ENVIRONMENTAL CONSIDERATIONS

WATER

Water is required for many activities. However the large-scale provision of conventional water supply has many environmental implications. Water needs to be stored (sometimes taking up large areas of valuable land and disturbing natural drainage patterns with associated problems from erosion etc), it also needs to be pumped (using energy) through a large network of pipes (that need to be maintained and repaired). Having delivered the water, a parallel efforts is then required to dispose of this after it is used, ie sewerage systems. Reducing water consumption supports sustainability by reducing the environmental impact required to deliver water , and dispose of this after use in a conventional system. (Gibberd 2003:147).

Rainwater

Rainwater is harvested, stored and used.

Water use

Water efficient devices.

Grey water

Grey water (water from washing etc) recycled (to flush toilets or water plants).

Runoff

Run off reduced by using pervious or absorbant surfaces. Hard landscaping minimised, previous surfaces specified for car parking and paths.

Planting

Planting has low water requirement (indigenous species).

ENERGY

Buildings consume about 50% of all energy produced. Conventional energy production is responsible for making a large contribution to environmental damage and non-renewable resource depletion. Using less energy or using renewable energy in buildings therefore can make a substantial contribution to sustainability. (Gibberd 2003:147).

Location

Building located within 400m of public transport.

Ventilation System

Passive ventilation system.

Heating and Cooling System

Passive environmental control system use.

Appliances and Fittings

Energy efficient fittings and devices specified. 80% of light fittings are fluorescent/low energy consumption.

Renewable Energy

Buildings uses electricity generated from renewable sources ie wind, sun.

RECYCLING AND REUSE

Raw materials and new components used in buildings consume resources and energy in their manufacture and processes. Buildings accommodate activities that consume large aomounts of resources and products and produce large amounts of waste. Reducing the use of new materials and components in buildings and in the activities accommodated and reducing waste by recycling and reuse supports sustainability by reducing the energy consumption and resource consumption. (Gibberd 2003:148).

Toxic waste

Arrangements made for the safe disposal / recycling of toxic/harmful substances ie batteries, printer toners, vehicle oil.

Inorganic waste

Arrangements for sorting, storage and pick up of recyclable waste.

Organic waste

Recycled on site ie compost.

Sewerage

Contribution to mains sewerage from toilet minimised through use of compost toilets, and other ‘local’ systems.

Construction waste

Construction waste minimised through design careful management of construction practices. Design limits wastage by designing to comply with modular dimensions of materials etc.

SITE

Buildings have a footprint and a size that take up space that could otherwise be occupied by natural ecosystems which contribute to sustainability by helping create and maintain an environment that supports life. (By, for instance controlling the carbon dioxide and oxygen balance and maintaining temperatures within a limited range). Buildings can support sustainability by, limiting development to sites that have already been disturbed, and working with nature by including aspects of natural ecosystems within the development. (Gibberd 2003:149).

Brownfield site

Building constructed on a site already previously built on.

Neighbouring buildings

Building does not have harmful affect on neighbouring buildings ie over shading, where access to sunlight is important.

Vegetation

Site has extensive vegetation. Opportunities have been taken to plant in car parking areas, and in and around buildings ie atriums, window boxes and roof gardens.

Habitat

Site has provide habitats for animals. This includes a coordinated landscaping strategy that takes into account planting, water and habitat etc.

Landscape inputs

Landscape does not require heavy artificial input i.e. fertilizer, insecticide and pesticide.

MATERIALS AND COMPONENTS

The construction of buildings usually requires large quantities of materials and components. These may require large amounts of energy to produce. Their development may also require process that are harmful to the environment and consume non-renewable resources. (Gibberd 2003:149).

Embodied energy

80% of the building materials and components made from materials and components with low embodied energy. Low embodied energy materials include locally (within country) made and sourced timber, concrete, concrete block timber windows and doors.

Material / component sources

90% of materials and resources from renewable resources.

Manufacturing processes

Environmental damage limited during product component development. No green house gases released, no pollution caused.

Recycled / reused materials and components

10% of building materials and components are reused or from recycled sources.

Construction processes

Building and construction process designed to minimally impact the environment. Requirement for large scale vegetatjon clearing and earth movement minimized.

SUSTAINABILITY AND BUILDING MATERIALS

It is important to thouroughly understand the implications of the building materials selected for any particular building, and their environmental impact.
3 of some of the most commonly used materials, namely aluminium, steel, and concrete are good examples of how the aesthetic appeal comes with high hidden embodied energy requirements.

ALUMINIUM

Aluminium has come to symbolize the essence of progress in architecture, and the proud finish in high-tech architecture. However the production of aluminium represents one of the most extreme forms of resource abuse.
Made from bauxite ore, aluminium is the product of a finite commodity, calculated as a world reserve of little more than 24.0 billion metric tons. The majority of of this resource, other than the 4.44 billion metric tons found in Australia, is located in the developing, primarily in Guinea (5.6 billion metric tons), Jamaica (2.0 billionmetric tons), India (1.0 billion metric tons), and Brazil (2.8 billion metric tons). Bauxite is extracted primarily by strio mining, which scars the landscape and creates general environmental disruption. (Steele 1997:209).

Aluminium is commonly manufactured using the Hall-Heroult electrolytic reduction process. This process takes place in a smelter, wherin alumina powder is is dissolved in long narrow carbon-lined vats containing molten cryolite, or sodium-aluminium flouride. An anode is lowered into the bath transfers 250,000 Ampere of electricity through it, sperating the alumina molecules into aluminium. The aluminium is periodically drawn out of the vats during the process, which never stops. After processing, the aluminium is fabricated through various techniques, including casting, extrusion, and rolling, and may be painted or anodized. (Steele 1997:209).

The extensive amount of energy needed to process aluminium, the substantial toxic waste generated, and the extensive requirements for fresh water qualify qualifies the product as containing a high embodied energy.

CONCRETE

Cement which makes up 10 to 20% of a concrete mixture is the most energy-intensive component to produce. It is manufactured by heating limestone with clay. The materials are fed into into a long sloping sloping rotary kiln, which has progressively hotter zones, eventually reaching 1480 degrees Celsius. As it rotates, the kiln slowly mixes the contents moving through it, generating the neccessary chemical reaction, through hydration. Neraly 1500 kg of limestone and clay, or shale, are required tp produce 1 ton of finished cement. A great deal of carbon dioxide, as well as nitrous oxide, sulphur, and other pollutans are generated by the coal used to heat the kiln. (Steele 1997:210)

STEEL

Steel is made from iron ore, which is mostly found in developed countries. Reserves estimated at approximetely 65 billion metric tons are found in the following countries: Australia (10,2 billion metric tons), Canada (4,6 billion metric tons), United States (3,8 billion metric tons), South Africa (2,5 billion metric tons), and Sweden (1,6 billion metric tons). An addition 14,5 billion metric tons is found in developing countries, such as Brazil, Veneezuela, China and India.
The basic ingredients in steel production,iron ore, limestone, and coal, are each produced in complicated processes of their own, makingthis the most energy-intensive of all construction materials. (Steele 1997:226).

The 3 selected materials provide an example of how much natural resources go into manufacturing some of the most commonly used construction materials. Architects need to be more aware and selective of thir choice of materials based on their environmental impact.

ENERGY SOURCES

In a world of constantly diminishing renewable resources it becomes impoerative to take advantage of the most commonly available energy source-the sun. It is a good source for light, heat, and sometimes even electricity. In the context of South Arica, the moderate climate allows for the exploitation of the outdoor environment.
Buildings should be orientated to capitalize on the ample available daylight, however, the effects of solar heat loading should be clearly understood. For example the roof takes 60% of the heat load, and that the north facade takes 30% and 20% of the heat load in summer and winter respectively.

Climatic wind conditions should be analyzed and the orientation and design should respond accordingly, the provision of openable windows allows a building to ventilate naturally, and increases the the amount of fresh air circulating. Generally, air-conditioned buildings are sealed-off altogether to assist the technical requirements of the mechanical system, the result is that only 5 to 10% of the air is usually fresh-air, opposed to 30 to 40% in naturally ventilating buildings.

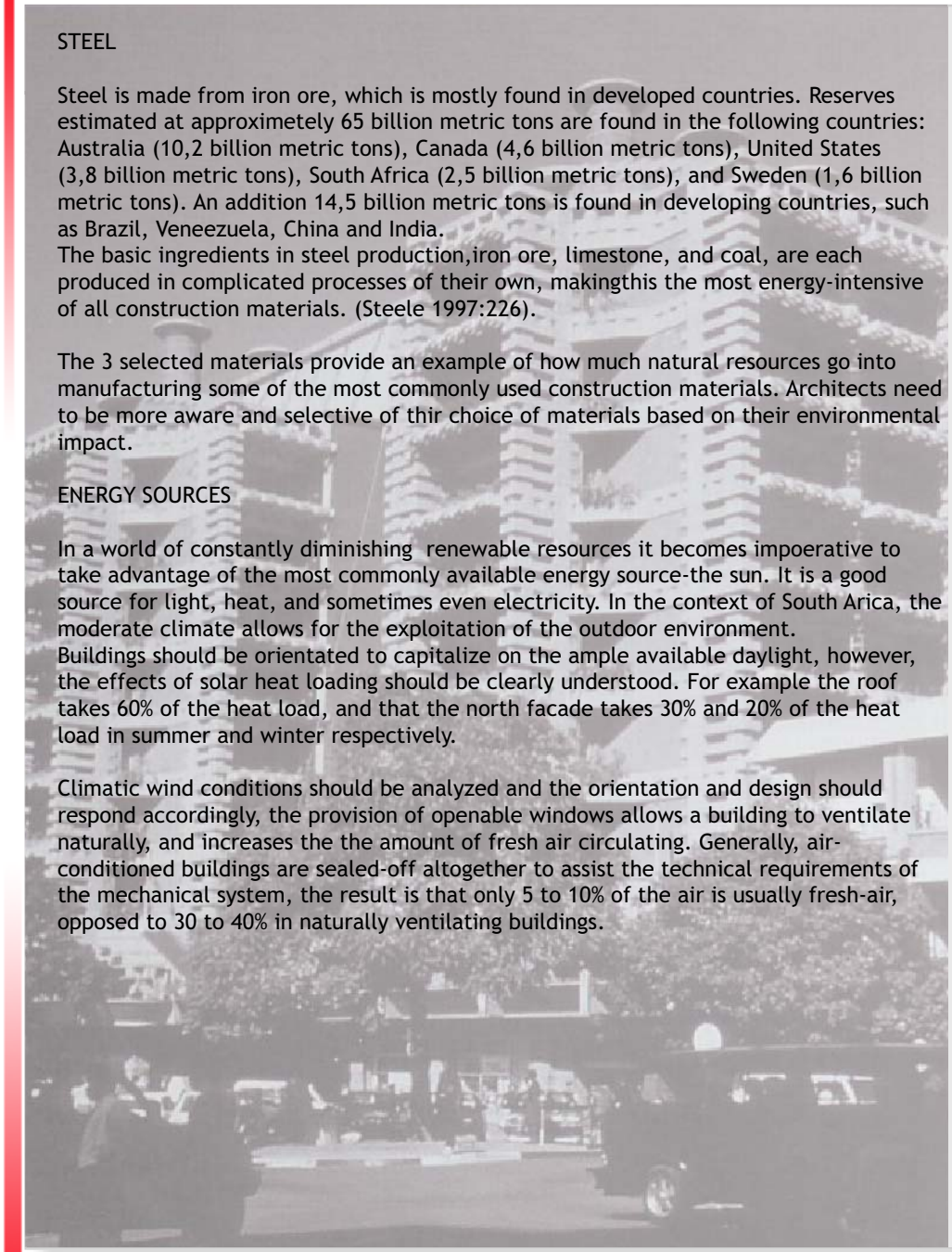

TABLE 2 Embodied energy of materials

MATERIAL	EMBODIED ENERGY MJ/ kg	MJ/m³
Aggregate	0.1	150
Straw bale	0.24	91
Soil-cement	0.42	819
Stone (local)	0.79	2030
Concrete block	0.94	2950
Concrete (30Mpa)	1.3	3180
Concrete precast	2.0	2780
Lumber	2.5	1380
Brick	2.5	5170
Cellulose insulation	3.3	112
Gypsum wallboard	6.1	5890
Particle board	8.0	4400
Aluminium (recycled)	8.1	21870
Steel (recycled)	8.9	37210
Shingles (asphalt)	9.0	4990
Plywood	10.4	5720
Mineral wool insulation	14.6	139
Glass	15.9	37550
Fibreglass insulation	90.3	970
Steel	32.0	251200
Zinc	51.0	371200
Brass	62.0	519580
PVC	70.0	93620
Copper	70.6	631164
Paint	93.3	117500
Linoleum	116	150930
Polystyrene insulation	117	3770
Carpet (synthetic)	148	84900
Aluminium	227	515700

Note: Embodied energy values are based on several international sources – local values may vary. These values are to be used as a guide only.

(Astrup 2005)

SBAT ASSESSMENT CRITERIA

The building performance is assessed in terms of sustainability, using the SBAT principles. The first step is to set the realistic targets that the design will strive to achieve, thereafter the building's social, economic, and environmental performance is assessed.

TARGET SETTING

TABLE 3 Target setting table

	Criteria	No Requirement 1	Low Requirement 2	Medium Requirement 3	High Requirement 4	Essential 5
SO	**Social**					
SO1	Occupant Comfort					•
SO2	Inclusive Environments					•
SO3	Access to Facilities					•
SO4	Participation and Control					•
SO5	Education Health and Safety					•
EC	**Economic**					
EC1	Local Economy					•
EC2	Efficiency of Use					•
EC3	Adaptability and Flexibility					•
EC4	Ongoing Costs				•	
EC5	Capital Costs					•
EN	**Environmental**					
EN1	Water			•		
EN2	Energy				•	
EN3	Waste			•		
EN4	Site				•	
EN5	Materials and Components			•		

(Gibberd 2003:140).

BUILDING PERFORMANCE - SOCIAL

	Criteria	Indicative performance measure	Measured	Points
SO 1	**Occupant Comfort**	Explanatory notes		4.5
SO 1.1	Daylighting	% of occupied spaces that are within distance 2H from window, where H is the height of the window or where there is good daylight from skylights	100	1.0
SO 1.2	Ventilation	% of occupied spaces have equivalent of opening window area equivalent to 10% of floor area or adequate mechanical system, with upolluted air source	100	1.0
SO 1.3	Noise	% of occupied spaces where external/internal/reverberation noise does not impinge on normal conversation (50dbA)	80	0.8
SO 1.5	Thermal comfort	Tempreture of occupied space does not exceed 28 or go below 19oC for less than 5 days per year (100%)	80	0.8
SO 1.5	Views	% of occupied space that is 6m from an external window (not a skylight) with a view	90	0.9
SO 2	**Inclusive Environment**	Explanatory notes		4.2
SO 2.1	Public Transport	% of building (s) within 400m of disabled accessible (20%) and affordable (80%) public transport	100	1.0
SO 2.2	Information	Comprehensive signage provided (50%), Signage high contrast, clear print signage in appropriate locations and language(s) / use of understandable symbols / manned reception at all entrances (50%)	70	0.7
SO 2.3	Space	% of occupied spaces that are accessible to ambulant disabled / wheelchair users	80	0.8
SO 2.4	Toilets	% of occupied space with fully accessible toilets within 50m along easily accessible route	100	1.0
SO 2.5	Fittings & Furniture	% of commonly used furniture and fittings (reception desk, kitchenette, auditorium) fully accessible	70	0.7
SO 3	**Access to Facilities**	Explanatory notes		3.8
SO 3.1	Children	All users can walk (100%) / use public transport (50%) to get to their childrens' schools and creches	70	0.7
SO 3.2	Banking	All users can walk (100%) / use public transport (50%) to get to banking facilities	100	1.0
SO 3.3	Retail	All users can walk (100%) / use public transport (50%) to get to food retail	70	0.7
SO 3.4	Communication	All users can walk (100%) / use public transport (50%) to get to communication facilities (post/telephone/internet)	70	0.7
SO 3.5	Exercise	All users can walk (100%) / use public transport (50%) to get to recreation/excercise facilities	70	0.7
SO 4	**Participation & Contro**	Explanatory notes		4.5
SO 4.1	Environmental control	% of occupied space able to control their thermal environment (adjacent to openable windows/thermal controls)	80	0.8
SO 4.2	Lighting control	% of occupied space able to control their light (adjacent to controllable blinds etc/local lighting control)	80	0.8
SO 4.3	Social spaces	Social informal meeting spaces (parks / staff canteens / cafes) provided locally (within 400m) (100%)	100	1.0
SO 4.4	Sharing facilties	5% or more of facilities shared with other users / organisations on a weekly basis (100%)	90	0.9
SO 4.5	User group	Users actively involved in the design process (50%) / Active and representative management user group (50%)	100	1.0
SO 5	**Education, Health & Sa**	Explanatory notes		4.0
SO 5.1	Education	Two percent or more space/facilities available for education (seminar rooms / reading / libraries) per occupied space (75%). Construction training provided on site (25%)	100	1.0
SO 5.2	Safety	All well used routes in and around building well lit (25%), all routes in and around buildings visually supervised (25%), secure perimeter and access control (50%), No crime (100%)	90	0.9
SO 5.3	Awareness	% of users who can access information on health & safety issues (ie HIV/AIDS), training and employment opportunities easily (posters/personnel/intranet site)	50	0.5
SO 5.4	Materials	All materials/components used have no negative effects on indoor air quality (100%)	100	1.0
SO 5.5	Accidents	Process in place for recording all occupational accidents and diseases and addressing these	60	0.6
			(Gibberd)	

BUILDING PERFORMANCE - ECONOMICAL

	Criteria	Indicative performance measure	Measured	Points
EC 1	**Local economy**	Explanatory notes		4.2
EC 1.1	Local contractors	% value of the building constructed by local (within 50km) small (employees<20) contractors	80	0.8
EC 1.2	Local materials	% of materials (sand, bricks, blocks, roofing material) sourced from within 50km	80	0.8
EC 1.3	Local components	% of components (windows, doors etc) made locally (in the country)	90	0.9
EC 1.4	Local furniture/fittings	% of furniture and fittings made locally (in the country)	90	0.9
EC 1.5	Maintenance	% of maintenance and repairs by value that can, and are undertaken, by local contractors (within 50km)	80	0.8
EC 2	**Efficiency**	Explanatory notes		4.4
EC 2.1	Capacity	% capacity of building used on a daily basis (actual number of users / number of users at full capacity*100)	90	0.9
EC 2.2	Occupancy	% of time building is occupied and used (actual average number of hours used / all potential hours building could be used (24) *100)	80	0.8
EC 2.3	Space per occupant	Space provision per user not more than 10% above national average for building type (100%)	90	0.9
EC 2.4	Communication	Site/building has access to internet and telephone (100%), telephone only (50%)	100	1.0
EC 2.5	Material & Components	Building design coordinated with material / component sizes in order to minimise wastage. Walls (50%), Roof and floors (50%)	80	0.8
EC 3	**Adaptability**	Explanatory notes		4.2
EC 3.1	Vertical heights	% of spaces that have a floor to ceiling height of 3000mm or more	100	1.0
EC 3.2	External space	Design facilitates flexible external space use (100%)	90	0.9
EC 3.3	Internal partition	Non loadbearing internal partitions that can be easily adapted (loose partioning (100%), studwall (50%), masonary (25%)	90	0.9
EC 3.4	Modular planning	Building with modular stucture, envelope (fenestration) & services allowing easly internal adaptaptation (100%)	60	0.6
EC 3.5	Furniture	Modular, limited variety furniture - can be easily configured for different uses (100%)	80	0.8
EC 4	**Ongoing costs**	Explanatory notes		3.2
EC 4.1	Induction	All new users receive induction training on building systems (50%), Detailed building user manual (50%)	0	0.0
EC4.2	Consumption & waste	% of users exposed on a monthly basis to building performance figures (water (25%), electricity (25%), waste (25%), accidents (25%)	60	0.6
EC 4.2	Metering	Easily monitored localised metering system for water (50%) and energy (50%)	70	0.7
EC4.3	Maintenance & Cleaning	% of building that can be cleaned and maintained easily and safely using simple equipment and local non-hazardous materials	100	1.0
SO 4.5	Procurement	% of value of all materials/equipment used in the building on a daily basis supplied by local (within the country) manufacturers	90	0.9
EC 5	**Capital Costs**	Explanatory notes		3.5
EC 5.1	Local need	Five percent capital cost allocated to address urgent local issues (employment, training etc) during construction process (100%)	90	0.9
EC5.2	Procurement	Tender / construction packaged to ensure involvement of small local contractors/manufacturers (100%)	90	0.9
EC 5.3	Building costs	Capital cost not more than fifteen % above national average building costs for the building type (100%)	70	0.7
EC5.4	Technology	3% or more of capital costs allocated to new sustainable/indigenous technology (100%)	30	0.3
EC 5.5	Existing Buildings	Existing buildings reused (100%)	70	0.7

(Gibberd)

BUILDING PERFORMANCE - ENVIRONMENTAL

	Criteria	Indicative performance measure	Measured	Points
EN 1	**Water**	Explanatory notes		3.1
EN 1.1	Rainwater	% of water consumed sourced from rainwater harvested on site	40	0.4
EN 1.2	Water use	% of equipment (taps, washing machines, urinals showerheads) that are water efficient	100	1.0
EN 1.3	Runoff	% of carparking, paths, roads and roofs that have absorbant/semi absorbant/permeable surfaces (grassed/thatched/looselaid paving/ absorbant materials)	80	0.8
EN 1.4	Greywater	% of water from washing/relatively clean processes recycled and reused	0	0.0
EN 1.5	Planting	% of planting (other than food gardens) on site with low / appropriate water requirements	90	0.9
EN 2	**Energy**	Explanatory notes		3.5
EN 2.1	Location	% of users who walk / cycle / use public transport to commute to the building	80	0.8
EN 2.2	Ventilation	% of building ventilation requirements met through natural / passive ventilation	70	0.7
EN 2.3	Heating & Cooling	% of occupied space which relies solely on passive environmental control (no or minimal energy consumption)	50	0.5
EN 2.4	Appliances & fittings	% of appliances / lighting fixtures that are classed as highly energy efficient (ie energy star rating)	90	0.9
EN 2.5	Renewable energy	% of building energy requirements met from renewable sources	60	0.6
EN 3	**Waste**	Explanatory notes		0.9
EN 3.1	Toxic waste	% of toxic waste (batteries, ink cartridges, flourescent lamps) recycled	10	0.1
EN 3.2	Organic waste	% of organic waste recycled	0	0.0
EN 3.3	Inorganic waste	% of inorganic waste recycled.	80	0.8
EN 3.4	Sewerage	% of sewerage recycled on site	0	0.0
EN 3.5	Construction waste	% of damaged building materials / waste developed in construction recycled on site	0	0.0
EN 4	**Site**	Explanatory notes		2.6
EN 4.1	Brownfield site	% of proposed site already disturbed / brownfield (previously developed)	80	0.8
EN 4.2	Neighbouring buildings	No neighbouring buildings negatively affected (access to sunlight, daylight, ventilation) (100%)	70	0.7
EN 4.3	Vegetation	% of area of area covered in vegetation (include green roofs, internal planting) relative to whole site	30	0.3
EN 4.4	Food gardens	Food gardens on site (100%)	0	0.0
EN 4.5	Landscape inputs	% of landscape that does not require mechanical equipment (ie lawn cutting) and or artificial inputs such as weed killers and pesticides	80	0.8
EN 5	**Materials & Component**	Explanatory notes		3.1
EN 5.1	Embodied energy	Materials with high embodied energy (aluminium,plastics) make up less than 1% of weight of building (100%)	80	0.8
EN 5.2	Material sources	% of materials and components by volume from grown sources (animal/plant)	30	0.3
EN 5.3	Ozone depletion	No materials and components used requiring ozone depleting processes (100%)	70	0.7
EN 5.4	Recyled / reuse	% of materials and components (by weight) reused / from recycled sources	40	0.4
EN 5.5	Construction process	Volume / area of site disturbed during construction less than 2X volume/area of new building (100%)	90	0.9

(Gibberd)

SBAT ASSESSMENT RESULTS

The sustainable builidng performance outcomes for the Pretoria station interchange development are indicated in the chart below. The building performs reasonably well in the social and economic section, but falls quite short on the environmental aspects. The SBAT analysis has helped identify areas of sustainability concern, and also areas of positive impacts.

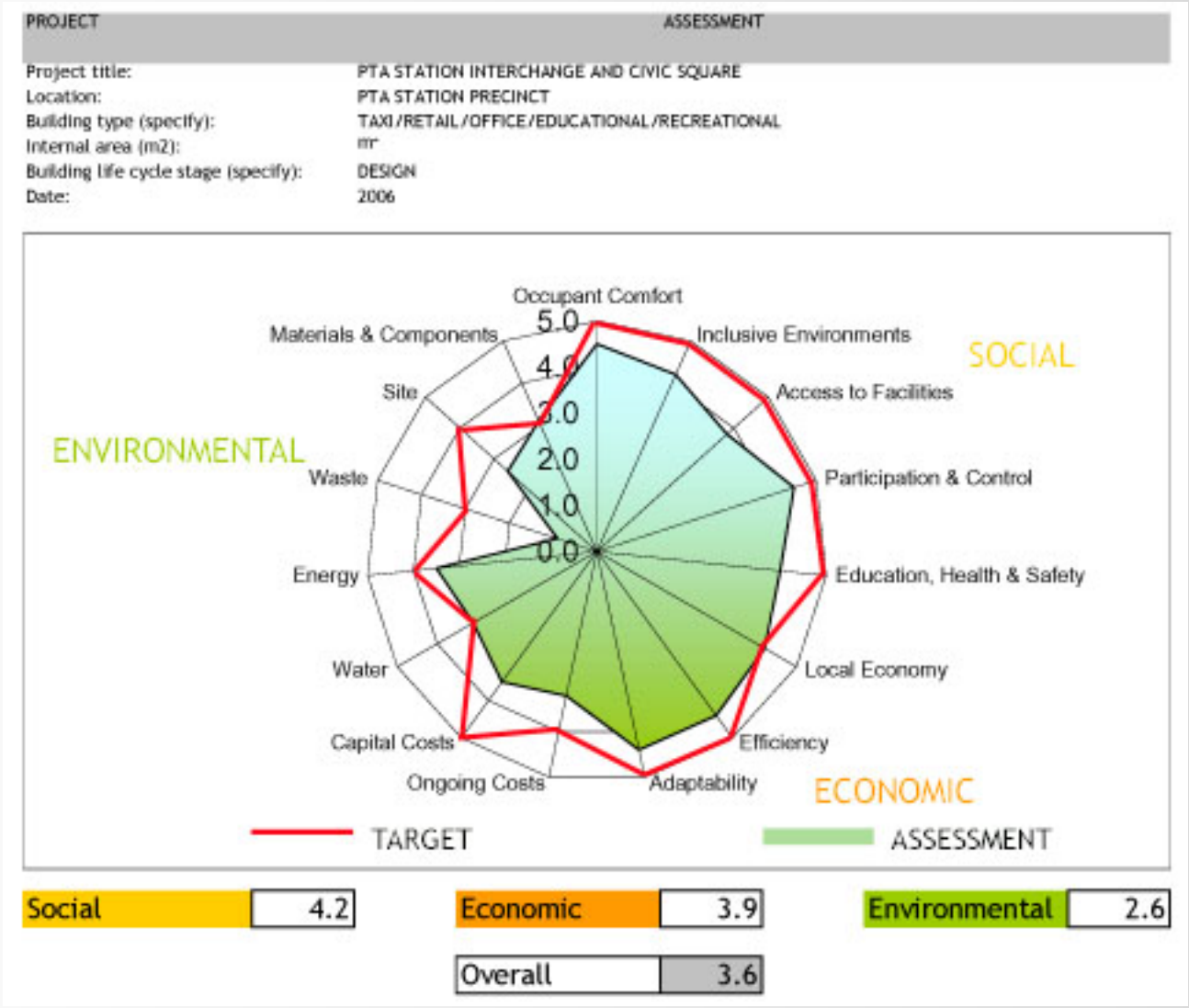

Figure 3.7.1 SBAT results chart

DERMOGRAPHICS - GAUTENG PROVINCE

POPULATION

The Gauteng province accounts for 1.4% of the 1 219 090 km² total land area of South Africa. However, the province is home to 19,7% of the estimated 44 million population. The city of Tshawne has a population of approximetely 1,5 million people.

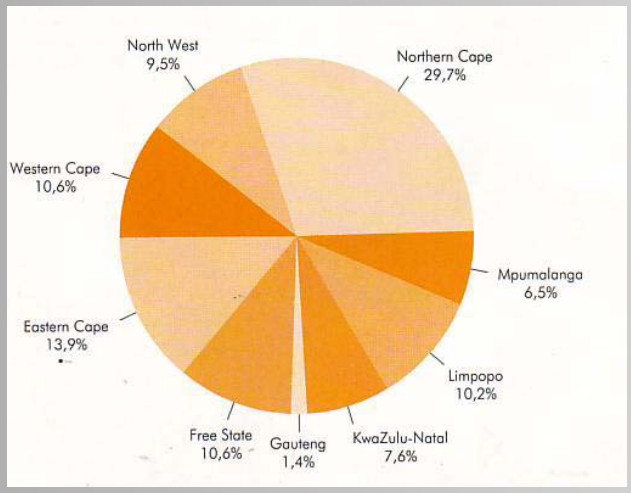

Figure 3.8.1 Land provincial allocation (Census 2001)

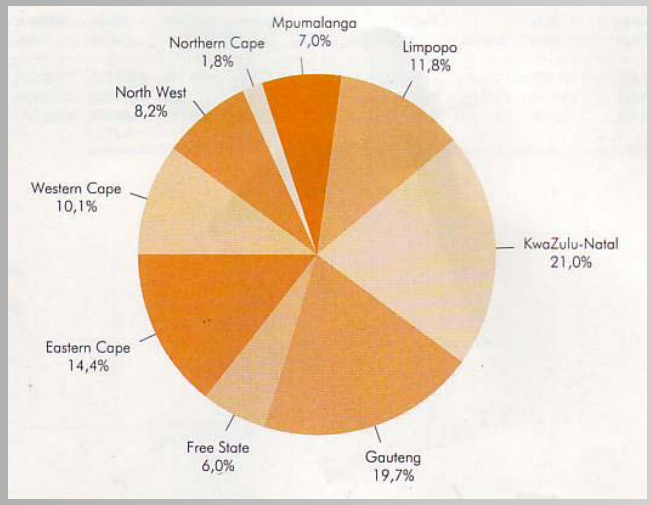

Figure 3.8.2 Population provincial allocation (Census 2001)

EDUCATION

Statistics reveal that only 8,4% of the 8,8 million people have higher education qualification. 20,4% have matric qualifications, 38% have some secondary school exposure, and an alarming 17,9% have no schooling altogether.

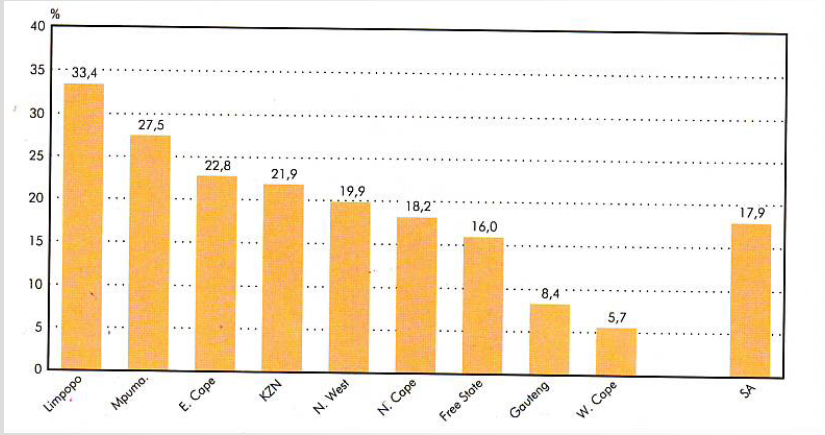

Figure 3.8.3 Percentage of people aged 20 and over with no education (Census 2001)

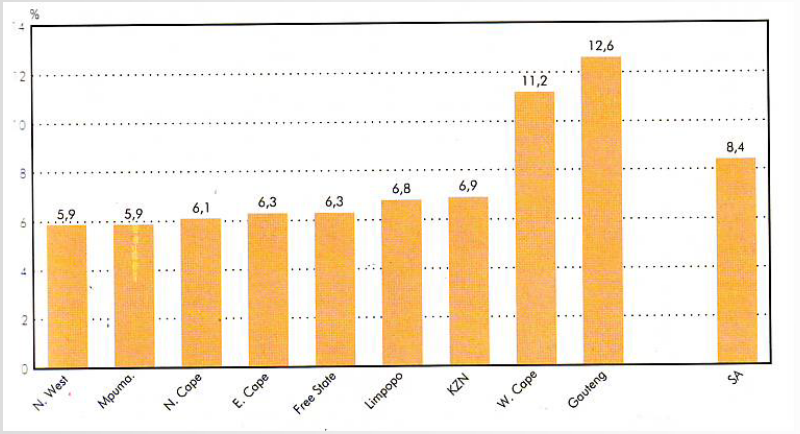

Figure 3.8.4 Percentage of people aged 20 and over tertiary education (Census 2001)

ECONOMY

Based on Cesnsus 2001 statistics, 50,4% of the population is ecomomically active, 19,9% is unemployed, while 29,7% is not economically active.