Chapter 5.8.2

Ecologically sound urban development

5.8.2

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INTRODUCTION

This sub-chapter highlights some of the environmental concerns that need to be taken into consideration during layout planning for local areas. This sub-chapter should, due to its cross-cutting nature, be read in conjunction with all other chapters. Urban management strategies and technological solutions are not addressed, and the guidelines are confined to mitigation through local layout planning. The aim is to provide generic guidelines to create a general awareness of environmental issues in local layout planning.

The overall aim of ecologically sound urban development is to minimise the negative impact of development on the environment, thus limiting the ecological footprint of development while moving towards greater sustainability over the longer term. The generic guidelines relate to the reciprocal relationship between the natural environment and human settlement activities.

CONCEPTS UNDERLYING ECOLOGICALLY SOUND URBAN DEVELOPMENT

Carrying capacity

Despite technological sophistication, humankind remains in a state of "obligate dependence" on the productivity and life-support services of the ecosphere. It is thus important for any development to take cognisance of the environment's carrying capacity which is defined as *its maximum persistently supportable load.*

The fundamental question for resource economics is whether the physical output of remaining species and biophysical processes, and the waste-assimilation capacity of the ecosphere, are adequate to sustain the anticipated load of human economy into the next century, while maintaining the general life-support functions of the ecosphere.

The impact of human settlements extends beyond their geographic locations. The true *ecological footprint* of a city is the corresponding area of productive land and aquatic ecosystems required to produce the resources used, and to assimilate the wastes produced by a defined population at a specified material standard of living, wherever on earth that land may be.

Cumulative impact

It is important to assess the natural environment using a systems approach that will consider the cumulative impact of various actions. Cumulative impact refers to the impact on the environment which results from the incremental impact of the actions when added to other past, present and reasonably foreseeable future actions regardless of what agency or person undertakes such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period.

Sustainability

Sustainable development implies the adoption of a holistic view of the interdependent relationship between human society and the natural environment. It acknowledges the links between the impact of human activities (particularly economic activities) on the functioning of physical and social environments, and vice versa. Sustainable development is also concerned with "development" - that is, the meeting of essential human needs and improvements in the quality of life. Sustainable development has been presented, therefore, as the means for providing an integrating framework for the reconciliation of human economic and social needs with the capacity of the environment to meet such needs in the long term.

The most commonly quoted definition of sustainable development is attributed to the Brutland Report: "development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development 1990).

Perhaps the most succinct description is provided by Holland (1992, p 242), who states that sustainable development: "is about recognising that this is the only planet we've got. It requires that we give consideration to the rights of future generations to make a living on the planet, and also to the rights of other species to share the world".

Fowke and Prasad (1996, p 62) identified a number of principles at the core of the sustainable development concept. The principles include the following:

- *intergenerational and intragenerational equity* - involves accepting that the current generation should not leave a degraded environment for the next generation, and recognition that equity within the present generation is a legitimate and necessary goal;
- *integration of economy and environment* - acknowledging the linkages between the health of both the economy and the natural environment;
- *dealing cautiously with risk, uncertainty and*

irreversibility - adoption of the precautionary principle and an anticipatory approach to potential development impacts;

- *conservation of biological diversity* - maintaining the variety of life forms and ecological integrity; and
- *recognition of the global dimension* - accepting that the impact of national, state and local policies and activities is not spatially or temporally confined.

No one of these principles can be given priority over the others: such is the nature of their interdependence.

Sustainable development is not a straightforward concept. It does not, therefore, provide us with simple list of do's and don'ts regarding human activities and the environment. Moreover, it places the responsibility back on society as a whole, rather than on science or some other "rational" decision-making medium, to make choices about how we live today, what kind of life future generations will lead and how environmental quality (upon which human society is so fragilely dependent) will be maintained. It is increasingly being recognised that local decisions hold the key to the quality of life in the urban environment and that linkages between urban and global sustainability are growing in importance.

Sustainable cities

It is becoming increasingly obvious that the future of the world will be an urban one. But cities and urban areas are also becoming the places where environmental problems are concentrated.

Expanding cities cause an ever-increasing loss in agricultural and bush land, introducing more and more pollution into waterways and the atmosphere. Biodiversity and native vegetation are lost due to urban and agricultural expansion. Cities in the developed world experience environmental problems such as pollution and congestion stemming from wealth and over-consumption, while the urban populace in the developing world is prone to environmental problems associated with extreme poverty and a lack of infrastructure. A poor quality environment leads to apathy and ultimately to acceptance of crime.

Despite it's many flaws it also needs to be recognised that the city in itself is a valuable resource. The city sustains economic, social and cultural life as we know it, and is a centre for innovation, economic growth, education and civilisation.

ECOLOGICAL GUIDELINES FOR SETTLEMENT-MAKING

The following section provides guidelines for considering ecological factors when designing local living areas to ensure the most suitable location of different land uses in a specific area.

Geological considerations

Undertake a detailed geological survey of the area

In approaching this task it is recommended that the document *Guidelines for urban engineering geological investigations* (1997), published jointly by the South African Institute of Engineering and Environmental Geologists (SAIEG) and the South African Institute of Civil Engineering (SAICE), be referred to.

An understanding of the geological characteristics of a terrain is essential for settlement establishment, for the following reasons:

- there are different structural requirements for foundations on different soil types (e.g. collapsible soil, clay, undermined areas);
- the cost of development, suitable land uses and density of development differ for various soil types;
- the geological features of the site determine the drainage features and patterns and the location of aquifers;
- slope and soil type indicate susceptibility to erosion; and
- areas of seismic activity and radioactivity need to be identified.

Van der Merwe (1997, p 6) describes the *most suitable terrain conditions* for urban development as having a smooth surface gradient with slope less than 12 degrees. This costs less to develop and can be developed at higher densities with less effect on erosion. Accessibility should not be restricted by topography (plateau areas). Suitable terrains should also have:

- no potential for slope instability features (land slides, mud flows);
- easy excavation for foundations and installation of services (normal depth of 1,5 m required);
- foundations above the ground water level or perched water table, with adequate permeability;

- development above the 1:50-year floodline;
- adequate surface and subsurface drainage conditions, with minimal erosion potential;
- no problematic soils (for example heaving clays, compressible clays, sand with some collapse potential, or dispersive soils) that will require expensive remedial measures, as well as no damaging differential subsidence or movement (less than 5 mm total movement at the surface allowed);
- no potential for surface subsidence due to the presence of dolomite (sinkholes) or undermining; and
- an area large enough to accommodate the projected population growth.

All these conditions need to be identified beforehand, as they impact on the suitability (Table 5.8.2.1) and development cost (Table 5.8.2.2) of the area.

Table 5.8.2.1: Geotechnical classification for urban development

	CONSTRAINT	MOST FAVOURABLE	INTERMEDIATE	LEAST FAVOURABLE
A	Collapsible soil	Any collapsible horizon or consecutive horizons less than 750 mm in depth.*	Any collapsible horizon or consecutive horizons more than 750 mm in depth.	A least favourable situation for this constraint does not occur.
B	Seepage	Permanent or perched water table more than 1,5 m below ground surface.	Permanent or perched water table less than 1,5 m below ground surface.	Swamps and marshes.
C	Active soil	Low predicted soil-heave potential.*	Moderate predicted soil heave potential.	High predicted soil-heave potential.
D	Highly compressible soil	Low expected soil compressibility.*	Moderate expected soil compressibility.	High expected soil compressibility.
E	Erodability of soil	Low.	Intermediate.	High.
F	Difficulty of excavation to 1,5 m depth	Scattered or occasional boulders less than 10% of the total volume.	Rock or hardpan pedocretes between 10 and 40% of the total volume.	Rock or hardpan pedocretes more than 40% of the total volume.
G	Undermined ground	Undermining at a depth greater than 100 m below the surface (except where total extraction mining has not occurred).	Old undermined areas to a depth of 100 m below the surface where slope closure has ceased.	Mining within 100 m of surface or where total extraction mining has taken place.
H	Instability in areas of soluble rock	Possibly unstable.	Probably unstable.	Known sinkholes and dolines.

Table 5.8.2.1: Geotechnical classification for urban development (continued)

CONSTRAINT		MOST FAVOURABLE	INTERMEDIATE	LEAST FAVOURABLE
I	Steep slopes	Between 2 and 6 degrees (all regions).	Slopes between 6 and 18 degrees and less than 2 degrees (Natal and Western Cape). Slopes between 6 and 12 degrees and less than 2 degrees (all other regions).	More than 18 degrees (Natal and Western Cape). More than 12 degrees (all other regions).
J	Areas of unstable natural slope	Low risk.	Intermediate risk.	High risk (especially in areas subject to seismic activity).
K	Areas subject to seismic activity	10% probability of an event less than 100 cm/s^2 within 50 years.	Mining-induced seismic activity more 100 cm/s^2.	Natural seismic activity more than 100 cm/s^2.
L	Areas subject to flooding	A "most favourable" situation for this constraint does not occur.	Areas adjacent to a known drainage channel or floodplain with slope less than 1%.	Areas within a known drainage channel or floodplain.

* These areas are designated as 1A, 1C, 1D, or 1F areas where localised occurrences of the constraint may arise.
Source: SAIEG (1997)

Table 5.8.2.2: Additional development costs due to geotechnical parameters

PARAMETER		CLASS 2	CLASS 3
A	Collapsible soil	+ 10% on infrastructure + 10% on building development	+ 20% on Infrastructure + 20% on building development
B	Seepage	+ R7 000 per hectare under (4) Reclamation	+ R20 000 per hectare under (4) Reclamation
C	Active soil	+ 10% on infrastructure + 10% on building development	+ 20% on infrastructure + 20% on building development
D	Highly compressible soil	+ 10% on infrastructure + 10% on building development	+ 20% on infrastructure + 20% on building development
E	Erodability of soil	+ 5% on roads and streets + 5% on drainage	+ 5% on roads and streets + 5% on drainage
F	Difficulty of excavation to 1,5 m	+ 12,5% on water supply + 12,5% on sanitation	+ 12,5% on water supply + 12,5% on sanitation
G	Undermined ground	+ 10 - 20% on infrastructure + 10 - 20% on building development	+ 30 - 40% on infrastructure + 30 - 40% on building development

Table 5.8.2.2: Additional development costs due to geotechnical parameters (continued)

PARAMETER		CLASS 2	CLASS 3
H	Instability on soluble rocks	+ 30 - 40% on infrastructure + 30 - 40% on building development	Not feasible - life threatening
I	Steep slopes	+ 25% on infrastructure + 5% on building development	+ 50% on infrastructure + 15% on building development
J	Areas of unstable natural slopes	+ 25% on infrastructure + 5% on building development	+ 50% on infrastructure + 15% on building development
K	Areas subject to seismic activity	+ 10% on building development	+ 20% on building development
L	Areas subject to flooding	+ 5% on total development	+ 10% on total development

Source: Williams (1993)

Identify geological materials with economic value

Identify, describe and quantify geological materials with economic value (ecological resources) such as construction materials, through an engineering geological investigation. Sand (calcareous) can be used as building sand and general fill material. Sand (silica) is used for glass-making, foundry sand, metallurgical uses, sand-blasting, filter sand, paint and filler manufacture, tile manufacture, adhesives, and standard sands for use in laboratories. Calcrete is used in cement manufacturing and as a road aggregate.

For low-income developments, assess the potential and appropriateness of the local geological materials for their use in unsealed roads

Through the assessment of the geological structure of local materials, their stage of weathering, the local hydrological conditions and climate, an engineering geologist would be able to select appropriate materials for use in unsealed roads. Unsealed roads, being dynamic systems, are affected far more by traffic, environmental and material conditions than sealed roads. The material is probably the principal component of the total system affecting performance and behaviour.

The requirements of durable coarse materials have been identified as follows (Paige-Green 1997):

- an ability to provide an acceptably smooth and safe road surface without excessive maintenance (i.e. freedom from corrugation, potholes, ruts and oversize material);
- stability in terms of resistance to deformation under both wet and dry conditions (i.e. essentially resistance to ruts and shearing);
- an ability to shed water without excessive scouring;
- resistance to the abrasive action of traffic and erosion by wind and water;
- freedom from excessive dust;
- freedom from excessive slipperiness in wet weather without causing excessive tyre wear; and
- low cost and ease of maintenance.

To fulfil these requirements, durable coarse materials must have

- suitable particle-size distribution;
- appropriate cohesion;
- adequate material strength; and
- adequate aggregate hardness.

Assess the risk of developing on shallow dolomite

A geological survey should be undertaken to assess the risk of development on high risk shallow dolomite. Shallow dolomite is a particular cause for concern where the absence of a protective overburden blanket and the presence of joints and dykes leave an area highly vulnerable to sinkhole formation. The geological hazard in shallow dolomite conditions appears to be broadly related to

- the depth of dolomitic bedrock;
- the nature of overlying material; and
- the nature of the joints and dykes in the dolomitic bedrock.

There are moral and financial implications to various parties if development proceeds on dolomite. Chapter 6 provides a list of general precautions for such developments.

Identify areas with potential subsidence due to undermining or reworked ground

The development potential (height of buildings) can be restricted on undermined areas. Alternatively, additional development costs could be incurred due to the additional reinforcement required in foundations.

Assess the erosion potential of an area by assessing the local rainfall pattern, prevailing wind direction, vegetation and soil type

Areas with a high erosion potential should be developed at lower densities, with more permeable surfaces. The removal of vegetation and topsoil by construction vehicles accelerates natural processes such as runoff, streamflow and erosive siltation (sedimentation) downstream, resulting in higher flooding potential and the decreased ecological functioning of streams. Slope, soil type and vegetation are the main factors controlling overland flow. The interaction between these factors should be assessed before development takes place (Figure 5.8.2.1).

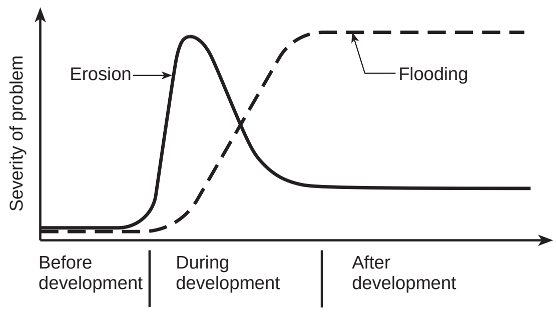

Figure 5.8.2.1: The sequential nature of erosion, sedimentation and flooding

Source: Walesh (1989)

Hydrological considerations

This section is complementary to Chapter 6, in which the detailed design and management of the stormwater system are described.

Identify groundwater recharge zones

Groundwater recharge zones (wetlands and aquifers) should preferably not be developed, or they should at least be appropriately developed (at lower densities with appropriate land uses) to allow for the infiltration of water.

The following activities can pollute the groundwater and special precautionary measures should be taken with regard to their location:

- landfills discharge leachate that may contain organic compounds like methane and benzene (residential garbage) or trace elements like zinc, chromium and lead (industrial landfills);
- some urban stormwater runoff infiltrates the water table and contaminates the groundwater;
- failures in septic tank systems release sewage effluent into the surrounding soil, and the groundwater downslope of such systems is therefore vulnerable to contamination;
- spills and leakages of petroleum products (petrol and diesel storage tanks) are known sources of groundwater and soil pollution;
- mining operations interfere with the groundwater and often degrade its quality; and
- the use of pesticides in agricultural activities poses a water-pollution threat.

Identify the 1:50-year floodline and floodplains around rivers

No development should be allowed in the 1:50-year floodline determined by an engineer, mainly for safety reasons and the protection of property.

The requirements laid down by the National Building Regulations and Building Standards Act (Act 103 of 1977) in terms of development within the 1:50-year floodline area are based only on safety considerations without proper consideration and understanding of the underlying natural streamflow processes. The Town Planning and Townships Ordinance (Ordinance 15 of 1986) also makes provision in Regulation 44(3) for the extension of floodline areas up to 32 m from the centre of a stream in instances where the 1:50-year floodline is less than 62 m wide in total. In order to improve this situation and to prevent backfilling and encroachment, additional measures will have to be implemented. These measures and guidelines could include the following:

- The 1:50-year floodline restriction should be seen as a minimum requirement for safety reasons only.

- Buffer zones with a minimum width of 10 m should be provided between the 1:50-year floodline area (32 m) and any proposed development, to ensure that no development has a direct impact on the natural flow of rivers and streams. No earthworks should be allowed within the buffer zone of any development.

- Where the 1:50-year floodline (32 m) and the 10 m buffer strip is not sufficient to cover areas frequently inundated by streamflow, additional land should be excluded from development to ensure that the stream and its natural processes are not directly impacted upon by a single development, to the detriment of all other developments upstream or downstream.

- In principle, properties that are severely impacted upon by floodlines, buffer zones and wetland areas should not be modified to increase the development area. Increased rights to the remaining area that could be developed should be investigated.

- Stormwater management on site should become the norm rather than the exception throughout the entire catchment basins of urban streams, as development on every site contributes to urban stormwater runoff. The sites adjacent to streams are usually the ones most affected by a lack of stormwater management throughout the drainage basin.

- The floodplain has the potential to be utilised for urban agriculture, if carefully managed (See Chapter 2).

No backfilling should be allowed in the 1:50-year floodline. No concrete channelling of rivers should be permitted

Land adjacent to streams is usually sought after by developers for high-density developments or business developments. In order to gain more valuable land for development it is common practice to modify the 1:50-year floodplain by filling it up, thereby creating artificially steep stream banks of highly erodable material (Figure 5.8.2.2). The cumulative impact of these practices and the total disregard for geomorphological and hydrological processes have disastrous effects during flooding. Further engineering efforts to reduce flooding - such as levees, concrete channels, damming and piping further destroy stream beds and habitats like ponds and wetlands.

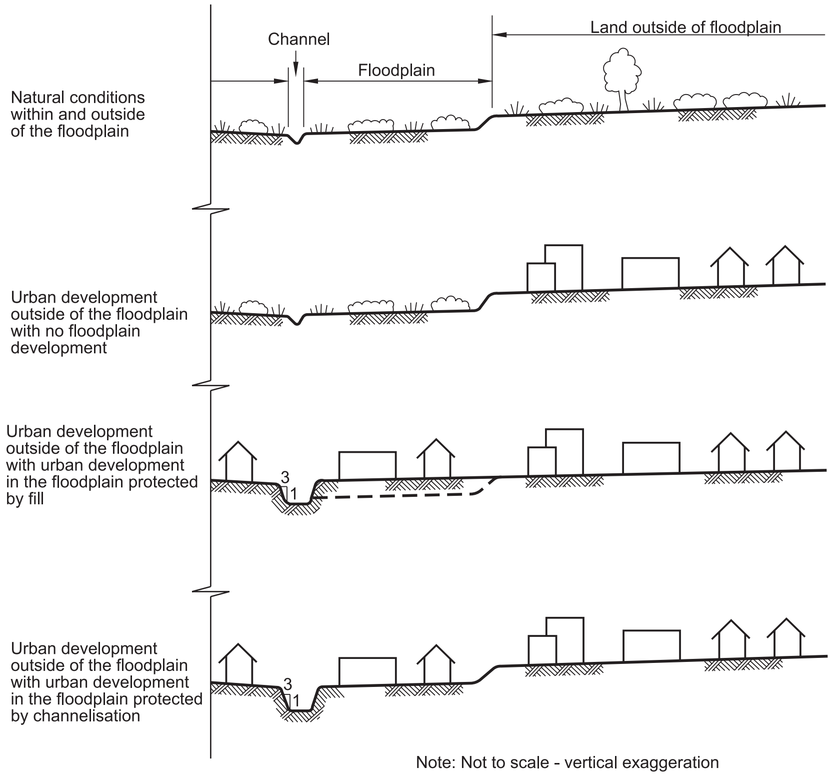

Figure 5.8.2.2: Encroachment into floodplains
Source: Walesh (1989)

The volume of water that runs down these streams will at least be constant or increase, due to development within its catchment area. Modification to the floodline on one side of the stream will have a direct effect on the position of the floodline on the opposite side of the stream. Consecutive backfilling and 1:50-year floodline modifications usually result in very narrow, steep artificial stormwater sewers replacing urban streams and their associated ponding areas such as wetlands, which cater for storm events and bank-overtopping. This type of modification is especially evident on commercial and business sites with stream frontage and it is usually required that more land for development must be provided and that parking requirements are adhered to.

Reduce imperbeable surface cover

New towns and suburbs are usually established on vacant land or natural veld on the outskirts of existing urban areas. In terms of hydrology, these vacant areas have not been extensively modified in terms of permeability, vegetation cover, and soil compactness, and the runoff from these sites can be accommodated by the existing stream channels and floodplains. Water loss through runoff is minimal in natural areas, compared to developed areas.

The development of single units on large erven, results in an increase in stormwater runoff due to the change from largely pervious surfaces on site to impervious surfaces.

Land subdivision causes increased densities and increased impervious surface coverages, resulting in higher stormwater runoff from the site. As intensity of land use increases, so the amount of impervious surface tends to increase (Figure 5.8.2.3).

Due to the variety of residential types, town-planning schemes differentiate between residential use mainly in terms of the number of units (density) per erf or hectare. Use is controlled by factors such as the height, coverage and floor area ratio applicable to the site.

The introduction of paving on residential sites is not covered by the "coverage" definition and is therefore totally ignored. Paved driveways, parking areas, hard landscaping, pools and tennis courts all add to the list of impervious surface areas on residential sites that are not at present taken into consideration in assessing applications for residential development. In theory, these paved areas could increase the impermeability of a site to 100%, especially in areas of high-density townhouse or cluster developments with restricted space for gardening.

Roads (including street surfaces, sidewalks and driveways) are a major contributor to impervious surfaces in residential areas - 63% and 65% respectively for high density and multifamily developments (Real Estate Research Corporation 1974, p 174).

Increased impermeability is not only directly related to increased runoff, it has also been shown to have a direct relationship with the pollutant loading of stormwater. The pollutant loading of stormwater increases with the percentage of impervious cover (Marsh 1991, p 161).

Different land-uses, residential densities and

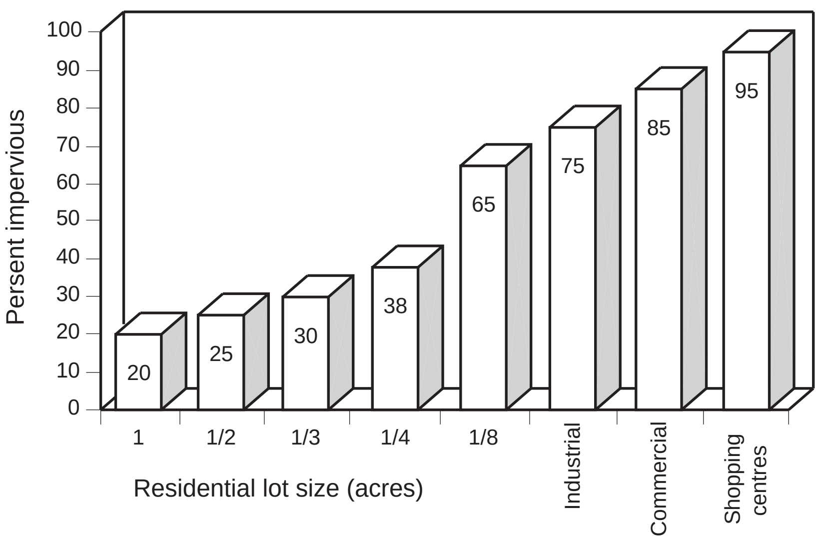

Figure 5.8.2.3: Average percentage of impervious coverage by land use

percentage of impermeable cover all result in different pollution loadings. (Table 5.8.2.3).

Limit stormwater runoff from parking sites

It is accepted that provision will have to be made for private vehicle parking, even in areas where public transport services are provided and where the design and locality of business areas encourage pedestrian use. The design of these parking areas could be improved, especially in terms of drainage and water pollution. Parking areas are designed and constructed as sealed surfaces in order to drain stormwater effectively to the nearest stormwater sewer or culvert and from there to the nearest stream. Polluted stormwater from these parking areas finds its way into the nearest stream, where it decreases water quality and increases erosion and flooding downstream.

Various methods are presently being used to solve the problem of impermeable parking lots. These methods range from permeable grass paving to bioswales and porous parking surfaces, such as gravel (Thompson 1996, p 60).

Bioswales have been used successfully in minimising the effect of stormwater runoff from parking areas as well as for filtering pollution elements. In essence, bioswales refer to a series of linear retention basins that move the runoff from parking lots as slowly as possible, along a gentle incline planted with indigenous vegetation. The vegetation, as well as check-dams at intervals, causes the runoff to pond and infiltrate through the topsoil and plant roots into the water table. This process prevents rapid runoff and also filters out certain pollutions. It has been estimated that these bioswales could draw off about 21 mm of rainfall over a 24-hour period, and that 60-70% of the suspended solids that cause water pollution could be captured by this system (Thompson 1996, p 62).

Porous parking surfaces such as gravel could also be used to improve the infiltration of rainwater, especially in conjunction with asphalt driving lanes. The parking areas or stalls consist of gravel while the lanes in between are constructed of normal asphalt or other hard-wearing, impermeable material.

The potential impact of parking areas associated with large-scale business and commercial developments should be minimised by reducing the number of bays required, secondly by taking into account that multiple-storey parking garages are more desirable and thirdly, by using various designs and materials such as described above to further minimise the effects of parking lots on runoff and pollution.

More detailed design guidelines for parking spaces can be found in Sub-chapter 5.3, which deals with hard open spaces.

Chapter 6 provides a more detailed description of land uses that have the potential to pollute water resources.

Table 5.8.2.3: Stormwater pollution for selected urban uses

LAND USE	DENSITY[a]	NITROGEN[b]	PHOSPHORUS[b]	LEAD[b]	ZINC[b]
Residential, large lot (1 acre)	12%	3,0	0,3	0,06	0,20
Residential, small lot (0,25 acre)	25%	8,8	1,1	0,40	0,32
Townhouse apartment	40%	12,1	1,5	0,88	0,50
High rise apartment	60%	10,3	1,2	1,42	0,71
Shopping centre	90%	13,2	1,2	2,58	2,06
Central business district	95%	24,6	2,7	5,42	2,71

a Based on percentage of the land covered by impervious (hard surface) material.
b Pounds per acre of land per year.

Source: Marsh (1991)

The layout plan should make provision for an appropriate level of sanitation services

It is only when services such as access roads, water, electricity, sewer, stormwater management and solid-waste removal are available that a particular land-use can reach its full potential.

Many studies indicate that high-density residential development without adequate services (informal settlements) is a major threat both to human health and ecosystem functioning. Contamination of stormwater runoff by high levels of nutrient and faecal bacterial loads and litter, mainly from informal settlements, create a more serious threat to water quality than the discharge from a sewage works.

The adequate provision of services during the construction and development of residential areas is, however, not the end of the process. Continuous monitoring and maintenance of these systems is of the utmost importance.

Developed areas with acceptable levels of modern sanitation can also contribute significantly to runoff pollution. This is primarily a consequence of poor maintenance, which results in leaking sewers, especially during dry weather, when these leaking sewers contribute to the maintenance of flow in streams. During rain events poor construction and maintenance of sewers and manholes result in stormwater runoff infiltrating the sewer system. This overloads the sewer system, with resultant overflow of sewerage effluent onto the land surface and potential "flooding" of the wastewater treatment works by excessive inflow (Jagals 1997, p 33).

Both a lack of services and poorly maintained services pose or cause risk to human and animal life. The following measures can help reduce the cost of services, and improve their performance:

- design layouts to reduce the length and therefore the cost of providing services;
- inform and educate the residents about the function and use of urban services;
- provide services that are cost-effective, both in terms of installation and maintenance;
- provide a level of service that is affordable to the residents and acceptable to the local authority; and
- incorporate stormwater design in the residential layout design, which should be designed in harmony with the topography and natural features.

Refer to Chapter 10 for options for - and the implications of - alternative sanitation systems.

Atmospheric considerations

The orientation and layout of erven should provide for north-facing housing units

Topographic aspects such as the slope and orientation of the site play a role in the solar energy gain or loss enjoyed in houses. A development on a steep south-facing slope will be colder than a similar development on the other side of the hill because it receives less solar radiation (see also Chapter 12.2).

Reduce the abundance of concrete and asphalt, and increase the amount of vegetation and open water

This will create higher volumetric heat capacities and greater rates of latent heat flux, thereby lowering air temperatures. Urbanisation can cause significant changes in atmospheric conditions near the ground. In heavily built-up areas of larger cities, these changes extend hundreds of meters above the ground, producing a distinct climate variant - the urban climate. Generally speaking, the urban climate is warmer, less well lighted, less windy, foggier, more polluted and often rainier than the regionwide climate. The desirable climatic effects of vegetated areas provide the rationale for the inclusion of parks and greenbelts in the urban area.

Determine the prevailing wind direction of the area and orientate erven and movement networks accordingly

Wind exposure promotes heat loss in winter, but can be used for ventilation and cooling in warmer climates. In addition, the prevailing wind direction has an influence on the dispersion of dust, noise and odour. Avoid creating windtunnels and provide windbreaks in the form of trees in areas with high winds.

Consider the location of industrial areas upwind of the living area

Most industrial emissions of air pollutants are referred to as point sources, which means that they come from a localised source. The ambient or "surrounding" levels of air pollutants from point sources depend on:

- the distance from the plant;
- the properties of the chemicals involved;
- the local topography; and
- the atmospheric conditions.

Promote the use of public transport (see also Sub-chapter 5.2)

The incomplete combustion of fossil fuels by motor vehicle emissions are a major source of air pollution associated with urban development. Significant emissions of greenhouse gases and respiratory irritants are emitted by diesel and petrol vehicles. Traffic-dense urban areas with high hydrocarbon and nitrogen oxide emissions lead to the formation of ozone and photochemical smog.

The amount of air pollution generated will usually depend on the frequency of private vehicle travel, the distances travelled and the congestion experienced during a trip. The most serious air pollution from motor vehicles typically occurs during morning rush hour, due to substantial congestion, increased pollution caused by cold engines and the more static nature of cold morning air.

At local level, traffic control should aim to provide an even traffic flow to reduce the air pollution caused by vehicles stopping and pulling away. This can be done by having fewer stop signs and by synchronising traffic lights on major roads.

Higher-density areas with sufficient public facilities within walking distance could result in increased pedestrianisation and a decline in private vehicle use.

Parking requirements should be investigated in detail to evaluate their contribution to people's inclination to travel by car rather than use other modes of transport. Where no fee is charged for parking at major business and commercial nodes, this encourages private vehicle movement.

Consider noise sources taking into account temperature, prevailing wind direction and local topography

Although excessive noise levels could be generated during construction it should be recognised that business/commercial nodes could also generate noise on a continuous basis during normal operation. Vehicle movement, especially heavy delivery vehicles after hours, could create noise nuisance. Promotions at shopping centres including loud music and or restaurants open till late could be the cause of complaints from surrounding residents.

- The screening of walls and thick vegetation could reduce/contain the impact of noise to a certain extent.
- Noise impact assessments might become mandatory for all major shopping centre and entertainment complexes.
- Additional measures, such as the soundproofing of venues, might become standard procedure, especially for entertainment venues.
- Time limits could be placed on the duration of concerts.

Consider the provision of buffer zones around land uses that generate excessive levels of noise, dust or odour

Buffer zones around industries, to limit the impact of emissions ranging from gases and odours to noise and light spill, are seldom used in South Africa and are poorly developed. Buffer zones are usually required where residential and industrial land-uses are located side by side. It is generally accepted that levels of emissions decrease, or are diluted, with increasing distance from a source. A safe distance could in theory be determined for a particular industry type, where emission levels on its boundary would be considered acceptable in residential areas.

Such buffer zones are commonly associated with wastewater treatment plants in South Africa. A buffer distance of 1 000 m from the building that generates the emissions is the norm in Greater Johannesburg at present. Offensive odours are usually the reason for the establishment of these buffer zones around wastewater treatment plants.

Apart from buffer zones surrounding mine-tailing dams (1 000 m), and buffer zones around nuclear facilities (up to 18 km for Koeberg), no buffer distance guidelines for a range of industries causing off-site impacts exist to assist urban managers in South Africa. Careful thought has to be given to the design and management of buffer zones to prevent their becoming hideouts or escape routes for criminals and scenes of criminal activity (see Sub-chapter 5.8.1).

Biodiversity considerations

Areas with a high degree of biodiversity should be developed as open spaces or low-density residential areas

The impact of residential development on soil, vegetation and wildlife is mostly associated with the large areas of vacant land, usually at the edge of urban areas, that are required for residential development.

Natural vegetation (veld) is also heavily impacted upon by expanding urban areas - a process known as "urban creep". Residential development is less sensitive to steep gradients, rock, and various soil types. It is therefore found on land which is not suitable for most other urban land-use. The development of vacant land (veld) for residential use results in the destruction of the habitats of various kinds of wildlife. Gardens and lawns may attract a variety of wildlife, but are seldom a replacement for the species that once inhabited the area.

The negative effects of development on biodiversity can, however, be limited by appropriate densities, careful site planning and design.

The development of sites near urban rivers and streams, or the incorporation of these streams in landscape proposals, is a further cause for concern. Natural systems such as streams have been formed and have evolved over thousands of years in direct relationship to the surrounding topography, soil type and vegetation cover. Extensive vegetation clearing and levelling usually changes the immediate topography to such an extent that the natural watercourses may cease to exist. Extensive landscaping of urban streams to “fit in” with the proposed development usually results in the creation of a dam or large enough water feature to create the very popular “waterfront” type of development. The mere construction of a dam in a free-flowing stream has an impact on aquatic life, water temperature, stream velocity, sediment load and water quality.

Sites containing streams, rocky outcrops and indigenous vegetation of note should be carefully considered and, if possible, incorporated successfully and sensitively into the settlement.

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