs
- Customer loyalty and enhanced public image
- Attracting and retaining dedicated staff
- Long-term business benefits

Studies have shown that most hotels use energy inefficiently. The reasons behind this are due to not paying enough attention to energy requirements during the design phase, not considering the energy consumption of selected equipment during the procurement phase, or lack of energy management during the operational phase. Air conditioning, lighting and water pumping represent the main three activities demanding electrical energy in the hotel business. Special attention is given to these demands. Design and selection as well as efficient operation requirements are presented and assessed.

Guidelines and considerations for efficient operation of hot water/steam generators are presented to address the thermal load requirements of hotels, which are represented in hot water for domestic use and steam for the laundry



Climate responsive building

A-2 Energy Efficient Buildings

2-1 Active design Approach

In the past, buildings were constructed using passive measures primarily because of the lack of energy supply resources. After electricity was discovered and became easily available, reliance on active measures such as electric lighting, ventilation and air conditioning gained predominant use. They represented an easy and quick means of satisfying comfort concerns in buildings. It became possible to create building environments that are totally controlled and divorced from their surroundings.
In this process architecture lost its connection to place. Also less attention was paid to the operating costs of these buildings.

This led to a trend in building design that could be called the passive approach. In this approach, an architect generally designs a building and an engineer will afterward try to adapt the building to its surrounding climatic conditions. In most cases this entails the use of active measures (e.g., mechanical ventilation and/or air conditioning) in all spaces without much concern for energy consumption.

As it became known that energy from fossil fuels is limited and they will be depleted eventually, and as the environment became a concern, energy consumed in buildings to maintain these new environments was seriously addressed. An active design approach has now emerged. In this approach close professional cooperation between architects and engineers is a prerequisite. It is a continuous and interactive dialogue, which starts

during the early design phase and continues throughout the different project phases.

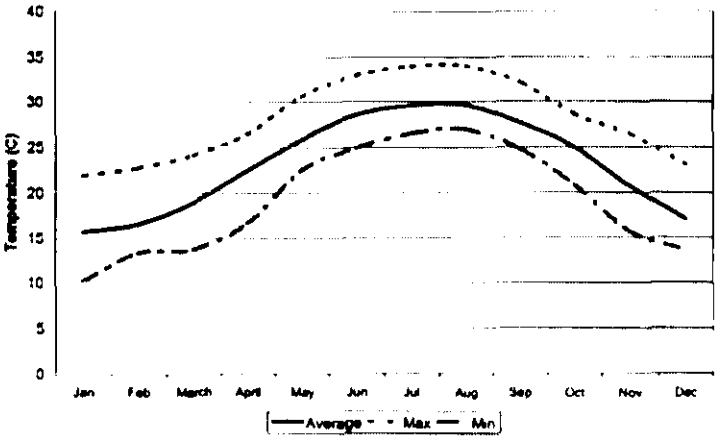
In the active design approach thermal evaluations of the architect's designs are made throughout the design process. This includes both static and dynamic analyses. This will enable the architect to assess the impact of using passive energy measures in his design to reduce the reliance on active measures. Throughout the aforementioned dialogue a combination of active and passive measures can be developed as a compromise for a difficult site. Active design also relies on the thermal properties of a building's envelope to create a protective barrier against the external environment. For instance, in hot and dry climates a building envelope with high external reflective properties (to minimize the impact of Solar radiation) and high thermal storage capacity (to balance the variations in temperature) is desirable. Also controlled ventilation (i.e., ventilation during the night only) and natural cooling methods must be used to provide additional approaches to maintaining the desired internal comfort conditions. Opening up the building envelope for daylight is a critical issue in an active design process in order to serve contradictory principles: to avoid heat gains coming through the openings and at same time to minimize energy consumption for artificial lighting.

Active architectural design is site specific and depends on the climate, topography and geography of the site. In addition, it also depends on the financial, economic and social conditions of the site.

2-1 Climatic Parameters for Active Design

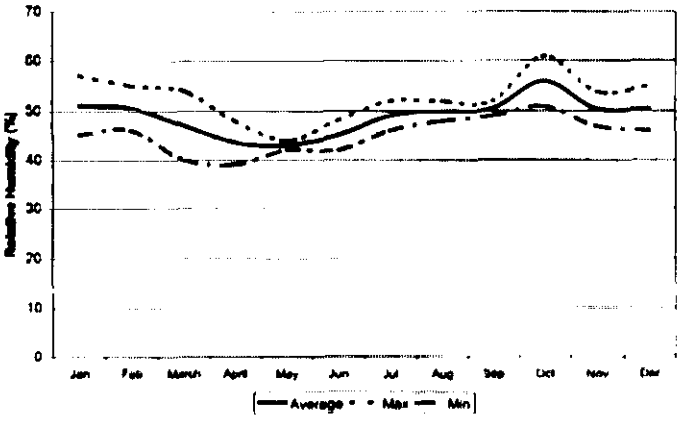
The following climatic parameters should be evaluated for an active

Average Temperatures for Hurghada*



Average data for 330 months between 1951 and 1990 (RSSTI)

Average Relative Humidity for Hurghada



Average data for 330 months between 1951 and 1990 (RSSTI)

Average rainfall (mm)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
0.1	0.4	1.0	0.1	0.1	0.0	0.0	0.0	0.0	0.2	0.4	1.2	3.5

Average data for 330 months between 1951 and 1990 (RSSTI) .

Average Hours of daylight

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
9	10	10	10	10	13	13	12	11	10	9	8

Average data for 330 months between 1951 and 1990 (RSSTI) .

Average direct normal solar radiation (kWh/m^2/day)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Anuual
5-9	6-7	5-7	6-7	5-6	6-7	6-7	6-7	6-7	6-7	5-7	5-7	5-7

(NREL)

Average wind speed and direction

Speed (m/sec)	N	NNE	ENE	E	ESE	SSE	S	SSW	SWS	W	WNW	NNW	All Directions
0-5	7%	4%	1.2%	1%	1.5%	1.8%	1%	0.6%	0.6%	6.4%	23.4%	7%	55.5%
5-10	8.7%	0.5%	0.1%	0.1%	0.1%	0.2%	0.1%			1%	12%	20%	42.8%
10-15				0.1%				0.1%				0.1%	0.3%
>15		0.1%	0.1%	0.1%									0.4%
All speeds	16%	5%	1%	1%	2%	2%	1%	1%	1%	7%	36%	27%	99%

Average data for 330 months between 1951 and 1990 (RSSTI) .

design:

- Solar radiation
- Air temperature
- Humidity
- Wind
- Precipitation

In addition to the climatic parameters there are other parameters that influence the climate. These parameters include:

- Site topography
- Ground cover and vegetation
- Water covered areas
- Building densities

Solar radiation includes direct and indirect solar radiation. Direct solar radiation is the component of radiation received directly from the sun. Indirect solar radiation includes both diffused and reflected solar radiation. Diffused solar radiation is the radiation received from the whole sky vault (i.e., the sky, clouds and atmosphere) and it does not have a specific direction. Reflected solar radiation is the radiation that is reflected from the ground and other objects (e.g., other buildings).

The climatic data can be obtained from the metrological agency where average data over several years are usually available. The effect of other parameters on the microclimate such as ground cover and vegetation, water covered areas and building densities are usually assessed through specialized computer programs that evaluate these parameters.

A-3 Active Design Process Checklist

This checklist highlights the points of concern to ensure an energy efficient design in new buildings. The checklist can be used as a basis for evaluating the proposed design regarding its integration with the surrounding environment. The owner or investor can use this checklist with his/her architect or consultant.

3-1 General Checklist

Location

- Consider the optimum microclimate effects from site design
- Minimize exposure to solar radiation
- Consider exposure to cooling breezes

The built environment

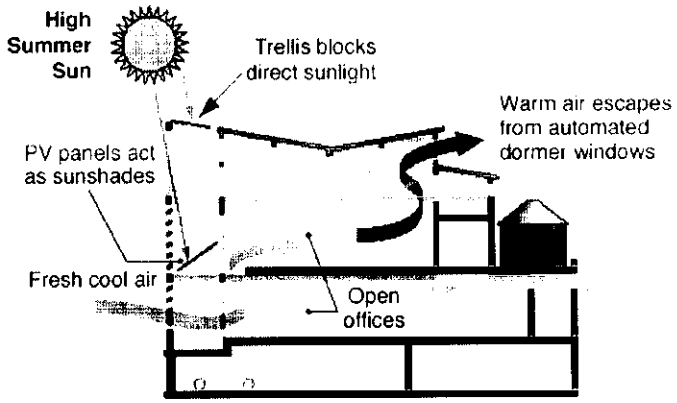
- Consider the grouping of buildings
- Optimize orientation for solar protection and wind direction
- Consider the density and surface-to-volume ratio of buildings
- Consider building depth and spacing
- Consider urban landscaping and vegetation as well as pedestrian networks

The external environment

- Ensure that external spaces are comfortable (e.g., shaded) and landscaped to reduce heat gains and maximize air flow through buildings
- Design landscaping that assists in microclimate management to reduce energy use .

Vegetation improve micro climate and reduce glare

Use of shading on the building



South windows accept indirect sunlight to light building interior without heating it

Internal planning

- Plan and zone according to function, occupancy levels, and time of use .
- Plan to minimize the number of different thermal zones
- Identify particular functions or uses requiring special conditions, control or monitoring; deal with them separately or in zones rather than raising the servicing and energy consumption of the building as a whole
- Plan for flexibility for future changes

Thermal response of building envelope

- Design openings to reduce solar gains, and to maximize day lighting and air flow
- Select materials, construction and finishes to give optimum thermal response and reflect occupancy patterns
- Design the building envelope and components to make thermal control as easy as possible
- Maximize heat removal through the envelope by natural ventilation and cooling aids
- Provide ventilation provisions that are climate responsive and reflect the time of use, function and occupancy levels of a building
- Consider appropriate air movement patterns
- Consider positioning, size, treatment and use for openings designed for ventilation purposes

Controls

- Design a building envelope that allows control and adaptability in response to climatic variations

- Design openings that are operable to control internal air flow
- Design protection for openings to provide flexibility to regulate heat gains and day lighting levels depending on the position of the sun

Allowance for future changes

- Internal planning
- Building envelope
- Service installation

3-2 Detailed Checklist

External openings

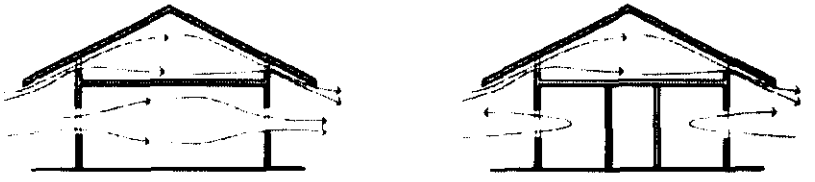
- Location, sizing and treatment that will maximize ventilation and minimize solar heat gains
- Location, sizing and treatment to maximize natural lighting and minimize glare
- The provision of shading devices and other forms of sun protection
- The provision of air inlet and outlet openings in the roof cavity and walls for heat dissipation

Building envelope

- Materials and construction selection: climate responsive and control heat entry and removal
- Consider all potential areas where air gaps and thermal bridging may occur

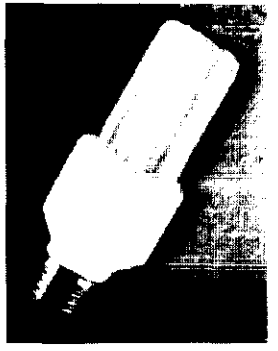
Ventilation and cooling provisions

- Check zoning



Provision of air inlet and outlet opening in the roof cavity

Provision of shading for direct sun protection



Use energy efficient Lamps

Consider task lighting rather than general illumination

- Check that the building envelope is designed to optimize ventilation and cooling possibilities
- Select and locate appropriate ventilation and cooling devices and systems so that they respond to specific and changing climate conditions
- Provisions for appropriate operation: user control or management control
- Mechanical ventilation should be used to compensate only for climate impacts rather than poor building design

Control internal heat sources

- Minimize casual internal heat gains from lighting appliances and occupancy to avoid internal over heating
- Artificial lighting should be zoned, controlled and activated in areas where and when there is a need for light
- Minimize heat release from appliances (e.g., refrigerators) and other equipment (e.g., computers) by selection made on the basis of energy efficiency
- Minimize heat gains from occupants; consideration at the design stage of possible occupancy levels of each room and the range of activities
- Adequate ventilation of densely occupied spaces
- Consider zoning/grouping high-grade heat sources for better energy management

Lighting installation

- Use minimum illumination levels and consider task lighting rather than general illumination
- Use energy-efficient lamps and luminaries
- Consider time and intensity controls
- Use light-colored internal finishes to improve lighting conditions

Design detailing and documentation

- Ensure that appropriate materials are specified and construction is properly dimensioned to avoid over sizing
- Ensure that documentation states all requirements for commissioning, testing, handover, occupation and maintenance
- Provide user education through manuals/training
- Allow for the potential of future changes to the building

Design feedback

Designers should return to learn the opinions of occupants, observe performance and to take spot measurements where appropriate to adjust building performance and for future design reference.

3-3 Design and Checking Tools

There are various tools at the disposal of a designer that can be used to check design decisions.

Simple analysis

Solar charts provide a comprehensive and easy to use design aid for the prediction of solar radiation exposure and shading of a building. *Mahoney tables* are used to arrive at a series of performance specifications.

Computer modeling

- A number of computer programs are available to predict design performance. The capacity of the programs is becoming more and more advanced, which will make future physical modeling less necessary.

A-4 Rehabilitation Guide for Existing Buildings

When making rehabilitation decisions, certain conditions cannot be altered, for example, the location and orientation of buildings.Others can prove costly or difficult to change, such as the size and positioning of openings. However, individual components in the urban and building environment can be altered and modified to reflect specific climatic characteristics. Each decision regarding rehabilitation should be done in relation to specific climatic conditions, the changed function, or the time of use or occupancy levels of internal and external spaces, and in relation to how these decisions will impact on parts that remain unaltered.
Rehabilitation possibilities that can be incorporated at various levels are presented below.

4-1 Rehabilitation Considerations

Location

- The location of other elements can be used to affect the microclimatic conditions of an existing building
- The location of shelterbelts and manipulation of land contours can be used to alter wind forces in both direction and velocity.
- If the rehabilitation of an existing building involves the addition of new buildings, they can also be sited to alter the microclimate that surrounds existing buildings (e.g., their exposure to solar radiation and air movement).

Orientation

- The orientation of an existing building cannot be altered, but measures can be taken to design according to orientation when a building is being rehabilitated.
- For changing the use of a building: the function and use of internal spaces should be related to orientation. For example, rooms used in the afternoon and evening can be located facing in an easterly direction.
- For addition of components to the building envelope: the design of additions and alterations made to the building envelope should be related to orientation.

Urban environment

- Pedestrian networks
- Existing urban spaces
- Building facades

Built environment

- Examine whether the surface-to-volume ratio and the density are suited to the climatic conditions.
- Secondary elements such as verandas and colonnades to reduce heat gains.
- Incorporate landscape strategies that can alter the surrounding condition of a building
- Rehabilitation of the existing external space to assist in microclimate management at the urban and building scale.
- Water, planting and enclosure devices such as walls can be used to create pleasant and usable outdoor spaces.
- Enclosing spaces so that they can be managed and, by alteration of

microclimate, improve airflow.

- Planting tall trees with high canopies

4-2 Building Envelope

Roof

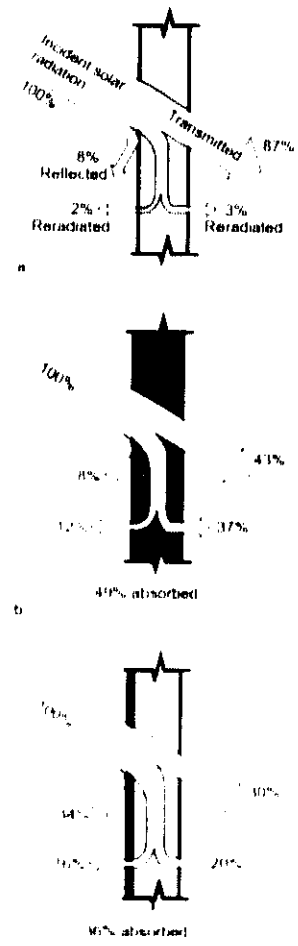
- Roof forms can be rehabilitated to reflect internal functions, orientation and climate characteristics.

Investigate the potential for the following:

- use of composite or two separated roof structures.
- addition of a ceiling to create a composite structure.
- landscaping strategy that directs airflow across the external surface of the roof for cooling.
- Installing wind-catching devices to control the roof cavity or wind-catching structures to cool the internal spaces.
- Including air inlet and outlet openings to cool a roof cavity or reduce undesired heat transfer from the roof.
- Select materials based on climate characteristics, function and time of use of the internal space and according to how they will affect the existing conditions.

Walls

- The rehabilitation of walls should reflect the function and use of rooms adjacent to them and their orientation.
- Investigate the possibility of rehabilitating an existing wall into a composite wall as a means of reducing solar radiation impact.
- Investigate the potential of incorporating ventilation openings in new walls to act as a cooling mechanism.



Examples of heat transmittance through: a. ordainary glass b. absorpitive glass and c. reflective glass.

- Investigate the incorporation of secondary wall elements to reduce solar radiation impact such as verandas and colonnades.
- Reduce heat gains (and glare) affecting the walls by a landscaping strategy such as shade planting and groundcover selection.
- Select materials based on climate characteristics, orientation, function and time of use of the internal adjacent spaces and study how they will affect the existing conditions.

Floors

- Select materials to improve internal comfort conditions such as hard cool surfaces or light materials and openings.

Openings

- Openings should be designed according to the detailed checklist for new buildings.
- Addition of shading and protection devices for existing outside of openings.
- Shading devices such as louvers can be adjusted and can alter the direction of airflow and lighting.
- Select materials for shading devices that will reflect heat rather than be an added heat source.
- Select glass that can reduce heat gains by absorbing or reflecting heat.

Air gaps and thermal bridges

- Investigate the whole of the building to ensure that there is no uncontrolled heat entry from air gaps and infiltration.

Materials

- Choices of materials should reflect climate characteristics, orientation, internal building functions and how they react in relation to existing materials and building elements.

Internal Building Provision

- Control internal heat sources and lighting installation.

4-3 Ventilation And Cooling Provisions

- Ensure that appropriate ventilation levels are provided to reflect climate characteristics, functions, and time of use and occupancy levels of individual internal spaces.
- Incorporate structures or devices for structural cooling and ventilation purposes.
- Regulate openings to encourage the stack effect.
- Ensure that internal partitions do not impede internal airflow.
- If new building elements are introduced, investigate the possibility of combination solutions such as use of a staircase to create stack and venturi effects.
- Investigate the need for a means of supplementary natural ventilation or simple mechanical devices that can be used when wind speeds are low and for structurally cooling components of the building envelope.
- Investigate the use of solar-powered systems to run mechanical devices.
- Use a landscaping strategy for evaporative cooling of external and internal spaces.

A-5 Standards for High Energy Efficiency Equipment

Energy efficiency is related to the design of equipment that consumes energy as well as the operational conditions of this equipment. In other words, it is related to the equipment's efficiency as well as how this equipment is being used efficiently. If the equipment being used is not efficient, regardless of optimization of operational conditions, the system will suffer low efficiency. Therefore, proper selection of equipment with the highest possible efficiency is one of the key decisions to ensure an energy efficient system.

5-1 Labels for Energy Efficiency

Labels for energy efficiency are used to specify the consumption for energy consuming equipment. This label is usually fixed on the equipment in the case of large units such as refrigerators and air conditioners or printed on the packaging as in the case of electric lamps. The label usually contains information of concern to the customer, which help to differentiate between the different models to identify the most efficient one. Therefore, these labels include a standard scale where the corresponding efficiency of the equipment is identified on this scale. Letters usually identify this scale, where the category "A" refers to the most energy efficient equipment.

Egypt has adopted a labeling system for both air conditioners and refrigerators. This labeling system is applied for all locally manufactured and imported units. This system was designed to take into consideration the prevailing environmental conditions. The labeling system will be implemented starting in 2003. However, the minimum efficiency levels will be obligatory starting from 2005.

The approved label for air conditioners includes information regarding the brand, model, capacity, and a scale for the Energy Efficiency Ratio (EER) categorized into five levels designated by letters. The energy efficiency ratio (EER) is the ratio between the cooling capacity in British Thermal Units (BTU) and electricity consumption in watt hours. The labeling system covers a cooling capacity up to 36,000 BTU hours for the window type and 65,000 BTU hours for split units. The minimum accepted EER for the window type was set at 8.5 BTU/watt hours and the minimum accepted EER for the split units was set at 9 BTU/watt hours.

For refrigerators and freezers, the label also includes information regarding the defrost system. The scale for energy efficiency was identified as the annual electricity consumption per cubic feet of the refrigerator. This means that class "A" will have the lowest value, or the highest efficiency, while class "E" will have the highest value, or the lowest efficiency.

Table 5-1. Minimum efficiency values for operating deep well pumping systems

Input Power Intervals		Electromechanical Efficiency (%)
kW	hp	
5.6 - 14.9	7.5 - 20	52
15.7 - 37.3	21 - 50	56
38.0 - 93.3	51 - 125	60
94.0 - 261	126 - 350	64

Table 5-2. Minimum efficiency values for submersible pumps

Pump Capacity L/s	Electromechanical Efficiency (%)
up to 2.0	48
over 2 up to 5	61
over 5 up to 15	71
over 15 up to 25	72
over 25 up to 30	74
over 30 up to 60	77
Over 60	78

5-2 Standards for Pumps

Pumps are used extensively in hotels and resorts. Water pumping is necessary to supply domestic water. Also submersed or deep well pumps are used to pump saline water from the well to the water desalination plant. These pumps consume large quantities of electrical energy since they operate for a large number of hours. Specifications have been developed for the minimum efficiency of these pumps to ensure their efficient operation and minimize the consumption of electrical energy.

5-3 Standards for High-Efficiency Equipment

Different types of equipment used in the hotel business include chillers and air conditioning units, boilers and water heaters as well as energy dissipation equipment such as heat exchangers and cooling towers. Water chillers in the central air conditioning system along with the lighting system represent the main demand for electrical energy in hotels and resorts. Regarding fuel consuming equipment, units such as steam and hot water boilers are responsible for most of the hotel's demand for fuel. The thermal to electric ratio of a hotel is usually on the order of one. Accordingly, a hotel that has a demand of 1 MW will consume around 110 kg of oil equivalent per hour (around 122 liters of # 2 oil per hour, which is the fuel commonly used in the Red Sea area). Therefore, the first step to conserve energy is considering the energy efficiency of the selected equipment for space conditioning as well as hot water and steam supply.

Because Egypt currently does not have energy efficiency standards,

standards applied in California in the US were selected because they are advanced and were recently updated, and were developed for an area with similar environmental conditions. In 2001, the California Energy Commission adopted the AB 970 Energy Efficiency Standards for Residential and Nonresidential Buildings,[1] which outline minimum efficiency requirements for air conditioner and heating equipment as well as heat dissipating equipment.

Table 5-3. Reference values for efficiency of motors

Motor kW	Motor hp	Efficiency (%)
up to 1.5	up to 2.0	68
Over 1.5 up to 2.2	over 1.5 up to 3.0	72
Over 2.2 up to 3.7	over 3.0 up to 5.0	73
Over 3.7 up to 5.6	over 5.0 up to 7.5	75
Over 5.6 up to 7.5	over 7.5 up to 10	77
over 7.5 up to 11.2	over 10 up to 15	79
over 11.2 up to 14.9	over 15 up to 20	80
over 14.9 up to 22.4	over 20 up to 30	81
over 22.4 up to 29.8	over 30 up to 40	83
over 29.8 up to 44.7	over 40 up to 60	86
over 44.7	over 60	87

[1] For a copy of the standards, see http://www.energy.ca.gov/title24/

A-6 Efficient HVAC Systems and Energy Management Systems

The purpose of a Heating, Ventilation and Air Conditioning (HVAC) system is to provide and maintain a comfortable environment within a building for occupants. The four main functions of an HVAC system are to control temperature, humidity, air distribution, and air quality. According to the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), typical design conditions are as follows:

- Temperature: 23oC
- Relative humidity: 50%
- Air movement: 0.15-0.25 m/s
- Ventilation: 7-9.5 L/s outside air per person or CO2 concentration less than 1000 ppm

For hotels and resorts the electric demand of the HVAC system represents 40% of the peak demand and around 20% of annual electric energy consumption. According to the prevailing environmental conditions in the Red Sea coast, the main function of the HVAC system is to provide cooling rather than heating. Cooling is usually required for around 5500 hours per year. Accordingly, the energy efficiency of the HVAC system represents one of the main challenges for efficient operation of a hotel or resort

6-1 Thermal Loads

The HVAC system is required to provide cooling/heating to compensate for the effect of:

- Heat as well as humidity generated by inhabitants,
- Heat transferred through the building shell,
- Heat due to the lighting system or direct sun radiation through windows and openings,
- Heat carried out by infiltrated air through openings or leaks as well as ventilation, and
- Heat generated by any existing machines such as refrigerators or computers.

6-2 Types of HVAC Systems

The HVAC system could be either a central or distributed system. For the central systems, central chillers are used to provide chilled water, usually on the order of 6oC. Water is pumped by the chilled water pump to air-handling units, which are located close to the demand points. Air-handling units include fans, which drive the air over the chilled water coil. Accordingly, air temperature is reduced to the required degree. Air is introduced to the conditioned space through a set of distribution ducts and well-placed outlets. The ventilation system draws back the air from the conditioned space through draft fans. The drawn air is re-circulated after being mixed with fresh air to control its quality as well as to maintain its temperature.

It is important to mention that the same operational principle is valid in the case of heating. The only difference is that hot water is being pumped instead of chilled water. A water heater, or a boiler through a steam/water heat exchanger, is used to provide this hot water. Sometimes an electric coil (heater) is used instead of the hot water coil. For humidity control steam is injected into the air to achieve a comfortable humidity level.

The central system described above is known as an air/water system. Another alternative among the central systems is known as the all-water system. In this system water is pumped to a set of fan coils instead of air-handling units. These fan coils are located in the conditioned space. A fan coil is simply a water coil and an air fan to circulate the air over the coil.

Air handling Units

Fan Coil (Internal View)

The third alternative among the central systems is the DX system where air is cooled by passing it over a refrigerant coil. No chilled water is used. Consequently the system does not include air-handling units. Cold/hot air is driven to the conditioned space through a duct system with well-placed outlets.

The distributed systems consist of small separate units. These units could be window type air conditioners, split units, or small DX units. Central systems are more efficient than the distributed systems due to their reliance on larger units, which are usually more efficient. On the other hand, distributed systems enjoy operational flexibility and less initial cost.

6-3 Components of HVAC Systems

The main components of a central HVAC system are:

- Chillers,
- Cooling towers,
- Chilled water pumps and piping systems,
- Air distribution ducts and outlets, and
- Control and energy management systems.

A distributed system typically consists of either window type or split unit air conditioners, which are installed directly in the conditioned space.

It is important to mention that a mixed or hybrid system could be used. This may consist of central system for the main building of the hotel or resort and a distributed system for chalets and bungalows.

Chillers

Chillers are the main energy-consuming units in the system. Chillers can be classified into three types, which are described below.

1) Vapor compression chillers, which use refrigerant such F 22 or 134a.
2) Absorption chillers, which use water as a refrigerant and absorbent liquid to control the necessary vacuum in the cooling cycle. This absorbent is regenerated using heat. The heat is provided in the form of hot water, steam, or direct fire.
3) Hybrid systems.

Cooling Towers

Cooling towers are used to provide the necessary cold water for the closed cycle cooling system of water-cooled chillers. A cooling tower works on the principle that when a part of a hot water stream is evaporated it will draw the necessary heat for evaporation from the rest of the water. This will lead to a reduction in the water temperature.
Great attention should be paid to the treatment of the cooling water in the cooling tower. Badly treated cooling
water or insufficient blow-down will lead to scales precipitation in the cooling system, which will affect its efficiency and increase the energy consumption of the chiller. On the other hand, exaggeration in blow-down will lead to loss of treated water. This will increase the operational cost of the cooling tower due to the increase in the make-up water. Cooling towers are necessary for water-cooled chillers, which are recommended for high chiller efficiency; however cooling towers have

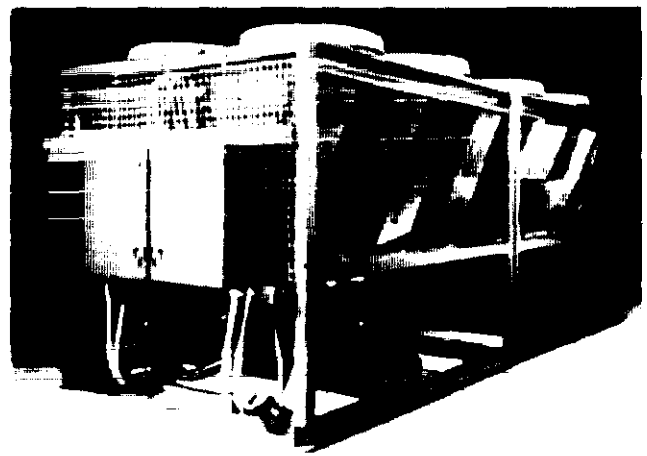
their operation and maintenance demands. Therefore, using sea water for cooling the chillers may be one of the best options for chiller cooling. This can be done either by specifying the chiller to be a sea-water-cooled type (similar to chillers used in ships), or using a primary fresh water cooling circuit, which is cooled using sea water using an additional heat exchanger. This arrangement will provide a supply for the cooling water as well as improve the operation of the water desalination system through supply water preheating.

Chilled Water Pumps and Piping Systems

Chilled water pumps and piping represent an important part of the central HVAC system. The piping system diameters as well as design should maintain a minimum pressure drop. Also the system should be well insulated to reduce heat loss. The pumps should be properly sized to ensure operation at or close to their design points. Also the pumps should be a high-efficiency type and their driving motors should be high-efficiency motors.

Air Distribution Ducts and Outlets

The air ducts may extend through unconditioned areas or outdoors of the conditioned space. Insulating these ducts is of great importance to avoid heat loss (in the case of heating) and heat gain (in the case of cooling). Also insulation of the return passage air is important to reduce the load on the chiller.



Water Cooler Vapor Comp. Chiller

Air Cooler Vapor Comp. Chiller

6-4 Control and Energy Management Systems

An energy management system can save energy by eliminating manual control and providing a continuous level of control that cannot otherwise be achieved. Several control strategies include the following:

- Time control
- Use of occupancy sensors
- Optimum start and stop
- Duty-cycling with temperature reset
- Other temperature-based control schemes
- Control of the peak demand

Temperature Control Strategies

Several temperature control strategies can be used. These include:

- Vary the temperature of the supply air to the space while keeping the airflow rate constant. This is known as the constant volume, variable temperature approach.
- Vary the airflow rate while keeping the supply air temperature constant. This is known as variable volume, constant temperature approach.
- Vary the supply air temperature and flow rate. This is known as variable volume, reheat system.

Energy Storage

Energy storage is not an energy efficiency application. It is considered a demand side management application. Demand side management includes actions that are taken to reduce the peak demand of a load (i.e., HVAC system). Since the demand on the HVAC system is changing over the day hours, it is possible to homogenize this demand through storing cooling/heating energy during low demand hours and reusing this stored energy during peak demand hours. This will increase the demand slightly during the low demand hours, while reducing it during the high demand hours. Several storage media are available, such as chilled water, ice, or eutectic salt. The feasibility of this system depends very much on the site as well as operating conditions and the cost of electricity.

6-5 Guide for Energy Efficient HVAC Systems

Reduce load from the building shell

- Be careful of over-sizing the system and compare your designed demand with similar operating facilities.

Energy efficient chillers

- Use a water-cooled chiller whenever possible instead of an air-cooled chiller.
- Use feed water to the desalination unit for cooling the chiller if it is available.

- Use a sea-water-cooled chiller whenever it is permitted if a desalination unit is not available.
- Do not exaggerate in the standby capacity, because this represents unused investments.
- Absorption chillers are not recommended unless they are used as a part of a cogeneration system.
- For existing chillers, review their specific energy consumption to find out the feasibility of changing it. This usually proves feasible if the specific consumption is higher than 0.75 kW/TR.
- If the existing chiller is air-cooled, changing it will have an average simple pay back period of three years.
- Use a chiller that is equipped with soft startup facility as well as a high-efficiency motor.
- For heating periods it is preferable to use the hot water jacket of a generation facility, through a heat exchanger, whenever this is possible.

Cooling towers

- Use a cooling tower that is equipped with a variable speed drive fan to optimize its energy consumption at part load condition.
- Check the quality of the packing material of the cooling tower as well as the availability of a mist eliminator.
- Ensure proper operation of the water nozzle to achieve proper water atomization.
- Monitor the water quality of the cooling tower and ensure proper water treatment.
- Monitor the water quality of the blow-down to avoid excessive or reduced blow-down.

Chilled water pumps and piping systems

- Ensure proper insulation of the pipe especially those parts extended in unconditioned areas.
- It is not recommended to extend the chilled water pipe close to the hot water pipes.
- Select suitable pipe diameters to ensure less pressure drop across the chilled water network.
- Select suitably sized pumps to ensure their operation at or close to their best efficiency point.
- Use high-efficiency motors for the pump drivers.

Air distribution ducts and outlets

- Ensure proper insulation of the air ducts especially those parts extending into unconditioned areas.
- Ensure minimum pressure drop across the duct system.
- Ensure minimum air leak from the system through the selection of suitable fitting as well as proper installation.
- Ensure properly sized and placed outlets.
- Properly size the fans to ensure their operation at their best efficiency point.
- Use variable speed control for the fans instead of damper control to create a variable air flow control strategy.
- Use high-efficiency motors for the fan drivers.

Control and energy management systems

- Use energy management techniques including preset temperature with duty-cycling, optimum start and stop, and programmable time-scheduled operation.
- Reduce the peak demand of the chillers through using a load control scheme.
- Adjust the control of starting and shutting down units to ensure optimal loading of the unit to achieve the highest possible efficiency.
- Reduce infiltrated air through the use of automatically operated air curtains and rotating doors.
- Use occupancy sensors in the guest rooms.
- Use micro-switches attached to the windows and doors to stop the HVAC system when a window or a door is open more than a preset delay period.
- Use CO2 sensors to optimize the quantity of the fresh air rather than a fixed setting for the fresh air damper.
- Check and re-tune the control system of the HVAC system on regular basis to avoid drift, false signals, and malfunction.

A-7 High-Efficiency Lighting

Lighting represents around 40% of electric energy consumption in hotels and resorts. In addition to its main function in providing light, lighting systems are normally used for decoration and signage purposes.

7-1 Lighting Systems

A lighting system consists of:

- Lamps, which includes both the bulbs as well as necessary ballasts;
- Fixtures, reflectors and luminaries; and
- A control system, which include switches, sensors and dimmers.

7-2 Types of Lamp Bulbs

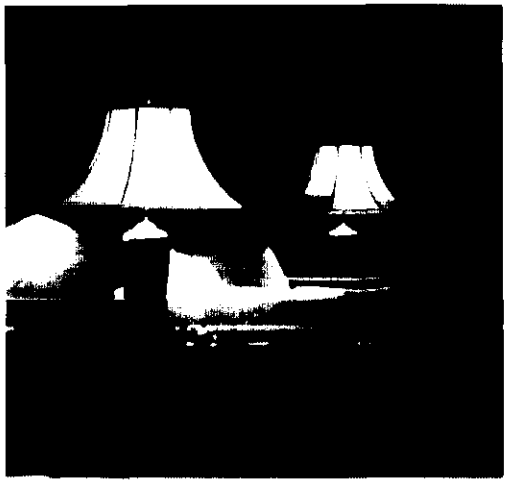
Several types of lamps are available, includes the lamps described below.

Incandescent lamps

An incandescent lamp consists of a tungsten wire filament on a suitable mount enclosed in a glass bulb containing a gas or vacuum (for lamps below 40 W). Incandescent lamps have obvious advantages, which are compact size, low cost, easy handling and installation, and suitability for use with reflectors for concentrated light beams. Their warm light and excellent color rendition result in their use for almost every lighting application. The average life for an incandescent lamp is approximately 1000 hours of operation.

light beams. Their warm light and excellent color rendition result in their use for almost every lighting application. The average life for an incandescent lamp is approximately 1000 hours of operation

Incahdescent lamps



Incahdescent lamps are used as a source for warm lights

Fluorescent lamps as a source for daylight

Fluorescent Lamps

The fluorescent lamps create an arc between two electrodes in a glass tube filled with an atmosphere of low-pressure mercury vapor and inert gas. Light is produced by the phosphor coating on the inside of the glass, which is activated by the ultraviolet energy of the discharge. The average life for a fluorescent lamp is approximately 12,000 hours, although newer lamps are appearing with lives of up to 20,000 hours and even 24,000 hours.

The most commonly used florescent lamps are the 1.2 m 40 W lamps, with a light output of 2500-3000 lumens, and 20 W lamps. A wide variety of energy-saver fluorescents have been developed over the last 10 years. The first generation lamp was a 36-Watt lamp. The second generation used improved phosphors to achieve a 15% reduction (34 W for a typical 40 W lamp), with a light-output reduction of only 3%. The locally manufactured 36-Watt lamps in Egypt fall into this second category.

Compact Fluorescent Lamps

These lamps are designed small enough and bright enough to replace incandescent lamps, often fitting into the existing fixture. These lamps are available in various wattages from 5 W to 18 W and provide savings of 65% to 75% compared to incandescent lamps of the same light output. Compact fluorescents combine small size, high efficiency, excellent color rendering, and long life. New fixtures and ballasts are being designed, and compact fluorescents can now satisfactorily perform in all incandescent lamp applications.

Blended Mercury Lamps

These combine the operating principles of several lamps: the mercury discharge of high-pressure mercury lamps, the phosphorus coating of fluorescent lamps, and the resistance filament of incandescent lamps. The blended lamp has a low color temperature, bright white light with good color rendition, and a high power factor. Its life of 6000 hours is several times as long as the equivalent incandescent lamp, but only a fraction of the life of true high intensity discharge lamps. It suffers from low efficacy, relatively short life, and relatively high cost.

High Intensity Discharge (HID) Lamps

This includes different types of lamps.

Mercury Vapor Lamp: It is also called the high-pressure mercury lamp. The efficacy of mercury vapor lamps is a maximum of only 63 lm/W and their life expectancy is 12,000 hours.

Metal Halide Lamps: The main application of metal halide lamps is in spot lighting for large areas like parking lots and city centers where good color rendition is important. Their life expectancy is 12,000 to 20,000 hours. These are used especially in replacing incandescent lamps in retail areas and other areas where color rendition is important. They have a shorter life (7500 hours) and a relatively high initial cost.

High Pressure Sodium Lamps (HPS): Due to their high efficacy (80 to 140 lm/W) they are commonly used for public lighting and floodlighting. They often replace mercury vapor lamps. Lamp life is on the order of 20,000 to 24,000 hours. Metal halide is usually still more cost-effective for good color rendition.

Low Pressure Sodium Lamps (LPS): The LPS lamp is the most efficient of the common lamps, converting 35% of its energy into visible light, and having efficacies as high as 180 lm/W. Its color rendering is very poor. Its light is a deep yellow, making colors very difficult to distinguish. Nevertheless, outdoor lighting applications are the most common sites of its application. It is available in ratings between 18 W and 180 W. The life of LPS lamps is approximately 18,000 hours. LPS lighting is attractive as an initial investment.

Ballasts

Lamp ballasts come in a wide variety of designs and capacities to correspond to the range of available lamps. They consume a certain amount of power, and can be characterized by their efficiency. Because ballasts consume in the range of 15 to 20% of the lamp wattage, they are of interest in energy-saving and high-efficiency lighting applications. Advances in ballast technology over the last 10 years have significantly improved their performance and reduced their energy consumption.

7-3 Fixtures, Reflectors and Luminaries

A good luminary has the following characteristics:

- Focuses a majority of the lamp's light onto or into the area to be lit (i.e., it is efficient),
- Minimizes both direct and indirect glare from the luminaries to the occupants of the space,
- Ensures that the lamp does not overheat,
- Meets certain manufacturing and performance standards, and
- Is appropriate to the decor of the space.

7-4 Lighting Control Systems

A lighting control system can be as simple as on/off switches ranging up to an automatic control system with sensors, timers and dimmers. Light control could be zonal in nature or integrated as a compete system. Some of the major functions that can be included in a lighting control system are described below.

- Fixed power reduction: Reductions in power, and consequently in light level, may be desired due to over-design of the lighting system, changes in the use of a space, or to save small amounts of power without the persons in the space noticing the light level reduction.
- Lumen depreciation compensation: When lighting is first installed, it often has a higher light output than necessary to compensate for lumen depreciation as the lamps age. The control system can reduce the output to avoid wasting energy, and gradually increase power over the life of the lamps.
- Daylight compensation: Power can be decreased to certain lighting circuits near day-lit areas to maintain adequate light levels according to an ambient light sensor.
- Time-of-day scheduling: Use of a timer allows control of different lighting circuits according to the use of the area.
- Demand biting: Power to certain lighting circuits can be reduced or cut off completely, depending on their priority, to avoid an electrical demand peak.
- Occupancy scheduling: Occupancy sensors can easily be integrated into an overall system to control small or large circuits with one or more sensors.

The costs of lighting control systems vary widely, as do the options offered; it is difficult to compare different systems. Costs range from as low as US$100 per control relay for systems with simple switching and time program functions, to over US$250 per relay for more complete lighting control systems.

Lighting Standards

Lighting standards are the levels of light or illumination level in "Lux", which are sufficient to perform the required task. Energy will be wasted if the lighting level exceeds these standards. The recommended illumination levels for different areas in a hotel business are presented in the following table.

7-5 Factors for High-Efficiency Lighting Design

Efficiency is only one of many considerations in designing a lighting system, but it is certainly one of the most important. This section describes 10 factors, many of them interrelated, which should be reviewed in the process of designing or re-designing any lighting system. Efficiency is considered in each of the design factors discussed below.

1) Identification of Lighting Requirements
2) General Local and Task Lighting
3) Use of Daylight
4) Room or Space Characteristics
5) Types of Lamps
6) Glare
7) Selection of Light Fixture
8) Deterioration in Light Output
9) Lighting Switching and Control
10) Initial vs. Operating Cost .

Installation of Occupancy Sensors

Given: Number of fixtures	16
Fixture wattage draw	44 Watt
Time lights needed	15 minutes/hr
Occupancy sensor cost	175 LE
Operating hours	4,000 hr/yr
Electricity cost	0.15 LE/kWh

Savings: fixture draw x no. of fixtures x time lights off x hours of operation x electricity cost

0.044 kW/fixture x 16 fixtures x 0.75 x 4,000 hr/yr x LE 0.15/kWh
= 317 LE/yr

payback: Investment/savings= 175/(317 LE/yr) =0.6 years

Guidelines for Lighting Illumination

Area	Illumination Level (Lux)	
	Europe	USA
Circulation Areas, Corridors	100	100-200
Stairs and Escalators	150	100-200
Rooms and Toilets	150	100-200
Shaving and Make-up	500	200-500
Entrance Hall	300	100-200
Dinning Room	200	100-200
Kitchens	500	200-1000
Surroundings	N/A	10
Parking Lots	N/A	20
Shops, Stores and Exhibition areas:		
Conventional Shops	300	200-500
Self-service Shops	500	500-1000
Supermarkets	750	500-1000
Showrooms	500	500-1000

Replace 60-W Incandescent with 11-W Fluorescent

Given: incandescent wattage	60 watts
Fluorescent wattage	15 watts
Incandescent lumens	920 lumens
Fluorescent lumens	900 lumens
11-W fluorescent cost	LE 32
Operating hours	4,000 hr/yr
Electricity cost	LE 0.15/kWh

Savings = (Incand. Watts – fluor. Watts) x hours of operation x electricity cost
(0.060 kW – 0.015 kW) x 4,000 hr/yr x LE 0.15/kWh
= 27 LE/yr

Payback: Investment/savings = LE 32/(LE 27/yr) =1.2 year

Replace Blended Mercury with High Pressure Sodium

Given: blended Mercury	250 watts
HPS wattage draw	175 watts (Nominal 150 watts)
Blended mercury lumens	5500 lumens
HPS lumens	13500 lumens
HPS fixture cost	228 LE
Operating hours	4,000 hr/yr
Electricity cost	0.15 LE/kWh
Replacement rate	2 blended mercury by 1 HPS

Savings: (blended mercury draw – HPS draw) x hours of operation x elec. cost
{(0.250 kW/lamp x 2 lamps) – 0.175 kW} x 4,000 hr/yr x LE 0.15/kWh
=LE 195/yr

Payback: Investment/savings = LE 228/(LE 195/yr) =1.2 years

7-6 Guidelines for Energy Conservation in Lighting

Reduce General Lighting

- Regularly measure light levels, and reduce them to the minimum required by removing lamps or fixtures, or using lower-output lamps.
- Reduce artificial lighting to the extent that natural light is available.
- Use task lighting to increase light levels where needed locally; reduce general lighting if task lighting is used.
- Lower the mounting height of lamps to permit the use of lower-output lamps.
- Clean lamps and luminaries regularly to maintain light levels, or even to permit use of lower-output lamps.
- Paint walls, ceilings, and other reflecting surfaces with white or other light colors to maintain light levels, or even to permit the use of lower-output lamps.
- Disconnect ballasts where lights have been eliminated, or where burned-out lamps will not be replaced.
- Set up group re-lamping programs.

Reduce or Control Extraneous or Unnecessary Lighting

- Turn off lights when not in use; mount a campaign for everyone to turn off lights when not in use.
- Rewire light switches to allow more localized control of lighting.
- Rewire light switches to allow more than one level of lighting in a given area.
- Install timers or timer switches in little-used areas.
- Use occupancy sensors in areas not permanently occupied to ensure

lighting only when persons are present.

- Use photocells to control exterior lighting.
- Use natural light: install skylights or windows and keep them clean.
- Eliminate lights that serve little or no purpose, such as those above high storage stacks or shelves or in unused corners of stockrooms.
- Install an automated lighting control system.

Use High-Efficiency Lighting Equipment (Retrofit or New Construction)

- Use higher-efficiency, lower-wattage lamps in existing fixtures.
- Convert to more efficient light sources (e.g., fluorescent, metal halide, sodium vapor).
- Use high-efficiency or electronic ballasts instead of common electromagnetic ballasts.
- Use high-efficiency luminaries, such as mirrorized reflectors or thermally controlled fixtures, to reduce wattage or number of lamps used.
- Eliminate inefficient lamps from hotel stocks or ordering forms.
- Use a life cycle cost comparison when selecting lamps and luminaries, or when designing lighting systems for new construction.

A-8 High-Efficiency Steam and Hot Water Systems

Steam boilers are used to generate steam, which is usually used in the laundry and sometimes in the HVAC system for either heating or humidity control and can be used for the heating the swimming pool. Also, steam could be used to generate domestic hot water using steam/water heat exchangers. Hot water heaters can be used to generate domestic hot water or for heating as well as humidity control purposes.

8-1 Steam Systems

A steam system usually consists of a steam boiler(s), steam distribution system, heat exchangers, and condensate return system. All the steam system components should be properly thermally insulated.

Steam Boiler

A steam boiler is used to generate steam necessary for different thermal demands such as laundry and hot water necessary for heating, humidity control, and domestic use. Boilers should be properly sized for the steam load.

Steam Distribution System

The steam distribution system is the piping system that connects the boilers where the steam is generated to the demand sites. The system usually consists of the steam header, main branches, and connecting pipes. Also the system is equipped with valves for control. The system should also be optimally routed to reduce the necessary pipe length to the minimum.

Pipe connections should be properly selected as well as the gasket material.

Proper supports should be selected to support the pipes.

Insulation of the steam piping system is crucial to efficient operation. Proper insulation material as well as the proper thickness is important.

The system should be equipped with a properly located drain point to bleed the condensates that form in the system.

Heat Exchangers

Heat exchangers are those apparatus that are used for transferring heat from one medium to another. One type is the steam/hot water heat exchanger, where steam is used to heat the water to produce hot water. The external surface of a heat exchanger should be thermally insulated to ensure minimum heat loss. Also it should be properly sized to ensure its satisfactory operation as well as minimum pressure drop for the flow. Selecting equipment for its effectiveness is crucial to ensure proper operation as well as economical costs.

The heat transfer surfaces of a heat exchanger should be kept clean to ensure its efficient operation.

Selection of the material for the heat transfer surfaces of a heat exchanger should have the highest possible heat transfer coefficient as well as the ability to resist corrosion.

Condensate Return System

The condensate return system is the system that collects the condensed steam and forwards it back to the boiler. It is important because it saves

the energy that was necessary to preheat the make-up water if the condensate return system does not exist. Also it reuses the condensed water, which is highly pure and consequently saves both water and chemicals that are used in water treatment.

8-2 Hot Water Systems

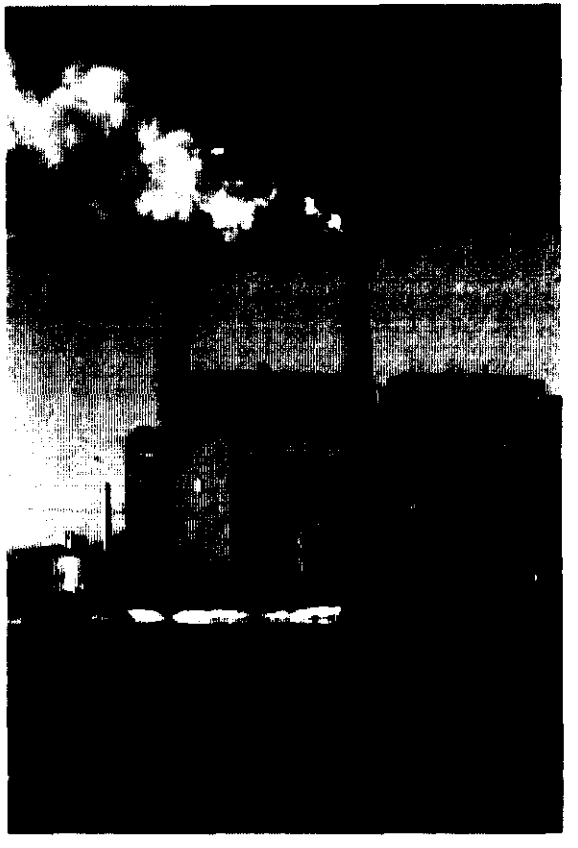
A hot water system may rely on a steam boiler to generate steam, which is used to heat water in a steam/water heat exchanger, or it may consist of a fuel-fired or electric water heater. From the energy point of view, using an electric water heater is completely unfavorable due to its higher operating cost compared with the fuel-fired heaters.

A hot water circulating pump is usually used for a domestic hot water network to ensure availability of hot water as soon as the guest opens his tap and to pressurize the hot water network. To reduce the energy consumed by this pump, it is important to install the main hot water tank as close as possible to the guest rooms to reduce the length of the network.

8-3 Waste Heat Recovery

In resorts where a self generation facility is available, hot water as well as steam can be generated using recovered heat from the generator.

Steam can also be generated using the heat recovered from the exhaust gases of the diesel engine. This can be done using engine exhaust heat recovery steam generator (EEHRSG). This arrangement is called cogeneration where heat energy in the form of hot water and steam are produced in addition to the electricity generated. This arrangement, providing the availability of the generation facility, has a simple pay back



Steams Generators

period of three to four years.
Also during summer, heat can be recovered from the chillers to preheat domestic hot water. This will reduce the energy consumed in heating water. Accordingly, the chillers will be used to provide simultaneously chilled as well as hot water.

8-4 Use of Solar Heating

The Red Sea Coast enjoys high solar radiation sufficient to operate solar heaters. The standard active solar heating system consists of a solar collector, hot water storage tank, and electric heater to compensate for times of high demand and availability of solar heated water. The average portion of hot water generated using electricity is around 30% of the total hot water produced.

The cost of heating 1 m3 of water to 60oC using electricity is 9.34 L.E. considering the prevailing cost of diesel-generated electricity. The equivalent cost using a fuel-fired water heater is 1.55 L.E. Therefore, it is recommended that the solar heating system be integrated with a fuel-fired system rather than an electrical system. This integration will have a higher initial cost due to the extensive plumbing work, however it has it definite energy and cost savings.

It is also important to mention that since solar heating relies on many solar collectors (distributed system) it is very suitable for resorts that have a dispersed structure such as separate, attached or detached chalets. This is because the heaters can be installed as close as possible to the demand sites, which reduces heat loss and the need for circulating pumps.

8-5 Guide for Energy Conservation in Steam and Hot Water Systems

- Increase Boiler Efficiency
- Ensure Proper Insulation
- Reduce Boiler Load
- Improve efficiency of Hot Water System
- Use Waste Heat Recovery

A-9 Energy Efficiency Benchmarking for Hotels and Resorts

9-1 Energy Benchmarking

Energy benchmarks represent the energy consumption norms of the best practice in the industry. They are used as a point of reference to evaluate the performance of a specific hotel regarding its energy use. The difference between the existing energy consumption indicators and the benchmark values represents a potential energy savings in the facility under concern. Therefore, having a set of benchmarks is of great importance to improve energy efficiency in the hotel industry.

Before benchmarks can be set for hotels, appropriate performance indicators of energy efficiency that are widely applied across the industry must be established. Ideally, these indicators should normalize the energy performance of a hotel for variables beyond the control of the energy manager, such as the size or location of the hotel or the number of guests. Indicators expressed in cost terms are of little benefit because they mix the changes in energy prices with consumption.

The most widely accepted energy benchmarks in the hotel industry are energy consumed per room (MJ/room), energy consumed per square meter of floor area (MJ/m2), energy consumed by food cover (MJ/food cover), and energy consumed per guest (MJ/guest). The last indicator considers the impact of occupancy level on energy consumption.

According to the APEC report, Institutionalization of a Benchmarking System for Data on the Energy Use in *Commercial and Institutional Buildings*, an average energy intensity of around 1,250 MJ/m2 has been measured for a group of 158 hotels in the United States. Also an average intensity of around 1,070 MJ/m2, 1,400 MJ/m2, and 1,250 MJ/m2 were found for smaller groups of hotels in Hong Kong, Singapore, and Chinese Taipei, respectively.

9-2 Parameters Affecting Energy Consumption

- Type of hotel
- Hotel classification
- Hotel capacity
- Hotel occupancy
- Laundry
- Water consumption

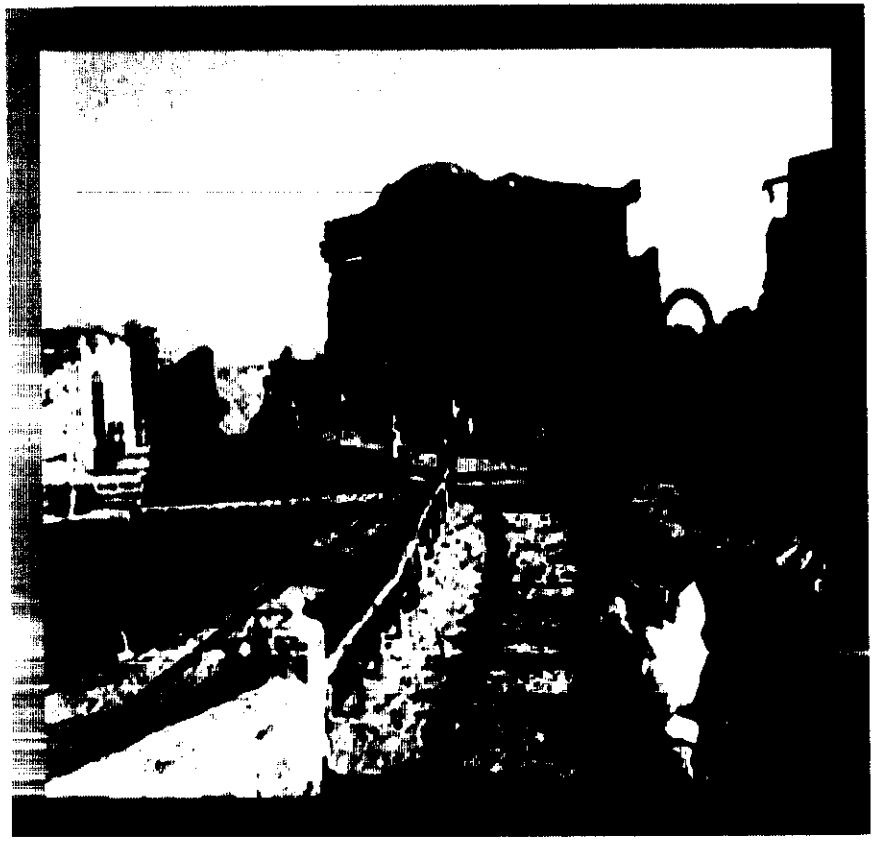
9-3 Internal Benchmarking

It is important for each hotel to develop an internal benchmarking system that relies on recording energy consumption for several years. By comparing its current energy consumption with its specific benchmarks, a hotel can develop a picture of how its performance compares with their measured best practice. Also it is important for the hotel management to install meters at different parts of the hotel for electricity, fuel and water consumption to have energy indicators for certain areas or activities such as the restaurants, reception area, or laundry.

[2] Bloyd, C.N., Mixon, W.R., and Sharp, T. Institutionalization of a Benchmarking System for Data on the Energy Use in Commercial and Industrial Buildings. Honolulu, Asia-Pacific Sustainable Development Center East-West Center for APEC: 1999.

Environmental Best Practice For Red Sea Tourism Development

Executive Summary



PART B

A. Energy Management

B. Landscape Architecture

C. Landscape Planting

D. Solid Waste Management

E. Water and Sanitation systems

B

Landscape Architecture

B-1 Landscape Architecture & Sustainable Development A Conceptual Framework

B-2 Types of Landscape Architecture Specialization

B-3 The Challenges of Landscape Analysis and Evaluation

B-4 The Challenges of Landscape Master

B-5 Best Practices in Detailed Landscape Design

B-6 Best Practices in Implementation and Operation

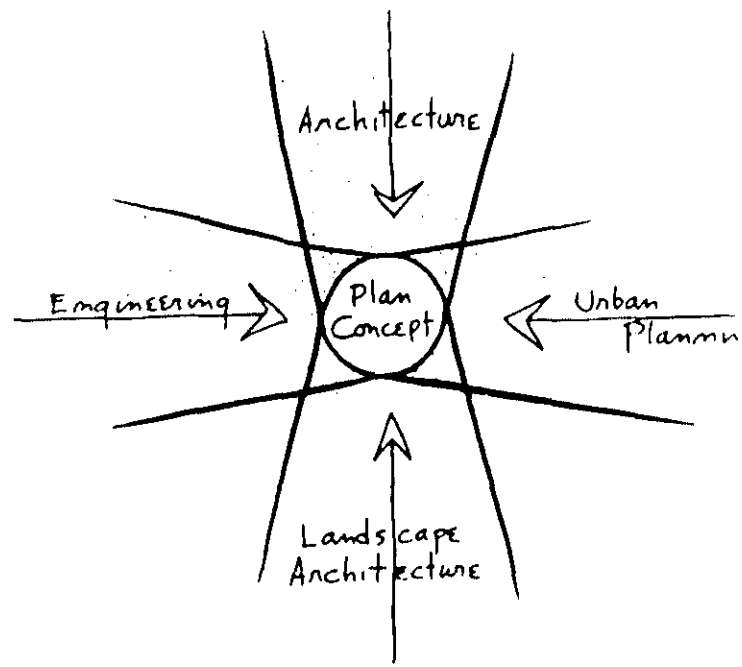
B-1 Landscape Architecture and Sustainable Development: A Conceptual Framework

1-1 Defining Landscape Architecture

This Sourcebook assists those involved in tourism development in Egypt by enabling them to work more effectively with landscape architects. Landscape architecture is the design and planning profession that applies both science and art to achieve the best use of the land. This diversified knowledge is essential for meeting the challenges of booming resort areas along the Red Sea. Unfortunately, people perceive landscape architecture erroneously as limited to decorating the exterior spaces with ornamental plants. This is false and confuses the profession of landscape architecture with "Horticulture Sciences".

The Tourism Development Authority (TDA) is publishing this Sourcebook to highlight the need for landscape architecture in tourism development and to share its practical experience. Tourists are attracted to a vacation destination by the elements of the landscape, the architectural character, and by the image of the region. Therefore, experienced developers rely on both: landscape design and on architecture to define a special theme for their projects from the beginning to the end of the development process.

Throughout the process landscape architects stress the enhancement of the natural environment by assigning land uses, manipulating landforms, locating outdoor activities, and preserving ecosystems. Their tasks include



Sustainable tourism development can be achieved when the members of the design team cooperate in producing the conceptual plan. They should include architects, urban planners, landscape architects and engineers .

Landscape architecture is the art of improving people's use and experience of outdoor spaces.
Source: John Simonds, 1961.

designing driveways, walkways, bicycle and walking paths, horse back riding trails, steps, ramps, outdoor lighting, outdoor seating, planting schemes, water features, railings, signs, walls, fences, outdoor structures, roof gardens, public parks, and outdoor sport fields.

1-2 Landscape Architecture Specializations

Since the environmental movement of the 1970s, the realm of landscape architecture has diversified considerably, and therefore, landscape architects have expanded their professional activities. The emerging trend toward specialization in the practice of this field continues in response to the new challenges of information technology, industrialization, and urbanization. The variations of landscape architectural practice are particularly useful for tourism developments; however, each of these variations is actually a distinct field of knowledge and requires a specialized set of skills. Today, the market growth demands three clearly definable yet related types of landscape architecture specializations including:

- Landscape Analysis and Evaluation
- Landscape Master Planning
- Detailed Landscape Design

Landscape analysis and evaluation is a level of practice that deals with large regions, has a strong ecological base, examines visual and cultural resources, requires a team approach, and produces land suitability maps, land use plans, resource analysis and synthesis, and development policies. Landscape master planning builds upon the landscape analysis and evaluation stage and involves: preparing a comprehensive set of site inventory and analysis maps, outlining a preliminary program, preparing

a project brief, formulating conceptual schemes that suggest alternative patterns of activity, circulation systems, outdoor forms, and developing a final accurate master plan.
Detailed landscape design provides the information needed in a contract document including: staking and layout plans, grading and drainage plans, earthwork computation, roadway and utility profiles, planting plans, irrigation plans, construction details (lighting, signage, fences, etc.), specifications book, and material summaries.

1-3 Selecting a Qualified Landscape Architect

Assembling a professional design team is a key to successful tourism developments. Ideally, it should include at least an architect, civil engineer, and landscape architect. Such a multidisciplinary team ensures efficient operation, profitable investment, and satisfied guests.

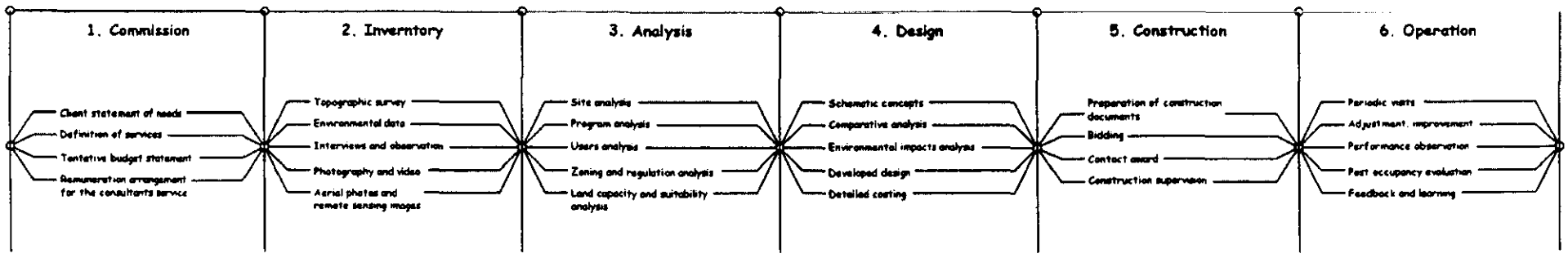
Selecting a qualified landscape architect is another essential task that should be mastered by investors.
Best practices that guide this search include:

- Determine what is needed and write it clearly and concisely in a short letter. Specify the stage(S) requiring landscape consulting.
- Prepare a comprehensive "Request for Proposal" for large projects. Include project background and objectives, services required, deliverables, and client responsibilities.
- Develop clear evaluation criteria for hiring your consultants.
- Set realistic budgets for both: your project and for the consulting fees. Recognize that landscape architects operate within a competitive market place.
- Explore the available market of landscape consultants. Particularly for complex projects, only consider firms that specialize in the services your project requires.
- Insist on a balance between landscape architects, engineers, and architects and be aware of potential professional turf battles. Imbalance leads to costly errors in design and construction and could cause irreversible damage to the site's ecosystems.
- Assess the qualifications, educational background and practical experience before consultation selection. Some claim the title of landscape architect without adequate credentials.
- Know the differences of various consultants. Horticulturalists receive their education in agriculture. They know plant and soil sciences but are limited in landscape design, planning, and construction. Qualified landscape architects stress the ecological approach, expect total involvement, and focus on master planning, urban design, and complex mixed-use projects. They use new technology including remote sensing, geographic information system, and computer-aided drafting.

1-4 Phases of the Landscape Development Process

Today, land development has reached new levels of sophistication in construction techniques, marketing and sales concepts, managerial and administrative approaches, and imaginative ways to finance project costs. More significantly, for the first time, a development team was brought together with the landscape architect included as a key member. The Landscape Architect popularized an ecological design process parallel to the land development process, which coincides with the concern for the Red Sea coast's natural and cultural heritage and includes six phases: Commission, Inventory, Analysis, Design, Construction, and Operation. Professional agreements can be verbal (but preferably written in the form of a letter) or a standard contract. Generally, the commission phase has many functions. These include:

- Identifying clients and users,
- Outlining objectives,
- Determining location,
- Scheduling timetable,
- Clarifying responsibilities,



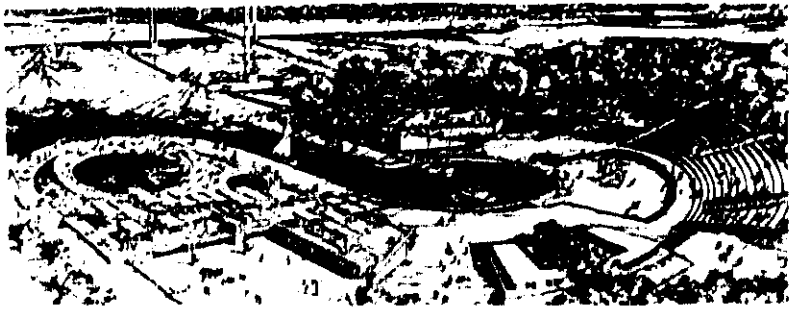
The Landscape Development Process

- Projecting a budget, and
- Stating the expected output.

The inventory phase involves a systematic data collection procedure which includes a topographic survey, aerial photos, environmental resources, and observations/ interviews. The data are assembled under four headings:
- Physiographic
- Natural ecosystems
- Cultural resources
- Visual resources

The analysis phase generates four studies including:
- Site Analysis
- User analysis
- Program analysis
- Zoning & regulations analysis

The design phase occasionally is called "synthesis" and involves various steps including:
1. Land capability & land suitability analysis, and/or a land use map
2. Schematics
3. Cost estimates
4. Comparing concepts
5. Design development
6. Environmental impacts



The landscape construction document is the tool that ensures the design team that their ideas are communicated fully to the contractor who is implementing the project.

The construction phase consists of contract document preparation including:

- Layout Plan
- Grading Plan
- Utility Layout
- Roadway Profiles
- Planting Plan
- Site Details
- Outdoor Furniture
- Irrigation Plan
- Lighting Plan
- Landscape Specifications
- Bid Procedures

Other steps may include bidding, contract award, and supervision of construction. The operation phase focuses on producing efficient management and maintenance plans plus yearly operation guidelines for the following items:

- Irrigation systems
- Soils and topsoil
- Fertilizers
- Turf areas
- Planting areas
- Pruning
- Plant diseases
- Pest control
- Street furniture
- Outdoor lighting
- Grounds security

1-5 The Criteria of Sustainable Landscape Architecture

A sustainable landscape architecture project is one that keeps the carrying capacity of the surrounding ecosystems from adversary intervention, resources depletion, or habitats degradation. Specifically, a landscape development project is considered environmentally sustainable when it:

- Locates suitable sites for outdoor activities,
- Locates different facilities sensitively to capitalize on existing opportunities,
- Locates different facilities sensitively to avoid existing constraints,
- Maintains or improves the carrying capacity of different ecosystems on the site,
- Preserves unique areas that are capable for particular uses (agriculture lands; wetlands; mangroves; coral reefs; or wildlife habitat; etc.),
- Minimizes the probability of adverse environmental impacts,
- Mitigates unavoidable environmental impacts,
- Takes advantage of native plants, scenic views, and all natural features,
- Emphasizes the issue of sustainability,
- Promotes long-term value systems,
- Stresses a holistic approach to development,
- Encourages a comprehensive cost-benefit analysis, and
- Emphasizes policy incentives.

1-6 The Role of " Best Practices" in Tourism Development

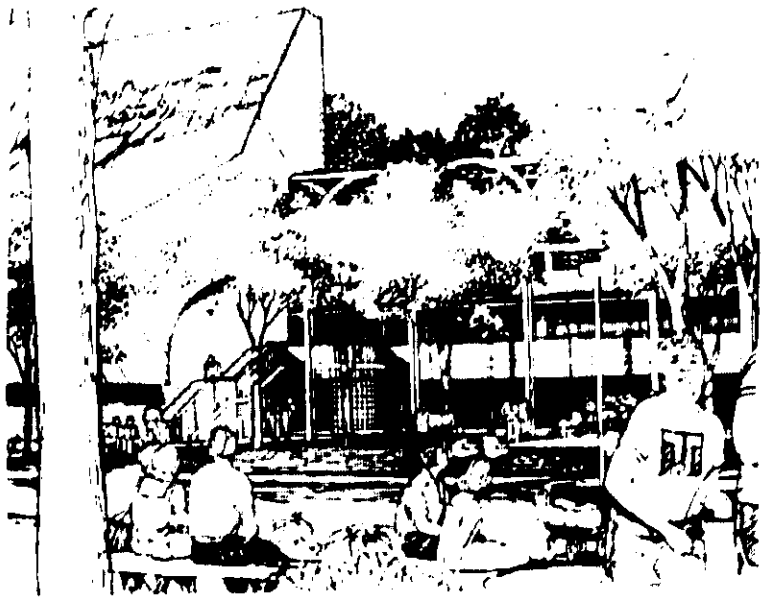
Development specialists define best practices as an initiative that has a demonstrable positive impact on people's quality of life; encourages partnerships between the public, private, and civic sectors of the society; and helps in achieving socially, culturally, economically and/or environmentally sustainable development.

Best Practices in tourism development are promoted as a means of:

- improving environmental policy;
- raising awareness of potential environmental problems and solutions;
- sharing knowledge and experience;
- building a data-base of case studies; and
- unifying reporting formats.

Four factors affect the selection of a landscape architecture project for the "Best Practices" list. First: the project's tangible and positive impact on the living environment of people; Second: its demonstration of harmonious partnership between the members of the multi-disciplinary design team, TDA, and the investor; Third: its innovation within local context and transferability to regional context, and; Fourth: its impact on one of the following areas:

- Reducing pollution;
- Improving environmental health;
- Improving waste collection, recycling and reuse;
- Greening the site and effective use of public space;
- Improving production cycles of renewable resources;



Sustainable landscape development has many characteristics. The designer has to be aware of them and try to maximize their achievements in each outdoor space.

- Reducing consumption of non-renewable resources;
- Protecting and conserving natural resources;
- Using energy efficiently; and
- Preserving visually, historically, and culturally important sites.

1-7 Learning from "Best Practices"

Best practices studies in landscape architecture represent a database of case studies that should grow over the years and could ultimately become a useful tool for policy makers, government officials, professional consultants, and potential investors.

Best practices are used for:

- promoting productive partnerships and technical cooperation between TDA, the Red Sea Municipalities, consultants, and investors;
- training and educating employees and managers of tourism facilities;
- allowing other regions and other developers to adapt validated experiences in future projects;
- analyzing current trends in landscape planning, design, construction, and maintenance;
- developing awareness of specific issues related to the Red Sea coast;
- networking people and organizations involved in tourism development of similar type, size, or climate;
- improving capacity-building in the field of landscape architecture and its related industries; and
- adjusting various policies that affect the landscape architecture contribution to tourism projects.

B-2 Types of Landscape Architecture Specialization

2-1 Landscape Analysis and Evaluation

Three clearly definable yet related types of landscape architecture practices have emerged in recent years. They are: landscape analysis and evaluation, landscape master planning, and detailed landscape design.

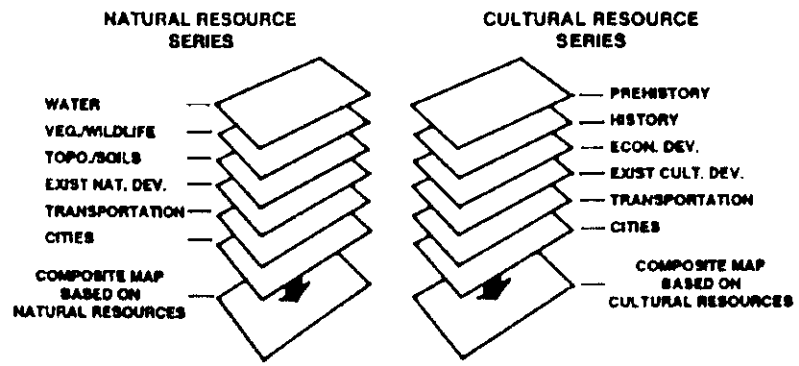
Landscape analysis and evaluation is the scientific and environmental domain of landscape architecture. It is considered a distinct level of practice since it:

- Deals with large regions and macro environmental factors,
- Has a natural science base, and examines the ecological processes and systems,
- Surveys landscape features, and produces Visual Resources Management (VRM) studies,
- Addresses land use planning issues, and
- Requires a team of environmental scientists to advise the landscape architect.

While landscape surveying compiles facts about the site ecology, landscape analysis involves the following tasks:

- investigating the past and present conditions of the landscape,
- projecting its future,
- determining what could be attempted, and
- programming what should be accomplished.

The landscape analysis and evaluation team is usually comprised of representatives from different fields including:



Potential tourism destination zones can be identified by conducting a complete inventory and analysis of natural resources and cultural resources. Composite maps can then be prepared by using GIS programs. *Source: William March, Landscape Planning, 3rd Edition, 1997.*

- Plant sciences
- Wildlife management
- Soils and geology
- Physiography
- Meteorology
- Hydrology
- Marine sciences
- Systems ecology

The final product of their work includes one or more of the following:

- Environmental inventory
- Opportunities and constraint map
- Land capability/suitability maps
- Environmental impacts assessment
- Land use plan
- Facility planning study
- Site selection study
- Analysis and evaluation of unique ecosystems
- Socioeconomic and cultural values

2-2 Landscape Master Planning

Landscape master planning builds upon the "Landscape Analysis and Evaluation" studies. Landscape planners apply a process that helps them sort data, generate analysis, determine synthesis, and produce alternative solutions. Although the process remains the same, the design expression varies according to the landscape character.

A landscape master plan is a long-range, comprehensive diagram illustrating the development upon completion of all projects and should:

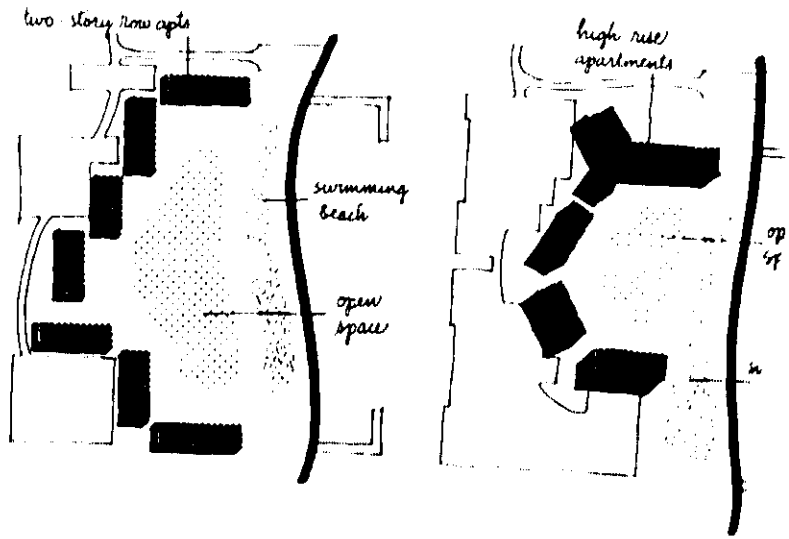
- assign different land uses to capable zones;
- create logical relationships between buildings, and outdoor activities;
- allocate adequate space to each outdoor activity;
- site structures according to their functions and relative importance; and
- conserve the ecological, visual, and physical resources.

Many factors influence the landscape master plan of tourism projects along the Red Sea in general. These are:

- The client is nature-oriented.
- The landscape features are established (the sea, the mountains, the desert, and the sky).
- Land area is plentiful.
- Flat coast offers minimum planning restrictions.
- Level lands are flexible since its approach is not dictated by topography.
- Extensive opportunities to explore property boundaries exist.
- Open view is abundant and is dominated by the dome of the sky.

- Sites are exposed to hot and dry summers, occasional flash floods, and harsh winds.
- Structures are perceived as imposed elements.
- Indigenous materials contribute to the landscape character.
- Dominant flat sites offer little privacy, are exposed evenly to the climate, have a neutral landscape quality, have no focal point, lack the third dimension, and depend on buildings and outdoor activities to dramatize their sameness.

Best practices in the landscape master planning phase include: examining more than one concept; suggesting clear criteria to evaluate alternative concept, allowing clients to accept, reject, or modify any concept, using various media to present the plan; maximizing the use of indigenous materials, and applying xeriscape schemes.



Developing alternative master plans allows the stakeholders to explore a variety of concepts and themes before making the final decision.

Detailed landscape design involves the coordination of buildings, circulation systems, outdoor spaces, and landscape amenities.

2-3 Detailed Landscape Design

Detailed landscape design deals with the search for forms that satisfy the project's program. It involves three elements: the pattern of outdoor activities, the pattern of outdoor circulation, and the suitable forms that support both patterns. It is the stage when the designer gives specific quality to the diagrammatic spaces suggested in the master plan. The detailed landscape design includes four tasks:

- Selection and placement of plant materials.
- Selection and placement of paving materials.
- Design and placement of outdoor lighting fixtures, structures, street furniture, signs, fountains, sculptures, fences, gates and walls.
- Design outdoor spaces such as parking lots, roof terraces, amphitheaters, waterfront walkways, outdoor plazas, and trails.

The final product of the detailed landscape design phase further develops further the landscape master plan by showing essential dimensions and materials, property line and adjoining highway, outside walls of the buildings, site elements, utilities, paved areas, vegetation, pavement materials and patterns, walls, fences, steps and other structures, proposed plants, water fountains and pools, outdoor lighting, rocks, sculptures, and other furniture and planter boxes.

Best practices in detailed landscape design stress preparing a program for every space; responding to the users and the site analysis; maximizing the use of prepared sand; local stones and desert plants; minimizing the use of grass areas; and adopting a maintenance schedule. A qualified person who prepares a detailed landscape design document should have a good education, training, experience, familiarity with the project, and patience to explore alternative solutions.

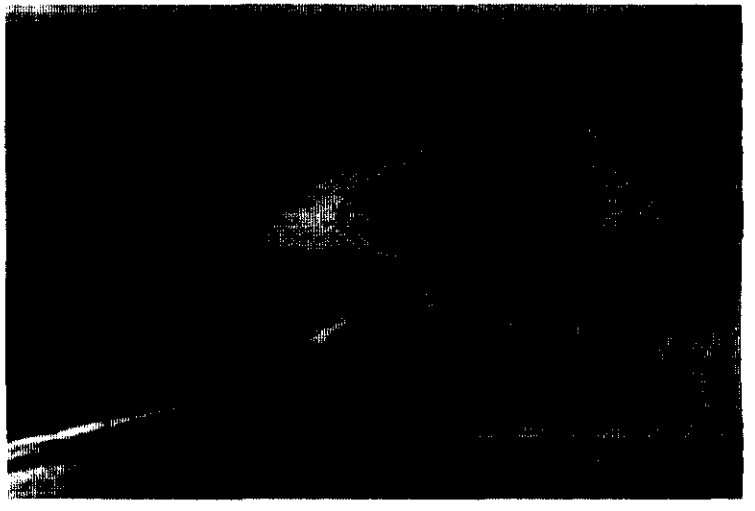
B-3 The Challenges of Landscape Analysis and Evaluation

3-1 Site Selection Criteria for Beaches

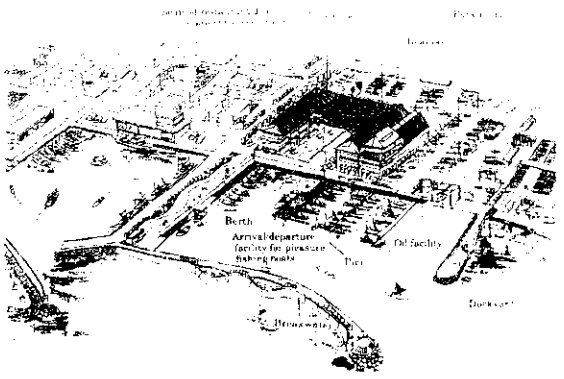
Site selection is based on identifying the opportunities and constraints of an area of land and begins with a complete program. It may follow either of two alternative scenarios: First, the investor may propose a development for a specific site, which he owns or will buy. The landscape architect, based on his site analysis may approve the selection, reject it, or approve it with conditions. Second, the investor may have a program in mind and request his landscape consultant to find an appropriate piece of land that meets the required program.

Beaches require space to provide for the users and protect the natural environment. The beach should accommodate areas for crossovers, setbacks, services, and access to the shoreline for all users without surpassing its carrying capacity. Heavily used beaches should not be located near coral reefs or susceptible natural resources. To protect view sheds and avoid water, air, and noise pollution, beaches must be distanced from industrial harbors, busy roads, boat traffic, marinas, and pollution sources.

Factors that influence the selection of a site for a beach include: sun exposure, water quality, salinity level, water temperature, water depth, beach soils, micro-climate, beach erosion, accessibility, dunes conditions, coastal flora, water circulation, surrounding land use, and beach slope. Today, selecting a suitable site for beaches may apply new techniques



Estimating the carrying capacity and then preparing a master plan for the resort's beach ensures an orderly progression of development and pleasant experience of visitors.



Marina facilities should be thoughtfully laid out and carefully planned since they tend to attract a variety of land uses and services.

for coastal zone planning, including: remote sensing and satellite imagery, aqualung diving, laboratory simulation, and 3D modeling.

Best practices in beach planning include: preparing a master plan for the beach, establishing setback lines, protecting vegetative cover along the beach, monitoring beach erosion, re-nourishing eroded beaches, and establishing beach carrying capacity.

3-2 Site Selection Criteria for Marina Facilities

TDA field investigations concluded that only a few places along the Red Sea coast are suitable for building marinas and related facilities. Its previous studies addressed the issues of designing and constructing the marine structures. This Sourcebook deals briefly with the characteristics of sites that are suitable for marina development. The site selection criteria of marina facilities include the following factors:

- Navigable waters with no obstructions from rocky islands, coral reefs, etc.
- Adequate water depth.
- Minimal tidal influence.
- Adequate foundation material of both land and water.
- Natural shelter to protect from rough waves and wakes.
- Adequate waterfront to allow easy access of boats.
- Close proximity to existing roads.
- Minimum effect of water currents.
- Connection to roadways that can handle traffic and boat trails.

Sufficient land area to accommodate related facilities.

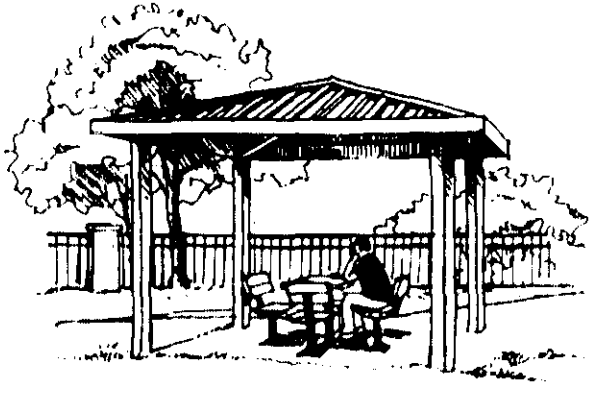
Eventually, small boat use is expected to increase and become an even

more popular recreation activity than others along the Red Sea as costs of boats go down. As potential boat users see launching zones and boat service areas develop, they will be encouraged to engage in this recreation. Those who are not will most likely become involved in fishing. As a result, clustering fishing piers with boat launching facilities and boat mooring piers is now considered a good practice. Boat launching facilities refer to these primary support facilities as appropriate for boat launch areas and include parking, trailer storage and ramps. Fishing piers refer to bridge-like structures reaching from the shore into the water. They provide easy access for fishermen to deeper water close to shore. Boat mooring piers refer to shore facilities for short term, water-related visits to the shore. Because marinas vary greatly in their design, function, location, and capacity, it is difficult to conclude which best practice can apply to all types of marinas.

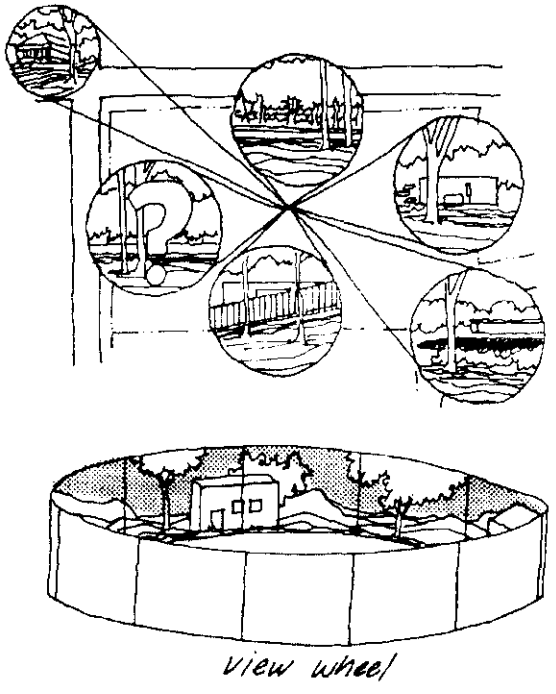
3-3 Site selection Criteria for Outdoor Recreation Spaces

Successful outdoor recreation spaces result from knowledge of various fields such as design, planning, and behavioral sciences. These fields provide alternatives for using leisure time, space, energy, and money. Recreational areas are classified according to their scope, size, client, or location including:

- Children's Play Lot: ½ acre to one acre
- Cluster Playground: 3 to 10 acres
- Village Park: 15 to 25 acres
- Tourism Center Recreation Complex: 100 to 150 acres
- Natural Environment Area: 5 acres minimum
- Nine-Hole Golf Course: 75 acres [or 150 acres for 18 holes]



A village park tends to be the hub of many active recreation activities, and therefore, requires a variety of supporting res t areas, shelters, and family picnic facilities.



The visual survey of a site can be carried out in different ways. One method is to sketch or photograph different ways. One method is to sketch or photograph different directions of the site to record a number of significant views from a specific vantage point. The view wheel is another method where a three hundred and sixty degree view wheel is prepared by patching a series of panoramic photographs together.

- Campground: 90 to 120 units per area

Outdoor physical recreation areas in a typical resort serve three types of activities: water sports, competitive land sports, and moving sports such as walking, hiking, bicycling, horseback riding, and mountain climbing.

Best practices in designing outdoor recreation areas include:

1. Children play lots should be located within walking distance of guest.
2. Night lighting of outdoor facilities is a necessity since it extends the use through the evening and reduces vandalism and accidents.
3. The landscape programs of these areas should aim at attracting the visitors to participate in a variety of recreation, education, and cultural activities.
4. The programs should ensure a balance between:

- Outdoor recreation and indoor recreation;
- Physical active recreation and passive recreation;
- Social activities and quiet areas;
- Individual sports and team sports;
- Children's games and older youth and adults;
- Participant involvement experience and spectator involvement games;
- Water recreation and land recreation;
- Organized sports and unstructured recreation;
- Winter activities and summer activities; and
- Daytime activities and evening activities.

3-4 Methods of Visual Resources Management

Today, most tourism developments require a detailed visual analysis. The Red Sea coast from Safaga to Shelatin contains rich visual resources that

should be surveyed, recorded, analyzed, and evaluated before any further developments are planned or implemented. A landscape architect who specializes in visual resource assessment should be included in the team who will prepare this study for each geographic sector. Based on such a study, TDA can proceed with confidence on encouraging tourism growth while preserving and enhancing the visual characteristics and scenic qualities of the region.

The recent Visual Resources Management (VRM) methods and techniques used by U.S. Agencies are especially helpful to tourism planners. TDA has the choice among four primary approaches of visual assessment. Any of these approaches are effective in assessing the visual resources of the Red Sea coast. These approaches are: a) the psychophysical, B) the expert, ac) the cognitive, and d) the experiential.

a) The Psychophysical Approach focuseson surveying the tourists' preference of specific qualities and elements of the surrounding scenery including the panoramic landscapes, feature landscapes, enclosed landscapes, focal landscapes, canopied landscapes, detail landscapes, and ephemeral (or short lived) landscapes.
b) The Expert Approach depends on the evaluation of the visual qualities by trained experts whose background incorporates design and environmental studies.
c) The Cognitive Approach emphasizes human meaning associated with landscape properties.
d) The Experiential Approach stresses public participation as it considers landscape values based on interaction of visitors with the landscape.

B-4 The Challenges of Landscape Master Planning

4-1 Programming the Outdoor Spaces

According to TDA regulations, 80% of the land area used for tourism projects should remain open spaces. Buildings and light structures cover the other 20%. This large outdoor area represents major investment. Since tourists do not swim, dive, as sunbathe all day, the need exists for a variety of outdoor activities to occupy their time, and that requires preplanning.

Some tourism projects function poorly, and their open spaces discourage visitors' use. Experts believe that a root failure of projects lies in their poor programs. A landscape architecture program is a written and graphic document that records client needs and gives essential instructions to the design, implementation, and operation teams of the project. It ensures the quality of the outdoor living experience and the efficiency of the day-to-day operation. A good landscape program should:

- List the expected activities, by whom, and with what purpose;
- Propose a number of places where physical form and human activity are ideally associated;
- Specify the intensity and timing of use;
- Determine desirable connections;
- Synthesize the views of developers, managers, users, and designers; and
- Coordinate with the architectural program.

4-2 Planning the Outdoor Circulation System

A primary criterion for a pleasant resort area is a successful circulation system. The success of circulation systems depends on safety, efficiency, amenity, and cost. Roads, bikeways, and pedestrian trails are the means of circulation within tourism developments. When they are well thought out, they improve the project's functional efficiency and social life by providing:

- Space for waiting, socializing, entertaining;
- Location of utilities;
- Network of safety services;
- Visual orientation; and
- A resort identity, character, and theme.

Since walking is the most frequent means of movement within a tourism center, the landscape architect should note that:

- most places are seen by the pedestrians,
- most viewing are from eye level,
- speed and line of movement influence the level of details noticed,
- pedestrians are sensitive to the texture of their path and are conscious of distances, and
- pedestrian flow may be induced, arrested, divided, pooled, channeled, directed, diverted, or accelerated by detailed landscape design.

Best practices in circulation system design include:

- using an interdisciplinary team approach to system design and planning;
- providing a hierarchy of streets, bikeways, and trails.
- focusing on safety and amenity while planning the alignments;

- striving to achieve maximum efficiency and economy;
- taking advantage of landscape amenities, scenic views, and natural features;
- separating vehicular traffic from pedestrian flow;
- allocating adequate and continuous pedestrian paths;
- diversifying the experience of the users of the circulation systems;
- economizing in the initial and running cost of the circulation system;
- evaluating the circulation before, during, and after implementing the system, and
- planning circulation routes with due regard for the handicapped.

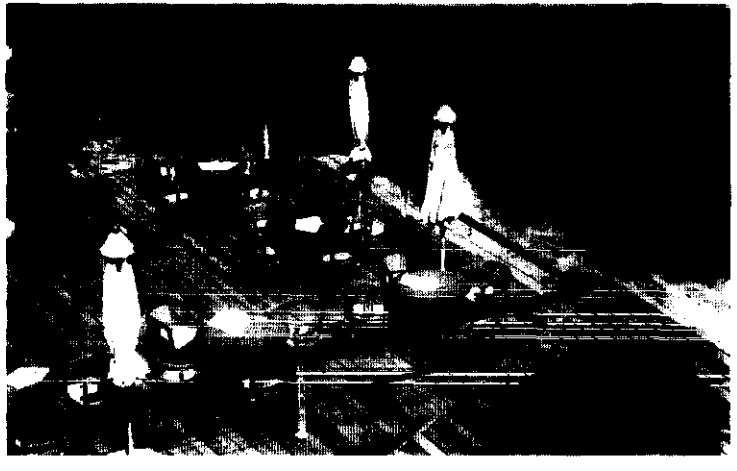
4-3 Designing the Outdoor Rooms

Outdoor spaces are different from architectural space in terms of their scale, looser boundary, informal geometry, subtle connections, changing microclimate, and limited kinds of materials and elements. It is important to treat the site as a series of outdoor rooms, to visualize its human experiences, and to enhance its three-dimensional organization of spaces.

The success of an outdoor room is based upon design criteria that include:
- the relationship of each outdoor room to the site, its circulation, and buildings;
- the interrelationship among different outdoor rooms;
- the relationship of exterior activities to the surrounding landscape; and,
- the functional relationship within each outdoor space; and
- the visual composition of each outdoor space.

Outdoor spaces differ in their function, size, orientation, treatment, and user. These spaces include: children playgrounds, picnic areas, camping

Separating vehicular traffic from pedestrian circulation flow ensures safety of guests and efficiency of operation.



A primary criterion of designing a successful outdoor room is to maximize its interaction with surrounding landscape amenities.

grounds, fishing areas, beaches, canoeing area, rowing areas, tot lots, outdoor cafes and restaurants, private gardens, golf courses, swimming pools, rock climbing sites, parks, marinas, terraces, roof gardens, plazas, amphitheaters, sports fields, boardwalks, and hiking. Also, biking, horseback riding, jogging, and fitness trails.

Outdoor spaces should provide the tourists with certain human experiences including:

- a free choice of activity,
- an opportunity to relax,
- a change to engage in physical activities,
- a possibility to build new friendships,
- an opportunity to learn about nature, and
- a chance to experience new lifestyles.

Best practices in designing outdoor spaces include:

- defining the boundaries;
- providing protection from the climate;
- let the site character suggest the design concept;
- consider the views from inside it, as well as from the outside;
- plan for the inevitable seasonal change;
- design for daily cycles;
- provide focal point for orientation;
- develop comprehensive program for each space; and
- plan the entrances and approaches with care.

B-5 Best Practices in Detailed Landscape Design

5-1 Earthwork and Landform

Grading is an act of remodeling the form of the land and it always involves some degree of soil movement. It can solve technical problems like saving trees and preventing soil erosion. Also, it aims at:

- Creating flat areas to site buildings, outdoor spaces, and parking lots,
- Developing circulation networks flat enough to travel on, and
- Providing design special effect, such as soil mounds to screen views or provide privacy.

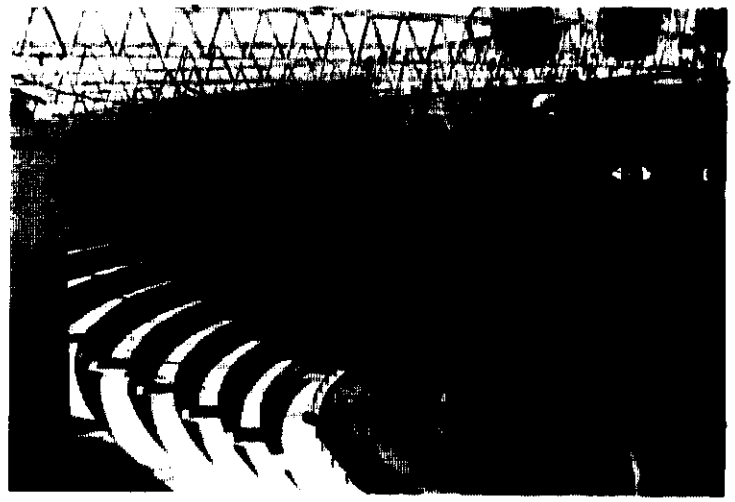
Every region has its own family of landforms, a combination of wadis, hills, convex or concave slopes, ridges, summits, caves, depressions, and cliffs. Normally, some slope is necessary to allow excess water to drain. When a site planner changes the landform, various changes occur including the drainage patterns, natural vegetation, soil composition and erosion.

A grading plan directs all earth moving operations. A successful grading and land forming scheme should:

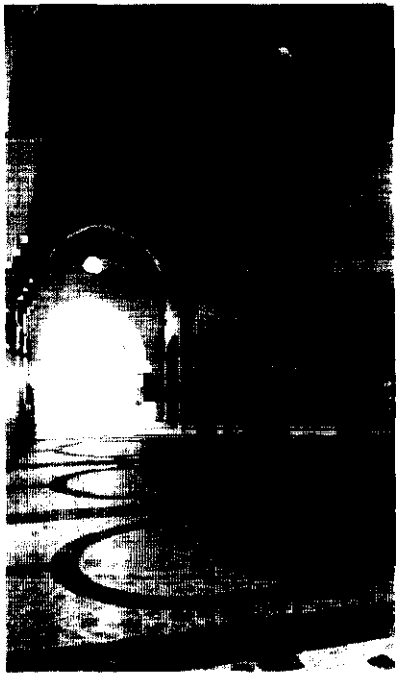
- Identify topographic features and address its problems and opportunities,
- Minimize and balance cut and fill,
- Avoid major disturbance of the natural drainage system, natural vegetation cover, and natural soil composition.

Best practices in grading focus on five strategies including:

- Reduce the area to be graded;



Identifying different landforms helps in selecting appropriate site for different exterior activities, e.g. a concave slope is ideal for outdoor amphitheatre.



A large vocabulary of paving types, colors, textures, and patterns exist.

- Use multi-story building;
- Break the large flat use area into several smaller ones;
- Change building orientations and the site configuration;
- Regroup small land parcels by applying incentive zoning, such as Planned Unit Development (PUD) to allow investors land development options, while still protecting the unique natural amenities of the site.

5-2. Paving

Comfortable and beautiful paving can make walking an enjoyable experience. Therefore, an important task in preparing detailed landscape design is selecting outdoor paving materials. Selecting a specific paving should result from careful study and knowledge of materials since it can influence pedestrians in many ways: a) it can guide the movements; B) it can channel the direction of pedestrians; it can prevent or discourage their encroachment on certain areas, or it can slow down the flow of pedestrian traffic. The choice of any material for the exterior space is determined by its texture, pattern, and color, as well as:

- The function of the paved area;
- The type of traffic anticipated;
- The conditions of the site;
- The availability of materials;
- The availability of the skilled work, and
- The costs of installation and maintenance

Available types of paving materials include:

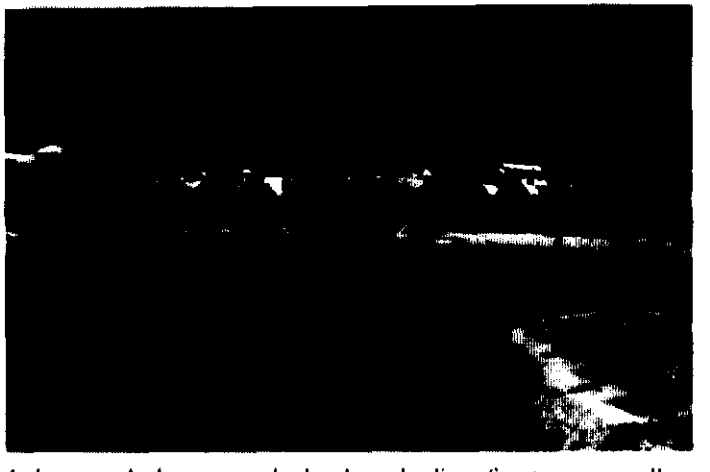
- Brick or pre-cast pavers,
- Concrete or stamped concrete,
- Stones (natural and cut),

- Terrazzo,
- Turf pavers,
- Asphalt,
- Gravel,
- Stabilized soil,
- Graded and compacted earth surface, or
- Wood boards.

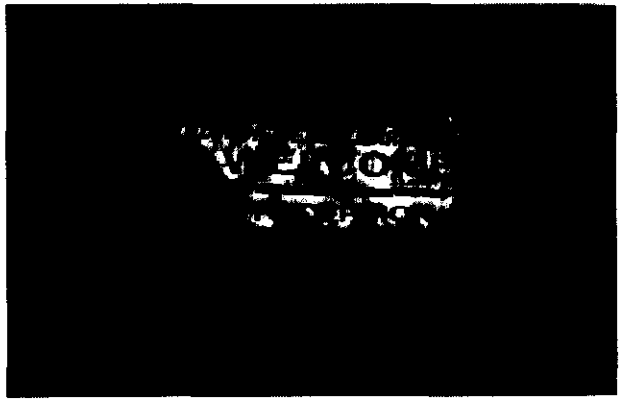
5-3 Water Features

Designers use water and water features in the landscape for different utilitarian and aesthetic reasons including human consumption, irrigation, climate control, active recreation, and beautification. In the hot arid Red Sea area certain considerations should be stressed:

- Drinking fountains are a necessity near athletic fields, campgrounds, and other outdoor activities.
- Irrigating plant materials is essential in all tourism projects. Fertilization programs can be carried out efficiently through liquid solvents in the irrigation system.
- Available irrigation methods include: flooding, spraying, and drip irrigation.
- Water modifies the microclimatic conditions at the site scale. Accordingly, the presence of water in a pool, fountain, pond, or spray cools the surrounding air temperature.
- Water is used for recreation as in swimming, diving, snorkeling, water polo, water ballet, fishing, surfing, boating canoeing, etc.
- Water can introduce many aesthetic dimensions in the landscape. It adds serenity, dynamic qualities, pleasant sounds, impressive views,



Lakes, ponds, lagoons and other large bodies of water are excellent modifier of the microclimatic conditions of any site, particularly in the coastal deserts.



Lighting in critical location of the site helps in communicating clear and effective messages to visitors.

and relaxing atmosphere. By its fluid nature, water can take a variety of visual forms including flat, quiet, still, reflecting, turbulent, gushing, exploding, spraying, or dancing. Fountains that use elaborate and multidimensional system are expensive.

Best practices in designing and managing water features in exterior spaces include:

- Conserving and protecting natural water ecosystem including wadis, salt or mud flats, swamps, sabkhas, and plastic and organic clay sites.
- Protecting outdoor water features from severe climatic conditions including exposure to the intense solar radiation, sand storms, saline water, and dusty wind. These are capable of causing considerable and irreparable damage to water and plumbing systems
- Ensuring the efficiency and effectiveness of the irrigation system, so that each plant gets the right amount of water it needs.
- Avoiding wasteful methods of irrigation such as the flooding and spray irrigation systems. Both waste a considerable amount of water through evaporation.
- Blending art work with outdoor water features
- Ensure high quality in designing, installing, and maintaining outdoor water features

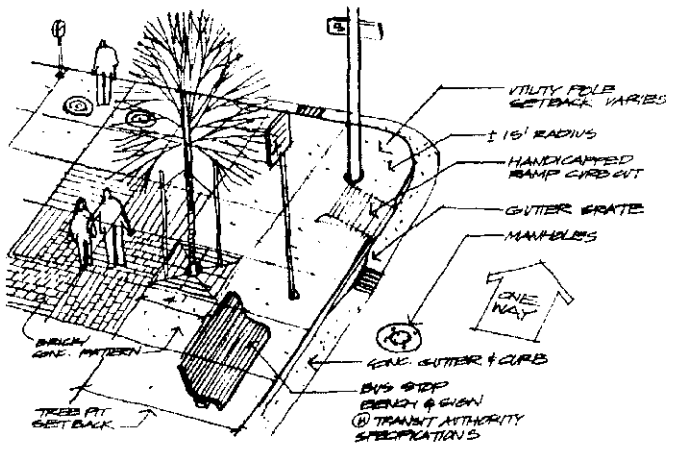
5-4 Outdoor Lighting

The image of a tourism development is enhanced by well-planned outdoor lighting. This adds remarkable dimensions to the experience of visitors. Exterior lighting is not just a decoration, but also an essential element in the landscape that serves many functions including:

- Guiding visitors safely throughout the resort,
- Improving grounds security,
- Allowing longer nighttime use,
- Emphasizing important elements (entrances, facades, etc.),
- Highlighting significant landscape features (fountains, sculptures, trees, marinas, and signs), and
- Creating special effects for unique occasions (Eid, Ramadan, Christmas, weddings, and national festivals).

Best practices in outdoor lighting design include:

- Ensuring adequate functional lighting for security and safety of entrances, walks, steps, gates, bridges, intersections, ramps, dead ends, tunnels, remote exterior spaces, and all circulation routes;
- Retaining a specialized lighting consultant in large and complex projects;
- Balancing the economic advantages and energy efficiency of sodium, halide, and mercury vapor lamps with the human impacts of incandescent lamps;
- Allocating the appropriate amount and type of light for different areas, surfaces, and locations, i.e., residential use, public use, etc.;
- Using light to produce dramatic effects in planted areas;
- Coordinating tall outdoor lamps with adjacent hotels to prevent glare inside rooms and suites;
- Using warm light sources for all pedestrian scale lighting;
- Continuously lighting the primary pathway and boardwalk that parallels the seashore;
- Placing outdoor lighting either above or below eye level to avoid directing it at people's eyes or windows; and
- Planning the night skyline of the coast near tourism areas adjacent to active ports and marinas.



Designing and placing outdoor furniture requires thoughtful process of determining their functional requirements, predicting user's needs, and assessing environmental conditionsof the site. *Source: R. Harris and N. Dines, Time-Saver for Landscape*

5-5 Street Furniture

Street furniture should help establishing outdoor rooms that are functionally useful and aesthetically pleasing. Outdoor spaces are just envelopes where activities are carried out, but within these envelopes tourists need many objects that make outdoor spaces livable including:

a) Objects for functional use such as benches, tables, bollards, walls, fences, gates, lighting fixtures, trashcans, and drinking fountains.
b) Objects for comfort such as shelters, kiosks, guardrails, steps, ramps, trellises, and umbrellas.
c) Objects for aesthetics including sculpture, fountains, flower pots, and murals, and
d) Objects for information like maps, flags, signs, directional signs, clocks, and symbols.

The landscape designer should harmonize all these parts into a coherent whole, since they often tend to be too numerous, wide in range, and serve too many functions. Outdoor furniture set the dominant quality of the resort's exterior environment since they are constantly used and seen by the guests. They may be small in scale, but should neither be randomly added at the end, nor picked up quickly from catalogues.

Best practices in designing outdoor furniture include:

- Spending the time and money in selecting, designing, and placing different types of furniture;
- Assigning a team of a landscape architect and an industrial designer to deal with outdoor furniture issues, in coordination with the architect, engineer, and the hotel manager;
- Visualizing the daily experience of the visitors before deciding on

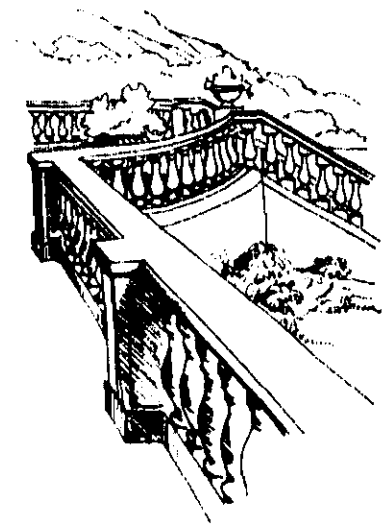
placing elements like public telephones, trash cans, beach showers, bike racks, benches, lights, and drinking fountains;

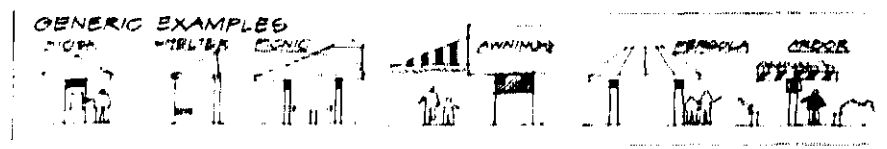
- Coordinating the colors, forms, materials, textures, and relationships of outdoor furniture, lighting, and signage system within each project and/or tourism center; and
- Regulating and clustering signs, furniture, and lighting fixtures wherever possible since they often clutter the landscape and overwhelm the view.

5-6 Outdoor Structures

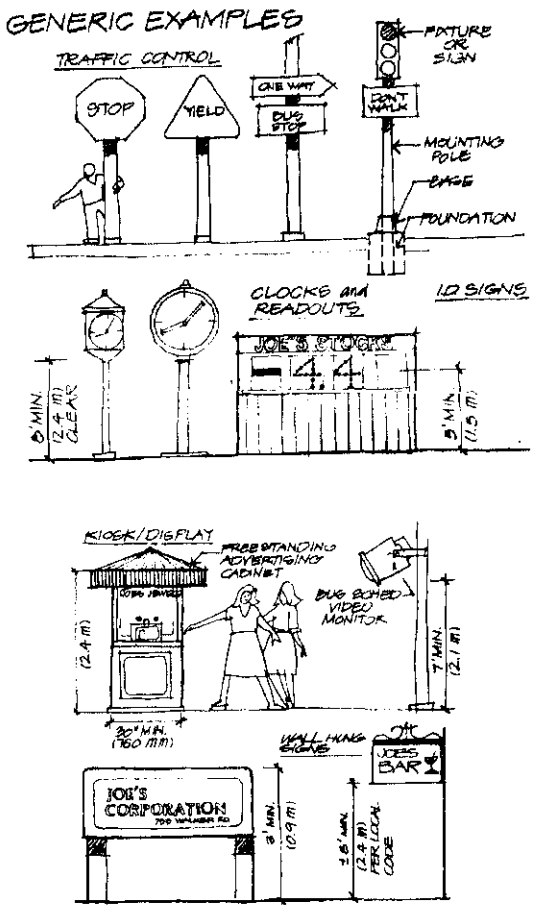
Outdoor structures are single purpose buildings that are primarily designed and used in the exterior space. Most projects entail the use of more than one outdoor structure. Each of these small buildings performs a special function. They may provide shade, shelter, information, recreation, socialization, and communication to the guests throughout the site. They include:

- Pavilions and gazebos
- Gates and portals
- Pergolas and arbors
- Wooden decks
- Music band kiosks
- Tents and canvas structures
- Picnic shelters
- Bus shelters
- Steps and ramps
- Walls and fences
- Children play equipment
- Telephone booths





Outdoor structures vary in their function and construction method. A familiarity with alternative prototypes helps in providing functionally useful and aesthetically pleasing outdoor space.
Source: R. Harris and N. Dines, Time-Saver for Landscape Architecture, 1990.



Signage system standards and guidelines may be included in the original landscape development master plan to ensure a sense of unity among various generic types of signs.
Source: C. Harris, N. Dines, Time Saver for Landscape Architecture, 1990, McGraw-Hill Co.

- Bollards
- Seats and benches

Just like other aspects of the detailed landscape design, outdoor structures should be carefully selected and sensitivity used as an integral component of the landscape composition. Without careful design, they can clutter and uglify the tourism complex, or through coordinated and elegant design, can add an accent of a gaiety, touch of beauty, and/or a sense of history to the most ordinary elements of the outdoor environment. Since outdoor structures are placed near the users, their detail and arrangement influence the total image of the project. They can be built in many materials including wood, metals, concrete, brick, stone, concrete blocks, plastic, and canvas. The properties of each of these building materials are different and so the methods of working with each material – the shaping, fastening, preserving, maintaining and finishing – are also different.

5-7 Signage System

Landscape designers should aim at clarifying and regulating the flow of information throughout the site by ensuring that each sign is accurate, appropriately placed, and intelligible. Planning the signage systems should be treated holistically and not in a piecemeal approach since it affects the image, quality, and safety of the entire development. Five types of signs exist including:

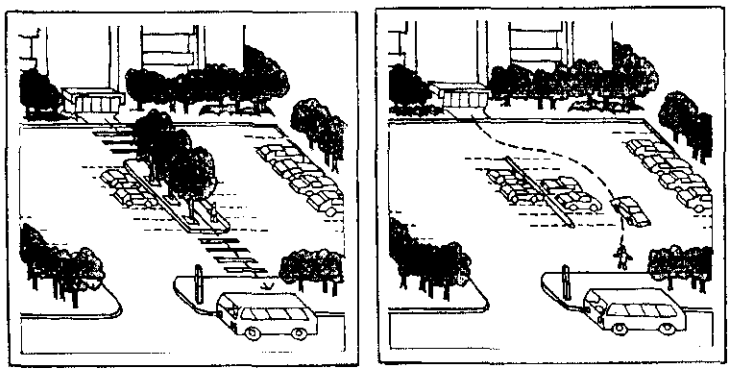
a) Directional Signs
b) Identification Signs
c) Information Signs

d) Regulatory Signs
e) Confirmatory Signs

The competition for the attention of a pedestrian or driver could turn these types of signs into a sea of conflicting graphics and verbiage which confuses instead of informing and guiding the visitors. Signs that are perceived as ambiguous, redundant, or useless could also distract visitors.

Best practices in designing signs in tourism areas include:

- Grouping various signs into clusters based on the five categories of signs.
- Planning, unifying, and coordinating each category in terms of lettering style, color scheme, lighting and overall design.
- Initiating design controls and landscape standards that govern all site elements including signs, paving, street furniture, lighting, and all other elements.
- Developing codes that define the size, type, number, and placement of commercial advertisements.
- Providing travel-information centers in strategic locations to disseminate maps and brochures.
- Highlighting needed Information and orientation/directions to important destination points.
- Creating a Hierarchy of Signs serving primary vehicular movement, and then secondary and/or pedestrian movement.
- Celebrating chosen character in signage design to reflect the architectural style of proposed buildings.
- Determining the appropriate languages. In Egypt, signs should be at least bilingual in Arabic and English, in addition to clear pictographs.
- Selecting the appropriate building materials and posting technique



A major concern in parking design is to provide safe and experience for visitors as the move from the vehicle to the reception lobby.
Source: Canadian Mortgage and Housing Corporation, 1980.

5-8 Parking Design

Parking of cars, vans, buses, campers, small carts, pickups, large delivery trucks, and all other service vehicles is a major site planning problem. The significance of designing and locating parking facilities is due to the reliance of most visitors and workers on the car for moving around the resort area. Parking types vary, and each of the five existing types has advantages and disadvantages. These include:

a) On the street .
b) In small parking bays along the road .
c) In large parking lots .
d) Underground below main buildings .
e) In multi-story garages .

Best practices in parking lot design include:

- Providing safe access and egress.
- Develop a pleasant transition and progressive experience form the parking lot to the hotel entrance.
- Experimenting with alternative concepts, shapes, and circulation flow lines before selecting a parking layout.
- Providing logical circulation among the resort entrance, approach, parking, and reception lobby.
- Accommodating all vehicles efficiently and safely in terms of their maneuvering dimensions,
- Ensuring ideal gradients, optimum turning radius, and appropriate aisle and stall widths.
- Providing the kind of paving that visitors prefer.
- Segregating different traffic types, particularly cars, buses, and service

vehicles.

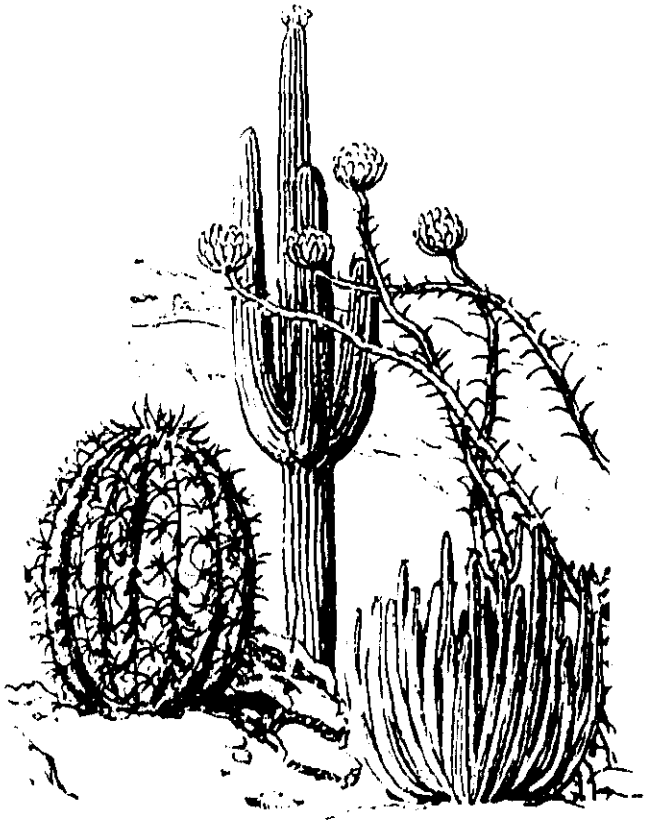
- Improving the landscape design quality of parking lots by introducing plants and dividing large lots by raised planting boxes.
- Screening large parking lots by using berms, evergreen hedges, or combination of both.
- Considering handicapped parking needs by providing stalls of extra width, depressed curbs, and reserved parking spaces near the hotel entrance.

5-9 Planting Design

The primary objective of planting design today is to solve environmental problems. However, planting and landscaping are complex components along the Red Sea region due to its arid climate, strong wind, salty sea breeze, limited water resources, and hot temperatures. These are compounded by typical impacts of urbanization including the increase of harder surfaces that collect and radiate heat, the operation of motor vehicles, air conditioning units and other machinery that generate excess heat and air, water, and soil pollution. Also, only a small number of plants are tolerant to such harsh conditions.

Best practices of functional use of plants include:

- Treat plants as architectural elements that form walls, roofs, or floors in order to give privacy, to screen, to reveal a view progressively, or to articulate a space.
- Treat plants as engineering components that muffle noisy sounds, direct and guide vehicular and pedestrian traffic, control natural and manmade glare and reflection, light, movement, and microclimate of the site, soften or absorb noxious gases, intercept dust and dirt particles, cleanse



The uniqueness of desert plants and their successful adaptations to their environment is important to consider.Many of these native plants require only occasional supplemental water. Some stay a lush green on modest amounts.

the air of impurities, and deter soil erosion.

- Treat plants as design devices that control and influence the microclimate through intercepting solar radiation, absorbing sand storms, and controlling wind and temperature.
- Highlight the use of plants as aesthetic feature including as: a unique element, background, foreground, frame, two-dimensional shadows, reflection, and silhouette.
- Exploit the three-dimensional qualities of plants by viewing them as: sculptural, textural, colorful dynamic, visual controllers, complementing, unifying, emphasizing, softening, decorating, or modulating element.
- View plants as multi-use design elements that encompass education and identification, conservation, provision of food and shelter for wildlife, supplying food for humans, and creating pleasant scents.

B-6 Best Practices in Implementation and Operation

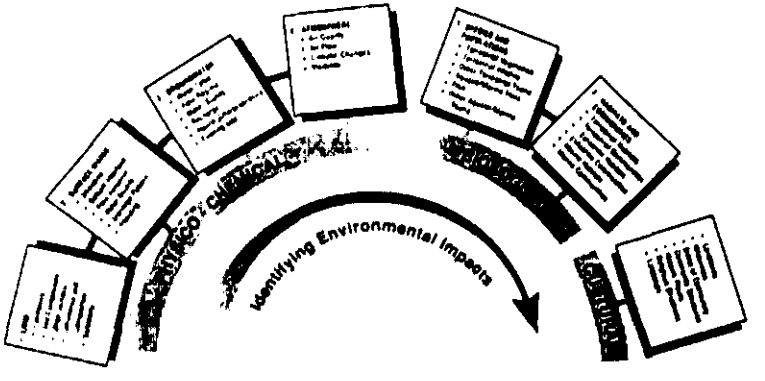
6-1 Assessing the Environmental Impacts of Landscape Projects

Tourism projects require special environmental attention. In certain simple and low impact projects, alternative approaches to the typical Environmental Impacts Assessment (EIA) required by TDA and EEAA are used. These approaches include:

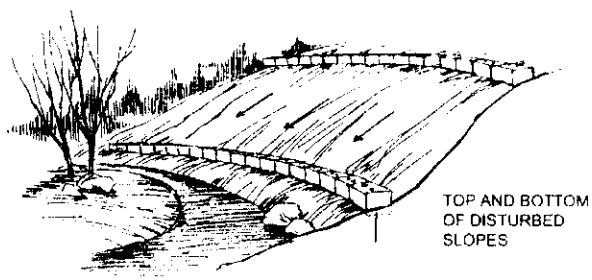
a) design criteria, standards, and/or ordinances,
b) construction supervision programs,
c) sitting criteria, and
d) inspection procedure and auditing programs.

Best practices in environmental impacts assessments of the landscape component of the project include:

- Describe the proposed development comprehensively including each stage of the project cycle.
- Control and monitor the landscape construction stage.
- Control and monitor all elements and activities associated with the landscape operation.
- Control and monitor the decommissioning and restoration stage
- In addition to the "do nothing" alternative, explore adequate number of project alternatives. The conceptual design phase should experiment with variation in:
- Location and alignments of circulation elements;
- Size / location of various buildings;



The simple checklist method of identifying impacts is one of the most systematic approaches used by environmental analysts.



If the grading plan involves distributing or creating a sloped embankment, hay or straw bales should be placed at the top and bottom.These bales help in preventing the eroded soil from washing across the siteor reaching the existing watercourses.

- Size / location of various outdoor areas; and
- General site layouts and servicing arrangements.
- Ensure a simultaneous progress in the landscape design process paralleled to progress in conducting the Environmental Impact Assessment (EIA).
- Draft a clear and comprehensive "EIA Terms of Reference" for the required section on landscape development.
- Determine systematically the potential impacts of the proposed landscape development and environmental carrying capacity of sensitive ecological sites or cultured properties.
- Assess secondary and tertiary landscape impacts, in addition to the primary impacts.
- Maximize the use of quantitative analysis of
- Treat mitigation as a tool for landscape enhancement.
- Define the carrying capacity of different outdoor spaces.
- Consult with potentially affected people and organizations.
- Prepare a Regional Environment Impacts Assessment (REIA) to address the current rapid growth of tourism along the Red Sea.

5-2 Landscape Construction

Careless construction practices can damage valuable natural features of the landscape, lead to soil erosion, and/or even pollute the coastal zones of the Red Sea. The landscape construction phase starts when the client approves a master plan. It includes three tasks:

a) preparing the landscape construction documents,
b) overseeing the bidding, and
c) administering the construction contract.

The landscape construction documents usually contain:
a) landscape construction drawings,
b) technical specifications, and
c) bidding guidelines.
The landscape architect may be required to perform various other tasks including:
- Estimating the costs of the landscape project,
- Coordinating his work with other design consultants,
- Assisting the investor in conducting and soliciting bids,
- Organizing and managing the bidding materials,
- Answering any questions that future bidders may have,
- Assisting the investor/developer in assessing different bids, and
- Helping the client in drafting the landscape construction contract agreement.

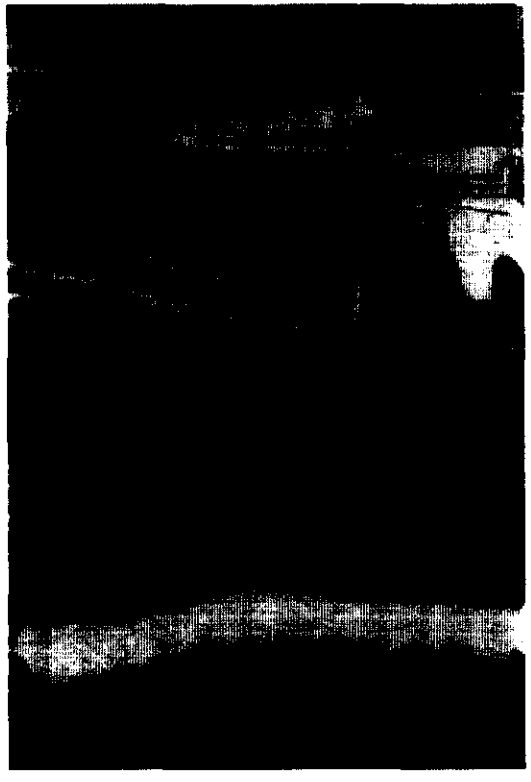
Upon granting the project to a bidder, the landscape consultant may be asked to carry other responsibilities on behalf of the investor including:
- supervising the contractor's work,
- monitoring construction progress, and
- documenting and evaluating the performance of contractors.

Best practices in landscape construction include:
- retaining the services of a landscape architect,
- supervising the construction should be firm, fair, and fast,
- tolerating field adjustments when it is agreed upon by all parties,
- forming a maintenance team in advance and encouraging it to gain understanding of the project installations,
- grading, paving, and installing plants in optimal weather only,
- preparing soil properly, especially for ground cover and plant pits,
- preventing any erosion, dumping, and soil compaction on the site,
- stating the dates and types of inspection visits by the landscape architect,
- adopt cost-effective methods for controlling soil erosion, managing waste disposal, and protecting the landscape amenities.

5-3 Landscape Maintenance and Operation

The management and maintenance of the grounds of a resort is as important as its landscape master plan and detailed design. The landscape management plan should focus on preserving the coastal desert's ecosystem by:
- Protecting all indigenous plants,
- Introducing other species only after ensuring that they are established exotics in the Red Sea region,
- Maximizing the use of compacted and treated sand, rough grass, or wild herbs and groundcover instead of lawns,
- Limiting the use of paving and dense grass to heavy traffic areas,
- Narrowing the use of insect control to times of epidemic outbursts, and
- Preparing and implementing landscape maintenance plan that includes: budget; set of priorities in the form of zoning map (low maintenance zone, medium maintenance zone, and high maintenance zone); timetable of routine upkeep; and guidelines for the intensive care and partial replacement of plants.

The landscape maintenance supervisor is the most crucial person in the operation staff. He/she should have some university education in woody



In large tourism complexes the landscape architect should designate and classify the site into various zones. This is highly recommended since some areas may require intensive maintenance, others medium maintenance, and yet other low maintenance depending on the plants, soils and location.

plants, entomology, plant pathology, weed control, horticulture production, landscape construction, landscape maintenance, and management science.

In addition to maintaining healthy collections of plant materials, he and his crew perform diversified tasks from mowing grass to cleaning swimming pools and removing leaves. Typically, a landscape maintenance supervisor is in charge of the following duties:

a) supervising installation of new plants,
b) supervising the irrigation system,
c) supervising the turf maintenance,
d) managing the application of pesticide,
e) managing the application of fertilizer,
f) managing soils and topsoil,
g) managing pruning and transplanting,
h) purchasing and managing grounds equipment, and
i) maintaining a close contact with the landscape industry.

Best practices in landscape maintenance and operation include:

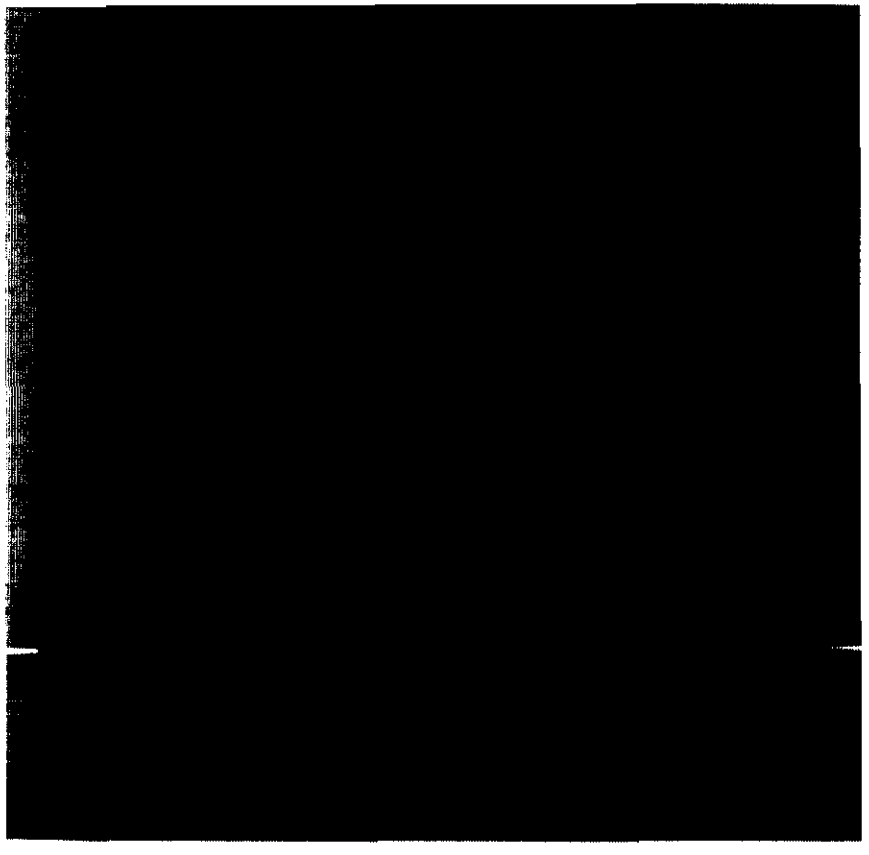
- Maintaining roads, rights-of-way, exterior grounds, golf courses, beaches, and dunes should be carried out by well-trained crews and specialized supervisor.
- Assigning administrative responsibility to a management company or separate department.
- Governing the management company by a charter that is part of all sales and lease agreements.
- Empowering the management company to enforce the environmental standards required.
- Dividing the grounds into low maintenance zone, medium maintenance zone, and high maintenance zone.

- Establishing a record-keeping system to serve the following functions:

a) to remind the management how long a particular task took,
b) to record who performed the work,
c) to register when the work was done, and
d) to state what equipment & supplies were necessary to complete the job.

Environmental Best Practice For Red Sea Tourism Development

Executive Summary



PART C

A. Energy Management

B. Landscape Architecture

C. Landscape Planting

D. Solid Waste Management

E. Water and Sanitation Systems

C

Landscape Planting

C-1 Importance of Planting Design in Landscape Architecture of Coastal Resorts

C-2 Framework of Landscape Planting Design

C-3 Landscape Planting Design Stages

C-1 Importance of Planting Design in Landscape Architecture of Coastal Resorts

1-1 Introduction

Landscape architecture is one of new fields of specialization within architecture and urban design in Egypt.

It started to play a leading role beginning in the early 1990s in association with growing interest in the development of tourist centers and resorts on the Red Sea coast. Landscape architecture has a direct impact in creating an exterior natural environment that meets various requirements and functions including:

- Environmental
- Architectural and Urban
- Aesthetic

This section addresses the planting design process, which plays an integral role in achieving the objectives of landscape architecture. Planting design has an immediate impact on the users' visual perception of the overall tourist product (resorts and tourist centers) as well as the overall tangible image of the property. It also has a very significant environmental return by enhancing and protecting the natural environment of the area.

2-1 Planting Design Team Work:

Planting design within landscape architecture is a team effort with many parties involved working together with continuous cooperation and exchange throughout the phases of planting design process. To achieve the intended design goals, this team is typically composed of:

- Landscape Architect.
- Horticulturist.

The first phase of planting design involves analyzing the site and its data, and studying the requirements of the owner and management companies especially in major resorts and tourist centers. Next, the design phase involves the landscape architect identifying the main ideas and the urban, architectural, aesthetic and environmental goals for the project using his expertise with plant characteristics, site characteristics, and environmental conditions. After approval of the main concepts in the design phase, the team begins developing the construction documents. In this phase, team members cooperate in identifying the types of plants and trees that are most suitable for the site parameters and characteristics and achieving the design goals. Typically, the team prepares a demonstration of some design alternatives within the context of achieving the main ideas and design goals. The owner and management company are given information to choose the best of the alternatives within the budget limits of the project according to various factors and criteria such as costs, maintenance requirements, or the applicable environmental legislation

C-2 Framework of Landscape Planting design

This section outlines the types of plants used in landscape planting design, factors affecting selection of plant elements for landscaping purposes, and plant use in landscaping

2-1 Types of plants used in Landscaping :

1-Trees

Which can be divided into:

A-Deciduous Trees

B-Evergreen Trees

2-Shrubs

Which can be divided into:

A-Deciduous shrubs

B-Evergreen shrubs

3-Grass

4-Ground Covers

5-Climbers

6-Aromatic and Medical Plants

7-Succulents

8-Palm and Palm-like trees

9-Annuals

2-2 Factors Affecting Selection of Plants Elements for Landscaping Purposes

1-Form

2-Color

3-Texture

4-Scale

5-Growth Rate

6-Maintenance and Pest Resistant

2-3 Plants Use in Landscaping:

1- Urban and Architectural Functions:

- Screening undesired views /sights
- spaces formation
- orienting routes
- Embellishment of streets
- Provide privacy

2- Environmental and Climatic Functions

-Protection from sunrays (canopies)

-Protection from wind (wind buffers)

-Blaze Control

-Protection against noise pollution

3- Aesthetic Functions

-Completion

-Unit

-Confirmation

-Softness and leniency

-Aesthetic individual example

-Oriented Vision

C-3 Landscape Architecture Planting design Stages

Planting design is one component of landscape architecture. In general, main stages for landscape architecture include:

1) Data collection and analysis for planting process,
2) Proposed design,
3) Construction documents,
4) Implementation, and
5) Maintenance and Follow-up.

This section presents best practices related to planting design in all these stages, in addition to some important concepts and definitions. It is also important to conduct the landscaping design process concurrently with urban and architectural design and utility development. These other design elements have a direct impact on the success of the project as a whole, and on landscaping development in particular.

3-1 Data Collection and Analysis for Planting Process

The first stage of landscape architecture is aimed at identifying the environmental elements and constituents, whether natural or manmade, and analyzing those assets to develop information necessary for the proposed design stage. The process of data collection is carried out by several professionals and requires some specialized studies and analyses, as described below. The data collection and analysis process for planting design in landscape architecture includes collection and analysis of data for:

- Natural elements.
- Urban and architectural elements.

A-Best practices for analyses and studies on natural elements:

The designer in the Red Sea coast environment must take into consideration the natural elements because they have a powerful influence in the success of the landscape plantings. Elements that should be analyzed are described below.

- Analyze climatic elements

These analyses are important in identifying and selecting the types of plants and trees that suit the natural characteristics and climatic conditions of the site. The required analyses include:

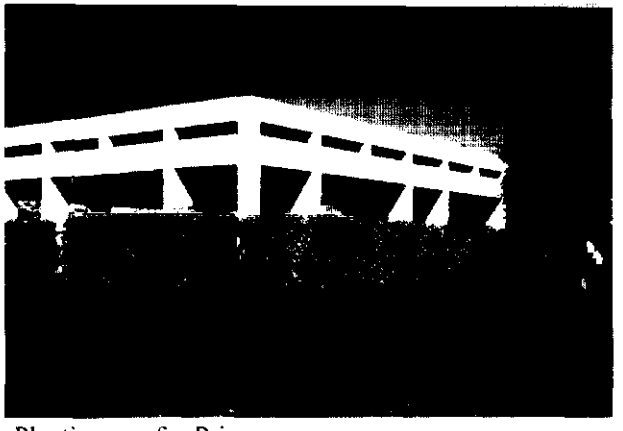
. Temperature .
. Humidity.
. Sunrays and angles throughout the day and year.
. Wind strength, direction and type.

-Analyze soil samples

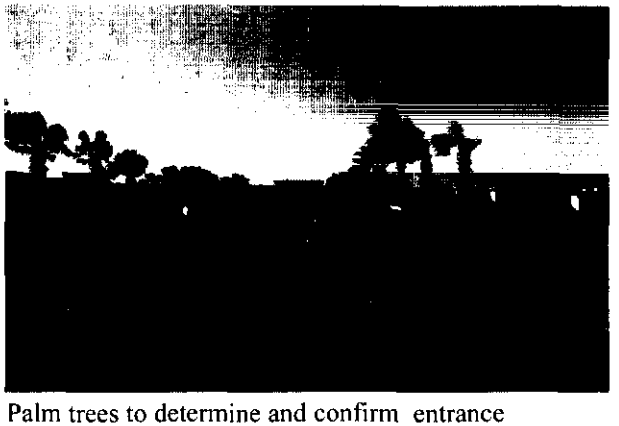
These analyses are also important in identifying and selecting the types of plants and trees that suit the site's natural characteristics. The required analyses include:

. Soil type (sandy, clayey)
. Chemical properties
. Soil permeability

- Identify seawater level and its relationship to the parts of the site in the highest tidal points. This will have a direct impact on the success of the planting process.



Planting use for Privacy



Palm trees to determine and confirm entrance

- Identify the local plants on the site and study the site's vegetation cover as well as its value and significance, in an attempt to benefit from the existing natural characteristics in the conceptualization of landscape architecture. Local plants have special capacities for tolerating the site's natural characteristics and climatic conditions.
- Study the quantity and quality of water available for irrigation under the optimum and best practicable site operating conditions. This would assist largely in determining the arable areas and lands within the context of the water quota for the project. It will help prevent creating future problems for irrigation works in providing adequate water for irrigation.

B-Best practices for urban and architectural analyses and studies:

There are many factors that should be studied and analyzed for use in the proposed design stage. The primary factors include analyses of the site, its urban components, and the functional relationships between its parts, and also some architectural studies related to landscape architecture.

The designer should study and analyze the elements and components of the project to identify the requirements and inputs of each area or space with regard to plants and trees, and the intended function (environmental, urban, aesthetic, visual) to select the most appropriate plants for the required function in the design stage. Such elements include:

- Determine and confirm resort entrance
- Provide visual separation for some project components such as the services/utilities area

- Provide appropriate shades/canopies in the pedestrian pathways
- Protect some spaces and buildings from undesired wind
- Provide appropriate privacy for some project components such as patio and deck areas

The landscape architect must address the plans, elevations and sections of buildings comprising the project to study their relationship with the ambient environment. The objective is to determine how the building outlines control the architectural form and the facades, as well as the significant masses in both volume and height, in order to take these inputs into consideration.

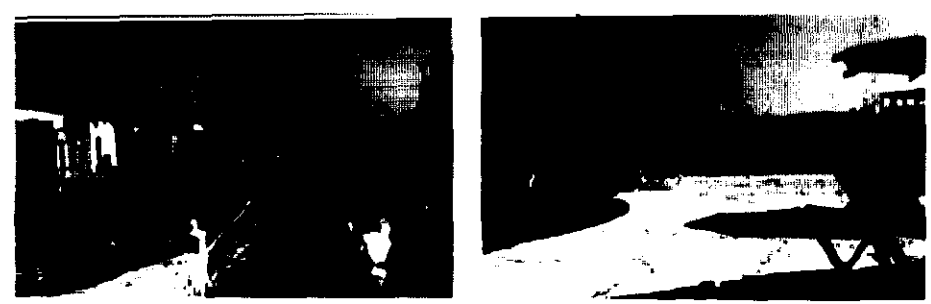
The designer also must study the texture and the external color of the architectural facades to select those elements of plants that are most compatible with the external aspect of the buildings on the site.

The landscape architect must consider the master plan related to the utility networks and systems for the project site. This plan indicates the directions of the network and its pathways as well as the right-of-way, all of which should be taken into consideration in planting design process.

3-2 Proposed Design Stage:

This stage involves developing the final master plan for planting design with all its elements, meeting all the requirements and satisfying all the functions, and taking into account the results of analyses and studies about the project site from the preceding stage. The landscaping design process must be concurrent with the urban and architectural design and

Native Plants in Red Sea Region



Samples of uses the simplicity and Human scale in Planting Design

utility development, in order to create the best alternative solutions in an integral context with the architectural and urban planning. It is also important to ensure cooperation between the landscape architect and the horticulturist to study the best means for selecting the types of plants and trees to ensure a successful design that meets the basic functions (urban, architectural, environmental, aesthetic) for the project objectives. Plant selection should also be consistent with the natural characteristics of plants and trees, the parameters and capabilities of the site and the environment, and appropriate operation and maintenance requirements.

Climbers Plants used on Southern and Western Facades

Designers must avoid using Needle plants in Paths and beside seatings

Best Practices and Principles in the Proposed Design Stage:

1-The landscape architect must be completely familiar with and understand the previous stage of analyses and studies and their results, and how they reflect directly and indirectly on the design stage.

2-To facilitate starting the planting design process, there should be a general concept to connect various areas of the site together and to create a distinguished feature for the project. Then, the areas of the site should be designed individually within context of the general concept.

3-Use native plants because they can tolerate the environmental conditions and natural characteristics of the area, and are generally the most successful.

4-Avoid planting trees in the pathway of utilities to prevent damage in the future from tree growth.

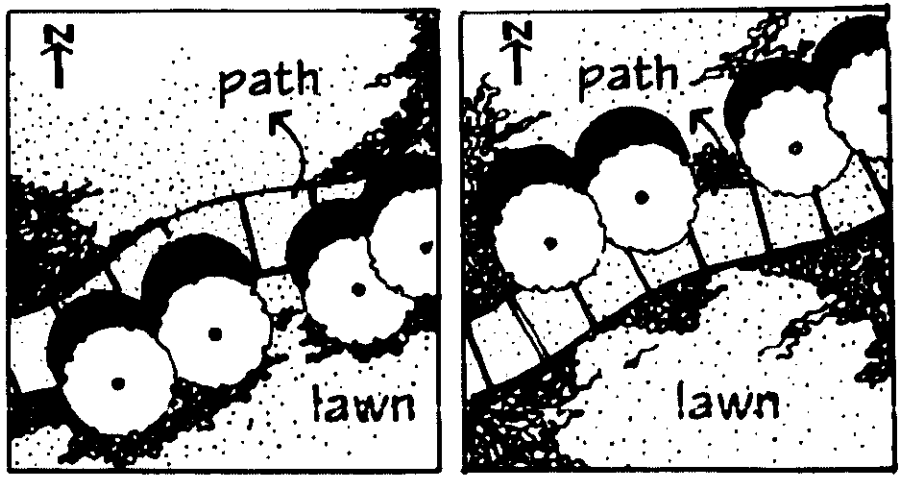
5-Avoid, as much as possible, using plants that produce seasonal pollens that could cause sensitivity problems for some people.

6-Avoid planting evergreen trees in the middle of green grass areas, as this would cause permanent shading leading to damage of the grass below.

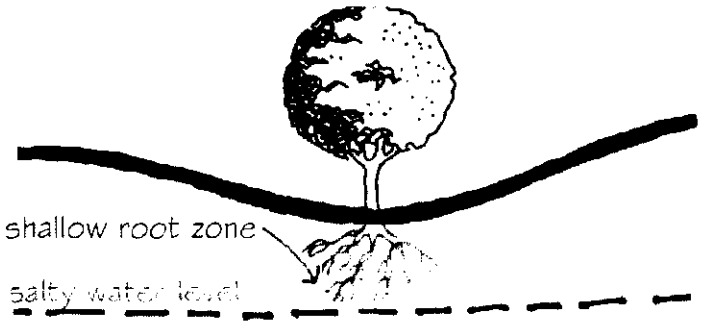
7-Avoid using trees with fruit, seeds, or poisonous leaves, especially in areas of public parks for children, and avoid trees that have thorns, especially beside pedestrian pathways or seating areas.

8-Use evergreen or climbing plants or trees in the southern and western facades, which can greatly contribute to protection from sunrays and moderate the temperature of these surfaces, as well as reducing power

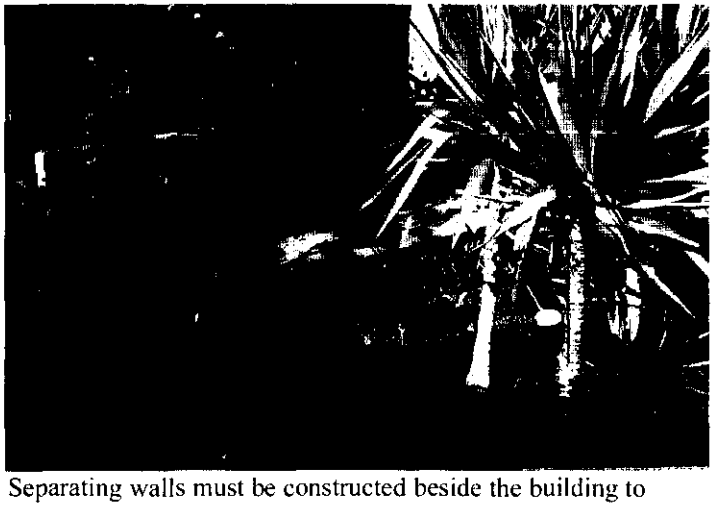
Cacus and Rocks are used in Planting design



Plants positions in paths should planted to give shadow on path



Shallow root zone Plants should planted in Low lands to avoid negative impact of salty water level



Separating walls must be constructed beside the building to protect it from execed irrigation water

consumption rates in an indirect way.

9-Avoid using deep rooting trees beside light construction works, such as fences or retaining walls, because future root growth can lead to the emergence of cracks and fissures therein leading to their collapse and causing direct financial losses.

10-Some types of plants are highly sensitive to diseases and pests, and create a habitat for such diseases. A designer should not use these plants, except in rare situations where they will be subject to maintenance and continuous monitoring.

11-Incorporate some design concepts using selected natural materials and elements such as rocks, fossilized trees, and gravel, in addition to creating some areas of special native plants such as cactus and desert plants. Known as zeriscape, these design concepts create an environment compatible with the surrounding climate and reduce the need for providing irrigation water.

12-When planting trees beside pedestrian pathways to provide appropriate shading during daylight, the sun movement should be studied as well as the location of tree planting to provide the maximum shading possible.

13-When used for shading purposes, trees must be horizontally branched and rapid growing. Deciduous trees should be planted in the winter to ensure maximum survival after planting.

14-Avoid planting deciduous trees beside the swimming pool to reduce the burden of maintenance and cleaning from falling leaves.

15-Areas with highly saline groundwater that is close to the soil surface, especially if they are low-lying areas, require special consideration. In such areas, the landscape architect must select trees and plants with shallow root zones to avoid the negative impact of the salty water.

16-When establishing wind buffers, the selection and design of trees must be appropriate for this function. The designer should consider selecting evergreen and rapidly growing trees with pin-like (thorny) leaves that are wind resistant and can be planted closely together and grow vertically.

17-Avoid planting green grass areas directly beside buildings. A distance of 50 cm of gravel must be left in between buildings and the planted area, or build a separating wall beside the original wall of the building, to prevent damage to facades, foundations or grounds from storm water or excess irrigation water.

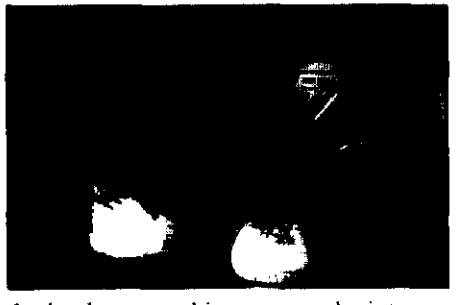
18-Use climbing plants in large areas to be cultivated or covered, as they require limited water quotas when compared to the surface cover they provide.

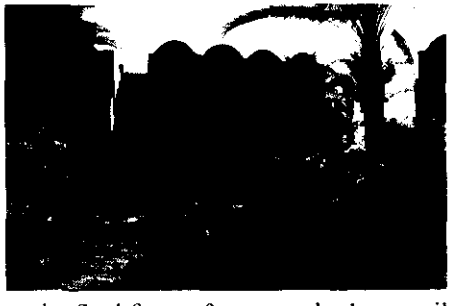
19-The landscape architect should consider the irrigation methods when selecting the types of plants and trees, and their water requirements relative to the water quota throughout the day for the project. The landscape architect should avoid the selection of plants requiring varied irrigation water requirements in the same integral formation.

20-Avoid as much as possible the planting of trees in areas that are close to the sea and are exposed to wind and humid air coming from the sea direction, which would lead to death or damage of these trees.

Sample of planting on beach

21-The landscape architect must take into account the final form of trees or shrubs or soil cover after their complete growth, especially on the design of the configurations or groups. The final composition may change completely and the needed visual image may change.





the landscape architect must take into account the final form of trees or shrubs or soil cover on their complete growth,

Use the climbing plants in the large areas to be cultivated or covered, as it requires limited water quotas if compared to the covered surfac

3-3 Construction Documents:

This stage is a sequel to the master planning stage, and is the step where the landscape architect provides all the drawings and documents (plans, sections, elevations and details) and the bill of quantities and specifications for all the landscaping elements. These will be provided to the contractors assigned to perform the landscaping tasks to prepare for implementation. Construction documents include:

1-Planting Plan
2-Irrigation Plan
3-Planting Details
4-Irrigation Details
5-Bill of quantities and specifications for Planting Plan
6-Bill of quantities and specifications for Irrigation Plan

3-4 Implementation Stage:

1-Definition

This is the initial implementation stage of landscape planting. It is very important because imperfect implementation due to unfamiliarity of owners or management company executives with the basic principles can lead in the future to financial and environmental burdens.

2-Best Practices and Principles in the Implementation Stage:

1-Planting should be implemented during the best time for planting and in coordination with site construction. The best time to start cultivation is in the months of February and March when the temperature is most suitable for agriculture, and cultivation is best managed in the early morning. Also, for some projects, implementation of planting should precede or be concurrent with on-site construction works, especially for slow-growing plants, to ensure that they have grown appropriately by the inauguration of the resort. This requires complete coordination with the quantity of water available for irrigation during this stage. Measures and precautions should be developed to protect these plants during on-site construction.

2-Deciduous trees or plants must be planted inside containers. In case of planting during summer, it is preferable to avoid this, but if necessary those trees should have been cultivated in boxes or barrels. Evergreen plants must be grown with adequate time in big containers or wooden boxes or barrels before planting.

3-Areas for landline planning must be dug and cultivation must be arranged for those specified areas according to the plans and construction documents.

4-The arable soil must be prepared to be free of stains and construction wastes. The line should be filled with arable soil. It is preferable to mix organic compost fertilizers with the soil, with addition of super phosphate fertilizers and a fungicide to avoid any infections with fungi after cultivation.

5-Avoid transferring clay soil from the Nile Valley to the site. This type of soil might be infected with some pests or diseases, which would transfer these pests or diseases to the new site and then to adjacent sites.

6-Trees and shrubs should be planted in the middle of the landlines and on a similar line. After cultivation, apply irrigation with abundant water and stabilize the soil around the plants firmly.

7-Tree supports are measures that provide for sound tree growth in a vertical position to avoid bending, which affects growth and its appearance. Supports must be located in the heavy wind direction to protect the stems, especially in the early stages of growth. Supports can have varied and miscellaneous shapes, which must not affect the tree body.

Tree Trimming is necessary to preserve function and figure of plant

3-5 Maintenance and Follow-up stage:

1-Definition

The maintenance stage begins after the completion of the cultivation process and distribution of the plants by the agricultural contractor (if any). This stage includes irrigation, planning, fertilization, trimming, pest and disease control, damage replacement process, cutting the grass area, and the process of setting the borders. These activities must be conducted by skilled labor, with experience in garden landscaping and familiar with using the required equipment, under the supervision of an agricultural engineer. The maintenance team must understand the nature of plant growth and the objective of the planting design in order to preserve it and achieve successful long-term results.

2-Best Practices in the Maintenance and Follow-up stage:

-**Tree Trimming.** The process of disposal of tree trimming wastes has a direct impact on the environment, whether trimming of dry or dead branches to preserve the aesthetic form of the plants or trimming of branches infected with pests and diseases. The best means of getting rid of these wastes is to cut and bury them in a deep hole to produce compost, which can be recycled to serve as environmentally friendly organic fertilizers.

-**Fertilizing Process**. The fertilizing process is one of the most important factors in the maintenance and follow-up stage. Plants need regular fertilization to preserve their freshness and strength. Stronger plants acquire resistance to pests and infections. The best types of fertilizers are the organic fertilizers resulting from the recycling of trimming wastes.

-**Pesticides and Pest Control.** Experts recommend application of environmentally friendly pesticides to avoid toxic chemicals. Some natural components are now available , and it is preferable to apply bacteriological and fungal components in pest and disease control. This is in addition to the possible use of farmonic traps.

-**Replacement of Damaged Plants**. Any damage in the root leads directly to the death of the plant due to inadequate drainage or the infection from various diseases. When this occurs, the plant must be replaced and it is important to evaluate the causes to prevent further damage to the new plants.

-**Irrigation System**. There is no doubt that the effectiveness of the applied irrigation system has a direct impact on the success of planting and tree planting. Irrigation by spray and sprinkling (mechanical/electric system) encourages water savings. This is consequently reflected in reduced landscape maintenance costs. This type of irrigation system can be adjusted for appropriate timings of irrigation water for the climatic conditions. Irrigation is preferable in the early morning or during sunset to avoid periods of high temperatures to preserve the life of the plants and to conserve water.

Manual irrigation systems that depend on labor are more costly in terms of water consumption. They also lead to misdistribution of water over plants or green grass areas, which leads to some problems due to over-irrigation or under-irrigation.

When using treated wastewater in irrigation, such wastewater must be fully treated to avoid the death of plants and green areas. In case of over-irrigation, it can lead to serious environmental problems, due to

Sample of Irrigation system

Sample of Manual Irrigation

the leakage of too much treated wastewater into the soil and the generation of bad odors, as well as causing health risks to resort visitors and employees.

-**Environmental Education**. The owner or management company may choose to prepare identity cards for each plant including some of its distinguishing characteristics. These cards must be fixed in a sound manner that causes no harm to the plant. These cards serve as educational material for the visitors to the resort.

Environmental Best Practice For Red Sea Tourism Development

Executive Summary

PART D

A. Energy Management

B. Landscape Architecture

C. Landscape Planting

D. Solid Waste Management

E. Water and Sanitation systems

87a

D

Solid Waste Management

D-1 Framework for Solid Waste Management

D-2 Best Practices –Design and Implementation of Solid Waste Programs .

D-3 Best Practices for Construction Waste Reduction

D-4 Best Practices for Resort Operations Waste Reduction

D-5 Best Practices for Waste Disposal sites

D-6 Additional Sources of Information

D-1 Framework for Solid Waste Management

1-1 Background

Solid waste is possibly the most visible and widespread environmental problem on the Red Sea Coast. Solid waste is randomly disposed along roadways and on vacant lands within the vicinity of all construction sites, operating tourism centers, and cities. Litter is widely scattered across the desert and found on the coral reefs and beaches. Solid waste and litter threaten the very foundation of the Red Sea Coast's tourism economy. If solid waste management is not improved, the conditions witnessed in northern (more developed) parts of the Red Sea Coast will become the reality in the south as development progresses.

Good solid waste management requires more than just technical solutions (e.g., facilities and equipment to handle solid waste). It must be carefully developed and implemented. In fact, solid waste management should be just one component of a comprehensive Environmental Management System (EMS) adopted by hoteliers. The Tourism Development Authority (TDA) and RSSTI have extensive information and resources for investors and developers interested in EMS .

1-2 Current Solid Waste Characterization and Management Practices

Problems from improper solid waste management are increasing on the Red Sea Coast. Until solid waste management (and other) best practices are widely implemented by tourism centers, development and human activity will destroy the natural environment (the foundation of the

Benefits of Solid Waste Management Best Practices

- Reduced environmental impacts
- Reduced impacts on tourism business
- Reduced costs
- Improved public image
- Compliance with environmental regulations
- Conservation of landfill space
- Support for local economic and social development

Table I-1. Estimated Current and Projected Solid Waste Generation for Red Sea Tourism Centers (Tons per Day)

Average Waste Generation:	2.18 Kg/GN	
	Hotel Capacity:	
Current	17,021 rooms	
Projected	186,000 rooms	
	Total Generation (Tons/Day):	
Occupancy Rate	Current Capacity	Projected Capacity
50%	19	202
75%	28	303
100%	37	405

tourism economy) on the Red Sea coast.

Construction Waste Characterization

Construction waste on the Red Sea Coast consists of:

- Basic construction wastes like sand, gravel, bricks and concrete;
- Waste generated from excavation of foundations; and
- Other construction materials, such as wood, paints, fiberglass, tile, reinforcing steel and other metals.

Construction wastes are characterized by very little organic matter an low compressibility. Most of the components of construction wastes ar recyclable, although they have low intrinsic value.

Resort Operation Waste Characterization

The waste generation rate ranges from 0.60 to 3.42 kilograms per gues night (Kg/GN), with an average of 2.18 Kg/GN.

Current waste generation from Red Sea tourism centers ranges from 1 to 37 tons per day depending on occupancy rate. This number will jum to 202 to 405 tons per day upon full development of the Red Sea Tourisn Centers . This does not include municipal solid waste from cities o construction waste from tourism development activities

Solid waste from tourism centers is mostly comprised of organics (kitche waste and yard waste), paper and plastic . Together they account fo more than 80 percent of waste from resort operations. Recycling an composting these materials would dramatically reduce waste disposal

Current Solid Waste Management Practices

The observations listed below sum up the current solid waste situatio

for Red Sea resorts and tourism centers.

- With few exceptions, there is no management of construction waste. Construction waste is randomly disposed on vacant lands and along roadsides.
- Waste from resort operations is removed from the property, but is either randomly disposed along roadsides and in the desert, or taken to one of the existing dumpsites.
- All existing dumpsites are poorly sited and unmanaged.
- Litter is a major concern for all Red Sea hoteliers. Litter is caused by random disposal, existing dumpsites, and lack of adequate service in the cities.
- Littering in the sea by the dive boats is another major concern.
- Several resorts have implemented waste reduction measures.

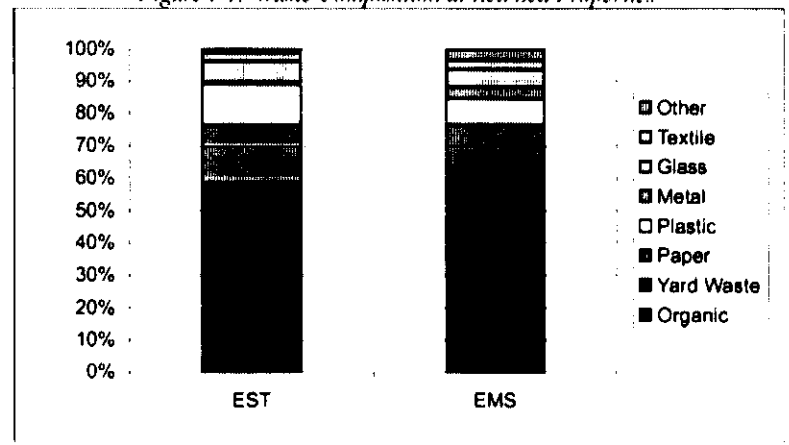
However, little recycling actually occurs. Contractors mix all waste back together when they collect it.

1-3 Regulatory Framework

The primary national legislation related to solid waste management is Law No. 38 of 1967. The Minister of Housing also issued Executive Decree No. 134 of 1968.

Law No. 4 of 1994 (The Law on Environment) has broad coverage over environmental issues. The Prime Ministerial Decree No. 338 of 1995 promulgates the Executive Regulations of Law No. 4, which cover many areas of environmental protection. Other relevant laws for solid waste management are: Law No. 31 of 1976, Law No. 106 of 1976, Law No. 43 of 1979, and Law No. 3 of 1982.

Figure 1-1. Waste Composition at Red Sea Properties



Source: EMS data from PA Government Services (2000), EST data from Winrock (1997)

Note: EST project did not quantify yard waste separately from organics.

Eight Steps to Design & Implement Solid Waste Programs:

Step 1—Incorporate Solid Waste Management into Design
Step 2—Establish Solid Waste Policy and Management Structure
Step 3—Conduct a Waste Assessment
Step 4—Identify Waste Prevention Options
Step 5—Identify Waste Diversion Options
Step 6—Identify Waste Disposal Options
Step 7—Design Solid Waste Management Program
Step 8—Implement and Manage Solid Waste Program

Important Concepts in Solid Waste Management:

Waste Prevention
– Actions to reduce the amount and/or toxicity of waste.

Waste Diversion
– Actions to divert discarded materials from disposal, including reuse, recycling and composting.

Waste Reduction
– Actions that include waste prevention and waste diversion.

D-2 Best Practices –Design and Implementation of Solid Waste Programs.

There are eight steps necessary to design and implement a good solid waste management program. The steps, and the order in which they are presented, are in and of themselves a best practice for implementing solid waste management.

2-1 Step 1—Incorporate Solid Waste Management into Design

Before construction even begins, Red Sea tourism center developers and their design teams must consider solid waste management issues and incorporate them into the design of facilities and infrastructure. Waste reduction can be accomplished without changing the unique character of the resort desired by the developer. When designing a resort or tourism center and preparing specifications for construction, there are many ways to reduce or eliminate waste.

Design for Waste Prevention
Thoughtful design of tourism centers can help prevent waste from being generated during construction and reduce construction costs. Best practices to design for waste prevention include:

- Design in harmony with the site,
- Balance cut and fill material,
- Specify construction materials that eliminate waste, and
- Include reuse in project design.

Design for Waste Management

Tourism centers and resorts should be designed to accommodate and facilitate waste management activities including source-separation, recycling, composting, processing, collection and disposal. Best practices to design for waste management include:

- Identify locations for waste collection containers,
- Provide space for on-site processing, storage and collection of waste,
- Provide space for on-site composting,
- Designate area(s) for construction waste management, and
- Site and design controlled disposal sites.

2-2 Step 2—Establish Solid Waste Policy and Management Structure

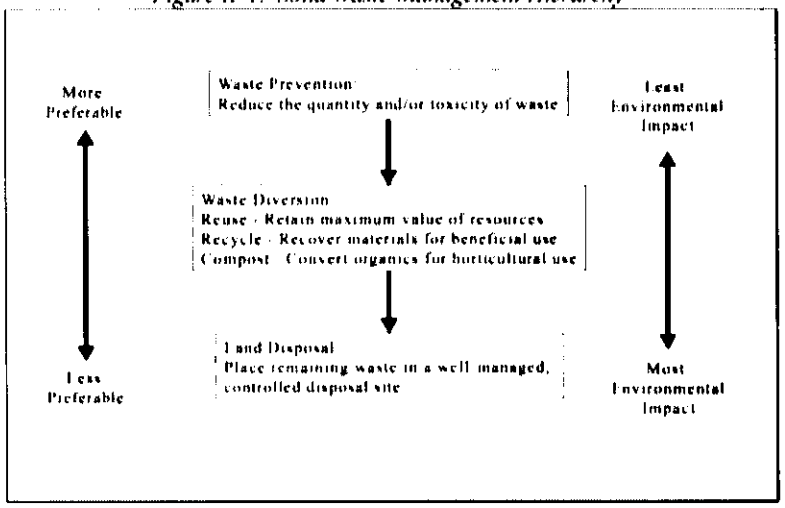
When the resort or tourism center begins operations, it is important to have a solid waste policy and management structure in place.

Establish a Solid Waste Management Policy

Top management must adopt an explicit solid waste management policy as part of an overall EMS policy statement. A written solid waste management policy should state the following at a minimum:

- Commitment to comply with all environmental laws and decrees concerning solid waste management,
- Commitment to the solid waste management hierarchy
- Establishment of a specific solid waste reduction goal (e.g., 50% waste reduction during construction and operations), and
- Establishment of responsibility for management and operation of a solid waste management system.

Figure II-1. Solid Waste Management Hierarchy



Appoint a Solid Waste Manager/Team

Company management must appoint staff who will be responsible for the day-to-day efforts involved in solid waste management:

- Construction sites – Designate a single person (e.g., Construction Manager or Environmental Control Officer) to handle solid waste management responsibilities.
- Small resorts – Designate a Solid Waste Manager and liaisons in major departments (e.g., administration, food and beverage, house keeping, grounds keeping, physical plant).
- Large resorts and ITCs – Establish a Solid Waste Team composed of several individuals representing various properties as well as the different major departments listed above.

Incorporate Waste Reduction into Purchasing Policy and Practices

Company management must establish an environmental purchasing policy that addresses waste reduction. The policy must state a commitment to:

- Assess the full life cycle costs and benefits of products, and
- Inform suppliers of the environmental purchasing policy.

Traditionally, purchasing decisions are based on three factors: price, quality and customer service. An environmental purchasing program expands the definition of these criteria to consider all costs and benefits associated with the purchase, use and disposal of products and their packaging.

2-3 Step 3— Conduct a Waste Assessment

The Solid Waste Manager/Team must conduct a waste assessment to determine:

- Sources of solid waste,
- Current solid waste management practices,
- Quantity of solid waste generated, and
- Composition of solid waste.

When implementing solid waste management best practices prior to construction or operations, tourism centers can rely on existing data (see chapter I). However, given the diversity of tourism facilities along the Red Sea, hoteliers must consider their own unique operations. The Solid Waste Manager/Team should follow the best practices described below to complete a waste assessment.

- Identify sources of solid waste,
- Document current solid waste management practices,
- Measure solid waste generation, and
- Perform a waste sort.

2-4 Step 4—Identify Waste Prevention Options

Waste prevention is defined as any action that reduces or eliminates solid waste. Waste prevention is proactive, aimed at preventing wastes from being generated in the first place. It includes:

- Designing for efficient use of materials,

- Utilizing durable and repairable products,
- Fostering efforts to reuse materials,
- Reducing or eliminating packaging,
- Utilizing materials efficiently to reduce waste, and
- Eliminating or reducing the use of toxic and hazardous substances.

The benefits of waste prevention include:

- Achieving cost savings through reduced purchasing of supplies and materials,
- Reducing waste disposal costs,
- Reducing energy consumption and pollution,
- Implementing conservation of natural resources, and
- Developing an environmentally conscious public image.

chapter III of this manual summarizes best practices for waste prevention on construction sites. Section IV summarizes best practices for waste prevention at operating resorts.

2-5 Step 5—Identify Waste Diversion Options

Waste diversion includes reuse, recycling and composting. It can provide many benefits, including:

- Achieving cost savings through avoided disposal costs and revenue from the sale of recovered materials,
- Reducing the size of land disposal sites,
- Reducing pollution,
- Implementing conservation of natural resources, and
- Developing an environmentally conscious public image.

Chapter III of this manual summarizes best practices for waste diversion on construction sites. Section IV of this manual summarizes best practices for waste diversion at operating resorts.

2-6 Step 6—Identify Waste Disposal Options

Existing disposal sites are causing widespread problems that degrade the beauty and economic value of the Red Sea Coast. They are uncontrolled or, at best, poorly managed. Waste is strewn about the site, the wind scatters waste across the desert, open burning causes air pollution, and informal scavengers face constant threats of disease and injury. Red Sea Coast tourism centers have four options for land disposal:

- Develop and operate a dedicated disposal site for the property,
- Develop and operate a disposal site for the tourism center,
- Participate in a regional landfill that serves more than one tourism center, and
- Utilize existing municipal disposal sites.

chapter V of this manual outlines best practices for those who choose to develop and operate their own waste disposal site.

2-7 Step 7—Design Solid Waste Management Program

Using the information gathered during previous steps, it is now possible to design the solid waste management program. Every tourism property is unique, so there is no single program design that will work for all of them. The Solid Waste Manager/Team must develop a program that suits the property's individual opportunities and constraints.

Existing Uncontrolled Disposal Site on the Red Sea Coast

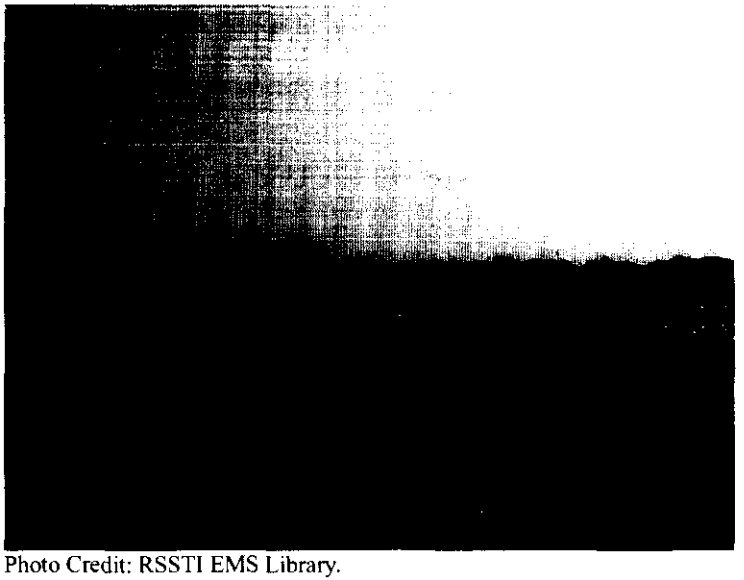


Photo Credit: RSSTI EMS Library.

Select Waste Reduction Strategies and Designate Materials for Waste Diversion

The Solid Waste Manager/Team must select waste reduction strategies to implement and designate the materials to target for waste diversion based on the guiding principles listed below.

- Waste management hierarchy – In conformance with the solid waste management policy, waste prevention should be the first option considered for each material. If prevention is too costly, impractical, or not possible, then waste diversion options should be considered. If waste diversion cannot be justified, only then should a material be designated for disposal.
- Cost – Many waste prevention and diversion measures can reduce the cost to operate a resort. However, current waste management practices on the Red Sea do not represent the true cost of solid waste management. Tourism properties need to consider both the tangible and intangible costs when selecting waste reduction strategies (e.g., the cost of a controlled disposal site versus the negative impact of litter on the tourist economy).
- Potential waste reduction – Waste prevention and diversion strategies need to target those materials that constitute the highest percentage of the waste stream. They provide the greatest potential for waste reduction.
- Ease of implementation – At the same time, the Solid Waste Manager/Team should focus waste reduction efforts on materials that can be easily eliminated or recycled regardless of how much of the waste stream they constitute.

- Availability of markets – There must be markets willing and able to accept recyclable materials. Without a market, there is little reason to separate a material for recycling.

- Impact on operations – Will this strategy have a positive or negative impact on quality of service Will it improve or reduce worker efficiency Will it increase or reduce labor requirements Will it be necessary to change or allocate new equipment and facility space

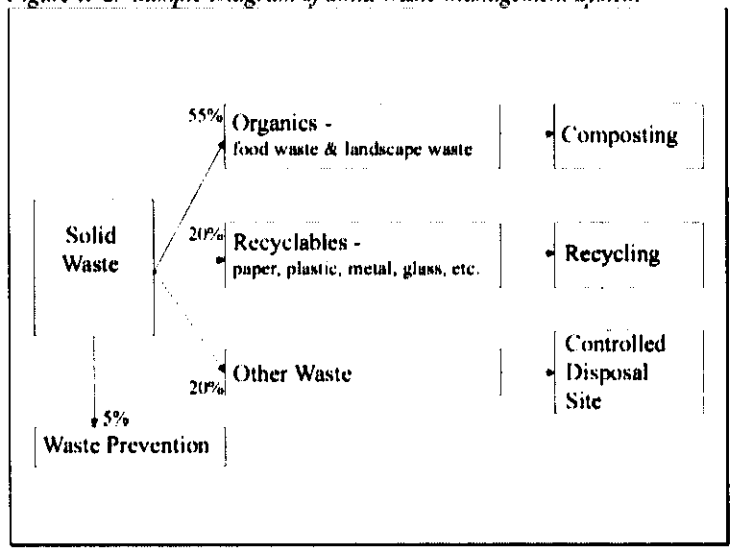
Select Waste Disposal Strategy

Tourism centers on the Red Sea coast have the ability to transform waste disposal practices, set an example for the public sector, and preserve the natural beauty upon which their business depends. They can accomplish this by implementing best practices at the disposal sites they utilize. The Solid Waste Manager/Team should use the following criteria when selecting the waste disposal strategy.

- Site availability – Is there a suitable site for disposal located on the back land Are other sites located elsewhere in the tourism center better suited for solid waste disposal
- Quantities of waste – Does the resort or hotel generate sufficient quantities of waste to warrant development of its own disposal site
- Other nearby properties – Is a master developer or some entity to facilitate cooperation between properties

- Existing disposal sites – Do existing waste disposal sites in the area conform to best practice guidelines Is it possible for the tourism

Figure II-2. Sample Diagram of Solid Waste Management System



Designing a solid waste management program entails:

- Select waste reduction strategies and designate materials for waste diversion,
- Select waste disposal strategy, and
- Design the solid waste management program.

property(s) to upgrade an existing disposal site to meet best practice guidelines

- Equipment requirements and availability – Does the property or tourism center have the necessary equipment Will the disposal site be large enough to require full-time equipment

Design Solid Waste Management Program

The Solid Waste Manager/Team must address the following issues when designing the solid waste management program for construction sites:

- Identify collection points,
- Determine source-separation requirements,
- Select collection containers and determine container locations,
- Install litter fencing,
- Identify hauling options,
- Require waste management plans from subcontractors,
- Incorporate performance measures in subcontractor agreements, and
- Document the construction waste management program.

The Solid Waste Manager/Team must address the following issues when designing the solid waste management program for operating resorts:

- Identify collection points,
- Determine source-separation requirements,
- Determine collection frequency,
- Select collection containers and determine container locations,
- Design the in-house collection system,
- Determine on-site processing requirements,
- Design the central processing and storage area(s),
- Identify hauling options, and
- Document the solid waste management program.

2-8 Step 8—Implement and Manage Solid Waste Program

Once the solid waste program has been designed, it is time to implement it and manage ongoing operations.

Contracting for Solid Waste Management Services

In most cases, construction sites and operating resorts will rely on an independent contractor to operate at least some part of the solid waste management program. Contractors may be hired for collection and hauling, disposal site operations and/or recycling services. The following steps must be taken to secure a good contract for solid waste services.

- Identify potential contractors – A list of potential solid waste contractors can be compiled from business listings and conversations with other developers and hoteliers. Make sure to identify not just private companies but also NGOs that may offer services.

- Select contractor(s) – Contractor(s) should be selected using a competitive bidding process based on both quality of service and cost – not simply the cheapest cost.

- Negotiate and sign contract – A written contract between the property and its solid waste contractor(s) is necessary to ensure that services conform to expectations. Contracts for solid waste services must explicitly define the work requirements, minimum performance standards, and penalties for non-performance.

- Incorporate waste reduction incentives in contracts – Solid waste collection and disposal fees should be based on the quantity of waste handled, and not a simple flat fee. This allows one to reduce waste collection and disposal costs through waste reduction efforts.

- Monitor contractor performance – All solid waste contracts must contain explicit provisions stating where materials will be taken for disposal. There must also be penalties levied against the contractor if the property's recyclables and/or waste are not handled according to the contract terms.

Program Start-up

A strong start-up phase is important to successful implementation of a solid waste management program. In general, best practices for program start-up include the following.

- Carefully plan sequence of program start-up.
- Provide information and training to all employees and contractors.
- Have all contracts for waste management services in place four to six weeks prior to start-up.
- Distribute collection containers and written instructions one week prior to start-up.

Implementing and managing solid waste program entails:

- Contracting for solid waste management services,
- Program start-up,
- Training and awareness, and
- Ongoing program management.

- Have monitoring and record keeping systems in place at least two weeks prior to start-up.

Training and Awareness

Training and awareness programs are critical to proper functioning of the solid waste management systems. Programs based on best practices require significant changes in people's behavior. Without initial training and ongoing encouragement, it is easy for people (e.g., construction staff, subcontractors, employees, guests) to revert to old patterns of behavior and threaten the success of the program. Training and awareness programs are needed for the following separate audiences:

- Employees
- Sub-contractors
- Guests
- General public

Training and communications must be ongoing; the need does not disappear once the program has started. Moreover, as the program matures, changes will be made, programs expanded and new procedures adopted.

Ongoing Program Management

After program start-up and training, it is important to maintain best practices for ongoing management of the solid waste program. Best practices for ongoing program management include:

- Maintain accurate solid waste records.
- Monitor program operations.
- Perform periodic waste assessments.
- Evaluate new waste management strategies periodically.
- Review program operations with top management.

D-3 Best Practices for Construction Waste Reduction

chapter III presents best practices for waste prevention and waste diversion at construction sites.

3-1 Waste Prevention

Waste prevention is possible during all phases of project development: design, subcontracting, materials procurement and construction. Best practices for waste prevention at construction sites include the following.

- Incorporate Waste Prevention into Purchasing:
- Prepare accurate estimates of construction materials.
- Order materials on a timely, as-needed schedule.
- Eliminate toxic and hazardous materials.
- Reduce Packaging Waste:
- Encourage suppliers to use durable, re-usable transport packaging.
- Return durable packaging and shipping materials to suppliers.
- Return non-durable packing and shipping materials to suppliers.
- Incorporate waste prevention strategies into supplier agreements.
- Incorporate Waste Prevention into Construction Practices:
- Use pre-fabricated construction components.
- Use pre-cast concrete components.
- Establish central fabrication and cutting stations.
- Maintain equipment and tools.

Portions of resort was raised using clean construction waste

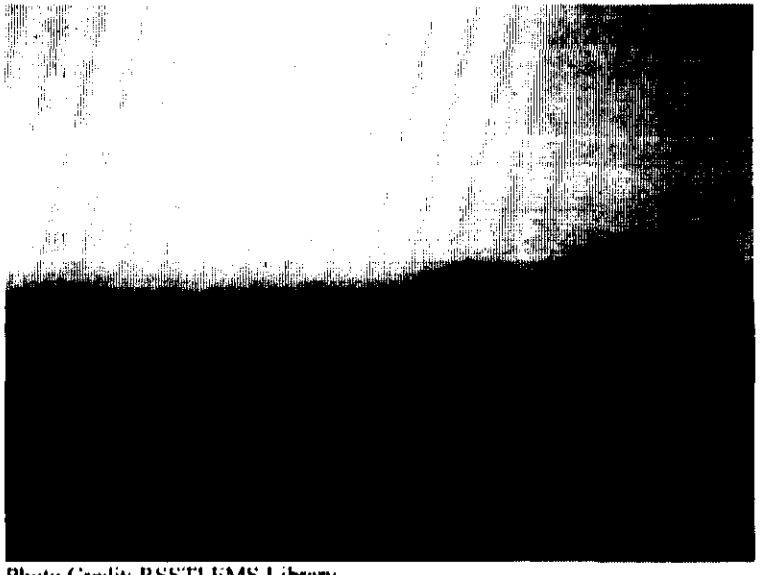


Photo Credit: RSSTI EMS Library.

Recyclables found in construction waste:

- Concrete
- Excavated soil and rubble
- Brick
- Asphalt
- Glass
- Scrap metal
- Gypsum wallboard
- Wood
- Plastic
- Porcelain
- Cardboard

3-2 Waste Diversion

Best practices for waste diversion at construction sites include the following.

- Identify options for salvaging building materials,
- Use excess excavation material as structural fill,
- Use mixed rubble for non-structural fill,
- Source-separate and recycle materials from construction waste, and
- Exchange excess building materials with other construction projects.

D-4 Best Practices for Resort Operations Waste Reduction

chapter IV presents best practices for waste prevention and waste diversion at operating resorts.

4-1 Waste Prevention

Best practices for waste prevention at operating resorts include the following.

- Implement Waste Prevention in all Departments – Each department of a resort performs specific activities and generates different wastes. Therefore, each has its own specific waste prevention opportunities.
- Implement Waste Prevention for Toxic and Hazardous Wastes – Toxic and hazardous substances are used in many departments of resorts and hotels. The Solid Waste Manager/Team should complete an inventory of them during the waste assessment and implement strategies to reduce or eliminate usage.

4-2 Waste Diversion

Best practices for waste diversion at operating resorts include the following.

- Implement Waste Reuse in all Departments – Reuse strategies exist that can reduce the amount of waste generated in every department.
- Source-separate and Recycle Materials – Nearly every component of the solid waste stream can be diverted from disposal by recycling.
- Source-separate Organic Materials for Animal Feed and Composting

Using Desert Plants Reduces Landscaping Waste

Photo Credit: RSSTI EMS Library

Example of Bulk Soap Dispenser

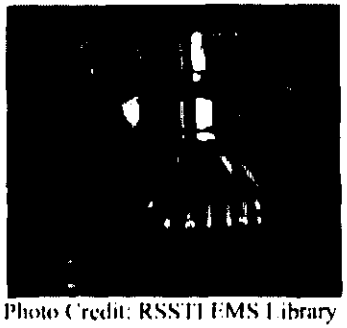


Photo Credit: RSSTI EMS Library

Examples of waste prevention strategies successfully implemented at Red Sea resorts:

- Purchase cleaning products in bulk and use refillable dispensers
- Eliminate use of plastic bag liners in waste receptacles
- Purchase beverages in bottles that are returned to vendors and refilled
- Eliminate single-serve packets in food services
- Use refillable soap dispensers in guest rooms
- Xeriscaping

Sorting and Storage for Recycled Materials

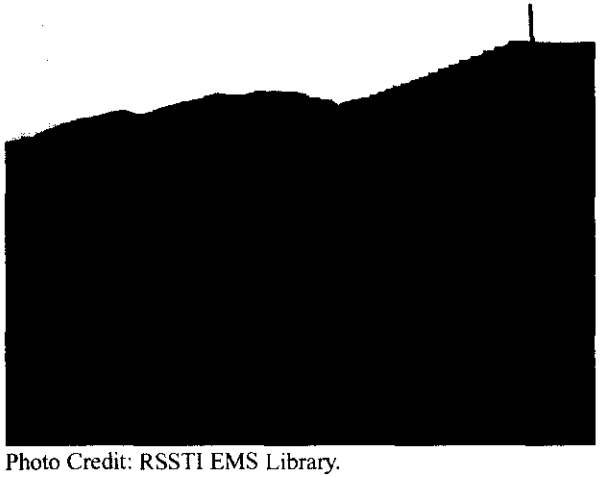


Photo Credit: RSSTI EMS Library.

Examples of waste diversion strategies successfully implemented at Red Sea resorts:

- Reuse plastic buckets as durable liners in outdoor litter baskets
- Re-dye old linens and convert them into tablecloths
- Recover landscape waste and food waste for animal feed
- Recycle plastic bottles, aluminum cans, paper and cardboard

Four materials comprise more than 80 percent of the average resort's waste: food waste, landscape waste, paper and plastic. Waste diversion efforts that focus on them can dramatically reduce the amount of waste that must be disposed.

– Organic materials account for a major part of the solid waste generated by Red Sea resorts and hotels. This includes food waste and landscape waste. Local people are able to utilize a significant amount of the organic waste a feed for the animals. On-site composting is a waste diversion strategy that not only diverts organic waste from disposal but also produces a valuable soil amendment.

Recyclables found in resort waste:

- Cardboard
- Office paper
- Newspaper
- Food waste
- Container glass
- Other glass
- Metal cans
- Scrap metal
- Rigid plastic containers
- Plastic bags and plastic film
- Landscape waste
- Cooking oil and grease
- Motor oil
- Furniture
- Electronic equipment
- Appliances

D-5 Best Practices for Waste Disposal sites

Chapter V describes best practices for resorts and hotels that choose to develop and operate their own waste disposal site. These practices are not state-of-the-art for engineered sanitary landfills, but represent minimum standards for waste disposal in an arid environment with limited development as is found on the Red Sea Coast. Section V also provides recommendations regarding solid waste incineration.

5-1 Siting a Waste Disposal Site

Sitting a controlled disposal site entails the following steps

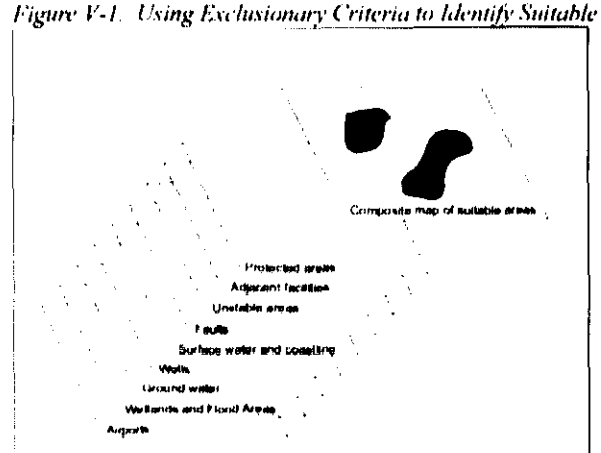
- Estimate disposal site volume,
- Identify suitable areas,
- Compile site-specific information,
- Rank potential sites,
- Submit Environmental Impact Assessment, and
- Obtain approval from Egyptian Environmental Affairs Agency.

5-2 Design and Construction

The design and construction of a controlled waste disposal site involves the following steps:

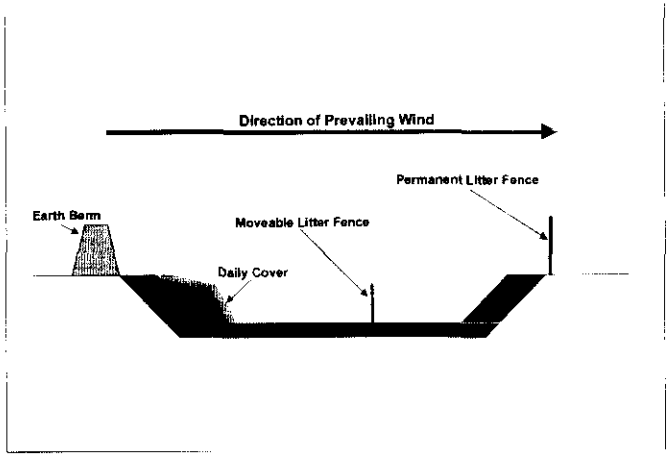
- Design the area for waste disposal,
- Design for litter control,
- Design other site features,
- Prepare design and construction documents,

Figure V-1. Using Exclusionary Criteria to Identify Suitable Sites



Adapted From: USEPA, 1995.

Figure V-2. Landfill Design Features for Litter Control



- Construct the controlled disposal site, and
- Construct filling area in phases.

Windblown litter is a ubiquitous problem at existing Red Sea disposal sites. Litter control is based on three principles:

1) secure the waste,
2) minimize the effect of the wind, and
3) catch windblown litter

5-3 Operations

The operation of a controlled waste disposal site requires daily management. Factors that are important to effective operations are:

- Provide required equipment,
- Hire necessary personnel,
- Manage incoming loads,
- Apply cover,
- Maintain operations for litter control, and
- Make provisions for dump scavenging.

5-4 Recommendations Regarding Solid Waste Incineration

Solid waste incineration should not be considered by Red Sea tourism centers. Although incineration offers certain potential benefits, it is not recommended for the following reasons: incineration is more expensive than land disposal; incinerators are constructed from highly specialized components; and incineration does not eliminate the need for a controlled disposal.

D-6 Additional Sources of Information

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On-Line Resources

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Best Practices for Eco-Tourism.
www.isr.gov.au/sport_tourism/publications/bpe/start.html

Benchmark Hotel Program
http://www.benchmarkhotel.com

Caribbean Alliance for Sustainable Tourism.
Waste Audit Manual for Caribbean Hotels and Resorts.
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Cooperative Research Center
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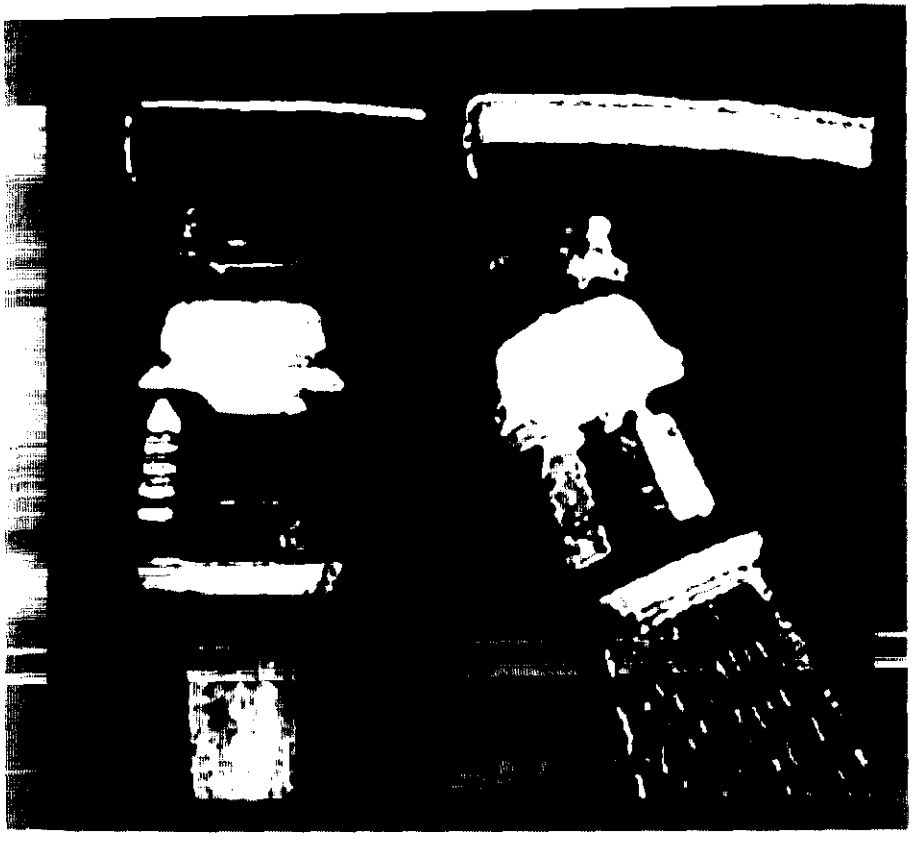
Environmental Best Practice For Red Sea Tourism Development

Executive Summary



PART E

A. Energy Management

B. Landscape Architecture

C. Landscape Planting

D. Solid Waste Management

E. Water and Sanitation systems

E

Water and Sanitation systems

E-1 Framework and requirements for the planning and implementation of water and sanitation systems for tourism centers

E-2 Guidelines for the design, construction and operation of water systems

E-3 Guidelines for the design, construction and operation of sanitation systems

E-4 Water and sanitation systems for coastal and desert eco-tourism properties

E-1 Framework and requirements for the planning and implementation of water and sanitation systems for tourism centers

1-1 Water and sanitation project requirements

The water and sanitation sectors play an important role in the early stages of tourism development, constituting between 15 20 percent of a project's total estimated cost. The possibility of installing such systems will determine the very existence of a project and may be the limiting factor for a project's success.

This guidebook will list requirements and define needs, allowing investment parties to determine the optimum selection and application of water and sanitation systems. Experiences highlighting successes and failures will be included to allow for optimizing proposed solutions. Principles of best practice for conservation and pollution prevention will be considered.

Ten years ago, the Egyptian Ministry of Housing, Utilities, and Urban Planning (MHUUP) released the Egyptian Building Code in a multi-volume publication. However, in the field of tourism there is no specific code that applies, and no enforcement of any code. Various codes are applied virtually at the whim of the investor, construction manager, or contractor.

The Egyptian code may be applied to water and sanitation networks; however, there is no current code for desalination plants or wastewater treatment plants of the size and scale used in tourism projects. Well-organized, well-managed, and integrated development projects may apply codes properly and solicit inspections. Minor projects, however, are less likely to either solicit such inspection or to be the target of attention from the overburdened bureaucracy. Unfortunately, in the case of water and sanitation systems, the majority of problems arise during the stage of operations and maintenance.

The Egyptian Tourism Development Authority requires developers to identify sources and methods of supplying potable water and ways of disposal of wastewater. In the documents submitted by the developer, technical reports and drawings should be submitted showing the water supply, sewage, irrigation and fire networks.
As for wastewater treatment and disposal, TDA forbids dumping of raw or treated sewage into the sea.

TDA has defined a set of rules and requirements that the investor should follow. These allow estimation of the system requirements and the overall outlines of its components. These requirements were determined in view of the applied Egyptian standards and codes, also the applied environmental regulations and laws were taken into considerations.

TDA's proposed design water consumption for tourism hotels

Hotel classification	Proposed design water consumption	Required water supply capacity of the hotel (m^3/day)
5-star	0.80 m^3/room.day	(number of rooms) x (1.0 m^3/room.day)
4-star	0.70 m^3/room.day	(number of rooms) x (0.70 m^3/room.day)
3-star	0.50 m^3/room.day	(number of rooms) x (0.60 m^3/room.day)

The use of water-intensive vegetation, inefficient irrigation technology, and poor irrigation practices will greatly increase the property's irrigation requirements (e.g., manually irrigating turf grass during daytime hours)

E-2 Guidelines for the design, construction and operation of Water systems

2-1 Water needs of the project

One of the first steps in the design of a property's water system consists in evaluating its required water supply capacity, that is, the maximum volume of water the property is expected to consume when operating at full occupancy. This evaluation needs to be done with care because the property's required water supply capacity will affect many important elements in the planning and design of its water and sanitation installations.

The three key parameters that, in addition to the property's number of rooms or the maximum number of guests, greatly affect its required water supply capacity include:

- The star rating or classification of the hotel - The indices that can be used to estimate the maximum domestic water needs of a water efficient hotel are presented in the table.
- The number of employees housed in the hotel or in adjacent staff quarters - The required water supply capacity should be increased by 0.15 – 0.2 m3/day for each employee that is housed on property.
- The irrigation needs of the gardens - Given Egypt's arid climate, irrigation can have a huge impact on the required water supply capacity of any property that does not have access to treated wastewater for irrigation or whose irrigation needs exceed the output of its wastewater treatment system. The total water needs of a property's gardens is largely a function of (a) the suitability of the selected vegetation to the

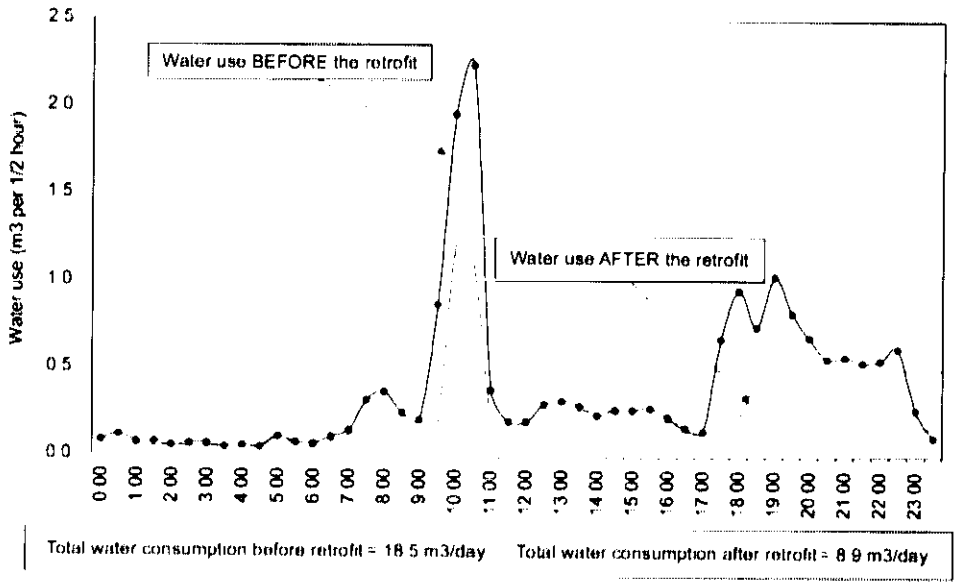
local climate, (b) the use of water efficient irrigation technology, (c) the use of water efficient irrigation and gardening practices, and (d) the size of the irrigated areas. The project team must carefully account for these factors when determining the future water needs of the gardens and the impact that irrigation will have on the property's required water supply capacity.

According to RSSTI's experience along the Red Sea coast, the consumption of water per m2 of irrigated land can ranges from 1,000 to 7,000 liters/year, depending on plant selection and the water efficiency of the irrigation and gardening practices.

2-2 Water conservation - equipment issues

Building water efficient hotels makes a lot of sense, and particularly so in areas where water is scarce or expensive. The benefits of water conservation include:

1) lower water bills or lower operating cost of the on-site desalination plant;
2) lower wastewater management, treatment and/or disposal costs;
3) improved performance of the wastewater treatment system, which in turn improves the quality of the treated effluent and reduces the health risks of treated wastewater irrigation;
4) lower energy consumption and costs achieved mainly by reducing pump operations and the volume of hot water drawn by the property's fixtures;
5) Enhanced sustainability of the water source (e.g., aquifer);



water use profile of a guestroom block (14 rooms, 25 guests) before and after the water conservation retrofit

"This data was collected over two consecutive days, during which the same 25 guests occupied the same 14 rooms "

Figure 3.8 and 3.9 Drip irrigation systems commonly used in Red Sea hotels

The planning and design phases offer a unique opportunity to include important water conservation features throughout the property, in particular in the design of the water pressurization and supply systems, the selection of plumbing fixtures and appliances, the layout and composition of green areas, and the design of the irrigation system. Failure to do so can easily increase the property's actual water needs by 100% or more: the long-term cost of this unfortunate oversight is therefore enormous.

In most cases, water conservation technologies and measures are simple and easy to implement, have minimal maintenance needs, require modest investments, and offer very short payback periods (typically ranging from 1 to 6 months).

2-3 Water conservation - operational issues

The benefits provided by the water efficient features can be sustained in the long run only if they are properly operated and maintained. As such, the property should pay attention to operational and maintenance issues, such as:

- Devising an effective preventative maintenance program for the water supply system, plumbing fixtures and water-using equipment.
- Reducing its future maintenance load by taking into account maintenance concerns in the detailed design of the water system.
- Devising a water monitoring program to track its water consumption and detect leaks.
- Drafting standard operating procedures for all activities that have or could have a large impact on water consumption (e.g., irrigation and pool maintenance operations).
- Adopting strategies to reduce the volume of dirty laundry generated by the property. Simple measures, such as a towel and bed linen reuse program, can cut the laundry load by more than 50%. In addition to saving water, reducing the volume of items processed through the laundry also reduces the laundry's labor requirements, its energy and chemicals consumption, and the wear and tear on the washers and dryers.
- Training employees to practice water conservation in their daily activities.
- Inviting the guests to participate in the hotel's water conservation efforts.

2-4 Water source

The typical water source options available to coastal and desert tourism properties include:

1) The direct connection via a pipeline to an existing water system;
2) The indirect connection via tanker trucks to an existing water system;
3) The operation of a desalination plant by an individual property; and
4) The operation of a desalination plant by a group of neighboring properties within the context of an Integrated Development Center (IDC).

When deciding on the water source that best fits the needs and limitations of the property, the project planners must carefully evaluate the following factors.

- Water needs of the property - The water needs of the property may limit the applicability of some of the possible water source options. For example:

- A property with small water needs (50 m3/day or less) should not consider installing its own desalination plant unless there are no other alternatives or it can guarantee that the plant will be operated properly. TDA requires that the source of water should be reliable and sustainable. A long agreement should be available to prove to TDA the source sustainability.
- Because of high costs and logistical problems, a property that consumes more than 50 m3/day will probably be unable to rely to tanker trucks to meet it water needs.

- The possibility to form an IDC or locate the property in an existing IDC - Establishing or joining and IDC with centralized utility services is generally the best alternative for properties that do not have access to an existing water source. The IDC structure allows them to pool their resources to build a large centralized desalination plant which can produce water at a minimum cost. It also relieves individual properties from the responsibility of operating their own plants and disposing of the reject brine.

- Proximity and capacity of existing systems - This is an ideal solution for any property that is unable to participate in an IDC, but its applicability is often restricted by the lack of utility infrastructure or by the limited surplus capacity of existing desalination plants.

- Acceptability and reliability of the water source - The TDA will not approve a project unless it has access to a water source that can adequately meet the property's needs and produce water of acceptable quality.

Improper disposal of reject brine in an absorption pond

Some architectural features, such as this tower of an El Gouna hotel, can double up as water towers

- Suitability of the RO plant's brine disposal system - Any property or IDC that plans to build a desalination plant must demonstrate that the reject brine will be disposed of in a manner that minimizes the potential for environmental damage.
- Quality and skills of the future system operators - Inadequate desalination plant operations can render the product water unfit for human use, increase the system's operating costs, and greatly reduce the service life of its components. No property should therefore consider building an on-site desalination plant unless it can guarantee that it will have the required in-house expertise or access to a competent outsider contractor.

2-5 Water storage tanks

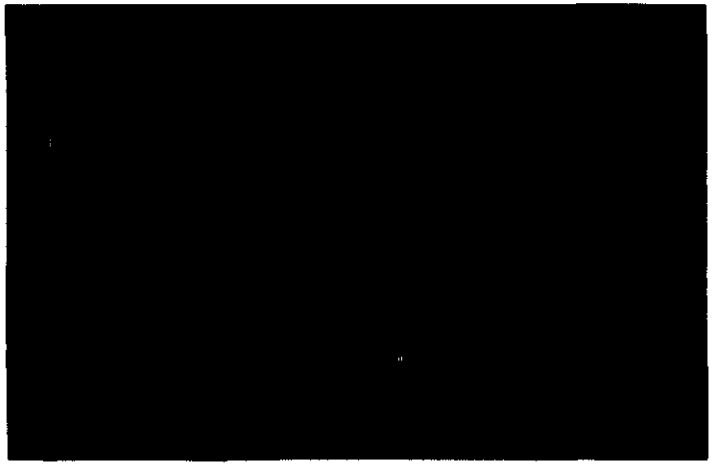
A property must have one or more storage tanks of sufficient capacity to ensure that an adequate volume of water is available at all times to meet the normal water needs of guests, staff and back-of-house operations, and its fire protection needs.

- Type of storage tanks - Water can be stored in underground or elevated storage. The choice between these alternatives is typically driven by operational requirements and aesthetic concerns. The use of elevated storage tanks may not be approved by TDA if it negatively affects the aesthetics of the property.
- Storage volume for domestic water - The capacity of the domestic water storage tank(s) must be sufficient to meet the property's maximum water needs for a period of at least one day.

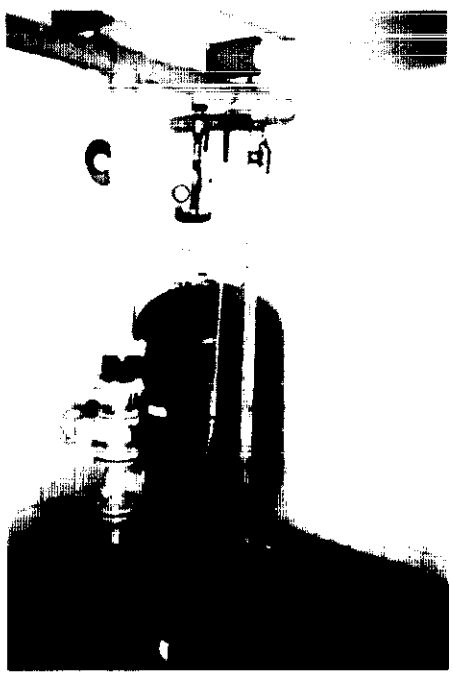
- Storage needs for fire protection - In addition to the domestic water storage requirements, the property must at least have a 120 m3 water reserve to meet its fire protection needs for the overall site and layout. This reserve can either be separate from or combined with the property's domestic water storage. In case of existing hotel or multistory building with multi-purposes, the consultant should estimate the needed fire fighting reservation and add up to the pre-determined water and fire reserve.
- Location of the storage tanks - The water storage tanks should ideally be located as close as possible to the property's main water distribution network and as high as possible; at the highest level situations, in order to minimize pressure losses.
- Tank configuration - The domestic water should ideally be stored either in two (or more) separate tanks, or in a single tank that is divided into two separate compartments.
- Water quality protection - The domestic water tanks must be properly designed to protect the quality of the water during storage.

2-6 Water pressurization system

In its simplest and ideal form, the pressurization system consists of a single elevated storage tank that is fed directly from the water source and operates without pumps or special controls. Unfortunately, and typically due to site constraints, most systems are more complex and include water supply pumps, fire pumps, and hydropneumatic pressure tanks or variable frequency pump controllers.



Typical configuration of a hydropneumatic or direct pressure system



Electric and backup diesel fire pumps at a 310-room, 5-star Red Sea hotel

The following issues should be considered when selecting and designing a property's water pressurization system.

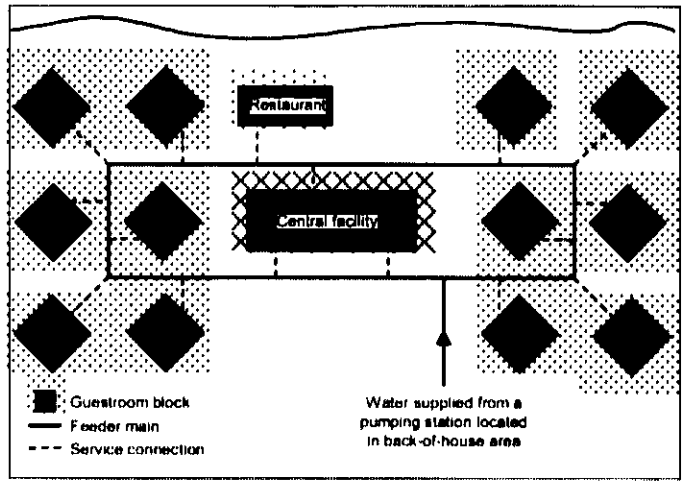
- If possible, take advantage of gravity - Gravity pressure systems typically have lower operating costs and are easier to maintain and operate than the other systems.
- Use the water pressure provided by the source - If the property is supplied by a main that carries sufficient pressure, it should take advantage of this pressure either to forego the need for pumps or to reduce the run-time of its water supply pumps.
- Base the system design and equipment selection on sound engineering analysis
- Use energy efficient equipment - All pumps should ideally use high efficiency motors.
- Provide backup pumping capacity - Each pumping station should be equipped with a standby pump (or pumps) of sufficient capacity to ensure the proper operation of the water supply system in case of pump breakdown or maintenance.
- Provide adequate pumping capacity for fire protection - The pumps that supply water to hydrants and other fire protection systems should have the capacity to generate the required fire flows. In addition, the property should take the necessary precautions to ensure the proper performance of the fire protection system in case of a power failure.
- Operate the water distribution system at a reasonably low pressure (e.g., 2 to 4 bars) - High water pressures are wasteful in terms of the

extra cost of the equipment and energy required to produce them, and the increased volume of water consumed by fixtures and lost through leaks.

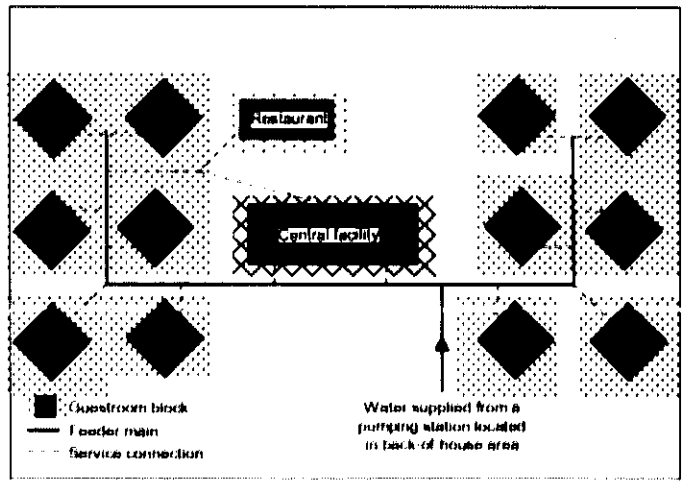
2-7 Water distribution system

The purpose of a water distribution system is to deliver water to all points of use in an adequate amount and at a satisfactory pressure, under both normal and exceptional operating conditions. To ensure the adequacy and integrity of the water distribution system, appropriate consideration should be given to the following guidelines and issues.

- Detailed design of the water distribution system - The design of a water distribution system is a complex exercise that should be based on sound analysis and thus entrusted to an experienced engineer.
- Feeder main configuration - The layout of the property's feeder mains should ideally be looped rather than branched.
- Location and position of water supply lines - All standard precautions must be respected when defining the location and position of water supply lines.
- Valve selection and location - The selection and placement of valves in the water distribution system must be based on sound engineering analysis.
- Selection of pipe material - The principal factors to consider when selecting the type of pipe for a specific application include: its ability to withstand the maximum anticipated internal and external pressures; its resistance to corrosion; and, if applicable, its resistance to high



Typical layout of a looped feeder main



Typical layout of a branched feeder main

Galvanized steel pipes removed from a Red Sea hotel after only 10 years of service because the corrosive RO water used by the hotel shortened the service life of these pipes by more than 75%

water temperatures and UV radiation. A property should be particularly cautious when considering the following possible applications:
- the use of metallic pipes in aggressive soils;
- the use of metallic pipes to convey desalinated water;
- the use of plastic pipes, other than CPVC and polypropylene, in hot water distribution systems; and
- the use of plastic pipes in areas exposed to direct sunlight.

- Installation precautions - The property must ensure that all due precautions are taken during the construction of its water distribution system.

- Fire protection - The property can operate either separate or a combined fire protection and domestic water supply systems, but it must comply with the following requirements.
  - The system must be able maintain a pressure of at least 1.4 bar at the fire hydrants while delivering the required flows.
  - The diameter of the pipes that carry the fire protection water must be greater or equal to 100 mm.
  - The distance between adjacent fire hydrants cannot exceed 150meters.

E-3 Guidelines for the design, construction and operation of sanitation systems

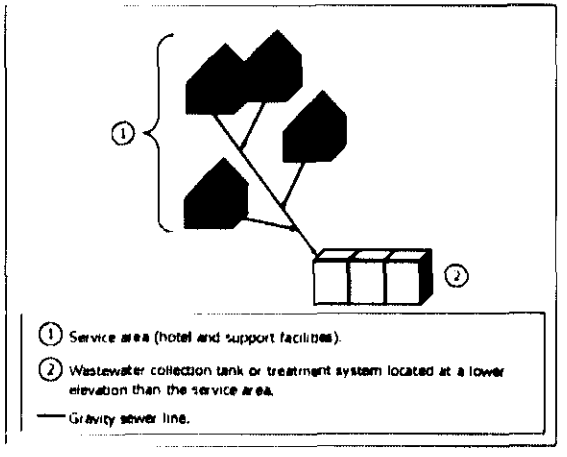
3-1 Wastewater collection system

The principal issues to consider when planning and designing a wastewater collection system are presented below.

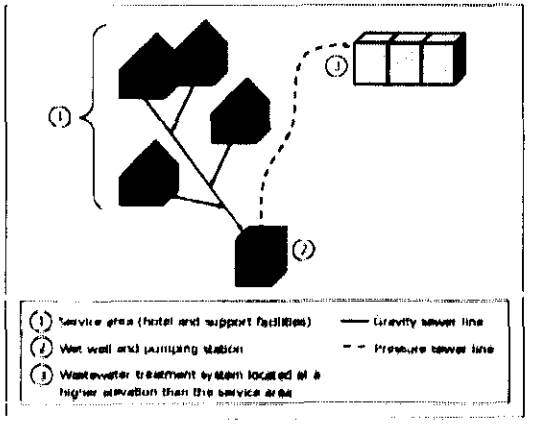
- Design of the wastewater collection system - The design of a wastewater collection system is a complex exercise that should be based on sound analysis and thus entrusted to an experienced engineer.

- System configuration - Hotel wastewater collection systems typically fall in one of the following categories: gravity sewers, pressure sewers and combined gravity and pressure sewers. Gravity sewers transport wastewater by gravity along a downward-sloping pipe gradient, while pressure sewers pump the wastewater from a central collection point (wet well) into a pipeline (force main) that conveys it to the point of discharge. In a combined gravity and pressure system, a gravity sewer is typically used to convey the wastewater from the buildings to a wet well, and a pressure sewer is then used to pump the collected wastewater from the wet well to the point of discharge.

Gravity sewers have low operating costs and should, therefore, be the preferred option for any property with suitable topography and subsurface conditions. Unfortunately, given that wastewater treatment plants in coastal hotels are typically constructed farther inland and on higher ground than guest facilities, many properties are unable to handle their wastewater by gravity alone and must rely on a combined gravity and pressure sewer system.



Schematic representation of a conventional gravity sewer



Schematic representation of a combined gravity and pressure sewer system with a single wet well and pumping station

- General considerations for the planning and design of a wastewater collection system -
  - Take future developments plans into account when designing the layout and capacity of the wastewater collection system.
  - Avoid discharging stormwater flows into the sewer system. Stormwater flows from roofs and paved surfaces should ideally be disposed onto the surrounding grounds. However, the possibility of studying a combined system capable of handling the sewage along with the storm water may be studied by the designer, hence the Egyptian code of practices allows for its applications. In certain views, this combined system may have advantage over the separate system, that the wastewater organic loading is decreased, and the storm water allows for cleaning of the settled solids of the sewerage network. It should be mentioned also, that the rate of flooding in Egypt is minimal, accordingly, such combined system will not enlarge the system capacity.
  - Avoid placing sewer lines in areas that will be subjected to large surface loads.
  - Ensure there are no cross-connections between the water supply lines and the wastewater collection system. However, if it was applied, certain precautions for the arrangements between the water and wastewater pipelines should be applied.
  - Maintain an adequate separation between sewer and water lines.
  - Ensure the materials used for the construction of sewer lines and appurtenances are adequate to the soil conditions.

3-2 Wastewater treatment

All hotels must have access to a suitable treatment system that is able to purify their wastewater to a level that allows for its reuse in irrigation or proper disposal. The wastewater treatment options available to coastal and desert tourism hotels typically fall in one of the following categories.

1) The direct connection through a sewer line to an existing wastewater treatment plant.
2) Wastewater collection in holding tanks and off-site transport by tanker trucks to an existing wastewater treatment plant.
3) The operation of a wastewater treatment system by an individual property.
4) The operation of a centralized wastewater treatment plant by a group of neighboring properties within the context of an Integrated Development Center (IDC).

The choice of the option that best suits the needs of the property will largely depend on the following factors.

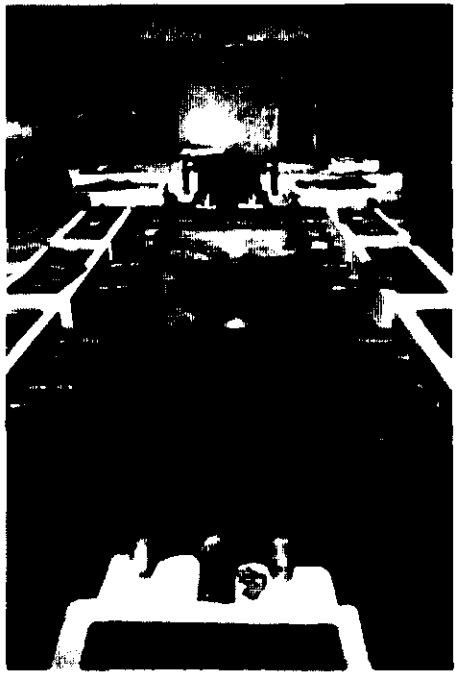
- Volume of wastewater - The volume of wastewater generated by the property may limit the applicability of some of the possible wastewater treatment options. For example:
  - Trucking collected wastewater to an existing treatment system is typically suited only to properties that generate small wastewater flows (e.g., 50 m3/day or less).
  - A small hotel should not consider building a sophisticated wastewater treatment plant (e.g., an activated sludge system) unless there are no alternatives or it can guarantee that the system will be properly operated.

The volume of wastewater generated by a hotel is proportional to its domestic water consumption (i.e., the water consumed in all of its operations excluding irrigation). It can range from a low of 40% of domestic water consumption for a property equipped with an extensive grey water collection network, to a high of 90% of domestic water consumption for a property with no grey water system.

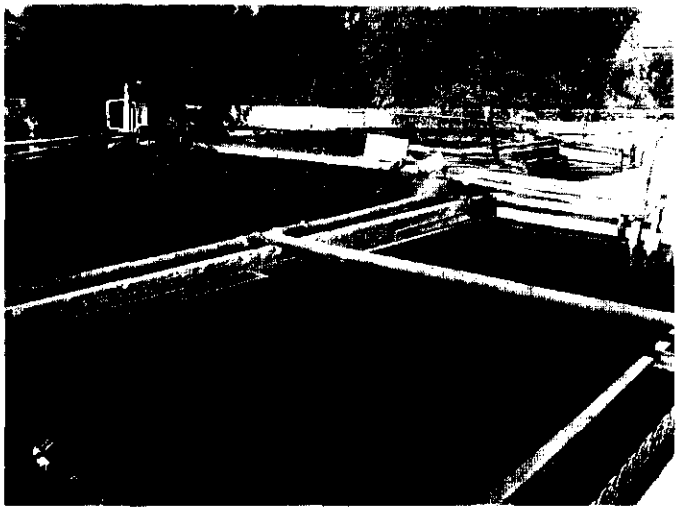
- The possibility to form an IDC or site the property in an existing IDC - Establishing or joining an IDC with centralized utility services is generally the best option for any property that does not have access to an existing wastewater treatment system. The IDC structure allows properties to pool their resources to build a centralized and efficient wastewater treatment plant. It also relieves them from the responsibility of operating their own treatment systems and producing a treated effluent that is suitable for use in irrigation.

- Proximity and capacity of existing systems - Relying on an existing treatment system is an attractive solution for any property. However, this option can have significant drawbacks.
  - The cost of trucking wastewater can be prohibitive for properties that generate medium to large flows (i.e., more than 50 m3/day) and do not have a sewer connection to the treatment plant.
  - The system's operator typically charges a fee for the wastewater treatment service.
  - By losing control over its wastewater, the property loses a potential source of low-cost irrigation water.

- Quality and skill of the future system operators - No property should consider building a sophisticated wastewater treatment plant and, in



Activated sludge wastewater treatment plants used in Red Sea hotel



Activated sludge wastewater treatment plants used in Red Sea hotel

particular, use the treated effluent for irrigation unless it can ensure that the treatment system will be properly operated.

- Selection of wastewater treatment technology - Most of the wastewater treatment plants in service along the Red Sea coast are based on the activated sludge process. However, given its high initial cost and strict operational requirements, an activated sludge system is typically not suited for properties that generate small wastewater flows (e.g., 50 m3/day or less) or don't have the resources to operate it properly. Besides the activated sludge process, there are many other proven systems that can be used to treat the wastewater produced by hotels. For example, "natural" treatment systems -- such as intermittent sand filters, subsurface soil absorption systems and evapotranspiration beds -- compare favorably to the activated sludge process in terms of performance and cost, and are particularly well suited to properties that generate small wastewater flows (e.g., 50 m3/day or less).
- Effluent polishing for use in irrigation - Regardless the type of treatment system used, the treated wastewater must be filtered and disinfected before it is used for irrigation.
- Approval from EEAA &TDA - The design of wastewater collection & treatment systems must be subjected to the TDA & EEAA approval.
- Sludge management - The property must have the means to properly handle the sludge generated by its wastewater treatment system. The typical sludge handling options include: collection and transport to an off-site facility for treatment, and on-site stabilization and subsequent use as a soil conditioner. Poorly stabilized sludge presents significant health risks and should never be used to fertilize hotel gardens.

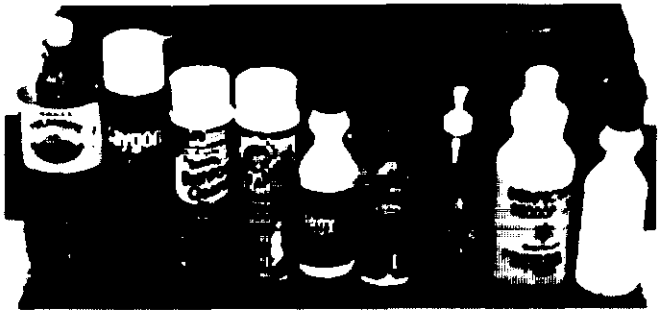
3-3 Wastewater modification - volume and pollutant load reduction

The volume and quality of the raw wastewater generated by a property can have a major impact on the wastewater treatment, disposal and/or reuse system. For example:

- large wastewater flows increase the required capacity and the operating cost of the treatment system;
- Wastewater flows in excess of the design capacity of the wastewater treatment system affect its performance and lower the quality of the treated effluent;
- The discharge of toxic chemicals into the property's drainage systems harms the beneficial bacteria that purify the wastewater in a biological wastewater treatment process; and
- High concentrations of sodium, boron and other deleterious elements in the raw wastewater can make the treated effluent unsuitable for use in irrigation.

As such, the property should strive to reduce the volume and improve the quality of the raw wastewater generated by its operations. Wastewater volume reduction - Water conservation and greywater irrigation are the two main strategies that can be used by a hotel to reduce the volume of wastewater discharged to its wastewater treatment or disposal system. The impact of these strategies can be significant -- for example, an extensive greywater collection system can reduce the property's wastewater flow by more than 50%.

Pollutant load reduction - The property should avoid, to the extent possible, discharging into its drainage system products that can disrupt the wastewater treatment process or affect the quality of the treated effluent. This objective



The excessive use of chemicals by housekeepers in guestrooms and other areas can greatly affect the quality of the wastewater generated by hotels

Required treated wastewater quality for irrigation of unrestricted and restricted access

Parameter	For unrestricted access areas	For restricted access areas
BOD_5	≤ 10 mg/liter	≤ 30 mg/liter
SS	≤ 15 mg/liter	≤ 30 mg/liter
Free chlorine residual	≥ 0.5 mg/liter	≥ 0.5 mg/liter
Fecal coliform	≤ 100 count / 100 ml	--

Irrigation practices should avoid ponding of treated wastewater

can be achieved by adopting a number of relatively simple and low-cost wastewater management practices, including: selecting judiciously the chemicals used in laundry, housekeeping and stewarding operations; training staff on the proper use of chemicals; monitoring chemicals' consumption; and installing well-designed grease traps on kitchen drains.

3-4 Treated wastewater irrigation

Individual hotels or IDCs that operate wastewater treatment plants are required to dispose of the treated effluent in an environmentally sound manner -- the discharge of even high-quality effluents into the sea is forbidden. This requirement, combined with the high cost of fresh water in many tourism centers, makes treated wastewater irrigation an ideal solution for effluent disposal. However, any property that contemplates the use of treated wastewater irrigation should be fully aware of the potential problems and dangers associated with this practice, and take all necessary precautions to minimize health risks and ensure the adequate performance of the irrigation system.

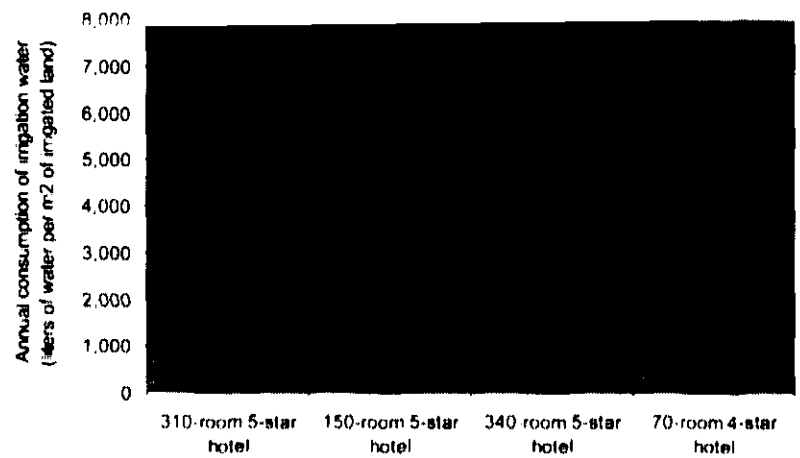
The principal issues to consider when planning, designing and operating a treated wastewater irrigation system are discussed below.

- Effluent quality and monitoring - The quality requirements for treated wastewater that is used for irrigation are defined in Egypt's Environmental Law 44/2000 and 4/1994 (see Table 3.1). The property should regularly monitor the quality of the irrigation water produced by its on-site wastewater treatment plant (or ask the supplier to conduct the necessary quality control tests, if the property purchases the treated wastewater from an outside source) to ensure it meets the specified quality requirements.

- Application of the treated wastewater - The irrigation water should be applied in a manner that minimizes the risk of human contact with the treated wastewater (e.g., by using emitters that apply a controlled amount of water directly onto the soil and avoiding the use of sprinklers).
- Design of the irrigation system - Irrigation emitters should be large enough to minimize clogging problems, and the irrigation lines provided with cleanout and blowoff features.
- Training - Gardeners should be trained to handle and apply the treated wastewater in a manner that minimizes the potential risks to public health and the environment.
- Safety precautions - The property should:
  - provide protective gear to the gardeners who come in contact with the treated wastewater.
  - irrigate at night or dawn when guest and staff traffic is at a minimum;
  - irrigate sensitive areas with fresh water (e.g., children's playgrounds); and
  - ensure the irrigation system can be operated only by authorized employees.
- Irrigation water needs - According to RSSTI's experience along the Red Sea coast, the consumption of water per m2 of irrigated land ranges from 1,000 to 7,000 liters/year, depending on plant selection and on the water efficiency of the irrigation and gardening practices. Hotels with water efficient gardens and irrigation practices are typically able to meet their irrigation needs with their treated wastewater during most of the year, and have to use some fresh water for irrigation only during brief periods of very low occupancy.

Consumption of Irrigation Water in Red Sea Hotels

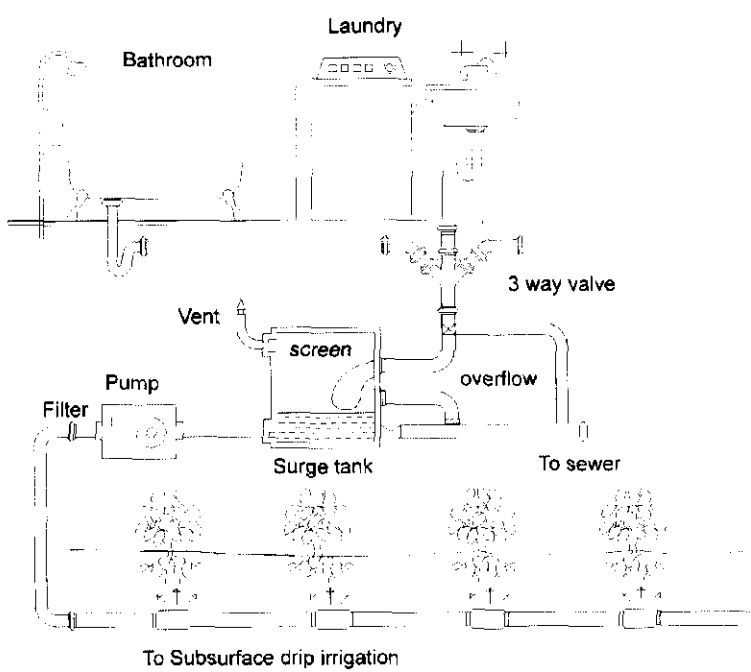
Plant selection and distribution, irrigation technology, and irrigation practices have a dramatic effect on the amount of water consumed by a garden. This fact is illustrated in the following figure that presents the total amount of irrigation water consumed per square meter of irrigated garden in several Red Sea hotels



NOTE The water consumption figures include the treated wastewater, the domestic water and any other type of irrigation water used by the properties

Annual consumption of irrigation water per square meter of irrigated surface in Red Sea coast hotels

"Although different in style and composition, the gardens of these four properties were all aesthetically pleasing. However, the gardens of the most water efficient hotel consumed only 1,000 liters/m2.year," while those of the least efficient hotel required as much as 7,000 liters/m2.year.



Schematic of a graywater collection and irrigation system (www.homeenergy.org)

3-5 Grey Water irrigation

Grey water consists of the lower-strength wastewater that is discharged from showers, tubs, bathroom sinks, laundry washers and pool filters. As greywater is largely free of human and other noxious wastes, it contains fewer suspended solids and pathogens than raw wastewater and, thereby, requires a minimum amount of treatment before it can be reused for subsurface irrigation.

Including a grey water system in the design of the property can bring important benefits.

- Grey water accounts for 50 to 70% of the total volume of raw wastewater generated by a hotel. An extensive grey water collection and irrigation system can thus reduce by more than half the required hydraulic capacity of the wastewater treatment system.
- A grey water system can reduce by more than 50% the wastewater disposal costs in properties that must transport their wastewater by truck to an off-site treatment plant.
- A grey water system can provide an ample supply of low-cost irrigation water to properties that don't operate their own wastewater treatment plants and don't have access to treated wastewater for irrigation.
- The valuable nutrients contained in grey water, such as phosphorus and potassium, benefit the plants and reduce the need for synthetic fertilizers in the gardens.

Although grey water presents a much lower risk than raw wastewater, it still contains pathogens and must be handled and used with proper care. Grey water should never be used for above-ground irrigation unless it is treated to achieve the same quality requirements imposed for treated wastewater irrigation.

E-4 Water and sanitation systems for coastal and desert eco-tourism properties

4-1 Characteristics of eco-tourism properties

The principal features that characterize eco-tourism properties are as follows.

Eco-tourism properties are typically located in remote areas.

- They are small and typically accommodate less than 20 guests.
- Their guests generally seek a close interaction with the natural and cultural elements of the site, and expect the property to be sensitive to environmental and cultural issues.
- The design of the facilities should be in harmony with the surroundings, with a strong emphasis on simplicity, resource efficiency and minimizing environmental impacts.
- Eco-tourism properties generally provide fairly basic services.
- Guest activities focus on the surrounding environment rather than on the facility itself.

These unique characteristics permeate every aspect of eco-tourism properties and have a profound impact on the planning and design of their water and sanitation systems.

4-2 General considerations for the planning and design of water and sanitation systems for eco-tourism properties

- The property should be self-sufficient in its energy needs and minimize its use of non-renewable energy sources. This goal can be largely achieved by avoiding energy-intensive operations, using energy efficient technology to meet essential needs, and using alternative sources of energy.
- Given their small size and isolation, eco-tourism properties should rely on systems and technologies that have basic operating, maintenance and monitoring requirements.
- To comply with its commitment to environmental protection and the efficient use of resources, the property should give preference to water and sanitation systems that do not generate problematic wastes and can meet its needs in the simplest and most natural manner possible.

4-3 Guidelines for the planning and design of water systems for eco-tourism properties

- Water conservation - Eco-tourism properties must pay particular attention to water conservation, not only to control costs but also to fulfill their commitment to the efficient use of resources. Given the special nature of eco-tourism and of its clientele, these properties are able to implement conservation measures that are beyond the reach of conventional hotels: for example, the use of composting toilets which eliminate the need for flush water and the generation of black water; and the use of high-efficiency plumbing fixtures such as 2-liter/minute faucet aerators and 6-liter/minute showerheads.
- Water needs - Water consumption in eco-tourism properties should range from 100 to 200 liters per person per day (counting staff and guests) depending on the type and effectiveness of the water conservation measures implemented.

- Water source - The range of water source options available to eco-tourism properties include:
  - Direct connection to a water supply pipeline - This is the ideal water source option but, given that most eco-tourism properties are located in remote areas, few are ever be able to even consider its applicability.
  - Well or spring - When available, natural water sources can be used to conveniently and cost effectively meet a property's water needs. However, the properties that rely on this option have to pay particular attention to water conservation and ensure their water demands do not harm the sustainability of the source. In most cases, water drawn from natural sources has to be treated before it can be used for general sanitary applications and/or for human consumption.
  - Trucked water - Tanker trucks are in many cases the best option for supplying water to a property that does not have access to a fresh water source. Although trucked water is generally expensive, this option frees the property from the costs, the energy requirements, and the trouble and responsibility associated with the operation of an on-site reverse osmosis (RO) plant.
  - On-site RO plant - Because of their strict maintenance and operating requirements, brine disposal needs, and high energy consumption, RO plants are typically not suited for eco-tourism projects.
  - Potable water supply - Unless the property can guarantee that its source provides water of potable quality and prevent its contamination during storage and distribution, it will need to purchase bottled water or, possibly, rely on a small "point-of-use" treatment system to produce the potable water consumed by guests and staff.
  - Water pressurization system - The range of water pressurization options include:
    - No pressurization system - The property could altogether avoid the need for a water pressurization and distribution system by manually drawing water from the source (storage tank or well) and transporting it to the points of use.
    - Gravity pressure system - A gravity pressure system is easy to operate and maintain, and has low and intermittent energy requirements: it is therefore an ideal solution for supplying pressurized water to an eco-tourism property. The pressure provided by the system can be very low (less than 0.4 bar at ground level) and can be obtained by a locating the elevated storage tank above one of the buildings.
    - Hydro pneumatic system - Although hydro pneumatic systems are simple in design, maintenance and operation, the following drawbacks limit their use in eco-tourism properties: they require a constant source of energy, consume more energy than gravity systems, and generate needlessly high pressures.
- Water distribution system - The design of the water distribution system should be simple and compact in order to minimize pressure requirements and potential leakage losses. The typical strategy used to achieve this objective consists in concentrating the points of water use in only a few areas of the property (e.g., designing a central bathroom facility instead of individual bathrooms in every cottage).

4-4 Guidelines for the planning and design of sanitation systems for eco-tourism properties

- Grey water irrigation - In order to simplify its wastewater management system and eliminate the use of fresh water for irrigation, the property should ideally collect all its grey water and use it for subsurface irrigation. The irrigation system should be as simple as possible and rely on gravity, rather than pumps, to convey the grey water to the green areas.
- Composting toilets - Composting toilets offers many benefits and are by far the best solution for managing human wastes at an eco-tourism property.
  - Composting toilets do not use water and thereby produce no black water. A property equipped with composting toilets will produce only grey water, which can readily be used for irrigation, and may forego the need for a wastewater treatment and/or disposal system.
  - The use of composting toilets significantly reduces the property's water needs and costs.
  - Composting toilet systems have minimal energy needs. The exhaust fan is the only element of the system that consumes energy, and it can readily be operated from a photovoltaic panel equipped with a small battery pack.
  - They are hygienic, do not generate odors and are not aesthetically offensive.
  - They have minimal operating and maintenance requirements.
  - They transform wastes into a stable and safe soil-like material which can be used as a fertilizer.
- Flush toilets - Flush toilets consume water and generate a waste flow (black water) that must be handled through an appropriate treatment system. They have many drawbacks compared to composting toilets, and should ideally not be used in eco-tourism properties.
- Black water treatment and/or disposal - Any property that uses flush toilets will need to build a black water treatment and/or disposal system. In order to minimize the property's maintenance and energy load, the selected system should be as simple as possible and have no (or minimal) energy requirements. The black water management options that are best suited to eco-tourism properties include:
  - Collecting the black water in a holding tank and trucking it to and off-site treatment plant.
  - Pre-treating the black water through a septic tank and discharging the settled effluent to a subsurface absorption system or an evapotranspiration bed.
  - Pre-treating the black water through a septic tank, discharging the settled effluent to an intermittent sand filter, and reusing the treated effluent for irrigation.