



Design Investigation



General design objectives

A number of design objectives were identified during interviews with the Rand Water Nature Reserve and with the Delta Environmental Centre in Johannesburg. Additional objectives were generated from site specific conditions with regard to climate, topography, vegetation and traffic.

- Pragmatic design is an obvious prerequisite. The building should have a dual function. It is to provide for public functions as well as to accommodate a private office sector. Public functions include a restaurant, conference facilities, and exhibition space.
- Office layouts should be flexible, and provide ways of adapting to the specific needs of the client.
- Circulation routes should be legible and must allow for wheelchair access.
- The design should be environmentally responsible and responsive to the climate.
- The design should incorporate the existing landscape and vegetation as far as possible.
- The building should be a 'living organism' managing all the resources it uses or creates in such a way to be sustainable.
- Disposing of waste should be handled responsibly and environmentally-friendly ways.
- The design of the building and facilities should be such that with proper scheduling of times and venues it could be used for various community activities.
- The design of the building should be representative of the role **water** plays in our lives.



CIRCULATION

In a conventional office building circulation would be limited to 15% of the total floor area. In this building, the circulation and the linear flow and progression of the building form one unified element. Therefore, the circulation would be incorporated throughout the whole of the building (the value of this can not be quantified). Vertical circulation through ramps and stairs. Staircases should be close to ramps and must serve as an alternative means of vertical circulation in the event of fire.

Escape routes should comply with the requirements of the NBR, section TT19.



SPACE PLANNING

Norms and Standards

- Offices 12m²
Meeting rooms 2m²/person
- Parking
Typical bay 2,5mx5.4m
Bus 3.5mx13.5m
Aisle width 7.2m up to 15m for a bus
- Ablution
To comply with NBR part "P" as a minimum requirement for a class A2 building.

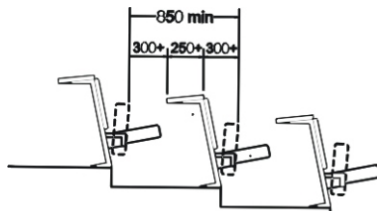
Population = 500		Men			Women	
	WC	Urinals	Hand wash basins	WC	Hand wash basins	
	3	7	3	12	6	

Fig 45a. Table 7 - National Building Regulations SABS 0400

- Fire safety
To comply with NBR parts "T" and "W".
- Facilities for the disabled
To comply with NBR part "S".
- Auditorium / Lecture room

Auditoria/Lecture Room		
SEATS	200	
DIMENSIONS	Auditorium	12x8
	Stage	5x7
TOTAL AREA		200

Fig 45b. Criteria for auditorium



The following seating dimensions must be complied with:

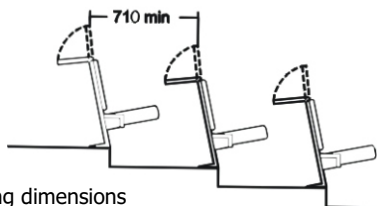


Fig 45c. Seating dimensions

Ramps and stairs offer the primary source of vertical circulation within the office sector.

ATRIUM

The lighting in the interior of the building would range from very sharp direct light, to very cozy diffused light, as the building progresses from 'dirty water' towards 'clean' water. Parallel to this runs the progress from 'gas' towards 'solids'. In the atrium of the building the quality of light would be a mixture of all these aspects, to embody the symbolism of dirty undrinkable water and chaos in the 'gas' phase.

The atrium does not only contribute to achieving these qualities, but also creates the potential of integrating the surrounding landscape with the building. The idea is to create a vibrant social space, the nucleus of the community of employees.

ATRIA

Atria naturally temper variations in the external environment. A buffer zone is created which acts as an intermediate climatic sector between the external and the internal environments. In the case of this building the external spaces flow into the internal spaces to create one new space with it's own characteristic climate and sensorial experience.

As a result of the atrium being exposed to the external environment to some extent, it becomes dynamic in the sense that gradual temperature swings occur in relation to outside changes in temperature. These gradual changes have the effect that they keep the occupants alert in contrast to controlled, static conditions.

Certain plant species can be used to assist in achieving indoor comfort levels.

(Fourie, 2002)



Fig 46. Water Technology Museum interior, Osaka, Japan by Tadao Ando

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Fig 47. Naoshima Contemporary Art Museum interior, Kagawa, Japan by Tadao Ando



IDENTITY

The first clue concerning the identity of the proposed building can be derived from the site and its context. As discussed in the context study of this document, the site has a prominent character, mainly as a result of its location. If the site is developed in the same way as the surrounding buildings, the new building would have no architectural character and would form part of yet another blunt building pattern. To give this site an 'address', development thereon should aim to achieve prominence.

This characteristic can be emphasized by providing the building with a prominent entrance that would be seen from the pedestrian route along the Apies River on the west and by the main vehicular traffic along Nelson Mandela Drive on the south eastern side of the site.

Furthermore, the site asks for a design that is visually stimulating, draws attention and evokes emotion, due to the sensorial experience of water in all its phases. According to Mrs. Jennevive Koopman from the Department of Education, the building should be functional, but it shouldn't only follow function. The building or parts of the building may also function as a monument or object in the landscape.

The identity of the new Water Wise Centre should be representative of the cardinal role that water plays in the life of every person. This identity is associated with stability or instability, local technological expertise, awareness of environmental issues and the importance thereof and an understanding of the value of education in Water Wise living methods for the community, society and world today. Just as important is the ability of the building to reflect its context.

(Fourie, 2002)



Fig 49. Water Technology Museum interior, Osaka, Japan by Tadao Ando



Fig 48 Walkway with cascading water on side

MATERIALITY

Public functions are housed mainly on the southern side of the building, due to its accessibility and visibility from all important movement axes.

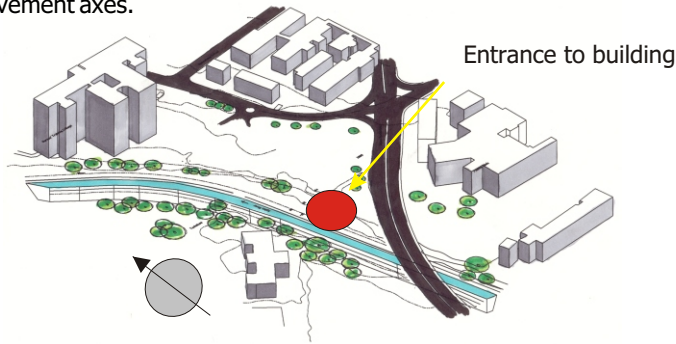


Fig 50. Showing location of entrance to building

As discussed in the foregoing paragraph, this part of the building serves the purpose of being visually stimulating, a concept which is achieved to some extent by introducing organic shapes. The decision to use such shapes has the consequence that building materials and construction techniques need to be selected carefully. Aesthetic goals need to be met, but the relevance of an appropriate construction technique which adheres to practical criteria cannot be underestimated.

A variety of possibilities exist. One possibility was implemented by Tadao Ando, at his Museum for Water Technology in Osaka, Japan.

Here stone cladding is fixed to a prefabricated metal sub-structure. The cladding is precision-cut under strict factory conditions. The result is a smooth wall which appears to be solid and can be manipulated to suit a variety of organic forms.

A second possibility is the use of stone cladding fixed directly with mortar to a concrete or masonry structure. This construction technique has its limits, but is commonly used in South Africa. The concern with this technique is the constant contact that the materials have with water.

Tadao Ando's language in the pursuit of pure geometrical form is clearly visible even in the selection of material. Mud banks, rough timbers and weather-stained stone form the bulk of materials used in the museum.

By negotiating an intricate series of courtyards and blind concrete walls he dignifies the blandly anonymous setting. He added sheet metal cladding to the concrete and expressed diagonal structural bracing on the exterior. This has the effect of softening the impact of the concrete that he uses with such deftness.

The counterpoint for the overwhelming spaces is a circular drum, open to the sky, that is linked with the water court at one end. As one moves from the rectangle to the circle you are gently channelled up by an elliptical ramp to the front door of the museum, like water trickling uphill. This sequence of architectural experiences delivers one to the introductory space of the museum.



Fig 51. Stone and sheet metal cladding.



Fig 52. Spherical staircase to the front door.



Fig 53. Blunt concrete walls with water cascades

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BUILDING CLIMATE

Moderate Highveld climate

The main factor of concern in this type of climate is the wide daily temperature swing, accompanied by strong solar radiation levels in summer. Humidity levels are naturally moderate, but might change to higher levels due to the nature of the building. The distinct rainy season is during summer and the dry season during winter.

Design Implications

In general, negative aspects should be minimised and positive aspects exploited. Openings should be arranged in such a manner as to allow for solar gain during winter and to control solar gain during summer. Solar control devices, when applied indoors, should have a low thermal capacity to eliminate heat gain, and could have reflective qualities to promote natural lighting.

Thermal mass is advised on east and west facades and at roof level to limit indoor temperature swings. Facades that are exposed to direct sunlight, should be shaded by external shading system. Natural ventilation should be maximised during summer, provided the supply air is from a cool source. A air displacement system would be used for to achieve the above. The natural water source on the west edge of the building should be integrated into the above. Natural ventilation should be minimised in winter.

(Fourie, 2002)

Indoor comfort conditions.

1. Effective temperature 21° to 24°C
= 60% air temperature
+ 40% mean radiant temperature
2. Relative humidity 40% - 60%
(This excludes the exhibition spaces where water features would be part of the space)
3. Air Supply
Fresh air supply 5l/s per person
Indoor air movement < 0.3 m/s

This should ultimately be achieved through passive design techniques and will be discussed later on in this document.

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BUILDING DESIGN

The main factors that influence the climate within and energy consumption of a building are as follows:

1. Shape and orientation

Energy losses occur mainly through the envelope of a building, i.e. facades and roof. The shape of the building impacts dramatically on the amount of energy that is lost and gained through the envelope. The ratio between the north and west facades can be optimised to limit exposure to the west and exploit exposure to the north, especially during winter. A typical ratio is roughly 1:2. Different climatic regions obviously have different optimal values, but in temperate regions this value can be accepted as average.

Another factor to take into account is the floor area relative to the facade. The optimal scenario is to limit the facade area and to enlarge the floor area. The greater the floor area, the smaller the influence of the outside temperature on the building and the smaller the structural cooling load per m². The higher a building, the larger the energy consumption due to the fact that energy is required to transport for example water and people vertically.

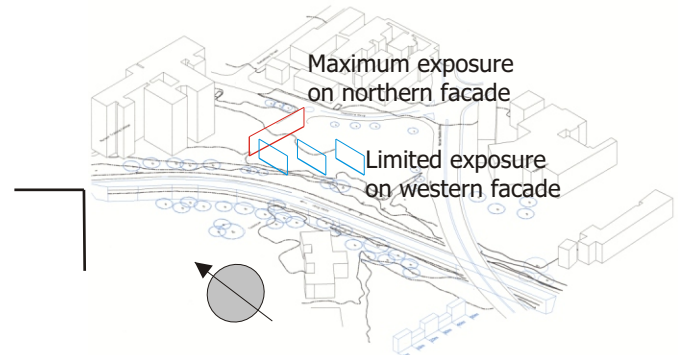


Fig 54. Exposure on northern and western facades

Temperature influences on building interior
Natural ventilation maximised in summer
East-west orientation
Medium colours (direct exposure to sun)
Thermal mass
Shaded north facades

Fig 55. Indoor temperature influences



2. Mass

It is common knowledge that the mass of a building can be utilised as a heat store. Buildings that are thermally heavy are recommended for areas where the outside temperature is consistently above or below the interior temperature. Thermal mass delays the passage of heat and causes a thermal lag effect. Hence heat can be stored during the day, possibly in the structure of the building, and be applied during the night to assist in limiting internal temperature swings. An open floor plan could assist in thermo-siphoning, in that it allows the heat from the warmer, usually northern, parts of the building to spread to the cooler parts. This scenario is applicable to winter circumstances. During summer, heat can be removed by cold night air, provided there is sufficient ventilation.

(Fourie, 2002)

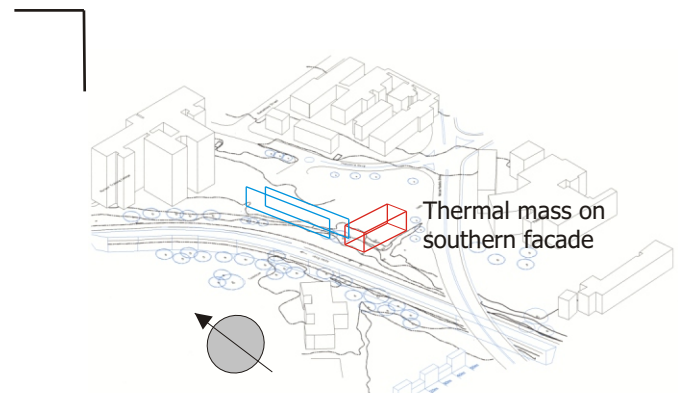


Fig 56. Thermal mass on southern facade counteracts heat loss



BUILDING ENVELOPE

3. Insulation

The building envelope has a significant impact on heat gain during summer and heat loss during winter. The prime function of insulation is to reduce these gains and losses. The table on the right suggest typical insulation values of external surfaces of a building. The facade should optimally have a maximum value of no more than 10 W/m² (heating or cooling load) of the net usable area.

External Surface	U-value (W/m ² K)
Roof	0.3
Walls	0.5
Exposed Floors	0.05

Fig 57. Diagram with U-values of materials

4. Glazing

As a general rule glass should be selected for functional rather than aesthetic reasons. Energy consumption increases proportionally with glazed area. Large glass facades, although their function is to provide a view and natural interior lighting, contribute vastly to excessive heat gains and losses. For this reason no glazing is required at levels below 600mm above floor level or 2000mm above floor level. In short, if the glazed area is less than 25% of the facade area, single glazing is sufficient.

As far as lighting is concerned, diffused light is better than direct sunlight, since the latter causes glare and internal heat gain. Only 44% of the solar energy spectrum is light, whereas 53% is heat energy. Heat energy can penetrate a building through conduction or radiation, and it is therefore recommended that both the U-value and shading co-efficient of the chosen glass be taken into account.

(Fourie, 2002)

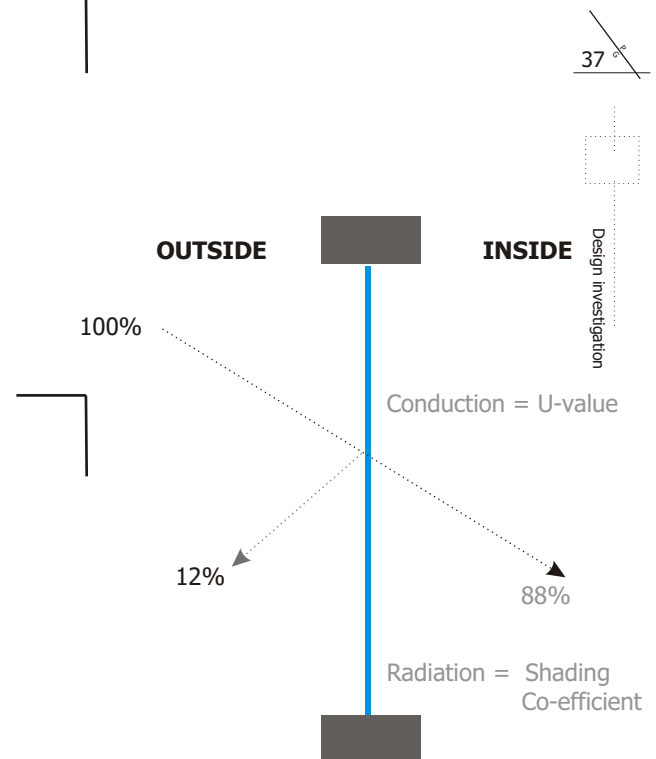


Fig 58. Heat transfer through clear glass



ENERGY CONSERVATION

Factors to consider

- Alternative energy sources: solar, wind, photovoltaic, biological.
- Waste heat recovery from exhaust air: Thermal storage.
- Energy management systems. Continuous monitoring of energy use.
- Thermal transport factor: rate of heat supplied or removed, divided by the energy used by the distribution system.
- Energy contracting: The owner appoints a specialist to manage energy consumption and shares the savings with the specialist.
- Flexibility of building usage or load changes.
- Occupancy: The building is divided into climatic zones which operate independently. Occupancy varies - some zones have higher occupancy levels than others. Occupancy also varies within one zone over a period of time. Through monitoring, energy consumption can be regulated in relation to occupancy.
- Embodied energy of materials used:

(Fourie, 2002)

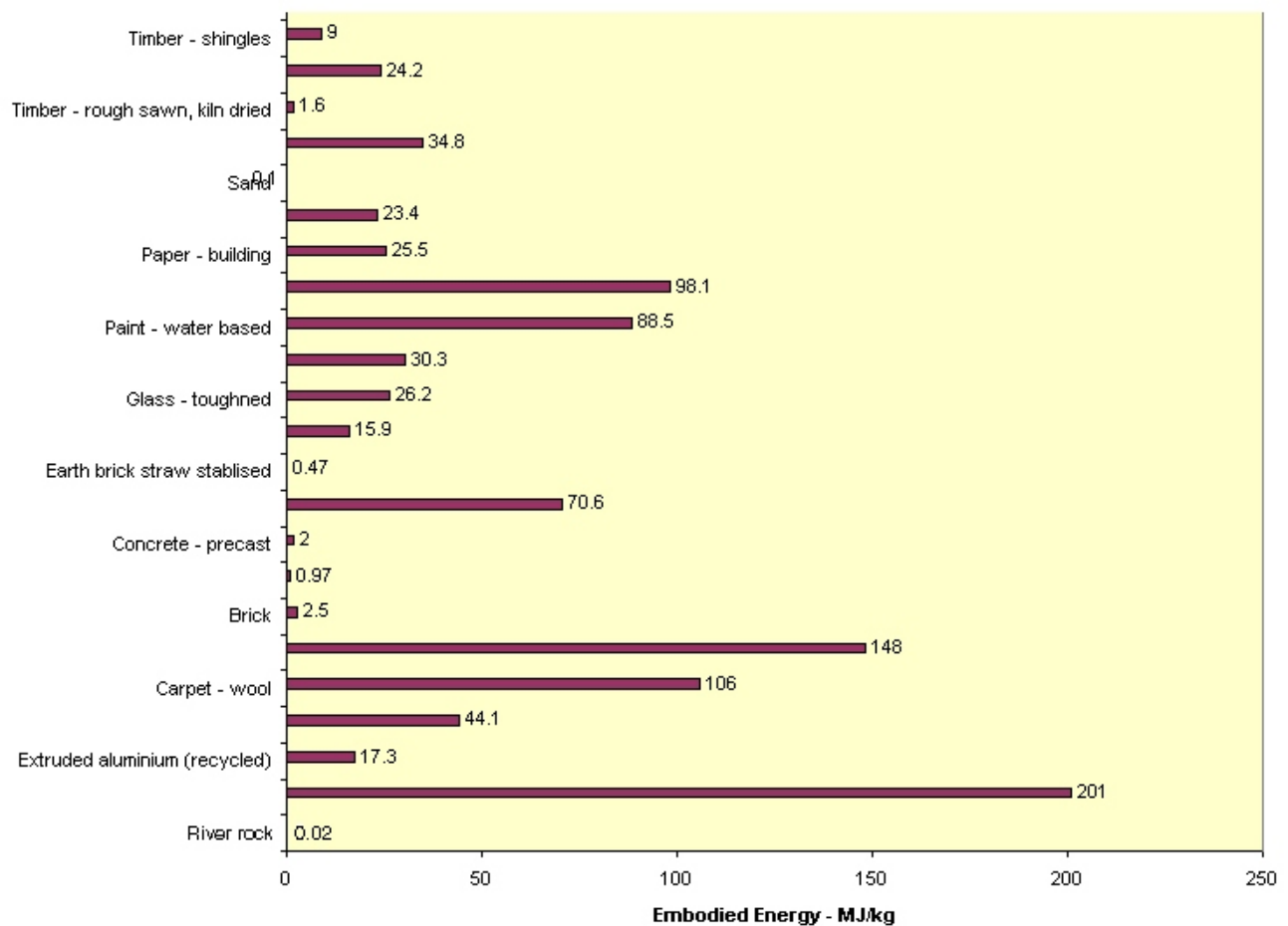


Fig 59. Embodied energy of building materials

ENERGY CONSUMPTION

Energy conservation goal

Energy consumption goals were set out in collaboration with the client, taking into account the level of energy conservation as illustrated in the diagram below:

LEVEL OF GOAL	CONSUMPTION GOAL	STRATEGY
	kW h/m ² . annum	
Technical limit	<100	Latest technology with no regard to cost
Excellence	100-200	Innovative design with strong focus on energy
Good	200-300	Energy conservation as high priority
Average	300-400	Energy conservation up to competitive commercial limits
Energy Intensive	>400	Energy conservation is not considered

Fig 60. Table showing energy conservation goals. (Krige, 1997:20)

(Fourie, 2002)

ENERGY CONSUMPTION

Based on 2 500 operating hours per annum.

The desired goal is somewhere between excellent and good. Typical values for an office building of roughly 3000m² would be in the range 250 - 410 kWh/m² annually. Architects can diminish energy consumption levels. Activities generating heat, e.g. computer rooms, can be localised in the cooler zones of the building, whereas non-heat-generating activities can be arranged in the hotter zones of a building. The diagram below illustrates this concept.

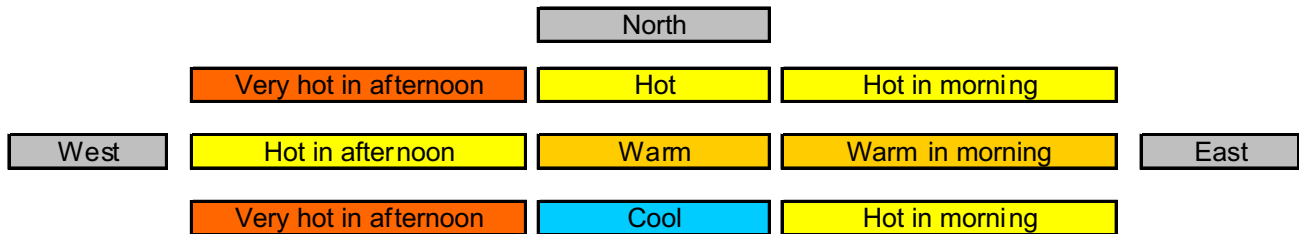


Fig 61. Heat gain of building facades

(Fourie, 2002)



LIGHTING

The energy consumption involved in the lighting of a building can be in the order of 30% - 60%. Energy can be conserved by allowing for individual control of lighting levels and also by dimming perimeter lighting when daylight levels are high.

Heat gain as a result of lighting need not necessarily be a negative factor. Return-air light fittings can be specified to allow the heat generated by lighting to be released through the ceiling.

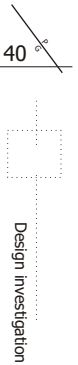
Performance criteria : luminance levels

General offices	-	300	lux
Parking	-	50	lux
Storage	-	200	lux
Reception	-	100	lux
Conference rooms	-	100	lux

(Fourie, 2002)



Fig 62 & 63. Kiasma Museum of Contemporary Art / Helsinki, Finland.....Architect: Steven Holl Architects / New York City



The use of natural light during day time can achieve required luminance levels. Not only are energy costs cut, but a more humane atmosphere is created.

