NATURAL INTERFACE STUDY

VELDFIRE RELATED PLANNING GUIDELINES

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GLOSSARY OF TERMS

1. Asset Protection Zone: The zone between the built environment and the hazard area within which modifications are made to protect the built environment. The width of the zone and elements within it will vary depending on the context.

2. Built Edge: The edge of the built environment. In its detailed determination, this may or may not be contiguous with the current cadasrtally defined Urban Edge.

3. Fire (Veldfire) Management Plan: A plan which directs the response of a land owner in the event of a fire. The content of the plan will differ according to the context and the land use and should be determined in conjunction with the relevant fire protection service.

4. Fire Trail: A vehicular access route within the Asset Protection Zone which is provided when the built edge is not separated from the natural environment by a formal road.

5. Fuel Modification: The action by a landowner to modify the amount of combustible fuels in a series of zones between the built edge and the hazard area.

6. Inner Protection Area: The inner of the two areas which together comprise the Asset Protection Zone. The depth will vary depending on the context. The inner protection area is the area of greatest action to reduce the risk from veldfires through fuel modification, landscaping, storage of combustible materials etc.

7. (Natural) Interface Zone: The zone of interaction between the built and natural environment.

8. Outer Protection Area: The outer of the two areas which together comprise the Asset Protection Zone. The depth will vary depending on the context. The outer protection area is an area of active reduction of fuel loading to reduce the intensity of an approaching fire.

9. Urban Edge: The cadastrally determined edge to the metropolitan area as envisaged in the Metropolitan Spatial Development Framework and refined in the Urban Edge Reports.

10. Veldfire Hazard: An area at risk from Veldfires. For the purpose of this document, the entire Peninsula is assumed to be a high risk Veldfire Hazard area. Veldfire Risk Mapping will in due course determine different degrees of risk for different areas along the interface zone. This will allow for a more considered response to veldfires.

1.0 BRIEF AND INTRODUCTION

In January 2000 residents of Cape Town watched as wildfires ravaged the Cape Peninsula and areas in the Blaauwberg region. The estimated direct cost of the fires was in excess of R30 million (Source: GGU@UCT).

Following the destructive veldfires of January 2000, the Santam/Cape Argus Ukuvuka: Operation Firestop campaign was launched.

One of the objectives of the four-year campaign was to develop policies and guidelines with regards to fire-risk and post-fire stormwater management, relating to development along the urban/natural interface. The natural interface strategy (NIS) emerged as a project to address this challenge.

In April 2001, the Ukuvuka NIS phase 1 status-quo assessment was completed. This comprised a review of Local Authority management practices in dealing with fire, a review of the fire related legislation and legal tools available to the Authority and a review of Provincial, National and International trends with regard to fire risk management. Phase 2 of the NIS was seen as providing a “tool kit” or manual for use by the Local Authority as well as the provision of implementation strategies.

Phase 2 was divided into two studies, the development of appropriate veldfire-related planning guidelines for development in the natural interface zone (the subject of this report) and the development of guidelines for stormwater management on slopes adjacent to natural areas (completed in January 2004).

During 2002, consultants were appointed to prepare a Guideline Manual to assist the Local Authority in its consideration of development applications that affected the Urban Edge. This document was completed in Draft in 2003, and it was determined that the development of veldfire related planning guidelines should be incorporated into the Guidelines Manual, but developed in such a way as to also be able to stand alone. MLH Architects and Planners and Piet Louw Architects and Urban Designers were appointed in 2003 to prepare the veldfire related planning guidelines.

2.0 THE STUDY AND EXISTING DOCUMENTATION

The relationship of this study to other studies that have been done in the more recent past, is illustrated on figure 1. In summary, there are four streams of documentation:

2.1 NATURAL INTERFACE STUDY STATUS QUO ASSESSMENT

After the devastating fires of January 2000, and the establishment of Ukuvuka campaign, a status quo assessment was undertaken of management strategies in the planning, environmental and engineering fields related to fire-risk, as well as legislation and legal tools available and international trends in fire-risk management at Local Authority level. A report titled "Ukuvuka Natural Interface Study Phase 1 : Review" was completed in April 2001. The report listed a number of issues and problems related to planning and stormwater management, including:

- Existing planning layout guidelines do not promote fire sensitive design
- Lack of vehicular access due to closed cell layout
- Long runs from fire fighting positions
- Tight layout and narrow reserves hinder fire-fighting vehicles
- Lack of direct access to the natural interface zone due to houses backing onto this zone
- Informal settlements have severe access problems
- Roads with steep gradients reduce access for fire tenders
- Natural stormwater channels are cut off and cause flooding in urban areas.

The report made several recommendations including:

- Development of planning related veldfire guidelines that can be implemented through land use management procedures
- Clarification of design standards that urban stormwater systems need to be designed for to accommodate periodic increases in flow associated with veldfires and fire management practices.

2.2 URBAN EDGE GUIDELINES MANUAL

The Urban Edge emerged from the Metropolitan Spatial Development Framework (MSDF) which gave rise to four Urban Edge reports. One of the underlying principles of the MSDF is the notion of a compact city promoting efficiency. The principle supports the concept of an urban edge, which would contain the lateral sprawl of the city. The Urban Edge was broadly defined in the MSDF and refined to a cadastrally based line in the four Urban Edge reports.

With growing pressure for development within the City, the number of development proposals, which affect the edge, is increasing. In order to assist the Local Authority officials to deal with these applications, and to establish a set of criteria which could assist in the formulation of an appropriate application, consultants were appointed to prepare the Urban Edge Guidelines Manual. This was completed in January 2003. The Guidelines Manual provides a decision-making framework which allows the Local Authority officials to review and evaluate development applications that affect the urban edge. This provided a vehicle for the inclusion of fire-related planning guidelines for areas along the urban edge/natural interface zone, which is the subject of this report.

2.3 GUIDELINES FOR STORMWATER MANAGEMENT ON SLOPES ADJACENT TO NATURAL AREAS

The City of Cape Town adopted a Stormwater Management Strategy in 2002. A document titled "Guidelines for stormwater management on slopes adjacent to natural areas" was completed in support of the strategy. This document also gives effect to the recommendation from the Natural Interface Study status quo assessment for design guidelines to address fire-related stormwater management issues on the slopes of the mountainous areas of the City.

2.4 FIRE MANAGEMENT PLAN FOR THE CAPE PENINSULA NATIONAL PARK

The CSIR prepared a Fire Management Plan for the Cape Peninsula National Park (CPNP) in 2000. The plan reviewed the current situation with regard to fire management in the CPNP and formulated a fire management plan. Simultaneously, guidelines to reduce fire risks on properties adjacent to the CNPN were also developed by the CSIR. Ukuvuka has published these guidelines in a Z-folder for distribution to the property and homeowners bordering the CPNP

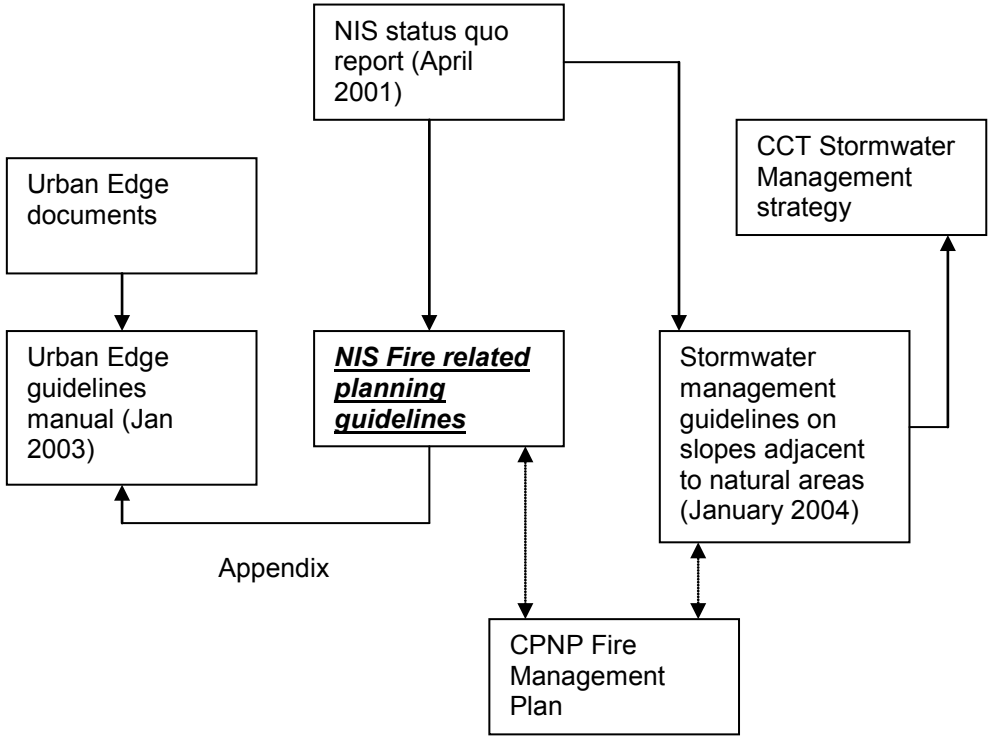


Figure 1 Relationship of this study to other studies and documents

3.0 APPROACH AND METHOD

the Cape Metropolitan Area and, in particular, the Cape Peninsula, is characterised by a number of conditions, the particular combination of which gives rise to the veldfire risk in the area.

Recognising the problem:

- Hot, windy dry summer conditions
- Sloping topography
- Poor access for emergency vehicles as a result of past planning
- Vegetation that requires fire to evolve and regenerate
- A build-up of invasive alien vegetation, increasing biomass/fuel load
- Use of combustible construction materials
- Inadequate fire-scaping of gardens
- Lack of awareness on measures that can be taken to reduce the developmental risk.

The approach and method adopted for these guidelines is based broadly on the same philosophy as that adopted for the Urban Edge Guidelines Manual. In this regard, the veldfire related planning guidelines are seen as being one element in a continuum of elements moving from the most natural to the most built. (See figure 2). The determination of guidelines for a specific site will be dependant on the site itself and its relationship to the full range of elements that need to be considered with respect to veldfires. As such, the guidelines and the way in which they are implemented will vary along the length of the urban edge as the conditions along the edge vary.

The approach and method adopted to establish the veldfire related planning guidelines, is intended to provide the framework for an appropriate decision to be taken or action to be undertaken. As in the case of the Urban Edge Guidelines Manual, it is not intended, nor would it be practical, to provide the solution for every meter along the interface zone. Rather, these guidelines establish the principles, which should be taken into account by both the developer or owner of a piece of land at risk from veldfires, as well as by the relevant authority in its consideration of development applications in this context.

Like the principles established and expounded on in the Urban Edge Guidelines Manual, the principles set in this document, which in their consideration and implementation would give rise to an appropriate form of development, are in many instances simply good planning practice. This by its nature takes into account far more than merely the site itself and the maximisation of economic opportunity in this regard. In consideration of the principles, a multi faceted approach to the analysis of the site or condition is engendered which will determine the most practical solution for the site or condition in question. Such an approach would by implication take into account the impact of the development on the broader environment, and that of the environment on the development in light of the principles established in the Urban Edge Guidelines manual and in this instance more specifically with respect to veldfire risk.

This approach then sets up the method for the analysis of a site or development at risk from veldfires. As this study is seen as being part of the Urban Edge Guidelines Manual, the normative position and principles established in the urban edge manual (that of sustainability and the acknowledgement and promotion of uniqueness) are equally applicable. The method of analysis is therefore based on the creation of a composite picture through the layering of informants, rather than focusing on a single aspect.

The following sections of this report follow on the approach and method as discussed above. Section 4 deals with the principles that need to be considered in addressing development and veldfire risk. These generic principles are applicable everywhere on the urban edge but will vary in importance and significance, depending on the context. Sections 5 to 8 deal with specific guidelines and section 9 applies these to the Peninsula Urban Edge.

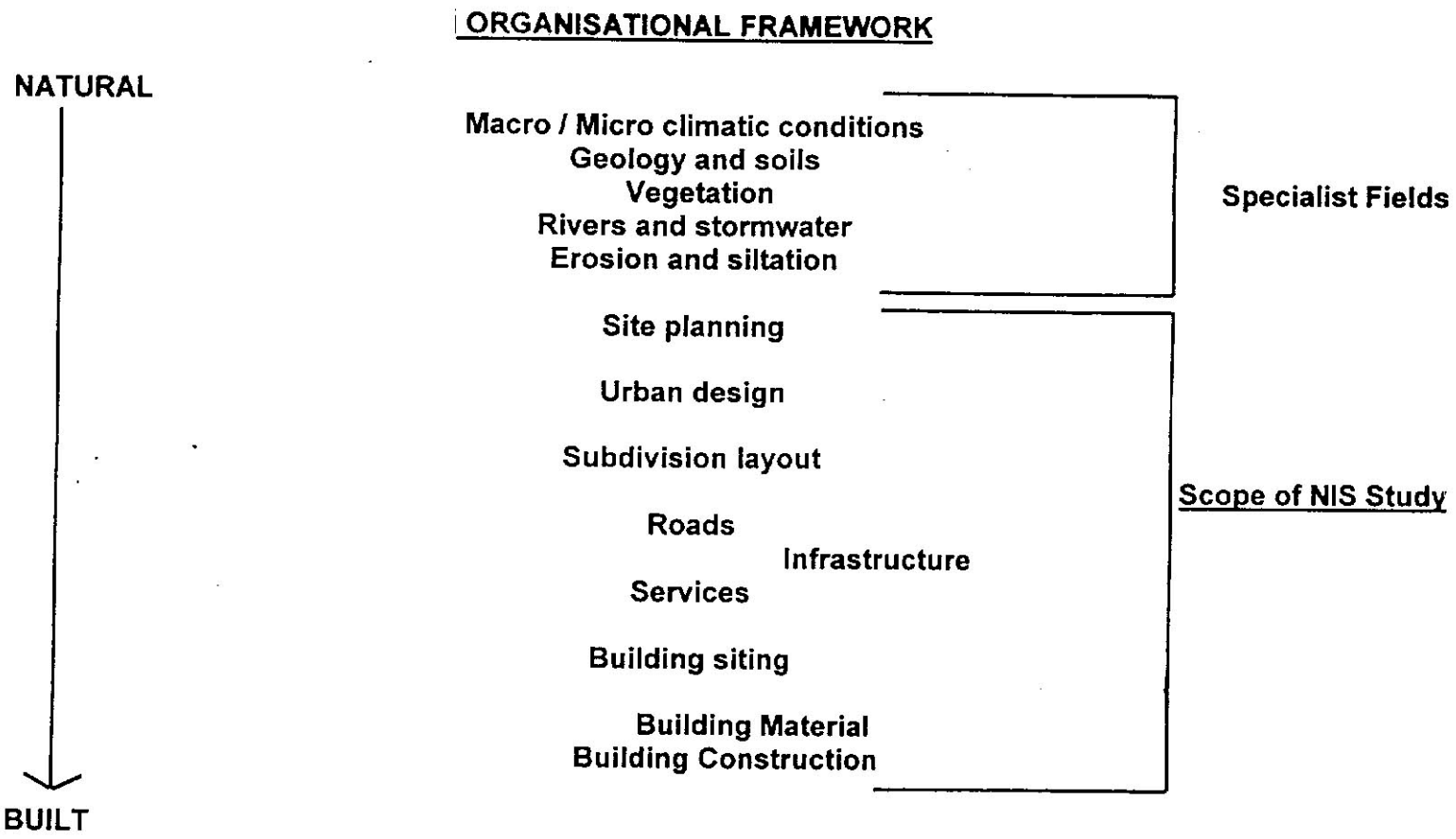


Figure 2: Organisational Framework

4.0 GENERAL PRINCIPLES

One of the fundamental principles that has emerged out of the Guidelines Manual is the fact that the "Built Edge" to the city need not be consistent with the "Urban Edge". This concept is discussed in section 3 of the Guidelines Manual and is illustrated on figure 3 in this report.

In the Cape Peninsula fire plays an important ecological role in the dominant fynbos vegetation. Many fynbos species require fire to regenerate. For this reason fire risk will always exist, and developments must be designed to accommodate this risk.

The overarching principles which dictate the manner in which the detailed planning guidelines related to veldfire protection are established, are as follows:

- The acceptance of a "Built Edge" to development, which may or may not coincide with the defined "Urban Edge". This concept is discussed further in section 3 of the Urban Edge Guidelines document and illustrated on figure 3 of this document.

- The provision of an Asset Protection Zone comprising an Outer Protection Area and an Inner Protection Area together with a road or fire trail. The principle of an Asset Protection Zone is discussed in the following section.

- The legislative requirement of one property owner to protect another against the possible spread of fire between the properties concerned as defined in the Veld and Forest Fires Act.

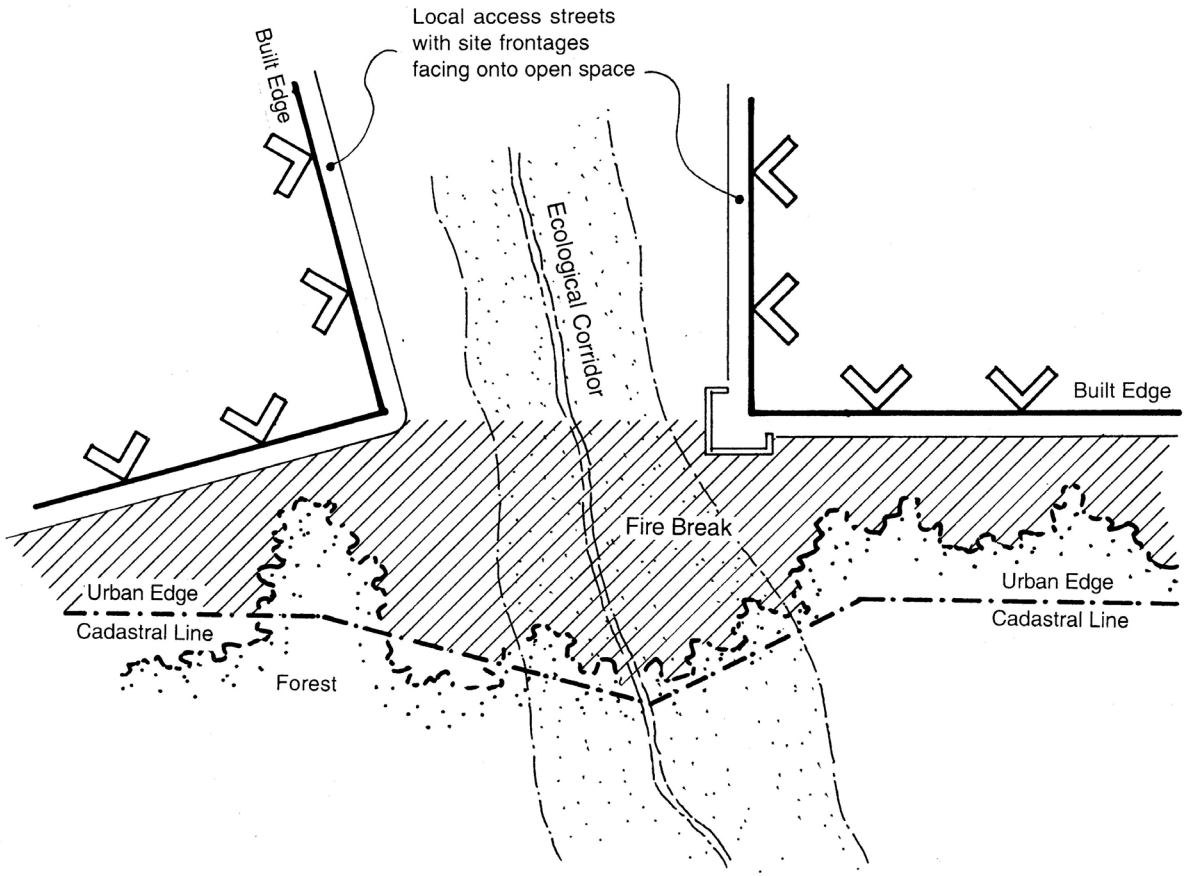
- Sustainable development – long term sustainability rather than short term gain.

The manner of applying these principles is dependant on the nature of ownership in the interface zone as well as the particular circumstance under consideration i.e. existing development, new developments or a change in development rights. Within existing developments, these guidelines should be treated as recommendations for landowners. In new developments or where a change of development rights is being sought, the guidelines may be enforced by the Local Authority depending on the circumstance.

The environment in which a particular development is proposed, can intensify or reduce veldfire risk to that development. It is important to integrate veldfire risk issues into the contextual and site analysis. It should be kept in mind that veldfire risk is often not restricted to the site but imposed by the context or adjacent land-use. As such, the following general principles should apply.

- Developments should not be allowed where environmental constraints preclude necessary risk reduction measures e.g. provision of adequate access, clearing of vegetation or necessary fire infrastructure, or where other mitigating measures cannot be provided.
- Developments should not be allowed on slopes steeper than 1:4, or where water pressure will be inadequate to control a fire on the slope behind the development.
- Development should not be allowed in forested areas, especially where removal of trees to reduce fire risk will significantly alter the cultural landscape, unless specific conditions exist on the site which may justify the development and / or remedial measures can be implemented to lower the fire risk.
- Adequate provision should be made in site planning and road layout to accommodate additional stormwater after fire-events, especially on steep slopes. Refer to the Guidelines for stormwater management on slopes adjacent to natural areas.
- Consideration should be given to the erodability of slopes above a proposed development. Erodability maps should be consulted where these are available and developed where they are not.

These principles are fully supported by the concept of the Asset Protection Zone which is discussed in section 4.1, and together with the Asset Protection Zone, are used to derive the guidelines as set out in sections 6 to 8.



Source:- Urban Edge Guidelines Manual for the City of Cape Town
MLH Architects & Planners in association with Piet Louw Architects, Urban Designer, Planner
January 2003

Figure 3: Urban Edge/Built Edge Concept

The line of the built edge does not necessarily follow the Cadastral line of the Urban Edge, although it could co-inside with it. The essential objective is to establish a strong clear built edge and therefore define the extent of the natural domain. Allowance is made for ecological and river corridors, and fire break opportunities. Local access streets with site frontages face onto the unbuilt domain which can accommodate a range of uses. (See Figure 5 of the Urban Edge Guidelines Manual)

4.1 Asset Protection Zone

The concept of an Asset Protection Zone has its origin in the documentation that has been prepared for bushfire protection in Australia. The aim of the Asset Protection Zone is to protect life, property and valued public assets. It comprises an inner protection area and an outer protection area and is a zone which is managed to reduce veldfire hazard to an acceptable level. The nature and width of the Asset Protection Zone as well as its application, will vary depending on the physical nature of the edge condition as well as the particular circumstance (existing or new development or a change in development rights). The Asset Protection Zone is a buffer zone between the hazard and any development with a primary purpose of reducing veldfire fuels between the hazard and any habitable structure and providing appropriate access to the hazard area. (figure 4)

The Asset Protection Zone should incorporate an Outer Protection as well as an Inner Protection Area.

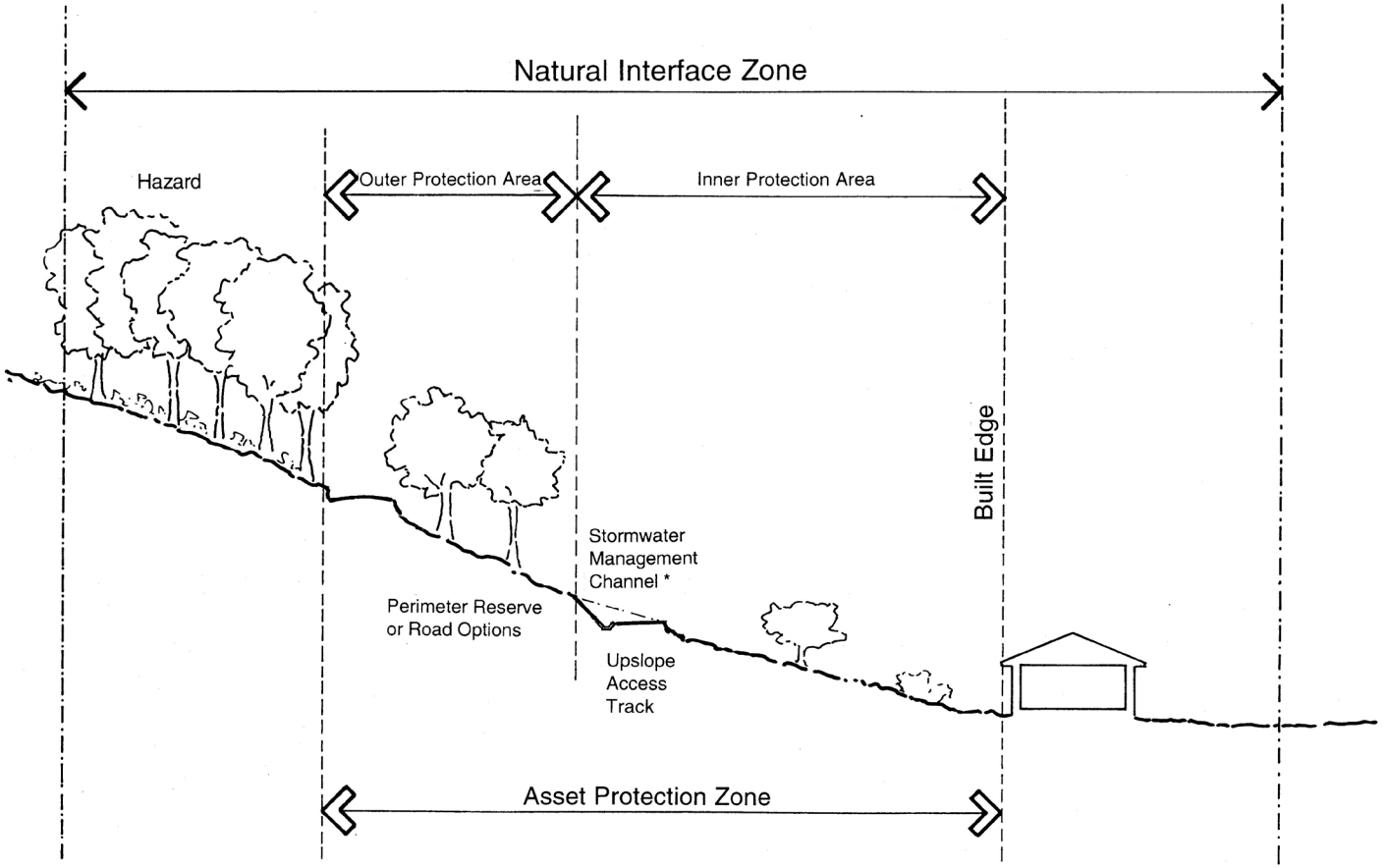
The outer protection area is located adjacent to the hazard area, and is an area where fuel loadings are actively reduced. This would substantially reduce the intensity of an approaching fire, reducing the level of direct flame, radiant heat and ember attack on the inner protection area.

The inner protection area extends from the edge of the outer protection area to the built edge (figure 4). Within this area, the presence of fuels should be minimised, to minimise the impact of direct flame contact and radiant heat on the development. The depth of the inner protection area will vary depending on slope. Generally, the greater the slope, the greater the intensity of an approaching fire and the greater the extent of inner protection area required. Within the inner protection area, planting and landscaping should take into account veldfire hazards, and storage of flammable materials (woodpiles, paint, gas etc) as well as wooden sheds, stacked building materials etc. should not be allowed.

Ideally a road or “fire trail” should exist between the outer protection area and the inner protection area. The intention of this is to provide fire fighters with easy access to the hazard area, provide a safe retreat for fire fighters and to provide a clear control line from which to conduct hazard reduction or back burning operations. A perimeter road is the preferred option where possible.

The perimeter road should have a reserve width of 20m (subject to visual impact) and the gradient along the road should not exceed 15 degrees. If a fire trail is provided, it should be a minimum of 6m wide and trafficable by fire fighting vehicles in all weather conditions. It should link into the adjacent road system at regular intervals. Fire trails should be inspected by the Local Authority annually.

As noted earlier, the provision and nature of the Asset Protection Zone will differ along the length of the interface between the built environment and the natural environment. The extent of the Asset Protection Zone will respond to the different edge conditions but is driven by the legislative requirement of one land owner to provide adequate protection for a neighbour against fire spreading from one property to another. In addition, the provision and location of the Asset Protection Zone is dictated by the existing circumstance (existing or new development or a change in land use rights) as well as the physical conditions of the context.



Source:- NSW Rural Fire Service

For more detailed stormwater run-off related information refer to:-

* Ref :- Stormwater Management on Slopes Adjacent to Natural Areas,
City of Cape Town Development Service,
Transport, Roads and Stormwater Directorate
November 2003, Version 1,0

Figure 4: Components of an Asset Protection Zone

5.0 APPLICATION OF VELDFIRE PLANNING GUIDELINES

The Veldfire Related Planning Guidelines form a part of the Urban Edge Guidelines Manual. As noted in section 3 of this document, the approach adopted in this document is consistent with that in the Urban Edge manual. The Veldfire Related Planning Guidelines provide an additional set of criteria which should be considered by both an applicant as well as the Local Authority in the formulation and consideration of a development proposal in an area which affects the urban edge and is at risk from veldfires.

Three circumstances exist along the urban edge, which dictate the manner in which the guidelines as discussed in the following sections of the document can be applied.

1. Existing development – The application of the guidelines in this circumstance will relate principally to remedial actions that could occur outside of the developed property, and recommended good housekeeping actions on the property, with a view to limiting the potential risk from veldfires.

2. Change of development rights – Any application to amend existing development rights affords the relevant authority the opportunity to ensure that the guidelines apply to the new development to the extent possible.

3. New development proposals – In addition to the review of new development proposals in the light of the “Urban Edge Guidelines”, all new development proposals should take into account the “Veldfire Related Planning Guidelines”, as set out in this document. Development proposals which do not conform to these guidelines should not be supported, unless specific conditions exist on the site which may justify the development and / or remedial measures can be implemented to lower the fire risk.

In addition, the conditions along the natural interface zone vary along its length. These differing conditions will cause the width of the Asset Protection Zone to vary. This concept is illustrated on Figure 5. In the first instance, there is the legal requirement of one property owner to protect another from the spread of fire from property to property. This requires a firebreak of 7.5m on each side of a property boundary. (For practical reasons this 15m wide firebreak is normally provided entirely on one property). Within the natural interface zone, this firebreak follows the cadastrally defined urban edge. However, as pointed out earlier, the Urban Edge and the built edge need not be contiguous, and where this condition exists, it would be reasonable to assume that the Asset Protection Zone would extend from the built edge to the legally required firebreak on the cadastral boundary.

Where the urban edge and the built edge are contiguous, the asset protection zone would be at least as wide as the required firebreak, but could be wider depending on the physical circumstances at that point along the interface zone.

The following sections explore the application of these principles in terms of land use, site planning and urban design, infrastructure, building siting and landscaping and building materials and construction. Section 9 than explores all of the principles discussed as they apply directly to the peninsula.

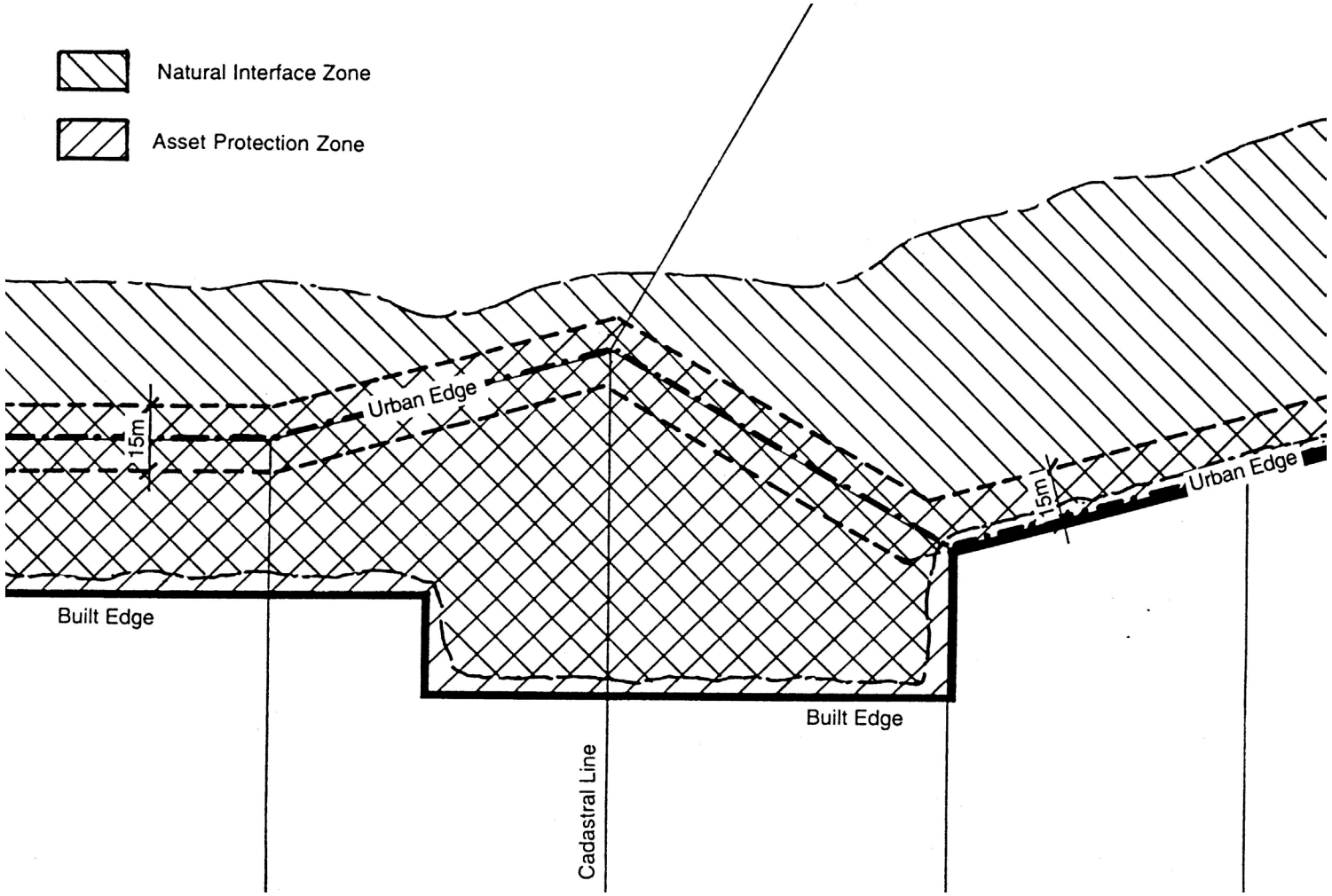


Figure 5: Different Edge Conditions

6.0 SPECIFIC GUIDELINES IN PLANNING FOR VELD-FIRE RISK

Based on the principles discussed in section 4 together with the concept of the Asset Protection Zone, the following specific guidelines are put forward to address land use, planning and urban design.

6.1 LAND USE GUIDELINES

Different tiers of planning control land use distribution in the metropolitan area. These range from the Urban Structure Plans, through 4.6 structure plans and down to local area 4.10 structure plans as provided for in the Land Use Planning Ordinance (LUPO). In addition to these plans, actual land use rights throughout the metropolitan area are controlled in terms of the applicable zoning schemes. To the extent that properties along the urban edge and within the interface zone have existing rights in terms of their zoning, very little can be said about appropriate land uses in these areas. In short, these land use rights can be exercised by the land owner. Of greater importance in these instances are the principles of site planning and urban design, infrastructure, building siting, landscaping and building materials and construction as discussed in the following sections.

However, in the circumstance where land owners are seeking development rights or seeking to change existing rights, Local Authority officials should be mindful of the potential impact of fire on different land uses.

Land uses which should not be permitted in the interface zone include those which may be the source of fires or are a potential hazard to adjacent areas or fire fighters if they are impacted on by fire. These would include land uses such as:

- Power plants or major infrastructure related to power.
- Sawmills and timberyards
- Junkyards
- Liquid fuel depots
- Offensive and hazardous industries which are a high fire risk.
- Chemical industries
- Service stations
- Ammunition storage / dumps

Land uses which are likely to be of concern include those that are likely to be impacted upon by fires and require consideration from the perspective of veldfires before they proceed. Examples include:

- Land-uses which are likely to result in a high concentration of people on a particular site and which may require evacuation such as flats, townhouse and group housing schemes, lodges, guest houses and hotels, places of assembly, commercial and retail premises, schools and tertiary education facilities, prisons, institutions for the mentally or physically disabled, retirement complexes, child care facilities, boarding houses and hospitals.

- Developments which can create control difficulties within their confines such as: bulk stores of combustible material, factories, warehouses, waste disposal and landfill depots and plantations.

- Informal developments which are both at risk from veldfires, with limited infrastructure and significant access problems, as well as a potential source of fires. Informal developments should not be permitted adjacent to or within the interface zone, but where these exist, special attention should be paid to applying the principles set out in this document to the extent possible.

While clearly, not every land use is listed as either of concern or which should not be permitted, the intention of this principle Is very clear. The relevant authority, in the consideration of an application, must consider the land use principle as it relates to veldfire hazard in arriving at a final recommendation.

6.2 FIREWISE PLANNING AND URBAN DESIGN

Many of the problems relating to fighting veldfires adjacent to urban areas can be traced back to problems with site planning and road layout. Road and erven layout should provide adequate access for fire-fighting and evacuation of residents in the case of an emergency.

A number of basic principles apply in this regard which should be used to inform the consideration of development applications in the interface zone. In the case of existing developments in the interface zone, it may not be possible to apply the principles to their full extent. However, in many instances, actions can be taken by landowners/developers which would be in line with the intention of the principles and which would assist both the landowner/developers and the fire services in the event of a veldfire hazard threatening the properties concerned.

In the case of both existing and new development proposals, owners and developers must be made aware of the document prepared for the City of Cape Town Catchment, Stormwater and River Management Branch titled “Stormwater Management on Slopes Adjacent to Natural Areas”.

The principles and actions are discussed below with the principles illustrated on figure 6.

- All new development applications on the urban edge must be circulated to the fire services for comment. If necessary, the fire services may call for a veldfire management plan for the area, the content of which is to be determined by the fire services for the application under consideration. The design of the development may be required to be amended on the basis of the fire management plans. These, therefore, must be provided prior to the final approval of the application.

- Ideally, developments should be separated from the interface zone by a public road or at least by a fire trail in accordance with the principle of the Asset Protection Zone as discussed earlier.

- Where subdivisions back directly onto the interface zone, the uninterrupted length of such subdivisions should be kept to a minimum.

- In the event that the subdivisions cannot be broken to provide direct vehicular access to the interface zone, the layout must provide for and ensure access across selected properties from the internal road to the interface zone and fire trail/fire break.

- Avoid cul-de-sac access routes longer than 100m in the interface zone.

- Cul-de-sac access to the interface zone must terminate in a turning circle large enough to accommodate the fire service vehicles. Direct access from the end of the cul-de-sac into the interface zone should be provided.

- Individual cul-de-sacs must be linked with a fire trail.

- Avoid long and convoluted patterns of subdivision and avoid narrow streets in layouts, which would result in access difficulties in the event of a veldfire.

- In existing developments, care must be taken not to close down any existing access routes to the interface zone. Applications by adjacent land owners to acquire public passages which provide access to the interface zone should be carefully considered taking into account the proximity of alternative routes and the security of adjacent residents.

- Existing gated communities which back onto the interface zone and take access from an internal road should ensure the ability of fire services to access the interface zone via the development. If a locked access is provided on the interface zone, management of the community must ensure that this can be opened at any time should the circumstance warrant this. All gated communities adjacent to the interface zone should be required to develop a fire management plan.

- Where necessary allow for incremental road widening to park or turn fire-tenders around.

- For erven bordering directly onto the natural area, a sufficient building line should be imposed to allow a buffer (inner protection area) between the natural area and the first buildings.

- If, in a new development, erven will border directly onto the natural area, a minimum erf size that allows for a sufficient building line and inner protection area must be designed.

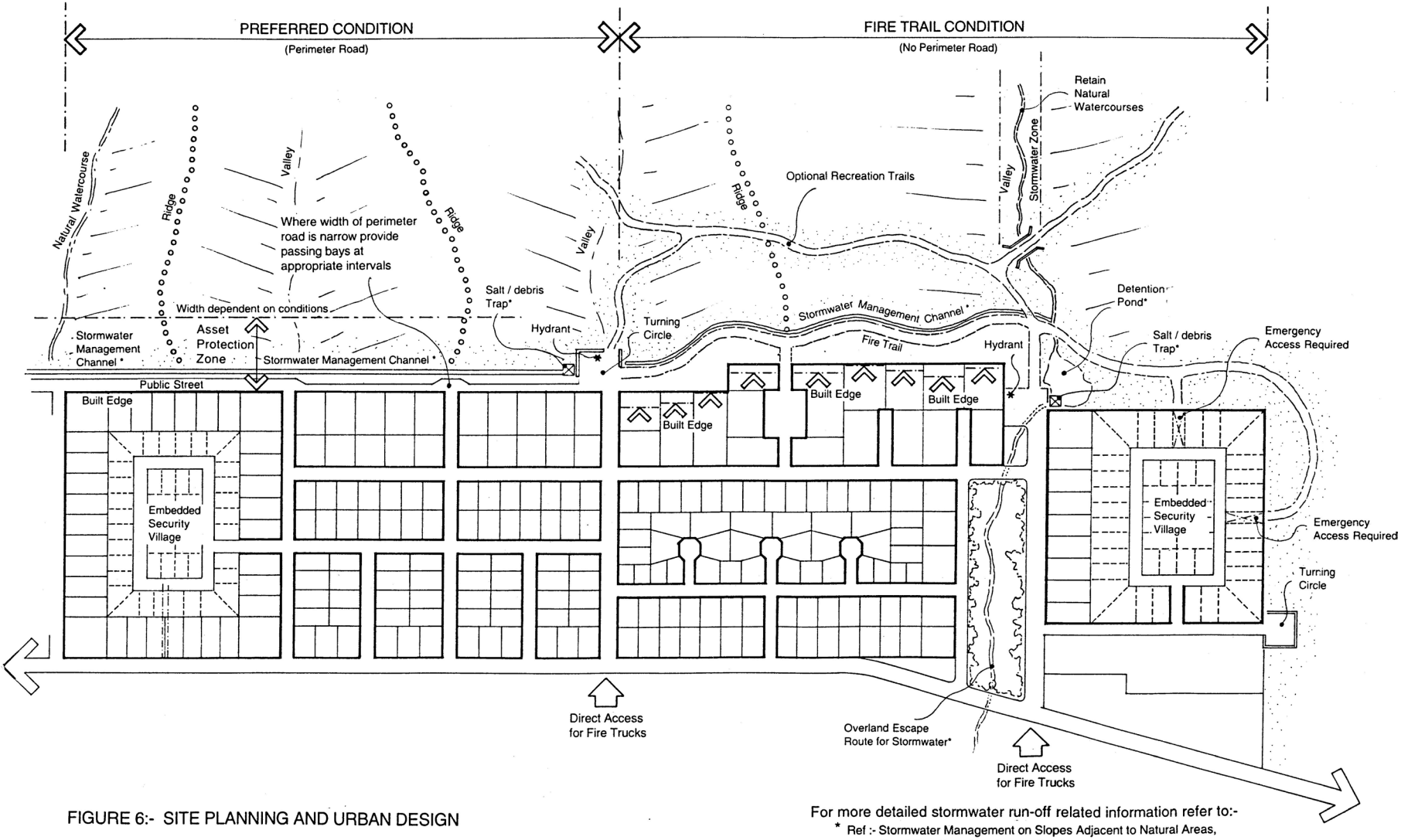


FIGURE 6:- SITE PLANNING AND URBAN DESIGN

For more detailed stormwater run-off related information refer to:-

* Ref :- Stormwater Management on Slopes Adjacent to Natural Areas,
City of Cape Town Development Service,
Transport, Roads and Stormwater Directorate
November 2003, Version 1,0

7.0 VELDFIRE RELATED INFRASTRUCTURE GUIDELINES

Infrastructure mapping was undertaken for the Northern Peninsula area in 2002 and is underway in the Southern Peninsula. It is anticipated that this work will continue in other parts of the City at risk of veldfires. It is proposed that these maps should be consulted where available to inform the assessment of new development proposals in the natural interface area. The maps are currently available from the Cape Town Fire Services.

7.1 ROADS

Design issues related to road layouts and access for fire vehicles are discussed in section 4.2.3. Technically roads should conform to the minimum standards prescribed by the Local Authority as well as with section 12(1) of the community fire safety bylaw, and to the following principles:

- Roads should be two wheel drive all weather roads.
- All roads in the interface zone should be two way with a minimum 6m wide hard surface or unless otherwise agreed with the Local Authority.
- Roads should be through roads with perimeter roads linked to the internal system at an interval of no greater than 500m. Cul-de-sacs should be avoided but if provided than no longer than 200m. Turning circles in cul-de-sacs should have a minimum reserve dimension of 22m by 22m or unless otherwise agreed with the Local Authority.
- Capacity of roads and bridges should be designed to carry a fully loaded fire fighting vehicle.
- Restrict the use of speed humps and chicanes on perimeter roads.
- Curves on the road should have a minimum inner radius of 6m and the minimum distance between inner and outer curves should be 6m.
- Maximum grades on the roads should not exceed 15 degrees and preferably not more than 10 degrees.
- There should be a minimum vertical clearance of no less than 4m above the road at all times.
- Roads should be of sufficient width to allow fire fighters to work around their vehicle.
- Roads and properties should be clearly signposted and numbered. Bridges must indicate load rating.
- Road reserves should be kept clear of bushes and long grass.
- In the event that only a narrow road can be provided, passing bays should be created every 200m and should be at least 20m long by 3m wide.

7.2 SERVICE SUPPLY

All services must be supplied to at least the minimum standard prescribed by the Local Authority. In addition, the following principles should be considered in the provision of services in the interface zone:

- Electrical transmission lines should be underground.
- Where overhead lines are provided, short pole spacing should be used.
- Trees should be kept well away from overhead lines. Regular inspection of overhead lines must occur.
- Large gas cylinders should be kept clear of other combustible materials.
- Large gas cylinders close to buildings should be positioned such that release valves are directed away from the building and other fuel sources.
- Developments isolated from mains water supplies for fire fighting purposes should consider the provision of and access to static supplies on the property including the provision of a non electric pump.
- Mains water supply should be on a ring main system.
- Water supply infrastructure should be designed according to the South African National Standard for Community Protection Against Fire (SANS 1090:2003) or otherwise required after consultation with the Cape Town Fire Services.
- Fire hydrants must be clearly identified by SABS 0139 signage, accessible and maintained. A clear unobstructed path between the hydrant and the most distant part of a development should not exceed 90m.
- Household garden taps should have a 19mm diameter to ensure adequate water flow and should be located away from the house. Tap fittings should be metal and rubber hoses rather than plastic should be used in the interface zone.
- Sprinkler systems can be provided but should be regarded as an additional protection measure.
- Overhead telephone lines are often damaged by veldfires. Households should be encouraged to keep a battery operated am / fm radio available to facilitate communication in areas where cell phone communication is restricted.

8.0 VELDFIRE RELATED BUILDING SITING, LANDSCAPING, BUILDING MATERIAL AND CONSTRUCTION GUIDELINES

It has been recognised that fire embers are the main cause of house loss during bushfires. The predominant cause of houses destroyed by bushfire is due to fire gaining entry into the house or by igniting of adjacent fuels such as gardens, fences and adjoining buildings, which if left to develop eventually consumes the entire house. Research has conclusively found that the dominant mechanism of ignition of houses is airborne embers entering buildings or landing on vulnerable parts of buildings.

Significant protection to buildings can be obtained by providing a clear zone of low risk vegetation, with 9m given in international literature as a guide. The CSIR developed recommendations for property owners and occupiers to reduce fire risk to properties on the urban edge (CSIR Report ENV-S-C 2000-104). (See Annexure 1). In addition, in terms of section 34(2) of the Community Fire Safety Bylaw, "the owner or person in charge of the premises may not permit vegetation to grow or accumulate thereon, or other combustible material to accumulate thereon, in a manner likely to cause a fire hazard or other threatening danger".

There are a number of siting principles which can be applied to individual erven within a development in areas where a veldfire hazard exists. These siting principles need to be taken into account at development application stage, or when rezoning land or at construction stage. It should also be noted that all developments proposed within the Cape Peninsula Protected Natural Environment require specific approval. In terms of this approval, the use of combustible building materials may be limited or even prohibited.

8.1 BUILDING SITING GUIDELINES

- Avoid ridge tops.
- Avoid steep slopes, particularly upper slopes and narrow ridge crests. 1:4 maximum where feasible.
- Avoid locations where an adequate Asset Protection Zone cannot be provided within the property or subdivision boundary.
- Locate dwellings where vehicular access from two directions can be provided away from identified hazardous areas.
- Avoid building on top of narrow gullies, which are natural chimneys.
- Surround isolated habitable buildings with a wide driveway of gravel, concrete, pavers, etc.
- Avoid building on slopes with a south-easterly aspect where possible as these slopes are more prone to veldfires.
- Build on level ground wherever possible.
- Where buildings must be constructed on sloping land, they should be built on cut-in benches rather than elevated or above fill.
- Avoid raised floors or buildings built on "stilts" which allow embers to penetrate below the building.
- Locate the habitable buildings near the property entrance for easier access / egress.
- Locate water storage on-site and near buildings, where municipal water is not available.

Figure 7 identifies and highlights different degrees of fire risk in relation to slope and exposure to the direction of the fire.

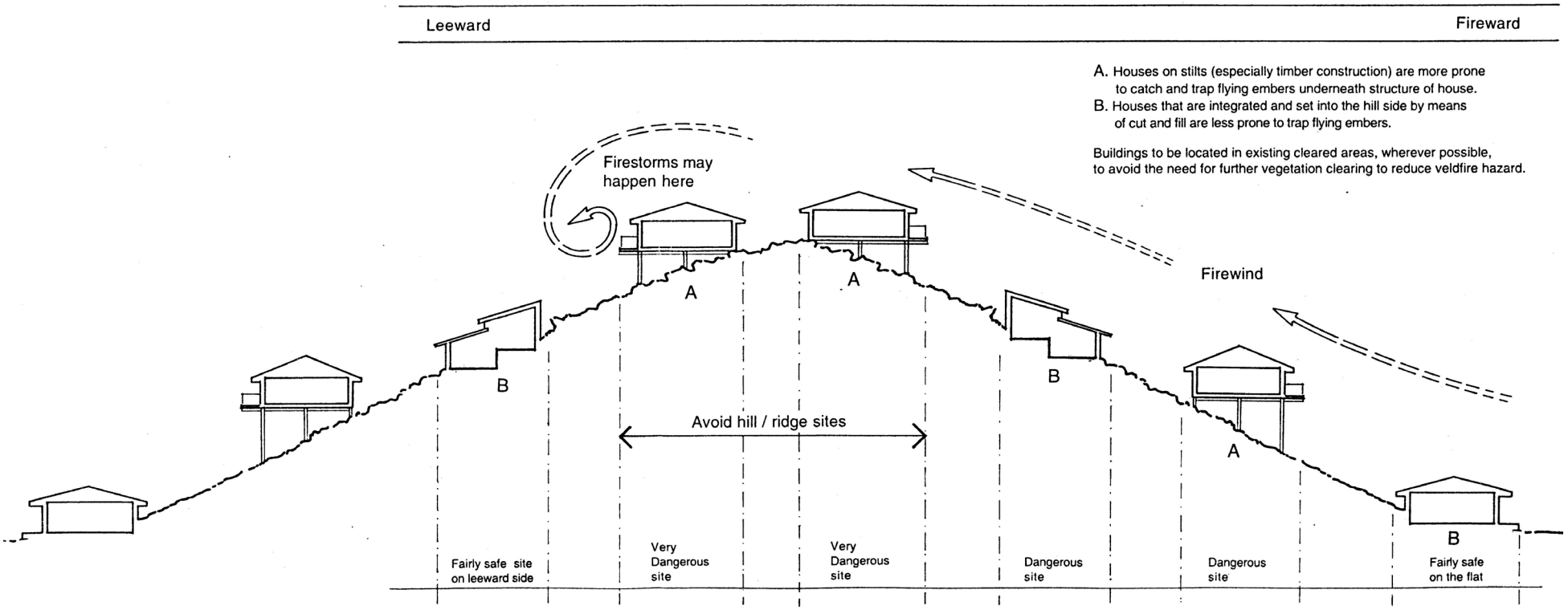


Figure 7: House Sitting
Houses on fireward-facing slopes are very exposed to showers of embers which blow from a firefront.

8.2 LANDSCAPING GUIDELINES

Where required, clearing and landscaping should be undertaken to mitigate fire risk and in a manner which minimises ecological impact. It should also be appreciated that radiant heat and flame contact can generally be prevented by landscaping.

Figure 8 illustrates the principle how natural or specially created protective features can prevent falling embers from reaching the properties and starting spotfires there. The combined principle of layering, filtering and shielding make up the totality of the protective feature.

8.2.1 Fuel Modification

Where it is necessary to reduce fuel loads through clearing, the concept of fuel modification should be implemented, which involves a wide strip of land where flammable vegetation has been removed or modified or both and partially or totally replaced with drought-tolerant, fire-resistant plants. It provides an acceptable level of risk from veldfires. Fuel modification also provides a reduction of radiant and convective heat, thereby providing fire suppression forces a safer area in which to take action.

More specifically, fuel modification considerations include the following (figure 9):

- A Setback Zone, a Wet Zone, an Inner Thinning Zone, and an Outer Thinning Zone for extreme heavy vegetation. The total width of a fuel modification plan would, like the width of the Asset Protection Zone, be dependant on the context, and could be up to 50m. (Figure 9)

- Stabilisation of soil to prevent erosion.

- Stormwater management measures.

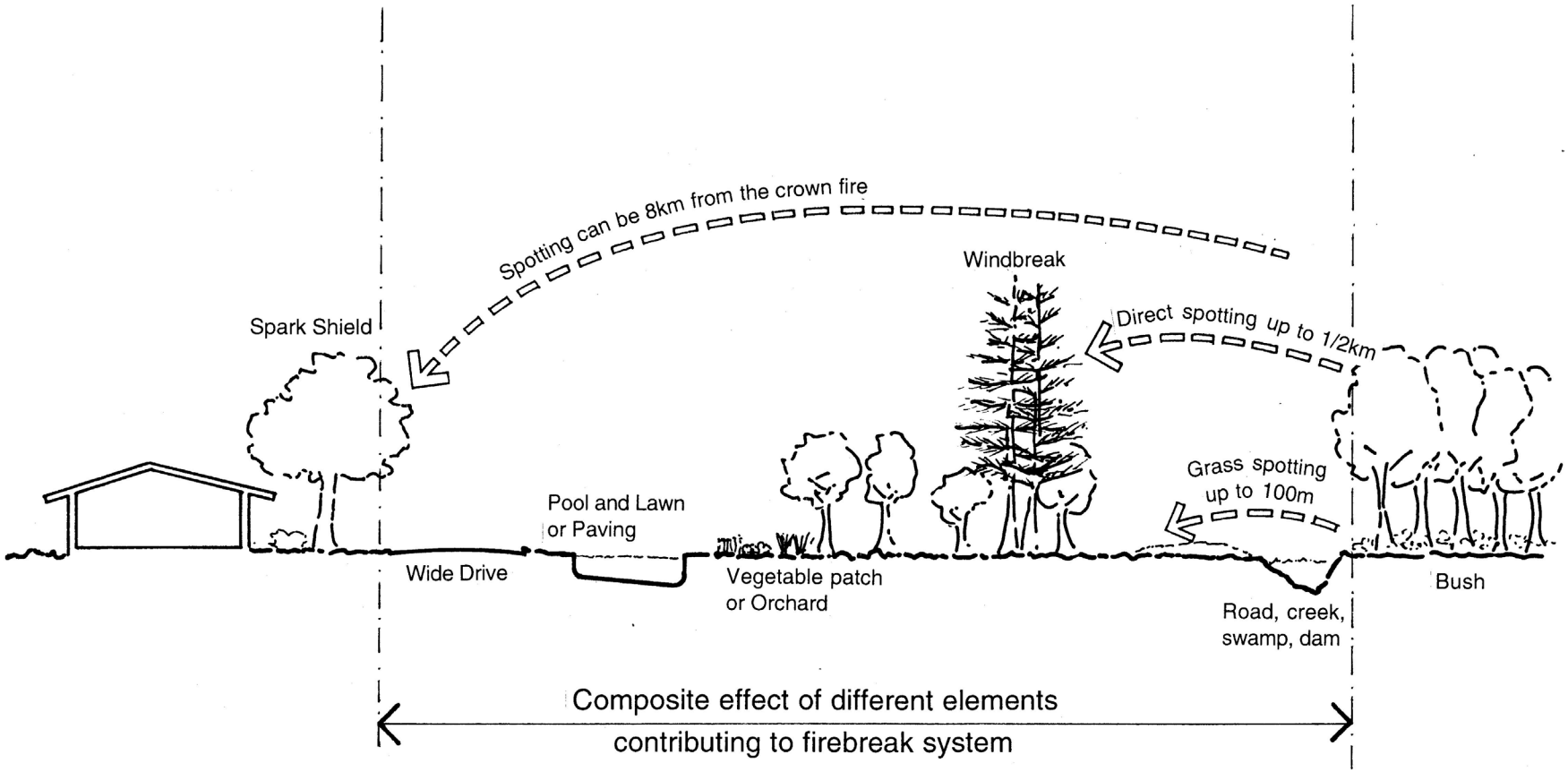
- Plant list, allowed only from the approved list of plants that are relatively fire resistant and drought tolerant.

The CSIR guidelines include guidelines for fire-scaping of gardens, with the local climate and vegetation in mind (See Annexure 1 : CSIR Report ENV-S-C 2000-104)

8.2.2 Landscaping

In addition, these guidelines for planting and fire-preventative landscaping in Fire-Risk Areas can be used:

- Limit use of plants known to be especially combustible.
- Limit planting in large unbroken masses, especially trees and large shrubs.
- Limit use of plants which develop large volumes of foliage and branches.
- Limit use of plants which have dry or deciduous foliage during part of the year.
- Limit use of plants which develop deciduous or shaggy bark.
- Limit use of plants which develop dry or dead undergrowth.
- Limit massing of vegetation adjacent to structures, especially under eaved, overhangs, decks, etc.
- Limit massing of shrubs at bases of trees or large shrubs.
- Conduct yearly maintenance to reduce fuel volumes, eliminate weeds, remove dead vegetation, etc.

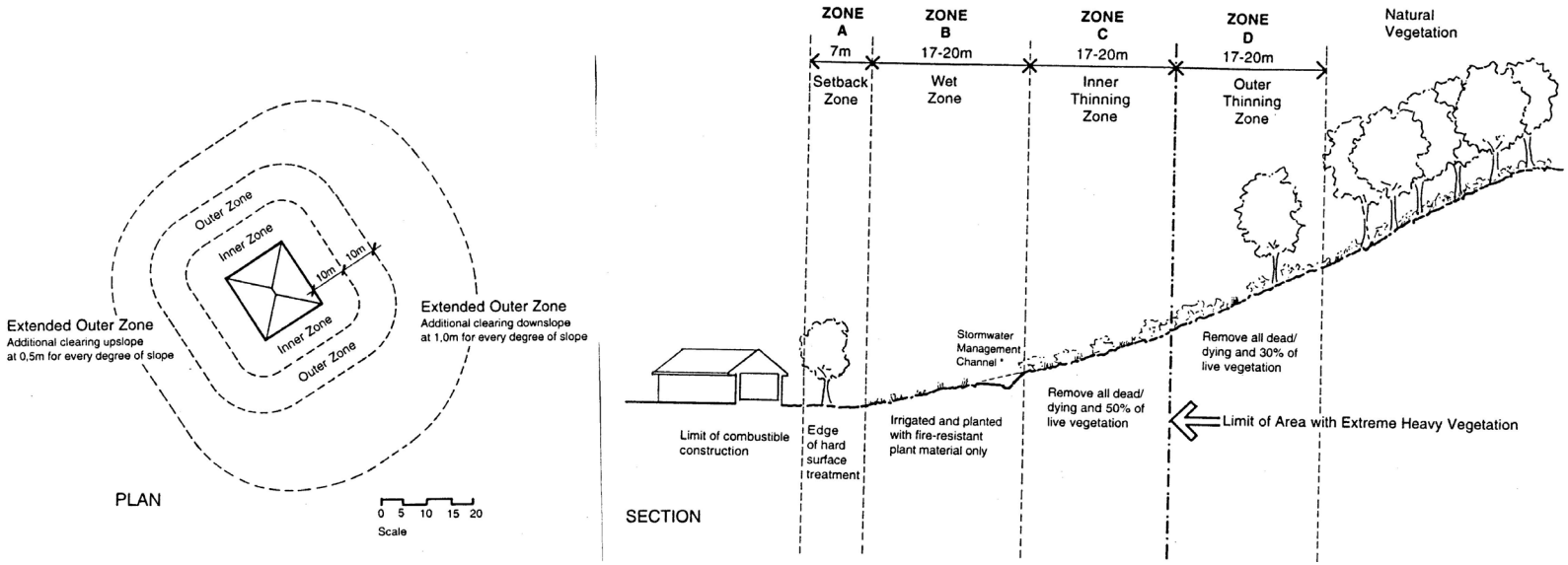


Source:- The Complete Australian Bushfire Book, Joan Katherine Webster,

Figure 8: House Sitting and Landscaping
Natural or specially created protective features can prevent falling embers from reaching properties and starting spotfires.

- Topping of trees is discouraged. This creates excessive branching and can increase the fire danger.
- Plant a well designed and maintained windbreak to help reduce the windspeed, filter out flying sparks and debris and slow the spread of the fire round the property.
- Build a stone wall, earth mound, hedge or covered fence as a radiant heat shield. This should be fairly close to the building.
- Place a vegetable garden, orchard, swimming pool or tennis court between the house and the expected fire direction.
- Locate the woodpile away from the expected direction of the fire.
- Thin out tree foliage into clumps so there are breaks in the tree canopy.
- Remove garden refuse promptly.
- Remove ground litter and undergrowth by raking and mulching or burning.
- Remove dead trees and dead branches from individual trees.
- Prune lower limbs of trees (up to 2m from ground level) and bushes to prevent low flames climbing into the tops of the trees.
- Remove trees, shrubs or grass which is close to, overhanging or touching the house.
- Select and plant the least combustible plants, especially close to the house and other structures.
- Locate all garden sheds well away from the house.

"A fuel modification is a wide strip of land where flammable vegetation has been removed or modified or both and partially or totally replaced with drought-tolerant, fire-resistant plants. It provides an acceptable level of risk from veldfires. Fuel modification also provides a reduction of radiant and convective heat, thereby providing fire suppression forces a safer area in which to take action."



Source: Fire Protection in the Wildland/Urban Interface: Everyone's Responsibility, Publisher: National Wildland/Urban Interface Fire Protection Program, United States Fire Administration

For more detailed stormwater run-off related information refer to:

*Ref: Stormwater Management on Slopes Adjacent to Natural Areas, City of Cape Town Development Service, Transport, Roads and Stormwater Directorate November 2003, Version 1,0

Figure 9: Fuel Modification Diagram (adapted)

8.3 BUILDING MATERIAL AND CONSTRUCTION GUIDELINES

Buildings and structures in high veldfire risk hazard zones can be designed and constructed to reduce fire risk. The prevention of embers entering a house, ceiling cavity or underfloor area is an important fire safety design feature.

In terms of protective actions in relation to buildings and structures, the following should be undertaken:

- Thatch housing must have an approved sprinkler installation.
- Seal roof vents, eaves and floor vents with wire gauze screening.
- Secure any loose roof tiles.
- Clear leaves from gutters regularly.
- Fit windows with clip-on wire gauze screens, to be used in the event of fire.
- Avoid storing fuels and paints in out-buildings and 'wendy-houses'.
- Remove combustible materials such as wood piles that are in close proximity.
- There should be no creosote fencing on perimeters facing the edge.

In addition, some basic "housekeeping actions" if undertaken by individual landowners, would greatly assist fire fighters and protect individual properties from the hazard of veldfires. These are:

A. Protective Actions: Outside the Property Boundary

- Reduce fuel loads – remove alien species and debris by clearing activities.
- Pay special attention to fuel load management in down slope areas.

B. Protective Actions: Within the Property Boundary

- Plant screen trees on the boundary – canopies should be separated and a minimum of two metres between canopy and ground is required.
- Cut grass and other vegetation under screening trees.
- Plant hedges against the boundaries (not Cypress).
- Plant barrier features in the garden, using succulents and other high foliage moisture vegetation.
- The garden should be easy to walk through in all directions.
- Remove dead and dry vegetation and litter from the gardens.
- Remove hanging dead and dry branches from trees (e.g. palms).
- remove combustible and dry vegetation from under decks, against walls and pillars.
- Remove hanging baskets and dry material from the building.
- Avoid wooden fencing or out-buildings on the boundary – especially creosoted material.

C. Protective Actions: Buildings and Structures

- Fit windows with clip-on wire gauze screens, to be used in the event of fire.
- Seal roof vents, eaves and floor vents with wire gauze screening.
- Clear leaves from gutters regularly.
- Secure any loose roof tiles.
- Avoid storing fuels and paints in out-buildings and 'wendy-houses'.
- Remove combustible materials such as wood piles that are in close proximity.
- There should be no creosote fencing on perimeters facing the edge.
- Thatch housing must have an approved sprinkler installation.

9.0 CONTEXTUAL INTERPRETATION

The principles as discussed in section 4 have been applied along the entire interface zone of the Cape Peninsula Mountain Chain. In the absence of a detailed hazard map for the peninsula which would identify different levels of hazard in different areas (based on issues such as fuel loading, slope and climate), it has been assumed for the purpose of this exercise that the entire peninsula is a high hazard area.

A set of maps have been prepared which cover the Peninsula. On these maps, different conditions along the interface zone are identified in terms of the issue that they present in relation to veldfires. The following situations are identified together with the requisite actions necessary to address the issue based on the principles:

- **Good Access** – Maintain outer protection area component of the Asset Protection Zone on the hazard side of the access route.

- **Restricted Access** – No direct access available. Explore and secure alternative access routes including fire trails.

- **Poor Direct Access** – Access exists but the form of access is inappropriate e.g. Cul-de-sacs with limited or no turning circles. Provide turning circles or link the cul-de-sacs via fire trails.

- **Inappropriate Access** – Access roads too steep with limited or no manoeuvring capability. Explore and secure alternative access routes including fire trails.

- **Limited Access** – Access is available via private property such as through the grounds of a block of flats or gated community. Secure access rights across the property and explore alternative access routes.

- **Circuitous Access** – Existing subdivisions create a convoluted access to the interface zone. Provide adequate signage.

- **Inappropriate Land Use** – Limit or restrict expansion and explore opportunity for relocation. Require a fire management plan.

- **Fire Management Plan** – Land use or layout not ideal in terms of veldfires. Require fire management plan.

- **Isolated Development** – Pockets of development outside the urban edge. Limit any further expansion and require a fire management plan.

- **Potential Future Development** – Vacant land with possible development potential inside the urban edge. Ensure the principles as set out in section 4 of this document, together with those contained in the Urban Edge Guidelines Manual are taken into account in any development proposal.

- **Informal Settlements** – These settlements present a host of issues that need to be dealt with from the point of view of veldfires. At the very least, an Asset Protection Zone should be provided on the hazard side of the settlement and should be actively and constantly maintained. A fire management plan should be developed and the necessary fire fighting infrastructure and access provided and maintained. The Asset Protection Zone in these circumstances should be wider than normal to assist in the prevention of the spread of fires from informal settlements into the interface zone and hazard area.

10.0 CONCLUSION

As noted, the applicability of the principles will vary along the interface zone depending on the specific conditions at any one point. The major factors affecting the application of the principles are the physical circumstances, the ownership of the land and the status of the development at the time.
However, in general the following position in regard to the interface zone should be adopted:

- All new developments must adhere to the principles as set out.
- All new developments must be referred to the relevant fire service for comment prior to approval.
- Where at all possible, remedial actions based on the principles as set out, should be implemented in existing developments. At the very least, the applicable sections of the relevant legislation should be enforced.

Finally it is recommended that the Local Authority formulate a checklist related to the veldfire hazard in the interface zone, against which developments can be tested. The following checklist from the Goldcoast region in Australia is provided by way of example.

Development Requirement	**Potential Veldfire Hazard Rating**		
	Low	**Medium**	**High**
Appropriate land-use		*	[
Submission of a Fire Management Plan		[	[
Appropriate subdivision design	*	[	[
Provision of fire fighting infrastructure	[	[	[
Input of Local Fire Brigade	[	[	[
Appropriate building construction	*	[	[
Provision of adequate private water supplies	*	[	[
Appropriate clearing & landscaping	*	[	[
Improved community awareness	[	[	[

Notes:
* Advisory only
[Development requirement

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ANNEXURE 1

CSIR Report ENV-S-C 2000-104

Recommendations for property owners and occupiers: reducing fire risk to properties on the urban edge – Cape Peninsula

Prepared for:

Cape Peninsula National Park

Prepared by:

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Division of Water, Environment and Forestry Technology
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Stellenbosch

November 2000

Table of Contents

1. INTRODUCTION

1.1 Background

Wildfires will occur periodically within the Cape Peninsula National Park, a result of both accidental and deliberate ignition. These fires may cross the park boundaries and impact upon the urban areas adjacent to the park. The CPNP intends to maintain good relations with its neighbours on the park boundaries and therefore wants to have in place information, advice and strategies that will minimize the risk of damage any such fires may cause.

1.2 Terms of Reference

The CSIR was asked to provide a list of suggested fire risk reduction measures that could be used by property owners in the proximity of the CPNP. This information is to be provided in the form of a brochure or Z-folder. In addition, a short report was to address the following issues:

1) The nature of the problem with respect to wildfires on the "urban edge"

2) The factors that will contribute to the risk of fire damage

3) Possible mitigating measures to reduce the risk of fire damage

4) Proposals for amendments to municipal by-laws with the aim of reducing fire risk

This report addresses these Terms of Reference. The risk factors contributing to the possibility of fire damage and suggested mitigating measures are considered together within each section. A summary list of mitigatory actions is given at the end of Chapter 3.

The findings presented here will be included in the CPNP Fire Management Plan.

2. THE NATURE OF THE PROBLEM

2.1 Fire Behaviour and the Characteristics of Fuels

Fire behaviour is determined by the characteristics of the fuels available and the fire climate. Fire climate is dependent on air temperature, humidity and wind speed and moisture residual in the vegetation and litter. High air temperatures, low humidity and high wind speed dry the vegetation, increasing fire risk and the difficulty of extinguishing a fire once it has started.

There are three basic fuel types:

1) Elevated fuels
2) Bark fuels
3) Surface fine fuels

Elevated fuel comprises shrubs and suspended material. The level of hazard depends on fuel continuity (horizontal and vertical), height, amount (weight), proportion of dead material, thickness of foliage and twigs and the flammability of the live material (McCarthy *et al*. 1999).

In the dead components, the size of the fuel is important in determining how quickly it can burn, and how quickly the moisture content can respond to changes in climatic conditions. The finer and dryer the fuel, the faster it will burn. Fuels that are packed tightly together will carry a fire much better than sparsely packed fuels. However, a fire can move through a sparsely packed fuels if it is much more intense and spreading at a greater rate.

An extreme elevated fuel hazard is a situation where the vegetation is tall (2-3m), dense and continuous from top to bottom, has large amounts of leaves and twigs and other fuel particles with a maximum thickness of less than 2mm. The proportion of dead material is 30 – 50% or more and there is a large quantity of dead elevated fine fuel (McCarthy *et* al. 1999).

Surface fine fuels refer to the litter on the ground surface, such as dead leaves, twigs and bits of bark.

Doubling the quantity of fine fuel quadruples the intensity of a fire (Wilson and Ferguson 1986). One of the most useful measures of the intensity of veld fires is Byram's (1959) fire intensity formula:

$I = Hwr$

where I is the fire intensity (kW m^{-1}), H is the heat yield of the fuel (kJ g^{-1}), w is the weight of available fuel (g m^{-2}) and r is the rate of spread of fire (m s^{-1}).

This formula is given here because in later sections some comparisons of different vegetation types are made and the basis of the comparisons are their different fire intensities. As will be explained further in the document, fire intensity is the key way of understanding fire characteristics.

2.2 Fuel Characteristics of Fynbos and Alien Invaders

Fynbos is a sclerophyllous shrubland vegetation that has evolved with fire, which is a necessary feature in maintaining the ecological functioning of the fynbos. It has fine leaves and significant proportions of dead material held aloft, forming a porous fuel bed of about 1 m deep (van Wilgen *et al*. 1985). Fires are possible in any season under suitable weather conditions (van Wilgen 1984).

The nature of the vegetation has changed over the last hundred to two hundred years as human settler communities have sought to modify their environments through the introduction of alien species, some of which have turned out to be highly invasive, for example the pines, eucalypts and acacias. Some of this invasive vegetation is highly inflammable , creates higher fuel loads than fynbos (see Table 1), originate from fire prone environments and are therefore highly adapted to fire. These characteristics promote more intense fires, resulting in the spectacular recent fires of January 2000 and their attendant damage and destruction of property.

Australia, from where some of South Africa's major invader species originate, has some of the worst wildfires to be found anywhere in the world. Dense, fire prone vegetation and hot dry windy weather combine to form extremely dangerous fire conditions in which the radiant heat intensities can reach extremes of 100 000 $kW.m^{-2}$. Ref

Eucalypts have high crude fat contents, which is equivalent to high heat content, and low foliar moisture, therefore the vegetation and litter burns easily. Eucalypts are also notorious for spreading spot fires because some eucalypts shed bark which hangs down in dry strips which are easily set alight and torn off in the high winds of a fierce fire (McCarthy *et* al. 1999). These burning bark strips can be flung into houses when wind speeds are high and there are openings through which the particles can pass. Pines also spot dangerously.

Fynbos does not have the same fuel or structural properties as some Australian or North American forests and this results in lower fire intensities. A comparison is given in Table 1.

Table 1. Fuel loads and fire intensities in different types of vegetation.

Vegetation type	Fuel Loads gm^{-2}	Fire Intensity kWm^{-1}	Reference
Savanna / grassland	100 – 1000	10 000	Stocks *et al*. 1997
Fynbos	1000 – 3000 Max 7000	20 000 – 30 000	van Wilgen *et al*. 1995 Stocks *et al*. 1997
Acacia Cyclops (Rooikrans)	9000	20 000 – 60 000	van Wilgen and Holmes 1986
Pine plantations	18 000 – 40 000	No data	See van Wilgen and Scholes 1997
Eucalypt plantations	42 000	No data	See van Wilgen and Scholes 1997
Australian eucalypt	> 21 000	60 000 Max 100 000	Luke and McArthur 1978 Cheney 1983
North American boreal forest	1500 - 5000	60 000 – 100 000	Stocks *et al*. 1997

* Approximated from flame-length 60-100m (Butler and Cohen 1998) and van Wilgen

Acacia cyclops (Rooikrans) is an example of an extreme elevated fuel hazard (See Section 2.1), resulting in fires that are particularly intense. A prime reason for getting rid of alien species is that we do not want to recreate Australian or North American fuel conditions on the Cape peninsula.

Fires in fynbos will travel more quickly than fires in forest because the fire is more exposed to the wind, unless the fire in a forest crowns, that is, it starts burning in the canopy and maintains its burning there by rapidly spreading from one canopy to the next, travelling fast and causing very intense fires.

2.3 Human Behaviour

Residential properties on the urban edge are often sought after for their aesthetic value, especially if they are in close proximity to picturesque landscapes and natural vegetation. People like to live in “green” areas, screened out from others, close to parkland. It is also inevitable, therefore, that the periodic wildfires within the CPNP will pose an occasional risk along the urban fringe.

The not unreasonable expectations of residents are that the fire-fighting services will protect their property. However, during wildfires in most challenging summer situations, fire-fighting services

might find themselves stretched to provide protection to all the properties that are at risk. They will probably restrict themselves to saving lives as a first priority, and to manage the fires in the areas where the risk is the greatest. The expectations of many residents may be unmet. A solution is to decrease the impacts of fire on the urban fringe where most of the interaction between wildfire and urban areas takes place.

Finally, ignition needs to take place. Before humans began to have an impact on the environment, lightning was the most common source of ignition. Now, with increasing population, opportunities for ignition are also increasing through arson or accident.

3. FACTORS CONTRIBUTING TO RISK OF FIRE DAMAGE AND MITIGATION MEASURES

3.1 The Key Risk Factor

Fire intensity has been found to be the most important determinant of house survival (Wilson and Ferguson, 1986), and therefore is the principle risk factor. Intense fires (> 30 000 kWm^{-1}) create high levels of radiant heat and high velocity turbulent winds. There are three ways a wildfire can ignite a building:

1. Spot fires from flying embers;
2. Radiated heat, and
3. Direct contact with flames.

The most common source of ignition in a house is because a burning ember enters and sets fire to something in the house (Webster 1986). Burning embers are swirled around at high speed in the fire generated winds and get forced into buildings through holes, ventilation ports and windows which have been cracked by the intense heat. Airborne debris may itself break windows in the case of particularly severe winds.

Fuel conditions, as explained in Section 2.1, have a direct influence on fire intensity. Wilson and Ferguson (1986) suggest that fuel reduction is a major priority for the protection of houses against bushfires.

3.2 Management of Fuel Loads

Vegetation, especially the pines, eucalypts and the Australian acacias on property boundaries, in gardens, on municipal lands, in public areas and adjacent open areas should be managed to maintain low fuel loads. The tall alien species should be removed, including the trash from the clearing operations. Fuel loads within properties should be similarly managed and garden refuse such as branches and leaves also be removed. Certain indigenous forest species have a relatively low flammability and these can be used to replace alien species where trees are preferred (See section 3.3)

The presence and size of trees in the garden is an important factor in house survival (Wilson and Ferguson, 1986). Fires burning only grass fuels pass relatively quickly in comparison to fires burning trees and fuels underneath them. These particular fires burn for a longer time (Cheney, 1983 cited in Wilson and Ferguson, 1986) and generate more airborne embers.

3.3 Designing the Garden for Fire Protection

The first task is to identify the fuel hazards in the garden. The home-owner should strive for a garden which has a low elevated fuel hazard, defined as '*Easy to walk through in any direction* (McCarthy *et al*. 1999). The garden litter load should not be greater than 15 mm deep (leaf litter is a surface fine fuel - see Section 2.1). Eucalypt leaves and pine needles don't turn into humus easily and are usually always highly flammable.

A variety of plants can be used as potential barriers for screening out radiant heat, intercepting wind-borne burning embers, or to slow down or stop the progress of the fire front. In general, the broad-leaved, high foliar moisture plants are the most suitable. They should be sited at the edge of the property on the fire-ward, that is, the CPNP side.

Avoid flammable shrubs under decks, up against walls, against wooden pillars or in hanging baskets. Trees with large amounts of dead leaves hanging down, such as palms, should not be in close proximity to the building. Burning branches may fall onto the house or they may be blown into the house by the strong turbulent winds. The dead leaves should be removed regularly where such trees cannot be removed.

Trees should be spaced at intervals and not touching, so as not to form a continuous canopy. Lower branches should be pruned so as to leave a gap between the ground and the lower limbs of the tree of at least 2 m. Maintenance must be done regularly however, the undergrowth below the trees must be removed and dead branches should be thinned out of the tree (See Fig 1).

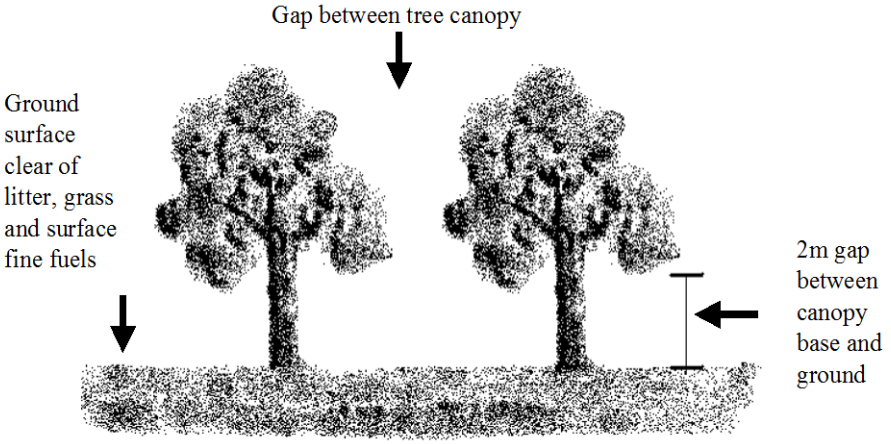

Table 2 List of trees suitable for use as a barrier against radiant heat and wind borne burning embers. Note that under severe fire conditions all trees will suffer scorch damage, nevertheless, their purpose is to provide screening at the *critical* time.

Scientific name	Common name
Olea europaea spp *africana*	Wild Olive
Podocarpus spp	Yellowood
Maytenus acuminata	Silky bark
Maytenus oleoides	Mountain maytenus
Maytenus lucida	Cape maytenus
Cunonia capensis	Rooiels
Apodytes dimidiata	White pear
Ekebergia capensis	Cape ash
Heeria argentea	Rockwood
Rhus lucida	Glossy taaibos
Rhus lancea	Karee
Rhus undulata	Kumibush
Clutia pulchella	Gewone bliksembos
Curtisia dentata	Assegai tree
Ilex mitis	African holly
Brabejum stellatifolium	Wild almond

Hedges can also be used as barriers, but more caution should be exercised with this method than for trees. Cypress hedges can have cores that are old, dry and brittle and are therefore highly flammable. They should not be used as a barrier, or be located near buildings. Other hedges can have significant cores of thin woody stems, hidden by a canopy of green leaves. These types of vegetation should be avoided. Species like the Australian myrtle – *Leptospermum laevigatum* – besides being highly invasible, have very fine leaves and are highly flammable. The more broad-leaved and sap filled plants are more suitable.

Table 3. List of plants suitable for use in hedges as a barrier against radiant heat and wind borne burning embers

Scientific name	Common name
Olea europaea spp *africana*	Wild Olive
Podocarpus spp	Yellowood
Tecomaria capensis	Cape honeysuckle
Bougainvilia spp	Bougainvilia
Brachylaena discolor	Coast silver oak
Diospyros whyteana	Bladder nut

Succulents have a very high foliar moisture content, are quite fire retardant and therefore are very suitable as a low-level barrier. There are many indigenous succulents ranging from aloes to the much shorter ground covers, they have further merit in that they do not require much watering.

Table 4. List of plants suitable for use as ground covers as a barrier and a meands to prevent carrying flames through gardens

Scientific name	Common name
Aloe spp.	Aloes (but remove persistant dead leaves)
Agapanthus spp	
Drosanthemum spp.	Vygie
Lampranthus spp	Vygie
Cheiridopsis cigarettifera	Vygie
Crassula coccinea	
Dorotheanthus bellidiformis	Bokbaaivygie
Euphorbia caput-Medusae	
Carpobroteus spp	Sour figs
Other prostrate ground covers	

Lawns will burn, albeit relatively slowly. If lawns are growing under wooden decking, there is a possibility of them carrying flames under the structure. Lawns should be kept as short as possible. Long grass is a definite hazard. Slash this where a mower cannot reach it. The arrangement of lawns should be organised so that there is no direct linear path from the property boundary along which wind could drive a fire right up to the house. See Fig 2

Hanging baskets that contain dry material are a threat, because flying embers could set alight the dry vegetation and bring flames into contact with roofing, wooded beams, curtains and highly inflammable material inside the house.

< Insert Figure 1 and 2 here >

3.4 Slope

Slope dramatically increases the speed at which a fire can move. Each 10 per cent increase in slope, doubles the speed of a bushfire (Luke and McArthur, 1977). So a fire travels twice as fast up a 10% slope as on level ground and four times as fast up a 20% slope (100% slope = 45° slope angle). Fires can travel up a cliff-face within seconds. Conversely, fire is considerably slowed when the headfire is going downhill. See Section 2.1 for an overview of the effects of spread rate on fire intensity.

When slopes exceeding 15-20° are combined with wind in the direction of the slope, the effect is to push the flames almost parallel to the surface and the flame front can cover the whole slope, that is, the whole slope becomes one sheet of flame. This can present an exceptionally dangerous situation for fire fighters.

Properties located on hillsides to take advantage of scenic views are especially vulnerable if they are upslope of areas with high fuel loads. Or, they may be on the borders of drainage systems. If the streamline has a steep gradient, these features form gullies, chutes or funnels in which a wildfire can be concentrated, which may be reinforced by wind turbulence exacerbated by the uneven terrain. In these situations, convective heat as well as radiant heat, can be a source of ignition. Vegetation below these properties should be a specific target for management action, reducing them to low fuel loads.

Properties down-slope of a fire, and where there is sufficient gradient, are vulnerable to burning material which rolls under gravity into the urban zone. This is a particular risk where forest plantations, or old plantation lands containing debris from past logging activities, exists above the urban zone.

Property owners in this situation should consider installing a suitably anchored wire mesh fence on the boundary of their property, or erect some other barrier such as a hedge (See Section 3.3).

3.5 Poorly Maintained Firebreaks

Firebreaks have been shown to be very useful in preventing fires from entering the urban edge when they are properly maintained. Although they often cannot stop fires which are approaching rapidly head on (when driven by the wind), they are much more effective in controlling fires that are moving obliquely to the firebreak. Poorly maintained firebreaks however allow a fire to be easily carried across into those areas requiring protection.

Regular maintenance of firebreaks is essential. Firebreaks at property boundaries are especially recommended where roofs, walls and decking are constructed of combustible materials. Firebreaks should especially be considered where roads cannot be used to separate the urban edge from the veld.

3.6 Building Design and Construction

3.6.1 Building vulnerability

One of the chief sources of ignition in a house is through ingress of burning embers. All buildings are at risk when situated close to fire-prone vegetation. Although brick and concrete masonry walls are inherently non-combustible, many architectural features are vulnerable, such as window openings, exposed timber gable ends, exposed timber roof members, barge boards, fascias and doors and loose roof tiles. Windows glass can fail relatively easily during a fire, allowing high levels of radiant heat to penetrate the interior or allow entry of burning embers, exposing the combustible furnishings (e.g. curtains) to direct heat and ignition sources.

Buildings with combustible external walls, for example “log cabin” type constructions, are also at risk, as are buildings with thatch roofs or other combustible roof cladding such as bituminous-based fibre sheeting or plastic, as might be found in informal settlements. Adequate fire breaks need to be provided at property boundaries, and gardens clear of dense flammable vegetation (See Sections 3.2 and 3.5). Accumulated dead vegetation or other combustible material such as wood-piles are a significant risk factor under buildings constructed on piles (stilts). Wood-piles can generate large amounts of heat over an extended period, adding to the heat load from the wildfire itself (Wilson and Ferguson, 1984). All under-floor areas should be kept clear of combustible materials and vegetation.

Timber decking and combustible walls are subject to regulations that specify that they must be a certain minimum distance from the property boundaries. Adherence to building regulations in the South Peninsula Municipality is monitored.

PVC gutters and down-pipes are not considered as high risk items as they would tend to char and melt under high levels of radiant heat and they do not contribute to the fire load as they only burn for as long as they are exposed to flame; they are self extinguishing, i.e. they stop burning once the flame is removed (Bryan Wallis, Fire Engineering Sciences, CSIR, pers. com.).

3.6.2 Practical ways of sealing the house

Openings to the house should be covered with fly-screen wire gauze, especially entry points to the roof and floor cavities. This includes especially under the eaves, roof vents and loose roof tiles (See Fig 3)

Home-owners can consider shutters for their windows, or wire fly-screens which could be clipped over windows in the case of an impending fire. The metal gauze reduces the intensity of the radiant energy reaching the window, and thus heat stress on the glass, quite significantly (Webster, 1986). Draft excluders can be fitted onto doors. Skylights should be guarded with non-combustible and sturdy covers.

One of the worst things to do is to pile furniture outside the house ***in case*** a fire ignites in the house. A big fire will rain burning embers onto the furniture piled outside. A house that is well defended is quite a safe place to be.

< Insert Fig 3 here >

3.7 Unattended Houses

3.7.1 Unattended houses and increased risk

It has been shown in Australia (Wilson and Ferguson, 1984, 1986), the United States and elsewhere, that unattended houses were more likely to be destroyed by fire than those that were actively defended. Small fires may easily be extinguished by residents, but in unattended houses, those small fires may eventually destroy the house (Wilson and Ferguson, 1986).

Properties should be defended by the owners, where possible. Families should have a plan of how to react in a wildfire situation and they should practise this once a year. It may be suitable for some residents to leave a property, while others remain to defend the property. However, it must be stressed that people defending their property should also have a viable escape route should they be overwhelmed by the fire.

Householders should not concern themselves with fighting the fire front (a dangerous task for which one must be specifically dressed), but from keeping flying embers from igniting any part of the house. The fire front may pass the house quickly, but residents need to remain vigilant on conditions **inside** the house for hours afterwards, as smouldering embers may only catch alight long after the excitement has resided. Many fires probably begin in the roof and can remain undetected for a surprising length of time.

There appears to have been a practice by the civil protection and security agencies to call for evacuation of properties that are threatened by fire. If there is a policy that supports this practise, it should be re-considered, for the following reasons:

1. Houses that are defended have a higher rate of survival, as described above;
2. Evacuations are demoralizing, can cause traffic problems and panic, anger and even violence in the ensuing chaos;
3. People desperate to load up valuable belongings usually cause obstructions along roads. In these situations there is also the risk of an **influx of people** from other communities, arriving to help their friends. Fire fighting teams can move along roads quickly that are kept clear, this will happen if people stay in their houses.

3.7.2 The risks of evacuation

It has been shown in Australia that people should not evacuate when a wildfire is close, this leads to panic, confusion and fatalities (Webster 1986). If evacuation is to take place, the young, aged and infirm should be evacuated well before the approach of a fire, while the fit and active should remain behind and defend the house. The problem is to know when is the right time to evacuate: immediately before a fire reaches the threatened area is not the right time, but when the fire is distant or small, evacuation seems like an overreaction.

Families should develop their individual plans of how to react during a wildfire event. During a potential crisis, they should listen to the radio (assuming that regular broadcasts on the progress of the fire will be given by the local radio station) and observe the weather conditions. If the wind should turn such that people believe themselves to be downwind of a fire, then it is time to act on their plan, remembering that a large fire can spot downwind over several kilometres and create new fire fronts relatively quickly.

Once a fire is near (within 200 – 300m), generally it is too late to leave. In this case the residents should close up the house and patrol its interior rigorously.

3.7.3 Active defence of houses

People should remain inside their houses during the passage of a fire front rather than outside, especially if the fires are intense. Australian work (Budd *et al*. 1997) has shown that even experienced fire fighters working with hand tools at the fire line cannot suppress headfires (at the head of an advancing fire) with an intensity of more than 1000 kWm^{-1}, or where flame lengths were greater than 2 m. Note that fynbos fires can easily go up to 20 000 kWm^{-1} (See Section 2.1), that is, twenty times the limit of manual suppression for **experienced fire fighters** who are appropriately dressed (loose fitting overalls, boots, head protection, vented goggles for eye protection, mask to prevent smoke inhalation) and are emotionally more attuned to firefighting.

Note that the dangers (and killer factors) of a wildfire are:
- Radiant heat;
- Dehydration, and
- Asphyxiation.

Inexperienced people should not be present at the fireline, where they may also be inappropriately dressed, not have the right equipment or the necessary teamwork to back them up in case something goes wrong or be susceptible to irrational behaviour if panic sets in.

Conditions inside a house would be much more amenable. If the residents are properly prepared, they will have ladders, buckets, mops and the garden hose inside. Curtains will be tied back or taken down. The residents would then patrol the inside of the house and remain vigilant for entry of embers. The roof manhole should be removed and the ladder placed to that regular check can be made inside the ceiling.

3.8 Storage of Highly Inflammable Materials on Premises

Storage sheds (so-called “wendy houses”) are often of combustible construction, (creosoted wood, for example), are sited near property boundaries and burn fiercely for an extended period of time once ignited. Burning storage sheds have been associated with higher rates of loss of the main

building to fire in Australian wildfires (Ferguson and Wilson, 1984). The problem is often compounded when they are used to store highly inflammable liquids (paints, fuels, cleaning liquids, etc) in some quantity.

Due attention must be paid to protecting these buildings from exposure to fire and to avoiding the storage of highly inflammable materials on the property.

3.9 Inflammable Materials on Roofs

Leaves and other organic material caught in gutters create a definite risk. This is especially likely where tree branches hang over roofs. Burning embers literally rain down ahead of a big fire, land on the roofs of houses and roll into the gutters where they will set fire to dead leaves and other materials collected there.

Gutters and any other structures or barriers on buildings that accumulate dead plant material should be cleaned regularly.

3.10 Fingers of Vegetation

Irregular boundaries formed by features such as gullies, ravines and ridges form "fingers" of vegetation that penetrate the urban environment can provide a "conduit" for wildfire to travel into the urban environment. These are most commonly a part of the natural drainage system that have obstructed building operations.

The vegetation in these areas should be managed to reduce fuel loads and maintain them in that condition. These areas should also be protected by firebreaks where possible. Note that there are usually steep slopes in these areas and the reader is referred to Section 3.4 for insight into the effects of slope.

3.11 Fire Size and Intensity

Large fires, that is, those with long fire fronts, or lines, can make contact with the urban edge over the whole length of the fire front, creating multiple opportunities for fire to enter the urban edge simultaneously. This stretches the resources of fire-fighting crews, who might then have to make rational choices about where to concentrate their efforts. There is little that the property owner can do in this situation, except be prepared to defend their properties should the situation require it. It will also help if the other risk factors mentioned in this document have be given prior attention.

3.12 Access Roads

In some areas, access roads separate the urban edge from the veld. It is much easier to fight wildfires from such roads than from those set well back into the urban zone and with access roads to houses. Typically, these are found on the steeper slopes where access roads approach the properties from below. Appliances attending fires in these cases have to loop round from one road to another in order to cover relatively short distances, this can use valuable time.

Properties which are difficult to get to, are located up narrow lanes and surrounded by thick and highly inflammable vegetation are at particular risk. Fire crews will be reluctant to attend fires in

these conditions if they cannot turn the fire tender around – it places them at risk of getting trapped. Adequate turning space should be provided and thick and highly flammable vegetation be kept back from the narrow roads.

3.13 Informal Settlements

Informal settlements are also often found on the urban fringe where vacant or undeveloped land can be occupied. The difficulties of fire-fighting in and from these settlements is compounded through factors such as:

- Density of development;
- Very narrow or non-existent access routes;
- Poor or non-existent emergency service infrastructure, and
- Widespread use of combustible building materials for walls and roofing (e.g. plastic sheeting, timber, hardboard and plywood for both structures and cladding).

In these settlements the risk of a conflagration spreading from the outer edges of the settlement into the rest of the settlement is much higher than it would be for less densely developed suburbs. These areas should be protected by firebreaks that may be wider than usual.

3.14 Failure of Water Supplies

Some houses are supplied with water through plastic water pipes. These are easily destroyed during a wildfire if they are lying on the ground surface, exposed to the radiant heat and flame contact. Water supplies become useless when critically needed for fire-fighting purposes. These pipes should be buried to a depth of at least 30 cm.

During a large fire there might also be a drop in pressure in the public supply as everyone begins wetting their gardens and houses as a preparatory measure. In this situation rooftop sprinklers may fail

3.15 Erosion and Sedimentation

Very intense wildfires remove the soil litter cover and damage the soil, creating a water repellent or hydrophobic layer in the soil (see Scott *et al*. 2000). Heavy rainfall onto the bare surface can result in substantial runoff and severe erosion. The eroded material is deposited as large quantities of rocks and mud further down-slope in buildings, on roads, and in storm-water drains, blocking them. This damage is not immediate, but often occurs some time after the fires when the first heavy rains of winter occur. A problem is that the link between the fire and the resultant damage is often not made because of the interval of a few months between the two events.

The only way to manage this risk factor is to reduce fuel loads and maintain them at low levels. Primarily this means removal of the invasive alien species and prescribed burning.

3.16 Lack of Awareness

Lack of awareness regarding factors contributing to increased risk is probably one of the greatest threats. There is a general lack of awareness of most of the risk factors but chiefly the need to reduce fire intensity through fuel load management and the prevention of ingress of burning

embers into buildings. Property owners and occupiers are much more likely to take preventative action once they become aware of the risk factors.

A public awareness programme should be implemented, it should focus on the risk factors and the recommended actions for reducing these. Such a programme would need to use a variety of means of communication, such as the print media, brochures, radio and television, where possible. The message should be adapted to the target audience. The Cape Peninsula Fire Management Plan should address these issues.

Residents also need to adopt a series of tasks throughout the year which would result in a much greater level of protection to their houses:

Spring – start of the fire season
- Clear gutters
- Slash long grass and undergrowth
- Remove trash and cuttings from property
- Inspect for and close gaps in house
- Trim overhanging branches

Summer
- Keep hose and mops handy
- Rehearse family fire drill/ emergency plan
- Mow grass
- Clear gutters
- Rake leaves and litter and remove from property

Autumn / Winter
- Prune plants
- Undertake general repair and maintenance

3.17 List of Protective Actions

This list is supplied as a summary of the actions described in previous sections:

Outside the Property Boundary
- Reduce fuel loads – remove alien species and debris from clearing activities
- Pay special attention to fuel load management in down-slope areas
- Construct firebreaks adjacent to the property

Within the Property Boundary
- Plant screening trees on the boundary – canopies must be separated and a minimum of 2m between canopy and ground is required
- Cut grass and other vegetation under screening trees
- Plant hedges against the boundary (not cypress)
- Plant barrier features in the garden using succulents and other high foliar moisture vegetation
- The garden must *Easy to walk through in any direction*
- Remove dead and dry vegetation and litter from the garden
- Remove hanging dead and dry branches from trees (eg palms)
- Remove inflammable and dry vegetation from under decks, against walls and pillars
- Remove hanging baskets with dry material from the building

- Avoid wooden fencing or out-buildings on the boundary – especially creosoted material

The Building

- Fit windows (at least the vulnerable side) with clip-on wire gauze screens – to be used in the event of a fire
- Seal roof vents, eaves and floor vents with wire gauze screening
- Clear leaves from gutters regularly
- Secure any loose roof tiles
- Avoid storing fuels and paints in out-buildings and "Wendy-houses"
- Remove inflammable materials such as wood piles that are in close proximity

Before Fire

- Plan response by residents to wildfire
- Rehearse plan every year
- Carry out garden maintenance and fuel reduction activities
- Clear leaves from gutters
- Have at hand hose-pipes, buckets, mops

During Fire

- Make decisions early – carry out the planned response - evacuate or stay?
- Stay calm, move about in a purposeful way and **do not run anywhere except in an absolute emergency**
- Close up house and screen off windows
- Seal gap between door and floor – use wet towels or similar items
- Don't pile furniture outside – remain inside, it is safer
- Patrol house interior and extinguish any small fires
- Remain vigilant after the fire front has passed
- Listen to public broadcasts on the radio

4. PROPOSALS FOR AMENDMENTS TO MUNICIPAL BYLAWS

Generally, changing local authority by-laws is not considered practical as the risk is not a general one, but is limited to properties on the urban edge. Education of property owners and occupier through high profile and intensive education/information sharing programmes in advance of high fire risk seasons is likely to be far more effective than reliance on regulation. We would encourage the use of local media (radio, TV and print), pamphlet drops, community meetings and any other means for providing information and raising awareness (e.g. daily warning announcements of the expected fire risk). See also Section 3.15.

It should also be borne in mind that some risks cannot be regulated against and that generally, risks need to be borne and accepted by the property owners, rather than the CPNP. For example, if a house owner wants to have a thatched house on the park boundary, the risk is for the house owner who needs to make the necessary arrangements for laying off his risk. The CPNP needs to focus carefully on where it's public liability begins and ends, and manage around that.

However, some items for municipal Bye Laws may be considered:

- Fuel loads in public areas, municipal lands, drainage lines and private gardens must be managed, as recommended in the central thesis of this document.
- Fire hydrants at the end of all *cul-de-sacs* (if not already in the structure planning)
- Houses on *cul-de-sacs* and on the urban fringe should provide for turn around areas so that fire tenders can get in and out quickly, the roads should be of sufficient width and gradient to allow easy access by fire tenders.
- Wooden fencing that has been treated with creosote burns fiercely once ignited. There should be no such fencing to the fire-ward side of the property, ie the side facing the CPNP.
- Thatch houses must have sprinklers.
- The houses on the urban edge must be connected to a ring main that maintains suitable water pressure even under conditions of heavy use (this is a standard civil engineering problem that is accommodated in many areas but might not be for houses at the extremities of the municipal system – this needs to be examined in the case of the SPM)

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