

**Quantifying the Visual Effects of Wind Farms;  
A Theoretical Process in an Evolving Australian Visual Landscape.**

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**Dissertation for Doctorate of Philosophy**

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2009**

**PART ONE: AESTHETICS PERCEPTION AND LANDSCAPE VISUAL ASSESSMENT**

# 1 INTRODUCTION

## 1.1 CONCEPTS OF LANDSCAPE

'A picture speaks a thousand words'. As a story book or poem replicates emotional encounters with landscapes, so to do pictures. Landscapes have distinctive differences in colour, pattern, textures and general composition of physical elements. Images can provoke a sense of passion, beauty and attraction. The appreciation of qualities of landscape characteristics can differ for each observer. With regards to landscape values and visual perception, there is a quintessential debate on whether aesthetics are inherent in landscapes; or in the eyes of the observer.

This chapter will introduce and define the concept of landscape and visual perception, engendering an argument for a research project to identify values of wind farm landscapes through visual representations.

The word 'landscape' will be used in preference to 'environment' as it refers to perception and is more concise whereas environment is more general (Bourassa, 1988). Other authors

have reflected on this distinction, Hull and Revell (1989) define landscape as

“the outdoor environment, natural or built, which can be directly perceived by a person visiting and using that environment”.

(Hull and Revell, 1989, p324)

Appleton (1980) has referred to landscape as the environment perceived, especially visually perceived. Daniel and Vining (1983, p41) have emphasised that landscapes are predominantly valued for their visual properties, limiting any multi dimensional sensual values of social, cultural and ecological factors. Furthermore, Steiner (1991) has discussed landscapes as all the natural features such as fields, mountains, water, forests that separate one part of the Earth from another. Consequently landscape is defined as that part of the environment which is viewed by the occupant.

In this sense the term landscape is ideological in visual representation. The history of which has seen it manifest from definitions of a view of the landform or inland scenery from a specific viewpoint or conversely a sketch or image frame of a

conceptualised representation mediated by an occupant of the original.

Daniels and Cosgrove (1988) have referred to landscapes as a pictorial way of representing and symbolising the environment. Subsequently landscapes can be “written, filmed, painted, grown or built” (Cosgrove and Daniels, 1988, p1). Therefore landscapes are products of human values that can be physical, iconological and ideological representations. Hence the essence of landscape provokes emotional attachments and experiences describing unique relationships of people and place. Consequently landscape has evolved to be inclusive of ideological and experiential values and not simply or purely aesthetic.

The poetics of landscape as a means of communication and emotional sensual attachments to place has taken on many different forms of media. The relationship of humans and their interactions with landscape has been equivocally documented and referenced in text, graphical representation in paintings, photography and numerous forms of art. To understand the context of Australian landscapes which due to the size of the continent are extremely diverse in character, Dorothea MacKellar (1908) has quite delightfully, with metaphorical

description, impersonated her vision of Australia’s landscape contrasted to the English pastured countryside.

'My Country'

*The love of field and coppice,  
Of green and shaded lanes,  
Of ordered woods and gardens,  
Is running in your veins;  
Strong love of grey-blue distance,  
Brown streams, and soft, dim skies, -  
I know, but cannot share it;  
My love is otherwise.*

*I love a sunburnt country,  
A land of sweeping plains,  
Of rugged [ragged] mountain ranges,  
Of droughts and flooding rains;  
I love her far horizons,  
I love her jewel[-]sea,  
Her beauty and her terror  
The wide brown land for me!*

*Mackellar, D. (1908)*

These associated memories imprint a patriotic image in the minds of those who have experienced the two contrasting landscapes. Mental images of scenes experienced both through filtered lenses and sensual pasts flood back as memories. The memories and perceptions of landscapes will most likely differ for each reader; however the poem is successful in depicting an idiosyncratic cultural form of landscape character.

Similarly pictorial representations can allude to emotional associations. Contextual similarities through colour, pattern and texture may represent the poem as the following imagery possibly does.

**Figure 1.1** Photo of the outskirts of Adelaide: Complex undulating topography with minimal vegetation coverage.  
Source: Brett Grimm



Perceptions of similar landscape forms can provide an alternative representation to text. The notion of a nominal comprehension of landscape as portrayed above states that cultural factors affect perception. However the cognitive process of image and text comprehension is still debatably inclusive of biological factors supplementing cultural intuition. (Bourassa, 1988, 1990, 1991)

In many ways, therefore, landscape is that part of the environment that is the human habitat, perceived and understood by us through the medium of our perceptions.

(Bell, S. 1999 p66)

Evidently perception is a term which is inclusive of sensual information. When we engage with landscape we utilise vision, smells, tastes, sound, textures and various other complex kinaesthetic senses to evaluate the environment we encounter. For this reason, this dissertation will focus on the visual sense as “vision accounts for some 87% of human perception, so is proportionately more important” (Bell, S. 1999, p3).

Visual culture is a term recently introduced to cover a broad research agenda in contemporary methods of communication. The image stands at the centre of contemporary culture. The multi disciplinary discourse, ‘vision and culture’ crosses fields of anthropology, art and history and to some degree can be defined as the relationship between popular technologies and social practices. Television and photography have consumed society. The age of consumerism and capital markets, has saturated the world with images. Provocative images are used in advertising and in movies inventing a fourth dimension of

emotional magnetism to a particular landscape. The relationship of image conception undoubtedly is focused on perceptive response. Images are created to replicate, and provoke emotional associations to places.

Consequently vision and perception of landscapes is closely related to theories on aesthetics. “The term ‘aesthetics’ comes originally from the Greek ‘aesthenesthai’, to perceive, and ‘aistheta’, ‘things perceived’ (Bell, S. 1999, p3).

Due to aesthetics and perception being previously topics dealt with by philosophers such as Kant, Locke, Plato and crossing more recently into landscape architecture and environmental science; Loewenthal, Tuan, Meinig and Zube, the reference material is broad in scope and varied in schools of thought. In the accompanying chapters the discussion will elaborate in further detail the theoretical relationships between diverse fields of environmental studies, psychology and physiology, referring to contemporary ideologies of aesthetics and landscape assessment.

Words and pictures can tell similar stories and are commonly used to reinforce each other as depicted in the relationship of McKellar’s poem and Figure 1.1. Visualizations for landscape

development applications are becoming ever increasingly important (Bishop & Lange, 2005). Accordingly Environmental Impact Assessments (EIA)<sup>1</sup> for development applications utilise pictures to substantiate potential effects. Wind Farms are but one form of development which is commonly examined in an EIA. Numerous questions can be asked with regards to the utility and value of the image in landscape development applications. The quality of how we fabricate and use these images is an important consideration in Visual Resource Management (VRM).

## 1.2 WIND FARMS; A RENEWABLE SOURCE OF ENERGY A CONFLICTING VISUAL CONCERN.

Since the 12<sup>th</sup> century in central Europe humans have harvested wind as a source of power to pump water. Some historians cite a reference to German knights building the first windmill in Syria during the Third Crusade (Shepherd, 1990). The innovation and evolution of the windmill has provided humanity with a sense of stewardship of the landscape. It was not until 1891 that the

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<sup>1</sup> An Environmental Impact Assessment is a professionally prepared report detailing the various alternative ways to do a development project outlining the positive and negative impacts from an environmental perspective. The report will be nominally inclusive of physical, cultural, historical, geological and visual predicted changes to the landscape.

Danish started to experiment with wind generated electricity (Gipe, 1995).

Due to global warming being a major environmental and economic concern, alternative sources of electrical energy generation are being employed to limit humanity's dependence on fossil fuel-based, carbon emitting generation processes. Wind farms are one form of alternative generation which can help suppress the amount of gaseous carbon emissions.

For the purpose of this dissertation a wind farm will be defined as 'an array of wind turbines located in close proximity to one another using the same substation (transformer) and power line to connect to an electricity grid' (Saddler *et. al*, 2004 vii).

Wind farms in their contemporary form are a relatively new technological fabric integrated predominantly into rural, agricultural landscapes. The vertical scale of the wind turbine generator (WTG) had not been seen before the early 1980s in Australia.

The evolution of the wind turbine in Australia can be characterized by the nostalgic Southern Cross wind mill which

has become an iconic element of the harsh, dry landscapes of Australia's outback.

**Figure 1.2** Southern Cross Windmill: Source Brett Grimm



It is difficult to compare or treat the Southern Cross wind mill in the same context as the contemporary version. The contemporary wind turbine being installed in Australia is an entirely new technological fabric much larger in scale and sleek in appearance and designed for different functional requirements. The Southern Cross wind mill was developed to pump water from the ground water table, not as an electrical power plant as its successors are defined.

**Figure 1.3** Wind farm located at Codrington, South West Victoria  
Source: Brett Grimm





The appropriateness of these structures sprawling across our landscapes has recently come under scrutiny. The major controversial issue is the visual effect caused by elements which are vertically unmatched by any existing reference in the landscape. Furthermore, wind farms present a new dynamic form into a relatively static landscape. The scale and motion of the blades introduce a visual effect not yet realised for its perceived affects. The conflicting issue at hand is the development of a sustainable energy generating wind industry and scenic amenity conservation.

It is common in planning ministerial assessments for the visual significance of particular landscape regions to be registered as areas of conservation.

In the early part of the twentieth century Tasmania employed Scenery Preservation Board to argue the case for scenery protection. But in more recent times in Australia- apart from the National Trust- there have been few powerful voices speaking on behalf of scenic values

For development applications which require an EIA, simulations or montages provided as part of the visual assessment are typically scrutinised, seemingly the major reference to discuss

and critique design proposals. The purpose of the representations is solely to 'communicate'; there is no textual language barrier, the comprehension of images and preference response for landscape may differ between cultures and sub-cultures (Kaplan & Herbert, 1987: Zube & Pitt, 1981). Thus understanding visual languages is an important characteristic which needs further development and research.

Wind farms are not a particularly new form of development. They have been in English, Dutch and Danish landscapes for decades; however the new generation of sleek engineered forms are a new addition to landscapes.

**Figure 1.4** Wind farm located at Star Fish Hill, South Australia Source: Brett Grimm



The scale of the WTG has transformed from 45 metres high (hub and rotor) in 1980 to 135 metres (blade tip) in 2000 (World Wind Energy Association, 2003). The reason for this being the energy output range increasing five fold from 400kW to 2MW<sup>2</sup>. These new turbines are categorised as third generation.

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<sup>2</sup> The energy produced is proportional to the diameter size of the blade revolution hence the larger the wing span the greater the amount of energy produced per rotation.

Due to the siting requirements for efficient energy production, turbines need to be located in open unobstructed areas where strong winds are prevalent. For economic feasibility they also need to be located close to a current grid network, reducing huge costs of transmission line connection. Consequently, ideal siting locations are typically in conspicuous locations within close proximity to the outskirts of residential suburbia. This undeniably creates a bipolar dilemma we are currently faced with; clean sustainable energy production or landscape visual amenity conservation. The siting requirements and conflicting issues of renewable energy production and landscape amenity conservation will be discussed in the proceeding chapters.

Various methods have been adopted to assess the visual impact of landscape developments. However these techniques have formally been used for static development forms and particularly not for the vertical scale of third generation turbines. None of these methodologies have been universally accepted. The development of new methods specifically for wind farm planning assessment has been discussed by numerous government and stakeholder organisations in Australia. A recent project 'Wind Farms and Landscape Values; National Assessment Framework', (2007), identifies a framework for

which methodologies can be developed to be accepted nationally as best practice.

Current planning and assessment guidelines in South Australia allude to an iterative process which includes landscape value assessment and a professional expert approach of character and inventory assessment. A review of various methodologies and conclusions of the National Assessment Framework (2007) are discussed in following chapters.

Theoretically there are two schools of thought currently utilised in visual assessment practice; the subjective and objective paradigms of visual assessment. One of the main questions posed by the current frameworks of assessment is to evaluate subjective public perceptions in combination with a quantified value of landscape visual change. The two paradigms of assessment differ with regards to whether aesthetic qualities are either inherent in the landscape or in the eye of the beholder.

This dissertation will elaborate on opportunities to evaluate landscape visual properties utilising Geographic Information Systems (GIS) to facilitate the analysis of site specific data. This will be outlined in detail in the proceeding chapters on current

methodologies used in practice and representational media for landscape assessment.

Furthermore, the current process of data collection specifically landscape perception values through survey sample will be explored with data processing and interpolation in a geographically referenced environment.<sup>3</sup> A key step forward would be to integrate visual media into a geographically referenced survey package for community participation.

Visualizations including GIS rendered maps and photomontages are currently used in the development processes as graphic representations of the final product. They are purposefully used to aid the client, public and stakeholders envisage the proposed or imagined scene. Hence they are used primarily as a means of communicating ideas. Typically in the past maps, plans and sections were used to convey ideas; however these images are at a high level of abstraction.

The history and use of these various representations will be examined along with current techniques of image generation and presentation specifically photo montage and video montage.

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<sup>3</sup> Within this dissertation geographically referenced data implies data which spatially orientates physical and psychological relationships to landscape in two or three dimensions.

The theory of image transactional depiction will be referred to and will give support to the structure of research questions and survey material in the case study. The transactional depiction model developed by Zonn (1984), illustrates the concept of image creation, perception and the sequence of landscape depiction. The model of human landscape interaction and image depiction, interpretation will be elaborated upon in proceeding chapters.

### 1.3 RESEARCH QUESTIONS AND OBJECTIVES

Several research questions and objectives have been derived to provide direction for this dissertation. The main research question for this thesis is;

- *Is it possible to develop a methodology for wind farm visual assessment which integrates tangible and intangible values?*

To further enhance the development of a visual assessment model, representational tools to be used in the process will be interrogated. Consequently a hypothesis has been developed;

*Static representations and methods of presentation for wind farm visual assessment are inadequate in depicting the dynamics of rotating blades and the resulting impacts on aesthetic values.*

In order to assist the investigation of this hypothesis, two subsidiary research questions have been derived.

- *Are static representations methods for wind farm visual assessment adequate in depicting the dynamics of wind farms and their affect on landscape aesthetic values?*
- *Can GIS be used as a tool to substantiate and cartographically illustrate a detailed degree of visual change and perceived landscape value?*

To answer these questions, several aims and objectives have been derived. These are;

- Analyse the current theoretical discourse of visual impact assessment for wind farm proposals.
- Develop a reliable, credible, practical, flexible and efficient visual assessment methodology for wind farms which integrates tangible and intangible values of perceived and physical changes caused by development.

- Develop a visual assessment model which uses dynamic media and geographic information systems (GIS) to accumulate landscape visual sensitivity values and objective values of landscape visual change for wind farm developments.
- Utilise an existing wind farm developed at Lake Bonney, South East of South Australia to validate and test the model.

#### 1.4 THESIS STRUCTURE

This chapter has introduced the concept of landscape perception and visual representation. The rationale and research objectives have been established as well as posing questions for literature direction and framing the body of work.

The structure of the thesis is as follows:

#### **PART ONE AESTHETICS & PERCEPTION OF LANDSCAPE**

##### **Chapter**

2. Theory of Landscape Aesthetics
3. Psychology, Aesthetics and Visual Perception
4. Theoretical Paradigms of Landscape Aesthetic Assessment and Methodological Divergence

#### **PART TWO VISUAL EFFECTS OF WIND FARMS**

##### **Chapter**

5. Theoretical Paradigms of Landscape Aesthetic Assessment and Methodological Divergence.
6. Wind Farms; Renewable Energy Technology In The Landscape
7. Visual Representation Tools for Landscape and Wind Farm Planning Assessments.

#### **PART THREE CASE STUDY**

##### **Chapter**

8. Integration of Quantitative and Qualitative Visual Assessment Methods
9. Discussion and Conclusion

## 2 THEORY OF LANDSCAPE AESTHETICS

### 2.1 INTRODUCTION

Aesthetics covers a broad array of disciplines, from philosophy and the study of art and nature, to physiology and the mechanics of the human eye and cognitive process. This chapter will elaborate on the philosophy of aesthetics with particular reference to the visual landscape and means for landscape visual resource management.

Landscape is inherently visual (Bishop & Lange 2001), whether physically seen through the naked eye or through cognitive images flooding the brain, visual impressions of places are prevalent to the human psyche.

The desire to evaluate qualitative visual experiences has been directed by a series of questions. Firstly to identify what humans appreciate in landscapes and secondly to describe why they value those qualities of a particular scene. Many research questions have been directed towards a holistic appraisal of landscape incorporating multi-sensual, ecological and cultural factors, whereas an ever increasing amount considers purely the visual phenomenon of perception.

Why is a particular landscape scene beautiful or aesthetically pleasing? Is it the composition of elements in the landscape or is it qualities or associations related to our cultural and biological upbringing? This discussion is commonly referred to as the philosophical debate on whether scenic beauty is an inherent quality of landscape or is 'in the eye of the beholder'?

The *Oxford English Dictionary* defines aesthetics as: 'the branch of philosophy which deals with questions of beauty and artistic taste' (Oxford 2002, p13). Aesthetics has also commonly been expressed as the study of beauty in both nature and art. Arguments of aesthetics enquiry have developed from psychological questions about the effects of beauty and theoretical developments concerning taste and perception.

The concept of beauty has been strongly linked to aesthetics since the classical period. Aesthetics is a philosophical discourse that deals with investigations of conceptual thinking. It is a search for realism based in arts not science; hence it is formerly conceptual in nature. There is considerable literature on aesthetics most of which is multi-disciplinary and arduous reading.

Philosophers of aesthetics have tried to explain through rational thought reasons for why certain qualities of objects permeate a sense of appreciation, a feeling of desire, emotional enjoyment. This has been articulated through a process of review and critique, questioning preceding work and developing ideas into new theoretical frameworks.

Sculpture, art, architecture, music, literature and landscapes are some of the objects which have been discussed to explain principles on converging aesthetic qualities of object forms. The former objects of sculpture, art and written poetry have had the foremost attention. To date landscapes have not been discussed with as much rigour, limiting the development of an aesthetic theory of landscape.

## **2.2 HISTORY OF AESTHETICS; A PHILOSOPHICAL DEBATE**

Aesthetics has been a philosophical discourse since the turn of the 18<sup>th</sup> century. Formerly a study of beauty (Socrates 469- 399 BC, Plato 427 –347 BC) the term 'Aesthetics' was adopted in 1750 (Baumgarten) and considered to be more inclusive of human-landscape and nature- landscape interactions.

### **2.2.1 Classical Period (500- 323 BCE)**

The classical period of aesthetic philosophy was guided by Socrates and Plato who were both of the opinion that beauty has a moral influence. Socrates believed that youth should be surrounded by beauty thereby improving sensual satisfaction, seemingly linking morality and aesthetics.

Plato, whilst guided by the mentorship of Socrates, founded the Academy in 386 BC. Based in Athens, the Academy was the intellectual centre of the Western world during the Classical Period. Numerous scholars were involved in the philosophical inquiry of art, architecture, politics and humanity. Aesthetics was commonly theorised as it crossed boundaries between different disciplines and professions.

Plato developed two theories both of which considered beauty to be inherent in objects. The 'definist' theory firstly considered certain properties of objects to permeate a sense of beauty, whilst the 'nondefinist' theory subjected the aesthetic response to an indefinable quality which became prevalent when the object was perceived as a holistic unit. Further, Plato described beauty as an absolute phenomenon, with both his theories being established from a conceived idea of beauty being intrinsic in objects.

Plato and later Aristotle (384-322BC) thought that moral virtues were rational controls over the passions and believed that nothing can be understood without grasping the objects form.<sup>1</sup> This focussed their concepts of aesthetics into slightly more tangible constructs of the visual dialogue between object's and humans. Contrary to this, intangible aesthetic qualities were believed to be intrinsic to the form of the object (Beardsley 1966, 1967).

Aristotle further developed these concepts from Platonian philosophy. He described beauty as an inherent quality in objects that were of a certain scale appreciated holistically by the observer.

Accordingly the classical period of aesthetic philosophy was led by the objectivist school of thought believing that perceived, aesthetic quality to be uniform to all observers, relative to the object that was being viewed.

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<sup>1</sup> The term information is literally derived from the philosophies of Plato and Aristotle. It means taking the form of something into one's mind, and letting that form shape the mind.

### 2.2.2 Christian Period

The early Christian period further developed this philosophy of beauty. Plotinus (204-269AD) related the concept of beauty to 'ideal forms'. He believed that beauty had intangible qualities, residing in the object. Plotinus rejected the Classical view that symmetry was a prevalent form of beautiful objects. He believed that beauty was appreciated from objects that irradiated symmetry rather than symmetry itself (Beardsley, 1966; 1967). This laid the foundations for the romantic and mystic schools of thought which developed in the 19<sup>th</sup> century. The relationship of symmetry and aesthetics was to become a point of discussion in contemporary philosophy in the book *The Analysis of Beauty* (Hogarth, 1955).

### 2.2.3 Medieval Philosophy of Aesthetics

Medieval philosophy of aesthetics was prevalent as a discussion from the fall of the Roman Empire to the Renaissance. Otherwise known as the Middle Ages of Western Europe, this era dating from approximately the 5<sup>th</sup>-15<sup>th</sup> century, was profoundly based in theology (Beardsley, 1966; 1967). Many of the philosophers during this period in time were educated within a Neoplatonist school of thought. Notably work by Aristotle was a key reference. The leading field of enquiry in philosophical debate was the existence of God



and the intangible qualities of life. 'To the medieval mind the visible world was a symbol of the divine and all created things were 'theopanies' or manifestations of the being of God' (Osborne 1968, p18).

The concept of beauty was independent of the material object, and other values associated with the form of the object. Beauty was thought to be the 'radiance of truth' shining through the symbolism of the object which was in itself an image of ontological perfection. The aesthetic experience of the object was thought to be a direct cognitive reflection on a higher metaphysical power. Accordingly the aesthetic experience of landscapes was thought to be a direct insight into the 'perfection of divine Nature. In medieval thought aesthetics was a branch of theology' (Ibid, 18).

### 2.2.4 Modern Philosophy of Aesthetics

During the 17<sup>th</sup> century Rene Descartes (1596- 1650) was influential in asserting the role of reason, building on truth and factual factors. Rather than associating aesthetics to intangible qualities of the object's form, he related intuition and deduction as sources of aesthetic knowledge (Beardsley, 1966; 1967). In other words intuitive aesthetics prompted discussions on whether cultural

associations to landscape contexts affected aesthetic perceptions. In addition deduction was a form of knowledge gained by a chain of events and was seen to be more tangible and scientific. This thought informed a universal logic to aesthetic philosophical discourse that was soon to be developed by German and British aestheticians, who were prominent empirical researchers of beauty during the 17<sup>th</sup> and 18<sup>th</sup> centuries.

British aestheticians John Locke (1632-1704) and David Hume (1711-1776) were influential in developing theories on human-landscape experiences. They were of the opinion that aesthetics and landscape appreciation was established from experiences. This body of work was labelled as the British empiricist philosophy.

Locke isolated aesthetic qualities into two schools of thought. His ideology of primary and secondary qualities of objects added another point of view to the argument on whether aesthetic qualities were inherent in objects and forms or in the eyes of the beholder.

Locke defined primary qualities as 'utterly inseparable from every particle of matter' (Hamlyn 1987, p172). This elementary association of particles and aesthetic appreciation was assumed to be of scientific tuition. This laid the foundations for what was to become the objective paradigm of visual assessment.

Secondary qualities of landscapes have been identified as phenomenalist. Experiences of touch, smell and sound create sensations that are subjective and intangible. Locke believed these affections to particular sensual responses were attributed to primary qualities. Accordingly the relationship between physical matter and phenomenon was considered with scepticism and confusion.

Shaftesbury (1671-1713) developed his viewpoint on similar principles; however he was consumed with theology and the notion of all things being God's creation. Harmony and beauty were believed to be morally generated from biological genes implying a similar line of thinking to Locke's primary qualification of particle matter (Beardsley; 1966; 1967).

Conversely, Hume rejected the view of inherent aesthetic quality in objects and constructed a theory of aesthetics being subjective and in one's own mind. Hume's resolve of aesthetics being a stimulus of subjective grounds called upon a new line of thinking with references to cultural intuition.

Another British philosopher who was integral in establishing the empiricists theory of aesthetic conception was Edmund Burke

(1729-1797). Burke was of the opinion that elements of landscapes have common aesthetic qualities that are appreciated through knowledge of previous experiences. Burke elaborated on this concept and further progressed to define terminology of aesthetic discourse; beauty and the sublime (Burke, 1757).

Beauty was thought to have originated and be empowered by human gender; it was associated with qualities of human experience. Formal qualities of proportion, harmony, unity and complexity were thought to be coincidental of emotional experiences. Conversely the sublime was related to intense emotional experiences and was foremost related to nature and human interactions. Sublime landscapes were believed to instil extreme sensations of surprise and mystification differing from the normality of everyday aesthetic experiences.

Burke and Hume were of the assumption that beauty could not be defined. Properties such as fitness, variety, unity, symmetry, proportion, and the list goes on, were all present in many objects which permeated a high level of aesthetic experience. However the majority could also be seen in objects which were thought to be ugly. Consequently Burke and Hume were critical of certain properties and concluded that beauty was in fact intangible,

challenging any notion that aesthetic appreciation could be associated to a common thread of properties.

### 2.2.5 The Germanic Influence

Philosophers from Germany followed similar paths of reasoning and developed concepts of higher order. Of particular note was the work of Gottfried Wilhelm von Leibniz (1646-1716), Alexander Gottlieb Baumgarten (1714-1762) and Immanuel Kant (1724-1804).

Leibniz's resolve of metaphysical ideology was integral to future discussions he raised referring to aesthetics. He was preoccupied with the discourse of ontology which inspired his argument for the physical world to be interpreted for its phenomenal sensual qualities.

Baumgarten was formerly a lover of art and poetry. It was his appreciation for art which led to his questioning and thought provoking work on aesthetics. Curiosity to explain numerous questions relating to perception of art directed him to write a book on the theory of art and beauty. Saw & Osborne have reviewed this book and state that Baumgarten,

Etymologically ought to have given the name 'aesthetics' to the study of perception. Instead he gave it to the theory of beauty; even defining aesthetics in his opening paragraph as 'the theory of the liberal arts...the science of sensory cognition'.

(Saw & Osborne 1968, p15)

It was Baumgarten's dissertation *Meditationes philosophicae de nonnullis as poema pertinentibus* (1735) which first acknowledged a higher order of perception.

Baumgarten first put forward the idea that the current system of philosophical discipline was incomplete and needed to be rounded off by the addition of a science of the "inferior cognition" which is mediated by the senses on the analogy of Logic which, as the science of the 'clear and distinct cognition' mediated by intellect, stood as a general introduction at the beginning of the four departments of Ontology, Cosmology, Ethics and Psychology into which the Woolffian metaphysics<sup>2</sup> was divided.

(Ibid, p15)

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<sup>2</sup> Woolffian theory is broadly speaking divided into two paradigms of work, ontology, which treats of possible things, and metaphysics which treats of actual things. Metaphysics is divided into three sub categories or subjects; the universe, the soul and god. These categories can be further explained as cosmology, rational psychology and rational theology.

Consequently Baumgarten was alluding to a theory of phenomenology and perception, a classification of aesthetics as a metaphysical construct of the universe. Baumgarten's philosophy had some strong points which gathered momentum and general acceptance. However in the years to follow Kant, who was formerly an advocate for the phenomenological discourse, raised some critical concerns especially relating to this definition and terminology of aesthetics. 'Kant criticized Baumgarten for restricting the word to the field of taste and proposed to apply it in its true etymological meaning to sense perception generally' (Ibid, p16).

Kant was questionably the most influential of the Germanic and 18<sup>th</sup> century philosophers. He was influential in discussing and posing theoretical arguments for many subjects in the evolution of humanity and cognition. In relation to aesthetics, Kant developed his theories from the empiricists, noting the need to decipher aesthetics for both its theoretical and practical ground. In his book *Observations on the Feeling of the Beautiful and the Sublime* (1764) Kant wrote at length, poetic commentary on the differences between the sublime and beauty. Kant was of the opinion that the sublime was an emotional characteristic of higher merit overwhelming the observer, whereas beauty was a general appreciation or like for a particular object.

Of note was his discussion on aesthetics particularly in his published work *Critique of Pure Reason* (1781) and revised editions which followed in *Critique of Practical Reason* (1788) and *Critique of Judgement* (1790). These three volumes informed Kant's resolve on the human conscious. In sequential order the books discuss knowledge, desire and feeling. The final body of work on feeling was of most importance to the philosophical discourse of aesthetics.

*Critique of Judgement* was fundamentally a resolve of Kant's thought process; a simplification of aesthetics to the theoretical and the practical. The agenda informed a series of conditions by which beauty was comprehended intuitively. Four conditions or what Kant called 'moments', condensed aesthetics to quantity, quality, necessity (modality) and relation. Andrew Lothian (2000) has summarised these moments into the following:

- *First Moment*  
Taste is the faculty of judging an object or a method of representing it by an entirely disinterested satisfaction or dissatisfaction. The object of such satisfaction is called beautiful.

- *Second Moment*  
The beautiful is that which pleases universally without requiring a concept.
- *Third Moment*  
Beauty is the form of the finality of an object, so far as this is perceived without any representation of a purpose.
- *Fourth Moment*  
The beautiful is that which without any concept is cognized as the object of a necessary satisfaction.  
(Lothian 2000, p14)

The first moment considered beauty to be a satisfaction generated from the representation of an object in the mind. Consequently Kant was alluding to the concept of aesthetic quality being determined by a valuation of an object due to phenomenological means not intuition or cognition. In other words landscapes are valued and appreciated subjectively; interpreted for satisfaction pending on personal representation of the object. Coincidentally this line of argument persuaded the thought that aesthetics was a product of the mind. Equivocally this meant that the aesthetic quality of an object would be the same regardless of whether it existed in physical space or not.

Because it is a judgement of taste and not of cognition, i.e. aesthetical rather than logical, it is inherently subjective. Thus the aesthetic qualities of objects exist only subjectively. It follows that the existence of the object is of no consequence.

(Ibid, 14)

Further to this discussion was the interplay of imagination and representation. It could be said that aesthetic satisfaction or 'beauty' resided in the synchronization of imagination and comprehension of the object's form.

Similarly the second moment related aesthetics to experiences of aesthetic objects and landscapes. Expanding on the first moment Kant developed a classification of aesthetic pleasures. The classifications were

- Agreeable aesthetic pleasure
- Pleasure in the Beautiful
- Pleasure in the Good

*Agreeable aesthetic pleasure* was relative to sensations permitted from the interaction of humans and objects. It is sometimes called

'animal pleasures', interpreted more explicitly as human wants and feelings. Notably this took into account personal biological facets such as desire, warmth, appetite etc.

*Pleasure in the Beautiful* was directed towards all things perceived and was symbolic of visual aesthetics of which this dissertation will be concentrating.

The third classification, the *Pleasure in the Good*, is of the cognitive nature, relating to all things abstract or in concept form which are intellectually considered.

The occupation of these different modes of aesthetics is considerably complicated. Kant was of the belief that these three categories covered all forms of aesthetic pleasure, however could only occur one at a time. The opposing argument was that due to intangible qualities theoretical and practical (rational and moral), convergence would occur.

Kant's rationale for this theory is depicted by the notion of the first moment stating that aesthetic is equivocally evident regardless of the presence or absence of the object matter.

The Beautiful and the Good are public pleasures both taking place in what could be described as a cultural form. The pleasure of the Good is transferred by communication of concepts, whereas the Beautiful is the perceived value assigned to the finished product. The relationship between these two forms can be referred to the empiricist's tuition and deduction theories. Conversely the pleasure of the Agreeable is set in the context of private consumption and it can not be shared.

How and when the aesthetic experience occurs was also source for Kant's argument that the categories occur exclusively. The incidence of pleasure in the Agreeable and the Good was always of interest, whereas the Beautiful could manifest emotions of disinterest. The timing of the experience was either immediate or delayed. Beautiful and Agreeable modes of experience were immediate, whereas the pleasure of the Good could be either delayed or immediate. Subsequently each aesthetic pleasure would be consumed exclusively in time.

Kant's theories evolved into the third moment. The third moment further indicates Kant's philosophy that aesthetic experience was subjective. Kant argued that the *purpose* of an object was not detrimental to the aesthetic pleasure from the object's form.

Equivocally speaking the perceived beauty of an object's form had no relationship to the function of the object.

Shorn of its many elaborations, Kant's analysis of our use of the expression "This is Beautiful" is that it expresses disinterested pleasure which we believe we are entitled to demand of any and everyone because the object judged is discerned to have a certain kind of perceptual form which is called by Kant the Form of Finality.

(McCloskey 1987, p 24)

Consequently the aesthetic experience was not connected to the conceptual, cognitive process. Typically this form of aesthetic experience was related to natural forms such as flowers and organic living organisms, which possessed sensual qualities without human purpose. This quality of an object had commonly been expressed as *free* to the visual occupant (Lothian, 2000).

On the other hand architectural objects have defined purpose. Architectural aesthetic experience is related to the cognitive process, with the comprehension of the form and associated function strongly related to the aesthetic experience.

It is this property of beauty that Kant considers is pleasing. A beautiful flower has beauty, which is free, whereas a beautiful building has a purpose, and therefore, functionality, which is not free. Such utility implies what a building ought to be – i.e. comprised of walls, roofs and so on, whereas beauty which is free contains "no concept of what the object ought to be".

(Ibid, 16)

Similarly the aesthetic experience of art is connected to purpose. Art, sculptural installations and poetry are all representations of conceptual thought.

Following this discussion, Kant proposed to identify some common general rules related to the form and composition of objects rather than colour and textual factors. In some respects Kant was attempting to assemble a general framework of aesthetic experience. Understandably this was an unsuccessful task as commonalities in object forms and taste cannot be objectified through conceptual fields. For the sake of this discussion, intangible qualities of objects cannot be identified and measured for their aesthetic effect; it is all relative to psychological and metaphysical phenomena. Subsequently the third moment is still open to debate, with some critical theory suggesting it has limitations in its

disposition of art and nature and the abandonment of disinterest (Guyer, 1979).

Kant's fourth moment continued to resolve the notion of a possible universal aesthetic. The experience of aesthetic pleasure from an object or landscape is consumed by the public. Consequently the fourth moment disregards conceptual thought and cognitive comprehension of object forms. In other words the aesthetic enjoyment is a public experience not private.

#### 2.2.6 Summary of Kant's Influence

To summarise the impact of the four moments described above, Kant was extremely influential in persuading a paradigm shift in aesthetic thinking. Upon reflection and statements raised by theorists such as Dewey (1958), the philosophical argument posed by Kant was contradictory to the time of his enquiry. During the 18<sup>th</sup> century, landscape design and aesthetic appreciation was more concerned with order for 'reason rather than passion' (Dewey 1958, p253). Humanity was deliberate in creating functional conceptual order to spaces and objects and overwhelmingly more concerned with rational thought. There was little merit in research that investigated intangible qualitative phenomena.

However it can also be stated that Kant's theoretical framework was also deductive and rationalist. The compartmental division and realisation of phenomenal and cognitive thought processes was to a large extent simplistic and scientific.

The effect upon subsequent theory was to give the separation of the esthetic from other modes of experience an alleged scientific basis in the constitution of human nature.

(Dewey 1958, p252)

Conceivably the rationalists' of the 18<sup>th</sup> century found this theory to be ungrounded in scientific fact. Critics were mainly concerned with Kant's argument for a universal aesthetic. The notion of the aesthetic experience being contrived from our mind's representation of the object with possible disinterest was considered extraordinary. This undoubtedly was a major discussion topic.

The universality discussion was led by the fact that aesthetic qualities of objects are present within all pleasurable experiences. Whether the object is present of physical space or not, an aesthetic pleasure can be ascertained. The significance of Kant's explanation



of pleasure and the different modes of its tuition and phenomenon can be explained by the concept of representation and imagination of the object's form. This has been stated by Lothian:

The state of harmony between an object's imaginative representation and our understanding yields aesthetic pleasure. Such pleasure is neither sensual nor intellectual; it does not involve fulfilling animal appetites and neither does it involve rationality or reason. It does not involve conceptual judgement. Objects that we consider beautiful have a special kind of formal quality dependent on their perceptual properties, a purposiveness of form but not of function, purposiveness without purpose.

(Lothian 2000, p17)

This implies that Kant was potentially evolving a formula for aesthetic deduction based upon tangible and intangible qualities. In due course this understanding of cognition and spiritual, biological phenomena is fundamentally pivoted towards today's debate. This dissertation will apply this rationale to the case study methodology developed in Chapter 8.

### 2.3 CONTEMPORARY AESTHETICS; IN SEARCH OF MEANING

The period to follow Kant and fellow German philosophers was literally a critique of Kant's ideologies.

The Romantic period was guided by Friedrich Schiller (1759-1805) and Georg Hegel (1770-1831). This was a period of revolt against tradition, evoking eccentricity and chaos in what was an ordered society. The open minded and illogical thought process persuaded theorists such as Schiller to argue a case for irrational divergence of aesthetic experience. In simple terms Schiller was developing a concept for the subjective realm of perception, disregarding Kant's universal response to the landscape.

Hegel was forming an art critique focusing his concerns on beauty with respect to painting, sculpture, architecture, music and poetry. His passion for art and representation was significant to his line of argument. The idea of aesthetic experience, specifically beauty, stemmed from the interaction of nature and its representation. The pleasure obtained from the connection between humans and the represented artefact was to Hegel more symbolic of the aesthetic experience of the human psyche. Consequently the pleasure obtained from natural objects was thought to be of a higher order of beauty.

Similarly George Santayana (1863-1952) was an important figure in arguing a case for the concept of intangible aesthetic values. The essential quality of aesthetics was pleasure personified by the perception of the landscape or object. The quality of the aesthetic experience was individualistic and could only be ascertained through cognitive thought, disregarding the argument that beauty could be associated with an objective measure of inherent qualities in the landscape or object, as Santayana argued. Furthermore in *The Sense of Beauty (1896)*, Santayana described beauty as 'pleasure objectified'. In this sense the objective value was ascertained by the experience of the landscape and not the physiological attachment to the landscape's parts. In addition Santayana argued that the resultant aesthetic experience was a combination of factors involving the interaction of the landscape and the landscape itself.

### 2.3.1 Beauty and the Sublime

The concepts of 'beauty' and the 'sublime' have commonly been used in philosophical debate to explain the magnitude of a pleasurable landscape experience. During the 18<sup>th</sup> century philosophers Edmund Burke and Immanuel Kant were both influential in investigating and defining beauty and the sublime. They were both of the opinion that the sublime is distinct of beauty.

Kant has been referred to in many texts for his ideas on 'free beauty'. The notion of complete integration of humans and landscape provokes a concept of immersion, which Kant believed was a state of free beauty. Kant considered both beauty and the sublime as indefinite concepts, however where beauty related to understanding, the sublime responded to reasoning which surpassed every standard of sense. Therefore the enormity of a sublime experience is superior and indescribable.

A similar argument has been documented by Arthur Schopenhauer, a German philosopher, following in the Kantian school of thought.

Schopenhauer was also of the opinion that pure aesthetic experience or beauty is fundamentally imposed on the occupant without will or choice. Furthermore, Schopenhauer also considered cognitive cultural variables and the comprehension of sense of place to impose a more pronounced sense of beauty (Foster, 1991).

The derivation of these concepts, contributes to the intersection of 'psychological indices of landscape preferences, philosophical considerations and designers' guiding principles' (Bell 1999, p72). It is the intersection of these interrelated subjects that will aid an understanding of what is appreciated as beautiful and sublime.

The concept of designer's principles has been the objective of aesthetic argument in the design professions, with specific interest in Architecture and Landscape Architecture. Design language has been developed to aid communication of visual concepts.

Terminology such as unity, diversity, complexity, legibility, mystery, scale and coherence have been used to explain the relationship of elements and pattern forms in the landscape (Bell 2004; Bell 1999; Kaplan & Kaplan, 1982). This interest in expressing and analysing patterns is representative of the semiotic school of aesthetic debate.

In simple terms, beauty and the sublime have been used in philosophical and design terminology to communicate the quality of satisfaction acquired from human-landscape interaction. Beauty is apparent and compelling in experiences which permeate a sense of satisfaction and appreciation; many common everyday experiences with nature will stimulate a response that would be described as beautiful. For instance the experience of walking through the fjords of Norway or coastal landscapes of South Australia, may well revitalize, stimulate and provide comfort. The difference in qualitative appreciation for each occupant is uncertain. However the nominal classification of these natural landscapes would be described as beautiful. As a result the comprehension of beauty

resides in the beholder, meaning the interpretation of what is beautiful is subjective. Conversely the apparent composition of a typical landscape pattern exhibits a universal sense of beauty. Subsequently it is apparent that beauty can be interpreted through biological and cultural factors. (Bell, 1999)

The sublime on the other hand is defined as an experience of extreme magnitude. The term especially refers to greatness with which nothing else can be compared; the experience can not be imitated or measured.

During the 17<sup>th</sup> century Joseph Addison, a British philosopher commented on the concept of the sublime as three pleasures of the imagination evolving from sight; greatness, uncommonness and beauty (Addison 1965). Hence there was no distinction between beauty and the sublime, they were integrated concepts.

The difference between the two concepts can also be related to the preoccupation of art as the aesthetic object. As previously discussed, art in its material form of representing natural and psychological patterns was formerly the body of aesthetic discussion (Beardsley 1967; Beardsley 1966; Langer 1953; Hogarth 1955; Hamyln 1987; Dewey 1958). Beauty was previously a concept that could be related to art as time allowed for comprehension and interpretation permitted cognitive thought. The

indirect transaction of representation in comparison to direct transactions of landscapes signified a divide in instantaneous experiences. Consequently the movement of aesthetic thought to be inclusive of natural forms, explicitly speaking of landscapes, provided rationale to the concept of sublime perception.

### 2.3.2 Art and Representation in Modern Aesthetics

Probably one of the main reasons why art has been so closely associated with aesthetic discourse can be explained by the theory and language of symbolism.

It can be argued that Ernst Cassirer (1874-1945) was formerly interested in medieval philosophy and the discourse of semiotics. However, dissimilar to medieval thought, Cassirer was not influenced by ontological questions of enquiry. Saw and Osborne (1968) distinguish the variations in schools of thought profoundly to

medieval thought regarded all nature including works of art as symbols of Deity; the moderns distinguish works of art as being alone symbolic in the aesthetic sense. It is akin to the medieval philosophy in holding that the appreciation of beauty is a cognitive act and that it is immediate, intuitive,

or non conceptual awareness of that which is symbolized.

(Saw & Osborne 1968, p29)

Cassirer, a neo-Kantian philosopher, formed opinions and theories on cultural constructs of cognition and the intuitive reliance on symbols to comprehend human evaluations of landscapes, hence aesthetic experience. In a literature review by Beardsley (1966), semiotics was considered to be an integral component of human consciousness, evident in the analysis of forms of art. Symbolism in this discussion was an abstract thought of the cognitive mind. The process of comprehension and representation of landscapes was critical to the aesthetic experience. For this reason Cassirer developed a theory based on the notion that humans are symbolizing animals, which is essential in determining aesthetic responses.

The theory developed is held distinct from the iconographic study of cultural symbols. Within the context of this theory, the capacity of the landscape to be recognised as a piece of art was questionable. The representation of the landscape through paint, photography, etc was however an equivocal piece of art.

The theory developed by Cassirer further explained the role of art as an aesthetic object. The 'work of art' was a symbol, with unique

characteristics, composed by the individual. Hence the aesthetic qualities of the work of art were symbolised as a unified whole, meaning the scene or depiction of the landscape could not be separated into elemental pieces.

The aesthetic experience associated to the work of art was singular, meaning it could not be replicated by any other form of media. For this reason art could not be the language of feeling as some theorists have argued. For example the representation of a landscape scene through a photographic lens may well illustrate the scene with visual clarity in terms of pictorial quality; however the emotional appreciation to another viewer will differ in its aesthetic experience. The cognitive act of interpreting and portraying the experience is in this instance the aesthetic experience.

For this reason the work of art is described as an aesthetic symbol of a landscape experience. In light of this it can be said that appreciation is primarily a cognitive act rather than an emotional response.

Susanne Langer (1953) further developed Cassirer's semiotic theory. The main focus of Langer's argument was based on her disclosure of Dewey's experiential model. Langer was of the opinion that aesthetics was more than pleasure perceived by

biological needs. The pleasure obtained from the perception of art was built upon by the comprehension of the language of symbols.

The theories developed by Cassirer and Langer have come under scrutiny from numerous theorists, due to the fact that natural objects cannot be symbolic as they do not represent cognitive interpretations of the human experience. Langer developed her theories based on art in its purist sense believing 'art is the creation of forms symbolic of human feelings' (Langer 1953, p40). Consequently the theories developed on semiotics are said to only apply to pieces of art in their literal form.

However this line of reasoning does not reflect philosophies developed in landscape appreciation. The complexities of which manifest a fusion of philosophies based in biological and cultural associations. A solution to this problem is to combine the two theoretical foundations of Dewey's biological aesthetic experience and Langer's intuitive symbolic comprehension into a holistic derivative form.

### **2.4 A FRAMEWORK FOR LANDSCAPE AESTHETICS**

Aesthetics throughout history has commonly been referred to as the 'sensory pleasure gained from contemplating works of art in a

detached academic way' (Bell 1999, p63). The connection between landscape, art and nature is essentially related to scenic landscape paintings and wilderness. As a result, one of the common topics discussed in contemporary landscape aesthetic philosophy is the lack of attention to landscape as an aesthetic object.

A major problem in developing a theory of landscape aesthetics is the fact that philosophers of aesthetics have not given much attention to landscapes as aesthetic objects. In fact, many philosophers limit the scope of aesthetics to embrace only discrete objects.

(Bourassa 1988, p241)

The theory of landscape aesthetics is allied to the experience or interaction of humans and landscape. Values of scenic landscapes are assigned to modes of interaction. As a result it is important in this research to theorise the concepts of multi-modal interactions of landscape and values of depiction, following the discussions by Dewey (1958).

Designers have for centuries been asked to create attractive living environments which infuse social, personal pride. It goes without saying that attractive places promote better living conditions by way of psychological wellbeing. Places that contain vegetation and

nature are typically thought to be attractive and valued with positive emotions influencing social behaviour (Ulrich 1986; 1991). Hence, why is it that design, as a very broad and general profession has not regarded the theory of aesthetics with as much importance as it rightly deserves?

Primarily the problem arises from the limited research enquiring about relationships between the two differing philosophical topics. This can be associated to the lack of cross-discipline research of which aesthetics is undoubtedly in need.

As described above aesthetics has been developed as a discourse in philosophy, with foundations in art as well as nature. On the other hand it has also been associated to research in physiology and environmental psychology; the mechanisms of the eye, perception and the cognitive process of the human brain. What has been lacking to date, especially in the design profession is a framework which crosses boundaries seeking relationships between the schools of thought.

The relationship between visual language and aesthetic preference is paramount to 'good design'. Consequently a framework connecting visual language and aesthetics is rightly overdue. A pragmatic approach is needed which identifies different schools of

thought and evaluates relationships between them. To simplify and progress work by Kant, an understanding of the means of aesthetic response and the nature of aesthetic response will provide a foundation for a theory of landscape aesthetics. In this sense aesthetics as a philosophical discourse has progressed from the perception of an object to be inclusive of art and nature.

To develop this theory, aesthetics must expand to encompass both pragmatic and humanistic approaches to landscape appreciation. In this sense research needs to be an amalgamation of experiential responses and valuation of physical forms. Lynch, in his acclaimed book *A Theory of Good City Form* (1981), theorised a divide in cognitive thought, separating pragmatic functional form, and phenomenological aesthetics. Lynch discarded aesthetics as a component of his theory believing it to be too difficult to associate aesthetic values to other aspects of cognition. Understandably the dissociation of aesthetics and experience marked a common thread in philosophical discourse.

John Dewey (1859-1952) elaborated on the dissociation of aesthetics and experience in his text *Art as Experience* (1958). He was of the opinion that biological factors were associated to aesthetic response

I do not see any way of accounting for the multiplicity of experiences of this kind (something of the same quality being found in every spontaneous and uncoerced esthetic response), except on the basis that there are stirred into activity resonances of dispositions acquired in primitive relationships of the living being to its surroundings and irrecoverable in distinct or intellectual consciousness.

(Dewey 1958, p29)

Dewey elaborated on the notion of the experience and the relationship to aesthetic interpretations. To Dewey the aesthetic experience of a landscape or object was a complete, engaged and interactive whole. The interaction of the occupant and the landscape was perceived to equate to an instantaneous experience. Consequently the aesthetic experience is a product and dynamic process of the objective and subjective.

### **2.4.1 Experience and Aesthetics; A Question of Immersion and Time.**

The experience of landscape does not explicitly relate to the visual cognitive sensual response. It also pervades to a seamless succession of emotional cognitive thoughts established through

biological and cultural intuitive variables. In simple terms, experience occurs continuously in every human landscape interaction, and everyday processes.

(Ibid, p35)

From a philosophical point of view the connection between experience and aesthetics can be related to Kant's moments as discussed previously. Firstly, the notion that taste is the faculty of judging an object or a method of representing it by an entirely disinterested satisfaction or dissatisfaction has some synergy to the opinion that landscapes are not experienced in a way that is contrived and composed into an experience.

In more simple terms, the synergy between experience and aesthetics can be associated with the process of the experience. Distraction and dispersion of thoughts during a landscape encounter develop a complex array of direct and indirect cognitive and phenomenological thoughts:

what we observe and what we think, what we desire and what we get, are at odds with each other. We put our hands to the plow and turn back; we start and then we stop, not because the experience has reached the end for the sake of which it was initiated but because of extraneous interruptions or of inner lethargy.

Dewey further developed the argument that the aesthetic manifests from the thought process of experiences of landscapes.

As one part leads into another and as one part carries on what went before, each gains distinctness in itself. The enduring whole is diversified by successive phases that are emphases of its varied colors.

(Ibid, p36)

In other words, the connection between the experience and aesthetic evaluation is relative to the process of cognition, evidently relative to the time taken to process the landscape interaction.

To explain this in more detail, the aesthetic response associated to the experience of diverse landscapes is to some degree inherently implied in the landscape characters' form and function; however it is also inherent in the observer's biological makeup. Consequently the experience of a landscape is formerly evaluated for satisfaction and disinterest through all its parts. Typically these aesthetic experiences are instantaneous, based on phenomenological ideals. In the end the whole landscape is perceived with an intuitive



rational process made up of all the parts in what would be categorised as cognitive thought.

Dynamics affects the experience and emotional reflection on the landscape being viewed. This can be interpreted two ways, firstly in the literal sense of traversing through a physical landscape or secondly as the succession of frames through which the cognitive process of aesthetic experience occurs. For example, to form a common analogy of a roller coaster ride with peaks and troughs, the experience of some moments in life are reflected upon as being bipolar in emotional engagement. Accordingly the train of thought provoked by the interaction of the occupant and landscape can have varied fluctuating emotional feelings compiled to a sense of satisfaction or disinterest, or from a visual aspect beauty and ugly.

Not dissimilar to arguments established previously by philosophers Locke and Hume who were influential in discussing the concept of experience and aesthetics, the landscape aesthetic is concocted of two schools of thought; tangible and intangible qualities. The relationship between the physical properties which make up the visual scene cannot however be interrelated to a common phenomenological valued response. In simple terms, there is no common unified form or model which represents a universal aesthetic experience.

On a similar discussion, different forms of landscape representation can provide different emotional experiences. For example the art of movie directing is fundamentally to narrate and illustrate a story through graphical and audiological media. The combination of imagery, movement, audio and theatrics fabricate an emotional journey. Cinematography is at the central point of the effectiveness of the visual journey in its interpretation of the landscape sensual experience. Like all pieces of art the movie is a symbolic representation of a real life landscape experience or imaginative ideal.

Consequently the object of landscape needs not to be a direct interactive activity. Other forms of landscape representation can impart a sensual response with intensity comparable to a direct experience. Of note, the visual experience of static photos has been tested by numerous theorists to be sufficient as surrogates.

Hence surrogates as of real life experiences through visual media provide a symbolic representation of an experiential moment of time. The use of static photos provides an artefact of a visual experience in time, of which the aesthetic experience has been suggested to be symbolic of real life experience (Hull and Stewart, 1992; Coeterier, 1983; Stewart, Middleton *et al* 1984).

This creates a more complex theoretical framework than previously discussed. On the one hand the landscape is static in time, whereas the visual aesthetic experience is either dependent on the perceptual factors involved at the time of perception which is instantaneous, or other dynamic factors in cognitive thought e.g. cultural and historical intuitive knowledge. However the use of photo surrogates does eliminate the senses of sound, smell and taste, providing an assessment based solely on the visual.

Within this dissertation consideration to perceptual and non-perceptual factors will be considered and discussed. The visual effect of a wind farm development in a particular landscape may have social and cultural cognition relative to the landscape's familiarity to the occupant or symbolic preconceived ideas of wind turbines.

Relating intellectual, non-perceptual factors to the scene or object afterwards is a different matter and it is then that history, culture, experience and so on can help in further appreciation and understanding. This is the critical point where an understanding and appreciation of the origin and dynamics of patterns in the landscape enters the equation.

(Bell 1999, p67)

Once again the connection between theories of aesthetic experience and comprehension diverge into a melting pot of tangible and intangible qualities. It is the ability to combine these theories into a holistic assessment process which arguably is essential to the profession of Landscape Architecture and in particular visual impact assessment.

## 2.5 SUMMARY OF THE HISTORICAL PHILOSOPHY OF AESTHETICS

This chapter has briefly discussed the large body of aesthetics which is subject to philosophical discourse. Some of the greatest minds in history, such as Socrates, Kant, Burke and Dewey, have devoted the greater part of their lives to emancipate the solution to 'what is beauty?' and 'how is beauty appreciated?'

Aesthetics has been a discourse of philosophy for centuries primarily questioning the sense of pleasure and taste relative to art. However over the years the discussion has progressed to be inclusive of natural forms. Landscapes are but one form of enquiry which has many research scholars debating theoretical rationale as to how to value and appreciate aesthetic experiences, and whether they are inherent in the landscape or perceptive responses in the eyes of the beholder.

This Chapter has firstly reviewed the evolution of aesthetic philosophical enquiry from the Classical period, notably the work of Plato and Aristotle. This Classical period was formerly engrossed with the concept of aesthetic qualities inherent in objects. Art was the subject of enquiry as an object form.

The Medieval and Christian period followed and developed theories based on theology and the grounding work of Aristotle. The notion of beauty residing as a product of intangible qualities in an object was suggested. However the concept of beauty being a creation of god transcended from the belief that beauty resided in Gods' mind, illuminated through order and proportion in object forms. Consequently beauty was a product of the object form.

The British empiricists followed. The questioning of Locke and Hume explored the notion of human experiences. Locke was the first to discuss the divide in theoretical thinking of beauty having both objective and subjective qualities. However his former and most prevalent discussion was on the primary tangible qualities of aesthetic experience. Nevertheless, the insight into subjectivity laid foundations for Hume and Burke to establish rationale for subjective interpretations of beauty and landscape as an object form.

The Germanic influence succeeded the paradigm shift towards the subjective school of thought. Immanuel Kant was most notable for his philosophical questioning and rationale of the subjective school.

Landscape quality fulfils all of Kant's prerequisites of beauty-landscape quality is without function and there is no ideal or limit, no conceptual judgement is made :- the response is immediate and the pleasure is often shared, the pleasure is gained without desire or want for it, the pleasure is a universal and a common response, and the pleasure is public, not private.

(Lothian 2000, p23)

Following in the foot steps of the Kantian school of thought, but with some disregard, was Santayana, Dewey and Langer. Further insight into complications of deciphering the intangible qualities of aesthetic experience transpired. The common thread of questioning considered the relationship of human-landscape interactions and transactional experiences. Numerous variables were considered in the perception and cognition of whether the experience is direct or indirectly applied.

## 2.6 CONCLUSIONS

As previously stated in this Chapter, landscape aesthetics has been a multi-disciplinary topic incorporating discussions in physiology, psychology, philosophy, architecture and environmental science just to name a few. Consequently as described there are a diverse range of theories developed from empirical research which have been used as foundations for landscape aesthetic preference studies (Zube *et al* 1982).

More symbolic of what has occurred in Landscape Architecture research to date are empirical studies into objective measurements of human-landscape experiences.

Overwhelmingly the discourse of landscape aesthetics and preference studies is piecemeal in disposition. There is no uniform framework referring to philosophical comprehension of relativity and the perception of landscapes. Hence the theories that have been developed are incomprehensive, limiting the ability to develop methodologies for landscape visual assessment.

### **3 PSYCHOLOGY, AESTHETICS AND VISUAL PERCEPTION.**

#### **3.1 INTRODUCTION**

The main objective of this chapter is to firstly provide an overview of Gestalt psychology, elaborating on its relativity to the aesthetic discourse discussed in the previous chapter. The origins and laws of perception and tools for evaluating how we read visual objects will enlighten mechanisms for landscape visual assessment.

The second objective is to provide a synopsis of landscape preference research, discussing several examples which have influenced current practice of visual assessment. This will provide a foundation to develop an appropriate theoretical framework to assess the visual effects of wind farms.

#### **3.2 ORIGINS OF GESTALT**

Gestalt psychology developed in the 19<sup>th</sup> century, as a series of questions established to disprove the structuralist approach to perception, realising that perception is not the aggregate of piecemeal parts. In other words the response to landscape is not an evaluation of the aggregate of its constituent parts.

One of the limitations of the structuralist approach is that it can not explain the depth and shape of perception. In addition an evaluation of separable parts philosophically can not equate for changes in perception, relative to changes in the composition of the landscapes parts.

In the 1890s, Christian von Ehrenfels, identified that the qualitative form of objects are properties of a whole which do not reside in its constituent parts. For example a table is not valued for the lines and angles or materials and space that it occupies, but is perceived by a combination of all the characteristics. However, Gestaltqualität also states that the constituent form may also portray a similar perceived value in an alternative relationship. For example the curvaceous form of the table legs and slender table top may remain, however the materiality may differ in the construction. Christian von Ehrenfels argued that qualities of forms and sensations of experience should be included in perceived cognitive theories.

Friedrich Schumann (1890), Max Wertheimer (1880-1943) and Kurt Koffka (1886-1941), disclosed the elementalist approach. Friedrich Schumann (1890), explained that a square turned

through 45° produces a diamond, still a square but in a more fragile state of balance.

It was not until 1912 when Wertheimer published a paper on the phi phenomenon – (the projection of two slightly separated spots of light in succession on a screen to give the impression of a single spot) that the theoretical field of Gestalt psychology was born.

Wertheimer's definition of Gestalt is broad to encapsulate the organisation of the whole object.

A whole whose characteristics are determined, not by the characteristics of its individual elements, but by the internal nature of the whole.

(Katz, 1950, p91)

'Gestalt' means form or shape, translated from the Germanic meanings of:



- A shape or form as an attribute of things
- The meaning of concrete entity per se that has, or may have a shape as one of its characteristics.




(Kohler, 1947, p177-178)

The Gestalt psychologists examined the process of cognition and linked the process of perception to dynamic structural units rather than a linear transgression of thoughts. This process derived a form to be dependent totally on the contribution of each element to the whole. This theory was applied to various philosophical enquiries of social and intellectual questions.

### 3.2.1 Gestalt Laws of Perception

There are several laws which govern the formation and translation of an object into stimuli. These are:

<p><b>Proximity</b></p> <p>Items close to each other are perceived as whole. For example three sets of two lines are seen, not six separate lines.</p>	
<p><b>Similarity</b></p> <p>Similar items are perceived as units. The organisation of the elements within a structure will be perceived. For example the vertical columns of squares and diamonds are</p>	

seen, not horizontal rows of squares and diamonds.	
<b>Symmetry</b>	
Items that form symmetrical units are grouped together. For example three sets of brackets are seen not six lines.	
<b>Closure</b>	
Items are seen as complete units, even if interrupted by gaps. The triangle is completed as a whole, not three sets of unconnected lines.	
<b>Continuation</b>	
Items with fewest interruptions or fewest separate contours or edges are seen as units. A curved line and a straight line are seen, not a straight line and three semi circles.	

(Gleitman, 1981, 214-216; Hockberg, 1974, 183-186; Lindzey et al, 1988, 132-133; Lothian, 2000, p29)

The tools of Gestalt described above are based on the belief that the brain will project order. To achieve this, the brain organises elements into a group as to which an object form is perceived as a whole. Gestalt laws governing the perception of wholes are described as

- Wholes are primary and appear before their so called parts (Law of Primacy)
- To perceive and react to wholes is more natural, easier, and occurs earlier than perception of parts
- Wholes tend to be as complete, symmetrical, simple, and good as possible under prevailing conditions (Law of Pragnanz)
- Wholes tend to be governed by internal rather than external factors (Law of Autonomy)
- Parts derive their properties from their place or function in the whole.

(Wolman, 1973, p422)

As described by Wertheimer, to comprehend objects one must view wholes 'from above down' not as the sum of the elements 'from below up'.

The whole quality is not just one more added element. The qualities of the whole determine the characteristics of the parts: what a part has to be is determined by its relationship to the whole.

(Wertheimer, 1974, p142)

For this process of cognition to occur, the mind organises the parts into a comprehensive whole that is more than just the sum of its parts. In other terms the whole possesses its own inherent properties that differ to any of the parts.

The Gestalt theorists expand on this discussion to explain that perception is more than just a mechanical process, of which beauty is not purely in the eye of the beholder, but depends on the organisation of comprehension and stimulation.

Kohler (1947) considered the psychological process to be an active interpretation of stimulus. According to Arnheim (1970) Gestalt psychologists do not suggest that Gestalt occurs with

automatic impulse, instead it is relative to exposure of repeated experiences of observation and stimulus.

### 3.2.2 Good Gestalt

The Law of Pragnanz or otherwise called 'Good Gestalt' developed as a theory that proposes stronger patterns to dominate psychologically weaker patterns. It is the composition of elements in a balanced simplistic form which provides an image of a completed whole object which provokes stimulation. For example the dislocation of a line drawing on a piece of paper, psychologically creates disequilibrium. The brain seeks ways of simplifying this and completing the object, for this reason a dotted line is read as a defining edge. Consequently, good gestalt allows predictions of missing parts in an object.

The overlooking of little gaps and bumps in otherwise coherent and simple shapes corresponds to important functions within the general Gestalt tendency towards a pregnant, coherent, and simple Gestalt. If we....listen to a jumble of nonsensical syllables we will unfailingly project a rhythmical and melodious pattern into them. When we are asked to repeat them we will reproduce them in a better Gestalt. The gap-filling and erasing of bumps recurs: syllables obstructing the easy flow of



rhythm are apt to be suppressed; missing feet are readily interpolated to make up the complete rhythm.

(Ehrenzweig, 1953, p23)

In other terms, all recollected landscapes will be organised as a completed vision, typically more stimulating than the experience itself; factors of aesthetic appreciation are emphasised and those of distraction are erased. Good Gestalt will prevail when all pretences and expectations are disconnected from the perception of an object. The perception of an object will ultimately convey its simplistic form.

### 3.2.3 Visual Segregation

Visual segregation is defined as the separation of an object from its contextual background for example a wind turbine from the cloudy sky. This phenomenon is not entirely qualified by visual senses, but is also relative to oral senses for example when a particular conversation is heard over competing background conversations. In other words it is the ability of a human to block out information and focus on a particular source.

Research into the visual perception of objects has investigated the concepts of figure and ground. The perception of reversible

figures (or interchangeable patterns) has provided an insight to the psychology of how people perceive visual mediums.

Formerly psychology asserted that only one figure can be seen and the other goes unnoticed, however Gestalt implies that only one figure can be seen at a time or an object can have only one function at a given time. Further investigations of figure ground concepts, establishes important principles of visual perception that shape belongs to the figure, not to the ground.

Koffka (1935) established a series of principles upon which figure ground concepts of visual perception manifest.

- They always involve, in however low a degree, a third dimension of space
- The ground serves as a framework in which the figure is suspended and thereby determines the figure
- The horizontal and the vertical exert an actual influence upon the processes of organisation by making figural organisation easier
- The smaller unit will, *ceteris paribus*, become the figure and the larger, the ground

- If two areas are so segregated that one encloses the other, the enclosing one will be the ground, the enclosed one the figure
- Those parts having the greater internal articulation will, *ceteris paribus*, become figures and
- The figure-ground distribution will, *ceteris paribus*, be such that the resulting shapes are as simple as possible; symmetrical figures are simpler than asymmetrical figures.

(Koffka, 1935, p190-192)

#### 3.2.4 Gestalt Psychology and Aesthetics

The relationship between aesthetics and Gestalt is believed to be directly proportionate according to Ehrenzweig (1953, p23), 'A good Gestalt is always an aesthetically pleasing Gestalt.'

Koffka (1935) also discussed the relationship between aesthetics and Gestalt. Using van Gogh as an example Koffka established an argument based on 'class schemas' which were defined as classes or trends of associations to objects being perceived. Van Gogh's paintings were not appreciated in the era of creation, but have become priceless works due to the development of comparative styles. Subsequently, the piece of art is not valued

on its own merits, but rather because it does or does not fit into prevailing schemas.

According to Ehrenzweig (1953), landscapes are valued and assessed in not dissimilar terms. Aesthetics and Gestalt are both relative to public taste. In the past some landscape visual compositions have not been appreciated for their unique qualities, in fact have promoted disinterest. However as time progresses and promotional material is used to advertise their unique qualities, they have been reassessed to be of significant importance as iconic (in some cases spiritual) scenes of deeper appreciation. For example Australia's interest in the arid inland landscapes of the Northern Territory has featured more prominently as places of high aesthetic quality.

The importance of Gestalt theory to landscape perception is not disputed according to psychology and aesthetics. However the literature on landscape analysis and preference studies has focused primarily on the parts with little emphasis on the whole.

A landscape is generally considered as an accumulation of its subsequent parts which may well reflect trees, hills and water bodies. The Gestalt principle of holism redefines this to suggest that the parts are a reflection of the whole. For example the

construction of a house comprises of walls, doors, windows and roof, as to which an architect will design with reference to the image and orientation of the whole house. This principle applies to man made structures of different functions. The question can be asked 'Does this principle apply to landscapes in which nature takes its own course?'

The physical qualities of a landscape provide characteristics which differentiate it from another. For example the dry arid Eucalyptus mallee scrub of the Australian outback has a much different visual aspect than the Daintree rain forest due to vegetation type and topographic variety. In other words, the locality and natural eco systems fabricate a visual scene which promotes a sense of place.

Introducing new developments which disregard the current composition of the whole, will disturb the perceived value of the landscape.

Change within a landscape comprises the introduction of a part that is contrary to the character of the whole, it may differ on account of scale, colour, texture, form or any combination of these and other factors. Drawing on

the Pragnanz principle, anomalies in the whole disturb Pragnanz and are disliked in consequence.

(Lothian 2000, p37)

This may help explain the initial objection of wind turbines and other infrastructural elements introduced into the landscape. However, there have been some iconic examples of landscapes which have been favourably influenced by the introduction of radical figurative elements. For example, the Eiffel Tower was initially loathed only to become an integral component of the majority of scenic representations of the Paris skyline. In event the object ceases to be regarded as a part of the whole and creates its own Gestalt.

The objective of sensitive integration design is to maintain the natural characteristics and high aesthetic quality of the landscape. However, in the process of design the whole becomes independent, as the inclusion of several parts will separate the comprehension of the whole. For example the implementation of wind turbines into a pastoral landscape may alter the visual quality of the scene by manipulating the whole such that it is inconceivable.

On the other hand the relationship of landscape aesthetics and Gestalt can be referred to the association of the aesthetic principles of unity and diversity. Unity can be directly related to holism which depicts the prevailing character of the landscape. Diversity relates to the parts of the landscape composition which provide visual interest. Consequently aesthetic quality is dependent on an overall unifying character that contains sufficient variety to give it visual interest.

With respect to the Pragnanz theory there are some principles of form which apply to qualitative landscape perception analysis.

These are:

- Comparative sharpness of outline
- Large geometric forms
- Conflict or juxtaposition between superimposed forms
- Symmetrical figures.

Landscapes with qualities representative of the above criteria will in general be preferred over those that do not. Whereas landscapes which present asymmetrical features in a complex incoherent form, will typically relate to a landscape of low aesthetic quality.

The concept of figure ground also plays an important role in deriving a relationship between gestalt and landscape aesthetics. Principles derived by Koffka (1935, p190-92), still apply to landscape as to which they were intended for the general observation of figurative objects.

- Visual segregation of figure and ground reinforces the depth of landscapes, thereby creating a greater sense of the spatial dimension and adding interest to an otherwise flat landscape.
- The ground services as a framework in which the figure is suspended and thereby determines the figure; in a painting the main feature is placed to advantage against the ground.
- The horizontal and the vertical exert an actual influence upon the processes of organisation by making figural organisation easier; in landscape photography a vertical element such as a tree is often set in the foreground to provide entry and scale in the scene and assist in its understanding.
- The properties of figures being the smaller and the enclosed relate to the experience of figures in landscapes.

Figure and ground play an important part in perception of landscape quality. The relationship of the figure to the ground derives the character of the landscape. For example, a tree on the top of a ridge line with the silhouette of the sun in the background will have a much different visual presentation than if the tree was in the valley below. Understandably the ground provides a foundation upon which the whole figurative image is formed. Hence the composition of figure/ ground relates to the comprehension of the scene, by means of scale, depth and contrast of forms.

Hence it can be derived that the 'qualities of a whole' can relate to the aesthetic quality and character of a landscape. The presence of Gestalts in landscape, correlate to visual quality and to the quality of the whole influencing visual perception.

### **3.3 Visual Perception**

The previous section of this chapter elaborated on the cognition of perception, and the relationship between aesthetic discourses. This section will discuss the history of visual perception and seek to explain the relationship between psychology and physiology and the means of visual sensory.

The link of psychology and physiology is commonly referred to as psychophysics, a theoretical approach which has been used in contemporary visual assessment studies. Psychology is a science based on objective empirical evaluations of the human being, meaning the process of evaluation is justified with derived findings.

#### **3.3.1 History of Visual Perception**

The history of theoretical visual perception dates back to Plato and Aristotle who argued diverse theories of eye projection and emanation. Plato believed that vision resulted from the eye emanating to the object as to which the sensation of the object was conveyed to the mind. Conversely, Aristotelian theory believed that vision was resultant of an emanation from the object being transmitted to the eye.

Various scholars established theorems based on the foundations of Aristotle. Euclid established a geometric and optical evaluation of form perception in relation to the visual angle and retinal size. Finally, Kepler (1571-1630) disproved Plato's theory and redefined the discussion on optics and retinal imagery. Descartes (1596-1650) used practical apparatus to examine the projection of light onto the retina of an ox's eye. Descartes believed that there was further analysis required to elaborate on

the connection between the cognition of the light projection on the retina and the brain.

The British Empiricists, argued a different case, Berkeley (1709) providing an insightful discussion on two separate forms of visual stimuli; mediate stimuli which includes depth perception and is an indirect transfer of information, and immediate or innate stimuli such as width or colour which are coherent due to biological and cultural references.

During the 1800's the knowledge of the brain and physiology evolved, as to which theories on visual perception were able to progress. Johannes Muller (1801-1858) developed a theory based on sensations producing signals that encode the shape and stimuli of an object from the retina to the brain. This transferred the debate from phenomenological discussion to scientific examinations. The principles upon which Muller constructed his argument are:

- Regardless of how a sense-receptor is activated- whether by light, sound, chemical substances, mechanical pressures or electrical stimuli- it will yield, if an experience results, a given type of 'secondary' quality.
- All that we are directly aware of in sensation is the state of the sensory nerve- the neurophysiological effect.

- Although sensations are subjective in that they are received by the senses, they seem objective.

(O'Neill, 1977, p5)

The last principle has connotations to the subjectivist/ objectivist debate and whether the landscape is perceived for inherent qualities or in the eyes of the beholder.

Research in the 19<sup>th</sup> century took a slight divergence and sought to explain the experiential qualities of landscape and its effect on visual perceptions. Hermann von Helmholtz undertook extensive research into sensory perception and what was termed 'unconscious inference'. It was Helmholtz belief that past experiences and observations were stimulus for coherence (Rock, 1984).

Later in the 19<sup>th</sup> century Fechner (1860) developed psychophysical methods which were employed to research empirical processes of perception. The empiricists assessed the point of stimulation with relation to the physical image and its projection on the retina, and then evaluated these in accordance with other sources of information acquired in perceptual experiences.

Psychophysics of space perception is based on seeking correlations between the information perceived through light projection on the retina and figurative compositions of the environment. The Gestalt approach to this implies that the information transferred will be absorbed holistically as a direct transaction.

In the early 20<sup>th</sup> century in the United States of America, J.B. Watson developed the behaviourist approach which differed in respect to the analysis of observable behaviour response rather than internal cognitive stimuli.

During this period the European Gestalt psychologists developed the phenomenological school of thought. This theory considered the perceptual experience to be innate in the occupant as a subliminal biological manifestation of genetics and cultural intuition.

In the latter portions of the 20<sup>th</sup> century, the leading psychological school of thought has been the 'Information Processing Theory'. This model reconsiders the process of information dissemination, whereby humans receive information about the environment primarily through visual stimuli which alters their behaviour in accordance with the comprehension of the information. This

theory arose from an understanding that the perception of a landscape or object is not complete upon receipt of the visual senses, but is also influenced by ongoing process of cognition; consequently it is a combination of retinal comprehension and memory.

#### **3.3.2 The Physiology of Vision and Image Representation**

Vision or retinal physiology is the transfer of light to the lens and cones of the retina of the human eye.

The centre of the retina, called the fovea is used for a high detail search on the area of fixation, while the periphery of the retina is used during selection of the next fixation point.

(Watson, *et al*, 1997, p60)

Vision is a dynamic process composed of foveal and peripheral modes. Even static images are experienced and deciphered through dynamic eye movements translating 'projected patterns of light on the rods and cones of the retina' (Danahy 2001, p126).

The movement of the eye is not however simultaneous to movements of the head which would provide 360° view of the

landscape. The coordination of the eye and head movements has been studied to decipher the process of image translation and field of view. One particular study by Barnes (1979) found that

- The eye can accelerate to reach a target fixation point much more quickly than the head
- Fixation will often occur without head motion when the target is offset from the current line of sight by 30 degrees of visual angle or less, with the likelihood of head motion increasing as offset angle increases.
- Head and eye motion begin almost simultaneously when the target fixation is offset by at least 15 degrees of visual angle
- The eye reaches the target fixation point before the head does, as the head reaches the target, the eye reverses direction and moves back towards a centred position relative to the head.
- Even after gaze is stable on a new fixation, the eye is still not fully centred relative to the head: it can be offset by as much as 15 degrees.

Foveal sensing is a cognitive construct of image generation, formed by dynamic scanning and assemblage of image frames

translated into a simulated model of the landscape. The concern for landscape assessment is that a landscape cannot be holistically assessed within its broader context if foveal vision is the solitary cognition.

The complex interconnected spaces and multi-layered visually porous edges of most landscapes require the combination of peripheral vision, movement and motion parallax and binocular vision to fully decipher the spatial qualities of a landscape.

(Danahy 2001, p126)

Peripheral vision provides a direct sensing of the complete scene, activating different emotive responses as it aids to capture motion parallax.

The peripheral vision system provides the cerebellum with information used to judge where the body is in space, where it is going, and at what relative speed and in what direction.

(Danahy 2001, p127)



Hence it is a valuable modal dimension of visual perception especially for landscape assessment, infiltrating a need to assess spatial cognition in representational formats.

The field of view of the human eye is an important consideration in developing any visual assessment methodology. There have been several different sources of literature which have debated the angles of view varying from 200°-120° horizontal to 50°-90° vertical. This is a measurement of binocular vision as to which scale and depth of field can be comprehended and peripheral vision.

For this dissertation the vertical field of view will be defined as 50° (Panero, 1979). However it is only within a 2-4° range that fixation of the highest resolution occurs. This region of fixation is the visual field of the fovea. The remaining receptors are called the ambient visual system and attract perceptions of movement and other spatial information. Understandably this will be of relevance to wind farm assessment, as the movement of the blades attracts ambient reception.

The horizontal field of view is commonly referred to in visual assessment dialogue. This field of view includes the peripheral (monocular) vision, which is described as 40° to each eye; within

this zone colour and depth of field are not registered. For the purposes of this dissertation the angle of peripheral vision has been subtracted from the field of view producing a binocular, 'active field of view' of 120°.

The process of image representation and cognition to the brain is one instantaneous stimulus incorporating short term memory and long term memory transaction. In summary, the image is transferred to the brain from the retina and integrated with successive images of previous experiences in a transgression of comparative laws of Gestalt figure/ ground and pattern comprehension.

Short term memory is likely to involve a construction of representative forms of quasi rehearsed information. This information is not intended to be maintained for long term use, it may only last a few seconds.

Long term memory is information stored for decades or more. The brain is able to store billions of pieces of information retrievable within rapid time frame.

The mechanism of short term and long term memory transfer is not entirely understood with varieties of cognition for distinct

visual experiences. Consequently the process is not linear taking on a spontaneous, dynamic model.

The process of landscape spatial cognition is relative to several visual cues which emancipate the ability of humans to calibrate space with a feeling of self awareness of distance and orientation. Some of these cues are;

- Detail perspective: the loss of visible detail of distant objects because of limitations of visual acuity and to the scattering of light by the atmosphere is known as detail perspective. Detail perspective and aerial perspective were cues used by Leonardo da Vinci and other painters of the Renaissance to give the impression of depth in paintings  
(Rock, 1984, p78)
- Texture gradient: The image of a large number of regular textures receding into the distance creates a gradient of image size  
(Bruce & Green, 1990, p156)
- Shadows: On the sides of hills and valleys provide an impression of depth; attached shadows reflect the depth of within an object itself while cast shadows are those that fall on surrounding surfaces. Attached shadows give a strong sense of depth, while cast shadows are

somewhat divorced from the object itself and provide little or no cue to depth.

(Rock, 1984, p75)

- Motion perspective: This is a kinetic cue and involves distant objects appearing to be virtually stationary when one moves past them, while nearby objects move swiftly past. "Objects nearby seem to be moving away from you at a velocity that increases the closer the objects are."  
(Kaufman, 1979, p199)
- Kinetic cues: Movement provides information about depth and distance that is not evident from a single static view. People with monocular vision estimate depth by movement.
- Familiarity of objects: Familiar objects such as a person, a car, electricity pole or a tree can provide a yardstick against which the distance and size of other nearby objects can be estimated.  
(Graham 1965, p504)

Gibson (1979) argued that these cues were inconceivable unless there is a continuous background upon which to refer the objects. This has synergies to the Gestalt concepts of figure/ground.

Commonly objects are seen against a background, with the edges contrasting in light intensity. The segregation of objects by fields of differing light makes a scene appear to have depth. The synthesis of form is created by the concept of figure/ ground and display of light projection to the retina.

### 3.3.3 Environmental Psychology

Several theories have been debated on the concepts of visual perception and the process of human environmental cognition.

Gibson (1979) developed the Ecological theory upon which the prior experience of similar landscape permits coherence. Gibson believed that the use of elements in the landscape rather than their form, colour, texture provided stimulus for aesthetic appreciation. Hence the functional characteristics of an object are what provide visual cues and ultimately values. This theory was discarded as it failed to interrogate the subliminal affordance of human/ environment interactions.

Daniel Berlyne focussed his research on the interaction of humans and the environment. The theory developed by Berlyne was based on aesthetic preferences being relative to the complexity of stimuli. The complexity of a scene is owed to the diversity of the composition of elements. Berlyne believed that as

the complexity increases so to does the aesthetic quality. However there is believed to be a saturation point as too which any more diversity to the landscape scene will have a negative effect on the perceived aesthetic quality.

The findings of various research experiments into the relationship of complexity and aesthetic quality for urban landscapes do not correspond to the linear verification in urban settings.

(Wohlwill, 1976, p46)

The Kaplan's developed a theory based on information processing. This theory involves humans extracting information from the environment. The information is typically categorised into forms of cognition; coherence and exploration which help in understanding the environment. The Kaplans state that humans aspire to understand and take part in their environment (Kaplan, Kaplan & Brown, 1989).

The Kaplan's propose that long term survival of the human species was dependent upon development of cognitive information processing skills which in turn led to preferences for landscapes that made sense to the observer. In other words, landscapes were preferred that

could be comprehended, where information could be obtained relatively easily and in a non threatening manner that provided opportunity for involvement, and that conveyed the prospect of additional information. According to this framework, landscapes that are preferred are coherent, legible, complex and mysterious. (Zube, 1984, p106)

Various theories and models have evolved based on these and complementary psychological constructs. The models which have been prevalent in the literature and landscape preference studies are

- Habitat theory (Orians)
- Prospect-refuge theory (Appleton)
- Affective theory- psychoevolutionary approach (Ulrich)
- Information processing theory – a functionalist evolutionary approach (Kaplan & Kaplan)
- Tripartite paradigm of aesthetics (Bourassa)
- Pyramid of influences (Dearden)

### 3.4 LANDSCAPE AESTHETIC THEORY

Aesthetic theory in landscape architecture has predominantly followed research in the social sciences, geography and psychological schools of thought. There has been limited

research undertaken by landscape architects since the late 1970s.

Theories in landscape aesthetics were developed from the discipline of visual assessment. During the 1970's techniques were developed to assess the relationship between characteristics of landscapes and aesthetic appreciation. Visual Management Systems (VMS) developed in the United States of America and United Kingdom, were specifically introduced to assess landscape visual effects of forestry.

Aesthetic theories developed by Landscape Architects have predominantly been influenced by how the term landscape is defined. In the majority of cases Landscape is that part of the environment that is occupied by human habitat understood through our perceptions. Therefore the relationship and engagement between landscape and aesthetics is direct and constant. The direct link

between the patterns and processes that make up the land, our perceptions of them and our constant aesthetic engagement that converts the physical dimension of land into the perceptual one of landscape.

(Bell 1999, p67)

Simon Bell has been influential in discussing the discourse of aesthetics and landscape architecture in his book *Landscape: Pattern, Perception and Process* (1999). Elaborating on the philosophical work of Dewey and successors, Bell explains aesthetic experience through two schools of thought; the 'integrationists' and the 'perceptual'.

In much the same way as the experiential school of thought, Bell has classified aesthetics to different modes of human- landscape interactivity. The two categories of which philosophies manifest are from either nature of aesthetic response or the means of aesthetic response. These two different approaches of enquiry offer solutions to the two opposing questions of, what we appreciate in the landscape and why? Consequently, contrasting philosophies can be related to each other through either experiential dialogue or cognitive assessments of valued judgements.

The integrationist school of thought relates to the concept of aesthetic experience being interdependent of cultural, historical and social variables. To elaborate on the concept of interdependent variables, opens up the field of enquiry to

aspects of anthropology, geology, archaeology as well as psychology and physiology to name a few.

In the preceding Chapter the discussion on aesthetic experience of landscapes is reliant on a combination of perception in its purist sense and the valuation of cognitive factors such as cultural layers. The relationship of these two approaches to landscape visual assessment has not been researched with critical rigour to date. The theory of assessment has been some what piecemeal.

Theories and research have developed concepts for integrated landscape appraisal according to interactions of humans and landscapes. Community consultation is but one way of assessing these interactions and is an integral component of current landscape planning assessments. Commonly the community is engaged in the first instance to discuss local significance of a particular landscape region, and secondly to review development and provide constructive comments. This also provides a stage for promoting community spirit and ownership of the development (Sanoff 2000; Selle 2005). Furthermore, local knowledge of particular landscape regions is critical to the success of the project.

The concept of *genius loci* or sense of place as it is commonly referred to now, is also established by the integrationists argument. The knowledge and comprehension associated to the interaction of social aspects and sensual elements of a particular landscape scene provides a powerful addition to the instantaneous pleasure ascertained by engaging with the landscape. The evaluation of the landscape scene is then not only appreciated for its initial pleasure but it also possesses a valued meaning.

Accordingly a case can be made to suggest that there are certain symbolic forms that possess universal aesthetic qualities. Conversely the difficulty of interpreting these qualities is founded in the discourse of semiotics and psychology.

To progress this discussion an understanding of the landscape as a simultaneous cognitive assessment can be directed upon the precedent pleasures obtained from experiencing landscapes of a similar pattern.

We frequently tend to recognize familiar patterns, and possibly prefer certain landscapes, because of our

prejudices. However new scenes of which we have no prior knowledge or cultural reference are also stimulating and contain an aesthetic dimension.

(Bell 1999, p68)

This statement lays claim to disregard the integrationists approach to aesthetic cognition and promote aesthetics as a solitary concept of perception.

The second school of thought is based purely on perception and is not dependent on any intuitive cultural or historical values. The emphasis of the 'perceptual' view is the instantaneous nature of pleasure or disinterest associated to a particular scene. This initial value is thought to be the overriding aesthetic experience.

We, therefore, gain an immediate aesthetic experience when we perceive the landscape; this deepens when we have knowledge of its origins and can appreciate it for its natural or cultural characteristics.

(Bell 1999, p70)

The development of a unifying theory will need to predict landscape preferences for all types of demographic respondents (gender, socio economic, culture, familiarity) and all types of

landscape contexts (mountain ranges, rain forests, coastal environments). A unifying theoretical paradigm would provide justified political support for landscape managers to conserve and implement sensitive design principles to landscape interventions.

### 3.4.1 Habitat Theory

The development of Habitat Theory set motion for several research questions into savanna landscapes. According to Orians the:

Savanna- type environments with scattered trees and copses in a matrix of grassland should be highly preferred environments for people and should evoke strong positive emotions.

(Orians 1986, p10)

Orians provided further analysis of savanna type landscapes, questioning the effect of the presence of trees. Tree measurements were made and compared to preferences of photographs. The forms and proportions of trees were assessed against the perceived attractiveness. This was later expanded into research studies to test Appleton's prospect and refuge theory making use of landscape paintings developed by

Humphrey Repton's Red Books. The study conducted by Heerwagen & Orians (1992) used images produced by Repton to show the effects of before and after landscape designs.

Prospect- refuge is arguably the most cited theory in landscape perception literature. Appleton a geographer at the University of Hull, derived his theory based on habitat and information processing and the philosophy of John Dewey. The inspiration for landscape perception is established from the interaction of humans and landscape. It was thought that beauty lay neither inherently in the object nor in the eye of the beholder, but rather in the relationship between the occupant and the landscape.

Habitat theory postulates that aesthetic pleasure in landscape derives from the observer experiencing an environment favourable to the satisfaction of his biological needs. Prospect-refuge theory postulates that, because the ability to see without being seen is an intermediate step in the satisfaction of many of those needs, the capacity of an environment to ensure the achievement of this becomes a more immediate source of aesthetic satisfaction.

(Appleton, 1975, p73)

Qualitative characteristics such as prospect and refuge used in human survival techniques (Appleton, 1975), have been accepted in principle through analytical analysis. Direct human landscape interactions which possess these characteristics are more than frequently of a high aesthetic quality providing some form of validity to this argument. Following the concept developed by Dewey, Appleton avoids the idea of beauty and instead of asking what beauty in landscape is, proposes to ask what is the source of aesthetic experiences which we appreciate and define as beauty? Appleton in *The Experience of Landscape*, (1975) allocates his theory of aesthetics to one posing question of intent:

“What is the source of that pleasure which we derive from the contemplation of landscape?” we are perfectly free to postulate that it may be different from the source of pleasure to be derived from any other experience. It raises other philosophical questions of course, such as “What is pleasure?”, but it does not impose the same limitations as that which for centuries so shackled the aestheticians as to render them impotent to give a generally acceptable answer to the simple questions “What do we enjoy about landscape and why?”

(Appleton 1975, p15)

Appleton’s *Prospect-Refuge* theory is thought to be biological in disposition. The framework for the theory is based on synergies between human and animal behaviour. Appleton believes that the location of biological needs within a particular landscape scene, will elicit a sense of affection. To further develop this argument it can be explained by the sense of satisfaction obtained from engaging in a landscape which has not been experienced before. The characteristic of prospect and sense of refuge will accommodate an aesthetic experience of delight or displeasure regardless of previous knowledge of the landscape. Subsequently, without any prior knowledge or attachment to place, the landscape scene provokes an instantaneous aesthetic response.

Bell (1999; 2004) describes the current opinion on this debate by reviewing the writing of various contemporary philosophers. Cheryl Foster (1991) has been a primary reference in Bell’s posing arguments. Foster’s work has primarily been influential in critiquing and appraising the work of Kant and more notably Schopenhauer. Bell has concluded that:

the experience, although subsequently informed and affected by non-perceptual factors is essentially a



perceptual one. This distinction turns out to be an important one, because it gives aesthetics the right to be treated seriously as a major factor in our lives.

(Bell 1999, p94)

On the contrary the degree of intuitive knowledge needed to associate the landscape form to a sense of security and aesthetic pleasure is questionable. This point is raised due to the fact that surrogates of direct landscape interaction, namely photos, equivocally represent the visual experience (Hull, 1992; Stewart, 1984; Coeterier, 1983). Hence does the effect of prior knowledge of landscape scenes influence the perception of the direct experience? This question holds many permutations relative to landscape transactions and depictions.

Further to this discussion, if the landscape scene has not been experienced before the photo is viewed then there must be some form of semiotic cognition that influences the perception of landscape surrogates such as photos. Coincidentally, the comprehension of common forms in the landscape scene must relate to the visual experience and composition of the visual scene during human – landscape encounters.

Having said this, two important questions have been raised. Firstly, the validity of photos as surrogates for direct landscape experiential transactions is not verified by the theory of biological perception. The assessment of photos relies on previous engagements with landscapes. Either that or the compositions of forms in the landscape are symbolic of a previous experience, giving precedents to a holistic sensual response?

Secondly, the assessment of aesthetic experience relies on all four sensual responses of sight, smell, sound and taste. It is questionable whether visual senses can equivocally represent the experience or these combined provide a complete pleasurable or dislike for a particular landscape? However it has been stated through numerous studies that the visual sense is the most effective in comprehending landscape and experiencing aesthetics (Bell 2004).

During the past 20 years numerous studies have been conducted to examine the validity of Appleton's theory. Abello, Bernaldez & Galiano found some corresponding findings to endorse habitat theory. On the other hand, a study conducted by Clamp and Power (1982) disqualified the prospect refuge theory having found no convincing results to reassure its validity.

### 3.4.2 Affective Theory

Affective theory is an alternative concept which is also concerned with human/ landscape interrelationships. Ulrich (1983), the founding academic, argued that landscapes produce in their viewers emotional states of well being, anxiety, happiness which can be detected by psychological and neurophysiological measures. The key to his theoretical paradigm is that emotional reaction to landscape occurs prior to cognitive thought, meaning aesthetic response is a psychological processing irrespective of comprehension. This research was based on like- dislike dichotomies, similar to subsequent studies which have used scales of beautiful/ ugly or scenic quality. In contrast to the Kaplan's information processing theory Ulrich proposed that:

immediate, unconsciously triggered and initiated emotional responses- not controlled cognitive responses- play a central role in the initial level of responding to nature, and have major influences on attention, subsequent conscious processing, physiological responding and behaviour.

(Ulrich et al, 1991, p207-8)

Ulrich used physiological testing tools such as alpha waves, heart rates, skin conductance and muscle tension to examine the emotive response of various environments. The findings of

various research programs which have enquired Ulrich's hypothesis have been quite compelling in support. However, understandably this realm of research is labour intensive and costly to conduct.

### 3.4.3 Information Processing Theory

Stephen and Rachel Kaplan have been influential in developing justification for a bio- evolutionary perception of landscape aesthetics. The assumption that humans prefer certain landscape patterns holds true for this theoretical framework.

The ability of the human body to visualise and comprehend large amounts of environmental information is compelling on whether the experience of the landscape scene stimulates a high degree of qualitative emotion.

Consequently, adaptive behaviour requires selective attention to certain components of the environment that in turn strongly influence our perception of the environment. In effect, the complex behaviour of organisms would be impossible in the absence of "filters" that emphasise, de-emphasise or eliminate

unnecessary information emanating from the environment (Bitar 2004, p31).

The theories developed by the Kaplan's have been elegantly summarised by Hassan Bitar's thesis which discusses the effect of "filters" on the comprehension of the landscape. His critique of previous empirical research studies elaborates on the biological *Information Processing Theory* developed by the Kaplan's. (Kaplan, S. and R. 1982, 1989, Kaplan, S. 1987, Kaplan, S & R. and Brown, 1989)

The Kaplan's model inspired by Dewey's school of thought, contemplates the relationship of human- landscape experiences. The model proposes that during environment encounters, humans gather information which is then processed and incorporated into mental cognitive maps. These maps stimulate preferential bias for particular landscape scenes for present and future interpretations of landscape experiences (Kaplan & Kaplan, 1989). Consequently, the theory of information processing involves the integration of perception and cognitive thought.

The Kaplan's have been extremely active in pursuing this theory of landscape perception and cognition. Through rigorous empirical studies they have concluded that several integral variables are required for a landscape scene to be appreciated. Firstly the landscape must be legible and coherent to the occupant, or viewer. The elements of the landscape must be composed in unison to illustrate a scene which can be readily comprehensible. This obviously has ramifications on other aspects of the landscape composition in terms of scale and proportion, which have been noted previously as factors which determine sublime landscape experiences. The Kaplan's have empirically certified a series of experiential common visual cues typical of highly valued landscapes. These are complexity, legibility and a sense of mystery and coherence (Kaplan & Kaplan, 1982).

The following is a brief discussion on the attributes of complexity, coherence, legibility and mystery:

- Complexity is defined as the diversity and variety of visual interest in a scene. Hence, landscapes which possess topographical variation and interchangeable foreground, middle ground and background, will intrigue the occupant.

- Coherence refers to the balance and unity within which the composition of elements in a landscape appropriately fit together.
- Legibility is considered to be the ease with which the scene can be interpreted for landscape processes and directional composition. Therefore the legibility of a landscape will enable the occupant to orientate themselves in the scene and stimulate a sense of comfort.
- Mystery refers to the concept of visual intrigue. The provision of undiscovered portions of the landscape scene, excite the occupant to want to know what is around the next corner. Hence the curiosity of gaining extra foresight into the landscape process empowers the occupant.

(Kaplan & Kaplan, 1982)

The determining factor in realising these attributes is the need to be able to implicitly envisage oneself in the landscape. Kaplan and Kaplan (1982) have explicitly highlighted the fact that the aesthetic appreciation of the landscape is determined by the cognitive assimilation of the occupant in the landscape scene.

A scene or landscape setting is not merely something to perceive, but something to enter into. Implicitly at least,

one must imagine oneself in the situation. One must consider how one would function if one were to enter into the space and move around in it. Thus, the longer-range, or more future, aspect of preference depends upon the analysis of the inferred three-dimensional space. The more immediate aspect of preference seems to involve the two-dimensional qualities of the scene.

(Kaplan & Kaplan 1982, p82)

To expand on this discussion, the notion of landscape familiarity is understood to be critical to the process of landscape appraisal. Consequently the theory of cultural symbology and the work of Langer (1953) are reflected upon within this theoretical framework.

Familiarity refers to the previous experience of a particular landscape or landscapes which exhibit similar patterns and processes. Prior experience elicits coherence, and legibility of the landscape scene. Potentially this will provide confidence to the viewer of the landscape, enabling them to use the cognitive maps that have been previously made as mental notes. Accordingly the cognitive maps provide legibility and order to the landscape. This line of reasoning also implies that

representations of direct landscape interactions e.g. photograph surrogates will induce cognitive maps of past experiences.

Therefore the appreciation of beauty in photographic landscape scenes will refer to past experiences in landscapes which possess similar patterns.

It is a straight forward connection from the notion that we are pattern-seeking organisms with a highly developed perceptual mechanism, to the idea that part of our natural response to what we perceive is aesthetic. If we are able, through our perception, to comprehend strong patterns in the landscape that are meaningful to us, then we may well find them more aesthetically attractive.

(Bell 2001, p207)

Primarily, landscape patterns and process which are familiar contribute to landscape comprehension and most notably preferential as the scene is identifiable and easily grasped. 'Conversely, a scene that is ambiguous and resists identification, or which places very high processing demands on the observer, should be less preferred' (Ulrich 1977, p280).

#### 3.4.4 Tripartite Paradigm of Aesthetics

Stephen Bourassa has been instrumental in addressing the debate on biological, cultural and personal aspects of landscape perception. The following statement summarises his pursuit of research

If both biology and culture serve as distinct bases for aesthetic behaviour, then it is necessary to go beyond both biological and cultural determinism toward a theory which would fully embrace both biological and cultural factors. It is also necessary to consider the role of personal idiosyncrasies and particularly personal creativity.

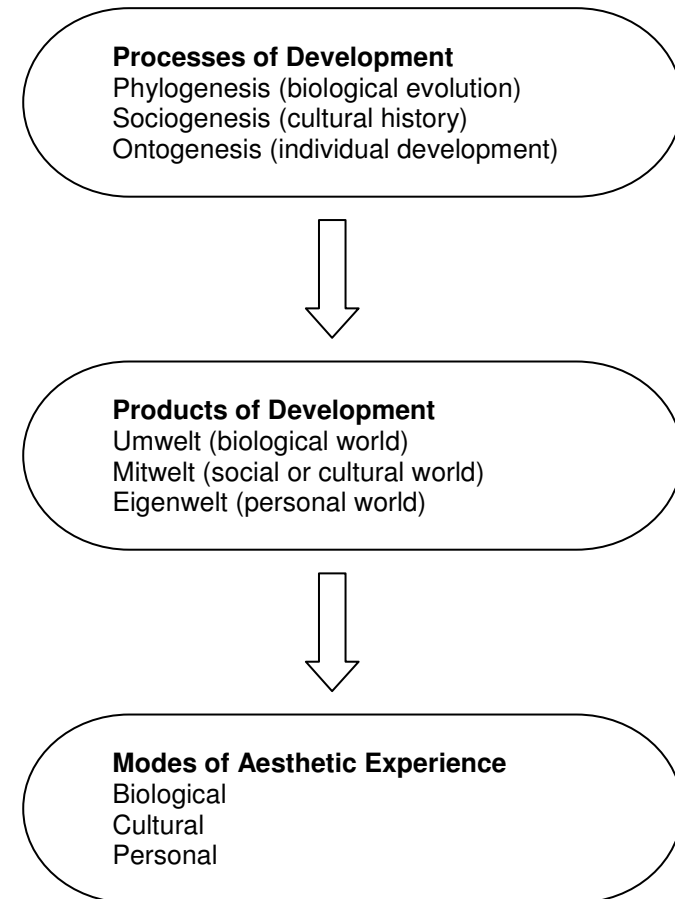
(Bourassa, 1991, p49)

Bourassa developed his research on the foundations of a Russian psychologist, Vygotsky. The tripartite philosophy of perception was based on the process of development rather than the product, which provided a derivation of the behavioural response.

Bourassa questioned the relationship of the tripartite, and critically reviewed whether the aesthetic experience is separate

for cultural intuition or biological mechanisms. The following diagram illustrates the process.

**Figure 3.1** Tripartite diagram Source: adapted from Bourassa (1991)



Bourassa believed that there are two forms of perception. Firstly, there are instinctual emotive responses which are provoked by biological mechanisms and secondly cognitive responses which are conceptions of cultural intuition.

Instinctual and emotional responses to landscape could occur separately from rational and cognitive responses, In other words, there could be separate innate and learned responses to landscape.

(Bourassa, 1991, p59)

In contrast to cognitive psychology, which assumes that emotive responses to landscapes occur post cognition, Bourassa has provided experimental evidence demonstrating that emotive stimulus can occur prior to cognition.

Based on the works of various scholars, Bourassa established an integrated framework which considers qualitative dimensions of landscape perception. Integrating the concepts of habitat theory, information processing and cultural studies, provided Bourassa with a literature foundation to develop a hybrid theory. Given the fundamental support for the evolution of the tripartite paradigm, Bourassa critiqued various assessment models and rejected empirical evaluations on the basis of defining absolute results solely defined by the biological process of perception.

Equally, numerous scholars have been critical of the framework developed by Bourassa. Seamon (1993) believed Bourassa's theory presented a:

bias against a formalist approach to landscape, an ignorance of phenomenological research which is supportive of landscape contributing to the aesthetic experience, and his reduction of the aesthetic experience to the three rather standard...dimensions of biology, culture, and individual.

(Seamon, 1993, p524)

### 3.4.5 Pyramid of Influences

In a somewhat similar structural framework to the tripartite paradigm, Dearden (1989) developed a hierarchy of information processing which calibrated biological, cultural and personal factors. The hierarchy of stimulus and information processing is relative to observer based differences and landscape based techniques which are devised to predict innate qualities. The hierarchy is devised to reflect the degree of social consensus for values of landscape variables. Societal Landscape variables are logically placed in order of innate qualities to factors which manifest from familiarity and demographic influences. The

degree of individual difference depends on the level of commonality to society and regional significance.

Based on this model of information processing, Dearden (1989) believes that techniques need to be produced which appropriately record the innate and individual qualities of landscape perception. This implies developing a methodology which combines objective and subjective information.

#### **3.5 CONTEMPORARY FRAMEWORKS OF LANDSCAPE AESTHETIC ASSESSMENT.**

The connection between landscape aesthetics and landscape preference studies is not as straight forward as one would predict. Landscape preference studies and qualitative assessments have not been subject to philosophical contribution to the extent of critical rigour required. The majority of theoretical frameworks developed in professional practice for landscape assessment of scenic beauty have been empirical in nature. The origins of these research topics have insignificant foundations or rational in the theoretical work of Kant, Burke or Dewey. Of note the studies and theories of Appleton and the Kaplan's have devoted time to invigorate discussion and argument on

qualitative assessment of landscapes. However these studies have been few and far between.

The theories developed by Appleton and the Kaplan's have been developed on the premise of human survival necessity. As previously discussed the biological evolution of human beings has manifest from hunter-gatherer characteristics. It has been suggested that landscapes which possess qualities of prospect-refuge are preferred to those that do not.

Locations which possess prospective views of the landscape are typically legible and easily comprehended. Accordingly, 'prospect refers to the ability of an individual to gather information about an environment with which to evaluate its characteristics and decide how to use it.' (Bitar 2004, p37) Subsequently there is a common thread between Appleton's *Prospect-Refuge Theory* and the Kaplan's *Information Processing Theory* which is theoretically associated to biological manifestations of the evolution of humanity.



Theories developed on the same premise of biological association to landscape preference have noted the affection of natural landscapes:

The bond of affection joining humans with the earth has always been strong but slippery-like stream water rushing over a smooth rock; we know it exists, but by the time we put our finger on it, it has moved elsewhere. A crisp definition of our affection for nature is nearly impossible to locate and, like an elusive mountain lion, we may learn about it only by circumscription of its territory from many vantage points. There is no one term which works perfectly and inclusively as a label for human emotional attachment to land and nature-only a family of related emotions: love, respect, oneness, awe, pleasure, indebtedness, dependency-and overlapping constructs for the objects of those emotions: earth, soil, place, land, 'nature.'

(Thayer 1994, p3)

The *Biophilia Hypothesis* described by Wilson (1984) and later by Thayer (1994), explains an innate attraction for natural living environments. The theory developed by Wilson refers to the relationship of landscape preference for natural environments

going beyond human survival necessities. Wilson (1984) suggests that humans have a desire for aesthetic, intellectual, informative and cognitive experiences derived from encounters with natural environments.

In support of the argument, Marx (1963) has credited the development of suburban sprawl to:

An inchoate longing for a more 'natural' environment enters into the contemptuous attitude that many Americans adopt toward urban life (with the result that we neglect our cities and desert them for the suburbs).

(Marx 1963, p5)

Marx, in his book *The Machine in the Garden* (1963) goes on to explain the evolution of the industrial age and its impact on the way society functions, through cultural, aesthetic and social complications.

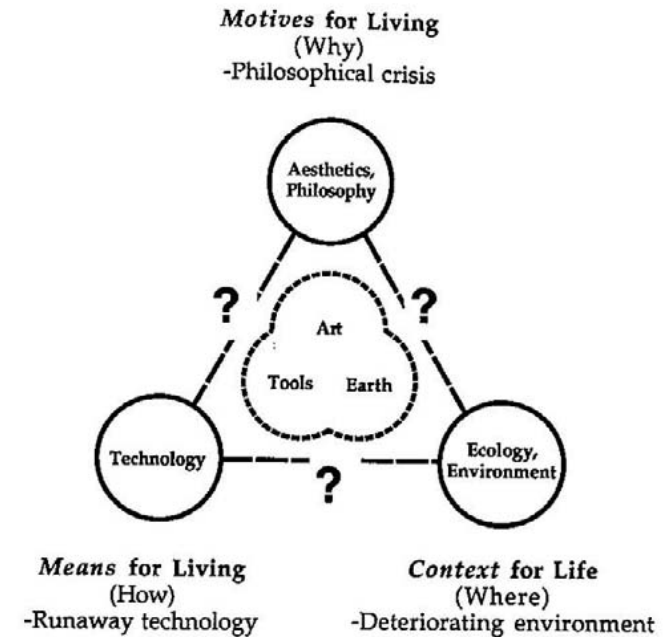
Similarly, Thayer (1994) has sought after answers to pending questions of how infrastructure in the landscape affects the means and motives of life. The concept of biophilia and

topophilia as derived by Thayer, define the interrelationship of aesthetics, ecology and technology.

The realms of human existence have evolved to be reliant on technologies. In simple terms, the tools with which we are able to produce daily consumptive items are dependent on the application of technologies. Society's preoccupation with technology and economic efficiency has in some circumstances inflicted an in balance between context, means and motives for living.

Thayer has illustrated these variables into a triangular model employed to communicate the balance and interactive process of how humans resolve the conflict of context, motives and means of living.

**Figure 3.2** Thayer's Triangular Model (Thayer, 1994, p31)



Thayer develops this field of enquiry by elaborating on the current trend of technological dependence.

Surely at the dawn of human evolution this triangular relationship did not exist; means, reasons, and context for life were bound up in one unselfconscious state of being. In modern American life, however, the triangle has emerged and expanded to the point where relationships

between the reasons, means, and context for life are so tenuously stretched and incongruous that the three realms often seem compartmentalised and no longer truly connected.

(Thayer 1994, p31)

The connection between aesthetics and landscape preference is not explicitly defined. The term aesthetics in this dialogue has become an activist for qualitative motivations for living. Thayer describes this use of aesthetic discourse in landscape architecture as 'supply side', being driven by most studies directed towards 'what is beautiful in landscapes?' rather than factors affecting the human occupant's experience, or subsequently a combination of both. Subsequently the majority of empirical research conducted in Landscape Architecture has been somewhat reductionist.

Another common point of discussion as an adjunct to Biophilia theory, is the preference for savannah landscapes. The basis of this theory has been subjected to the evolution of humanity, logical on the premise that humans evolved from African savannas, migrating to the other continents. It is believed the ancestors of humanity were inhabitants of landscapes which possessed open grassland edged with trees and a water body,

symbolic of savanna landscape characteristics. It is also worthy of note that landscapes which possess characteristics of a savanna experience will typically provide emotional benefits mitigating and relieving stress and illness to some degree (Parsons 1991; Ulrich 1984). It has even been proven through empirical studies that landscape surrogates such as photos and digital media of natural landscapes provoke a sense of well being. (Ulrich, 1995).

Alternatively the preference for a particular landscape may be due to previous experiences and familiarity. The symbolism of certain features in the landscape scene engages the occupant to feel comfortable and confident. Hence the reaction of the occupant to the landscape is reflected upon the process of cognition and information transfer. The presence and value of symbols and patterns in the landscape is representative of cultural associations (Cosgrove, 1984).

Accordingly, it has been commonly argued that the preference for particular landscapes is due to internal and external factors. External factors consider the landscape features such as topography, water bodies, vegetation variety and coverage.

Internal factors comprise of psychological cognitive constructs and biological background.

As previously discussed in the former sections of this Chapter, preferences for landscapes and aesthetic appreciation are separate areas under discussion. When referring to the relationship between aesthetics and preferences, the inclination to associate landscape preferences directly to beauty is theoretically incorrect. It is true that landscapes which possess a sense of beauty are preferred, hence the connection between aesthetics and landscape preference is interrelated. However, it is not possible to explicitly describe the preference of landscape scenes to be exclusively based on beauty. Cultural and biological factors affect the comprehension and meaning of landscapes in each human being, which may well influence their preferences for particular locations. Consequently 'the concept of "preference," it has been suggested, and there is some research to support this contention, that people's general preferences are a blend of personal, social, moral and economic factors' (Carlson, 2001).

### **3.6 SUBJECTIVE VERSUS OBJECTIVE SCHOOLS OF THOUGHT**

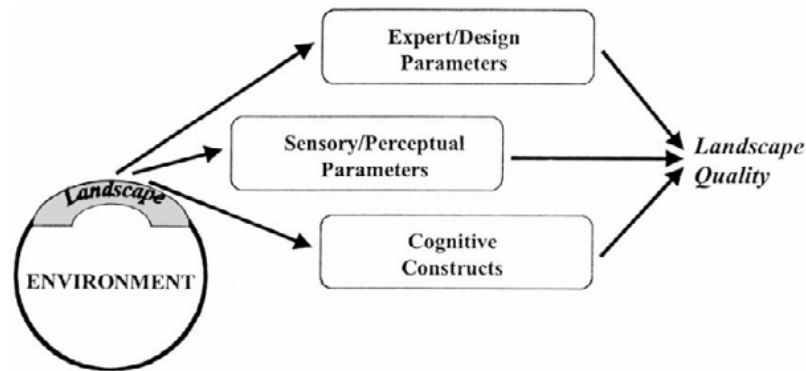
As already discussed in detail there are two different paradigms of aesthetic discourse and visual assessment. Firstly, there is the objectivist view that beauty is a quality which resides in the object matter. This theory considers predetermined criteria to be influential in affecting the aesthetic response of the landscape experience. Commonly this has been an approach employed by landscape architects, based on theories of composition of forms and patterns in the visual scene (Bell 1999; Bell 2004; Kaplan S & Kaplan R 1982, 1999; Appleton 1975). What is more the majority of models which have been employed to value the visual amenity of the landscape have been developed on the basis of a direct correlation between the association of humans and landscape elements. Primarily, landscape architects have been using descriptive approaches, to report on the coherence and interrelationship of the physical forms within a scene.

The subjective school of thought is focused on the psychometric and social sciences. It is how and what people perceive and value in the landscape scene. Consequently, the notion of individual perceptive responses to landscape scenes, elicit numerous questions of cultural and biological sensitivity.

Terry Daniel has been an advocate for a theory and assessment process which is inclusive of subjective values of landscape. Daniel (2001) has argued that a combined effort of subjective and quasi- objective measures is required.

**Figure 3.3** holistic aesthetic assessments. Integration of perceptive biological factors, cognitive cultural knowledge and professional expert objective measurements.

(Daniel, 2001, p268)



The debate continues today, however contemporary trends suggest that the subjective school of thought is preferred. Lothian (1999; 2000) has emphasised through a review of

philosophical and empirical research studies that visual resources are a public good, appreciated by the community. Justifiably this advocates the adoption of the subjective school of thought. Hence the assessment of aesthetic experiences in borrowed<sup>1</sup> landscapes should consider the perception and opinions of those that encounter that landscape.

The subjectivist method implies a cross section of the general community be sampled for their evaluation of landscape aesthetic value, or in other terms, the appreciation of beauty. This is quite an elaborate process relatively expensive to conduct and time consuming. Understandably, previous methods were based on public consultation meetings, assessing photograph surrogates. Arguably the process of consultation survey meetings is not time efficient, and difficult to organise. Consequently current trends are for internet based assessments, of which this thesis will consider to be a viable alternative option.

Conceivably landscape quality assessment is a discourse in theory and practice. The objectivist approach is typically conducted by a Landscape Architect, who evaluates the landscape in accordance to a set of criteria weighted into a

<sup>1</sup> Borrowed landscapes are described as the visual field extending beyond the boundary of property ownership. Hence the visual effect of the neighbouring property will affect the amenity of the immediate landscape.

matrix formula. The role of the Landscape Architect is extremely important for planning, social equality, ecological conservation and economic influences. The reason Landscape Architects are in a position of expertise is the culmination of years of formal training in reading landscape natural processes, and an appreciation of generic landscape preference typologies. Landscape Architects are formally trained to comprehend landscape process, through the perception of forms, lines, colours, textures and their interrelationships. Equivocally this implies an intuitive normality to landscape appreciation which values the composition of forms. Hence the current process adopted in practice evaluates the coherence of elements and forms to aesthetic pleasure, with subjective consideration for cultural variables. This approach to landscape aesthetic enquiry is profoundly deficient in landscape sensitivity to local significance, and paradoxically subjective in nature.

#### 3.7 SUMMARY OF LANDSCAPE AESTHETIC THEORIES

Contemporary aesthetic philosophical investigation has followed similar rational. Dewey and Langer's ideologies of experiential response to biological and cultural factors are symbolic of the theories that have developed within landscape aesthetics. Appleton and the Kaplan's have provided theories based on bio-

evolutionary aspects of human – landscape interactions. Appleton's *Prospect-Refuge* theory and the Kaplan's *Information Processing Theory*, both related genetic features to perception and beauty.

Appleton had proposed landscapes which possess observation points of prospect provided permit legibility and comprehension of the process and function, increasing pleasure. Similarly, the provision of refuge from predators and inclement weather stimulates a sense of security which is connected to a pleasurable experience. Theories created with an underlying principle to correlate human habitation to essential survival environments, have been categorised as survival enhancing qualities of landscape appreciation.

The Kaplan's theory resides in the notion of landscape scenery possessing a sense of complexity, mystery, coherence and legibility. The Kaplan's believed these factors are all common attributes of landscapes which permeate a pleasurable experience.

Coincidentally Appleton and Kaplan's theories are established on the basis of visual sensory being the dominant means of aesthetic experience. Consequently this thesis will bestow to

visual representation as a tool and source of landscape aesthetic assessment, specifically for interpreting the effects of wind farms within the landscape.

The following Chapters will discuss the interrelationship of biological and cultural responses to aesthetic experience which advocates a new field of discussion considering a fusion of theoretical enquiry (Bourassa, 1988). The pragmatic approach of Dewey's experiential response, Langer's symbolic intuitive landscape comprehension and the Kaplan's information processing theory combined with physiological parameters of vision, will enable a model to be produced which not only unifies, but also calibrates aesthetic experience of cultural and biological variables.

#### **3.8 CONCLUSION**

This chapter has provided a theoretical background to the philosophies of perception and psychological schools of thought. The origins of Gestalt psychology have been discussed which provides an understanding of information processing and landscape stimulation and comprehension.

The laws of Good Gestalt (Pragnanz) illustrate the rules of association to particular values for landscape and the knowledge that landscapes are perceived in their entirety, not as the sum of its parts.

Concepts of visual segregation (figure/ ground) are explained in terms of Gestalt psychology, supporting the argument for the comprehension of forms to be simplified and the shape will belong to figure not to the ground.

The way people perceive is affected predominantly by vision. The other senses form an experiential response to landscape, however vision is the dominant interaction. Vision is dynamic, responding to the reflection of light. The physiological mechanics of vision are briefly discussed, and the constraints of vision are quantified. Understanding the framed field of view in the landscape provides a cross reference for representational media. Hence, the horizontal field of view for a human should reflect the image media presented in a surrogate form.

A diverse range of models have been reviewed for their theoretical frameworks. These models have formed the

foundations for landscape aesthetic preference studies (Zube et al, 1982).

The theories are consistent with two paradigms, an objective cognition as to which the aesthetic quality is believed to be inherent in the landscape, and the intangible as to which the perception of aesthetic quality is manufactured by the eye of the beholder.

These two paradigms have been the basis for much debate. The models developed by Appleton, Orians, Kaplan's and Ulrich have primarily been focused on this question and postulate their claim to a rational framework to help manage human landscape interactions.

The habitat theory is biological in nature and provides an impetus for inherent qualitative dialogue. On the other hand, the information processing theory is concerned with the cognitive human behavioural response to the landscape, representing a contrasting opinion on human/ landscape interactions. This theory believes that the human stimuli are associated to cultural and biological references.

More symbolic of what has occurred in Landscape Architecture research to date is empirical studies into objective measurements of human- landscape experiences.

Overwhelmingly, the discourse of landscape aesthetics and preference studies is piecemeal in disposition. There is no uniform framework referring to philosophical comprehension of relativity and the perception of landscapes. Hence the theories that have been developed are incomprehensive, limiting the ability to develop methodologies for landscape visual assessment.

This thesis will endeavour to correlate subjective and objective theories to fabricate a model which can be used to assess the visual effect of wind farms within landscapes.



## **4 THEORETICAL PARADIGMS OF LANDSCAPE AESTHETIC ASSESSMENT AND METHODOLOGICAL DIVERGENCE.**

### **4.1 INTRODUCTION**

The objective of this chapter is to provide an overview of pertinent literature on landscape quality and landscape visual assessment. This field of research has grown substantially over the years to encompass a number of theoretical paradigms representative of emerging methods and techniques of assessment.

Various empirical studies have been employed to examine landscape aesthetic values. In addition, several different reviews of the theories and methodologies employed in landscape aesthetic research have been published (Vining and Stevens, 1986; Daniel & Vining, 1983; Penning-Rowsell & Lowenthal 1986; Taylor, 1987; Zube *et al*, 1975; 1982; Porteous, 1982). These reviews refer to analytical research, underlying theoretical themes.

Landscape visual assessment is but one component within a broader discipline of landscape assessment. With reference to philosophies of landscape aesthetics and landscape preference research discussed in previous chapters, a theoretical framework

will be explored within which wind farm visual assessment can be incorporated.

### **4.2 LANDSCAPE VISUAL RESOURCES**

Many academic theorists agree that the aesthetic value of a landscape is predominantly determined by visual characteristics (Daniel & Boster, p1976).

The concept of visual landscape resource implies a qualitative inherent characteristic, which enriches humanity. It also implies that visual properties of the landscape contain values which are worthy of recognition, and hence preservation. However, the visual landscape is not purely visual; the interaction of humans and landscapes permeates variable responses and mutations of physical form of what is seen, perceived and comprehended. The interaction of humans and landscapes can either desecrate or ameliorate the resource by way of interventions that can be conceived as compatible or adverse with the natural patterns of the landscape.

Landscape visual resource is a field of study, which seeks to ascertain values of landscape, which contribute to a human sense of satisfaction and appreciation.

#### 4. Theoretical Paradigms of Landscape Aesthetic Assessment and Methodological Divergence

The visual landscape is a tool or part of one that planning, design, and management can use to help protect the stability and integrity of the landscape.

(Litton, 1990, p102)

The concept of landscape being a visual resource is not a new idea. Dunn (1974) reports one of the earliest attempts at landscape qualitative assessment was published in the Addison Report (1929), which produced a list of areas designated as being of high scenic quality suitable for national parks in England.

Visual landscape assessments have also come to embody both a physical and representative form such as paintings, photographs and illustrations and a perceived cognitive form relative to past experiences.

The landscape is an image in the eye, a feeling in the gut, a set of physical components in space. It is a breath of the autumn air and a vast number of other things. There are those who think the landscape is a creation of the mind. There are those who think it is physical, three-dimensional and out there; I join this latter group for my own purposes and limitations, but do not deny the other characterisations

that may be given. Of course the landscape is of the mind and of the field and all the interactions of the two that may be conceived, a condition of frustrating complexity.

(Litton, 1990, p101)

Numerous theories and pursuits of academic research have been empowered by the concept of landscape visual resource. Embodying a diverse range of disciplines, from landscape architects to nature conservationists, geologists and philosophers, the underlying connection between humans and landscape interaction has been the visual experience and descriptive characteristics of landscape.

A technical skill of landscape architecture, which has remained a foundation for professional practice, is landscape site analysis. Accumulating information on what exists in the landscape is a prerequisite of the design process. From a visual perspective, documenting character zones, representative of homogenous compositions of topography, vegetation and human interventions, is critical to define values, and land use planning. Indicated in an interpretive guideline on a State Park Survey (Point Lobos Reserve, Monterey Coast), Olmsted (1954) classified the visual properties of the landscape into homogenous character zones. The analysis included a description of the visual

#### 4. Theoretical Paradigms of Landscape Aesthetic Assessment and Methodological Divergence

characteristics of pattern, form and colour. As part of a more detailed process, the visual properties were explained in unison with the ecological quality of the landscape and documented as an inventory assessment.

Sir Humphry Repton, in England, investigated and promoted pictorial slides, which documented the existing landscape through pictorial representation and sketch indications of planned improvements. *The Red Books of Humphry Repton (1976)* described this method of employing visual tools in describing the landscape character and potential alterations was instrumental in the development of photomontage techniques.

The foundations for landscape visual resource management were provided by these pioneers. However it was not until the 1960s - 1970s that visual resource management became an integral research field within landscape architecture academia. The history of visual resource management can be attributed to these two decades of academic questioning. Since the 1980s theories and research into visual resource assessment has decelerated (Litton, 1990).

Originating in North America and England as a response to legislative initiatives (U.S. *National Environmental Policy Act*,

1970), the majority of landscape visual assessment research occurred during the early 1960's with particular emphasis on 'expert'<sup>1</sup> based landscape visual studies. During this period political attention was directed to the management and conservation of scenic resources by way of establishing systematic tools and process of analysing landscape quality values (Taylor *et al*, 1987; Zube *et al*. 1982). In the United States:

from the mid 1960s through the 1970s there was a strong and rising interest and commitment to things environmental, including that of landscape quality. Some research money, though never in generous supply, was available. Landscape management policies were adopted by federal land agencies and work was progressing. Student enrolments in landscape architecture, environmental planning and forestry were up. The presidential administrations of Kennedy and Johnson were years of enthusiastic environmental support and 'aesthetics' was not an ugly word.

(Litton, 1990, p113)

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<sup>1</sup> The expert based assessment process is defined as the theoretical judgements of landscape values taking into consideration the composition of forms, lines and patterning. Whereas non-expert approaches consider public responses to the visual quality of the landscape. The term 'expert' should be used with caution as the alternative psychophysical (non-expert) approach is highly technical requiring statistical analysis.

#### 4. Theoretical Paradigms of Landscape Aesthetic Assessment and Methodological Divergence

Following the Kennedy (1917-1963) administration, the Nixon-Ford (1969-1977) and Carter (1976-1980) years of office adopted a more subtle environmental stance, committing adequate funding to federal land management agencies. Conversely, the succeeding Reagan (1980-1992) administration put a stop to the progress of land management practice by reducing funding to landscape research and environmental studies.

However during the decades of the 1960s-1970s, numerous academics such as Lynch (1960); Simonds (1961), Appleyard *et al* (1964), Crowe (1966), Litton (1968), McHarg (1969), Steinitz *et al* (1969), to name but a few, were influential in researching the visual landscape.

A brief summary of what was being investigated during this period has provided insight to the development of future research questions. The *Image of the City* (Lynch, 1960) substantiated a prophetic message of design vocabulary associated to the visual landscape. The theory driving Lynch's discussion is regarded as formalistic, grounded in qualitative descriptive representation of visual compositions of the city. The dialogue corresponds to an inventory of landscape.

The *View from the Road* (Appleyard *et al*, 1964) followed suit, illustrating and supporting the fundamental visual design principle's described by Lynch (1960). However, the study provided further insight to the landscape as a dynamic experience, alluding to the interaction of the human and landscape in multi-modal transactions.

The need to assess proposed road infrastructure was of concern during the 1960s, with increasing demands for high speed automobile highways in the United States. As a consequence, visual site design and landscape visual assessment encouraged design solutions, which were sensitive to the driver experience and surrounding landscape integration. This led to a new dialogue of research questions related to visual transience, orientation and speed of landscape comprehension. A number of the principles and graphic diagrams illustrating the visual sequence of experiences along a road corridor have been used as a technique in practical design process.

Litton (1968) was influential in providing a practical approach to visual landscape descriptions. A pioneer of inventory assessments of landscape and classifications of character zones, Litton's application of visual analysis has explored not only different graphic forms of analysis and the role of image and ecology in landscape values, but also a humanistic understanding of people and place.

#### 4. Theoretical Paradigms of Landscape Aesthetic Assessment and Methodological Divergence

Through Litton's work landscape was defined to be a physical scene.

McHarg (1969) explored the concept of ecological landscape and visual amenity as a layered process of landscape analysis and patterns. *Design with Nature* (1969) has been influential in enabling models for landscape assessment.

During the 1970s, the focus of research was diverse, interrogating aesthetic preferences from both a tangible and intangible aspect. Landscape management became a broader field of investigation encompassing psychological, semiotic evaluations. Unwin (1975) described a systematic landscape visual management in three phases of appraisal. Firstly, an inventory assessment of the existing landscape character is conducted, documenting physical forms and attributes, which compose the scene. Secondly, landscape aesthetic values are ascertained through judgements and preferences of visual properties in the landscape. Lastly, the landscape is valued for individual and community preferences for the visual quality of landscape character types. Consequently landscape visual assessment was to comprise of descriptive classification, analysis and evaluation into a rationale decision making procedure.

Numerous studies have sought to review the diversity of research and classify landscape visual assessment into theoretical schools of thought (Zube *et al*, 1982; Daniel & Vining, 1983).

For example, Arthur *et al* (1977) classified two approaches to landscape assessment; descriptive inventories and public preference models, with sub categories of qualitative and quantitative explanation. Dearden (1980) classified the approaches to be within one of three 'nodes of agreement'. The nodes comprised field based assessment, the surrogate assessment and methods of measurement. Porteous (1982) reorganised and streamlined the theoretical procedures identifying four paradigms of landscape aesthetic evaluation; the humanist, the activist, the experimentalist and the planner approach. Among the most widely cited is Zube *et al* (1982) who reorganised and simplified the paradigms to professional judgement and the cognitive. These two schools of thought comprised various models of assessment; ecological and formal aesthetic which constituted the professional judgement and psychological the cognitive. Daniel and Vining (1983) developed these conceptions, classifying methodologies into expert-ecological and formal aesthetic, psychophysical, psychological and the phenomenological models. This was to be reinvestigated by Zube (1986), who explored the conscience of human landscape interactions in delineating three paradigms within

which research objective manifest; the professional, behavioural and humanistic.

Landscape quality assessment thus seeks to determine the relative location of different landscapes along a dimension of scenic beauty. Some landscapes will 'give pleasure to the eye' more than others. Because human subjective judgement is unavoidable in assessments of landscape quality, a relevant question is whose judgements are to be followed. Historical standards, expert standards, contemporary public standards, or estimates of the standards of future populations, choices among standards are of little importance. When opinions diverge, some negotiation, compromise, or trade-off would seem to be required. Whatever referent population is chosen, landscape quality assessment requires that human aesthetic standards be applied to evaluate the visual impression made by a landscape.

(Daniel & Vining, 1983, p43)

### 4.3 PARADIGMS OF ASSESSMENT

A review of the literature has defined several theoretical paradigms of visual assessment research methodologies. These are the

Professional, Formal Aesthetic, Ecological, Behavioural, Psychophysical, Cognitive (psychological) and Experiential. Daniel & Vining (1983) reclassified the categories as Ecological, Formal Aesthetic, Psychophysical, Psychological and Phenomenological. In contrast Sell *et al* (1984) proposed that only four paradigms exist:

(Daniel & Vining's) Ecological and Formal Aesthetic are analogous to our Expert, and the Psychological and Phenomenological are analogous to our Cognitive and Experiential. Psychophysical is common to both research structures.

(Sell *et al*, 1984, p66)

#### 4.3.1 Professional Paradigm

As the terminology implies, the method of assessment involves professional 'expert' administered value judgements on the visual quality of the landscape. Typically trained and experienced landscape architects, planners or visual resource managers depict the quality of the landscape with respect to the pattern composition of forms. Carlson (1977) is of the opinion that experienced professionals are capable of interpreting the visual landscape for its compatibility to landscapes of high or low scenic value. Through

intuitive knowledge and skills in reading context, patterns and form, the professional paradigm of assessment is comprised of inventory descriptions and subjective judgements on potential sensitivities of public perceptions. Subsequently the expert based assumption of atypical landscape value denotes inherent and ecological qualities, which provide aesthetic value to the occupant. This mode has also commonly been referred to as either the formal aesthetic or ecological paradigms (Daniel & Vining, 2003).

##### **4.3.2 Formal Aesthetic**

The most widely used procedure for assessing the landscape is the formal aesthetic model, which is based on the assumption that the physical forms of the landscape have inherent qualities which radiate aesthetic values.

These properties are defined as basic forms, lines, colors and textures and their interrelationships. Expert judgements of the variety, harmony, unity and contrast among the basic landscape elements are the principal determinants of aesthetic value.

(Daniel & Vining, 1983)

In this model the landscape is assessed by the relationships between the forms constituting the elements of the landscape. The relationships are then classified into designated zones with respect to variety, unity, integrity and several other complex design related spatial characteristics.

Due to the highly technical nature of the process, it is recommended that trained 'experts' be engaged to conduct the field investigations. Various tools are used in the process of data collection and analysis, photographs, maps, vegetation surveys and representations of the landscape in question.

In addition, a semi-quantified method of acknowledging viewer numbers and sensitivity levels may also contribute to the classification zones of landscape visual quality.

A common reference to a formal aesthetic visual assessment procedure is the Visual Management System (VMS) developed by Litton (1968). The VMS assumes that scenic quality is directly related to visual variety, distance and diversity of the scenic landscape composition.

### 4.3.3 Ecological Paradigm

The majority of visual resource management research has been established on the premise of nature preservation or conservation. Human concerns for degradation of landscapes have infiltrated a need to review and assess ecological prosperity and sustainability. The connection between humans and landscape is at the forefront of ecological degradation and amenity observations. The ecological model is established on an implied assumption that natural, unmodified ecosystems have high intrinsic aesthetic values. The presence of human intervention detracts from the aesthetic value (Bitar, 2004; Taylor *et al*, 1987). For example,

‘human caused pollution of the air and water, and careless development of the land were seen as threatening the integrity of the natural systems’

(Daniel & Vining, 1983).

This model requires skilled expertise in biology, ecology and occupations of the environmental sciences.

Classification of area zones into ecological systems provides a basis for qualifying values according to biodiversity, endangered and critical zones. Human elements are designated as having a negative influence on the landscape. Hence the scaling of aesthetic

value is attributed to the degree of visual presence of human activity. At one end of the scale is a human-modified urban town, whereas the other end of the spectrum has a natural landscape with no visible symbols of human activity.

An example of the ecological approach to aesthetic assessment can be found in the research of Leopold (1969). The assumption that a unique landscape is of more significance than a nominal ecology, implicitly applied a rationale for the development of a ‘uniqueness’ ratio.

The uniqueness ratio was measured on factors of environmental measure and perception such as the extent of diversity of visible ecology. It has been suggested that this model does not directly correlate ecology values to aesthetic values. Understandably, unique landscapes of diverse biology may not correspond to high scenic value.

### 4.3.4 Behavioural Paradigm

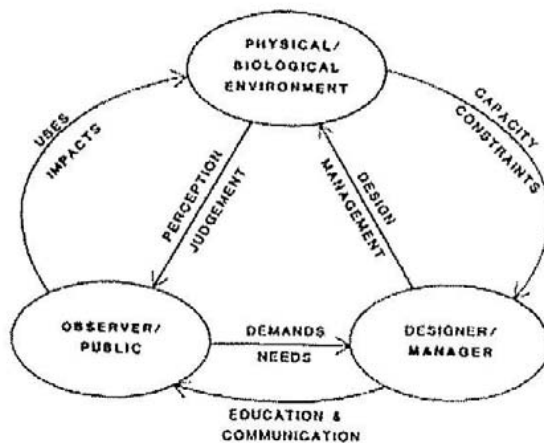
Also referred to as the ‘public preference model’ (Arthur *et al*, 1977; Daniel & Boster, 1976), the objective is to evaluate public perceptions and preferences. Established from psychological and behaviourism experiments, the model enquires about landscape stimulants on individuals occupying the landscape.



The assessment procedure does not require technical skills in describing and assessing the inherent qualities of the landscape. It is instead based on the examination of non-expert observer perceptions.

Vining & Steven (1986) developed a public preference model, which designated the function of the assessment to be a composition of demands, perceptions and judgements of the public, design and management of the landscape and the physical characteristics of the environment that were being viewed.

**Figure 4.1** Vining & Stevens (1986) public preference model of landscape quality



Two models have emerged as subsequent forms of the behavioural theory; the psychophysical and cognitive (Daniel & Boster, 1976; Zube *et al*, 1982; Daniel & Vining, 1983). Firstly the psychophysical approach constitutes the stimulus of the landscape to be principally a product of the object external to the observer. The second paradigm is termed the psychological or cognitive model. This theory is concerned with how the observer perceives and interacts with the landscape with reference to past experiences and visual information comprehension. The cognition of past experiences and associations to landscapes of a similar visual character can provoke contrasting impressions and aesthetic responses. Consequently, psychophysical models are concerned with measuring attributes of the landscape, whereas the cognitive is focussed on engaging the public's intangible relationships with the landscape.

#### 4.3.5 Psychophysical Model

Classical psychophysics (e.g., Fechner, 1860; 1966) sought to establish precise quantitative relationships between physical features of environmental stimuli such as lights, sounds or objects that were varied on a single dimension such as brightness, loudness, or weight.

(Daniel & Vining, 1983, p56)

#### 4. Theoretical Paradigms of Landscape Aesthetic Assessment and Methodological Divergence

The psychophysical model is primarily concerned with mathematically determining the relationship between physical attributes such as topography, water bodies and vegetation types and corresponding human perception values. The model has commonly been used by government agencies (Taylor *et al*, 1987) and for research purposes (Daniel & Boster, 1976; Wohlwill, 1979; Bishop, 2001; Lothian, 2000; Davis, 2003).

The theoretical model provides flexibility in conducting perception judgements, preference ratings and aesthetic values of landscapes, which are frequently scenic beauty assessments. In addition the model provides an engaging intuitive process, which can be used to assess hypothetical design proposals with the community.

The analysis of landscape quality perception values is commonly statistical, requiring skilled generation and interpretation. Multiple regression analysis is typically used to compare landscape scenes informing of significance relationships. Consequently an experienced statistician and landscape consultant is required to facilitate psychophysical studies.

Numerous studies have adopted this model, varying in techniques and objectives of assessment. Participants are asked to rate the landscape scene, indicating their preference, typically rating scales

are employed to quantify the effect. For example, a series of landscape photos may be assessed on a scale of 1 to 10, with 1 meaning low scenic quality and 10 high scenic qualities (Daniel & Boster, 1976; Lothian, 2000). Conversely, the scenes may be selected on a preference rating between pairs or groups of landscape scenes. A diverse range of stimulants can be used in rating the scenes, as described in bipolar dialectic assessments (Thayer, 1987).

Representation tools are an integral component of psychophysical and cognitive assessments. Photographs, visual simulations, sketches and various graphical landscape surrogates are used (Bishop & Lange, 2005).

Predominantly the model has been used for scenic beauty assessment. Daniel & Boster (1976) developed the Scenic Beauty Estimation (SBE) model, which required landscapes to be judged by a sample of people representative of the community as to where the assessment took place or similarly a target demographic. Various randomised landscape scenes assessed by the sample of viewers, interpreting the physical characteristics with regards to perceived beauty.

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The conceptualization of scenic beauty is based on the premise that beauty is an interactive concept inferred from judgements made by a human observer in response to his perception of a landscape.

(Bitar, 2004, p68)

Frequently the aesthetic dimension is found to be closely related to other psychological dimensions; a landscape that is judged as scenically beautiful also tends to elicit positive feelings of tranquility, freedom etc.

(Daniel & Vining, 1983, p66)

Consequently scenic beauty is neither entirely a construct of the mind or inherent in the physical forms of the landscape, it is assumed to be a product of both (Daniel & Boster, 1976).

A number of studies conducted by Buhyoff and colleagues have developed psychophysical models to investigate the effects of forestry and panoramic 'vistas' (Buhyoff & Leuschner, 1978; Buhyoff & Resenman, 1979; Buhyoff, Wellman & Daniel, 1982). Using multiple regression analysis the various relationships and landscape preferences can be formed. These models have provided forest managers with quantitative information of the scenic implications of forestry.

##### 4.3.6 Psychological (Cognitive) Model

The aesthetic or scenic quality of the landscape is generally viewed as but one of several dimensions of human response to views of the natural environment.

In contrast to the ecological model, which is based on the premise that landscapes possess intrinsic qualities, the psychological model focuses on the cognition and human response and not the landscape itself. The meanings and associations to landscape are processed with respect to previous experiences and cultural intuitions. In other terms, the relationship between humans and landscape is thought to be a product of the mind, in the eye of the beholder. Overtly researchers search for reasons why a particular landscape is appreciated, not what landscape. For this reason the psychological model is neither driven by expert descriptive subjectivity, or inherent objective psychophysical analysis. Potentially the psychological paradigm bonds the two together, providing a theoretical framework of human landscape transaction.

The method of assessment is commonly performed by surveying the public with colour photographs. The scenes may be rated on dimensions of emotional dialectics, such as fearfulness and stress.

The descriptive measures of evaluation are appointed by the research objectives and hypothesis.

A well known example of the cognitive model is the work administered by the Kaplan's. Demonstrated through cognitive empirical investigation, landscape preference ratings are thought to be associated to landscapes, which possess complexity, mystery, legibility and coherence (Kaplan & Kaplan, 1989).

An alternative study of roadside vegetation and peoples perceptions of complexity, coherence and depth was conducted by Ulrich (1977). Within this study, components of both the psychophysical and psychological were married coordinating an evaluation of preference ratings to cognition.

The common thread in methodological convergence is the approach to identify connections between subjective preferences for landscape and psychophysical variables. A proportion of these variables may in fact have links to physical elements in the landscape, whereas others will be intangible qualities of human perception.

#### **4.3.7 Experiential Paradigm**

This paradigm explores intangible qualities of everyday experiences, interpretations and interactions with landscapes (Lowenthal, 1972; Lynch, 1960). Otherwise known as the Phenomenological or Humanistic paradigm, the model depicts aesthetic appreciation to occur during human-landscape interactions (Taylor *et al*, 1987).

The major objective of this model is to comprehend individual aesthetic values, instigated during interactions with the landscape (Lowenthal, 1978). This is in contrast to psychophysical and psychological models, which acquire generalised aesthetic attributes to the simulated experience.

This primary method of collecting information is to engage community through interviews and immerse in the landscape, providing descriptive response of experiences. Zube *et al* (1982) clarifies the theoretical position of the humanistic paradigm to encompass methodologies, which are not judgemental, but deliberate on the experience of human – landscape interactions.

The work of Lowenthal (1972, 1978) and Meinig (1979) has been significant to the contribution of phenomenological research

questions. Lowenthal (1978) argued that the formal aesthetic approach to landscape visual assessment was arbitrary in event favouring the adoption of a combination of psychological and experiential valuations of people's perceptions.

Further, studies by Schroeder (1991) and Bishop *et al* (2001b) have enquired experiential responses of occupants in landscapes both of a real life interaction and virtual environment.

Typically, the process of this research is guided by the engagement and collection of public responses through surveys of open ended questions. The findings are analysed for any homogenous classifications of experiences, which is then attributed to landscape character and visual composition. The combination of qualitative and quantitative information provides a thorough understanding of human landscape interactions.

#### 4.4 CRITERIA TO EVALUATE VISUAL ASSESSMENT MODELS

Daniel & Vining (1983) have suggested four criteria to assess models of visual assessment. These are; reliability, sensitivity, validity and utility.

##### **Reliability**

The reliability of the model refers to the capability to replicate the process to surmount the same conclusion. In other terms the model applied needs to pose repeatability permitting consistency of results. If an assessment was carried out on a particular landscape development under certain conditions and applied to similar people or by an alternative assessor on a second occasion and did not generate the same results, it would be deemed unreliable (Taylor *et al*, 1987).

##### **Sensitivity**

The method of measurement should be sensitive to changes in the properties of what is being measured (Daniel & Vining, 1983). In other terms, it is critical that the model is able to measure the actual difference caused by the variable it set out to assess. If an assessment model were unable to attribute the value recorded to the variable then the model would be stated as having low sensitivity (Taylor *et al*, 1987).

##### **Validity**

This refers to the degree to which the model is able to represent the findings with authenticity. A method must not only provide reliable and sensitive values but they should also be credible to the assessment being conducted. Consequently, the values

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ascertained in the assessment need to be justified. A landscape quality assessment method should measure landscape quality- but it is often very difficult to test the validity of a measurement method.

Validation of a landscape- quality assessment method is a continuous process, and no single 'test' can confirm or disprove a method's validity. Perhaps the best that a method could achieve is the consensus of researchers and practitioners that the method measures 'landscape quality'.  
(Daniel and Vining, 1983, p40)

##### **Utility**

The final criterion, which needs to be considered, is the utility of the model. More profound to the practice of visual assessment, the utility of applying the model refers to the efficiency, practicality and general flexibility. Efficient methods imply reliability of the values with low cost of time, materials and labour.

Generality refers to the ability to employ the method with minor modifications to a range of different landscape development situations. For example, the model should be able to assess the effects of a mine expansion as opposed to a wind farm or residential subdivision for the same geographic location. Similarly, the model should facilitate comparisons of various other landscape

contexts with reference to a proposed development form. Equivocally the model should be able to compare different design scenarios of the proposed development.

In addition, methods need to provide utility to the integration of systematically related physical/ biological and social features of the environment, so that a holistic assessment of the landscape can be assessed for opportunities and constraints (Arthur *et al*, 1977). To add to this discussion, Daniel & Zube (1979) have alluded to a landscape assessment process which can combine, compare and decipher relationships between different social values of landscape in a separate process. Typical of other systematic processes a market value can be attributed to the designated category. However for landscape aesthetics, there is no predetermined system to assign credible values. Hence 'for commodities and for landscape- quality identification, location, amount, and grade must be assessed before value or worth can be determined. These prerequisites to valuation are the proper focus of landscape- quality assessment methods' (Daniel & Vining, 1983, p 41).

#### 4.5 SUMMARY OF LANDSCAPE VISUAL ASSESSMENT PARADIGMS

Numerous techniques of landscape evaluation have been devised. The variance in approach has been represented on the one hand by techniques used to rate subjective values of landscape user groups employing surrogate tools in assessment processes, or conversely inventory assessments conducted by professionals on field investigations.

Of the paradigms discussed above there are typologically three schools of thought; experiential, behavioural and professional models. Each paradigm has its advantages and disadvantages.

Zube *et al* (1982) recognises that no individual paradigm is capable of encompassing all the concerns of landscape visual assessment. Zube (1984) does however remark that due to a lack of a unifying theory, there is no evident connection between the paradigms, limiting further scope for an integrated unified landscape visual assessment theory.

The paradigms and methods of assessment are either expert based judgements or public preferences. A number of empirical studies have found a surmountable difference between the values

ascertained by expert and public preference models. Kaplan (1988, p54) commented that 'although experts are invaluable when used appropriately, they are a dubious source of 'objective' judgements about what people care about in the landscape'.

Typically the professional approach is conducted as a two staged process. Firstly, landscape character and inventory assessment, and secondly detailed assessment of the likely visual effects.

Professional judgements are frequently used in landscape assessment to classify the contrast and textures of forms and patterns reflecting the quality of scenic beauty. Visual factors such as variety are said to reflect the scenic quality (Arthur *et al*, 1977). Attempts have been made to verify the relationship between variety and perceived scenic beauty with several studies identifying preferences for complexity and visual stimulation formed by changes in the landscape (Arthur *et al*, 1977). Further studies and models have developed, for example the 'uniqueness ratio' (Leopold, 1969), which is derived from areas which possess variety.

More commonly these landscape assessments are documented as a descriptive interpretation of the landform. The efficiency and inexpensive nature of a sole assessor conducting a field

investigation is a positive aspect of this approach. More recently, quantification has been an objective.

The development of a quantified formula for scenic beauty estimation is thought to be a step in the right direction.

Resource managers are unlikely to turn to novel decision models solely to give equal consideration to nonpecuniary resources; it may be easier to provide indices of scenic beauty that are compatible with existing management models. These indices should be as reliable, accurate and precise as the quantitative estimates of timber, forage and water.

(Arthur *et al*, 1977, p114)

Using quantitative methods the relative quality of scenic factors can be valued, and weighted in terms of significance and then aggregated to compare different design scenarios.

#### 4.6 VISUAL MANAGEMENT SYSTEM (VMS)

The development of visual resource management can be attributed to linear sequential experiences of landscapes as pointed out by Litton and formerly advocated by Frank Waugh in 1918 in his

pamphlet on landscape engineering in National Forests (Smardon, 1986). This concept evolved in the USA to scenic corridor and linear landscape appraisals, with the introduction of *The Highway Beautification Act*. This was to be later followed by recreational resource audits and the Recreational Resources Review Commission (RRRC) authorising the establishment of a uniform system to classify recreational resources. The system comprised of six categories, which were later to be adapted by the Forest Service, the Bureau of Land Management, and the National Park Service (Smardon, 1986).

History has repeatedly documented man's appreciation for aesthetic resources of our public forests. Poets have described it painters and photographers have reproduced it, and lawmakers have defended it. Until recently, however aesthetic aspects have not been a primary concern for management of public forests.

(Arthur *et al*, 1977, p109)

The USDA Forest Service and US Bureau of Land Management (BLM) have been instrumental in developing a quantified Visual Management System (VMS), otherwise known as Visual Resource and Impact Assessment (VRIA), of which numerous contemporary models refer to.



#### 4. Theoretical Paradigms of Landscape Aesthetic Assessment and Methodological Divergence

The objective of Visual Resource Management is to manage public lands in a manner which will protect the quality of the scenic values of the landscape, in other terms to preserve the existing landscape character in accordance with policies and management initiatives.

Visual landscapes are a public good which require different levels of management in accordance with values prescribed by inventory assessments. The values assigned to areas of the landscape attribute to allocated management plans, which adjudicate standards for planning, designing and evaluating future projects.

The VMS system incorporates a two staged process. Firstly visual inventory assessment and secondly contrast rating system, which evaluates the proposed project against the base landscape quality ([www.blm.gov/nstc/VRM/8410.html](http://www.blm.gov/nstc/VRM/8410.html)), accessed March 28<sup>th</sup> 2007). The following discussion will provide some more detail on the process of assessment.

Visual resource inventory rates the landscape in accordance to the quality, presence and degree of landform, vegetation, water, colour, influence of adjacent scenery, scarcity and cultural modifications. In a systematic process, the visual resource is classified in

accordance to scenic quality, sensitivity levels and distance with reference to a weighted matrix.

Based on these three factors, the landscape is classified into one of four visual inventory classes. Class one being landscapes of high value, three and four classified of least value. Boundaries are created for management policies in accordance with these designated zones.

The sensitivity values of the landscape are incorporated into the matrix to measure public concern for scenic quality. The factors of assessment are classified into types of users, which are suggested to be recreational, tourists, workers or people who pass through the landscape on a regular occurrence. In addition the frequency of use of the landscape will determine the sensitivity of particular views. For example, areas designated to be highly populated will encompass a larger perceived visual change across the community.

The transition and interrelationship with adjacent land uses can also influence landscape perception. For instance, the land surrounding a natural conservation park maybe highly sensitive, opposed to the land surrounding a nuclear power plant.

Values of landscape sensitivity are then mapped into high, medium and low classifications. Figure 4.2 illustrates a typical overlay map of likely landscape sensitivity classification.

**Figure 4.2** Mapping sensitivity zones

NOTE:  
This figure is included on page 88  
of the print copy of the thesis held in  
the University of Adelaide Library.

The landscape is divided into distance zones to provide an indication of the likely degree of visibility. The zones are designated as foreground- middleground, background and seldom seen. The foreground- middleground (fm) zone includes areas within 3-5 miles (5-8 kilometres), whereas background is between 5-8 miles (8 and 24 kilometres). Distance zone maps are produced to clarify views along major roads within these zones. This can then be overlaid on sensitivity values and visual resource inventory maps to document a composite map.

As mentioned, the second stage of the procedure is contrast rating the proposed landscape changes caused by development. Visual resource contrast rating is explicitly a process of identifying suspected visual changes to the landscape. Generally the contrast rating will identify the size and magnitude, type of project, implications of the development to the existing landscape and anticipated ultimate use and lifespan of the project. In addition, a discussion on possible design techniques for mitigation should be suggested these may include:

- Reducing the size of cut and fill slopes
- Reducing the contrast of earthwork by rounding and toning earthwork slopes
- Maintaining integrity of the topographic units

([www.blm.gov/nstc/VRM/8410d.html](http://www.blm.gov/nstc/VRM/8410d.html), accessed 2<sup>nd</sup> August 2007)

- Retaining and enhancing existing vegetation and revegetation
- Minimising the number of visible structures using earth colours where possible to absorb the structure
- Recognize the limitations of colour. Colour (hue) is most effective within 500 meters, beyond that colour becomes difficult to distinguish. In addition, colour will have minimal effect in the background distance zones as the structure will silhouette against the sky.

([www.blm.gov/nstc/VRM/8410d.html](http://www.blm.gov/nstc/VRM/8410d.html), accessed 2<sup>nd</sup> August 2007)

The VMS method uses common landscape design principles to assign values. Landscape architects interpret the form, line, colour and texture to describe the landscape. The degree of visual effect relationship between the project and the existing landscape can be seen as in harmony by taking on similar basic elements or contrast, which is said to have a negative effect. Visual resource management is designed to separate the existing landscape and the proposed project into features and elements to be compared. From the evaluation ways are sought to manipulate the project to produce harmony.

The following diagram Figure 4.3 illustrates the systematic methodology.

**Figure 4.3** VRM model

**NOTE:**  
This figure is included on page 89  
of the print copy of the thesis held in  
the University of Adelaide Library.

([www.blm.gov/nstc/VRM/8400.html](http://www.blm.gov/nstc/VRM/8400.html)), accessed 2<sup>nd</sup> August 2007)

Finally, as can be seen in Figure 4.3, the VMS model of assessment aims to facilitate a quantified aesthetic value of landscape impact according to visual quality and sensitivities.

#### 4. Theoretical Paradigms of Landscape Aesthetic Assessment and Methodological Divergence

If aesthetic quality of the environment is to be seen as a resource and the demand on it is to be weighed against that on other resources then we must have an objective basis for comparison. And since objectivity has been achieved in regard to other resources by means of quantification, this seems the natural approach to take in regard to aesthetic quality. Moreover, if quantified measurement of aesthetic quality can be achieved, it would appear to allow for easy, direct comparison with other resources.

(Carlson, 1977, p135)

This is symbolic of a trend in visual perception and landscape qualitative research. Litton (1968) supports claims that research themes have adopted procedures to provide objective analysis and quantification of visual effect.

#### 4.7 LANDSCAPE CHARACTER ASSESSMENT

A landscape inventory assessment is a descriptive evaluation categorising landscape into typical characteristics. It is becoming increasingly more important in landscape decision-making and planning to classify and zone landscape regions into characters for management policies.

Landscape character assessment is a tool, which can contribute significantly to the objectives of sustainability and environmental protection. Distinctive from landscape valuation studies in the 1970s; landscape character assessment emerged in the 1980s as a tool to separate the classification and description of landscape character (what makes one landscape different from adjacent).

Landscape Evaluation	Landscape Assessment	Landscape Character Assessment
<ul style="list-style-type: none"> <li>- Focused on landscape value</li> <li>- Claimed to be an objective process</li> <li>- Compared value of one landscape with another</li> <li>- Relied on quantitative measurement of landscape elements</li> </ul>	<ul style="list-style-type: none"> <li>- Recognised role for both objectivity and subjectivity</li> <li>- Stressed differences between inventory classification and evaluation of landscape</li> <li>- Provided scope for incorporating other peoples perceptions of the landscape</li> </ul>	<ul style="list-style-type: none"> <li>- Focuses on landscape character</li> <li>- Divides process of characterisation from making judgements</li> <li>- Stresses potential for use at different scales</li> <li>- Links to Historic Landscape Characterisation</li> <li>- More recent emphasis on the need for</li> </ul>

#### 4. Theoretical Paradigms of Landscape Aesthetic Assessment and Methodological Divergence

		stakeholders to be involved
<b>Early 1970s</b>	<b>Mid 1980s</b>	<b>Mid 1990s</b>

(Scottish Natural Heritage and The Countryside Agency, unpublished)

Landscape character assessment can provide assistance to landscape planning and processes, which seek to;

- Identify environmental and cultural features in a geographic locality
- Monitor development and ecological change in an environment
- Interpret locations which maybe sensitivity to development and change
- Provide guidance to development and conservation of landscapes.

(Department of Landscape University of Sheffield & Land Use Consultants, 2002)

Landscape character is not solely a response of visual perception, it comprises of a combination of sensual experiences of sound, smell, taste, touch and our emotional feelings. However, typically landscape character is filtered to encompass a generalist view of the visual patterns arising from the combination of components in

the landscape. Particular combinations of geology, landform, soils, vegetation, land use and patterns of human settlement generate character.

Landscape character has been used in a broad array of situations; the main applications have been in planning and landscape conservation management. Planning has been informed by character assessments to:

- Inform development plans and policies
- Informing site design for landscape interventions, with particular emphasis on housing, renewable energy and other land uses.
- Provide analytical studies of development potential to investigate site locations which would be most suitable
- As an integral component and introduction to Environmental Impact Assessments

The role that landscape character plays in conservation of landscapes is symbolic of the assessment process to classify areas of value. Overtly this directive implies mapping boundaries of landscape classification, designated by land use, ecological integrity and providing management guidance on sustainable development.

The framework of landscape character assessment is commonly systematic, according to the situation it is employed. It is important to note that emphasis of landscape character is more descriptive and relevant to preliminary investigations of landscape, whereas landscape preference and value assessments are explicitly applicable to perceptions of quality.

The following discussion outlines the stages of the study as suggested by the Scottish Natural Heritage and The Countryside Agency (Department of Landscape University of Sheffield & Land Use Consultants, 2002). The assessment is broken into two stages, firstly characterization and secondly making judgments. Stage one comprises of four steps.

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##### **Stage one**

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- **Step one**

Define the scope of the study site identifying the scale and level of detail required whilst also distinguishing the stakeholder group and people/ resources required.

- **Step two**

An in depth desk top study of literature, maps and possible stakeholder input to analyse natural and social factors. These

variables of assessment may consist of geology, landform, drainage, soils, land cover/ vegetation, land use, settlement, enclosure and numerous cultural associations to place. Map overlays are developed for each category of assessment, with time frames and level of detail varied for particular projects.

Rivers and drainage systems, vegetation cover and soil types are all typical character components or physical attributes of the landscape. Cultural factors such as settlement patterns, heritage features of a built form and landscapes of human modification can also be described and graphically documented.

Combining the map overlays will provide areas of identifiable common character to be tested and verified in the field. From the preliminary findings it is suggested that draft landscape character types are described and possibly consulted with the stakeholder group.

- **Step Three**

Field investigations constitute the next phase of the assessment, analysing aesthetic, perceptual aspects and potential sensitivities.

The purpose of the field investigation is to collect as much information as necessary to:

- describe the character

- identify aesthetic and perceptual sensitivities
- update and review the desk top study data base
- assist in making judgements about the landscape and future guidelines for development or conservation.

Information is normally recorded on a field record sheet designed specifically for the objectives of the study. It is recommended that a systematic approach be adopted so that the quality of information collected is consistent. This can also comprise of sketch drawings, a checklist of required landscape process data and photographic documentation.

Aesthetic and perceptual attributes are to some degree intangible qualities entailing subjective evaluations. Variables such as scale, enclosure, diversity, texture, form, unity, colour, balance and movement are categorised on dialectic bipolar scales to record visual representations of the landscape. In addition sensual responses of smell, touch and sound are also arbitrarily assigned to the landscape, providing descriptive documentation for strategic guidance.

- **Step four**

Following the field investigation and visual clarification of the character zones, a refinement and description is required. Mapping

of these zones will provide graphical support and guidance for land management.

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**Stage two**

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Stage two of the procedure is to make value judgements to meet the objectives of the assessment outlined in stage one. Conducted in two steps the procedure is as follows:

- **Step five**

The first objective in making judgements on landscape character is to decipher what stakeholders to engage in consultation. In addition it is recommended that a review of the criteria used in the assessment would be beneficial to support claims made on behalf of the judgements.

- **Step six**

The outputs of the judgements will vary in accordance to the purpose of the assessment. Typical approaches to making judgements are in the development of landscape strategies and guidelines, identifying landscape capacity for change. This process can often be supported by stakeholder involvement.

Some of the skills required are in specialised areas, including landscape history, archaeology, ecology, agriculture and planning.

It is recommended that a core team of professionals, who are well versed in the topics of assessment, collaborate to document the landscape at question. Evidently it is becoming increasingly important to find ways of combining the assessments of various landscape typologies.

Geographic Information Systems (GIS) are playing a growing part in landscape character assessment. The efficiency of overlaying and assessing different aspects of the landscape in different combinations in accordance with the geographic location is convincing. GIS also has advantages in producing high quality presentation maps, connectivity to data bases for storage, retrieval and analysis and providing a dynamic platform to update and reconfigure the data as time and landscapes change.

With improved access to hardware and software and availability of digital data relevant to landscape, it is envisaged that GIS will be a requirement of landscape assessment studies into the future.

In addition to skills in GIS and landscape appraisal, it is also becoming increasingly important to possess facilitation skills, to support stakeholder involvement.

#### **4.8 LANDSCAPE CHARACTER ASSESSMENT: A REFERENCE TO SCENIC QUALITY ASSESSMENT.**

Landscape character assessment has primarily been based on visual properties of the landscape, which fundamentally has associations with vegetation and ecological systems. Simonds (1961) defined landscape character thus:

Landscape character is where there is an apparent harmony or unity among all the natural elements of a landscape, including the landforms, geology, vegetation etc. Each area has its own distinguishing landscape character, and each invokes a distinct response.

(Stuart-Street, 1994, p3)

In a similar dialogue of landscape classification and assessment processes, Leonard & Hammond (1984) defined landscape character to provoke qualitative values.

Landscape character types and subtypes are areas of relatively homogenous visual character in which comparisons of scenic quality are possible. Descriptive criteria called frames of reference define a range of scenic quality components, which exist within each character type.



#### 4. Theoretical Paradigms of Landscape Aesthetic Assessment and Methodological Divergence

While all landscapes have some value, some are of greater scenic value and importance than others.

(Leonard & Hammond, 1984, p60)

The connectivity of landscape visual assessment and landscape character can be established from landscape preference studies and psychophysical assessments.

The Forest Commission Victoria (1977) recognised visual resource as an essential component of landscape management, and were fundamentally the instigators of visual research in Australia.

Ultimately the Visual Management System (VMS) was established for broad scale planning.

Assigning visual quality values to landscape inventory assessment is a staged process. The first objective is to identify the resource base, which involves an analysis of the physical form of topography, vegetation and modifications and slightly less tangible variables such as social considerations of people who occupy the landscape.

The second stage is to conduct a more detailed inventory assessment, identifying and documenting landscape character types with respect to the presence of water bodies, vegetation and land use. The landscape character and inventory report can contain

descriptive professional visual jargon, which can be confusing to the general community. It is noted that it is inescapable to include some professional jargon, however it is suggested that the terms are clearly explained in a way that both public and professionals can comprehend (Brodbeck, 2005).

The degree of visual amenity is perceived to be directly related to the distance zones from the proposed development or landscape feature being assessed. The VMS establishes a foundation of assessing observer travel routes and volumes of traffic with respect to observer types, which can range from tourists, places of employment and local residents. The regional landscape is investigated for areas, which are accessible and classified in accordance with each of the classification categories.

The third stage of the process is to assess the landscape in terms of the scenic quality and public sensitivity levels. These are assessed in two separate procedures to be combined and reviewed for management guidelines.

Within the procedure particular landscape contexts and views are assessed by a professional consultant as being of high, moderate or low quality. In contrast public perceptions are weighted as being

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of high, moderate, low or very low sensitivity relative to the types of occupants, distance and frequency of habitation.

The psychophysical approach used to associate landscape character to scenic quality is dissimilar to typical empirical studies (Daniel & Boster, 1976; Daniel & Vining, 1983). The VMS process adopts a series of assumptions, which are suggested to increase scenic quality. These comprise of:

- Greater degrees of uniqueness in rock outcropping, water, sub-alpine heathlands and other natural features
- Greater degrees of naturalness and lesser degrees of man-made alteration
- Greater degrees of relative topographic relief and ruggedness
- Greater degrees of vegetative diversity and general landscape variety
- Greater degrees of vegetative diversity and green crop patchwork effects in agricultural landscapes
- Greater degrees of vegetative mixture and edge diversity in coniferous plantations.

(Leonard & Hammond, 1984, p60)

The arbitrary assignment of landscape scenic quality to landscape character types is not confirmed with public perception values. The classification is determined by referring to the landscape components of landform, vegetation and presence of waterform. This is summarised into a matrix table as follows:

**Table 4.1**

	High	Moderate	Low
Landform			
Vegetation			
Waterform			

The scenic quality classification is then transferred to a base map relative to landscape character type zones.

The final stage of the VMS framework, is to generate landscape management and visual quality objectives based on the findings of the two assessments.

The VMS model is fundamentally flawed for a number of theoretical reasons. Firstly, the model is developed by the subjective evaluation of scenic quality. Landscape character classifications are justifiably distinguished by areas of homogenous visual characteristics. However the assumed relationship between

sensitivity of views and landscape character zones is not supported. Within each landscape character zone, altered descriptions of high, moderate and low quality are illustrated. Accordingly, it is not possible to compare the scenic quality of different landscape character zones.

A similar procedure adopted in Victoria by Leonard & Hammond (1984), sought to classify landscape character zones to scenic beauty values. The intention of relating generic land use and physical attributes of landscape to qualitative social considerations of visual aesthetics on a strategic scale was a first in Australia.

The procedure systematically integrates both physical landscape elements (in total) and social considerations (people's concern for scenic quality) into management zones of relative concern for visual resource values.

(Leonard & Hammond, 1984, p5)

The objectives of both the VMS model and the model employed by Leonard & Hammond (1984) are symbolic of psychophysical models. However, these models are deficient in achieving the objectives of quantifying a relationship between physical properties of the landscape and sensitivity values due to their lack of empirical statistical analysis.

#### **4.9 LANDSCAPE QUALITY ASSESSMENT: - LAW OF COMPARATIVE JUDGEMENTS AND SCENIC BEAUTY ESTIMATION.**

Several methods have been developed to quantify landscape qualities. Daniel & Boster (1976) developed the Scenic Beauty Estimation (SBE) method, which seeks to identify and preserve areas of forestry, which emit significant scenic values.

Of the many resources we use, preserve, and try to improve, scenic beauty has proven one of the most difficult to measure in an objective, scientific manner. No doubt this is because beauty is only partially defined by characteristics of the environment, and depends, in large part, upon human judgment.

(Daniel & Boster, 1976, p1)

The concept of scenic beauty has been recycled in many philosophical debates; with no unified agreement as to how it is developed and on what theoretical basis it is a credible criterion of visual perception. The SBE method translates the concept of scenic beauty to be:

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based on the premise that beauty is an “interactive” concept. Scenic beauty is neither entirely “in the eye of the beholder” nor is it solely a property of the landscape. Rather, scenic beauty is inferred from a judgment made by a human observer in response to his perception of a landscape.

(Daniel & Boster, 1976, p13)

The SBE model is derived from the theory of Signal Detectability (Green & Sweets, 1966) and psychophysical scaling procedures (Thurston, 1927; 1948). The problem with rating and comparing peoples’ perceptions of landscape contexts is the accuracy and relativity of absolute values. For example, if respondents are instructed to use a 10 point scale of assessment, some observers may perceive the interval amid 3-4 differently than the interval of 6-7. Hence the relative perceptive values for each unit of measurement are diverse. Thurston (1927) derived scaling methods to provide relative credible values, referred to as the Law of Comparative Judgement (LCJ), to eliminate this discrepancy.

In simplified terms, the LCJ conveys the magnitude of a psychophysical assessment as the frequency of evaluation for a particular stimulus with respect to an alternative aesthetic experience.

The LCJ method requires a large sample of landscape scenes to be assessed. This is relative to the scale and representation of the landscape, as the number of paired comparisons grows with the number of photographs. For example, for 15 photos the number of comparative assessments would amount to 115. It is important to consider participant fatigue in the management of time required to complete the assessment.

Similarly, the SBE method adopts a process of comparative assessment whereby a range of landscapes can be statistically valued.

The objectives of the SBE model were to integrate tangible economic qualities of forestry with less tangible aspects such as visual aesthetics, cultural intuition, and cognitive values of landscape. By developing a systematic process, which objectively measures visual perceptions of landscape, statistical informed decisions can be made on a level foundation of all the variables of site assessment. This provides rigour to the adjudication of suitability of land use.

The application of the process can be outlined in three key steps:

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1. Representing landscape by colour slides
2. Presenting slides to observers
3. Evaluating observer judgments

Photographic representations of the landscape are randomly sampled to alleviate any biased views and compositions of the landscape. The locations of assessment are governed by a series of rules specified by distances and bearing angle of photos taken along a linear trail or in a systematic format. The photos are taken in random directions, limiting any bias. The number of photos required varies to provide an adequate coverage of any visual diversity. Ultimately only one or two photos may represent homogenous landscapes. The process of valuing landscape scenes is empirical. Photos taken from the chosen vantage points are processed into slides, which are randomly organized into the slide trays for presentation. The representation of the slides is predicated on 35mm slides, and not a Powerpoint™ presentation, which is a contemporary form of image presentation. There is an increasing potential to integrate powerpoint or PDF digital formats of landscape representations in survey data due to the ease of transmittal and data collection.

In an auditorium lecture room, samples of people (approximately 30 maximum) are invited to attend and participate in a research

experiment for visual landscape management. Detailed instructions are handed to the participant and verbally explained.

The first slides will be shown very quickly, just to give you an idea of the range of areas you will be judging. Try to imagine how you would rate these slides, using the “rating response scale” on the top of your scoring sheet. Note that the scale ranges from zero, meaning you judge the area to be very low in scenic quality, to nine, indicating very high scenic quality.

(Daniel & Boster, 1976, p 25)

Valued judgments on a 1 (extremely low scenic beauty) – 10 (extremely high scenic beauty) scale provides ordinal classification of scenic preference.

Participants establish their own personal criteria to value the ‘scenic beauty’ of particular landscape scenes. For example a rating of 5 out of 10 may be quite a significant value for a person who has high aesthetic criteria, whereas a value of 7 or 8 out of 10 could imply a similar relative value but based on lower aesthetic criteria. The SBE model takes this into account by reflecting a mean distribution of values representative of individual and perceptual differences amongst participants (Hull, Buhyoff & Daniel, 1984, p1089). Figure

4.4 illustrates the derivation of SBE score relative to a landscape slide assessment.

**Figure 4.4** Scenic Beauty Estimation Model

NOTE:  
This figure is included on page 100  
of the print copy of the thesis held in  
the University of Adelaide Library.

Two analytical processes are used in the SBE model, referred to as 'by observer' or 'by- slide' analysis. By observer is an evaluation of landscape preference associated to an individuals criteria, whereas by slide is a nominal evaluation of preferences for landscape types. Daniel & Boster (1976) have found only minor variance in the findings of both approaches for a given landscape area.

The difference between LCJ and SBE methods is the approach to apply comparative values to landscape scenes. Whilst the SBE method only permits one change of evaluation, the LCJ approach provides opportunities for diverse possibilities of comparison. In other words, the SBE method can produce similar perceptive values for different landscape scenes, whereas LCJ requires a choice between the landscapes (Hull *et al*, 1984; Schroeder, 1984).

It has been discussed that alternative methods can be efficient in developing maps. The process suggested by Daniel & Boster (1976), is to take photos at random angles from predetermined viewpoints. The viewpoints would be recorded by geographic positions, facilitating the collation of a visual inventory database. Further research and analysis of public perception ratings of the landscape scenes can be assembled into the database in order to construct scenic quality contours, similar to topographic maps.

(Daniel & Boster, 1976, p18)

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In contrast, a contour on the scenic beauty map represents the scenic qualities of the view from each point on that contour.

(Daniel & Boster, 1976, p53)

Inevitably this process has some limitations in identifying significant localized views, which may be located as intervals of assessed points. Consequently, it is dubious as to how many points would be required to validate a credible coverage of the landscape to create scenic contours. This poses future research questions to develop techniques to identify local views of significance.

An alternative method of mapping visual properties of landscape scenes was produced by Elwood Shafer (1977). This approach was adapted from the SBE method, and used in the US Forestry Service. The objective of this methodology was to measure landscape preferences, by associating values to quantified areas and perimeters of features in black and white photographs.

Measuring the area of shapes and patterns relative to descriptive categories of landscape components eg. sky, vegetation in the foreground, water, streams and lakes, provides a formalist

procedure which could be used to compare landscapes of various contexts as well as the perception value. Carlson (1977) describes the process as completely formalistic as the methodology measures only formal aspects of photographs- the shapes of the zones, not their contents, or the relationships between the shapes and lines. Consequently, there are three key assumptions to this methodology,

- The aesthetic quality of the landscape is meaningfully correlated with certain preferences for that landscape
- The relevant preferences are those of the general public
- The presence of the formalist theme

Bourassa (1991) was also critical of the process, believing it lacks theoretical derivation and causal links between independent and dependent variables.

Even though the process has its critiques, numerous studies have adopted the method with slight alterations for various landscape contexts. Anderson & Schroeder (1983) have used the model to depict relationships of urban landscape preferences. Hull & McCarthy (1988) utilized a derivation of the SBE and Shafer's method to research the effects of Australian wildlife on preferences. The SBE model has been used to investigate preferences of different demographic samples and educational background (Zube,

1973). Furthermore, similar studies have been conducted to examine the use of representational media in comparison to field assessments (Daniel & Boster, 1976; Zube *et al* 1987; Coughlin & Goldstein, 1970).

Of more recent past a study was conducted by Lothian (2000) to assess landscape quality associated to landscape character types and environmental associations of physical properties within the landscape.

##### **4.10 LANDSCAPE QUALITY ASSESSMENT OF SOUTH AUSTRALIA**

An alternative approach to classify landscape quality with reference to character zones was conducted by Lothian (2000) in his dissertation *Landscape Quality Assessment South Australia*.

Lothian set out to develop a methodology which could measure landscape quality across an expansive landscape region. The hypothesis was:

To provide, through a thorough analysis of human perception and interaction with aesthetics and landscape quality, a comprehensive basis on which to develop a

credible methodology for the large-scale assessment of perceived landscape quality.

(Lothian, 2000, p6)

Through a detailed review and critique of landscape assessment theories and analysis of the philosophical discourse of aesthetics, psychoanalysis and cultural studies, Lothian (1999, 2000) established a foundation for the development of a strategic model to value the aesthetic quality of landscapes.

The underlying theory of the model can be attributed to the subjectivist paradigm, rather than the objectivist. In other terms, the landscape is assessed with reference to the perceptions of the public. Referring to Kantian philosophy, which argued the visual landscape to be a public rather than private quality, the methodology employed by Lothian contrasts remarkably from previous visual landscape assessment studies.

In addition to Kantian philosophy, Gestalt psychology has informed and supported the development of Lothian's scenic beauty survey methodology. Gestalt principles of holism, unity, variety and visual segregation have been found to be influential to preference ratings of landscape quality (Koffka, 1935; Wertheimer, 1974).



Lothian (2000) partially reviewed and compared theories of landscape quality and perception to inform predictive models of landscape appraisal. Of particular note is the Kaplan's information processing theory (Kaplan & Kaplan *et al*, 1989) and Gestalt recognition, which are both endorsed as predictive models of landscape visual quality.

Fundamentally the key objective of the methodology developed by Lothian (2000) was to formulate an objective assessment of subjective values. It was vital to construct a model which does not attempt to measure attributes of the physical landscape and assume that these determined landscape quality independent of human perception; example being the VMS model described above. The preferences for landscape aesthetic quality needed to reflect the general community rather than any special demographic group. In order for this to be achieved, the model needed to engage the public's aesthetic preferences and then empirically analyse the values in relation to physical attributes in the landscape, assessing any commonalities for different landscape scenes.

##### **4.10.1 Empirical Methods of Landscape Preference Classification**

Lothian (2000) adopted a psychophysical approach to landscape quality assessment for a large-scale landscape of nearly one million

square kilometres. Evidently the process needed to utilise tools which could consolidate the values of diverse and sparse landscapes without the costs and time of engaging local residents in field assessments. Consequently the methodology utilised surrogate scenes in a consultation process that presented the various landscape regions and character zones on photograph slides.

Somewhat similar to the Scenic Beauty Estimation (SBE) method, the landscape scenes were rated on a 1-10 (1 being low 10 being high) by various demographic groups to a sample size of at least 300 participants as this number is considered to be optimal for statistical analysis. It is said that 'a sample of say 200 or particularly 100 or less will pose significant difficulties in analysis. Standard errors and standard deviations will be larger and the means may not be confidently taken as representing the community' (Lothian, 2000, p409).

The model developed by Lothian comprises of independent and dependent variables, statistical analysis and applying the results to mapping techniques. The following table documents in more detail the variable components:

**Table 4.2**

**NOTE:**  
This table is included on page 104  
of the print copy of the thesis held in  
the University of Adelaide Library.

(Lothian, 2000, p251)

The derivation of the independent variables has been determined by the size of the landscape study. For the purpose of creating a rational framework of photographic representation for such a large landscape, it was decided that a structured grid would be impractical requiring an alarming number of photographs. Alternatively if a larger grid were to be used, the number of photos would not be truly representative of the variance in landscape character. Or alternatively it would not be adequate to invite the public to provide photographs of landscape scenes as these would be artistically composed biased photos of popular landscapes, typically of high quality, which would neglect landscapes of lesser quality in the assessment.

#### **Collection of photographs**

The samples of photographs were compiled in accordance with a series of principles, which sought to limit redundancy. The principles were representativeness, equivalence, complexity, typicality and simplicity. Each variable was assessed against

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photos from the landscape region to provide a sample of diverse compositions. Hence the sample were calibrated to accommodate the variance in complexity of scenes, in landscapes of topographic variance, as opposed to flat barren landscapes. 'The overall aim is to evaluate the landscape, not the photographic representation of it, and composition that enhances the quality of the scene as a photograph is to be avoided' (Lothian, 2000, p259).

The following criteria was used in taking the photographs

- 50mm lens- similar to the human eye
- Photography at human eye level (1.7m); not elevated or depressed
- Horizontal format not vertical
- Landscape view extending to the horizon i.e. not a confined close up view
- Ideally sunny conditions
- Good exposure and clarity without strong side lighting avoiding early morning or late afternoon

For each photographed viewpoint the film numbers, film exposure and a brief description of the photos were recorded. The location of the photograph was marked onto the map, the location of which was as close as possible to known features. For a series of viewpoints a global positioning system (GPS) was used to record

the location of the photograph. In areas of high altitude and topographic variety a clinometer was used to equate the elevation of landscape features for reference.

The distribution of slides covering landscape regional zones was not proportionate. The Mount Lofty Ranges and lower north accounted for 34.5% followed by the far north and Flinders Ranges which accounted for 15.7% and 15.5% respectively. In total 2176 photos were captured of the South Australian landscape.

The number of slides used in the survey assessment was firstly guided by the classification of landscape character and secondly by a classification of landscape types. At the time of conducting the survey, the most detailed and relevant classification of landscape character regions was *Environments of South Australia*, conducted by Peter Laut & Associates and CSIRO Division of Land Use Research (Laut *et al*, 1977).

*Environments of South Australia (1977)* provided a framework for validation of landscape character regions. This report was based on biophysical attributes and categorised into a structured hierarchy of environmental landscape units. Additional categories have been used to classify zones in accordance to climatic zones which are

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relative and distinctive of land form, land use and land cover. The hierarchical classification was province- region- unit.

Typically environmental associations relate to character zones however there is some incongruence in the relationship of visual recognition of environmental associations. Consequently a more definitive process of acquiring classifications is supported.

In Lothian's study, the classification categories produced by Laut did not provide adequate coverage of regional variance. For example, taking into account Laut's definitions, landscape associations would provide somewhat similar character zones for the Mount Lofty Ranges and the Murray Valley, two regions of significant visual difference. For this reason Lothian adopted a process of defining landscape types, which could aid the consolidation of photographs representative of typical landscape visual regions. Landscape types were derived from the photographs taken for each region, thus forming supplementary evaluations of discreet differences in topology and land forms. Consequently, the hierarchy of landscape classification was derived relative to province- region- environmental association units and illustrative depictions of elementary characteristics such as the presence of water bodies, creek lines, gibber plains etc.

The final number of slides chosen to be assessed was 160, with two sets of 80 slides used in subsequent carousels, taking approximately 30 minutes for presentation and assessment.

#### **Survey Methodology**

The 160 slides chosen to be surveyed consisted of 10 test slides to inform the process of assessment, 5 slides of interstate landscapes to preclude any comparative values and for validation. The 150 slides used for statistical analysis, were manually randomised and presented to participants in several rating sessions with varied community, professional and student participant groups.

Different forms of media were used to advertise the sessions, including an article in *The Advertiser* newspaper and an interview with radio introducing the project and inviting people to attend a session. More direct forms of communication were to send emails to organisations and public departments.

At each survey session, after the participants had taken their seats, they were given instructions and a form to fill out their personal details. The instruction sheet clarified some important characteristics of the assessment process,

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I ask you to rate the scenic attractiveness of each scene on a rating scale of 1 to 10, with 1 being very low and 10 being very high. I ask that you try and use the entire range, don't sit in the middle. Also think of yourself standing in the scene and asking yourself, how much I like this scene. I don't want you to rate the quality of the photograph of the scene but rather the scene itself.

Two further things. Firstly I ask that you rate the scene on what you think about it, not on what you think other would prefer or what they should prefer. Secondly, if you have training and knowledge in the life sciences- botany, biology or in land management, I ask that you put this aside. I'm looking for rating of scenic quality, not on the extent of overgrazing or degradation or in terms of ecological significance.

Lothian, 2000, p268

The instructions are very descriptive and importantly phrased for comprehension. However, the degree of explanation can be perceived to over emphasise the requirement for intangible qualitative assessment, specifically asking people to neglect their knowledge and degree of landscape education.

The rating instrument was derived from a study of rating scales used in precedent landscape survey assessments. Survey assessment rating scales have ranged from 0-9, 1-10 and 1-5 scales. Some examples are shown in the following table

**Table 4.3**

Anderson & Schroeder (1983)	0-9
Arthur (1977)	0-9
Brown & Daniel (1991)	1-10
Bergen <i>et al</i> (1995)	1-10
Carls (1974)	1-5
Miller (1984)	1-5
Lothian (2000)	1-10

The scales of assessment differ depending on the rationale of ambiguity in assessment processes. For example, it can be assumed that a rating of 0 would imply a complete absence of visual quality in the landscape which is theoretically incorrect. Furthermore a rating scale of 0-10 would imply that 5 was the mid point which can neutralise the result. Lothian decided a rating scale of 1-10 was more efficient and statistically justifiable as it provides a choice of 10 points with a mid point between 5 and 6 which forces participants to choose on either side of the median. Furthermore a rating scale of less than 10 would not provide sufficient

discrimination between scenes. In addition, scales larger than 10 have not been tested in the literature review and it is envisaged that scales of 50 or 100 would provide impractical survey assessments with increased levels of scrutiny and mental fatigue for participants.

Further analysis of Lothian's process has indicated the rating scale to be theoretically ordinal, however some participants have divided the scale into equal proportions by submitting half marks, responding as if the scale is interval. Consequently, for a relatively small scale of (1-10) it can be projected that a landscape value of 8 would provide twice as much appreciation to that of a 4 value.

The statistical design of the process was of vital importance to determine the sample size and number of photographs required to validate a true indication of the variance in landscape character to valued judgements. The following describes the process, validation and objectives of the statistical analysis:

- Analysing preferential scores with corresponding scenes with similar characteristics e.g. presence of water, vegetation coverage, degree of naturalness.
- Means and standard deviations of the scenes for each group and respondent, and for each landscape region as well as the total.
- Testing of inter group means to validate the consistency

The size of the sample of photographs is of vital importance in determining the process of presentation and analysis. Lothian (2000) initially proposed to sample 1000 photos in groups of 200 which was suggested would take 30 minutes to complete. Purcell & Lamb (1984) found that personal redundancy was correlated to the number of slides shown and similarities between landscapes. Subsequently there was likely to be minimal variance in preference values for landscape scenes with a high degree of similarity. Following a review of literature and the landscape character zones to be assessed, Lothian decided to reduce the number of photographs to limit any redundancy.

The sample size of participants is defined by algorithms which equate required confidence levels and acceptable error levels with respect to the population standard deviation. The following formulae depict acceptable sample size in accordance to confidence levels.

1.  $n = (z\alpha/2 \cdot \delta/e)^2$
2.  $= \delta \cdot (1 - \delta) \cdot (z\alpha/2/e)^2$
3.  $n = 0.25 \cdot (z\alpha/2/e)^2$

Where:

n is the sample size

z is the z score for  $\alpha$

$\alpha$  is the required confidence level

e is the acceptable error level

$\delta$  is the population standard deviation

Algorithm number three assumes that the population standard deviation is (0.25). In this instance the sample size for various z scores would be:

Z=1.91 (95% confidence) n=91

Z=1.96 (97.5% confidence) n=97

Z=2.57 (99% confidence) n=166

Z=2.81 (99.5% confidence) n=198

Z=3.04 (99.75% confidence) n=231

(all with e held at 10% ( $\pm 5\%$ ))

(Lothian 2000, p255)

These values indicate the confidence level upon which the true error level will not exceed  $\pm 5\%$  for the population of South Australia. In other terms, the sample size required will need to be large enough to limit the effect of unaccountable variances in response.

### Survey Objectives

The emphasis of the survey was firstly to identify aesthetic quality of landscape, and secondly the relationship between perceived quality and landscape components such as land form, land use, presence of water, vegetation pattern etc. The physical relationship of landforms provides comparative assessments of preferential character types. The following is a list of landscape classifications used by Lothian to compare landscape values and contexts:

#### Land form

- Exposed rock face

#### Land cover

- Presence of trees
- Height of vegetation
- Density of vegetation

#### Land use

- Significance of ridges
- Trees in crops and pastures
- Trees in hills and pastures
- Mixed use vines
- Terrain in Mt Lofty Ranges

#### Water

- Coast
- Area of water
- Length of edge of water
- Movement of water
- Psychological rating
- Murray Valley
- Area of water
- Length of edge of water
- Psychological rating
- Inland water
- Area of water
- Length of edge of water
- Psychological rating

**Diversity**

**Naturalism**

**Colour**

(Lothian, 2000, p308)

**4.10.2 Discussion and Findings of Lothian's Landscape Quality Assessment**

Lothian's study accounted for a diverse range of landscape character zones. Consequently the findings of the study were compelling in solving interrelationships between perceived quality

and landscape visual compositions. The following is a summary of the main themes:

- Landscapes with topographic variety and in particular mountains rate higher than flat land.
- Coastal landscapes with cliffs rate higher than those without
- The presence of rock faces on mountain ranges increases appreciation values.
- Elevation of the viewpoint also has a considerable effect on the occupants appreciation of the landscape, this is affected by the angle of view
- The presence of trees increases ratings especially indigenous species
- Natural scenes rate considerably higher than agricultural.
- Landscapes with water bodies rate considerably higher

The findings from Lothian's study provide insightful information to develop an argument that landscape character is directly related to landscape values as both are determined by forms, lines, colours and textures. Subsequently, this model suggests that physical properties inherent in particular landscape character zones provide aesthetic value. For that matter the following question is put forward. Can visual qualities of landscape be assessed and valued



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in accordance to landscape character classification? Gestalt theory would suggest otherwise.

Gestalt implies that landscape quality is perceived as a holistic image of piecemeal elements, in other words the overall sum is different than the sum of its parts. Consequently landscape character and scenic value are determined by interrelationship of landform, land use, vegetation coverage and intangible qualities. Furthermore, the perceived scenic value may vary from different perspectives of a generalised landscape character zone. Hence scenic quality is not uniform to landscape character.

The model developed by Lothian provides a structured framework for strategic planning of regional landscapes which can be utilised for policy driven land management practices. The model is not intended to be practical for site specific assessment.

The process of assessment is theoretically based on principles of aesthetics, psychology and fundamentally is an objective empirical assessment which provides credible, statistical validation. The positive attribute of this approach is the justification and rationale to consult with the general public and assess perception values of landscape quality in an objective framework. The visual landscape

is a public resource and should be appraised by the public in assessing proposed developments.

The deliverable outcomes of the process are both statistical and graphic. Bar charts and mapping techniques provide a broad brush review of regional visual quality classification which can be used as a reference point in land management and policy.

The constraints of the process are that it is laborious and therefore costly to implement. Consultants are required to firstly evaluate the landscape character zones and then engage and consult the public. This is an intensive process requiring large distances of travel and photography. In addition, the hours necessary to organise survey material and sample participants can be inefficient in allocating resources.

Some additional limitations of the model are the deficiency in sensitivity to assess site specific development proposals. The model does not provide sufficient tools to assess detailed variations in landscape visual properties. It is more valid to assess tangible site specific visual change caused by a development proposal with a quantifiable formal aesthetic model, whilst referring to a strategic policy of perceived landscape quality as depicted by Lothian's state wide assessment.

#### 4.11 ALTERNATIVE METHODS OF MAPPING LANDSCAPE QUALITY

Studies in the United Kingdom have reported on approaches of mapping qualitative values. These studies have been important in developing management strategies to preserve landscapes, which are under threat of urban sprawl and development.

New methods and approaches are being formed to measure and map intangible qualities of landscape. The particular project at the centre of this discussion set out to identify tranquil areas defined as 'places which are sufficiently far away from the visual or noise intrusion of development or traffic to be considered unspoilt by urban influences' (CPRE & the Countryside Commission, 1995). A robust methodology utilising a diverse range of community participation tools, survey documentation and GIS was constructed to define and map tranquillity (MacFarlane *et al*, 2004).

One of the key attributes of the process is the incorporation of public consultation in the early phases of negotiating features which represent or detract from tranquillity. In other words, the parameters of assessment were adjudicated by the public.

The techniques used to engage the public were varied and flexible to meet the demands and most suitable form of communication to express their opinions. This can incorporate drawings, text, verbal discussions or a combination. The range of tools used in the tranquillity mapping project were

- **Spider diagrams**- where people draw diagrams of ideas that are related to each other;
- **Graffiti walls/ boards**- where people can 'brainstorm' and write any ideas (usually on post-it notes) that they have about tranquillity on the board;
- **Visual representations**- asking people to draw a picture of a real or imagined tranquil place, and to annotate their picture(s) with further details if necessary;
- **Mapping**- asking people to mark on maps where tranquil places are, and to add details of what makes that place tranquil in their opinion;
- **Bean voting**- where people comment on the ideas on the graffiti board and vote for the ones they agree with;
- **Circle diagram**- consisting of a number of concentric circles equal to the number of responses, with each participant moving a response one step closer to the centre of the circle if it is felt to be important.

(MacFarlane *et al*, 2004, p24)

To verify the results a series of techniques were used. Firstly triangulation was used which compares the results of different techniques employed to ask the same question. A subsequent approach was to consult with the participants in verification meetings asking the participants if they agreed or wanted to challenge or provide comment to the analysis.

The mapping process to follow, collated the results of the participation appraisal into a database. The GIS system modelled the database as the foundation to perform operations on the parameters identified in the objectives of the project. Due to the variables of assessment being extremely qualitative, it was up to the research team to review and classify the categories of response. It is vital at this stage of the process that the parameters of classification are transparent, limiting any biased manipulation of the raw data. It has been stated in the report that 'expert' judgements of factor weighting have been kept to a minimum.

The main innovative concept developed in this model is the ability to map relative rather than absolute values defined by boundaries. In other words, the maps do not illustrate cadastral lines which separate areas of tranquillity from those that don't. This advanced modelling technique produces surface maps which give a valued

score of tranquillity for landscape units rather than crude zones of high, medium or low tranquillity.

Mapping in a GIS based environment has enabled this model to overlay geographic referenced spatial data and query various relationships of subjective perceptions beside quantitative values of distance etc.

It is envisaged that elements of this methodology can be adopted to construct a model which seeks to qualify and map visual properties of the landscape in an objective credible, efficient,

#### **4.12 CONCLUSION**

This chapter has firstly reviewed the history of landscape visual resources and the notion of landscape as a public good. The origins of assessment in the United Kingdom and United States have been discussed through various disciplines of landscape related research. Formerly landscape assessment comprised of two forms; inventory and perception values. These skills account for various processes of landscape architectural design practice, specifically landscape character assessment and evaluating visual properties of the landscape to facilitate planning developments and management policy.

#### 4. Theoretical Paradigms of Landscape Aesthetic Assessment and Methodological Divergence

This chapter has explained that landscape visual assessment is but one component of a much larger discourse of landscape assessment. However the aesthetic value of landscape is predominantly related to the visual properties. Consequently, landscape visual resources have a significant effect on future development assessment proposals.

The second objective of this chapter was to review the theoretical paradigms of landscape assessment. Several research reviews of the theoretical schools of thought have alluded to the landscape being valued in accordance with either inherent qualities or the eye of the beholder.

The schools of thought have been further defined and classified to be the Ecological, Formal Aesthetic, Psychophysical, Psychological and Phenomenological. Each of the theoretical paradigms reveals an insight to the complexity of landscape values. Various models have been developed based on these theories.

Landscape architects, environmental scientists and geographers to name a few professions, have been engaged as consultants to conduct assessments based on these theories.

The models employed for visual assessment have predominantly been based on the formal aesthetic and psychophysical paradigms, which portrays two distinctive theoretical approaches to valuing landscapes. This chapter has described several models with varied techniques that provide a foundation to develop a consolidated framework that accounts for a refined theory of visual resource management.

## **PART TWO: VISUAL EFFECTS OF WIND FARMS**

## 5 WIND FARMS; RENEWABLE ENERGY, TECHNOLOGY IN THE LANDSCAPE.

### 5.1 INTRODUCTION

Wind farms produce energy directly from a renewable clean energy source *the wind*. Unlike numerous other sources of energy production, that produce energy through combustion producing gaseous by-products, wind energy has no known effects on global warming. This is the major attraction of wind power as an alternative source of electrical energy production.

As the population of humans occupying the earth steadily grows, the demand for electricity energy increases at an alarming rate. It has become evident in the current debate on climate change, that the need to supply energy from other means than fossil fuel is required.

Greenhouse gases such as carbon dioxide trap heat in the atmosphere accelerating climate change. Hence, the production of excessive gaseous substances during fossil fuel combustion for electrical energy production is a principal cause of some of the effects we are witnessing today. Since 1988, the Intergovernmental Panel on Climate Change (IPCC) has been making the same

recommendation of 60 percent reductions by 2050 to prevent dangerous climate change (IPPC, 2007).

Numerous alternatives such as gas, solar, biomass, geosequestration (clean coal technologies), geothermal, hydro electric and wind have been discussed. It is evident that a collective global response from all sources of power generation is required to combat the current levels of greenhouse gas emissions.

This dissertation is specifically reviewing wind turbine generators as an alternative renewable source of power supply. Wind turbines produce renewable energy by means of transforming wind energy into electricity; the process has no by-product of gaseous emissions. Hence, wind power is an attractive source of technology, which is evolving into a feasible option. Consequently, due to the current market forces and political green movement, wind power generation has seen rapid growth worldwide. 'For the last decade wind power has been the fastest growing energy technology in the world, having an average growth rate of about 30% per annum' (Diesendorf, 2003/04, p43). Numerous countries have installed statutory regulations and policy aims for a certain percentage of power generation by wind. Countries that have introduced wind energy targets are documented in the following table:

## 5. Wind Farms; Renewable Energy, Technology in the Landscape

**Table 5.1** Global wind energy targets (adapted from Auswind, 2006d, p1)

**NOTE:**

This table is included on page 116 of the print copy of the thesis held in the University of Adelaide Library.

During the 1990s, global wind generating capacity increased substantially (Pasqualetti *et al*, 2002), from 2000 MW in 1990 to 17,300 MW by the end of the decade (OECD, 2002).

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<sup>1</sup> Twenty North American States and the District of Columbia have adopted Renewable Portfolio Standard (RPS) requirements. An RPS uses market mechanisms to ensure that a growing percentage of electricity is produced from renewable sources, like wind power. This provides a predictable, competitive market, within which renewable generators will compete with each other to lower prices

Right now our industry provides the most cost competitive, grid connected, zero carbon emission energy technology available. It is proven and currently available for further deployment. Around the world, wind energy is the fastest growing energy technology.

(Auswind, 2006a)

This chapter will firstly elaborate on the evolution of wind farming and the components of a typical onshore development, followed by a brief discussion on the mechanics of how wind turbines convert kinesthetic energy to electrical energy.

The second objective will be to discuss the markets for generation, wholesale and retail of electrical energy in Australia. This will form the foundation to discuss the growth of a renewable energy industry in Australia. Further insight into financial costs of installation, energy production and percentage of power supply from renewable energies will highlight the current and projected market for wind energy in Australia. Furthermore, an examination of the current rate of growth with prospect for future growth of the wind farm industry in Australia, will determine the possible positive and negative implications this may have on landscape amenity.

Thirdly, the discussion will shift to a global perspective of environmental factors and visual site design of wind turbines. A more detailed review of research related literature on the visual design of wind farm layouts will comprise of concepts of comprehension, legibility and complexity and the wind turbine as a sculptural element. The discussion will expand on visual design considerations for wind turbines, explicitly details resultant of spatial arrangements of turbines and colour and form tests on perception ratings.

Fourthly, this chapter addresses the social implications of wind farm visual effects and perception values of wind farms as a technological fabric and symbol of sustainable energy. A review of recent literature and empirical studies used to decipher the communities perceptions of landscapes and wind farms will prelude to hypotheses such as '*Not In My Back Yard*' (NIMBY). Further insight to the symbolism and perception of wind farms will be discussed by describing several theoretical models, which have been developed to classify wind turbines as technological fabric in the landscape.

Finally, the discussion will redirect its attention to the growth of a global industry with particular reference to the experience of the world leaders in wind energy production: Germany, Spain, United States of America, United Kingdom, Denmark, Sweden and a

general discussion about the European Union. A brief review of the planning process and political, economic regimes will establish further insight into the current market acceptance and development of wind farms.

### 5.2 WIND FARMS; A COMBINATION OF ELEMENTS

A 'wind farm' is defined as a group of wind turbines which are clustered together to produce electrical energy. The development of a wind farm includes Wind Turbine Generators (WTG), vehicle access tracks, underground cabling for electrical interconnection and a switchyard (substation) for regulation of power into the transmission lines and the grid.

Each WTG acts independent of the others producing electricity from the available wind resource. The arrangement of the turbines is critical to the efficiency and profitability of the development. Consequently, the turbines are located to maximize the wind resource available and spaced sufficiently apart to not obstruct the circulation of wind to adjacent turbines.

The scale of the development ranges in size in accordance to the wind resource and land availability. In Australia this ranges from one to fifty five turbines in a single development proposal



([www.AusWEA.com.au/AusWEA/projects](http://www.AusWEA.com.au/AusWEA/projects)). However, a wind farm development at Lake Bonney along the Woakwine Range (in south eastern, South Australia), has been approved to increase to an aggregate total of 122 WTG. This is a combination of three different development applications by two different proponents.

Wind turbines have evolved in form and scale over the years. The current wind turbine installed in Australia since the late 1990's comprises of the following components:-

- Concrete foundation approximately twelve metres in diameter and three metres deep, buried with backfill and topsoil to enable grazing right up to the base of the tower:
- tower of approximately sixty to eighty metres in height, typically made from aluminous steel;
- nacelle that sits on top of the tower and houses the generator and mechanical gears of the turbine. The nacelle is located on top of a large bearing which is remotely censored to direct the blades into the prevailing wind;
- hub which is the nose cone located to the front of the blades and nacelle;
- rotor consisting of three blades made from reinforced carbon fibre a light but very strong and durable material.

**Figure 5.1** Components of a wind turbine generator  
(adapted from AusWEA, 2002b)

**NOTE:**  
This figure is included on page 118  
of the print copy of the thesis held in  
the University of Adelaide Library.

The evolution of wind farming has seen the wind turbine transform from smaller scaled machines constituting a larger quantity within a

particular landscape (Altamont Pass, California), to larger scaled machines less densely populated (typical of Australian developments).

I believe that the masses of wind machines seen at places such as Altamont Pass and San Geronio Pass in California do not simply transform the landscape, they threaten us as well.

(Brittan, 2002, p61)

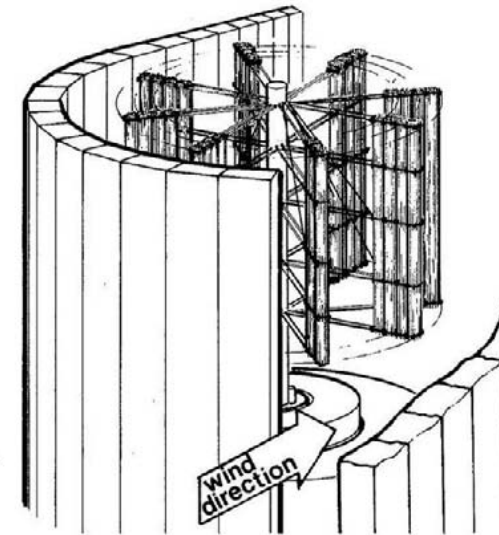
**Figure 5.2** Altamont Pass (Source: <http://pics4.city-data.com/cpicc/cfiles16464.jpg> accessed 12/12/09)

NOTE:  
This figure is included on page 119 of the print copy of the thesis held in the University of Adelaide Library.

The evolution of the wind turbine has seen it transform in shape, materiality and scale. This has significantly altered the visual

context from historical pasts of the vertical Persian panemone in the early 12<sup>th</sup> century (Figure 5.3), to the horizontal tower mills common throughout Europe (Figure 5.4).

**Figure 5.3** Vertical Persian panemone. One of the earliest known wind power technologies (Gipe, 1995a, p119)



**Figure 5.4** One of the first post tower mills in England  
[www.suffolkmills.org.uk/windmill.htm](http://www.suffolkmills.org.uk/windmill.htm), viewed 29<sup>th</sup> December 2007

fabricated a turbine, which was omni directional meaning it would operate regardless of the wind direction. The vertical axis of rotation also meant that the generator could be located on the ground, constituting a more practical mechanical and electrical connection and servicing unit.

**Figure 5.5** Darrieus turbine approximately 30 metres high two blades  
[www.biocrawler.com/encylopedia/image](http://www.biocrawler.com/encylopedia/image), viewed 29th December 2006

NOTE:  
These figures are included on page 120  
of the print copy of the thesis held in  
the University of Adelaide Library.

The wind turbine then took on many different forms including numerous models of vertical axis. French engineers who configured a model, which was symbolic of an 'eggbeater', conducted innovative experiments in the 1920's. The inventor D.G.M Darrieus

## 5. Wind Farms; Renewable Energy, Technology in the Landscape

Many different forms of Darrieus turbines have evolved over the years, some with three blades. Small-scale urban applications are also becoming available on the commercial market for rooftops of buildings, streetscapes and open spaces where wind is prevalent ([www.quietrevolution.co.uk](http://www.quietrevolution.co.uk), viewed 29 December 2006).

A limitation of the Darrieus model is the need for greater wind velocity nearer to the ground. The turbine is governed by bearing loads at the top and bottom of the drive shaft with large bending forces on the blades limiting the height of the machine. Hence, the turbine is not able to make use of stronger winds at higher altitudes. Furthermore, the rotor is not freewheeling and needs to be motored to efficient revolution speeds. Consequently, the cut in wind speed is relatively high. This means that the turbines will be stationary in low winds. This has an impact on the visual effect of the technology, as they will be perceived not to be working.

The horizontal rotor turbine has evolved as the preferred solution to commercial realities of development. Typical of what is seen in Australia the wind turbine generator consists of a tower, either two or three straight blades and a rotor generator located on top of the tower.

Over the years, the materiality and construction of the tower and blades have changed. This has quite dramatically altered the visual appearance of the turbine. The earliest generation of wind turbines, were constructed from steel lattice towers with a varied combination of blades (some having two, others three). Various wind farms in New Zealand developed in the 1990's (Tararua Wind Power Project 1995) have been developed using steel lattice towers (Kenetech Windpower KVS-33 Turbine with 120-foot towers). The wind turbines installed in Australia are all enclosed steel tubular poles, typically coloured matt white to a light grey.

**Figure 5.6** Turbines on the left are lattice towers used in New Zealand, Tararua Wind Farm (Works Consultancy Services 1995). On the right are the more common steel tubular towers; Codrington, Victoria: photo source (Brett Grimm, 2005).



The blades of the current day turbines range from 25-50 metres in length depending on the size of the tower and rotor. The speed of which the blades rotate is also variable, but ranges within 10 - 25 revolutions per minute. This speed can be perceived as smooth

and elegant at great distances, however up close the motion of the blades and the forces influencing the movement can be seen to be exhaustive. The average speed of the outer tips of the blades for a turbine of approximately 80 metres tip of hub in height (blade length 40-45 metres) is 210-215km/h.

The towers upon which the rotor and blades are positioned are typically made from steel. However, in Europe they have been made from various other composite materials including concrete in the past. Alternative composite materials are reinforced carbon fibre (Vestas Wind Systems, 2003).

The scale of wind turbines has changed dramatically during the 1990's early 2000. We have seen the size grow from 1980- 45 metres high (hub height and rotor) 1985- 50m, 1990- 65m, 1995- 100m and by 2000- 135m (World Wind Energy Association, 2003). Further speculative plans are for on-shore turbines over 200 metres in height, as already designed for off-shore developments in Europe.

Denmark is currently experimenting with five and 6MW generator towers that are twice as large as those in use today.

(Mercer, 2003, p96)

**Figure 5.7** Height of Wind Turbine Generators (WTG) (adapted from World Wind Energy Association, 2003)

**NOTE:**  
This figure is included on page 122 of the print copy of the thesis held in the University of Adelaide Library.

Evidently the larger the blade (rotor) diameter, the greater the amount of electricity output. Consequently, the tower needs to accommodate the circumference rotation of the blades to approximately half the height of the tower. Current rotor diameters are 80-90 metres, implying tower heights of 80 metres.

**Figure 5.8** Comparison of power output and average turbine heights (Durstewitz, 2003)

**Figure 5.9** Wind power output relative to turbine rotor diameter. ([www.windpower.dk](http://www.windpower.dk))

NOTE:  
These figures are included on page 123  
of the print copy of the thesis held in  
the University of Adelaide Library.

**5.3 HOW DO WIND TURBINE GENERATORS WORK?**

The motion of wind transfers kinetic energy into electrical energy in a direct transaction. As the wind speed increases more electrical energy is produced. However some of the energy in the process is converted into sound, heat and some continues in the form of air movement as turbulent air emerging behind the blades.

Internally, the blades which spin in accordance to the wind velocity are connected to a generator inside the nacelle. This generator produces the electrical energy. The energy produced is extremely sensitive to the wind velocity. For example, doubling the wind speed will produce eight times the energy. Hence 'the power output is a function of the cube of the wind speed, so doubling the wind speed gives eight times the energy potential' (Australian Uranium Association, 2007). However the power is regulated to mitigate variable fluctuations in the output of electricity into the grid, and also to increase the durability of the turbine. Consequently the following table describes the asymmetric relationship of power output and wind speeds for a typical turbine specification.

**Table 5.2** Wind speeds and power production specification

Wind Speed m/s	Wind Speed km/h	Operating Strategy
<4	<14	Machine shut down not worth wear and tear.
4-12	14-45	Output increases steadily with increasing wind speed.
12-25	45-90	Output remains steady and excess energy 'spilled' from rotor.
>25	>90	Machine shutdown for self protection.

Source: (adapted from, AusWEA, 2002b)

The efficiency of turbines has also dramatically increased as research and development of the technology improves. As of 2006

Australian wind farms are producing capacity factors between 30-35 per cent (capacity factor is a measure of the energy output of a wind farm compared with how much it would produce if the wind were blowing at a

speed high enough for maximum output all of the time). In Europe, typical capacity factors are much lower.

(Department of Environment & Heritage and Australian Greenhouse Office, 2006)

In the 20 years since 1980, the generation of power from a turbine has increased by 180 times at half the cost per unit of power (Auswind, 2007). Obviously it will be difficult to sustain this trend of development and efficiency, however the current levels of production are broaching on competitive figures of coal production.

#### **5.4 AUSTRALASIAN ENERGY SECTOR**

The energy sector in Australia has most recently come under scrutiny for the reliance on fossil fuels and resultant environmental concerns of carbon dioxide emissions. This has inaugurated the support of alternative renewable energy sources and the development of interventions to limit the amount of carbon emissions into the atmosphere. Furthermore, predicted time frames of mining finite resources such as coal are understandably a catalyst to develop strategies to prolong the resources available and eventually substitute to various other sources of electricity production.

#### **5. Wind Farms; Renewable Energy, Technology in the Landscape**

It must be stated here that this dissertation will only discuss the supply side of the energy market. Strategies to suppress the demand for electricity will also have a significant role in the formation of a reformed energy sector.

Energy expenditure in Australia in 2002-2003 was approximately fifty billion Australian dollars. Energy exports of natural resources coal, natural gas, oil, petroleum and uranium amounted to \$24.2 billion in 2004 (Prime Ministers Office, 2005). This highlights the importance of the energy sector to the Australian economy. Furthermore the level of support the energy sector provides for the economy is not to be underestimated solely in monetary terms. The industry, be it directly or indirectly through energy intensive manufacturing, employs approximately 150, 000 Australians (Prime Ministers Office, 2005).

The figures above speak volumes of the current reliance on the industry to maintain stability in the process of restructuring the percentage mix of electricity power generation. Consequently, it is important that the Australian Government strives to deliver its vision for an energy policy which aims to promote prosperity, security and sustainability of energy supply.



## 5. Wind Farms; Renewable Energy, Technology in the Landscape

The Australian Government's objective is to ensure that there is reliable access to competitively priced energy, the value of energy resources is optimised, and environmental issues are well managed.

(Prime Ministers Office, 2005)

Australian electricity generating capacity in 2003 was 45,000 MW of which 28,000 MW was coal fired. However it has been speculated that wind power could provide between 10,000-20,000 MW of power in Australia (Diesendorf, 2003).

The supply of electricity in Australia functions on state electricity grids and a national grid. This consists of each mainland Australian state obtaining several centralised coal-fired power stations. The coal stations have high capital cost and low fuel costs, operating 24 hours a day supplying 'base load' power. 'Peak load' power is also supplied to meet the diurnal demand. It is typically provided by gas turbines (high fuel cost, low capital cost) or hydroelectric plants (high capital cost, zero fuel cost). There is also coal-fired intermediate load power stations that can vary output according to demand. Diesendorf (2003) believes wind power can provide a proportion of base load power given economies of scale and peak load generation capital expenditure on gas turbines. For example:

it may be possible to operate an electricity grid with 40% of its energy generated from wind, without highly expensive long-term storage, the average cost of such a large amount of wind power plus back-up may be about 25% higher than if only 8% of grid energy came from wind. However, in the real world, this cost increase would be offset to some extent by the reduced cost of wind turbines in large-scale mass production. Furthermore, in most of the Australian States (not Victoria), it is possible to vary output of coal-fired power stations substantially over a period of an hour or so to help follow variations in demand and in wind power.

(Diesendorf, 2003, p44)

Accordingly the optimal composition of generation is determined by cost. Too much base load supply substantially increases the capital cost of generation, whilst too much peak load will increase the costs of operation. Consequently equilibrium is required to manage the cost of efficient generation to meet demand.

At present the market price of energy production does not consider the external costs of environmental degradation associated to carbon dioxide emissions. The cost of producing

base load electricity through thermal coal-fired generation has not been inclusive of environmental impacts in the past. Current political debate in Australia is considering the impacts on the economy of establishing carbon pricing (Tax) or trading schemes<sup>2</sup> (NOVA science in the news, 2005). However the Australian economy is reliant on energy intensive industry which is dependent on coal. Consequently, the Australian Government is extremely cautious of the likely impacts associated with a revolution of the energy sector.

#### 5.4.1 Sources of Primary and Final Energy

The composition of primary energy<sup>3</sup> supply in Australia in 2003 was 35 % oil, 28 % black coal, 19 % natural gas, 13 % brown coal and 5 % renewable sources. Coal which produced 78 % of electrical energy supply in 2000-01, is projected to continue to be the main source of electrical energy supply, despite considerable growth in natural gas and renewable forms.

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<sup>2</sup> Carbon tax and carbon trading are concepts developed by the Australian Government to combat the effects of climate change. A carbon tax will imply a percentage cost on production levels of carbon on industry. Ultimately this will affect prices to consumers. Carbon trading is derived from market forces enabling industry to negotiate carbon credits and emissions levels in accordance to production levels. In order for carbon trading to be successful, emissions targets need to be in place.

<sup>3</sup> Primary energy is the total consumption of all forms of energy in both the conversion of one form of energy to another, such as the production of electricity, and the end users such as households and industry.

**Figure 5.10** Consumption of Australian Energy Supply (ABARE 2004)

NOTE:  
This figure is included on page 127  
of the print copy of the thesis held in  
the University of Adelaide Library.

Coal is the major source of base load electricity generation and its combustion accounts for 92 percent of electricity emissions (derived from AGO 2004). Accordingly, technologies that would reduce coal emissions are potentially of great benefit to Australia's economy and environment.

(Prime Minister Cabinet, 2003)

The future projection of primary energy consumption is for a 2.1% growth per year till 2019-20. This would equate to a 50 percent

increase from 2003 figures. Final energy<sup>4</sup> consumed is also predicted to grow in excess of 50 percent to 2019-20. This prediction is largely due to a projected growth in transportation, manufacturing and construction sectors (ABARE 2004). It is expected that the recent increase in mining activity will also significantly impact on the projections.

**Figure 5.11** Total Final Australian Energy Consumption (ABARE 2004)

NOTE:  
This figure is included on page 128  
of the print copy of the thesis held in  
the University of Adelaide Library.

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<sup>4</sup> Final energy consumption which is the total energy consumed in end use. Final energy is typically less than primary energy reflecting the loss of energy in conversion. Hence the production of distribution and transmission of electrical energy supply.

## 5. Wind Farms; Renewable Energy, Technology in the Landscape

The point to be raised from these figures is the projected increase in demand for final energy consumed. Equivocally this infers the need to develop future generation plants to respond to demand. This will undeniably attract attention to future investment in the development of renewable sources. Wind power is but one form of technology which has been discussed to supplement the increase in power generation.

### 5.4.2 Wind Power as a Cost Effective Alternative Energy Source

A study conducted by Mallon & Reardon (2004) examined forecasts of base load<sup>5</sup> electrical energy production costs to the year 2020; comparing wind, coal and gas. The report provides economic evidence of coals competitive advantage and the market forces determining the energy generation mix. However, with increased oil prices and public awareness of the greenhouse effect the market is slowly transforming. This has seen a movement towards renewable sources, which inevitably leads to economies of scale and cheaper production costs.

The production costs of both wind turbines and the electricity they produce have declined by 75% over three

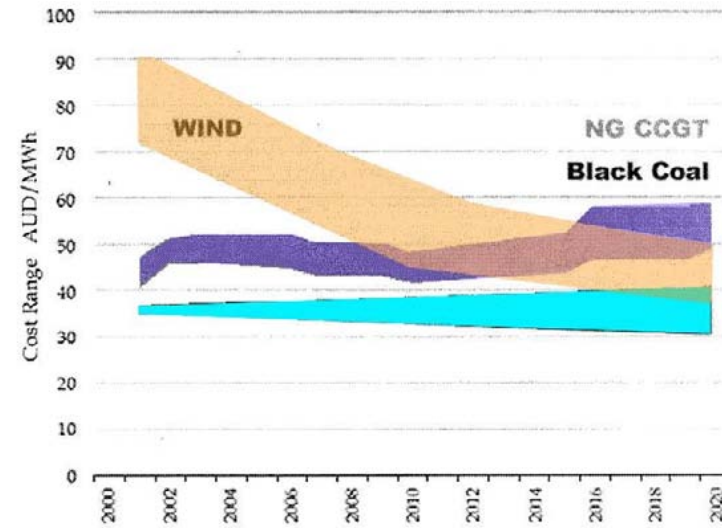
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<sup>5</sup> Base load energy is not illustrative of actual costs passed onto consumers, which may well be three times. Costs of transmission, distribution, losses and administration of supply are all substantial to the retail price per kilowatt hour.

decades. In the past ten years, installed capacity has doubled every three years, further driving down costs. (Mallon & Reardon, 2004)

The cost of producing electricity from coal furnaces is approximately \$40 per megawatt hour; this is in comparison to wind power which is approximately \$80 per megawatt hour (Mallon & Reardon, 2003). This figure is expected to be lowered as economies of scale and technological improvements are made. Some speculative projections have estimated wind power to be supplied at \$50 per megawatt hour by the year 2030 (Auswind, 2007), whilst some other studies have forecast the price to be as low as \$40 per megawatt hour by the year 2020 (Mallon & Reardon, 2004).

**Figure 5.12** Projected cost cross over ranges for wind, gas (CCGT) and coal.



**5.4.3 Mandatory Renewable Energy Target (MRET)**

Since April 2001, the Australian Commonwealth Government enacted the *Renewable Energy (Electricity) Act 2000*. Otherwise known as Mandatory Renewable Energy Targets (MRET), large electricity retailers and consumers are required to gradually increase their output or purchase of renewable energy by 2%, from 10.5% to 12.5% by 2010, or in other terms the Act requires 9,500 megawatt hours of extra renewable electricity per year by 2010, enough electricity to power four million people. However,

## 5. Wind Farms; Renewable Energy, Technology in the Landscape

due to recent increases in energy consumption and demand this only equates to a 0.5% increase.

The role of MRET is two-fold to encourage investment in renewable energy technologies and to reduce greenhouse gas emissions

(Kemp, 2004, [www.environment.gov.au/minister/env/](http://www.environment.gov.au/minister/env/))

This has provided a competitive market from various national and international companies to develop renewable electricity producing projects.

Wind power is but one of twenty different sources of renewable energy including solar, hydro and geothermal to name a few (*Renewable Energy (Electricity) Act 2000*). Interest in wind farming projects had seen a 21% increase in wind power projects from April 2001 to August 2003 (MRET Review Panel, 2003). Of the 21% increase, only 11% has been accounted for in Renewable Energy Certificates (RECS). Prosperous wind locations along the southern coasts of South Australia and Victoria have facilitated a strong growth in the industry.

Of recent times the Australian Government has been investigating the feasibility of alternative sources of energy and carbon geosequestration<sup>6</sup> (<[www.co2crc.com.au](http://www.co2crc.com.au)>).

The most important thing for the government to do is to form a view about greenhouse gas emissions and whether fossil fuel sources should meet the costs of their emissions. Then depending on the level of those costs, the promoters of alternative energy sources such as nuclear or renewable can form a business case.

Ziggy Switkowski  
(ABC 21.11.06)

Consequently, the concept of inclusive external emissions cost in what has been termed carbon trading will provide equality and cost competitive renewable energy.

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<sup>6</sup> Carbon geosequestration is the process of injecting carbon dioxide into the earth. The process is reliant on particular substrates of rock and geomorphology to encapsulate the gas in an underground reservoir. Hence, only specific regions of the earth can contain and break down the gaseous emissions to carbon compounds.

‘Auswind maintains that the market should be left to decide which technologies will best serve the nation’s needs, and that can only happen through the use of a market mechanism which creates a level playing field.’

(Auswind, 2007)

## **5.5 WIND POWERS IMPORTANCE IN THE COMPOSITION OF A REFORMED ENERGY SECTOR IN AUSTRALIA**

The MRET scheme discussed above has been successful in initiating market relief for the wind industry to be cost competitive with the low costs of coal currently experienced in Australia. Since coming into effect in 2001, MRET has generated investments of more than \$1 billion in renewable energy projects. However being an operative system of capacity targets, the current rate of growth and investment of renewable energy has absorbed the target suppressing the development of further wind installation.

Hence the market penetration of wind energy has been met by 2007, restraining the Governments intention to provide price relief for renewable technology till 2010. Mallon & Reardon (2003) have predicted that the wind power industry may become self sustaining by 2020 given technological development and future economies of scale. Hence the future growth of the wind industry

## **5. Wind Farms; Renewable Energy, Technology in the Landscape**

is reliant on an extension of the current scheme to 2020 at a pro rata proposed increase to 20,000 MW.

The Government believes, however, that the time has come to target support for renewable energy by addressing technical and regulatory barriers to widespread take-up rather than raising the general industry subsidies implicit in MRET - \$5 billion by 2020 at the 20,000 GWh level proposed by the Tambling Panel, and \$11 billion by 2020 at Labor’s proposed level.

(Kemp, 2004, [www.environment.gov.au/minister/env](http://www.environment.gov.au/minister/env))

The Australian Government has opted not to extend or increase the MRET target. It will however support the development of low emission technologies specifically renewable sources by means of research and development funding (Australian Greenhouse Office, 2004).

As a result the wind power industry is in a stationary position with the potential to increase investment reliant on carbon trading schemes, or similar Government induced MRET incentives. It is forecast that if the Government were to increase the MRET, then ‘actual trajectory of wind costs will have significant bearing on

the cost of the MRET market development scheme, since wind is likely to be the dominant technology in any MRET above the current level'

(Mallon & Reardon, 2004).

So how does this influence the prospect for future growth of the industry? Various organizations and individuals have estimated the percentage of sustained wind power achievable in Australia. Clive Hamilton (2002) together with the Australia Institute team have declared that we may eventually see perhaps 400 wind farms each with 30-40 WTG. More recently, they have argued the need for 500-600 wind farms or equivocally 11,000 WTG (Turton *et al*, 2002, pxiii). The Australian Wind Energy Association (2002b) has formalised realistic objective targets. The target is 5,000MW of wind power installed in Australia by 2010, which would equate to approximately 6% of Australia's energy needs. This forecast is unlikely to be achieved due to the current market forces; as prospective developments are not feasible without RECS. Wind power generation needs a subsidy to achieve critical mass.

Some additional issues that will need to be addressed if the market permits further growth of renewable sources, are the stability and flexibility of the grid network to allow fluctuating

## 5. Wind Farms; Renewable Energy, Technology in the Landscape

power supply. Due to wind being a variable resource, generation of power to the network needs to be able to accommodate a process, which permits variable output. As more wind farms are developed across the country, it is envisaged that fluctuations in power produced by wind will decline as wind speeds are determined by local weather patterns and these become more diverse the further apart they become. Furthermore, as long-term forecasting techniques and tools improve, the ability to alter fossil fuel generators in accordance becomes more efficient.

In addition, further research into electrical storage devices that would facilitate surplus generation during windy periods to be stored for peak consumption times would benefit the argument for wind power generation.

### 5.5.1 Current Wind Energy Developments in Australia

As of late 2007, Australia had 42 wind farms in operation, which equates to 563 wind turbines. To give an idea of the density of the turbines to land mass this equates to one turbine per 12,739 square kilometres. South Australia has 51% of Australia's wind power which equates to one turbine per 4,533 square kilometres (Auswind, 2006c).

In an average year, the amount of energy produced by wind farms in Australia is 2500 gigawatt hours of electricity enough to power

348,000 homes- equivalent to 80% of Adelaide's domestic consumption. This equates to a saving of over 3 million tones of carbon dioxide emissions per year, or taking 750,000 cars of the road; or comparably planting over 4 million trees. Each wind turbine can produce enough energy to meet the needs of 1000 homes (Auswind, 2006c).

The following tables verify the current developed and proposed wind energy supply in Australia. Specific details of wind farm locations in South Australia and Australia are documented in Tables 5.4, 5.5, and 5.6.

**Table 5.3** Summary of Australian wind power production as of late 2006, adapted from <[www.AusWEA.com.au](http://www.AusWEA.com.au)>

**NOTE:**  
This table is included on page 133 of the print copy of the thesis held in the University of Adelaide Library.

### 5.5.2 Proposed Wind Energy Developments in Australia

The amount of wind energy projects on hold, in feasibility or contractual negotiations is substantial. This raises future research questions with respect to why so many projects fold during the planning process.

As with most developments, this comes with positive and negative environmental consequences. The positive outcomes of reducing the reliance on fossil fuels and ultimately green house gas emissions are central to current public concerns of global warming. On the other hand, the potential negative impacts of numerous developments saturating the landscape character adversely are altering the amenity value of landscapes.

For example as projects develop in regions which possess prosperous climatic conditions with feasible connection to the electricity grid, the visual landscape character may in fact transform from what is perceived as an agricultural, grazed landscape to a semi industrial, electrical energy producing landscape. Consequently, future development of wind farm projects into feasible locations raises conflicting issues of regional landscape character conservation and economic efficient renewable energy.



A strategy for regulating and assessing threshold limits for wind farms in terms of scale and sequential developments in a particular landscape region can be informed by overseas experiences. Germany and Denmark are currently reviewing the effects of landscape saturation and density of wind farm developments (Gipe, 1995b).

Currently South Australia and Victoria are the leading developers of wind power. Due to the density of population being located along the coast, corresponding to the prevailing consistent wind resource and interconnecting grid network infrastructure, the opportunities for wind farm developments are financially enticing. A considerable proportion of the developments proposed are in agricultural/coastal landscapes between Adelaide and Melbourne and on the peninsulas of South Australia.

**Table 5.4** Existing wind farm developments in South Australia (Auswind, 2005b)

NOTE:  
This table is included on page 135  
of the print copy of the thesis held in  
the University of Adelaide Library.

**Table 5.5** Proposed South Australian wind farm developments 2006 (Auswind, 2005b)

NOTE:  
This table is included on page 136  
of the print copy of the thesis held in  
the University of Adelaide Library.

**Table 5.6** Proposed Projects in other Australian States 2006 (Auswind, 2005b)

NOTE:  
This table is included on page 137-139  
of the print copy of the thesis held in  
the University of Adelaide Library.

Analysing the scale of the proposed projects, and projecting an assumption that 2MW turbines will be used, we can predict that the average scale of the proposed projects will be approximately 45-50 WTG per development. Taking into consideration the scale of land required for such a proposal (typically 300-500 metre minimum spacing for each turbine to avoid wind obstruction), a rough estimate would predict 70 000 hectares (Mercer, 2003, p100). Consequently, consideration needs to be given to the extent of effect this may cause upon our landscapes. Of particular concern is the effect of landscape character transformation and visual modifications. Subsequently, in later chapters of this thesis, a suggested method will be discussed describing how to assess the likely cumulative visual effects of numerous wind farm developments within regional landscape context.

### 5.6 Criteria to Consider in Site Design of a Wind Farm.

The most favourable sites for wind farm developments are locations which have the following attributes:

- Strong and consistent winds
- Winds that blow at times of the day when the electricity is most needed
- Proximity to a suitable electrical grid

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- Land where wind farm development is appropriate, away from areas of high conservation value or areas with endangered flora or fauna species (eg National Parks and wetlands are not considered)
  - Identifiable and manageable cultural heritage issues
  - Open land without obstacles to the wind flow, and where such obstacles are unlikely
  - Broad community support and acceptance
  - Low population density
  - Good access for wind farm construction and maintenance
  - Suitable geology for access track base and foundations
- (AusWEA, 2002b)

As aforementioned in previous sections of this chapter, locations in Australia which typically possess more or less these qualities are along coastal regions. It is common for a prospective site to have strong prevailing unobstructed winds, in close proximity to the grid for connection, but within viewing distance to populations of rural townships.

The Australian Wind Energy Association (2002a) has produced guidelines illustrating the preferred siting requirements for wind turbines with relation to topography. Smooth hill tops have been recommended for airflow to be unhindered. Excessive turbulence causes fatigue, damage and shortens the life span of a turbine,

and therefore the viability of the project. Hence siting locations typically identified for development are associated to ridgelines and to a lesser extent escarpments, both visually prominent features within a rural landscape.

**Figure 5.13** Guidelines for designing wind farm efficiency ([www.AusWEA.com.au](http://www.AusWEA.com.au))

NOTE:  
This figure is included on page 141  
of the print copy of the thesis held in  
the University of Adelaide Library.

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Understandably, wind velocities and consistency primarily determine the commercial viability and success of a wind farm project. Some factors that may influence the identification of potentially windy sites are the surface texture of the surrounding landscape. The less uneven the landscape surface, the more consistent and greater the strength of the resource. For example, a mature wheat crop will slow the wind down in comparison to a closely grazed pasture. This may seem like a minor landscape variance, but the effect on wind velocity will influence power output significantly. A 15% percent increase in wind speed will produce a 50% increase in electrical power output, whereas a 20% reduction in wind velocity will limit the power output by 50% (AusWEA, 2002b). In addition, the larger the surface mass that the wind travels over, the slower the wind speed. This explains to some degree why further inland sites are not as lucrative for development.

Hence, developers of wind farm projects in Australia seek to find the best available wind resource. To aid in this process New South Wales and Victoria have produced a Wind Atlas, which illustrates the average wind velocities (Appendix 5). This is a valuable tool to determine locations, which could provide opportunities for viable developments. Other Australian states are still to follow this lead

If the retail price of wind energy was cost competitive with coal generated power, alternative sites more remote and further inland with less wind would become financially attractive. European experience provides examples of wind energy projects in locations, which are somewhat deficient of consistently strong wind ( $\geq 8\text{ms}$ ). The economies of scale of wind-generated electricity in these countries presents cost competitive pricing to the alternatives of coal and nuclear power. Hence, an increasing market share of wind energy generation in Australia will stimulate prospective projects in more remote locations proportionately away from urban populations (Mallon & Reardon, 2004). Of course, factors such as proximity to existing transmission line infrastructure for access to the grid become important financial costs.

Some other constraints which need to be resolved in the planning of a wind farm development application are the location, proximity and spacing of the turbines with respect to dwellings, National Parks, conservation areas, electromagnetic interference, noise, culturally significant landscapes, archaeological sites, native vegetation and bird and bat migration flight paths.

Commonly WTG will be separated by 3 to 5 rotor diameters (270-450 metres for a 45 meter blade turbine) across the prevailing

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wind energy direction and 5 to 7 rotor diameters (450-630 metres) with the prevailing wind energy direction (AusWEA, 2002b). For example, the density of a 20 WTG layout would be equivalent to 40 hectares.

Additional infrastructure will also need to be planned for, inclusive of access tracks usually wide enough for a semi-trailer and cranes maneuvering, substation which will house the interconnecting switch gear to enable the power to feed into the grid. Under grounding, the connecting cable between the turbines facilitates the compatibility of farming practices such as grazing and harvesting crops.

### 5.6.1 Wind Farm Siting and Noise Concerns

Numerous wind farm development proposals have undergone detailed inspections on the effects of noise on neighbouring properties and places of occupation. Fortunately acoustic noise emanation is measurable. This enables comparative analysis of common everyday experiences providing reference to judgements on whether the effects are permissible.

The main sound of the turbine is the swooshing sound of the blades as they move through the air. The sound of the gear box and generator is typically not heard unless standing directly beneath and in light winds. The noise produced by the wind farm

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increases with wind speed. Additionally, background noise also increases with wind speed, thus as the wind increases so to does the noise effect of trees and grasses etc. It has been suggested that:

The sound of a wind farm 100 metres away would be inaudible in many urban areas of Australia as it would be drowned out by wind related and other background noises.

(AusWEA, 2002b)

The following table illustrates the sound emitted from a wind farm from a distance of 350 metres.

**Table 5.7** Comparisons of indicative noise levels

Source/ Activity	Indicative noise level dB (A)
Threshold of hearing	0
Rural night-time background	20-50
Quiet bedroom	35
Wind farm at 350m	35-45
Busy road at 5km	35-45
Car at 65km/h at 100m	55
Busy general office	60

Conversation	60
Truck at 50km/h at 100m	65
City traffic	90
Pneumatic drill at 7m	95
Jet aircraft at 250m	105
Threshold of pain	140

The noise impacts associated with wind farms can be measured. Hence an objective calculation from neighboring properties and places of local, cultural significance can be carried out and graphically mapped to highlight areas of potential concern.

In the first instance background noise levels are assessed before the wind farm is installed with the expected noise level afterwards. Typically computer software is used to calculate the sound emissions taking into consideration the direction of wind and obstructions of built form, vegetation etc. The software also provides useful tools in mapping the area as a means of graphically representing the extent and degree of effect on adjacent landscape areas. Maps provide support to a technical report written by an expert identifying the definition of sound at sensitive locations and areas near the wind turbines.



To date there has been conflicting results from acoustic testing of wind farms. Professor Peter Styles of the University of Keele, United Kingdom, claimed that low frequency noise is detected by only the most sensitive equipment, which is at levels far below that at which humans will detect the low frequency. On the other hand Professor John Williams at Cambridge University has claimed that modern turbines cause social problems. However, numerous acoustic experts have stated that wind turbines do not emit significant low frequency infrasound and that there is no direct ill effect on human health.

Recommendations in Denmark have instructed that 40 dB (A) to the closest residential property is permissible in urban contexts and 45 dB (A) in rural landscapes. It has also been stated that in order to hear a turbine it must be 10dB (A) above background noise. ([www.windpower.org/en/tour/env/db/dbdef](http://www.windpower.org/en/tour/env/db/dbdef), last updated 18<sup>th</sup> May 2003, viewed August 2005).

In Australia the evaluation of the effects of noise for particular development proposals is conducted by the states Environment Protection Authority (EPA). Currently Standards Australia is developing a framework, best practice guidelines for assessment of wind farms and noise regulations.

### 5.6.2 Wind Farm Effects on Avian Activity and Bird and Bat Fatalities.

No single environmental issue has caused more consternation among wind energy advocates and environmentalists alike than the existing or potential effects that wind turbines have on birds. It is the kind of 'hot button' issue that elicits strong emotional responses, one that could, if not addressed; derail plans for expansion of wind energy not only in California, but elsewhere.

(Gipe, 1995a, p343)

The effects of wind farms on bird populations and migration patterns, has been a common topic of debate. According to Statutory Authorities and Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999*, wind farm development proposals need to consider, assess and monitor bird migration patterns and specify if there are any endangered species likely to be impacted.

Mortality rates and migration patterns of birds and bats are assessed by qualified ornithologists. Survey assessments within

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Australia to date have concluded that the risks associated to wind turbines and bird population is relatively low.

The impact of wind turbines on birds and bats is insignificant compared to the impact of domestic cats and the loss of habitat through development or even more dramatically, the chronic impact of ecological change due to climate change and rises in sea level induced by increased greenhouse gas emissions. In Australia, collision rates are generally around one to two per turbine per year.

(Auswind, 2002b)

Studies overseas particularly in the United Kingdom and United States have not been so conclusive. A study conducted in the United States by the National Wind Coordinating Committee (2001), found that wind farms kill an average of 2.9 birds per turbine per year. This figure is slightly higher than recordings from initial studies in Australian which have concluded that 1.3-2.7 mortalities per turbine per year. The American study was conducted at the Altamont Pass in California which was a first generation of wind farm planning and siting design, with turbines located in dense arrays. Evidently this site also had high avian and raptor activity, signifying a disproportionate rate of mortality.

Previous studies within this region in the 1980's conducted by California Energy Commission found that 99 birds had died in Altamont, 9 in Tehachapi and 40 in the San Gorgonio. A subsequent study conducted in 1989 by Biosystems, found that wind turbines were responsible for 160-400 birds fatalities per year at Altamont, a staggering statistic (Gipe, 1995a). Subsequent studies in the Californian region San Gorgonio Pass (Anderson *et al*, 2000) and Tehachapi Mountains (Anderson, 2000) have recorded mortalities rates of approximately 0.25 avian fatalities per turbine per year.

A study conducted in the United States by Western Ecosystems Technology (2001), has compared collision and fatality rates into the perspective of other built form structures. The following figures illustrate the disparity:

- Vehicles: 60 million- 80 million
- Buildings and windows: 98 million- 980 million
- Powerlines: tens of thousands- 174 million
- Communication Towers: 4 million- 50 million
- Wind Generation Facilities: 10,000- 40,000

(Western Ecosystems Technology, 2001, p1)

The figures above represent estimate annual collision mortalities in the United States and obviously consideration needs to be

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given to the density of urban form in comparison to the cumulative number of wind farms in operation. 'However, even if wind plants were quite numerous (e.g. 1 million turbines) they would likely cause no more than a few percent of all collision deaths related to other human structures' (Wind Ecosystems Technology, 2001, p1).

It is also worth noting that further research has suggested human related occupation to have caused alarming numbers of avian fatality with domestic and feral cats contributing to an estimate of 100 million bird fatalities per year (Wind Ecosystems Technology, 2001, p4).

These statistics have raised considerable concern to the community and environmental lobbyists, which has lead to several similar studies in Europe.

The Dutch Institute for Forestry and Nature Research (1984) conducted a pilot study of before and after effects of avian activity at Sexbierum, Netherland's first wind farm. This wind farm consisted of 18 turbines much smaller than the Californian experience. The assessment concluded that only 5% of the bird strikes were fatal, with an estimate of 68 bird fatalities during the study period of seven days and seven nights (Gipe, 1995a).

In Denmark, a four year research programme was conducted on the west coast of Jutland near Esbjerg. Some of the findings were conclusive, in commenting on the birds abilities to alter flight paths corresponding to whether the turbines were active or not. In addition, the study observed that the 'vacuum effect' created by turbulence of wind behind the rotors prevented birds from using the local region for nesting and breeding (Pedersen & Poulsen, 1991).

Another study conducted by ornithologists in Denmark established that:

the risk of collisions seemed negligible. They also suggested that local birds may habituate to the presence of the machines. To avoid conflicts, they sensibly recommended that wind turbine development should avoid the migratory routes and staging areas of sensitive species.

(Gipe, 1995a, p347)

Within Australia the experience has not been dissimilar in terms of community attitudes and observations. However wind farms are still a relatively new industry in Australia, hence very little

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research has been conducted to assess the impacts. Of note, the initial observations have concluded that the fatality rates will be some what less than what has been experienced in the United States. This is suggested to be partially due to Australia possessing fewer night migrating birds.

Since the first wind farm was installed in Australia a handful of wind farm development proposals in South Eastern Victoria have come under the magnifying glass for the effects on endangered species specifically, Orange Bellied Parrot (*Neophema chrysogaster*), Tasmanian Wedge Tailed Eagle (*Aquila audax fleayi*), the Swift Parrot (*Lathamus discolor*) and the White Bellied Sea- Eagle (*Haliaeetus leucogaster*). Several reports have concluded that the Orange Bellied Parrot is at critical risk of extinction in the next 50 years (Campbell, 2006).

The proposed Bald Hills wind farm project comprising of 52 WTG between Tarwin and Walkerville in Victoria, has been subject to planning and ministerial approval processes. Senator and Federal Environment Minister, the Honourable Ian Campbell, was publicly active in rejecting the Bald Hill wind farm proposal on the basis of the Orange-Bellied Parrot migrating through the region. In *The Age* newspaper Senator Campbell was stated saying

This bird could be extinct in 50 years. Even if you kill one bird a year, it will have an impact and likelihood to hasten their extinction.

(Campbell, 2006, p1)

The assessment and report conducted by an independent consultant, concluded that the likelihood of the parrot hitting turbines 'maybe very small- even barely noticeable- compared with natural mortality' (Campbell, 2006, p1).

The Bald Hill project was approved by the Victorian State Government on the basis of the consultant's findings. However the project was overturned by Federal Government, who decided to use the *Environment Protection and Biodiversity Conservation Act* to block the wind farm due to the possibility of 'up to one bird death per year'.

This example highlights the need for a consolidated methodology which forms regulations for assessment. This would also provide developers with specific details on which regions would not be permitted to be developed due to migration paths, and more importantly will help preserve habitat which is critically endangered.

From the research and literature it would be suggested that best practice guidelines to should be inclusive of

- Detailed studies of avian activity by qualified professional experts
- Locate turbines in locations which do not impede or obstruct known migration paths.
- Low density of turbines (enabling flight paths between the turbines)
- Minimise the number of turbines in an area that are identified as high risk to avian activity.
- Steel tubular towers are preferred to lattice towers, by means of minimising the locations for nesting and perching.

### **5.6.3 Electromagnetic Radiation and Interference.**

Communication systems such as television, radio, radars and mobile phones work on the premise of electromagnetic frequencies or in other terms wavelength radio frequencies.

The cause for concern in developing wind farms is the possible effects of obstructing frequencies. Due to wind farms and telecommunication towers both requiring locations with elevation to enable unobstructed landscapes, (telecommunications for line of sight, wind farms for wind velocity), then it is not uncommon for

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both forms of infrastructure to be located nearby. As a result it has come to attention that turbines may in fact interfere with these facilities by directly obstructing, reflecting or refracting the signals emitted from the transmitter.

The materials currently used for wind turbine blades are glass reinforced plastic (polycarbonate fibreglass) which will omit any potential significant interference; however within the local proximity this can not be conclusive.

Engineering solutions have been developed to limit any potential interference. The tower and blades are relatively slim and curved dispersing any transmission rather than obstructing. Furthermore, as previously mentioned, the blades are now made of composite fibreglass polycarbonate materials, which is transparent or non absorbent of radio frequencies. Regardless, it is still a good recommendation to compromise and assess the best outcome to site the turbines corresponding to transmission towers, especially those which use high frequency signals as they operate by line of sight.

### **5.6.4 Cultural Landscape Values; Indigenous Landscape Values**

It is extremely important in the early stages of locating prospective sites for wind farms to research and seek guidance on potential Indigenous significance of the regional area. In Australia 'state

and federal Aboriginal heritage legislation provide protection for Aboriginal sites, objects, and remains (that is traditional burials) that are significant to Aboriginal cultural tradition, and/or that are significant in archaeological anthropological, or historical terms' (AusWEA, 2002a, appendix 2, p10).

Native title exists in public lands which may have Indigenous people occupying the land who continue to follow their traditional laws and customs. Native title can not take away any one else's valid right to access the area if the intentions are already permitted or licensed. Consequently areas which may be in conflict will be considered for significance; however the native title will not be accredited as the overriding legislated land zone.

Hence it is wise for proponents to investigate the local regions' heritage through the relevant state *Aboriginal Heritage Act*, with reference to *The Native Title Act* (1993). Unfortunately, the records and resources available are not comprehensive in locating all sites within Australia. Consequently, the process of investigation needs to be able to accommodate monitoring and consultation if the following indicators of potential conflict exist:

- Evidence of Aboriginal artefacts on the surface which are believed to indicate the presence of sub-surface deposits

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- A prediction of sub-surface sites or objects based on data reported from a cultural heritage survey in an adjacent area, or nearby exposures of sub-surface deposits
- Previous records of similar sites with sub-surface evidence in the adjacent area, in a similar depositional context, or similar environmental or cultural zones
- Archaeologically sensitive landforms
- Conditions that restrict the visibility of the ground surface to less than 20 percent in an area considered to be archaeologically sensitive.

(AusWEA, 2002a, appendix 2, p13)

Hence it is wise for proponents to engage archaeologists and anthropologists to research the region for potential areas of sensitivity.

The directive of assessing landscape values is not entirely motivated by historical or Indigenous conservation. It has also become apparent that the 'sense of place' and local community appreciation of particular places and spaces needs to be addressed in an evaluation of the landscape.

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This implies more than just a value of the landscape's visual amenity but also the emotive, intangible qualities inherent in the landscape and in the eye of the beholder.

Consequently a considerable amount of consultation is required to equate landscape values corresponding to community perceptions. Over the years there have been numerous strategies to assess the community's associations, memories, knowledge and experience. It is extremely important that the process is transparent and the data collected is reported.

The process will need to be methodical for legibility, but flexible for different projects. For example, it might be more efficient and rigorous to conduct written surveys for a particular region, or on the other hand it may be better to conduct information sessions, community workshops, interviews or small group discussions.

The Australian Council of National Trust (ACNT) and the Australian Wind Energy Association (2004) collaborated to fund a research project into best practice guidelines for landscape value methodologies. A considerable part of the preliminary work included consultation and this has been documented to form a critical component of any methodology.

### 5.6.5 Wind Farms and Tourism

The siting of wind farms in Australia has typically been located along coastal agricultural areas adjacent to rural townships. Some

of these areas are considered to possess high scenic quality. This has raised several questions with respect to the effects this may have on tourism. International research and interpretative data collected in Australia has suggested that wind farms may in fact be a positive influence.

For example a wind farm located in Codrington near Portland, south western Victoria, has developed a small business, visitor information centre. For example, approximately 7,000 people attended the opening, with 1,000 people per month paying for a guided tour and 500 cars per week recorded to have stopped at the viewing car park (Harding, 2002). Educational tours have been developed with a small scale on-site van providing souvenirs and light refreshments. For a cheap price a tour will incorporate access to the base of the turbines enabling the experience of scale, noise and shear force of the turbines movements. The tours are also well informed with statistical information on energy production, house hold equivalence and emission savings.

The operators of the tourist facility have been enthusiastic about the response received.

For over two years, we have operated tours at the Codrington wind farm, and in that time have welcomed

many thousands of visitors, many of whom have come to the area specifically to visit the wind farm. We have only seen positive local economic benefits resulting from the existence of the Codrington wind farm....No technology is perfect, but a wind farm is one way of contributing to our energy needs, and at the same time to reducing greenhouse gas production and the associated climate change that may irrevocably change our coast line and way of life in the future if we do not take some action now. (Tim and Carmel Brady, *Moyne Gazette*, 18/9/2003, p2)

Similar experiences have been recorded across the country with over 80 cars per day travelling down to Esperance in Western Australia; this number has not diminished since the wind farm was commissioned twenty years ago.

Some international experience has also supported a positive effect. A study conducted in Scotland (MORI, 2002) has concluded that 43% of responding visitors said a wind farm would have a positive effect on their preference to visit the Argyle area. Only 8% felt that the wind farm would limit their interest in visiting this region of the United Kingdom.

#### 5.6.6 Aviation Obstacle Lighting

Due to the scale of wind turbines imposing 100 metres above the surface elevation, it has become apparent that they may obstruct and cause safety issues with flight paths.

Referring to *Civil Aviation Safety Authority (CASA) 2005, Obstacle Marking and Lighting of Wind Farms*:

where a wind turbine or a wind farm is proposed to be located near an aerodrome (within 15km), the proponent of the project should contact the relevant aerodrome operator on the first instance, to ascertain whether the proposal will infringe the aerodromes Optical limitation Surface (OLS).

If the proposed height of the turbines penetrates 110 metres from ground level to tip of blades then the proponent or aerodrome operator is required to notify CASA of the development proposal.

If the development proposal infringes on this criteria then CASA requires a wind farm to have obstacle lighting installed to indicate the extents of the development site. It is not a requirement to install a light on every turbine however, the highest elevated turbine must have a light installed and the interval spacing between lit WTG must not exceed 900 metres.



The lights are generally installed on the highest fixed point. The preferred location is towards the back of the nacelle.

**Figure 5.2** Location of light installation  
(California Energy Commission, 2005, p15)

NOTE:  
This figure is included on page 152  
of the print copy of the thesis held in  
the University of Adelaide Library.

There are three types of obstacle lighting low, medium and high intensity.

- Low intensity lights are to be steady red lights fixed to structures that are less than 45 metres high.

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- Medium intensity lights are for structures above 45 metres and consist of red flashing (hazard beacons) or steady red for environmentally sensitive areas.
- High intensity lights are for obstacles in excess of 150m.

To date the lights installed are medium intensity red GPS synchronized blinking lights with 2000 candela  $\pm 25$  percentage (200 lumen/m<sup>2</sup>) peak intensity (HASSELL, 2004).

The difference in peak light intensity between low and medium intensity is not directly proportional. Low peak intensity is 100 candelas compared to peak medium intensity 2000 candela. Furthermore, the human eye can only detect a 30% decrease in candela. For example, the human eye will only be able to detect a change in light intensity when the candela value decreases from 2000cd to 1400cd. Hence, it can be confusing when associating visual perception to candela values.

There is no current requirement to have light intensity directed below  $-1$  degree from the horizontal plane. Similarly, there is no intention to direct intensity 2-3 degrees above the horizontal plane. This limits the visual beam of intensity to a confined view range.

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This is attributable to the fact that the design of the lights is such that the intensity below the horizontal plane is reduced; decreasing the visibility of the light from the ground, i.e. the lights are markers for aircraft flying above the turbines.

(CASA 2005, paragraph 14.1)

According to CASA, the turbines will not require additional markings on the turbine towers. It is acknowledged that by day the turbines will be clearly visible due to the conspicuous scale and dynamic blades contrasting with the environment.

To date there has been limited empirical research into the effects of obstacle lighting on wind farms. However, there have been several recent field investigations, which have demonstrated the visual extents and intensity of light spill; Wonthaggi, Chalicum Hills (Victoria) and Blue Canyon California, United States (HASSELL Pty Ltd, 2006).

The Wonthaggi wind farm development consists of six wind turbines. Low intensity obstacle lights 100 candelas (peak) were installed as a demonstration of lighting impacts. The results suggested significant impact to the surrounding landscape region. It is important to note that low intensity lights have a greater

horizontal beam of illumination. The limited shielding and focus of the light would have affected the results. Similarly, Chalicum Hills used a medium intensity light with minimal beam shielding.

The Blue Canyon wind farm (California Energy Commission, 2005) consists of 45 turbines of which 14 have lights installed. On-site assessment and flight experiences identified that synchronized flashing lights are the preferred solution. The tests demonstrated that unsynchronized lights were a nuisance due to at least one light being illuminated at all times from different directions. It has been stated that synchronized lighting increases the legibility of the site extents and comprehension of the nightscape for aviation safety requirements and community visual effects. The conclusions of the study had emphasized that daytime lighting should not be installed, limiting the flashing effect.

The Naroghid wind farm visual impact assessment report (HASSELL, 2004) graphically indicates intensity of light spill by computation mapping, with relation to dwellings and viewpoints, not dissimilar to zone of visual influence mapping.

## 5.7 VISUAL EFFECTS

The most frequently mentioned objection to the use of wind energy is the perceived aesthetic impact that wind turbines have on the rural vista.

(Gipe 1995a, p252)

Visual amenity issues can be classified into two objectives of research: - those relating to the interaction of the wind farm development and the landscape context, and those relative to the wind turbine generator as a sculptural form. The former is more aligned to this thesis, questioning the relationship and perceptive values of wind farms within a landscape region, whereas the later involves analysis of the aesthetic qualities of the wind turbine generator as an object. Issues relating to the later have been studied by several sources, which will be discussed in this chapter. The objective of these studies has been to value the perceptions of qualitative variables such as colour, scale, and number of turbines. These studies have been rare, but they have provided a reference source for guidance.

Wind farm proponents should seek guidance from professional expertise in landscape character assessment. The provision of a

detailed interpretation of the existing landscape scenic quality will assist the possibilities for sensitive integration of the development.

### 5.7.1 Visual Site Design of Wind Farms

Frode Birk Nielsen, a landscape architect from Denmark, has been instrumental in discussing the spatial patterns of wind farm designs. Nielsen (2002) explained the transformation of objectives from the 1970s installations of solitary turbines to the gradual arrangement of orchestrated linear and directional grid arrays of turbines in the late 1990's, early 21st century. This transformation in form, function and scale has made an impression on rural agricultural landscapes.

Nielsen's discussion provides further detail into the process and techniques used, firstly to evaluate the existing landscape, and secondly to design the development as if it were a 'gigantic sculptural element in the landscape, a land-art project. The actual design, spacing, height, type of wind turbine, and surface treatment of the sculpture must depend on the potential of the landscape in question' (Nielsen, 2002, p117).

Nielsen believes that due to the imposing scale of modern turbines they cannot be and should not be camouflaged, conversely they should be celebrated in terms of the functional

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symbolic gesture of clean renewable energy for which they provide.

The only practicable way to achieve a result that is positive both visually and functionally is to accept the fact that large wind turbine installations are dominant units in the landscape, visible over great distances. This however does not mean that the landscape must be visually overwhelmed. On the contrary, a well-planned location for the wind turbines can enhance landscape contours and contrasts.

(Nielsen, 2002, p118)

Nielsen goes further to propose an aesthetic design blueprint. Order and legibility, simplicity, and coherence are important fundamental design principles. By providing a scene, which sustains clarity in form and function, enables the occupant to digest the contrasting elements. The best way to achieve this is to design the turbines in linear or geometric shapes with rhythm and order. It is however questionable as to how this transpires into different landscape contexts. Evidently, the majority of the analysis conducted by Nielsen was on flat terrain, not constrained by complex undulating topography. Site specific topography will

underscore the process of design and will be a determinant of negotiated grounds for accessibility to the wind resource.

An alternative approach to synthesize the deployment of turbines into the landscape has been proposed by Schwahn (2002). The importance of landscape character assessment is emphasized, noting in particular the need to conduct field assessment and report on the visual character zones at different distances. 'Although aesthetic characteristics defy quantification, they can be described' (Schwahn, 2002, p140). The identification of spaces through vegetation, topography, harmony, contrast, scale and proportion provides categorization of the visual context. Furthermore the identification and pattern of existing infrastructure in the landscape such as distribution transmission lines, provides a proportionate scale.

Whereas individual observers see objects subjectively, there remain many common interpretations. We see trees as natural elements in a landscape, and we will always view church towers as cultural elements. Harbor cranes, electrical transmission towers, and wind turbines are usually seen as elements of technical civilization.

(Schwahn, 2002, p142)

A common visual design attribute of technological landscapes is the standardization of elements. The appearance of multiple transmission line towers and or turbines convey coherence and legibility. However, as the number of elements increases the landscape becomes disorienting. The ability of the turbines to signify landmarks is less evident.

The repetition of turbines can become monotonous. In particular landscape regions the contrast between natural organic visual perspectives can illicit a saturation and imposing effect on the amenity. On the other hand, in agricultural industrial landscape regions the synergy of repetition of modified mechanized landscapes can be seen to be compatible. Consequently, it has been recommended that the same turbine should be used for consistency.

Although there is a need for more specific studies on the design of wind turbines and wind power plants, including means for creating their own individuality, the most effective way to avoid landscape standardization with wind turbines is to dedicate some areas and to exclude others.

(Schwahn, 2002, p142)

Similarly, Gipe (2002) has recommended that visual order is a prerequisite for sensitive landscape planning of technological infrastructure. By reducing visual clutter, and disorder as experienced in California, the array of turbines will form a cohesive development form with no obstructing visual interruptions. What has been described as the 'missing tooth effect' can be expressed by the segregation and rhythm of turbines which can be informed by turbines of a different scale and form; two opposed to three blades , lattice towers contrast to tubular pole or turbines facing a different direction or equivocally turbines not spinning. Further discussion has been surmounted into the effect of turbines not spinning, as they may be perceived as not working. Thayer & Hansen (1988) concluded from their assessment of Altamont Pass that inoperative turbines caused enormous social opposition.

Uniformity of the arrays can create harmony, which is implicit to successful integration. Hence, the density of the array should be minimized, with regular interval spacing between turbines.

Another common agreement is the need to segregate the arrays with areas of undeveloped landscape. This limits the saturation

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and cluttering of the landscape character. Additionally the number of turbines within an array should be limited to 10 turbines according to preference studies in Germany, Britain and Denmark (Gipe, 2002). Stanton (1996) disagrees with the suggestion that wind farm developments should be limited to 10 turbines. Stanton believes that the density and legibility of the wind farm cluster from certain viewpoints of assessment could well be less dominating relative to topography and vegetation screening. Similarly, Thayer (1987) emphasized the need to separate large arrays into smaller cohesive clusters, which are legible to the occupant. Hence, the main objective should be to consolidate the wind farm into smaller units, which are in harmony with the scale of the proposed landscape character.

Visual clutter is also caused by associated infrastructure such as transmission lines and substations. Careful planning design would suggest underground wiring is preferable (Thayer & Hansen, 1988) and the architectural form of the substation should be sensitive to the landscape colouration and textures. It has become common practice in the United Kingdom to design the ancillary built form out of locally sourced materials matching traditional building vernacular to the region.

Minimising the construction of roads is also a recommendation. Similarly limiting the footprint of the construction site, including concrete pad footing, will avoid the need to cut into the landscape, scarring the landscape forever. Consequently, planning needs to address circulation to the base of each turbine utilising existing roads if applicable, limiting the amount of vegetation clearance.

Finally, decommissioning of the wind farm when lease agreements are fulfilled requires rehabilitation of landscape vegetation and contours to the original colour and textures pre-development.

### 5.7.2 Shadow Casting and Flicker

The scale of wind turbines are very imposing, this creates shadow effects according atmospheric conditions, the angle of the sun, time of the day and seasonal variance.

Shadow flicker caused by wind turbines is defined as alternating changes in light intensity caused by the moving blade casting shadows on the ground and stationary objects, such as a window on a dwelling. No flicker shadow will be cast when the sun is obscured by clouds/ fog or when the turbine is not rotating. Shadow flicker is not the sun seen through a rotating wind turbine

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rotor nor what an individual might view moving through the shadows of a wind farm.

(Wind Engineers Inc. 2003)

The major concern from shadow flicker is the moving visual silhouettes across building windows and possible psychological effects of epilepsy and related health issues. Research in the United States and Europe has suggested that the wind turbines in question (second generation rural applications) will have nil effect due to the low frequency of strobing, dissimilar to the small scale domestic turbines which can possibly induce an epileptic episode (Gipe 1995a; HASSELL, 2004).

Wind turbines, nacelles and blades are all able to adopt different pitches, rotations and orientations. This complex dynamic form is difficult to assess the impact of flicker depending on wind direction, wind speed, sun angle and the specific time of the year. Consequently at certain times of the day corresponding to the geographical location, the sun may pass behind the blades of the turbine and cast a shadow. When the blades rotate the shadow flicks on and off. Overtly factors affecting shadow are

- Sun angle
- Time of year

- Wind direction
- Wind turbine orientation
- Wind tower height
- Wind speed
- Topography
- Vegetation
- Built form

Calculating the sun's lowest angle (winter solstice), a value for the potential worst case scenario can be calculated. As described above, the effect will be dependent on the adjacent topography, vegetation and built form which may screen or distort the shadow.

The intensity and contrast of the shadow defines the effect. In the absence of sun there will be no shadow, similarly the perception of brightness will determine the contrast of the shadow.

The distance of the turbine to the receptor will determine the effect of the flicker. A series of findings from field investigations and desk top studies (Wind Engineers Inc 2003) have suggested:-

- At longer wind turbine- receptor distances the cast shadow is 'out of focus'. This does not contribute to lower intensity but the flickering is less distinct.

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- Low visibility weather conditions (still sunlight) will result in low shadow flicker intensity.
- Shadows are fainter in a lighted room. Consequently, switching lights on will lower the intensity of incident shadow flicker
- Flicker intensity is directly proportional to distance- the closer the receptor is to the turbine the greater the flicker intensity.

### 5.7.3 Turbines as Visual Sculptural Form

Wind turbines can and should be built and sited in ways that accent- and do not detract from- their sublime role. Like a piano, a wind turbine is simply an artifact. The piano, a musical machine, can make great music only when played with skill. Similarly, a wind turbine can produce energy harmoniously with its environment only when designed, sited and operated with skill.

(Gipe, 1995a, p291)

The form of the turbine has not been researched with as much interest as landscape site design. Some inroads have been made in recent times to the acceptance and personal preferences of turbine colouration, scale and composition of form.

The visual design of the tower and turbine in the wind industry's infant days was primarily not a concern. It only became an important consideration in the development of the Danish industry where the focus was strongly linked to fabricate a model, which countered the negative connotations of wind energy in California.

Danish industrial designers including the world famous Jacob Jensen, were engaged to provide aesthetic advice on the proportions and forms of WTG structures. Design recommendations for the tower evolved from steel lattice towers with tapered smooth curves. Using the Eiffel Tower as a precedent the catalyst for the design was the smooth curves with no sharp demarcations from one form to the next. The result is a continuous soft curve, which provides visual clarity as the human eye, ascends from the base to the nacelle. This was achievable for turbines less than 25 m in height, as the footprint of the tower would not compromise the tapered curve and circumference of the blade rotation. However, as the turbine tower has increased in stature, the only option to maintain the visual clarity was to adopt the tubular tower.

By the mid- 1990s, no one was installing medium-sized wind turbines on lattice towers in northern Europe



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because of the difficulty in obtaining planning approval. European regulators prefer the clean lines of most tubular designs over those of lattice towers.

(Gipe, 1995a, p294)

The design of the nacelle and nose cones are critical to the holistic image of the turbine. The nacelle cover houses the drive train and mechanical working of the generator.

Just as parents ensure that, their children dress appropriately every morning before they go off to school, wind turbine designers, manufacturers, and operators should vow never to let their wind turbines go out in public without proper attire.

(Gipe, 1995a, p297)

The cover is an aesthetic response to the development of the tower with soft tapered curves forming aerodynamic simplicity, whilst also providing functional access to the mechanics within the tower. Of recent times, the nacelle has evolved from box forms to more organic curved teardrop forms. The refinement has symbolized the movement in the industry to consider 'that aesthetics takes its place alongside more prosaic design considerations' (Gipe, 1995a, p296).

As previously noted, the conspicuous nature of modern day turbines, limits any opportunity to camouflage. On the other hand, the colour of the turbines can provide some degree of assimilation depending on atmospheric conditions. For example, coastal landscapes of southwestern Victoria, typically possess atmospheric haze, reducing the contrast and visibility of white coloured turbines.

Steel tubular modern turbines are commonly seen to be a grey to off-white colour. Caroline Stanton (1996) has recommended white as the preferred colour due to the clarity and forthright statement of purity. Stanton believes alternatives such as grey or off-white which are a deceptive coy to camouflage the turbines. 'Whatever their colour, the turbines and towers will always appear black in silhouette' (Gipe, 1995a, p312). Stanton also believes that lattice galvanised towers should be avoided as they symbolize technological fabric of a by-gone era. Consequently, the argument posed by Stanton is to acknowledge turbines as a symbol of renewable clean energy, not to attempt to disguise them.

A recent study conducted by Lothian (2004) which sought to quantify community preferences of turbines in different landscape character zones of South Australia and turbine colour, found that

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white, blue and grey were preferable. Tan was the less preferred colour. Lothian suggests that there was a slight tendency for ratings to increase with contrast, meaning the legibility of the turbines was a critical component in values. Further studies by Bishop & Miller (2007) have affirmed the relationship of contrast and visual effect.

Research in Denmark (The Danish Wind Energy Association, 2000) and in Scotland (The Scottish Natural Heritage, 2001), have concluded that experiments in blade colour have shown that pale blue, brown and grey rather than white appear to be more recessive, whilst a matt surface reduces the amount of glint. In England planning guidelines suggest light grey to off white, whilst a study in Wales 'recommends off-white or pale grey and advises against green and brown unless the turbines will always be seen below the skyline. They also suggest a matte gel coat on the blades to reduce reflection' (Gipe, 1995a, p312).

The colour of the landscape must also be considered. Notably the landscape colors and textures in Europe differ considerably to Australia. Similarly, there is a great variance in Australian landscapes from the coastal regions of southwestern Victoria to remote undulating agricultural and mallee landscapes in South Australia. These landscapes will also change colour throughout

the seasons implying that a single selected colour will not necessarily be effective in concealing the turbines throughout the entire year.

Drawing on the findings of the studies mentioned above it can be concluded that white to off-white is the most preferred colour.

Further to this discussion is the need to paint the turbines one colour. Some projects have opted to paint the towers with different hues of green to off-white in a gradual gradient from the ground up, in order to assimilate the wind farm e.g. Swaffham, in Norfolk, eastern England. In some European countries and the United States of America, it has become regulatory to paint turbine blades with red hoop obstruction markings, if the locations of the turbines are in proximity to aviation aerodromes and flight paths. In Australia, these details have been avoided as the colour variance creates more contrast and complexity to the objects visual form.

**5.8 MACHINES IN THE GARDEN: PERCEPTIONS OF WIND FARMS IN RURAL LANDSCAPES.**

The aesthetic pollution is obvious when a piece of land is transformed into a whirling wind factory – Steve Ginsberg, writing in the Santa Monica Bay Audubon Imprint.

Lavatory brushes in the sky. - Comment by conservative MP Sir Bernard Ingham

Diamonds in the sky. –Comment by a member of the Tehachapi Heritage League during a discussion of wind energy in 1993.

(Gipe, 1995a, p251)

Community perceptions of wind farms and acceptance are arguably the most important social issue of wind farming development. Attitudes vary considerably depending on the individual's aesthetic value of the landscape and wind turbine generators as sculptural form and as a symbol of renewable energy supply. However there are also numerous other variables that filter into the equation of public perceptions to wind farming, wind turbines, landscape character appraisal and the process of development.

The development of wind-energy landscapes brings to the forefront a dilemma of conflicting values-safe and renewable energy development versus scenic preservation.

(Thayer & Hansen, 1988, p69)

The following sections of this chapter will discuss in detail these factors and comment on the global perspective of social attitudes towards wind farms.

**5.8.1 Emblem of the Artificial: Concepts of Topophilia, Technophilia and Technophobia.**

The industrial revolution represents a shift in the occupation of landscape and human / landscape interactions, primarily landscapes function. Leo Marx in his book *The Machine in the Garden* (1963) explains the shift during the romantic era as a violation of feminine tranquillity of pastoral landscapes.

the romantics portrayed the male features of the machine as thrusting their presence onto the feminine repose of the landscape.

(Marx, 1963, p28)

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Using sexual metaphors, Marx describes the implementation of machines (industrial infrastructure) into pastoral landscapes as crude masculine aggressiveness (Marx, 1963). This metaphor symbolises the effects of rail, transmission lines, pipeline and mining infrastructure which alter the landform by way of excavation, cuttings and/ or cumulative linear effects sprawling across the landscape passing through numerous different landscape character zones. It can be argued that this analogy does not convey the effect of wind turbines as they have minimal footprint, nominally in clustered forms, leaving localised scarring which can be rehabilitated post-decommissioning. On the other hand, the implementation of wind farms has visual associations with common industrial objects such as transmission lines due to scale, materials and symbolism of electricity generation.

In terms of wind farm developments, the conflict starts with the bond humans have with 'natural'<sup>7</sup> landscapes. Research has revealed that 'people respond positively to so-called 'natural' landscapes and prefer them to those landscapes with signs of human influence' (Thayer 1994, p6).

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<sup>7</sup> From a geographers perspective what is regarded as natural or wilderness landscape is a landscape bearing no marks of human modification (Jeans, 1982).

Robert Thayer (1994) has described the association of inherent preferences for natural landscapes as *topophilia*. Following previous work by Tuan (1974), who refers to topophilia as 'the effective bond between people place or setting' (p.4), Thayer draws on the concept of 'positive human emotions relating to affection for land, earth, and nature' (Thayer 1994, p5).

As discussed previously in chapter one, the aesthetic experience of landscapes are comprised of tangible and intangible qualities. The relationship between aesthetics and topophilia is somewhat embodied in the composition and intensity of the five senses that construct the experience. Tuan (1989) believes the aesthetic response that provokes topophilia is primarily the surface appearance of landscapes; however, the topophilic bond transpires from an intuitive understanding of the process of landscape and its function.

First, we live mostly in response to surface appearance, both of the landscape and of life's events. Second, although attractive, appearances may hide even greater realities. Third, plain or ugly surfaces are deceptive, for they may hide 'pearls of great prize', and fourth, beautiful surfaces are not always trustworthy for they may hide ugliness or other, deep flaws.

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(Thayer 1994, p8)

This is somewhat misguided as the aesthetic experience of landscape falls short of explaining the totality of topophilia. For example, the farmer who spends all his time on the land will not be subject to an aesthetic experience everyday. Similarly, a national park ranger or Sydney Harbour ferry driver will not register their daily activities as aesthetic experiences. These diverse occupations all have similarities in working in environments, which possess natural landscape qualities. In these cases, the topophilic response is the emotional attachment to the land as a place of work. This bond with the land can be associated to economic, financial incentives as opposed to environmental or social factors. Consequently, the relationship between aesthetics and topophilia is not directly applied.

The concept of landscape meaning is paramount to this discussion. Is landscape meaning inherent in the physical attributes and composition of the landscape or is it in the eye of the beholder? As previously discussed in chapters one and three, the experience of landscape is dependent upon cultural intuition. The experience of a particular landscape may result in several meanings. For instance, a small estuary running through a rural town may represent recreational swimming activities to the youth

of the town, whilst the farmers will view the river as the lifeline of their irrigation source and future income. Accordingly, the meanings associated to particular landscape characters are independent, residing in the observer, in the inhabitant of the space.

Humans also have a pre-occupation with technology (technophilia). Humans, being innovative problem solvers, have a fascination with creating tools, which help construct contemporary lifestyle evidence of the human power to impose his/her will upon the World

(Marx 1963, p230).

Evidence of this is overwhelming in today's society with the evolution of desktop computers, laptops, mobile phones with cameras all forming a new era of communication and productivity.

Contrary to this, some forms of technology have side effects associated to their applications and functions. For example, the innovation of mobile phones has meant that communication transmission towers for various networks are becoming an integral element in the urban and rural landscapes. Hence, some forms of technological intervention have imposed negative social outcomes.

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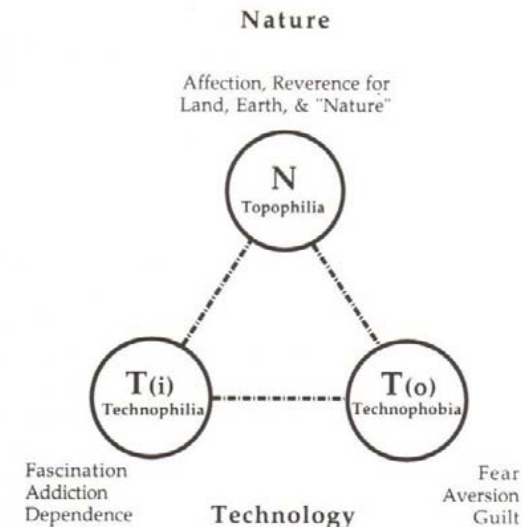
*Technophobia*, or the fear of technology imposing its will over humankind, is evidence of human's love-hate relationship for technology. Humans will always make mistakes, 'technologies, unfortunately, magnify them' (Thayer 1994, p48). This is most relevant in the discussion for and against wind farms, with a fascination and love for the productivity of clean energy, but a bipolar effect for the visual effect.

Modern civilization is dependent on electricity to power our homes and places of work. As discussed in the earlier sections of this chapter, the generation of electricity is primarily from coal furnaces, which have detrimental effects on the environment by means of carbon emissions. On the other hand wind farms as an alternative generation source are in some light fascinating, and dependable, due to wind being a renewable resource. Conversely the fear, aversion and guilt of installing hundreds of turbines into landscapes of natural and / or agricultural appearance is an overtly common experience which has been recorded in numerous social studies which will be discussed shortly.

From these three cognitive dimensions at the interface of perceptions, *topophilia*, *technophilia* and *technophobia*, Thayer (1994) has proposed an equilateral triangle model (Figure 5.15),

at which place 'affection for land and nature collide with love-hate ambivalence toward technology' (Thayer 1994, p49). The ideal world would envisage integration between topophilia and technophilia; however, the negative associations to technophobia dominate the real world image. The tension created between these three forces of cognition explains some of the current social issues in wind farm planning.

**Figure 5.15** Equilateral triangle of technology nature interface (Thayer, 1994, p49).



The late Sylvia Crowe provided insightful discussion on the topic of landscape character, industrialisation and the effects upon

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aesthetics. Crowe acknowledged in her book, *The Landscape of Power* (1958) that:

The country's life, which only a century ago was mainly static and rooted in the soil, is increasingly one of movement and mechanization. Travel, once concentrated on the railways, now not only chokes the road system but takes vast areas of land for airfields and requires the erection on the coast and hill-top of various forms of radar mast and navigational aid. Communication is served not only by telegraph posts and wires but also by means of television and broadcasting services.

(Crowe, 1958, p9)

This quote articulates the growth and prosperity of the western world's economies during the industrial revolution. This was partly justified due to development of landscapes into mechanised processing plants providing efficiency in production methods and new materials for building civilised urban environments.

The consumption of landscapes did not pose many cultural or aesthetic conservation issues in the nineteenth century. The impacts only become apparent in the twentieth century, some of which are still visible in urban renewal projects today for example

Glasgow, Scotland, which was at the heart of the ship building industry and is now being populated along the river frontage with residential, commercial and open space. If we are to learn from these lessons, we must value landscape for its worth not only in terms of economic values but also environmental and social.

From a national, as opposed to a sectional viewpoint, the need to consider the countryside as a whole and to balance the national wealth of consumer goods against the national wealth of a beautiful landscape should be a matter of course.

(Crowe, 1953, p10)

As industrialised urban forms are tending to sprawl and consume rural areas, the conservation of rural and natural landscape characters becomes a paramount concern. The higher value placed on these remaining landscapes due to the realization that they are becoming exhausted, signifies a shift in thinking to preservation as opposed to conservation.

In United States of America, there have been two different approaches to sustain the character of natural landscapes. One school of thought has been led by John Muir who formed the globally recognised environmental group the Sierra Club, known

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for their research and work on preserving 'wilderness' zones. The other philosophy which was at a tangent to this work was by Gifford Pinchot, who formed the U.S Forest Service, a large corporate body who were influential in landscape character assessment and research into consolidated methodologies. Pinchot's directive was to conserve natural resources, with the foresight of proportional development and visual changes.

This raises a discussion on conservation opposed to preservation of landscape visual character.

Landscapes themselves are neutral. It is our response to them that is not. To understand our response to differing landscapes and objects on the landscape, we need not only to examine their cultural and historical context, but also to explore the long running conflict between conservation and preservation.

(Gipe, 1995a, p255)

These two terms have been used interchangeably in the recent past. Conservation is a process of stewardship and management of landscape such that the cultural historic character of the place is retained for future generations, it does however acknowledge that sensitive development can and may be beneficial to the

landscapes sense of place. Preservation on the other hand is more direct in its definition to protect the landscape character (Taylor, 1989; *The Australia I.C.O.M.O.S. Charter of the Conservation of Places of Cultural Significance*, 'The Burra Charter', 1999).

Referring to Article 17, the Burra Charter<sup>8</sup> (1999):

Preservation is appropriate where the existing fabric or its condition constitutes evidence of cultural significance, or where insufficient evidence is available to allow other conservation processes to be carried out

(The Burra Charter, 1999, p5).

Hence landscape visual character needs to be assessed for cultural significance and clearly indicated in the proceedings of any wind farm project or technological intervention into the landscape.

Undeniably the implementation of wind farms into the landscape alters the visual character. The objective is to identify cultural landscapes and the degree to which the landscape can absorb

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<sup>8</sup> The Burra Charter is a planning reference document in Australia used to provide guidance for the conservation and management of places of cultural significance and is based on the knowledge and experience of Australia ICOMOS (International Council on Monuments and Sites).



technological fabric without altering the visual character of the cultural value of the landscape beyond repair?

One important consideration in the development of wind farms is the ability to rehabilitate the landscape to its former visual character after decommissioning. Arguably this implies that the process of conservation can be addressed. As stated in the Burra Charter (1999), Article 15.2

Changes which reduce cultural significance should be reversible, and be reversed when circumstances permit (p5).

Seemingly the concept of time will be a determining factor in accepting the degree of visual change over the life cycle of the wind farm development. For example the time span of a typical wind farm is 20 years, does the Burra Charter account for this in Article 15.2?

Similarly time is an important concept in public perceptions and acceptance of landscape change and wind farm developments (Gipe, 1995a).

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The discussion of preservation and conservation is extremely important in the context of infrastructure development and strategic planning. The example of locating wind turbines in rural landscapes brings to the forefront the dilemma of renewable energy production and scenic amenity preservation and conservation.

The conflict partly explains why many environmentalists support the concept of wind energy in the abstract (conservation) but may object to specific projects (preservation) in what has been called the NIMBY (Not in My Backyard) syndrome.

(Gipe 1995a, p257)

### 5.9 PUBLIC PERCEPTIONS OF WIND FARMS

Since the 1970's, at a global level there has been strong support for wind farms as a form of sustainable energy generation (House of Lords Select Committee on the European Community, 1988; Bell, *et al* 2005. Opinion poll studies around the world have also confirmed that in general the public support an industry reform from dependence upon fossil fuel and nuclear reactors to wind power:- 79% Canada, 80% United Kingdom and 82 % in Denmark (AIM Research A/S, 1993 cited in Daugarrrd, 1997). Most recently, this has been guided by public opinion on alternative sources of

generation and the trade offs between alternative forms of energy production. Wind power, being a renewable source with no emissions, represents a plausible solution to the concerns of greenhouse gas emissions.

**Figure 5.16** Power plant acceptance (Thayer & Hansen, 1989)

NOTE:  
This figure is included on page 169  
of the print copy of the thesis held in  
the University of Adelaide Library.

Figure 5.16 illustrates the disparity of acceptance values for alternative forms of energy generation. The graph indicates public opinion on power plant acceptability, more importantly it also shows the rejection values of power plants. Of particular note is that only 9% rejected wind farms, whilst approximately 25% considered fossil fuel an unacceptable source of generation and approximately 50% rejected nuclear power.

In contrast the results showed wind farms to possess the greatest NIMBY (Not in My Backyard) syndrome, followed by biomass, nuclear and fossil fuel. Within this study Thayer described the NIMBY syndrome as a willingness to accept and support a technology form in ones country but unwilling to accept the installation of the technology within 5 miles (8 kilometres) of one's own home. Due to the decentralised infrastructure required to produce sufficient wind power energy, the visual extent of the development is significant in comparison to conventional forms of power generation. The visual intrusion of wind farms occupy a greater percentage of the field of view and cannot be camouflaged or hidden. Wolsink (1989) supports this claim, providing further hypothesis that people unconsciously realize that opposition to wind farms is purely visual which is subjective and therefore dismissed, therefore they rationalize their objection to concerns of noise and avian fatalities.

The Scottish Executive commissioned MORI Scotland (2003) to conduct social research of residential properties within 20km radius of operational wind farms. Ten wind farms with nine or more turbines were assessed. All respondents of the survey lived within 20km of one of the ten wind farms. 1,810 adults were surveyed over the telephone with a response rate of 28%.

Overwhelmingly people were positive (20%), with minimal negative responses (7%), the remainder being the majority of respondents who believed that the wind farm had neither positive nor negative effects (51%) whilst (22%) lacked interest of wind farms. These figures remained considerably similar throughout the 20km field of study; implying distance was not influential in the response. Of note, a greater proportion of the respondents needed to be prompted to comment on the wind farm, as it was not high on their agenda of things they dislike or like about the landscape surrounding their place of residence.

The change in perception of the wind farm during the planning process to post-construction period found 27% to believe the wind farm would affect the landscape prior to the installation whereas post-construction only 12% perceived the wind farm as having an adverse effect. This is a common perception of wind farms, reinforcing studies by Wolsink (1989) which depicted a pattern of acceptance ratings relative to time.

**Figure 5.17** Acceptance over time Source: Pasqualetti (2002). (Produced by L. Arkesteijn after research conducted by Maarten Wolsink)

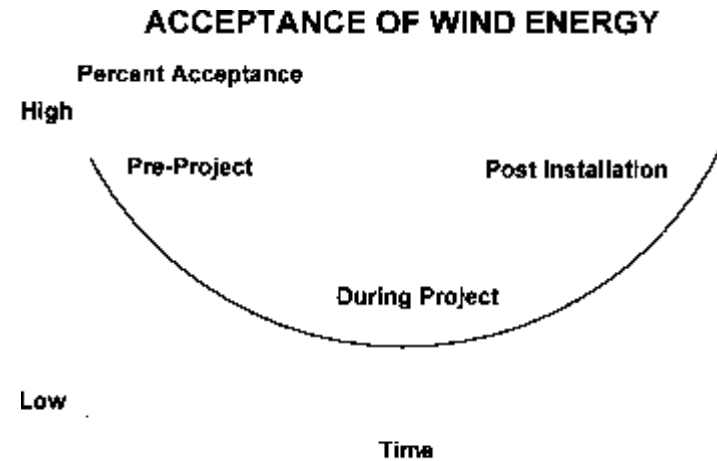


Figure 5.17 illustrates the local community support for wind energy during a typical development program. Commonly before any details of a prospective project are publicly announced, wind farming is considered a positive intervention. The sequence of events to transpire, accounts for the deterioration of acceptance; firstly, the local community is informed of the prospective project through media releases designating the site and number of turbines. This encourages skepticism and fear in the minds of the

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local community with numerous questions as to how the development may influence their own properties, life style and landscapes they value and associate meanings and memories.

More specified details are released through community consultation designating the layout of the turbines and associated infrastructure, power output, size of the turbines and visual montages from specified viewpoints. Community concerns are typically referred to visual, noise and avian fatalities. These variables are discussed and reviewed in the Environmental Impact Statement (EIS), as to which the project is assessed by the appropriate regulatory authority.

Upon acceptance of the project application, construction will proceed. During the construction process, the increase in traffic, noise and general inconvenience has an adverse effect on the acceptance, however this is minor according to MORI (2003), where 6% of the surveyed respondents said that there was increased traffic, whilst 4% said that construction caused noise and disturbance.

The increase in acceptance over time as illustrated in figure 5.16 is representative of the wind farm becoming a familiar feature within the landscape character. This theory is supported by

studies in the United Kingdom and the Netherlands respectively (Exeter Enterprises Ltd, 1993; Gipe, 1995b).

Throughout history, there have been many examples of technological installations, which have been strongly opposed during planning and construction, eventually becoming iconic elements of the urban fabric. Using the analogy of the Eiffel Tower, we can see some possible similarities unfolding in terms of community acceptance, objections and familiarity of the technological form. During the planning and construction process, the design was scrutinized by numerous artists, professionals and political circles with considerable vociferous disapproval. Charles Garnier, the famous architect of the opera house in Paris, was quoted saying the tower is a 'symbol of decadence and a menace to art and culture' (Gipe, 1995a).

Gipe's discussion alludes to a degree of social intuition. In other words, the effect of the media and community groups has suppressed individual views of the development. The division of the community and debate was informed by the elitism of social classification. Upon the opening of the Eiffel Tower, a number of these critics passed judgment, re-evaluating their preconceived ideas. In time, the Eiffel Tower won over its critics, and has now

become a global architectural iconic form, which is a symbolic reference to France and Parisian culture.

The similarities surrounding wind farm developments can be recognized in several media releases and common experiences evolving around the world. Even so, the analogy presented above must be acknowledged with caution. Wind farms are a multiplied unit form, limiting opportunities to become iconic cultural forms specific to place. Furthermore, the assumption that the relationship between the familiarity of landscapes and wind farms will promote a positive acceptance is inconclusive. The relationship is not a linear progression there are numerous social influences.

The Australian Wind Energy Association commissioned a telephone survey in 2003 assessing the perceptions of wind farm acceptance for a sample of 1,027 people. The results of the survey concluded that 94% thought that an increase in a renewable energy target was desired. Of the renewable energy sources, 95% supported the development of wind farms to meet the increasing demand for electricity. 91% consent to building wind farms in rural areas as opposed to not building them at all. The following Table 5.8 illustrates the acceptance of wind farms as opposed to current forms of generation in Australia.

**Table 5.8 Australia's** preferences for electricity generation. Source: Australian Research Group for AusWEA, August 2003, viewed February 2006, <[www.thewind.info/downloads/AusWEA.pr\\_7.9.2003.pdf](http://www.thewind.info/downloads/AusWEA.pr_7.9.2003.pdf)>

NOTE:  
This table is included on page 172  
of the print copy of the thesis held in  
the University of Adelaide Library.

Table 5.8 unmistakably signifies the support for wind energy generation as a popular alternative source. However at the local level there have been diverse public responses to proposed projects, with frequent local opposition to actual developments, a phenomenon which has been called the NIMBY (not in my backyard) effect.

The NIMBY effect has been driven by the 'proximity hypothesis', which advocates that those residing within closer proximity to the development will have negative perceptions. As with all

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ideological concepts, there are several different interpretations of how distance may effect social perceptions. Firstly, there is the point of view of the economist and developer who sees the NIMBY as 'free riders,' selfish individuals who cannot foresee the social 'public' reward. On the other hand, the external costs of the development are not equally born across all its users, posing an argument that this interpretation is naïve in suggesting NIMBY's are 'free riders'.

Attempts to prove this hypothesis have been inconclusive. In fact, studies conducted in Denmark found that those living closest were more positive in comparison to those living further away (Anderson *et al*, 1997; Krohn & Damborg, 1999).

In a more recent, study in Scotland (Scottish Executive Central Research Unit, 2000) the findings echoed the positive acceptance for those living closest to the wind farm. This is in contrast to studies conducted in the United States at the Altamont Pass. As discussed previously the Altamont Pass development represents first generation wind farming. Research and development of the wind industry has provided a valuable insight into efficiency and sensitivity of site planning. One of the earlier studies conducted was by Thayer & Freeman (1987) who used semantic differential scales to depict a sample of 600 people's perceptions of the

Altamont Pass wind farm development. The project aimed to identify and measure critical visual attributes, and symbolic meanings.

Landscape familiarity and reliability of the turbines were two issues addressed which revealed interesting findings. Those that lived in or around Altamont Pass surprisingly responded negatively, conceding that the acceptance of the wind farm over time was not conclusive. Thayer relates this finding to a couple of factors, but forthrightly to the perception of the reliability of the turbines.

The method of the study used static photomontages, which are limited in representing the dynamics, and functional symbolism. Thayer questioned the effect that this may elicit.

On the other hand, many subjects who frequently viewed Altamont commented that substantial numbers of the turbines were never turning.

(Thayer & Freeman, 1987, p394)

The conspicuous nature of wind turbines means that they are highly visible. The clarity of the functional operation is transparent to the viewer; either the turbine is spinning and producing

electricity or it is not. Consequently, viewers of wind farms expect the turbine to be spinning. If the blades are not turning, they are perceived to be an industrial waste product.

When significant numbers of turbines do not turn when the wind is blowing, that simple expectation is violated, leaving the viewer to guess the reason why.

(Thayer & Freeman, 1987, p394)

Nevertheless, research and development of wind farm planning has developed a better understanding of the efficiencies and outcomes of locating turbines in optimum wind positions, with fewer larger turbines, unlike the dense arrays of Altamont Pass.

A study in Ireland (Sustainable Energy Ireland, 2003) used photomontages to compare different compositions of wind turbines, assessing the number and spacing in different landscape character zones. Generally, fewer large turbines were preferred with the number of turbines limited to 25, which reiterates previous findings.

#### **5.10 NIMBY; SOCIAL PROCESS OF INTUITION**

### **5. Wind Farms; Renewable Energy, Technology in the Landscape**

Devine-Wright (2005), comments on the current literature and social research into public perception of wind farms as being primarily empirical in nature. As a general observation, two methodologies have been adopted; firstly opinion poll surveys of renewable energy sources and secondly case studies of people's perceptions prior to and after construction.

Empirical studies have typically operationalized public perceptions in terms of self-reported evaluations of discrete aspects of turbines, with items focusing upon visual, acoustic, socio-economic, environmental and technical aspects.

(Devine-Wright, 2005, p126)

Social empirical research and literature to date, has predominantly been directed by several questions. The following classifies these leading questions:-

- What is the level of public support and acceptance for wind farms as opposed to conventional forms of generation?
- Does the residing distance from the proposed development affect the perception and acceptance of a proposal?

## 5. Wind Farms; Renewable Energy, Technology in the Landscape

- Is there a change in perception of local community groups and residents post construction?
- Do residents who opposed the development prior to construction, lessen their negative attitudes over time?

The result of this body of research is useful to develop best practice guidelines to develop an understanding of some of the issues resultant of physical properties of wind turbines. However, the research is limited in the comprehension of psychological variables, which underpin the social relationships of people, place and the wider environment.

Social research in the United Kingdom (Devine-Wright, 2005; Haggett & Vigar, 2004; Bell *et al*, 2005), has digressed from this model of thinking to substantiate a theoretical foundation to develop concepts for future research. In particular, research by Devine-Wright (2005) and Haggett *et al* (2004) has queried the concept of NIMBYism and possible theoretical explanations for and against the hypothesis.

The argument posed by these studies justified a rationale to evaluate the perceptions not only of the technical and physical aspects of wind turbines but also the symbolic, cultural intuitive aspects. Within this research, it is envisaged that a transparent

process of community consultation initiated from concept development stage would provide a catalyst to an understanding of how the development is implemented and not merely, what the project constitutes.

The development and scrutiny of the NIMBY syndrome has embarked on two levels of theoretical directive, firstly to decipher the concept of NIMBY as a perception mechanism in social circles which has radiated negative connotations associated to wind farms, and secondly to discuss whether NIMBY is truly an ideological model warrant of digest.

The Landscape Research Group in Newcastle upon Tyne, have been extremely active in questioning the 'social gap' between general public support for renewable energy and local objection to new wind turbine installations.

If approximately 80% of the public in the UK support wind energy, why is only a quarter of contracted wind power capacity actually commissioned.

(Toke, 2002 cited in Bell *et al*, 2005, p460)

Commonly this figure is representative of the wind industry through out the world. It is a question of conjecture between the local and global. The knowledge of global warming is increasingly



becoming generalist, removed from everyday life, whereas the local knowledge of land prices and amenity are concerns of today. This concern is currently not understood in the planning system with no consideration to compensation measures for those that consume the external costs (visual, acoustic effects) for the greater good of the rest of society.

Of most concern in evaluating, the effect of a social gap is the degree of participation in the planning process. Commonly the model adopted for development and assessment of prospective projects is 'decide-announce-defend' (Bell *et al*, 2005, p462). This process induces public criticism rather than support, typically giving authority and dominance to opponents of wind power in the course of permit admission.

NIMBY as described by Bell *et al* (2004) is a combination of two gaps and three explanations in society's perception and attitudes towards wind farms.

The two gaps are defined as the *social gap*, which comprises of the high public support for wind energy generation and the low commission success rate, and the *individual gap*, which constitutes an individual having a positive attitude towards wind energy but actively objecting a proposed development in their

region. The individual gap is said to be a derivative of the social gap and is plausible in one of the three explanations for the occurrence of the social gap theory.

The three explanations for the social gap are summarized in the following table.

**Table 5.9** Social Gap Classifications (Source; Haggatt & Vigar, 2004)

NOTE:  
This table is included on page 177  
of the print copy of the thesis held in  
the University of Adelaide Library.

## 5. Wind Farms; Renewable Energy, Technology in the Landscape

The three social gaps *Democratic Deficit*, *Qualified Support* and *Self Interest* are interchangeable and reflective of common occurrences in development proposals. Each explanation is not intended to form a definitive argument; it is assumed that community attitudes are affected by each in some form.

Consequently, some common general outcomes can be prescribed from the definitions, which can lead to further questions and research investigation.

Community consultation in the planning process is commonly left to the later stages after the concept has been formed. This is symbolic of the inherent decide-announce-defend models of planning development and assessment. Evidently, this process is ineffective in engaging the local community and accrediting the level of support both for and against development proposals. Hence, it is suggested that new models of planning are considered which give emphasis to community participation. A shift in the planning process would imply a collaborative approach, limiting the bias and encouraging the silent majority to participate in the process.

Social geographers such as Hammarlund (2002) have shown through her research that

Involving the public in a wind power project has very little to do with hearings about ready-made plans, especially when a landscape has been evaluated by experts. Individuals appraise landscapes in different ways and there are several preferences to be considered. I have found that the opinion about a project is often expressed by an engaged elite. By elite, I mean a small group privileged by means, influence, or power in the local society.

(Hammarlund, 2002, p107)

This raises some important questions with respect to engaging the general community and not just those that have financial interest or commanding business interests and land use in the area. Hammarlund concludes by stating that

If a wind developer wants to get the job done, he must consult with and consider the opinions of the 'social landscape': that is, all people who will be affected by change.

(Hammarlund, 2002, p107)

It would be interesting to interpret responses and efficiency of planning processes that involved local community during the

## 5. Wind Farms; Renewable Energy, Technology in the Landscape

preliminary stages of site selection and site design. Further research into the development of methods and assessment techniques could aid this discussion.

The second suggestion would be to educate the public about wind farms, by provision of factual positive and negative attributes. The information provided should be established both in terms of the global perspective of emission reductions and the local in terms of consultant's landscape assessment surveys as compiled in EIA (Environmental Impact Assessment). It is important that the information is accessible and delivered with clarity in a concise format so the public can comprehend the effects of the development. Similarly, information provided by the local community to the developer or authoritarian should be recorded and documented correctly and used as a reference in project development.

The third and final consideration is the cost of development. It has become apparent in wind farm developments that financial benefits are acquired by the occupant of the land upon which the turbines are installed. Commonly this is paid as an annual lease per turbine. Typically, in Australia this can be a considerable supplementary income for a farmer who can still maintain his land use for crops or grazing around the wind turbines.

The problem arises from the inequality of compensation. Typically, the visual effect of the turbines will impact on neighbouring properties. The developer would investigate the degree of impact to neighbouring properties offering mitigation solutions through vegetation screening, which may not offset the individual gap. Consequently, neighbouring properties share none of the benefits but bear all the costs.

Compensation by mean of financial benefits is not always the correct answer to project procurement (Gipe, 1995a; Wolsink, 2000; Thayer & Hansen 1988). Locals may perceive this action as a form of bribery; hence, it is a strategy fraught with danger. However, this strategy does impose a series of questions:

Can qualified supporters of wind energy be 'bought' at an affordable price? Is it money that matters to opponents of wind energy or is it control over the character of developments? Policy makers must find answers to these questions before they can develop effective policy responses.

(Bell *et al*, 2005, p474)

The notion of a public benefit being a public cost implies social equality. 'Ownership' is key consideration in acceptance values and development of wind power. Research in Denmark (Gipe, 1995a) has claimed that cooperative wind farms are strongly supported with over two-thirds of the turbines in Denmark owned by individuals or local cooperatives. Investors of the cooperation, installing a sense of pride, and community, directly see the financial benefits. It is commonly accepted that local communities prefer to be in control of the project rather than the imposition of outsider influence.

In addition to the financial compensation, several positive outcomes are achieved in the planning of cooperatives. Generally, the wind farm proposal and specifically site design acknowledges local landscape values and resolves conflicting issues on a cost benefit ratio more considerate to the services of the local community. The trade off between cost and benefit is marginalised with the benefit of conserving landscape amenity, whilst providing renewable energy outweighing the financial loss of sighting turbines in less profitable areas.

European countries such as Germany and The Netherlands are following suit. Unlike their counterpart in Britain, where NFFO bidding discourages community ownership, German regulators

foster it. By the mid 1990s, two-thirds of the applications for the German federal subsidy program were from communities (Knight, 1993). In Australia, the story is quite different.

### **5.11 WIND FARMING: POLITICAL, SOCIAL AND ECONOMIC GROWTH OF A GLOBAL INDUSTRY.**

The global wind industry has seen strong growth since the late 1990s. Records have shown the industry had another successful year in 2006 with annual market growth of 32% following a record year in 2005 of 41% growth. This conveyed an increase of 15,197 megawatts (MW), which cumulates to 74,223 MW of wind power generation (GWEC, 2007).

**Figure 5.18** Global wind generation and predictions.  
Source (GWEC, 2007)

**Table 5.10** World leading countries for wind power generation until end of 2006.

NOTE:  
These figures are included on page 181  
of the print copy of the thesis held in  
the University of Adelaide Library.

(Source adapted from GWEC, 2007)

This has been accredited to an accumulation of numerous countries increasing their renewable energy sources in 2006, with particular reference to growth in new wind power markets in India (1,840 MW), China (1,347 MW) and France (810 MW) (GWEC, 2007). Comparing the totality of wind power generated in these countries to the current world leaders, we can see there is still a lot of potential to increase the percentage. The following table displays the world market leaders.

As can be seen in Table 5.10, the majority of wind generation is in Europe which equates for 65% of the total world generation. Germany generates the most power from their available wind resource with a market share of 27.8% of the global industry, a considerable amount. Of the other European countries, Spain has experienced a sustained rapid growth particularly in the southern Catalonian region where the wind resource is most prevalent. Denmark has sustained a large percentage of their power supply from wind energy (15% in 2001). This is currently increasing to 30-35% as the first generation turbines are being replaced by larger turbines. Future policy is to provide 50% by the year 2030 (Nielsen, 2002).

## 5. Wind Farms; Renewable Energy, Technology in the Landscape

The United States has also experienced a considerable rate of growth in the recent past. In 2006, the United States installed 2,454 MW of wind power generating capacity; the leading country for new development of wind turbine energy production. This reflects a combination of both private and public investments.

During the 2006-2007 period strong growth has also been witnessed in the Asian market with an addition of 3,679 MW, an annual growth of 53% in 2006. Of this China accounted for a 70% increase from the previous year.

On the other hand Australia has experienced slow growth since 2005. For cross reference we can compare Australia's 2007 cumulative wind power generation of 817MW, which equates to one twenty fifth of German generation. Even considering Australia's proposed generation of 6,163 MW, which accounts to only one third, we can foresee the strong potential to increase the energy generation from Australia's lucrative wind resources.

Future projections are for the level of growth of the global industry to be sustained till 2010 (Figure 5.16). The European Union has adopted a 20% target for renewable energy generation by 2020 which is substantial considering the current

rate is 6.5%. Reasons for such an ambitious target are not solely based on limiting greenhouse gas emissions but also to reduce the dependence on imports. Given the link between oil and gas, it is projected that for every \$20 (US) increase to a barrel of oil, the cost of Europe's gas imports rise by \$15 billion (US) annually. This represents a transfer of wealth to gas exporting countries. Consequently the economics of wind power generation is much more appealing (Zervos, 2007).

Several questions have arisen from the analysis of the global market of wind energy generation. Firstly what is the reason for the disproportionate adoption of wind power technology across the globe? Is it due to the available wind resource or is it embedded in political and economic policies?

The models adopted by Germany, Denmark and the United Kingdom differ in political strategic directions. It is important to understand some of the complications, policy formulas, barriers and potential effects on planning strategies which equate to social, economic and environmental sensitivities to landscape. Theoretically, Australia can learn from some of the mistakes and achievements made by these models.

## 5. Wind Farms; Renewable Energy, Technology in the Landscape

The boom of the German wind industry in the 1990s can be attributed to three factors. Firstly, the Government offered a subsidy for research and development which accounted for a payment per kilowatt-hour for wind energy produced in research accepted programs. Secondly, the Government introduced a policy which mandated utility companies to buy renewable energy at 90% of the utilities average retail rate. Thirdly, numerous states provided supplementary financial incentives by means of subsidies in the range of 14-30% of the installed costs. These factors were also coupled with the high utility rates in Germany. Consequently, the economic feasibility of wind farms was very competitive and quite lucrative for potential investors. The wind farms developed have been a culmination of private and commercial enterprises.

Denmark's wind industry was stimulated by high prices of importing oil which accounted for 95% of Denmark's power needs in 1975 (Gipe, 1995a). Being a net importer of energy, Denmark needed to source alternative forms to sustain economic prosperity. The relatively flat landscape and strong consistent wind resource coupled with the technical skill base of metal workers triggered the birth of an industry in manufacturing wind turbines and generating wind energy.

The significant difference in Denmark which sets it apart from the growth of other countries is the cooperative ownership of wind farms. The majority of farmers in Denmark are members of agricultural cooperatives. These cooperatives have substantial political influence by sheer numbers and more so influence on the planning of rural landscapes.

Financial incentives in the form of Government capital subsidies and utility requirements to pay 85% of the retail rate when buying electricity from privately, coop owned turbines, coupled with a carbon tax per kilowatt hour of energy produced from conventional sources, has provided lucrative financial incentives for farming cooperatives to collectively finance and develop projects. The strength of these developments is the social equality of community ownership and financial reward.

More recent developments in Denmark have proposed larger projects funded by utility companies. Of the potential projects proposed in the early 1990s only 50% was given authority to proceed. Due to community unrest with respect to outsider control of the development proposal and inequality of financial reward, numerous proposals have been rejected through planning. This has also been attributed to land use zoning conflicts with forestry competing for available land.



## 5. Wind Farms; Renewable Energy, Technology in the Landscape

The model adopted in the United Kingdom contrasts considerably. The major barrier to the growth of the industry was the difficulty of connecting to the state owned utility (Central Electricity Generating Board). Privatisation of the energy sector occurred in the late 1980s, bringing forth several outcomes which restricted the development of renewable sources. Firstly the Thatcher Government was stuck with an ailing nuclear industry, with no assurance that it would be able to compete in a privatised competitive market. Hence the Government introduced the Non-Fossil Fuel Obligation, which declares that utility companies have to buy a percentage of nuclear power at premium prices till 1998 which equated to six years of security. The provision for renewable sources of generation was impacted by this limited time frame of price fixing. In other words, the uncertainty of future cost forecasts was overtly risky as wind farms are long term capital investments. Policy reform in the late 1990s reinstated an increase in target megawatts generated from wind and the longevity of price assurance for 15 years. These developments have primarily been initiated by utilities and corporate affiliations.

The NFFO, with its requirement for costly financing and legions of attorneys, has also discouraged dispersed or

locally owned applications. There are very few individually owned wind turbines in Britain.

(Gipe, 1995a, p44)

A manifest delivered by the World Wind Energy Association (WWEA) (2002) has summarised the barriers encountered in the development of the global wind industry. The following is a brief summary of those relevant to the discussion of Germany, Denmark, United Kingdom and Australia.

- Subsidy schemes for conventional energy generation prevent competition from alternative sources.
- There currently is an information deficit among the public, developers and politicians. The distribution of environmental, economic and technical information is arguably ineffective.
- External costs of environmental degradation should be accounted for in the cost of energy generation. The introduction of carbon tax and trading would significantly reform the market for energy generation.
- Wind energy has a higher capital upfront cost, but lower generating running costs. Consequently Government policy should accommodate incentives for long term private investors.

- Local and regional populations have to benefit from the development of wind farms either through financial or other means.
- Local and regional populations should be included in the design process from the early stages of planning. Models which provide opportunities for cooperative or municipal ownership are encouraged.

## 5.12 CONCLUSION

Wind energy use will be one cornerstone to the energy supply of the future. Several countries demonstrate that wind energy use is technically and economically feasible. Wind energy will be a part of a future energy mix that will include solar energy, hydropower, biomass, geothermal energy, etc.

(WWEA, 2002, p1)

Wind energy is a different form of technology that requires vastly different application and spatial requirements. Unlike conventional sources of electricity generation, namely fossil fuel and nuclear, which can be centralized and located great distances from urban centers, wind farms are decentralized posing technical difficulties in connecting to existing

## 5. Wind Farms; Renewable Energy, Technology in the Landscape

infrastructure, storage of power and implications associated to conflicts of land use.

Wind turbines must be located where strong wind permeates and be relatively close to the existing grid for connection, typically implying sites located close to rural townships. Pasqualetti (2000) claims that the public faces a moral problem in accepting wind turbines within view of their back yards with reference to the normality of coal furnaces being located out of sight out of mind.

Research attempting to identify reasons for public opposition to wind farm developments have predominantly been focused on visual and noise effects (Simon, 1996). The visual effects are commonly referred to in media releases and negative connotations in the literature associated to impacts of wind farm development. It can be misinterpreted that wind farms only impose destructive effects on the amenity of the landscape, however as discussed in chapter one, aesthetic preference is predominately in the eye of the beholder.

Studies assessing the visual effects of turbines have varied in their objectives. Commonly visual studies have been conducted as a requirement to an Environmental Impact Statement (EIS). The objective of this process is for independent consultants to

## 5. Wind Farms; Renewable Energy, Technology in the Landscape

assess the potential visibility of the development from important public viewpoints. These studies are established on the premise that the wind farm will have a negative influence on the landscape. The concepts and terminology commonly used, such as 'visual impact', depicts negative implications of wind farm developments. Furthermore, studies of this nature typically conclude with mitigation techniques or guidelines to help hide or make the development 'invisible', also implying they are an intrusion and disliked.

Empirical research into the visual properties, perception and acceptance of wind farms has alluded to two common fields of enquiry. Firstly, the general broader global issue of wind farms as a renewable source of energy generation, and secondly the perception of the physical properties of wind turbines and location planning.

In terms of the visual character of wind farms and site design, several studies have provided a detailed analysis of the evolution of the turbine and the visual character of colour, scale, form and landscape site design (Gipe1995a, 1995b, 2002; Hammarlund, 2002; Lothian 2004; Pasqualetti 2002; Nielsen, 2002; Thayer, 1987; Thayer & Hansen 1988). Of particular note is a deficiency in research related to the dynamics of wind farms. Consequently,

there is a need to examine the effects of blade movement. Furthermore, there is a need to investigate current methods of visual assessment and their relevance to assess 'social landscapes' and dynamic elements.

As aforementioned, The Australian Wind Energy Association and Australian Council of National Trusts 2004; 2007) engaged independent consultants to review existing models used to assess wind farms and landscape values. From the literature review and consultation with stakeholders, a framework was produced for landscape assessment of wind farm developments.

The current guidelines produced by the Australian Wind Energy Association to develop successful wind energy projects are summarized in the following:

- Extensive community consultation
- If possible important views should be agreed with the community early in the process
- The cumulative effect of neighbouring wind farms should be considered
- Wind generators must be uniform in size and design (including direction of rotation)

## 5. Wind Farms; Renewable Energy, Technology in the Landscape

- Support tower, blades and nacelles should be painted the same colour- preferably off- white or light grey- and have a matt finish. They should not be used as billboards
- All wind generators within a wind farm should be kept operating
- The potential for shadow and flicker at residences should be assessed and minimized

(AusWEA, 2002b)

This chapter has discussed in detail all these items and referred to international literature for guidance and support in determining methods of assessing, public perceptions and means of moving into new fields of enquiry.

In the later sections of this chapter, emphasis has been placed on what is commonly referred to as community consultation. It has been suggested that this terminology should be reviewed and rephrased to 'community participation' as this alludes to an integral concept of engagement.

It is extremely important to engage the local community in the early stages of project decision making, instilling faith and trust in the developers and locals to provide knowledge on landscape concerns. It is extremely important that the proponent provide

information about the technical aspects of the proposed project in a legible format. Consequently, the proponent will need to be flexible in their approach to engage the community so that the project produces the best outcome in terms of social, environmental and economic values of landscape.

As discussed in detail throughout this chapter, the social sensitivity of the landscape should be considered in early site planning, possibly negotiating compensation to the local community by means of trust funds or some other socially uniform benefit.

Finally, in order for policies and processes to be developed, future research questions need to be answered:-

- Firstly, to what degree does the dynamic movement of turbine blades affect the visual perception of landscape change?
- Can current methodologies of visual assessment integrate values of perceived sensitivity and objective values of landscape physical changes?
- Are financial incentives and compensation important to opponents of wind farms and if so at what price?

These questions will be influential in the development of the methodology tested in the case study of this thesis. The following chapter will discuss and evaluate current models used in practice for visual assessment, providing a foundation for a new process of visual assessment.

## 6 WIND FARM VISUAL ASSESSMENT: METHODOLOGIES AND PROCESS.

### 6.1 INTRODUCTION

This chapter will review current methods used by specialist consultants to assess the visual effects of wind farms.

The first objective is to review current planning assessment procedures, legalities and suggested guidelines produced by municipal, state and federal government authorities and research related fields of enquiry in Australia.

Due to the infancy of the wind farm industry in Australia and complexity of planning resultant of the introduction of a built form of a scale and dynamic not encountered before, there is no uniform national framework for planning, consequently planning varies for each state.

The methods of assessment used in South Australia and Victoria will be described with examples from each state, revealing some experiences and imperfections in current processes.

Some of the controversy of planning regulations in South Australia and Victoria refer to the confusion of defining wind farms as a built form or public utility. In addition the current *Development Plans* (South Australia) and *Planning Schemes* (Victoria) refer to land use zones with various *Acts* legislating guidelines of development, most of which do not consider wind farms as a potential development form. These will be detailed and the process of lodging applications will be explained.

The second objective is to conduct a detailed review the of 'Wind farms and Landscape Values National Assessment Framework' project, commissioned by the Australian Wind Energy Association and Australian Council of National Trust (Planisphere, 2004, 2007). This Project was initiated to research and consult with stakeholders, regulatory bodies, professionals and community reference groups to decipher opportunities for a national assessment framework.

The third objective is to review and critique several wind farm visual assessment (EIA) and peer reviews, undertaken for wind farm developments in Australia during the late 1990s early 2000s. With reference to theoretical paradigms of assessment, the methods will be considered for their validity, credibility, utility, reliability, justification and clarity of information presented.

Furthermore, the models will be assessed for their ability to be duplicated for different landscape contexts permitting cross comparison of degrees of visual effect for different landscape regions.

By using several case studies, this chapter will illustrate the different processes undertaken by consultants highlighting common threads and differing aspects. The analysis of these studies will also provide an insight to the development and adaptation of models in a trial by learning approach to methodology fabrication. This will lead to future research questions which will provide a foundation for the construction of the proposed methodology employed and tested in this thesis.

Fourthly, this chapter will discuss best practice guidelines for visual assessment of wind farms in Australia with comparison to the United Kingdom, where Government agencies have pursued research into planning assessment frameworks. A suggested process of assessment will be outlined with description of the tools used in field investigations and desk top studies.

Finally as the industry develops and more landscapes are affected by wind developments, there will be a need to assess cumulative effects. It is foreseen that this will be an important consideration in

the future development and assessment of planning regulations and visual assessment studies. Consequently visual assessment methodologies need to maintain flexibility and be replicable. Methodologies need to be able to adjust to numerous scales; regional, subregional and local. Different forms of cumulative effects will be discussed in light of the experience of Scottish Natural Heritage who has been the most active in this field of enquiry.

## **6.2 PLANNING FOR WIND FARMS IN SOUTH AUSTRALIA AND VICTORIA; TWO DIVERSE APPROACHES ONE COMMON GOAL.**

The introduction of the Mandatory Renewable Energy Target (MRET) boosted the growth of wind farm developments during the early 21<sup>st</sup> Century, specifically in South Australia and Victoria, where strong prevailing winds are most available.

To date the growth of the industry in South Australia has been well received with few exceptions of local community opposition (Myponga, Sellicks Hill). The South Australian Government has been quite active in promoting and supporting renewable energies (Planning SA, 2002). Similarly the Victorian Government has been

supportive of the development of wind energy (Wawryk, 2004; The State Planning Policy Framework, 2003)

Victoria on the other hand has experienced a contrasting development of wind farm acceptance. 'Victoria has adopted a strategic approach while South Australia has a more reactive 'ad hoc' approach' (Hall & Harvey, 2006, p 721).

The differences in the procedures of assessment will be outlined below.

The Victorian planning system has fundamentally been directed by state based agencies. The National Trust of Australia (Victoria) has been extremely active in pursuing a strategic plan and assessment process to counter social community divisions and the conservation of landscapes of significance, particularly coastal landscapes in Victoria. Consequently, wind farm proposals in Victoria have experienced varied levels of acceptance, with developers risking prolonged and costly development assessment appeals (Coulston, 2002).

As described in previous chapters, wind turbines are a unique built form which has a scale and environmental effect without precedence. Consequently planning authorities such as local

councils, Development Assessment Commission, stakeholders, and the general public in South Australia are only starting to understand the complexities of integrating this form of development into landscapes.

Planning approvals are subject to environmental assessments, which depict the degree of effect the proposed development may have on properties with respect to noise, visual, flora and fauna, cultural heritage and archaeological significance including indigenous sites, vegetation, electromagnetic interference, aviation clearance and construction issues resultant of access and traffic circulation. All these factors need to be considered and weighted to form an appropriate decision on granting approval or not.

To date, the success of the majority of applications in Australia, have been determined by transparent methods of community consultation and clarification the degree of visual effect. Whilst Environmental Impact Assessments (EIA) provide information for decision makers, 'that information is also important to local communities that are likely to be affected by proposed projects' (Department of Environment & Heritage and Australian Greenhouse Office, 2006, p11).



Consequently this chapter will provide an overview of the South Australian and Victorian planning systems with specific insight to suggested national frameworks for visual assessment.

### **6.3 THE SOUTH AUSTRALIAN DEVELOPMENT PROCESS**

The legislative framework for development in South Australia is the *Development Act 1993 (SA)* and the relevant provisions of Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* Under the former Act 'no development may be undertaken unless the development is an approved development' (s 32). The Act defines development to be 'building work' or a change in the use of the land'. Undeniably, wind farms are a built form structure and are questionably a change in land use, for this reason they happen to come under the approval conditions constituted in the legislation.

There are four different procedures employed in granting approvals in South Australia. Firstly, applications by the private sector, secondly crown developments, thirdly major developments and fourthly projects involving electricity infrastructure.

#### **6.3.1 Private Development Lodged with the Local Council Authority.**

Private sector development applications are referred to the relevant planning authority which is typically the local council or regional development panel or otherwise stated Development Assessment Commission (DAC). Applications are assessed against the local council's *Development Plans* which designate cadastral boundary zones of landscape character building consents. These zones are typically characterised as rural, coastal, industrial, residential and commercial. The guidelines identify objectives and principles for each zone. These guidelines can be as explicit as identifying nature conservation with no building infrastructure permitted or conversely can identify a suitable scale, building materials and colours.

Due to wind farms being a new form of building infrastructure which does not occupy a large amount of ground surface, it has been argued in several applications that they are compatible to rural regions enabling traditional farming practices to continue with little to no disturbance (Wind Prospect, 2001). *Development Plans* do not contain specific policies on wind farms and applications are being assessed against existing frameworks:

## 6. Wind Farm Visual Assessment: Methodologies and Process

A development is complying in a zone only if it is identified as complying in the regulations and *Development Plans*. Various types of development may be listed as complying or non-complying in the Development Plans according to the zone in which it is proposed the development will take place.

(Wawryk, 2002, p341)

Wind farms have not been identified or documented to comply or not comply with any land use zone. To date wind farms have been considered Category 3<sup>1</sup> 'on merits' proposals. Subsequently, council *Development Plans* have had difficulty in addressing the complexities of wind farms, clarifying a need for a state based framework for renewable energies, specifically wind farms.

Planning SA (January 2002) released an Advisory Planning Notice for consultation, which clarifies wind farm developments in relation to the *Development Act*. The Advisory Notice explicitly outlines the development assessment process, identifying the relevant planning authority and criteria to be considered in the assessment.

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<sup>1</sup> Category 3 developments require the proponent to publicly announce the proposal to the owners or occupiers of adjacent land, or any other member of the public who the authority foresee as being directly affected. Under Category 3 assessments any member of the public may formally comment in writing to the authority on granting approval or objection.

Among the various assessment criteria, amenity of landscape is considered to be critical to the approval process:

Generally wind farms should avoid areas of scenic beauty/quality, particularly natural landscapes, main focal points including significant vistas and ridgelines, State and Local Heritage Place and areas of environmental conservation significance.

(Planning SA, 2002, p2)

The Advisory Notice was superseded by a published *Ministerial Plan Amendment Report* (2002). The key objectives of the report were to

- Identify issues relating to wind farm developments
- Raise awareness and generate debate on wind farm related policy issues
- Provide criteria and methodology to assist with visual assessment
- Assist councils on policy directions when conducting periodic review to ensure the appropriateness of their Development Plans and consistency with the Planning Strategy and when preparing amendments to Development Plans

(Planning SA, 2002, p1)

Highlighting the necessity for a strategic policy to provide clarity to the authoritarian, developers and public; the report provides a list of wind farm development effects which should be considered being:

- Visual impact
- Bird strike/ bird migration
- Native vegetation/ biodiversity
- Noise
- Location and design
- Cumulative impacts
- Consultation

Of these items it has been stated that visual impact is the most challenging issue to address due to its subjective nature. The report outlines a series of objectives to be accounted for in the visual assessment methodology. It even goes as far as describing a suggested process:

The methodology should take into account the various perspectives of the visual user groups represented in the local community, the degree to which turbines modify landscapes, the visibility of the proposal from public

viewpoints, the proximity to sites of significance such as conservation areas and national parks and the state significance of the landscape in question.

(Planning SA, 2002, p5)

### 6.3.2 Crown Development

Under section 49 of the *Development Act*, a special case is outlined which identifies development as public infrastructure or state government funded ventures. The project may be solely supported by state or a public, private partnership.

A wind farm is defined as a form of public infrastructure due to the construction, connection and provision of electricity to the grid network. Hence, state supported construction of transmission lines, and generation of electricity for public consumption, constitutes a crown development approval process. In South Australia, the Department of Trade & Industry has supported several wind farm proposals- Starfish Hill, Tarong Energy and proposed Sheringa, Elliston (Wawryk, 2002, p345).

The following sequence of events outlines the process of application:

- The state agency submits the application to the Development Assessment Commission (DAC) who is the planning authority for granting the approval. The state agency must also notify the local council of the proposal.
- Local council has two months to submit a report on recommendations of the project and any referrals required to evaluate the effects, this could be the EPA or Department of Environment and Heritage or DAC to assess the proposal against the councils Development Plan with reference to the council's submission.
- Within three months of receiving the application DAC must deliver a report to the Minister of Housing and Urban Development with recommendations from all consultants involved.
- Finally the Minister will acknowledge receipt and provide recommendations. If the project was non-complying then the Minister must table a report to the State Parliament before approving the development.

If the project is valued below four million dollars, the process eliminates public participation as the state agency does not publicly announce the project. Wind farms are typically above four million dollars, indicating a similar public announcement and process to private applications.

Generally proponents see this approach as a fast track procedure with minimal public notification and no rights of appeal against the Ministerial decision. On the other hand proponents are apprehensive that the Minister's decision may be non-complying without a right to appeal should the project become controversial and politically unacceptable.

Evidently the Crown development process has limitations in public notification and consultation, which inevitably can be the cause of adverse social unrest. This may be a cause for concern as it can filter negative responses of wind farm applications and development. This may outweigh the positive influences of renewable energy and the growth of the wind power industry.

### 6.3.3 Major Development

Unlike Victoria, there is no provision to designate large wind farms (eg over 30 MW) as major developments under the South Australian development application process although one wind farm, Myponga/Sellicks Hill, has been subject to this EIA process (Hall & Harvey, 2006).

Major developments are not too dissimilar to Crown Developments. The Minister will make a valued judgment on the

issues of location, scale and related policy targets, to adjudicate whether the project should be reinstated as a major project for the state.

This process involves the Minister referring the project to a Major Developments Panel, who produce an Issues Paper which is released for public comment. Submissions are returned to the Minister and compiled into a report which identifies the major concerns. The Minister will then inform the proponent of the degree of environmental assessment required implying either an EIA or Public Environment Report (PER).

These reports are inclusive of studies on the visual effects, noise effects, environmental sensitivities of flora and fauna, and any historical and cultural issues. The two reports are somewhat similar but vary in the level of technical detail required.

Upon completion and compilation of the report, the community is engaged once more to review and comment. The comments are received by the Major Developments Panel and referred to the Minister who tables the report to the Governor for final approval. The Governor's decision has no rights to appeal by either the public or the applicant.

This is a timely and costly process for the proponent, requiring flexibility in the design development and alteration of the scope and siting of the turbines if recommended. Ultimately the development is stringently assessed by numerous organisations and individuals, in a rigorous evaluation of all the effects. However the final grant of approval or refusal is directed by the Minister and Governor, implying the results of the process can be overturned by a sole decision. An example of this is Myponga/ Sellicks Hill, South Australia.

Myponga/Sellicks Hill was originally a proposal for 70 wind turbines within a rural farming landscape on the Fleurieu Peninsula, south of Adelaide. Due to the Department of Trade & Industry sponsoring the project on behalf of Trustpower Pty Ltd, the proposal was lodged as a Crown Development in June 2002.

The Minister for Urban Development & Planning declared the proposal to be a major development due to the sensitivity of the location. The Major Developments Panel produced an Issues Paper for public circulation. Upon receipt of the concerns, which were mainly visual impact, the Minister instructed the proponent to produce a Public Environment Report (PER). In consultation with Parsons Brinckerhoff (2003), the PER concluded that

The project will have a small but insignificant visual impact on the landscape. Any other potential adverse effects are insignificant compared to the substantial benefits provided and will be properly managed to ensure their impact is minimal.

(Parsons Brinkerhoff, 2003, pxxi)

The PER was released to the public for comment, upon which 270 responses were received from the public, 12 from State Government Agencies and two from Local Government. Some of the major issues resultant of the public remarks was visual impact, noise and negative impacts on tourism (Hall & Harvey, 2006).

The proponent made minor amendments to the project to alleviate visual effects reflecting the wishes and recommendations of the Development Panel. After three amendments in an attempt to alleviate the visual impacts, the proposal was granted approval by the Governor, under certain conditions of mitigation.

Since approval, certain Government agencies have leaked information with regards to the process of evaluation and the Ministers disregard to State Agency recommendations. Planning SA was quoted in *The Sunday Mail* (2004, 11<sup>th</sup> January); in concluding that the site was inappropriate for wind farms and

Planning SA staff they were upset that the Minister required them to change the draft report. Similarly *The Times* (2004, 5<sup>th</sup> January) reported a spokesman for the Minister for Urban Development & Planning, had stated that the draft assessment report identified visual concerns of which the Minister disregarded (Hall & Harvey, 2006).

Evidently, this project has raised public awareness of the issues resulting from wind farms, producing community confusion, disappointment and overwhelmingly emphasising the flaws in the planning system.

#### **6.3.4 Development Involving Electricity Infrastructure**

Section 49A of the *Development Act* which is also commonly referred to as *Electricity Act 1996 (SA)*, is applicable to licensed distribution companies of electricity. This form of application is limited to prescribed generators and distributors of electricity; it is not inclusive of privately supported wind farm developments.

A similar process to the Crown development assessment is employed. The Development Assessment Commission is responsible for assessing the proposal and reporting their findings and recommendations to the Minister for consent. Hence the

rights of appeal and public consultation process are limited. There have been no assessments under this Act/ clause to date.

#### 6.4 STRATEGIC PLANNING THE VICTORIAN EXPERIENCE

The structure of the Victorian planning system is somewhat similar to South Australia with some procedural differences.

Victoria is regulated by the *Planning and Environment Act* (1987) which is supported by council documents known as *Planning Schemes*. *Planning Schemes* contain Local Planning Policy Frameworks which designate zones and landscape overlays. Landscape overlays signify important characteristics such as historical, cultural, vegetation and fauna preservation. Local planning policies may also identify areas which could be developed with wind farms, for example South Gippsland Shire Council has installed a '*Wind turbine and windfarm development*' policy under their Local Planning Policy, Clause 22.01, which identifies land to the north of Toora as an area where wind farms are to be encouraged.

Amendments to the planning laws (*State Planning Policy Framework, 2002*) have directed attention to the implementation of

renewable energies (Clause 15). The key components of this policy seek to provide

- A Renewable Energy Strategy for Victoria
  - Consistent and streamlined assessment process
  - State Planning Policy for renewable energy
  - Planning Guidelines for wind energy facilities
  - A central point of contact with Government
  - Improving data on Victoria's wind resources
  - Locating wind energy facilities
- (Sustainable Energy Authority Victoria, 2004, p4-5)

The release of this document was supplemented by *Policy and Planning Guidelines for Development of Wind Energy Facilities in Victoria 2002 (Victorian Wind Energy Guidelines)*, which provides a framework for the assessment of wind energy projects in Victoria.

Applications for wind energy projects are assessed through one of two procedures

- Planning permit process, this applies to wind energy projects with a capacity of generation below 30 megawatts. Applications are submitted to the local council

authority for assessment against the *Planning and Environment Act 1987* supported by the local planning scheme.

- Environmental Effects Statement (EES), which applies to wind developments with a capacity above 30 megawatts. Generally this procedure will be 'called in' by the Minister for Planning.

#### 6.4.1 Permit Planning

Under the planning permit procedure the local council will weigh the costs and benefits of the project against their planning scheme with reference to the views of the Sustainable Energy Association of Victoria, the opinion of the Civil Aviation Safety Authority (CASA) and the *Victorian Wind Energy Guidelines (2002)*. The local council may also decide to convey with other state agencies and refer aspects of the project for comment including the Department for Environment & Heritage.

The *Victorian Wind Energy Guidelines (2002)* describe in detail, criteria which needs to be assessed and reported in the application. Of these criteria visual amenity is prescribed to be considered and assessed with respect to the Victorian Government's policy in support of renewable energy development. Hence, the degree of visual effect is to be weighted against the

benefits of renewable energy generation and greenhouse gas emission deductions.

The Planning Permit process engages the public for comment and representation.

Prior to making its decision, the responsible authority or applicant must give notice of the application to construct a wind energy facility to various parties, including the owners and occupiers of allotments or lots adjoining the land to which the application applies, and any other persons whom the responsible planning authority considers may be caused material detriment by the grant of permit.

(Wawryk, 2004, p7)

Proponents are asked to review and rebut any objections represented by the public to the local planning authority. Upon review of referred reports, representations and commentary, the local planning authority will conclude by either granting approval or refusal.

Under the *Planning and Environment Act*, the proponent and represented public objectors are permitted to appeal the decision



to the Victorian Civil and Administrative Tribunal (VCAT). This process has occurred twice in Victoria, for the Cape Bridgewater (Portland Wind Energy Project (PWEF), Energy Equity Corporation and Pacific Hydro) and for the Thackeray (South Gippsland, Stanwell Corporation Limited). Project details of the PWEF are discussed later in this chapter.

In addition, the *Coastal Management Act 1995 (Vic)* establishes legislation to protect and maintain coastal landscapes of significance whilst also promoting public awareness, recreational facilities and water quality. Under this Act, the Minister for the Department of Natural Resources & Environment can object to an application along the coastal zone. Furthermore, the *National Parks Act 1975* excludes wind farms from being developed in National Parks. This is a substantial strategic directive as 43 percent of Victoria's coastline is designated as National Parks.

#### 6.4.2 Environmental Effects Statement (EES)

The second approach is referred to the Minister for Planning. The *Planning & Environment Act* refers to a development assessment of significant effects of the environment (*Environmental Effects Act 1978*). Under this *Act* the proponent is entitled to refer the proposed project to the Minister for Planning and Planning Panels Victoria, to decide whether an (EES) is required. As has generally occurred to date, if the Minister decides an EES is required, the

Minister will summon the project to be assessed as an issue of major planning policy. Due to the complexities of wind farms,

the Minister has called in all wind energy proposals in Victoria since the Guidelines were established, including the Wonthaggi wind farm, which has a capacity of 10.5 MW (i.e. less than 30 MW). The primary reasons for this are the complexity of major wind farm proposals; the lack of experience of Councils in assessing such proposals as the industry is still in its infancy; and the policy implications of approving proposals that may have major social, environmental and economic impacts.

(Wawryk, 2004, p10)

Changes to the planning policy in 2002, specifically to address issues of wind farm developments, are said to still have problems related to community support and involvement in the process.

It is claimed that the current system has disempowered local community input and has set the stage for bitter conflicts over the location and siting of wind energy.

(Department of Environment & Heritage and Australian Greenhouse office, 2006, p16)

Furthermore, amendments to the planning policy fail to identify means of assessing the visual effects, as is commonly the case the visual effects are contested.

Although the visual impact is only one aspect of a wind farm development, the fact that other environmental impacts can generally be controlled by permit conditions means that visual impact is likely to be the major issue in any appeals against planning approval.

(Wawryk, 2004, p15)

The major limitations of this process are that the Minister has no legal obligation to accept the recommendations of the Planning Panel. Coincidentally, any public objections represented to the Panel will not necessarily be adopted, creating a tension in the community and a lack of confidence in the planning system. A notable example of the community losing faith in the planning system is the Portland Wind Energy Project (PWEF), formerly the Cape Bridgewater project.

#### **6.4.3 Cape Bridgewater Project**

Formerly developed by Energy Equity the proposal consisted of 33 wind turbines with a maximum height of 72 m. The turbines were to be located in an area of outstanding natural beauty, with

significant indigenous and geological heritage (*South Western Coastal Planning Scheme*, 1977; Victorian Coastal Strategy, 1988). The initial application was lodged with the Heywood Shire Council, who assessed the project against the *Heywood Shire Planning Scheme*.

At the time of application the *Heywood Shire Planning Scheme* was the legislated document, this was later superseded by the *Glenelg Shire Planning Scheme*; a new amalgamated council entity. The project was lodged with council prior to the release of the 2002 planning amendments meaning the council had limited source of reference to assess the complexities of the development.

Approval was granted by the Shire of Glenelg on the merit that the Cape did not have any local planning policy.

This decision was appealed and referred to the Victorian Civil and Administrative Tribunal (VCAT). The Tribunal considered and reviewed the visual impacts, noise, electro-magnetic interference, indigenous heritage and impacts on flora and fauna, whilst also consideration was given to the benefits of reducing greenhouse gases. The major concern was the visual impact on and around

## 6. Wind Farm Visual Assessment: Methodologies and Process

Cape Bridgewater which 'exhibits outstanding scenic qualities' (Hislop & Ors v Glenelg Shire Council, n 30).

The proponent of the project engaged a town planning consultant to review the visual effects. The findings of this report, suggested that the visual effect may well complement the location or improve the quality of the landscape by becoming a dynamic tourist attraction. The report went further to imply that 'if wind farms are to form part of the rural landscape, the community must come to accept their existence in non-spectacular, rural locations' (Wawryk, 2002, p349).

Based on the findings of the assessment, 'the Tribunal refused to accept that the turbines would enhance the view and found that in fact the wind farm would have a disturbing visual impact on the significant landscape values of the Cape' (Hislop & Ors v Glenelg SC ,n30). For this reason, a permit was refused with the Tribunal concluding that the proposed site exhibited 'very special attributes' that were 'highly significant for Victoria'. While it was difficult to place a dollar value on the scenic value of the landscape, the value in the opinion of the Tribunal in this instance inevitably far outweighed the benefits of developing a wind farm in this location (Hislop & Ors v Glenelg SC, n30).

Subsequent to the Cape Bridgewater project being overturned, the Portland Wind Energy Project (PWEF), which represented an expanded version of the concept, was proposed.

The proposal composed of a total of 120 turbines involving four different sites- Yambuk, Cape Bridgewater, Cape Nelson and Cape Sir William Grant. Due to the scale of the proposal the Victorian Minister for Planning called in the project, requesting the proponent to produce an EES. The Minister appointed a panel of three people to firstly review the EES and make recommendations; secondly to formalise recommendations to include wind energy development guidelines and assessment criteria to the *Glenelg Shire Planning Scheme*, and thirdly to derive strategic objectives to formulate a state policy for the Victorian coast to contend with the evolving development issues.

The Panel approved the project on the condition of certain recommendations. Of most concern was the assessment and impact of the visual landscape and the effects on tourism.

The visual impact report by the proponent was considered to be flawed because

the assessment of landscape character completely failed to identify the characteristics and features that made a particular landscape 'special', or different or more significant than other landscapes. For example, the assessments of Cape Bridgewater and Bridgewater Lakes landscapes failed to acknowledge that these landscapes were in any way special, or that by many existing measures they were likely to be measures of national or even international significance. Furthermore, the landscape assessments completely failed to capture the important qualities of those landscapes: the intimate scale and visual diversity of the Bridgewater Lakes landscape and the dramatic visual statement provided by the Cape Bridgewater headland, and the importance of the stark, clean lines of the Cape to its special landscape character. Nor was any attempt made to map such qualities so that the decision maker could form a view as to whether this or that siting choice would impact on this or that suite of landscape characteristics and values. This failure to identify the essential elements of these landscapes affected the entire assessment process because the impacts of the modifications to the landscapes by the turbine developments were then significantly understated, leaving the assessment process seriously flawed.

(PWEF Panel Report, 2002a, p65)

All things considered and notwithstanding the above criticism, the Panel supported the project with some recommended amendments. Firstly the Yambuk site required a more detailed assessment on the Orange-Bellied Parrot (*Neophema chrysogaster*) and potential conflicts with the migration path. Secondly, the Cape Bridgewater application was encouraged on the condition that the maximum number of turbines is limited to 23. In addition the Danish company NEG would need to invest in a turbine manufacturing plant in Portland. It was understood that the capital investment in Portland creating jobs in Victoria would offset any adverse effects on tourism. The Minister supported this argument, debating the economic benefits of regional growth outweighed the effects on scenic amenity. Interestingly, the argument of compromising scenic resources with economic growth seems to be short lived, similar to political circles.

The PWEF was accepted by the Minister without endorsement of the Panel's recommendations, leaving the planning system open to criticism. The community became apprehensive about what had transpired, considering the failure of previous applications and the longevity of the procedure. Undeniably this experience has caused

scepticism amongst the community and misrepresentation of the wind industry.

In addition the Panel's review of the visual assessment highlights the need for a theoretical framework.

### 6.5 NATIONAL PLANNING FRAMEWORK

The experiences discussed above draw attention to flaws in the current procedures. For the wind industry to sustain growth in Australia, a coordinated proactive rather than reactive national framework is required which provides clarity and transparency of information to the authoritarian, proponent and public. There are obviously limitations in the current site specific model of assessment based on merit of application. The controversy of scenic amenity conservation and wind farm developments is an issue needing strategic directives lead by research. To date there has been very little policy to manage landscapes of natural beauty, exceptions being

in the early part of the twentieth century Tasmania had a Scenery Preservation Board to argue a case for scenery protection. But in more recent times in Australia- apart

from the National Trust- there have been few powerful voices speaking on behalf of scenic values.

(Mercer, 2003, p92)

The Department of Environment & Heritage and Australian Greenhouse Office (2006), support the notion of a national strategic approach to the planning of wind farms. The challenges that this brings are quintessentially founded in the social and environmental realms of planning.

The most controversial aspects are those that affect local residents to proposed developments. This is why community consultation is a key requirement in all development approval processes. The extent, objective and timing of the consultation needs to be aligned to involve the public from the outset of the project enabling siting decisions to be determined by cultural values of landscape among other factors such as wind velocity. This trade off should be commensurate enabling the community to follow the design process of layout refinement according to the siting criteria.

To enable developers to locate landscapes which possess suitable site criteria, it has been suggested that a strategic

approach to assess environments and inform policy for land use zones be adopted (Hall and Harvey, 2006).

Strategic Environmental Assessment (SEA) entails an evaluation of the environment reflecting upon the policy, plan or program. Hence, it is a strategic level of investigation determining environmental suitability of land use and potential developments. Rather than being site specific, SEA enables classification of land zones for particular forms of development, and nature conservation.

Recent literature has requested that wind farms are coordinated into a strategic environmental assessment process of valuing and identifying landscape regions on a national basis (Hall & Harvey, 2006; Haack, 2006). A precedent study is in progress in the United Kingdom (DTI, 2002) which seeks to assess coastal regions for potential offshore development proposals. Similarly strategic assessments have been conducted in South Australia to examine landscape quality and wind farm development proposals respectively (Lothian, 2000, 2004, 2008).

Lothian's study of 'Scenic Perceptions of the Visual Effects of Wind farms on South Australian Landscapes' (2008) found that wind farms in landscapes of high scenic value generally diminish

the aesthetic value, but have a positive influence on landscapes of low quality. Further findings of the study depicted that there is no correlation between reduced visual effects and distance.

These forms of regional assessment identify sensitive areas and provide broad strategies for local councils to assess proposals. Strategic environment assessments make available information to the public and developers in the early stages of project realisation, providing the ability to compare alternative sites which is beneficial to regulating land use, efficiency of identifying feasible sites and sustainability of landscapes.

In addition planning recommendations produced by SEA provide informative data on the sensitivity of the environment to cumulative effects of several developments in a particular region. Alarming this is a vital component missing in site specific Environmental Impact Assessments (EIA) or Environmental Effects Statement (EES) as it is referred to in Victoria.

Due to the rapid rate of wind farm development proposals and the scale of current proposals exceeding 100 turbines, with environmental effects emerging across borders of councils and states, it is suggested that a national approach would be beneficial.

Following amendments to the Victorian planning laws in 2002, Victoria has developed a series of strategic policy 'no go zones' for wind farms. These include Public Conservation and Resource Zones under the *National Parks Act 1975* (Vic). In addition the development of a 'wind atlas' which cartographically represents wind velocity zones of Victoria, provides important information to developers in identifying feasible power generating sites.

The concept of developing 'no go zones' has particular merit in providing clarity to planning schemes, negating conflicts of social, environmental and economic prosperity of landscapes. Developing SEAs for wind farms particularly in coastal regions would be an important and progressive planning policy. Understandably the visual effects of wind farms can traverse landscape zones, characters and cadastral boundaries. As a consequence the potential impacts can be on a regional scale. Further to this discussion is the uncertainty of cumulative impacts as future developments transpire. The effect of numerous wind farms in a particular geographic region will exponentially increase the effect, to what degree is acceptable is un-determined. Hence, rational thought would suggest a state based strategic model of designating landscape compatibility zones in accordance to cultural, historic, economic and social value should be employed

to form an opportunities map, collated with the associated state wind atlas.

On the other hand it is still imperative to recommend site specific EIA for wind farm development applications that are to be located in zones of compatibility. The detailed location of the proposal should be assessed for environmental, social and economic impacts. The EIA process would comprise of a more detailed analysis of the intricacies of the proposed location, engaging the community at the forefront of any wind farm development application.

Consequently it is suggested that SEA would provide baseline data to inform developers of potential sites and landscapes which are off limits. Secondly it would provide authorities information to secure landscapes of particular social and environmental significance. Understandably the procedure of conducting a SEA would imply assessing environmental criteria of the effects of wind farms against the relevant *Planning Scheme* or *Development Plan*. To enable this to occur it is suggested that an overlay process of spatial information could produce opportunities and constraints map, identifying zones of compatibility (McHarg, 1969; Dunsford, MacFarlane & Turner, 2003a).

A suggested framework would be to assign quantitative values to landscape units in a geographically referenced data base.

Overlaying values of visual amenity, noise, flora and fauna etc., would enable an objective analysis of land use zones which conflict or permit the integration of wind farms. Methods to assemble values of landscape are currently being investigated. This thesis hopes to provide a solution to a procedure to quantify visual effects on a strategic and site specific level of planning.

#### 6.6 NATIONAL ASSESSMENT FRAMEWORK FOR LANDSCAPE VALUES

Most recently the Australian Wind Energy Association and the Australian Council of National Trusts (2005, 2007) have collaborated to support a project to investigate models for assessing landscape values.

Although methods of identifying the significance of some landscape elements (such as rare flora and historic buildings) and assessing impacts on some identified values have been adopted at local, state and national levels, there is no agreed framework for assessing less tangible landscape elements such as visual, aesthetic and cultural values.

(Planisphere, 2005, p1)

The aims and objectives of the project are firstly to identify the issues surrounding landscape values and wind farm perceptions, secondly to manufacture a nationally accepted methodology to assess and protect valued Australian landscapes while enabling wind farming development to occur, and thirdly to road test the methodology.

Consultation is the basis of the project discovering the complexities of the issues at hand and providing rigor to the collation of information. Consequently, the first stage of the project was to identify stakeholders and interested organizations from diverse occupations for consultation.

The first stage was conducted in 2005. The process of engagement was as follows

**Table 6.1** Stage one process of engagement (Planisphere, 2005).

NOTE:  
This table is included on pages 207-208 of the print copy of the thesis held in the University of Adelaide Library.



(Planisphere, 2005)

The consultation process targeted representatives indicative of experiences from developers, government agencies, professional consultants, local community groups and research related academics.

The engagement of the community was facilitated by some key questions. Firstly, the consultants asked participants what characteristics constitute a wind farm and particular components which influence site design. The results identified and supported previous studies and literature on issues of environmental, aesthetic, cultural and historical values of landscape. Consideration was given to positive and negative effects. It was noted that many people appreciate the appearance of wind farms citing the benefits and improvements of degraded landscapes (Smith 2003; Planisphere, 2005). Further, the following characteristics of wind farms have been recognised as positive aesthetic effects

- Sleek aerodynamic and sculptural forms
- Starkness and modernity of design
- Consistency and repetition of features
- A sense of order
- A strong presence
- Symbolism of harmony with nature
- Function of producing renewable energy
- Substitution of conventional green house gas emissive energy generators to clean renewable sources.

(Planisphere, 2005)

Most of the negative effects recorded in the consultation related to the imposing nature of the scale of the turbines and loss of aesthetic amenity. Numerous issues were raised with respect to the visual effect, notably distance and number of turbines within the field of view. Potential effects were documented on the changes in amenity of enjoying the existing landscape from residential properties, recreational trails and travel routes. Given that the heights of turbines are almost impossible to camouflage, the question has been asked 'Are there ways of siting and designing wind farms that might reduce the negative impacts' (Planisphere, 2005, p12).

Survey respondents suggested a series of possible guidelines to help mitigate the effects. Firstly it was suggested that clustering the turbines in arrays that do not impede on important sight lines would limit the negative effects. In addition it was suggested that clustering the turbines in small arrays avoiding dense spacing, with substantial open space between them, aids absorption. This is supported by Gipe (2002) and Inspiring Place (2002a).

Recommendations were also submitted to reduce the height of turbines to a more proportionally sensitive reflection on the existing landscapes spatial composition. This is fraught with difficulty as this would imply trading efficiency of power generation and feasibility of projects.

The height of wind turbines is a design constraint: the higher the rotor and the longer the rotor blade, the greater the amount of electricity produced. As a result, a reduction in rotor height or blade length can require an increase in the number of turbines proposed, which in turn might generate other unwanted effects, such as visual clutter and an increase in the amount of land required for the development.

(Planisphere, 2005, p13)

Emphasis was also placed on the visual appearance of the turbine as an element. Materiality and colour were discussed, resulting in recommendations for matte finished duco to reduce any glare. The colour range was suggested to be soft grey, tan and cream; contradictory to recommendations of previous research overseas where, white is preferred for its purity and clarity (Stanton, 1996).

The major objective of the survey was to ascertain an understanding of what landscape values comprise of and methodologies used to measure these values.

potential values of landscape vary: some authors use landscape value to mean only the visual character or aesthetics of a place; others use landscape values to include a range of qualities such as social, Indigenous, cultural, artistic and environmental values.

(Planisphere, 2005, p14)

It is important to clearly differentiate between the two with the knowledge that visual effects account for 83% (Bell, 2004) of perception. Consequently visual effects are commonly referred to for landscape amenity values. To the contrary, landscape values are broader than pure visual effects; they encompass intangible qualities of intuition. Social, emotional, historical and cultural

variables affect experience of a particular place. For this reason, it is rationale to think that a holistic model is required which provides flexibility in assessing individual affections of landscape and combinations of variables to decipher a true representation of landscape sensitivities.

A number of methodologies have been employed and accepted for assessing values of historical and environmental significance, indicating the potential effects, the degree of impact acceptable and opportunities to limit any adverse effects. In contrast the less tangible qualities of visual effect and cultural values are without defined methods or accepted tools to evaluate the existing landscape and potential effects. Policy and guidelines seek assistance in developing methods to enable a holistic framework, integrating methods to assess visual and cultural effects. There are currently several research related methods emerging for two separate assessment objectives (Inspiring Place, 2002; Planisphere & Context, 2007). The objectives of the methodologies, which are not specifically for wind farm assessments, are

- Visual effect assessment and scenic values of landscapes, integrating landscape character assessment.

- Contemporary cultural values, encompassing emotional and symbolic relationships of people and place.

Cultural values are referenced to familiarities of particular landscapes. Commonly assessed by engaging community groups it is critical that participation is a collaboration of people pursuing objectives that they themselves have defined. More often than not participation in assessing landscape values is conducted by surveys and public meetings. In these processes, particular landscape regions are classified in accordance to informed mapping techniques in an interactive procedure. Different forms of engagement can induce different levels of contribution (Sanoff, 2000)

Different models have been suggested and employed for visual assessment since the 1970s in the United States and early 1980s in Australia. Of particular reference is the work conducted by the National Trust, in Victoria and New South Wales and the Forestry Commission (1990). The development of Visual Resource Management Systems (VMSs) facilitated the evaluation of landscape character and provided an expert judgement of the scenic quality, and sensitivity of the landscape typically interpreted as high, mid or low in relation to vegetation, landform and presence of water. Alternative studies have depicted intangible

qualities of perceived sensitivities through surveys and psychophysical analysis.

Consequently cultural and visual landscape values are topics of assessment which are intertwined. Landscape visual resources are inseparable from cultural associations. However the degree to which the visual sense is pertinent to the significance of the cultural value is questionable. For example the emotional experience of a landscape emitting satisfaction may be due to the smell, tactile feel or warmth of the sun. Consequently, visual and cultural landscape values should be assessed purely on their own merit.

Visual assessment methodologies used in Environmental Impact Assessments (EIA) for wind farms have typically tried to interpret cultural values as a visual quality. The following discussion will explain in detail some common faults in combining visual and cultural values.

### 6.7 PORTLAND WIND ENERGY PROJECT (PWEP) VISUAL ASSESSMENT: - EDAW

The Portland Wind Energy Project Landscape and Visual Impact Assessment (2001), was prepared by EDAW for Sinclair Knight

Merz who were engaged to conduct the EES for Pacific Hydro Limited.

The process adopted by EDAW employs a model similar to the visual resource management systems developed by Litton (1968) and the Forestry Commission (2000). The following are the objectives of the study

- Define and describe the landscape character and develop siting criteria
- Define the viewshed<sup>2</sup> of the development and identify viewing locations.
- Assess the visual impacts of the development Provide guidance on techniques to help mitigate adverse effects.

The initial stages of the assessment involved collating and researching literature on empirical studies of overseas perceptions of wind farms. This background information provided the consultant direction to recognize common issues resultant of wind farm developments, planning and community consultation. It also supported claims in the report of subjectivity and attitudinal variance. It was concluded from the literature review that wind

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<sup>2</sup> Viewshed is a term used in landscape visual assessment which is defined as the theoretical extent of development visibility. It is commonly graphically represented by zones of visibility upon a regional topographic map.

## 6. Wind Farm Visual Assessment: Methodologies and Process

farms will be acceptable upon a transparent process of community engagement and clarity of information.

The first objective was to assess the existing visual environment. This study was conducted as desktop and field investigations. The primary task was to inform an understanding of the topography, vegetation coverage, land use, descriptive characterisation and identification of any significant features in the regional, subregional and local area. The following stages are illustrated in Appendix Chapter 6.

As can be seen in Appendix Chapter 6 the methodology is divided into two parallel processes. On the left hand side is site design criteria. This encompasses the identification of key viewpoints or zones of which the proposed development will be visible. Computer modelling and site observations provided informative appraisal of particular areas needing detailed evaluation.

The establishment of visual performance criteria was developed to help design the siting of the turbines. The following is the list of visual criteria considered

- The identification of significant views and key viewing locations

- The nature of the views: regional, sub-regional or local; panoramic, skyline, backdrop, etc
- Proportion of development sites visible from key viewing locations
- Understanding of the natural or cultural 'patterns' in the landscape
- Screening potential (existing or proposed)
- Potential landmark opportunities

(EDAW, 2002, p 10)

It is worth noting that the visual performance criterion was not informed by community values of landscape. Therefore the perceptions and appreciation of certain views and the local perceptions of wind turbines, did not inform the design decision making. This is one of the flaws of this process which will be discussed in more detail in the proceedings to follow.

Conversely the community were consulted on a couple of different site layouts which were developed during the process of negotiating economic feasibility of power generation, environmentally significant areas and visual sight lines. The community presentation and preference assessment occurred at a later stage of the process.

After the adoption of a concept a more detailed assessment was conducted on the degree of visual modification caused by the development. This was a subjective assessment based on a classification of high, medium or low visual modification. The definitions of the degree of visual modification were:

**Table 6.2**

NOTE:  
This table is included on page 213  
of the print copy of the thesis held in  
the University of Adelaide Library.

(Adapted from EDAW, 2002, p11)

A parallel process was conducted simultaneously which sought to identify land use zones and values of landscape sensitivity, reflecting potential user groups perceptions.

The EDAW model designates visual sensitivity to the intended user of the landscape, which delineates a predicted observation of the degree of acceptability to change (Figure 6.1). For example, a local resident will perceive changes to their local area with more criticism than they would for a development on the outskirts of a regional area. Similarly holiday makers will foresee the development with more criticism than industrial workers in the same area.

**Figure 6.1** Landscape Sensitivity matrix  
(EDAW, 2001, p25)

**Table 6.3** Landscape sensitivity matrix (Adapted from EDAW,  
2002, p12)

NOTE:  
These images are included on page 214  
of the print copy of the thesis held in  
the University of Adelaide Library.

Time, distance and land use were key variables to the perceived sensitivity of landscape change. These aspects were considered during the field investigations and base line data collection. In addition 'public attitudes and perceived sensitivities to the proposed wind farm development were sampled through the consultative process and the outcomes are incorporated into a sensitivity matrix (EDAW, 2002, p11).

The visual impact of the proposed development was said to be the aggregate of the two processes. The model utilised a matrix formula to combine and compare the degree of visual modification with the level of viewer sensitivity. The arbitrary values of high, medium and low enabled the consultant to predict a concluding statement of the likely visual impact. Table 6.4 illustrates the assessment matrix.

**Table 6.4** (Adapted from EDAW, 2002, p12)

NOTE:  
This table is included on page 215  
of the print copy of the thesis held in  
the University of Adelaide Library.

The conclusions to this process were to finalise the visual impact value ascertained for each viewpoint and propose guidelines to mitigate and ameliorate the view. Measures suggested were typically to plant vegetation within the local vicinity, which can over time maintain landscape character but help frame particular views whilst screening others. Similarly it was suggested that a broad regional revegetation program could provide a backdrop to the wind farm, assisting the absorption capacity of the landscape.

#### **6.7.1 Identifying Positive Attributes of the EDAW Model**

The methodology employed by EDAW has many positive attributes which can be referenced in the development of an assessment framework. Firstly it is imperative in the initial stages to conduct desk top studies of the regional landscape upon which

the proposed development is to be situated. An informed understanding of the history, culture, geomorphology, topography, evolution of land use, environmental significance, including conservation zones and areas of potential national, state or regional significance provides a good basis for further site investigations. Developing technical tools by means of computer modelling, constructing viewshed maps is also important in identifying areas of potential special interest.

Following desk top studies, a preliminary site investigation is beneficial to reinforce the knowledge acquired through literature and mapping, in addition providing ground verification of the information. The experience of the landscape also provides a stronger sense of the function and process of the landscape, contributing to a better understanding of the landscape character. Consequently, a detailed landscape character report illustrated with photographs is fundamental to the preliminary stages.

The intuitive process of engaging the community in site design layout is commendable. The concept of present- defend planning<sup>3</sup> is negated by a process of participation planning, limited to an

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<sup>3</sup> Present defend planning is a term used to define a process of planning which limits the degree of input from the community. It is commonly experienced when proponents design the project, present to the community and defend their decisions, without consideration of any public endorsed design interventions.



extent by negotiation of economic and environmental planning concerns. Consequently the process accommodates community preferences but is limited in the flexibility of acknowledging specific design transformations required to negate potentially adverse visual effects.

Detailed visual analysis is a separate issue which is informed by the character assessment report. Visual impact assessment presented in Appendix 6, consists of two parallel procedures. The division of two concurrent processes is justified by theoretical objectives. The degree of visual modification and significance of landscape sensitivity holds opposing views in terms of how the landscape is perceived. The criterion for assessing the degree of visual modification is primarily concerned with inherent qualities of landscape composition. It is a subjective conception of how the consultant perceives the view with respect to the composition of forms and presence of vegetation, water bodies, topography and naturalness of the landscape. In contrast landscape sensitivity values are theoretically agreed to be in the eye of the beholder. Hence the validity of separating these two processes is credible.

In terms of culminating the subjective and objective schools of thought, it can be conceived that a quasi-objective framework of assessment is produced. This has merit in assessing and

cumulating a value for predicted effects, given the degree of modification should be a combined quantification of visibility and perceived landscape sensitivities. However, the process adopted by EDAW to determine values for the degree of modification and sensitivity is flawed.

### 6.7.2 Limitations of the EDAW Model

The methodology employed by EDAW is in conflict with the theoretical paradigm of assessing subjective visual values. Contrary to assessing local peoples' perceptions of landscape character and significant views, the model adopts a generalist view on the degree of visual sensitivity according to classified user groups.

Evidently the classification of landscape user groups and distance zones is arbitrary. The degree of subjectivity in applying values to a particular landscape character implies an intrinsic quality of the landscape which is perceived by all the occupants. In addition the ordinal, values assigned to the view do not account for disparate intervals between classes, nor is there a baseline to reinforce and verify the publics' support for the findings. The process of assigning values from the scales is purely intuitive; there is no empirical evidence to support the claims.

The process of valuing the degree of visual modification is flawed in the subjective description of classification. What one human may see as being a high degree of change may well be moderate to the next person. The disproportional variance between the values restricts further investigations as to what the cause of the visual effect is and how it can potentially be mitigated.

Another critical concern of the process is the lack of statistical validity in addressing what the impacts are, and how they may be addressed. Accordingly the discussion on mitigation is based on conceptual propositions. It assumes that development is causing an adverse visual effect which is a bold assumption. Secondly the process assumes a degree of mitigation screening required would need to be a general canvas to obstruct view towards the development site. It would be rationale to propose mitigation to be proportionally commensurate to the visual effect.

The community consultation process failed to engage local residents and parties concerned. 'In particular the failure of the consultation process to influence the design of the development in any meaningful way or to provide a link between the community and the landscape designer or assessor generated very significant anger in the local community' (PWEF Panel Report, 2002a, p66)

Furthermore the process failed to capture the local community's ideals as to what constituted significant views and cultural values of the landscape.

This failure to identify the essential elements of this landscape affected the entire assessment process because the impacts of the modifications to the landscapes by the turbine developments were then significantly understated, leaving the assessment process seriously flawed.

(PWEF Panel Report, 2002a, p65)

#### **6.8 MACARTHUR WIND FARM LANDSCAPE & VISUAL IMPACT ASSESSMENT: - ENVIRONMENTAL RESOURCE MANAGEMENT (ERM)**

The Macarthur wind farm proposal comprises of 183 wind turbines at Macarthur, in the Moyne Shire, south-west Victoria.

A preliminary landscape assessment report was produced by Environmental Resources Management (ERM) on behalf of Macarthur Wind Farm Pty Ltd. Upon receipt of the initial proposal the Victorian Minister for Planning determined that an Environmental Effects Statement was not required and the project

would be assessed through the Moyne Shire's planning development process.

ERM were consulted to conduct the landscape and visual assessment component of the development application.

The methodology employed by ERM is described in systematic stages. The following Table 6.5 illustrates a simplified sequence of the stages of the assessment.

#### **6.8.1 Preliminary Landscape Character Assessment**

ERM were employed (June 2004) to report on the existing landscape character, by means of a descriptive photographic survey identifying land use, significant features, tourist viewpoints, topographic variety, vegetation pattern and canopy forms, visual fields noting areas of open expansive panoramic views and enclosed. The landscape character report presented a descriptive analysis and recommendations for designing the turbine layout.

#### **6.8.2 Landscape and Visual Assessment**

April 2005, ERM produced a detailed assessment of the proposed visual effect of the Macarthur wind farm. The methodology

employed is rigid and systematic. The following tables explain the stages of the procedure.

**Table 6.5** Summarised methodological process (Adapted from ERM, 2005, p4-5)

NOTE:  
This table is included on pages  
218-220  
of the print copy of the thesis held in  
the University of Adelaide Library.

equivalent to the objectives set out by EDAW. However, this is where the similarities of the two processes diverged.

ERM attempted to provide empirical rigour to the assessment. They sought to incorporate physiological human constraints to vision as a means of equating terms of reference to horizontal and vertical fields of view.

The viewshed of a single wind turbine could be calculated on the extent to which a single wind turbine (in this example the widest section is the swept path of the rotor) would intrude into the 60° central field of view.

(ERM, 2005, p28)

### 6.8.3 Positive Attributes of the ERM Model

Similar to the process implemented by EDAW (2002), the initial stage comprised of desk top studies and field investigations comprising of a review of literature and planning guideline recommendations.

The structure of the assessment implied a quasi-objective evaluation of the degree of visual modification. It included landscape character assessment, cartographic mapping of the zones of visibility and photomontage presentations; all considered

Furthermore the vertical field of view was described to be 10°. It was suggested in the report that 'once objects take up at least 10% of the vertical field of view, they can be more readily discernible (10% of 10° = 1°) and this visibility increases as the wind turbines increasingly take up a greater proportion of the vertical field of view' (ERM, 2005, p30).

The angles used for the horizontal and vertical fields of view which are pertinent to the calculations are inaccurate. What has been labeled the central field of vision was considered to account for

binocular vision (depth perception) and colour discrimination. This is correct as colour discrimination accounts for 50-60°, however binocular vision accounts for a wider field of view of 120-130°. Furthermore the vertical field of view is 120° comprising of 50° upper visual field and 70° lower visual field (Panero and Zelnik, 1979; Shuttleworth, 1980).

The distance of a viewpoint to the closest turbine is said to be the major determinant of the degree of visibility. The following table describes the blueprint used to relate distance to visual effect.

**Table 6.6** (Adapted from ERM, 2005, p31)

**NOTE:**  
This table is included on page 221 of the print copy of the thesis held in the University of Adelaide Library.

The values and descriptions assigned to distance zones were derived from the vertical and horizontal fields of view. This provides theoretical derivation and justification.

However the categories and ordinal values allocated do not facilitate comparison of different effects from various perspectives of the site. In addition the descriptions are uninformed by empirical research or public consultation. For example a wind farm located on a ridgeline within 4 km, may well be visually intrusive, in comparison to a wind farm that is within 2km but is screened by localised vegetation. Consequently there are numerous variables which need to be considered, not purely the distance to the nearest turbine.

The use of GIS as a tool for data collection and analysis is a development which has interesting possibilities. Visualising hypothetical turbines in a landscape can be achieved by site bearings, computed by Global Positioning Systems (GPS). As technologies and ways of using these tools develop, the assessment process of mapping environmental, social, and economic variables permit informed decisions. The development of GIS techniques should be recommended in the development of methodologies.

In addition the production of geographically referenced zones of visual influence, relative to topography provides a broad brush indication of the potential 'worse case scenario' of development visibility. This information can be incorporated with or assessed against landscape character zones, conservation areas, land uses, landscape values etc.

One of the strengths of the assessment methodology is the detail and rigour in developing photomontages. Due to the assessment process being reliant on representations of the landscape and proposed development, it is critical that techniques used to produce representations are reflective of actual site investigations and are based on specified human dimensions of visibility.

Photographs of the landscape were taken with a 70mm lens which has a picture angle of  $34.34^\circ$  and horizontal angle of view of  $28.84^\circ$ .

A 50mm lens (picture angle  $48.45^\circ$ , horizontal field of view  $39.59^\circ$ ) is often used for visual assessments as it is called a normal lens because it produces roughly the same picture angle as the human eye (about  $50^\circ$ ). However, the 70mm lens slightly increases the apparent size of objects in the middle and far distance and hence increases the apparent size of the wind turbines in the photomontages and this is the reason that this technique has been adopted for the photomontages within this report.

(ERM, 2005, p51)

The geographic coordinates of the locations from which the photos were taken were recorded with a GPS, so that the photo could be referenced for computer modeling in GIS software.

Two photos were taken from the same viewpoint overlapped by 1/3 to equate to a combined photo angle of approximately  $50^\circ$ .

This is in accordance with criteria set out in the horizontal field of

view calculations. The photos were digitally stitched together using computer software.

The next stage involved superimposing wire frame models of the development on the photo. By referencing topography, camera angle and known features in the landscape, the wire frame model was matched to the photo. Computer software 3D Studio Max™ was used in this process to model and render the turbines.

#### **6.8.4 Limitations of the ERM model.**

The linear systematic process employed limits any iterative coordination with local community groups, incorporating turbine layout design advice to accommodate the sensitivities of the landscape.

The major fault in the method is the disregard for community values of the landscape and proposed development. Throughout the whole process there is no evidence of community involvement in deciding viewpoint locations of particular value and sensitivity. It is also worth noting that the method does not contribute to visual site design criteria, which can be utilized in valuing the degree of visual effect. This limits any discussion on the potential movement or re-organisation of particular turbines which impede to the detriment of particular landscape amenity aspects.

Furthermore the values assigned to landscape sensitivity are attributed to the consultant's subjective interpretations. The sensitivity of viewers to change within the landscape surrounding the wind farm, have been suggested to depend upon a number of criteria. These have been referred to as:

- Location: The sensitivity of a potential viewer varies according to location. Occupants of a natural park or wilderness area will most likely be more sensitive to the juxtaposition of new man made elements.
- The rarity of a particular landscape: rare landscapes are valued more highly
- The scenic qualities of a particular landscape: Landscapes that have dramatic topographical changes, presence of water, coastlines etc have greater sensitivity to alterations

(Adapted from ERM, 2005, p46)

Each of the landscape character zones identified in the field assessment was assigned a value in accordance to the above sensitivity criteria. Each viewpoint used in the detailed visual impact assessment was classified to one of these character zones and sensitivity value. Contrary to common acceptance that people

experience aesthetic satisfaction from particular landscape compositions (Lothian, 2000; Kaplan et al, 1979, 1989; Kaplan 1979a, 1979b ;), this process is flawed as the intricacy of landscape appreciation is not solely due to the criteria used. In addition values of public perceptions should be accounted for their cultural associations and intangible attachments to particular landscapes and wind farms as a development form. The effects of human modification may in fact not detract from the amenity of the landscape.

In addition the methodology recommended classifying the extent of the viewshed to a particular land use character.

Recognising that the viewshed is not the limit of visibility, but rather the extent to which turbines no longer have a significant visual impact on the landscape, then the extent of a viewshed differs in the context of different landscapes.

(ERM, 2005, p26)

This is a rather arbitrary statement, needing evidence from empirical investigations. For example agricultural landscapes are classified as human-modified landscapes but potentially could have a larger viewshed than a natural landscape of rugged topographic relief screening long distant views. The classification

of different viewshed types in accordance to the land use is not supported by empirical research to date. Further research is required to assess the hypothesis, that “a viewshed in a man-modified landscape is different to a viewshed in a pristine landscape or landscapes where there are no apparent signs of human influence” (ERM, 2005, p26).

Finally the major concern of the methodology is the subjective assignment of categorical values. A series of matrix table identified the visual effect with respect to distance, visitor numbers, and a subjective interpretation of landscape sensitivity.

The number and frequency of people travelling along public roads was accounted for in the assessment process. The length and types of road located within the visibility zone of the viewshed were recorded and rated for Average Annual Daily Traffic (AADT) volumes. The rates of traffic were referenced to:

**Table 6.7** (Adapted from ERM, 2005, p60)

NOTE:  
This table is included on page 224 of the print copy of the thesis held in the University of Adelaide Library.



The classifications of the ratings were once again arbitrary, not being based on local community frequency of use but by a transient population. In simplified terms local roads may not have the high level of travel as that of a highway, but may in fact have a higher level of sensitivity due to resident frequency of use. Consequently there are faults in using this matrix in the evaluation.

As discussed above each viewpoint is assessed to be high, medium or low in accordance to the distance, visitor numbers and predicted sensitivity of the view.

The assessment of the overall visual impact is based on the lowest rating of any single factor (i.e. visitor numbers, landscape sensitivity or distance).

(ERM, 2005, p4)

The rationale for this rating procedure is of most concern. What is implied is a generic evaluation of the landscape, to accommodate a toned down impression of the degree of visibility and perceived visual change. It is unjustified to register a low degree of visual effect due solely to distance, frequency and volume of roads or an arbitrary evaluation of landscape sensitivity.

The results of the report illustrate the inconsistency of the methodology. All the viewpoints recorded a low visual impact. For example viewpoint 10 was within 1km of the development, was registered as being in a low sensitive area with low volume of traffic. The overall visual impact was recorded to be low. This is questionable as development approval on the basis of traffic volumes or suggested perceptions of landscape character amenity imply that the road network will not change and that local residents are oblivious to the effect on the landscape they occupy.

Evaluations from residential house dwellings were treated as a separate issue with a high degree of sensitivity, with distance being the criteria for assessment. In a similar process an overall value was assigned based on the lowest rating. Contrary to the guidelines set out in the methodology the evaluation for each house recorded an overall visual impact of high- (low with vegetation screening). This highlights the variability and inconsistency of the method.

In conclusion the method employed by ERM has some underlying strengths in the formation of an empirical study of visibility constraints and photomontage development which can form the basis of further investigations. However the neglect of public perceptions, community participation and the arbitrary assignment

of ordinal ratings, questions the credibility, reliability and justification of this model.

## 6.9 HASSELL MATRIX

HASSELL Pty Ltd has been involved in the assessment of a number of wind farm visual assessments particularly in South Australia and Victoria, and a single wind farm development assessment in New South Wales.

The methodology employed by Hassell draws reference to '*Best Practice Guidelines*', Australian Wind Energy Association (2004) and Planning SA '*Wind farms Planning Bulletin* (August 2002). Appendix 6 illustrates the procedure conducted.

In their preamble Hassell states that "issues such as public perception and acceptance of sustainable energy sources and/or other valid but more subjective issues do not form part of the visual assessment process" (Hassell, 2004, p1).

The assessment procedure used for Naroghid (Hassell, 2004a), Waitpinga (Hassell, 2004b) and Taralga (Hassell, 2005) employed the same methodology, theoretically aligned to the formal

aesthetic model. The visual assessment procedure was carried out with regards to

- An evaluation of the existing visual environment at local, sub-regional and regional levels
- An assessment of the visual impact on the surrounding environment having regards to the degree of physical modification and the potential sensitivity of viewers.

### 6.9.1 Base Line Studies: Preliminary Landscape Assessment

The initial stages of the process involved desk top studies of relevant literature, mapping zone of visual influence with respect to turbine layout clustering, and designation of local, subregional and regional zones.

Distance zone maps were produced indicating the threshold distance of the visual field (20km), regional zone (5-20km), subregional zone (1-5km) and the local zone less than 1km to the nearest turbine. This mapping was utilised on the preliminary landscape character field trip.

Landscape character assessment was performed during a preliminary landscape assessment. A detailed photographic illustrated report was produced which described landscape patterns, processes and specified features of the landscape.

A general discussion located distance zones particular land uses and vegetation patterns, signifying areas of expansive panoramic views and those more enclosed. During the field investigation mapping produced, documented landform, particular sensitive areas, and localised vegetation buffers.

The Zone of Visual Influence (ZVI) was cross referenced during the preliminary field visit. The ZVI does not compute the effects of any vegetation; it is based purely on geographically referenced topographic surveys. Ten metre contours are commonly the only source of geographic digital data available, which limits the accuracy of the ZVI. Consequently during the field visit, consideration was given to the effect of vegetation, localised topographic relief and built form development within the regional, subregional and local zones. The extent and orientation of views were documented. This forms a vital reference in selecting viewpoints for photomontage production and detailed visual assessment.

### 6.9.2 Detailed Visual Assessment: HASSELL Matrix

The Hassell matrix was employed to assess a series of viewpoints which were selected in consultation with the local planning authoritarian and developer. The local planning

authority will commonly consult local landholders and community groups to discuss potentially sensitive areas and suggest particular locations.

Wind farm assessments conducted by Hassell have typically identified and assessed several viewpoints for each development proposal. The viewpoints were typically representative of a western, eastern, northern and southerly aspect of the site. Each viewpoint was represented with a photomontage, which simulated the predicted view of the proposed wind farm (Hassell, 2004a, 2004b).

The technical process of photomontage production is critical to the credibility of the assessment. Commonly photomontages are critiqued by the local community who are sceptical of the realism portrayed. Hence a theoretical and technically derived method is needed to support and confirm the accuracy.

The proponent produced photomontages for Waitpinga and Naroghid wind farm proposals with technical guidance support. Utilising specialised wind farm development software, and specified photo capture criteria, the photomontages were representative of what would be seen

on site looking towards the centre of the wind farm development.

The first objective was to capture wide angle photos of the viewpoints specified. A 50mm lens camera was recommended as it is equivalent to the focal length of the human eye. Several photos were taken from each viewpoint with overlaps for stitching together. Geographic coordinates were recorded for the position of the photograph and bearings recorded for the centre of each photo for referencing in a computer software package.

The technique behind referencing photos to the computer model is to establish a wire line camera model in a suitable computer modeling graphics package. The camera settings contain all relevant visualization information e.g. direction, type of camera lens used. The photos are either scanned from a film or downloaded from a digital camera. The camera model is referenced to the geographic locations of the viewpoints. In addition a render function can position a 3-dimensional model of a Wind Turbine Generator (WTG) into the image with the correct proportions.

The alignment of the wire line camera model and photo is refined by altering the pitch and rotational angle of the model to match the photograph. Vegetation was not modeled so it was important for the wire line to fit the terrain not the top of trees. The turbines were rendered and lighting was positioned to represent the particular time of the day and year.

Utilising the photomontages a detailed assessment was conducted in a subsequent field investigation. The photomontages were reviewed on site to determine any inconsistency that may be prevalent. Each montage and viewpoint was assessed with respect to

- Degree of visual modification (amount of change and ability of the landscape to absorb change)
- Horizontal visual effect (height of the development in the landscape)
- Vertical visual effect (spread of the development in the landscape)
- Distance of visual effect (distance between viewpoint and development)

(Hassell, 2004a, 2004b, 2005)

Each of these criteria was rated out of 5, with scores representative of a quasi-objective measurement. The scores were then combined in a matrix to provide an indication of the visual effect from the viewpoints. This was then interpreted against the context of the landscape character, zone of visual influence and potential sensitivity of the landscape to occupants who may experience the landscape. The Hassell Matrix is illustrated in Appendix 6.

The matrix tables describe and classify the landscape according to land use, vegetation pattern, and sense of naturalness. They also imply a quantified value of the visibility of the development by way of calculated judgments of the degree of visual modification, horizontal, vertical and the effects of distance.

The values assigned to the criteria were weighted upon expert judgments (Landscape Architect's) impressions and classifications. The degree of visual modification classified the ability of the landscape to absorb the development in accordance to vegetation and existing built form infrastructure. The categories were divided into percentages representative of an arbitrary evaluation. The value was

simplified to a derived value out of five. This limited the ability to record variance within the category zones.

The Horizontal visual effect was measured in accordance to,

the field of vision (FOV) experienced by the human eye which is described as an angle of 200° horizontally. Using this fixed visual reference, an assessment of the possible impact of development within this measurable area is undertaken. The centre of the development is established and an angle of 100° each side is defined. The extent of visual effect within this zone is then measured. The overall assessment is made of the entire development, rather than of the individual objects that may form the proposal. This measurement of effect is then described as a percentage of the panorama

(HASSELL, 2004b, appendix c)

The 200° angle of the horizontal field was defined as the visual limit of the human eyes, included monocular vision.

Consequently this includes peripheral vision, and a 40° angle to

either side of the binocular vision which is devoid of depth and scale recognition (Panero & Zelnik, 1979).

The Hassell Matrix in Appendix 6 illustrates, an arbitrary measurement produced to equate a value for the percentage of the 200° field occupied by the development. This measurement is classified into ordinal category zones.

The degree of vertical visual impact was equated to be a percentage of the vertical visual extent 150°. It is unknown where this angle has been referenced, raising suspicions as to the credibility of the measurements.

The ordinal values assigned to the criteria provide a suggestive visual impact of the proposed development. The sum of the individual parts was summarized to define a final visual effect.

**Table 6.8** Hassell matrix final visual effect

Degree of Visual Effect	Value (total of previous criteria)
Severe	21 to 25
Substantial	17-21
Moderate	13-17

Slight	9-13
Negligible	5-9

### 6.9.3 Limitations of the HASSELL Matrix

The underlying faults and limitations of the Hassell matrix can be associated to the equal weighted scales of all the factors combined. The model designated equal values to vertical, horizontal, landscape character, degree of visual modification and distance. This can be explained by the analogy of comparing apples with oranges.

Not being able to define a quantifiable visual effect with specificity limits the ability to compare viewpoints and alternative turbine array designs and alternative locations. For example a rating value of 13 (moderate) visual affect, representative of a rural pastoral grazing landscape character with minimal landscape absorption capacity, cannot be compared with any definitive qualitative assurance to a value of 15 (moderate) in a landscape characterized with vineyards. The values and definitions are too arbitrary. One person's significant effect may be interpreted by another person as moderate.

Lothian (2003) raises concerns of the validity of a reductionist approach to evaluate components of the visual landscape. Lothian recommends landscape scenes to be assessed as a holistic view rather than as a sum of its parts. Lothian states 'the reductionist approach forensically dissects and analyses the components but whether the net results accord with how people view landscape is not considered' (Lothian, 2003, p2).

One of the more critical concerns of the methodology is the exclusion of community participation in the process. Hassell clearly states at the outset of the assessment that public perceptions do not form part of the process of assessment.

Landscapes are ideological constructs they stem from perception. Consequently people create their own conceptions of what landscape means to them. Cultural and biological evolution, depict the associative symbology of landscapes, which can be interpreted in various ways. Accordingly the landscape is seen through the eyes of the beholder i.e. their environment as they know it (Meinig 1979, Zube et al 1982, Lowenthal, 1978).

Landscape values are synonymous with aesthetic visual values. Perception of visual aesthetics is a phenomenon related to persons existing knowledge, experience and emotional response. Consequently landscape values will be assessed according to emotional sensual memories for each individual's attachment to particular landscape forms and compositions.

This report does not take statistical analysis of community landscape aesthetic values through consultation process. The current methodologies employed for this analysis are time consuming and permeate little understanding of turbine dynamics and real life landscape experience. However specific viewpoints have been discussed in the detailed visual effect to be moderately sensitive.

(Hassell, 2004a, p30)

By excluding consultation of community landscape visual values and generalizing the sensitivity of landscape, the process is limited in assessing the significance of the proposed development. Conversely the Hassell model predicts that the visual effect will imply adverse impacts,

however this may not be the case, as the development may in fact improve the aesthetic amenity of the landscape

Finally, as previously mentioned the scales and tools of measurement are predominantly intuitive not empirical. Combining the ordinal values assigned to each of the criteria amplifies the subjectivity of the landscape architect's classifications.

#### **6.10 GRIMKE MATRIX**

The GrimKe matrix was developed as a progression of the Hassell matrix (2004a), taking into account methodological convergence, commentary from various wind industry stakeholders, research related fields of enquiry, authorities and appraisal of community concerns. The foundations of the matrix have been jointly developed by Warwick Keates and the author of this dissertation with refinements in depicting variables of assessment and methods of calculation by the author. The landscape absorption capacity measurement has been developed by the author.

The matrix has been used for two development proposals in the south east of Victoria. On behalf of Drysdale Wind Farm

Pty Ltd and Woolsthorpe Wind Farm Pty Ltd, Wax Design (2007a; 2007b) administered detailed visual assessment for proposed wind farms in Drysdale and Woolsthorpe using the matrix.

Following preliminary landscape assessments conducted by Planright Environmental (2004, 2005), Wax Design (2007a; 2007b) was engaged to evaluate the visual effect of the proposed developments, specifically from selected viewpoints identified by the proponent in consultation with the local council. The procedure was not too dissimilar to those discussed above. However, the tools and objectives of the methodology used to quantifying the visual impact were notably different.

Using technical tools to visualize the project, the assessment procedure employed by Wax Design, sought to clarify an objective measurement of the visual change caused by the proposed development.

The initial stages of the methodology comprised desk top studies reviewing the preliminary landscape assessment, collating digital GIS information of the site and creating a terrain model and viewshed maps. The geographic



coordinates of the turbines and viewpoints for assessment were loaded onto a hand held GPS, to be used for directional and distance measurements on site.

Photomontages were produced of the selected viewpoints by the proponent using specialized wind farm software (WindFarm™). The photomontages included a description of the angle of view and geographic coordinates. The photomontages were produced for a horizontal field of view of 120° representing the visual limit of binocular vision. An innovative tool used by Wax Design was to print the photomontage on A3 transparent acetate film, enabling onsite visualization by cross referencing vegetation and topographic features, producing onsite simulations, or in other terms mapping the visual effect in front of the human eye.

Using GPS, the location and extent of the wind turbines were evaluated for the angle of the visual field occupied by the development from each viewpoint. The bearings of the two widest visible turbines in the photomontage were geographically referenced to the viewpoint. This provided information on the distance and angle between the two referenced turbines. The GPS also provided information on

the elevation of the viewpoint which can be referenced to the height of the turbines above sea level (ASL).

This procedure was also used to reference where the development is spatially in the landscape and whether it was visible as an overview in the preliminary landscape assessment. Other references were used, such as buildings, trees, and landmarks to confirm the location of the proposed development in the landscape.

To provide an understanding of the overall visual effect of the wind farm on the landscape. The GrimKe Matrix considers two key aspects in terms of understanding visual impact; existing landscape visual character and visual assessment. The following aspects of visual effect are assessed as part of the GrimKe Matrix:

### **Existing Landscape Visual Character**

- Relief (the complexity of the land that exists as part of the underlying landscape character)
- Vegetation Cover (the extent to which vegetation is present and its potential to screen and filter views)
- Infrastructure and Built Form (the impact of development on landscape and visual character)

- Cultural and Landscape Value (quantification of recognised planning overlays)

#### **Visual Assessment**

- Percentage of visual absorption (ability of landscape to absorb and screen the visual change).
- Horizontal visual effect (spread of the development in the visual landscape).
- Vertical visual effect (height of the development in the active visual landscape).
- Distance of visual effect (distance between viewpoint and closest WTG of the development).

The initial assessment is a quasi-objective measurement, where a landscape architect considers the existing landscape character of the site with respect to the viewpoints that have been selected as part of the assessment criteria. The second phase is to assess the change to the visual field in accordance to the development proposal.

Each of these aspects is rated out of 5, with the scores used to provide an indication of the significance of visual effect from selected viewpoints and the degree of visual change.

This is then considered within the general context of regional and sub-regional zones, impact on properties in close proximity to the wind farm and the potential viewer's sensitivity.

The GrimKe Matrix is documented in Appendix 6.

#### **6.10.1 GrimKe Phase 1:- Existing Landscape Visual Character**

The criteria assigned to assess a value for the existing landscape is based on the Information processing theory (Kaplan et al, 1989). The interactions of humans and the environment is said to be relative to four predictable variables, these being coherence, complexity, legibility and mystery. These variables are said firstly to help one understand the environment and secondly to provoke and encourage further exploration. A further study by Brown & Itami (1982) proposed a model which related scenic resource values to landscape preference components. The framework developed relationships between natural landform and cultural land use into predictable values. The two models have been summarized and illustrated by Lothian (2000) as follows:

**Table 6.9** Kaplan model

**Table 6.10** Brown and Itami model

NOTE:  
These tables are included on page 235  
of the print copy of the thesis held in  
the University of Adelaide Library.

(Lothian, 2000, p199)

The GrimKe matrix applies predictors of the landscape reflecting these variables to make valued judgments on the existing landscape character.

The relationship of topographic relief assists in defining the landscape and the visual character of an area. This is relevant in terms of the position and elevation of a proposed development within the landscape and the viewpoint. Topography is assessed both on site (from each viewpoint) and as part of a desktop digital terrain model review. The assessment considers the topographical complexity in terms of foreground, middle-ground and background. Within each zone an assessment is made of the complexity and scale of topographic variations. This is then equated to a summarized percentage range expressed in five categories; no or minor, limited, moderate, increasing and substantial (Appendix 6).

Vegetation coverage is assessed in a similar process of analysis from each viewpoint. A valued judgment on the scale, vegetation form, and degree of the visual field, occupied by vegetation is summarized into a percentage range.

The inter-relationship of landscape character and signs of human occupation through infrastructure and built form is assessed. From each specified viewpoint, a valued

judgment is made on the percent of the visual field occupied by built form infrastructure.

The final evaluation is relative to cultural and historical artifact. The cultural and landscape value assessment is a survey of the regional area around the development up to 20 km. The 20km distance zone is derived with reference to the Sinclair Thomas Matrix and site assessment which depicts the extent of potential visual effect of the development.

The measurement considers the recognised cultural, heritage, natural and social overlays that exist within the landscape. This assessment is predominantly conducted as a desk top survey and only measures recognized places listed on state heritage and national trust agency registers. The measurement is representative of the cadastral area designated as the historical and/or cultural place of significance. The cultural / historic areas are combined and then weighted as a percentage of the regional 20km area.

The process of objectively measuring cultural and historical places of significance has some merit. Separating the assessment process of cultural and visual landscapes and objectively valuing these areas in a numerical quantification

relative to the extent of the visual field is an innovative procedure.

Overtly this process withdraws and detaches visual assessment from heated debates on landscape assessment of intuitive associations to landscapes which is a much broader topic of evaluation and understanding. For example a landscape assessment would constitute numerous studies of tangible and intangible qualities experienced during human landscape interactions. Detaching the landscape cultural evaluation into a separate process provides credibility to the rationale of the visual study. The imperfection of this process would be the limited knowledge and lack of informative data available to locate places of cultural importance to the local community. It would be suggested that a rigorous consultation process mapping locations of importance be carried out in a separate cultural landscape assessment.

The visual landscape character value is the aggregate value from each of the assessment criteria, relief, vegetation cover, and infrastructure and built form and cultural and historical overlays. The existing landscape value forms the

base line to be used to assess the percentage of visual change created by the development.

### 6.10.2 GrimKe Phase 2:- Visual Assessment

The objective of the second phase of the study is to quantify the development's visual change to the field of view from specified viewpoints.

As outlined in Appendix 6 each viewpoint is assessed with respect to, horizontal and vertical visual effect, landscape absorption, and distance.

The horizontal visual effect refers to the field of vision (FOV) experienced by the human eye and is described as an angle of 200°-208° horizontally. This field of view includes the peripheral (monocular) vision, which is described as 40° to each eye. Within this zone colour and depth of field are not registered. For the purposes of the GrimKe matrix the angle of peripheral vision has been subtracted from the field of view producing a 'binocular field of view' of 120° where depth and scale cognition occur (Panero & Zelnik, 1979).

The centre of the development is established at each viewpoint on site using GPS, with reference to the photomontage developed. The overall assessment is made

of the entire development, rather than of the individual turbines. Theoretically this is representative of Gestalt psychology

A whole whose characteristics are determined not by the characteristics of its elements, but by the internal nature of the whole.

(Katz, 1950, p91)

The extent of the horizontal visual field is calculated by the difference in compass bearing between the widest visible geographically referenced turbine Waypoints<sup>4</sup> from a particular viewpoint. This is measured using a GPS and a bearing compass. The measurement of effect is then described as a percentage of the 120° binocular field of view. The value is then assigned to one of the classification zones (Appendix 6).

The vertical visual effect is a measurement based on similar principles. The extent of the vertical visual field is described as 120°, based on 50° above the horizontal plane and 70° below. This assessment ensures that the visual effect takes

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<sup>4</sup> Waypoint is a technical term for geographic positions or locations in a Geographic Position System. They contain geographic coordinates and possibly associative attributes, such as elevation, date, and time etc.

into consideration the proximity and vertical scale of the proposed development. The distance of the viewpoint to the turbines is obviously a critical factor in the vertical visual effect.

The vertical visual effect is measured as the angle between the bottom of the lowest visible turbine and the highest tip of blade which can be seen. This angle is then represented as a percentage of the vertical field of view (120°).

The angle is measured on site using a clinometer<sup>5</sup>, with reference to the photomontage. Hence as the turbines are only hypothetical, referenced heights of vegetation and existing infrastructure in the photomontage are used to record the interpretative vertical visual extent of the development. A value out of 5 is assigned to calculate the percent of vertical visual effect in order to classify the degree of vertical impact (Appendix 6).

The percent of visual absorption (PVA) is a value equated from the photomontages, which are technically derived from the human fields of view and specified camera lens

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<sup>5</sup> A clinometer is an instrument for professional measurements of heights and angles. Heights can be measured from any distance and position using trigonometry. Electronic clinometers provide quick results providing angles of view from the horizontal plane.

requirements. This is an innovative approach requiring further investigation.

Digital photo adaptation software packages provide support to evaluate layers of information in a prospective photo. Hence as the photomontages are produced in a digital form it is fitting that they can be compatibly exported to software which can trace the proposed effects of the development.

Photoshop™ is a software package which is commonly used for graphics and photo manipulation. The process of equating landscape absorption capacity values uses several tools within Photoshop™ to determine pixilation values for defined areas.

Using a wire frame model of the proposed wind farm development draped on top of the photo, the area occupied by the development can be marked and associated to a layer within drawing commands of Photoshop™. The magic wand picker which selects pixels in accordance to colour and contrast variation can then be used to select foreground screening topography and vegetation. The selections are associated to a separate layer in Photoshop™ and colour coded to represent the absorption or otherwise

representative of visual screening. The area marked as absorption screening is trimmed to the extent of the area occupied by the development. The pixels within each layer are equated using the histogram tool. The landscape absorption capacity is calculated as the percentage of the screening area opposed to the area extent of the development in the field of view. The percentage is then classified into a percentage range (Appendix 6).

Finally, the distance of the viewpoint to the nearest turbine is equated as a percentage of the extent of the viewshed (20km). The effect of scale, topography, vegetation, and weather, changes with distance, and in turn changes the degree of visual effect. Standing onsite at each viewpoint the exact distance can be calculated using GPS by selecting the closest waypoint function (all the turbine locations are stored as waypoints in the GPS).

The distance zones are classified in accordance to 5 categories equating to the threshold extent of visibility being 20 km. Consequently, the distance zones are 0-4km, 4-8km, 8-13km, 13-18km and distances over 18km.

Each of the assessed criteria, horizontal and vertical effect, and distance and landscape absorption values are expressed as values out of 20 as described in the matrices in Appendix 6. The aggregate of all the values are then expressed as a percentage out of 20. This value is redefined as a coefficient to be multiplied to the landscape character assessment.

### **6.10.3 GrimKe Phase 3:- Percentage of Visual Change**

The objective of the assessment process is to evaluate the visual landscape character change, caused by the proposed development. The two assessments administered in the above discussion evaluate firstly a baseline landscape character value and secondly the degree of visibility of the development.

The Percent of Visual Impact (PVI) is expressed as a coefficient of visual change to the baseline landscape character value. This calculation directly expresses the effect of the development on the landscape, the change to the visual character and the reciprocal visual impact.

- Baseline Landscape Character expressed as a value between 4 and 20.

- Coefficient of Visual Impact: calculated as total visual impact achievable of 20 divided by visual assessment value.

**Table 6.11** Calculation of Percent of Visual Impact

Coefficient x landscape character value expressed as a percentage = Percent of Visual Impact on Landscape Character
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The following is an example of the percent of visual impact calculation.

**Table 6.12** Landscape character assessment

Relief	3
Vegetation coverage	3
Infrastructure built form	2
Cultural landscape overlays	2
Total Landscape character	10

**Table 6.13** Visual Impact

Horizontal visual effect	3
Vertical visual effect	1

Absorption capacity	3
Distance	2
Total visual effect	9
<i>Coefficient 9/20</i>	<b>0.45</b>

**Table 6.14** Calculations

$10 \times 0.45 = 4.5$	Landscape character x coefficient
$4.5/20 = 0.225$	Value of landscape character due to the visual impact
$0.225 \times 100 = 22.5\%$	Percent of visual impact

(adapted from Wax Design, 2007a, 2007b)

This value is then referred to a percentage weighted table (Appendix 6) which grades the visual significance of the development into classifications.

**6.10.4 GrimKe Matrix: - Concepts for Refinement.**

The model has many positive attributes reflecting a progression of methodological objectives and tools of measurement. The main focus of the GrimKe matrix is to produce an objective measurement of the visual effects of



the development, limiting the degree of subjective interpretations implied in precedent assessments. This has been achieved to some extent; however the value system and quasi-objective values assigned to landscape character are arbitrarily exaggerated by the classification of percentage ranges, underscoring faults in the theory and derivation of values.

The values assigned to landscape character are subjective interpretations based solely on physical compositions of elements in a scene. This raises theoretical concerns of the process of evaluation based on the assumption that the landscape has intrinsic qualities. However as discussed in chapter two, landscape amenity is appreciated by the eye of the beholder. Intangible qualities of the landscape can only be perceived by the occupant of the scene. In addition it is questionable as to whether one landscape architect's evaluation is representative of a peer's assessment, emphasizing the deficiency of reliability in measurements.

Nonetheless, the model possesses utility for peer reviews. Specifically used for site assessment, the model can be applied to numerous sites for cross comparison. Further, the application and derivation of the visibility criteria provides

empirical justification of how the effect has been created. In other terms the percent of visual impact can be investigated in further detail of how the effect has been produced. Consequently the model can be applied as a design tool in an iterative process of evaluation. For example the percent of visual impact may be significant from a particular viewpoint due to an expansive horizontal and low level of landscape absorption. Mitigation techniques can be applied to this viewpoint such as removing turbines to limit the horizontal effect, or planting vegetation to conceal a proportion of the development. The refined design scheme can then be reevaluated and measured to determine the implications of the changes on the all the viewpoints, and translated to the proponent for feasibility implications.

The manner in which cultural and historical values are calculated is innovative and reverent of the divergence between landscape visual assessment and landscape assessment. Landscape visual assessment is but one component of a much broader study of landscape assessment. Hence maintaining severance between evaluations of more tangible qualities relative to experiential and nostalgic concerns is imperative to consolidate validity to the process of visual assessment.

With this in mind, it would be suggested that the method of measuring cultural/ historical overlays should be reviewed against the viewshed, identifying and calculating cultural and historic areas that are in the visibility zone. This would then be redefined as a percentage of the visually influenced regional area, representing cultural landscapes affected by the visual encroachment of wind turbines.

Conversely the value ascertained will not be indicative of the perceived intangible values associated to the affected cultural landscapes. To understand the change in values and level of acceptance, consultation studies would be required rating peoples perceptions of the significance of the existing landscape compared to the visual change. As a consequence the assessment needs to consider whether the landscape quality could be enhanced by the presence of a wind farm, or if it would detract from the landscape quality.

#### **6.11 ATTRIBUTING COMMUNITY VALUES TO LANDSCAPE VISUAL ASSESSMENT: THE PSYCHOPHYSICAL APPROACH.**

An alternative process employed by Environmental Policy Solutions (EPS) (2001) has been used in South Australia to review the methodology and findings of the Myponga wind farm visual assessment conducted by Hassell (2003). In addition the methodology employed by EPS was used to research a strategic environmental assessment of the visual impact of wind farms in South Australia (Lothian, 2004).

The methodology measures differences in ratings of the perceived scenic quality of a scene with and without a wind farm indicating whether it has a positive or negative influence (Hull & Bishop, 1988).

Theoretically this is an entirely different approach to visual assessment, emphasizing the need to consult the local community in evaluating landscape scenes indicating the theoretical premise that visual landscapes are a public good.

The efficiency of evaluating different landscape scenes requires a model which can use representations of the

landscape, with and without the development with statistical validity. Consequently in this procedure, photographs are used as surrogates for field assessments of scenic quality. Studies have shown that colour photographs can give similar ratings as field studies (Brown *et al*, 1988; Dunn, 1976; Kellomaki & Savolainen, 1984; Shuttleworth, 1980; Stewart *et al*, 1984; Trent *et al*, 1987).

The use of photographs as surrogates provides obvious advantages over transporting large groups of people on field investigations. Furthermore, the development of digital editing software has provided utility of using photographs of before and after development scenes.

In addition the use of photographs enables a much broader strategic assessment to be conducted comparing landscape regions and different character types that are in disparate locations. Similarly projections of landscape modifications over periods of time can be rated on a comparable basis.

The empirical nature of the process provides statistical support to the justification of the findings. In simplified terms the procedure quantifies subjective perceptions of landscape alterations, providing guidelines on potential

significant factors which could influence the visual effect such as distance, colour variation of the turbines and landscape physical properties such as the presence of water bodies.

Surveys are conducted sampling a general and broad cross section of the public. It is imperative to the validity of the sample that it is a non-biased judgment. The survey was conducted by three different means,

- sessions by which people were engaged directly,
- internet web link address
- compact disc distributed to work organizations to be completed during office lunch breaks.

The most efficient and productive method was by internet with 280 responses within seven days. The consultation sessions returned 134 responses from mainly tertiary students and professionals, whereas the distribution of compact disc surveys produced 37 responses (Lothian, 2004, p10-11). This qualifies the internet as an efficient tool for swift response.

## 6. Wind Farm Visual Assessment: Methodologies and Process

The study used a 10 point rating scale with (1 – very low, 10 – very high) sampling over 300 adult participants who were broadly representative of the community.

The photographs used for the assessment were representative of 35 proposed wind farm locations and 33 locations where wind farms could be located in accordance to wind availability. Wind turbines were superimposed into the photos representative of the perspective scale and depth of field.

The findings of the study identified a significant difference between scenes with turbines and those without. The major divergence has been suggested to be caused in coastal scenes which possess the presence of water.

The perceived significance of effect in accordance to distance is most evident within the 1-3km distant zone. Surprisingly the ratings with and without the wind farm, arranged by the distance suggested that the negative effect actually strengthened with distance.

Up to 7 km, wind farms had both a positive and negative influence but beyond this distance, the effect was almost wholly negative.

(Lothian, 2004, p18)

This is in contrast to research which has suggested that visual impact decreases as distance increases (Hull & Bishop, 1988). Further investigation is required to decipher a comprehensible reason for the correlation between distance and perceived effect. A possible explanation could be that wind turbines provide visual interest at distances upon which they are identifiable.

A review of the methodology employed has suggested a number of key objectives and positive attributes. Theoretically the model distinguishes a shift in research and assessment. Rather than trying to identify the physical and spatial attributes that cause the visual effect, this approach reflects the community's visual preferences and in the process engages social participation, endorsing political support.

Moreover, as long as a quality distinction is to be made, neither approach can avoid basing landscape assessment on human, subjective value judgments.

(Daniel & Vining, 1980, p43)

The empirical structure of regression analysis provides statistical support to identify plausible causative factors. Trends and patterns to responses present likely variables affecting the value of scenic amenity. On the other hand, it is relevant to point out that just because we establish a close relationship between two variables in regression analysis, this can merely mean that there is an association between variables. However, the effect may well be attributed to a third variable which has not been studied.

The methodological process is time consuming, labour intensive and therefore costly to operate. With regards to wind farm developments it can be argued that photomontages “are not cheap to produce, are fundamentally inflexible and of course cannot depict movement” (University of Newcastle, 2002, p24). In addition the model is limited in utility being highly skill-based covering the selection of participants, photography of

scenes, and statistical analysis of the content of the photographs.

#### **6.12 SOUTH AUSTRALIAN BEST PRACTICE GUIDELINES**

Planning SA (2002) has suggested a methodology which is applicable to both wind farms and transmission line assessments and comprises of two parallel procedures:

- Visual modification- the extent to which the development is visible and the degree to which the landscape visual character changes from specified viewpoints.
- Viewer sensitivity- Identification of existing landscapes of cultural significance and an assessment of the degree of effect the proposed development may influence amenity values of people’s perceptions.

The two parallel processes indicate two theoretical models as discussed above, psychophysical (viewer sensitivity) and formal aesthetic (visual modification). However with further detail the method implies viewer sensitivity to be a professional expert informed decision on a particular

person's reason for occupying the landscape, time spent viewing the landscape, and familiarity of the landscape. These factors are all valid, but do not account for the intended purpose of the assessment which is to validate viewer sensitivities which are within the eye of the beholder.

The model seeks to combine these two theories of assessment in an analysis and justification of potentially sensitive locations, with reference to a quantified value of visibility. Appendix 6 illustrates the suggested framework.

The first stage of the process is an evaluation of the existing visual character of the landscape, typically an evaluation from desk top studies and field assessment. The key tools used at this stage are aerial maps of the region, topographic maps, historical photos, literature on geomorphology, cultural events and brochures relative to the townships and landscape surrounding the proposed site.

A Zone of Visual Influence (ZVI) map is produced to illustrate the extents of visibility and the significant areas in need of field investigation. ZVI are generally worst case scenarios, calculated by complex software which

cartographically identifies line of sight according to topography in a digital terrain model (DTM).

Zones of visual influence maps provide a worst case scenario as they do not include features such as vegetation or buildings that might screen turbines from viewing points.

The ZVI map is also categorised into designated distance zones. This division has been labelled; local, sub-regional and regional areas. The distance zones of the areas have been defined as local 0-1 kilometres from the proposed development, sub-regional 1-5 kilometres and regional greater than 5 kilometres (Planning SA, 2002, p21).

The preliminary field investigation is conducted with reference to the collected background information. Utilising the ZVI map, the field investigation is able to ground truth areas of potential sensitivity, also identifying land use, vegetation density and canopy structure, dwellings, townships, walking trails, local community places of cultural, historical, scenic amenity. From this more detailed understanding of the landscape, particular viewpoints are identified to be representative of the visual effect of a

particular landscape character unit and assessed in a more rigorous process.

The second stage is to fabricate photomontages from the chosen viewpoints to simulate the appearance. The montages are used to assess the degree of visual effect with respect to the physical change and sensitivity of perceived changes. It has been stated that professional consultants with experience in visual assessment should be engaged to conduct this process (Planning SA, 2002).

The proposed development and landscape is to be assessed for its compatibility against a series criteria

- The scale of the view with respect to natural and built form infrastructure
- Presence of water bodies
- Complexity of topography and ruggedness
- Distance of the viewer and the percent of the field of view consumed by the development
- Land use of the site and surrounding visual context.

Research has suggested that these factors influence the degree of scenic quality (Lothian, 1999, 2000; Daniel &

Schroeder, 1979; Hull & Buhyoff, 1986). Consequently natural landscapes with minimal human modification are likely to have a substantial degree of visual modification, whereas human modified landscapes are suggested to have a less opposing degree of visual effect.

The visual sensitivity is also relative to social and cultural intuition. In more simplified terms the landscape is interpreted differently depending on experiences and knowledge of particular landscapes. For this reason, it has been suggested that potential occupants of the landscape are valued for their particular utilisation. For example tourists may have a different impression of the scenic quality of the existing landscape and the effect of the proposed development opposed to local farmers who occupy and view the landscape everyday. Similarly different types of tourists (e.g. eco tourists, family tours, mass market commercial tourists) may value wind farms differently according to informative intuition. It has been suggested that a matrix model similar to that used by EDAW (2002), be used to evaluate likely sensitivities of viewpoints in accordance to the frequency of visits and likely inhabitants (ACNT & AUSWEA, 2007).

It is also strongly recommended that community consultation should be conducted to assess landscape sensitivity, identifying viewpoints, supporting and integrating community concerns in the design process.

Wind farm developers experienced in this field have found that comprehensive consultation with the community increases rather than reduces the support for wind farm projects.

(Planning SA, 2002, p24)

The best practice guideline (Planning SA, 2002) recommends the visual assessment to conclude with a final statement on the predicted visual effect and suitability of the development. Numerous mitigation techniques and site design guidelines are suggested to limit the effect, upon which conditional approval may be granted.

The visual assessment report will need to be reviewed along with other notable assessments against the municipal Development Plan or Planning Scheme. This process forms a structured approach which can inform the authoritarian, developer and public with clarity and transparency. The council may also refer the application to a range of authorities for advice and comment. These may include the

Environment Protection Authority (EPA), Coastal Protection Board, Transport SA, National Parks and Wildlife, the Department of Primary Industries, Resources SA, Department of Environment and Heritage and Aboriginal Affairs and their equivalent state agencies in Victoria and South Australia respectively (Wawryk, 2002).

Some of the limitations of this approach which seek further guidance include formulating an objective quantified value of community sensitivity. The example of the matrix model Figure 6.1, illustrates the dependence on a sole assessor's subjective interpretations of potential sensitivities. Accordingly, the credibility and justification of this method is theoretically flawed. The process of engaging community and public associations and values for landscape scenes needs to be assessed site specific, not as a general categorisation of occupant frequency and use.

Furthermore, the rationale to determine an aggregate visual impact according to sensitivity values with the degree of physical visibility has not been modelled. Calculating or weighting sensitivity values to visibility modification has not been researched to date to the knowledge of the author.



**6.13 AUSTRALIAN WIND ENERGY ASSOCIATION BEST PRACTICE GUIDELINES FOR LANDSCAPE VISUAL ASSESSMENT**

Australian Wind Energy Association (Auswind) and Australian Council of National Trusts (ACNT) released in 2007, *Wind Farms and Landscape Values National Assessment Framework*. This report builds on work undertaken in 2004/5 jointly by the ACNT and Auswind.

Visual assessment on the other hand is an inseparable aspect of how people experience landscapes:

visual amenity must always be considered in the context of the existing environment and with an appreciation of the value that the local community puts on rural character and landscape attributes, and the environmental assessment will reflect this.

(Auswind, 2002, p29)

The effect of vision on cultural and spiritual landscapes, requires an understanding of how the landscape is perceived, its process and validation of the visual modification generated.

Given that the visual impact of the development is likely to be one of the more significant issues in the assessment of the project, it is highly recommended that experts in the analysis of the visual characteristics of the environment are consulted. For example landscape architects may be able to provide professionally presented quantitative descriptions of how the visual impact a project is likely to have.

(Auswind, 2002, p29)

The framework recommended does not refer to any particular profession being engaged. It does however require expertise in community consultation, identifying landscape features and mapping community values, landscape character classification, constructing and interpreting mapping of the visual effects and landscape character units, inventory assessment, modelling, visualisations and quantifying the visual effect of the development.

The sequence of the recommended framework is logically structured into several steps providing clarity for developers, authoritarians and stakeholders (Appendix 6).

Firstly, the proponent is recommended to incorporate into a pre-feasibility stage an investigation of any readily ascertainable community values associated to the landscape, and potential conflicts with developing a wind farm in the regional location. This would constitute an evaluation of any literature on historical and cultural artefacts, places of tourism significance and identification of specific view corridors and identification of any other similar developments that may contribute to the effect. This procedure is suggested to be a broad brush assessment, overlooking any need for consultation. The proponent will then assess the projects findings to determine whether to proceed.

The second phase considers a more detailed landscape appraisal. One of the key objectives of the detailed assessment is to engage the community, identifying key stakeholders and facilitating their involvement in valuing and defining local associations to places of significance. Conclusions are to be made about the importance of

landscape values across communities, regions, state and national.

Following the detailed review of landscape values, the proposed development needs to be described and modelled in a digital format as accurately as possible. The legibility of the graphics and text will need to be coherent for public review, consequently it is important to keep visual jargon to a minimum.

Various mapping techniques are recommended to be created using graphic representations of the proposed development. A digital terrain model, incorporating zones of visual influence is a prerequisite to the procedure of identifying specific viewpoints requiring detailed review.

A detailed description and photograph illustrated report of the potential visual effect from the surrounding landscape is produced to support the identification of key viewpoints in the ZVI. This provides justification of field assessment review, distinguishing areas of dense vegetation growth and pattern.

Photomontages are suggested to be representative of key public aspects, typically public roads, settlements, or places of recreation. The viewpoints chosen to be simulated should also be representative of community values, justified by the ZVI and certified by the municipality. It has been suggested that 10-25 viewpoints should be provided. Depending on the size of the development and visual extent, 25 viewpoints might seem excessive given there is likely to be monogenous visual character types, hence similar visual effects from several viewpoints.

Numerous tools have been used to value the percent of visual change. In step 3 of the *National Assessment Framework (2007)*, the objective is to assess the impact on landscape values. Firstly, identifying areas of positive and negative stimulation, and secondly defining the degree to which the landscape value has altered by the development. Thirdly the results of the degree of visual change need to refer to a level of acceptance classification criteria (e.g. slight, moderate, and negligible).

The procedure and tools available to achieve a credible and comprehensive understanding of the likely visual impacts on landscape values are not universally accepted. Coincidentally,

the intent of attributing visibility to adverse effects on landscape values highlights some inconsistencies and faults in the framework adopted to develop visual assessment methodologies.

To accomplish a classification of the proposed alteration to landscape values the *National Assessment Framework (2007)* accepts the employment of matrices as a component in the evaluation of landscape values and the magnitude of impact. The framework does not go as far as specifying particular matrices or criteria to be used.

With respect to matrices and ordinal ratings of landscape visual effect, it is overtly critical to reconsider the aims and deliverable outcomes of the assessment process. As mentioned previously the visibility of the development may in fact be beneficial, stimulating the landscape. Consequently assigning a derived classification of completely, substantial, partially or negligible will imply negative connotations and distortion of the true value of visual and perceived change. When equating the percent of visual modification, it is important to take into account the perceived effect. Furthermore to generate justified objective

measurements it is imperative that the matrix formulae are derived from interval ratings.

Methods and tools to assess visibility and perception have been discussed in previous sections of this chapter. Supporting research has sought to explain the inter-relationship between visibility and perception (Bergsjö *et al*, 1982; Bishop, 2002; Miller *et al*, 2005) and particularly Bishop & Miller (2007) who investigated the effects of distance, contrast, atmospheric conditions and movement specifically for offshore developments. Typically empirical studies have sought to evaluate public perceptions of wind farms with regards to turbines as a renewable energy source, the number of turbines, colour, scale, and distance (Lothian, 2004; Mori Scotland, 2003; Sinclair, 2001; Wolsink, 1990, 1989; AEA Technology 1988; Simon 1996; Thayer & Freeman, 1987). Gaps in the literature and research have identified a need to evaluate any possible relationship between the degree of visibility and perceived effect of wind farm developments.

The *National Assessment Framework (2007)* would benefit from studies of this nature, providing a theoretical foundation to calculate the visual effect.

The *National Assessment Framework (2007)* alludes to a composite model incorporating visibility and perception impact values, however does not develop or recommend models to accomplish this.

The final effect and conclusions need to be reinterpreted for the acceptability of the development. In addition a discussion on the potential mitigation on adverse effects needs to be considered and measured against the perceived acceptance value. Ultimately two questions are raised in deciding the suitability of the development.

- Is the proposed wind farm acceptable in relation to the values held about this landscape?
- If it is acceptable, what ongoing management or mitigation measures are needed? Are the mitigation measures practical and viable (developer to consider the financial and practical considerations)?

## 6.14 INTERNATIONAL BEST PRACTICE FRAMEWORKS FOR WIND FARM VISUAL ASSESSMENT.

Wind industry development is more advanced in several countries, notably Denmark, Germany, Spain, United States and the United Kingdom (GWEC, 2007). As a result time has permitted visual assessment guidance to be refined to accommodate inconsistencies and faults in methodologies. Best practice guidelines have been reviewed, critiqued and developed to ensure concerns raised by community groups, proponents, government agencies, authoritarians and consultants are incorporated. Various reports, reference books and policies have been developed during the late 1990s early 21<sup>st</sup> century. The following discussion provides an insight to wind farm visual assessment guidance research in the United Kingdom and policy in Germany which is at the international forefront of establishing economic tools of assessment.

### 6.14.1 United Kingdom: Guidance Measures to Validate Professional Judgements.

*The Visual Assessment of Windfarms: Best Practice Report* (2002) published by Scottish Natural Heritage produced by the University of Newcastle in the United Kingdom, has been an

essential document for refining and developing policy frameworks and guidance on specifying the use of tools in the EIA process.

This document involves case study research on several existing wind farms in Scotland. In addition the project encompasses an in depth review of relevant guidance, research on visibility and significance of visual impact, review and evaluation of zone of visual influence mapping- drawing conclusions on the extent of visibility, and an evaluation of various tools used in visual management systems.

The report distinguishes visual impact assessments to be an independent but integral component of landscape and visual assessment, which also encompasses landscape character assessment, landscape sensitivity and landscape significance studies.

The recommendations and guidance are documented into several categories:

- Zone of visual influence
- Viewpoints
- Visualisations
- Magnitude

- Environmental condition and human perceptions
- Receptor sensitivity
- Significance

Zone of visual influence (ZVI) is a tool which is encouraged to be used for analytical desk top studies forming a baseline assessment. It is recommended that computer generated theoretical ZVI should be cross examined onsite, to verify the magnitude of the visibility with reference to vegetation and built form. Supplementary information is required as to how the ZVI was constructed and a description of the limitations to clarify any possible exclusions. It is recommended that for turbines in excess of 100m (maximum swept area); that the viewshed should extend to 30km, beyond this distance the limits of human visibility occur (University Newcastle, 2002).

Viewpoints for assessment in this policy are determined by the ZVI and preliminary field investigation. The basis of selection is demonstrative of potentially sensitive views and locations. It is considered important to select the viewpoints onsite, to avoid under-estimation of the visual effect caused by vegetation screening. Therefore it is considered imperative that the selected view is not prejudicial reflecting a localised obscured view. The number of viewpoints will vary depending on the particular

landscape context. However there should be a sufficient number to achieve an effective coverage of the likely effects according to perspective, character of the receptors landscape and distance. It is also considered vital that the viewpoints identified are documented with precision, using geographical positioning systems (GPS) and documentation of the orientation towards the development site.

The production of visualisations which are commonly the most referred to documentation in visual impact assessments, is a technical process commonly critiqued for its lack of relativity. It is vital that the procedure of manufacturing photomontages is clearly documented. A series of general rules have been suggested

- Panoramas should be spliced together using standard normal photographs taken with a 50mm lens.
- Wire frames should be used in appropriate combination with photographs as working documents
- Viewing parameters of the photomontage are indicated, suggesting a 20cm image height on an A3 sheet, viewed from 30-50 cm.

(University of Newcastle, 2002, p60)

The magnitude of effect relative to distance has commonly been referred to as the Sinclair-Thomas Matrices (2001). The tables outlined in the matrices identify zones of effect in accordance to distance from the development. The incongruity of the matrices to field assessments has been critically reviewed. The panel of professionals who conducted the field studies found the matrices difficult to use

because the separation between magnitude and significance was not always clear or was mixed. In addition they take no account of the influences of different landscape character or visual context. Whilst there is probably not much controversy over a judgement that the visual effect is dominant close to a windfarm and indistinct or negligible at long distances, the matrices lack clear differentiation in the middle-distance zones. It is here, of course, that most debates and controversies over magnitude and significance exist.

(University of Newcastle, 2002, p62)

The term significance is used in visual impact assessments to denote the perceived visible intrusion of the development. Determining the significance of effect is the objective of visual impact assessment.

The relationship between visual receptors sensitivities to landscape and magnitude of visibility is always context- specific, which may be local, sub-regional, regional, state or national.

Significance is a concept or metaphor for symbolism. 'Significant places are symbols of who we are and our connections with places through emotions' (Taylor, K (1997, p9). Hence significance is subjective, it has human values, which may or may not correlate to the cultural importance of particular landscapes. 'Significance inheres in ordinary places-ordinarily sacred-connected with ordinary people' (Taylor, 1997, p9). For that reason the term significance should be used with caution in landscape assessment dialogue.

Ultimately the degree of significance is representative of individuals, government authorities and policy appraisal. It is a human judgment which may or may not be in agreement. Therefore it is important to differentiate magnitude of visual effect and perceived significance of effect as two separate characteristics.

The recommendations are to clearly identify the connection between magnitude and significance at the start of the project so that the results are derived with transparency. Matrices are suggested to be an effective tool for explaining the correlation between the visibility and magnitude; however the simplicity of relating significance to a complex set of criteria is somewhat arbitrary. For example a medium level of visibility alteration to a coastal landscape, will not necessarily cause a medium level of visual effect on landscape sensitivity, it may well be perceived as a significant impact.

Significance is not absolute and can only be defined in relation to each development and its location. It is for each assessment to determine the assessment criteria and the significance thresholds, using informed and well-reasoned judgement supported by thorough justification for their selection.

(Landscape Institute *et al*, 2002, p92)

A subsequent report produced conjointly by Horner & MacLennan & Envision (2005) supersedes the University Newcastle study. This report explicitly updates guidance on visual tools used in assessment procedures. It does not go as far as developing frameworks and methodologies to use mapping and simulation

tools to assess the magnitude of visibility and significance of sensitivity.

*Guidelines for Landscape and Visual Impact Assessment (Landscape Institute and Institute of Environmental Management and Assessment, 1995; 2002)*, is an informative reference which develops strategic modelling for visual impact assessments.

The aims of these Guidelines (1995; 2002) reiterate the need to differentiate between the judgments of significance of change which involves subjective opinion and magnitude of visual change which is generally an objective and quantified evaluation.

The methodology suggested explicitly describes a systematic staged process, indicative of the formal aesthetic model frameworks discussed in previous sections of this chapter. The stages of the process are consistent with environmental assessment reports, introducing the project by explaining the scope, scale and location of the existing landscape, followed by details of the proposed developments design scheme. This is followed by a systematic measurement of the magnitude and significance of the visual effect. Mitigation is a subsequent stage applied to limit any adverse visual effects by employing strategies of avoidance, remediation and compensation with consideration



for magnitude and significance. Mitigation should also explore opportunities to enhance the landscape.

The procedure for landscape character assessment and baseline studies has generally been well received with minimal variation in the means of applying tools, collecting data and deliverable outcomes. On the other hand, Impact Assessment has been cause for concern with numerous alternative procedures. Quantitative and qualitative data needs to be recorded covering

both landscape impacts, that is changes in the fabric and character of the landscape; and visual impacts, that is changes in available views of the landscape and the effect of those changes on people.

(Landscape Institute, 2002, p46)

As mentioned in previous methodology reviews, impacts on likely receptors and landscapes have commonly been documented in matrices. These tools have been useful in categorising views and potential sensitivities, in a concise and legible form. The (United Kingdom) Landscape Institute guidelines suggest and recommend the magnitude of visual influence can be quantified based on the numbers and types of viewers affected, mapping with symbols or tones to denote the distribution of major and

minor visual impacts. Conversely the significance of visual effect is more difficult to measure and justify with credibility.

In assessing the significance of landscape and visual impacts, reliance should be placed upon commonsense and reasoned judgement, supported wherever possible by substantiated evidence.

(Landscape Institute, 2002, p48)

The criteria suggested to be utilised to determine significance of visual effect are

- Sensitivity of the affected landscape area, in accordance to character.
- Impact magnitude, the degree of visual change and likely duration of effect.
- Adverse or beneficial impacts.
- Professional judgement by trained and experienced landscape architects who can depict the suitability of the development and predict likely levels of effect.
- Consultation with locals who express opinions and associations to particular landscape contexts.

(Landscape Institute, 2002)

## 6. Wind Farm Visual Assessment: Methodologies and Process

The weighting and scale of the each of the criteria has not been determined. Evidently this is major cause for concern as each model is likely to differ for different landscape contexts. Consequently the adaptability and utility of the model for cross comparison of different sites is subject to criticism.

Ultimately the model concludes with a final statement of effect combining sensitivity values with magnitude of visible alteration. What has been termed significance thresholds denotes a simplified matrix formula, which without empirical investigation generalises the impact as low medium or high.

As a result the final threshold graph depicts a relationship whereby equal weighting of magnitude and sensitivity levels are combined. Theoretically this is in conflict with the objectives and basis of measurement.

The general guidance submits a recommendation to avoid numerical classification.

Numerical scoring or weighting should be avoided.  
Attempting to attach precise numerical values to qualitative resources is rarely successful, and should not

be used as a substitute for reasoned professional judgement.

(Landscape Institute, 2002, p53)

This has been disproved by numerous research studies in visual perception ratings (Lothian, 2000; 2004, Daniel & Vining, 1983; Palmer, 1983; Daniel, 2001; Arriaza *et al*, 2004). In these research publications, multiple linear regression based modelling has been utilised to substantiate objective measurements of qualitative landscape preferences.

Mitigation techniques are conceptual schemes used to describe measures to limit the degree of adverse visual significance.

Mitigation should not be an afterthought, or something that is applied to the final scheme design to soften its more obvious adverse effects. If this approach is adopted, mitigation only serves to mask what would otherwise be an unacceptable design, rather than dealing with the underlying problems.

(Landscape Institute, 2002, p54)

This is an important point to be raised as what commonly is documented towards the conclusion of the EIA, should avertedly

be considered in the preliminary stages of landscape character evaluation, as a point of schematic concepts to enhance the landscape. Enhancement and mitigation should be united. This would redirect the objectives and framework of landscape visual assessment to be a positive reflection on landscape character. In event the landscape visual assessment would promote a more dynamic and iterative design tool.

Compensation measures have been a point of discussion in techniques to aid mitigation of landscape amenity.

For compensation to be effective, a reliable assessment is needed of the nature, value and extent of the resource that would be lost, so that like can be replaced with like, or where this is not possible, other related environmental enhancement of at least equal value is undertaken.

(Landscape Institute, 2002, p58)

This form of mitigation is conceivably flawed due to the subjective nature of the assessment process and compensated replacement costs. Whether this is economic incentive through financial reimbursement, nearby land reclamation and revegetation or other means of environmental sustainable amelioration, the

location of the adverse affect will still be consigned to the immediate vicinity.

Furthermore without quantifying the degree of landscape sensitivity, it is outmost impossible to base a weighted factor index on a compensation value.

#### 6.14.2 Germany: A Case for Compensation

As of 2007, Germany is the world leader in installed wind energy capacity with 20,621 MW per annum (GWEC, 2007). As a consequence of financial incentives and political determination to generate wind energy, Germany has experienced rapid growth in wind energy development in the early 1990s. This has fuelled debate from various landscape protection societies as landscape character is becoming overwhelmed with wind farms. As a consequence The German Nature Conservation Law or commonly referred to as the federal nature conservation statute, *Bundesnatursschutzgesetz (BNatSchG)* was introduced to provide valued relief from landscape alterations.

every new development requires special mitigation measures which often lead to compensatory levies paid to the local authorities for the perceived impacts

(Hoppe-Kilpper & Steinhauser, 2002, p 87)

Landscape specialists and consultants to the German government have strategically informed the process of assessing landscape quality. Through this form of analysis the subjective nature of landscape perception is transformed to quantitative mathematical values. Qualitative aspects of the landscape are assessed against a comprehensive list of criteria and then combined to formalise an aggregate value. The corresponding value ascertained is transformed into a compensation area measurement of land remediation.

Werner Nohl has been an integral member of the consultant team developing quantitative methodologies for landscape compensation. Nohl (1993; 2007) defines the policy employed:

The German Nature Conservation Law requires that the aesthetic loss in the landscape, caused by a building structure, has to be compensated by generating an adequate area (in hectares) of high landscape aesthetic or scenic quality. This implies the theorem: quality may be substituted to a high degree by quantity.

(Nohl, 2007, Unpublished)

The procedure to assess the aesthetic impact of a wind farms is based on a systematic approach, incorporating a professional

consultant judgement on landscape sensitivity, and perception values in accordance to visibility criteria such as distance. The process is summarised in the following steps:

**Table 6.15**

<b>Step 1</b>		Determination of <b>total impact</b> of area (a 10 km buffer radius of the development site is assessed). It is assumed the extent of visibility and aesthetic loss will be within a 10km radius.
<b>Step 2</b>		Subdivision of the total impact area into <b>landscape aesthetic units</b> that are of homogenous character.
<b>Step 3</b>	<b>F</b>	<b>Actual Visual Impact</b> area. Identification of landscape units which are within visibility zones of the development.
<b>Step 4</b>		Determination of the existing landscape character units <b>landscape aesthetic value</b> . Using a rating of 1-10 (1 being low 10 being high) for the

		degree of complexity, naturalness and preserved typicality.
<b>Step 5</b>		Determination of the landscape character unit's <b>landscape aesthetic value after the wind farm has been built</b> . Using a rating of 1-10 (1 being low 10 being high) for the degree of complexity, naturalness and preserved typicality.
<b>Step 6</b>	Step 4 - Step 5	Determination of the <b>aesthetic impact intensity</b> of the windfarm in each landscape unit
<b>Step 7</b>		Determination of the <b>visual vulnerability</b> of each landscape character unit. Using a rating of 1-10 (1 being low 10 being high) for topographic relief, multiplicity of elements, vegetation density)
<b>Step 8</b>		<b>Protection value</b> of each landscape unit. Value on the need to preserve the landscape zone.

<b>Step 9</b>	Step 4 + Step 7 + Step 8	<b>Aesthetic sensitivity</b> in each landscape character unit
<b>Step 10</b>	Step 6 + Step 9	<b>Aesthetic loss</b> in each landscape character unit
<b>Step 11</b>	<b>E</b>	Determination of <b>aesthetic loss factor</b> . In accordance to the values ascertained in step 10 the values is redefined as a percentage out of 10.
<b>Step 12</b>	<b>B</b>	<b>Compensation factor</b> for each landscape aesthetic unit. It is assumed in Germany that 5-20% of the area of a landscape is of special value for nature conservation. The compensation factor is then equated to be within the range of 0.05-0.20.
<b>Step 13</b>		<b>Visual distance zones</b> equate dot be within one of three categories (0-200m; 200-1500m;

		1500-10000m).
<b>Step 14</b>	<b>W</b>	<b>Perception coefficient</b> for each visual distance zone. Base on the theorem that aesthetic effects decrease over distance.
<b>Step 15</b>	<b>K</b>	Amount of compensation area. <b>K= F x E x B x W</b> for each unit which is then aggregated to he total amount of compensation area ( <b>L</b> ).

Following step 15 the proponent of the wind farm development will need to buy or rent the area calculated in (**L**) which is typically recorded in hectares. The total amount of compensation area will need to be aesthetically improved ‘according to a landscape plan, which has to be worked out by an approved landscape architect’ (Nohl, 2007, unpublished).

This procedure is quite unique in its attempts to substantiate a relationship between sustainability of aesthetics. However a critical concern of the model is the lack of consultation and remediation to the locals who endure the consequences of the development. The geographic location of landscape compensation is not explicitly defined. Similarly the quality of

aesthetic improvement is subjective, requiring validation and critique from the aspect of community reference groups and authoritarians. For example the remediation of ecological wetland landscapes with native grasses may not be conceived as an aesthetic improvement to the majority of local residents, but on the other hand the addition of a recreational park which is less sustainable ecologically may have a greater aesthetic value. Hence the determination of aesthetic values and objectives of the aesthetic compensation, need to be defined and clarified in a transparent consultative process respective of local community values.

The major fault of the model is the subjective assignment of numerical values to landscape aesthetics. Quintessentially, the theory behind the procedure is flawed. The values ascertained are assigned by a sole assessor which installs a degree of subjectivity without justification of the intrinsic quality relative to protection values. There is no certainty that a peer review would conclude with the same values for landscape visual impact. Furthermore, the process of aggregating and weighting landscape character to generalised concepts of compensation factors is unjustified. As a result the significance of the effect is measured independent of critical community values.

More detrimental to the cause is the theorem of trading landscape visual amenity in a particular location for increased aesthetic amenity in another land use zone. The rationale that wind energy provides multiple benefits that accrue to society as a whole is true to the value of greenhouse gas emission depletion. However the costs of wind energy's impacts are on a local level, indicating that aesthetic trade offs should be commensurate to a particular location. Ultimately compensation measures are difficult to achieve because the wind turbines cannot be hidden behind trees or hedgerows in the vicinity of the wind farm.

In Australia, alternative forms of compensation have been distributed. The most prolific form has been proponents managing a community trust fund. An example of this has been in Lake Bonney central wind farm developed by Wind Prospect Pty Ltd in South Australia. An extract from the development application describes a typical financial compensation incentive.

'Wind Prospect will instigate a level of local project funding through the establishment of a Lake Bonney Central Wind Farm Trust Fund. The Trust Fund will obtain a proportion of the revenue of the wind farm and redirect it into local community projects such as:

- The establishment of a 'Lake Bonney Landcare Group'
  - Contributing to local community-based Alternative Energy projects
  - Sponsorship of local events/ field days
- (Wind Prospect, 2002)

### 6.15 CUMULATIVE IMPACT ASSESSMENT

Cumulative impacts are often used to refer exclusively to landscape and visual effects, however cumulative impacts can also correlate to a wider range of positive and negative social and environmental implications.

Due to the rapid growth of the wind industry and associated repercussions in land use conflicts, a strategic plan is required which can facilitate regional and site specific wind energy assessments. Guidance is required to assess the possible combined effects of numerous wind farms within a geographic region when assessing a development proposal.

The Scottish Natural Heritage (SNH) has been influential in discussing and formulating a process to assess cumulative impacts.

To define the term cumulative effects the Scottish Natural Heritage has stated 'the cumulative effect of a set of developments is the combined effect of all the developments, taken together' (SNH, 2003, p3).

To explain this in more detail we can imagine the development of two wind farm development proposals within the same geographic location. The combined visual, social, economic or environmental effects of the two developments combined is not merely the sum of development A and B, but potentially less or more than these individual proposals. Accordingly the visual effect of a turbine on a ridgeline in a vast expansive landscape may provide a single focus, whereas a secondary turbine located on an adjacent ridgeline will have the same effect on its own but as a combined composition may change the visual experience of the observer. Furthermore the ecological effects, specifically bird mortalities will need to be assessed for combined development proposals. The ramifications of sole developments may not have any detrimental impact on mortalities and population but combined with numerous developments possibly could.

In assessing the cumulative effects of landscape change this should not be limited to the assessment of proposed turbines, it should be contextually assessed for its associations and visual

relationships to existing or proposed forestry, and industrial infrastructure. In other terms the assessment should encompass a holistic landscape appraisal.

The model developed by the Scottish Natural Heritage has informed a possible direction for Australian local and state planning systems to consider. These approaches are:-

- Site specific assessments, where each individual development application is submitted. This would form part of an EIA.
- Strategic planning, as part of an informed zoning amendment to assess the potential thresholds of a geographic region to absorb developments.
- 

### 6.15.1 Site Specific Cumulative Visual Assessment

The process is driven by the application to develop a wind farm which may be:-

- An extension to an existing wind farm, either under construction or built.
- A subsequent extension to a lodged planning application which may have been approved but is still to be constructed



- More than one development proposed at the same time by numerous proponents.
- An extension to two or more existing wind farms within the geographic location.

Consequently the assessment of the development application will need to consider the existing landscape context and future development proposals. In some circumstances it may be a requirement to assess future speculative developments, in association to the current proposal. This may not be desirable unless the project has been submitted as a formal development proposal, as it will miss inform the results of the submitted projects scope and effects.

An important variable that needs consideration is the extent of the geographic region to be assessed. For visual assessment a logistical approach would be to extend the field of study to areas that theoretically can see the turbines. Needless to say the cumulative visual effects will vary for specified viewpoints. For example from viewpoint A, turbines associated to one of the developments may not be visible, limiting the degree of impact. However the cumulative effects may still be witnessed by a change in the visual experience of the occupant traversing from viewpoint A to B. In other words the perceived value of landscape

change within the visual field will have variable factors of cognition and perception related to preconceived ideas of landscape character and previous experiences. Hence the extent of the study boundaries should not be limited to zonal jurisdictions but should encompass the visual field of the proposed developments.

The process employed will need to be documented and assessed in an EIS report directed and submitted by the proponent.

#### **6.15.2 Strategic Cumulative Visual Assessment**

The evaluation of cumulative effects of wind farms could be used as a preliminary study to devise planning policies and development strategies for regional zoning. In other terms the process could be used in a hypothetical scenario evaluating threshold values for landscape absorption capability. This would be comparable to conducting a Strategic Environmental Assessment (SEA).

As discussed above this thesis is focused on the visual effects of wind farms hence the discussion on cumulative effects implies only the visual.

The key aim of strategic assessment is forward planning. In some ways it is not dissimilar to devising a framework for the current discussion of identifying 'no go zones'. For this reason the process can be prospective, meaning scenarios proposed and assessed could be hypothetical. The method would be to assert a number of development proposals and evaluate the cumulative effects, identifying threshold values of acceptance and sensitive landscape regions. By determining the scope of development absorbed by the landscape will delineate a strategic policy framework to be administered by the local or state planning authority.

Consideration needs to be addressed as to how the regulatory planning authority administers applications. Understandably developers will only wish to assess the impacts of their current proposal. Proponents will wish to keep the details of the proposal classified from competing developers and the general public until feasibility studies have been conducted. For example a proponent lodges an application for a wind farm consisting of 32 WTG along the ridge of a coastal landscape. At the time of lodging the application a second proponent is conducting feasibility studies to develop a 25 WTG wind farm 5km north of the primary development. The second developer requests to submit the application having assessed the environmental associations of

the landscape without any other proposed development. Hence the second developer may be unaware of any other proposed applications within the same region. Furthermore the developer will only be focused on assessing the environmental effects for their proposal, confining the study scope to minimize costs. Having said this it is only reasonable to expect the developer to assess schemes that have either been built, have permission, or are currently lodged applications.

In this case a cumulative visual impact assessment will be required. An assessment considering both proponents applications will need to be carried out. A series of questions are raised with regards to how, who and what is to be assessed:

- Firstly who should be instructed to assess the cumulative impacts?
- Due to the differing timescales of the development applications is it reasonable for the initial application assessment to be deferred until the cumulative assessment is submitted?
- Given the findings of the cumulative assessment, does the assessment imply that the initial application will need to be revised or even withdrawn if need be?

- What information is required to evaluate the combined visual effect?
- How does the employed consultant acquire the necessary data to assess the combined developments given they are confidential information?
- Who engages and employs a visual assessment consultant to assess the cumulative effects?

Consequently planning authorities are in some respect intermediaries between two development bodies. They have access to the information required to assess the combined effects of development proposals. Hence it can be suggested that the planning authority; local council or state government (pending whether it is lodged as a major project) should administer the cumulative assessment. Therefore the planning authority should engage a private third party consultant to conduct this work, at the expense of the development application.

Which developer should pay? Well in this instance we can resort to the well used phrase 'early bird gets the worm'. Consequently the application which is lodged second shall burden the costs of the assessment process. Similarly if there is an existing wind farm the proponent would be required to assess the impacts of the combined existing and proposed development.

Consequently it is at the planning authority's discretion as to how they wish to proceed with the assessment. They may wish to defer the assessment of the original application and determine the two combined or conversely may value each on their merits as separable portions with a supplementary cumulative evaluation.

The transparency and transfer of information is an interesting dilemma. During the feasibility and planning process the developer's turbine locations are commonly confidential information. Hence prior to the submission to the planning authority, the Environmental Impact Statement (EIS) will be confidential information. Upon receipt of the EIS the planning authority will provide to the public the relevant documentation upon request. There is no requirement for the developer to provide information prior to the submission of the application. Hence it is in the best interest of the planning authority to establish a good working relationship between the competing developers and encourage cooperation. This may well be a sticky point in the current process as the market is very competitive for sites with prosperous wind resource.

Further to this enquiry is complications created when the proposed wind farms are located in two separate jurisdictions. In

this occurrence the two planning authorities will need to cooperate in determining the assessment of potential cumulative effects. Of particular note the case study at Lake Bonney, south eastern South Australia is located across two regional councils, Wattle Range District Council and Grant District Council. For most cases in this situation the development proposals would be reinstated as major developments and assessed by the state planning body, in this case Planning SA. However this was not the case for the Lake Bonney development due to the stage one application being accepted with minor discrepancies.

### **6.15.3 Magnitude as Opposed to Significance of Cumulative Visual Effect**

The degree of cumulative visibility of wind farm developments is determined by the size of the proposals, topographic relief, and distance between the development locations. This would be representative of the relationship between the Zones of Theoretical Visibility (ZTV) of the two proposals.

In addition the cumulative effect may also cause landscape character transformation in a particular geographic location. For example two separate developments may be located within driving distance but cannot be visible in unison. In other words the

perceived threshold of landscape character in a particular region needs to consider traverse experiences.

The Scottish Natural Heritage (2002) has derived four categories of cumulative visual effect. The effects are classified as either cognition of combined visibility or succession of perceived landscape character. The categories are as follows:

#### **Combined visibility**

When a proposed wind farm is located within a visible distance to existing developments, the observer from a particular viewpoint may be able to see more than the one wind farm development.

#### **Succession**

When the observer has to turn to see the various developments from the same viewpoint. The developments can not be seen at the same time, they are in a different arc of view. However the cumulative visual impact will have a degree of perceptible value.

#### **Sequential effects**

When the observer has to move or travel through the landscape to view the various developments. Sequential effects should be

assessed for travel along regularly used routes (major roads).

Different degrees of sequential effect will be evident:-

- Frequent sequential effects occur when the developments appear regularly with short time periods in between. The speed of travel and distance between wind farm developments will be determinants of the significance of the effect.
- Occasional sequential effects occur when there are long time lapses between development forms.

### **Perceived**

When two or more development forms are present but can not and have not been seen by the observer. Due to information brochures signage and knowledge of a wind farm being located in the geographic area the occupant of the landscape may have preconceived ideas of the character. The influence of the information may be adverse or beneficial to perceived responses.

Evidently the relationship between visibility and perception is fundamental to the discussion on cumulative effects. In what is undeniably a dynamic predicament of tangible and intangible reasons, the model of assessment required vindicates strategic environmental assessments covering regional issues on landscape character and wind farm compatibility, and thresholds

of perceived wind turbine density in particular geographic regions. Moreover the assessment model should still be able to be adapted and applied to site specific development proposals directing design layout advice and detailed measurements of visibility and visual sensitivity.

### **6.16 REFLECTIONS, ADAPTATIONS AND METHODOLOGY CONVERGENCE.**

Visual impacts are a subset of a greater body of research in landscape assessment. They relate exclusively to changes in the visual field and perceptions of people viewing the landscape.

Landscape impacts and visual impacts do not necessarily correspond. For instance a building development in a particular location may have significant effect on localised fauna habitat however it may have a minor visual disturbance due to the scale and absorption of vegetation screening. Similarly telecommunication towers located in an industrialised area may have a significant visual effect due to the scale and relationship to other built form but minimal to negligible landscape effect.

There is universal acknowledgement that visual effects are important, that they depend on distance, size, visibility and other factors, and on both landscape and visual receptors.

(University of Newcastle, 2002, p11)

From review of the literature, planning guidance regulations and consultant environmental impact assessments, it has become evident that a unified theoretically based visual assessment framework is required.

Planning guidance has suggested two different assessments, site specific environmental impact assessments (EIA), and strategic environmental assessments (SEA). As discussed the difference between the two is broadly relative to the confines of the site boundaries and intricacies of the objectives of assessment.

Strategic assessments, inform zoning policies typically on a state or national basis, without defining a specific project proposal. This has advantages in defining 'no go zones' for wind farm developments, limiting the conflicts of landscape use and community unrest.

Environmental impact assessments are project specific, evaluating the design scheme, identifying attributes which have both positive and negative impositions on the landscape.

A visual assessment framework suggested by Wulff (2002) integrates both SEA and EIA planning structures. The following Table 6.16 illustrates the systematic approach.

**Table 6.16**

NOTE:  
This table is included on pages  
270-271  
of the print copy of the thesis held in  
the University of Adelaide Library.

## 6. Wind Farm Visual Assessment: Methodologies and Process

This model, if applied, would provide far greater certainty for wind energy developers, landowners and local councils and would do much to reduce the level of conflict that has been such an unfortunate element of the recent Portland and Toora wind energy proposals.

(Mercer, 2003, p114)

In addition this would remove the need for local planning schemes to be amended and modified to allow wind farm developments.

Models are being developed in the United Kingdom (Lange & Hehl-Lange, 2005) using interactive visualisation tools to engage community participation in the visual site design of the turbines. This method is applicable in the preliminary stages of public consultation, informing the proponent, landscape architect and regulatory planning authority of potentially sensitive views. It is also an efficient tool taking into consideration the ability to assess and collect data of large regional areas with out the need to conduct laborious site investigations with community reference groups.

Adapted from Wulff, (2002)

The framework proposed by Wulff is rational in developing state based policy.

In addition the use of interactive 3D visualisations and dynamic simulations has helped communicate the proposal to lay-persons, experts and decision makers, saving time and money in what could be long lasting litigation from opposing residents.

As technology develops communication between GIS data and 3D visualisations in an integrated two-way connection (Bishop & Lange, 2005); will provide scope for efficient community based real time planning. In addition the increase of internet bandwidths will also provide a potential service for interactive 3D displays, 'but further research on topics such as the appropriate level-of realism is still required' (Lange & Hehl-Lange, 2005, p349).

### 6.17 CONCLUSION

The installation of wind farms in the landscape often causes aesthetic conflicts. Although wind farms provide a renewable alternative to the combustion of fossil fuels, wind power is not generated without any social concerns. Planning decisions and policies need to consider and assess the aesthetic preferences and visual effects which are so pertinent. Consequently visual assessment planning

instruments are needed to provide objective, quantified measurements of a proposed visual experience.

Landscape visual assessment is a component of a broader study of landscape assessment which can commonly form part of Environmental Impact Assessments. The role of landscape architects in this process is to provide professional and technical expertise in comprehending visual landscape patterns through:-

- Geomorphology
- vegetation type and form
- scale and proportions of foreground, mid ground and background
- character and land use and
- technical expertise in visualising and simulating the proposed landscape alterations.

It seems unlikely that local communities will ever entirely accept the assessment of a quantitative visual assessment model to determine the visual impacts of a specific wind farm proposal. Nevertheless it is the objective of this thesis to develop a unified framework which encompasses two separate models of assessment, measuring the magnitude of visibility and the significance of visual effect.



As an important part of EIA, and regulatory planning process, the model developed needs to accommodate a quantified objective evaluation of the landscape before and after the proposed development.

Although local community members, tourists and traversing occupants are not going to agree on impacts, application of an impact estimation process based on empirical research at least forces the factors to be considered. This also provides credible, justified results for development decision makers.

Consequently it is suggested that a model should be developed which integrates an objective measurement of visibility and an objective value for sensitivity of people's perceptions. This provides something concrete which can be debated over theoretical aesthetic discourse rather than subjective concepts of visual impact without substantiation.

At present the models employed for visual impact assessment of wind farms in Australia are based on two models of diverse theoretical discourse. Firstly, the formal aesthetic model which is conducted by an experienced

landscape architect or environmental scientist is based on an arbitrary assessment of visibility and the presence of particular landscape characteristics.

It is recognised that, unlike some other aspects of EIA, landscape and visual impact assessment relies less upon measurement than upon experience and judgement; although all do have a part to play.

(Landscape Institute, 2002, p4)

Typically formulated in a matrix, the final assessment is rated in an ordinal classification. Alternative formal aesthetic models have been used with no uniform classification of criteria for assessment. For this reason the conclusions to the assessment are not representative of a verified peer appraisal.

The human field of view which is commonly referred in assessing the extent of vision from a particular viewpoint has not been confirmed for a consistent horizontal and vertical angle. It is recommended that guidance be given to consent a particular field of view.

An alternative method has employed a strategic psychophysical analysis. This approach is empirical, statistically validating the significance of sensitivity. By engaging the community in assessing before and after static simulations through surveys,

Planning SA (2002) has proposed a framework which integrates the assessment of landscape sensitivity values and the degree of change in the visible character of the landscape. However there currently is no means of validating with any certainty if there is a relationship between the magnitude of visual alteration and the significance of perceived landscape modification.

Various visualisation and field assessment tools are used in the process. Zones of visual influence and GIS maps are used to assess the extent of the visual field and likely impacted areas. Photomontages are used to simulate the proposed development from specified viewpoints. The importance of GIS applications to incorporate data capture, storage and analysis has not been fully explored for visual assessment. Considering visual assessment is but one component of a complex layered process of EIA, it is envisaged that landscape visual assessment models could

be assisted by GIS applications. It is hoped that with the adoption of GIS the magnitude of visibility and significance of sensitivity can be overlaid to help determine the affected areas and the likely degree of the visual impact.

This would address the need for a unified assessment, in addition calibrating the zone of visual influence to be inclusive of landscape visual values.

## 7 VISUAL REPRESENTATION TOOLS FOR LANDSCAPES AND WIND FARM PLANNING ASSESSMENTS

### 7.1 INTRODUCTION

The common phrase 'a picture is sometimes worth a thousand words' is good reason to investigate the development of representational media in landscape visual assessment process, with particular reference to wind farms.

Humans perceive the environment through numerous senses, commonly the auditive system, tactile system, olfactory system, gustatory system and the visual system. By far the most dominant is visual which is suggested to account for more than 80% of perception (USDA Forest Service, 1973; Bruce *et al*, 1996). Kurzweil (1990) claims that the visual sense can process 50 billion bits per second, whereas the auditive can only process one billion bits per second.

The primary objective of visualisation is to convey information in a legible and efficient manner. Visualisations have been used for centuries and are increasingly becoming more important in

landscape design, planning and environmental research projects to predict changes to the environment. Landscape Architecture and natural resource management professions have developed tools to represent existing landscape conditions and proposed changes according to a set of design intentions or projected natural processes.

As a means of communication, visualisations have evolved over the last several years. In the early 21<sup>st</sup> century, developments in computer graphics have provided exciting opportunities for representational media. Some of these developments have included the generation of three-dimensional computer modelling of landscape environments and data base GIS applications. The hardware and software available today provides a platform for realistic rendering of natural environments and various ways of viewing information.

Visualisation is a method of computing. It transforms the symbolic into the geometric, enabling researchers to observe their simulations and computations. Visualisation offers a method for seeing the unseen, It enriches the process of scientific discovery and fosters profound and unexpected insights. In many fields it is already revolutionising the way scientists do science (McCormick, 1987).

The process of image comprehension and theory of transactional depiction will be discussed in the light of the knowledge images are represented with a certain degree of bias. The agent (person developing the visualisation) must firstly grasp the concept of information to be provided and the context in which it is to be presented. The level of abstraction, symbolism, scale, detail required and format all influence the perception. It is vital to understand the fundamental process of image construction, comprehension, representational media and tertiary comprehension. This provides a foundation to discuss alternative media of representation and validity of landscape surrogates.

Visual representations are commonly used for consultation processes, identifying the potential changes to a scene, simulated in perspective views either through sketch, computer modelled, photographed or a combination. Some times several alternative schemes are represented and used to conduct preference studies.

Visual tools have become increasingly more evident in Environmental Impact Assessments specifically for infrastructural projects to investigate potential social

implications. Development assessment has become more rigorous on the visual effect of developments, requiring photo realistic simulations of the proposed project. Wind farms are but one form of infrastructure which has been interrogated for the visual implications on society.

In the past wind farm developments have come under scrutiny for insensitive siting. As discussed in previous chapters, the conspicuous siting of wind turbines is due to the conflict of available prevailing winds in locations which are close to the electricity grid for connection. This has typically meant coastal landscapes on the urban fringe of rural communities.

Visual tools have been used to simulate the appearance of wind farms for community consultation, environmental impact assessment (visual assessment) and planning development assessments.

One key consideration of wind turbines which sets it apart from other forms of infrastructure is the dynamic element of the blades turning. Animations and video are new ways of capturing the visual focus created by the blades turning. Currently static photomontages are the primary visual documentation due to the nature of EIS being a written paper document. This chapter will

discuss current tools used in representing wind farms, supported by an analysis of potential guidelines and future directions to utilise dynamic media.

The key objectives of producing visualisations of landscape environments are to create an opportunity to evaluate the potential changes to the experience incurred by development or natural causes. Evidently this will provide the community with a consensus on future directions. Furthermore visual tools provide analytical tools to examine the relationship between humans the environment.

It is essential in the professions of the built environment and environmental sciences to be able to illustrate potential changes to landscapes caused by proposed developments. Maps, plans and sections are common forms of documenting design proposals; however these forms of communication are some times inadequate. Perspective views are a simple form of communicating common everyday visual occurrences which the public can relate to. The sense of depth, scale and context are easier to comprehend than plan and sections (Bishop & Lange, 2005).

### **7.2 TRANSACTION AND DEPICTION OF LANDSCAPE REPRESENTATIONS**

The transactional model is concerned with the connection, or transaction, between the individual and the perceived environment, while the depiction model is concerned with the character of the environmental image presented by a medium.

(Zonn, 1984, p145)

In other words the reception or comprehension of a particular landscape is determined by the quality of information provided. All of the information is provided either directly or indirectly. Directly acquired information is obtained through direct contact with the landscape. In this model the individual is close enough to see, hear, and feel the many elements that constitute its total ambience (Appleton 1975; Meinig, 1979). Indirect information is supplied by someone else who has experienced and interpreted these elements of the landscape (O'Brien, 1982). In some cases this indirect contact is the only means of acquiring information about the character of the landscape. For example photographs of friends or family travel holidays may be the only source of information available to value landscape characteristics. These may supplement experiences of landscapes with similar visual

compositions. It can be said that there is no substitute to direct engagement of places of sublime experience such as the Grand Canyon or Niagara Falls etc. However it can also be said that photographic records of landscapes can also provide alternative creative impressions by emphasising elements that can not be discerned by the human eye, utilising zooms and telescopic lens to project wide angle views etc.

To acquire a more credible understanding of wind farm visual perception, we need to initially understand the ways in which people create meaning from the consumption of mass culture with particular reference to wind farm perception in various landscape contexts.

The transactional view is considered particularly appropriate because it accommodates and, in fact requires that the unit of analysis include the human, the landscape, and transactions between them. It offers a way of conceptualising landscape assessment broadly as multi-modal and multi-experiential. It provides a conceptual orientation that is broad enough to accommodate the diversity inherent in the three paradigms.

(Zube, 1984, p108)

The focus of this discussion is the interconnectivity of the individual and the environment which is being perceived. Meanings of landscapes are not simply projected by the individual to a static object. It is a dynamic process upon which individual transactions with landscapes are filtered by images in various presentation methods.

The transactional model provides a series of considerations which are thought to be essential to the foundation of an environmental perception framework. The first consideration is that the individual can be immersed in the landscape, hence multi-directional and multi-modal. The experience is translated through the senses surrounding the individual, not solely visual. Within this mode of information transaction, the individual must be selective in referring to information as there is too much information available to be comprehended in one transaction.

Depictions of landscape are varied according to the transaction of the landscape experience, representation media and creativity of the filtered media presented. For example the depicted medium varies according the individual who manipulates the medium. The media used to portray the landscape affects the perception of the landscape and for that

reason should be specified in its objectives of information transfer. Consequently it is of critical importance that the media used to portray the landscape is appropriate to the objectives and intent of comprehension and valuation. For example a motion picture will provide dynamic visual imagery as well as audio sensual information whereas photographs only provide static visual imagery.

A model of landscape depiction and perception described by Zonn (1984), illustrates four methods which incorporate direct and indirect transactions. Figure 7.1 illustrates Zonn's transactional depiction model.

**Figure 7.1** Transactional depiction model (Zonn, 1984,p 147)

NOTE:  
This figure is included on page 279  
of the print copy of the thesis held in  
the University of Adelaide Library.

In Zonn's model, illustrated above, person A and B are portrayers. The only difference between the two is that person A has only a direct transaction whereas person B has both a direct and indirect. The time lag of perception and depiction may occur instantaneously for example taking a photograph or prolonged as a written article telling stories of a past experience in the landscape. Person B has two transactions, which provides

complimentary, supplementary or redundant information. The indirect transactions may vary according to the occupant's information collection and representational media. For example a resident of a city will have both a direct and indirect depiction, relative to real experiences and indirect through advertising images of the locations visited.

Persons C & D are perceivers only, playing no role in the creation of representation and hence are only depicors. Person C only sees or experiences a particular landscape through an image provided. Person D on the other hand has an indirect and direct transaction. For example a person may view pictures of Paris, the Eiffel Tower, Notre Dame and having seen these through various forms of media may be inspired to visit the sites and experience them first hand. Many of our visions of the world beyond that experienced in normal travels are those translated by person C, whilst the complimentary experience common to most tourists is that illustrated by direct and indirect transactions such as person D.

### 7.3 HISTORICAL CONTEXT OF VISUALISATION

People have been using images as a form of communication for thousands of years. As previously discussed analogue forms such as hard copy paper prints of plans, sections, sketches, perspectives, physical models and more recently photomontages have been used. Of these, physical models and sketches are the oldest dating back to the Egyptian and early Chinese tombs. These forms of representation can be described as time capsules framing the environment for evaluation against the current landscape context. This provides a useful tool to predict the future evolution of natural processes.

Maps are thought to have been conceived at least 8000 years ago with the earliest known dating back to 6200 BC. The first known examples of terrain mapping are chronologically documented to be 2300 BC which is a depiction of a landscape of Iraq (Delano-Smith, 1987). Since then maps of two dimensional qualities have been refined and evolved, however the purpose of the map has remained the same.

Perspective sketches are documented to have been invented around 465 BC in Greece (Geyer, 1994; Bishop & Lange, 2005).



It was not until the Renaissance period that sketch perspectives became a common form of graphic communication.

Filippo Brunellechi (1377-1446) developed the vanishing point where all parallel lines meet at a single invisible point. This is an extremely important technique which today forms the basic foundations for perspective drawing. Techniques of perspective sketches developed during 15<sup>th</sup> century which had a compound effect on the development of three-dimensional representations which evolved for the most part during the 20<sup>th</sup> century.

Within the profession of Landscape Architecture, Humphry Repton (1803) was the mastermind behind visualising the design concept with clients using perspective views of the current landscape with an impression of a predicted rendition of the likely visual changes. In Repton's famous Red Books, the process of image construction and presentation is simplified to communicate with clients the existing condition perspective drawing under a paper overlay of the projected changes. A similar process of presenting perspectives was employed by Frederick Law Olmsted for his concept of Central Park (Beveridge & Schuyler, 1983).

Photography became a popular representative media in the middle of the nineteenth century. Techniques have evolved to mix different forms of media. The development of digital photography has reinvigorated the use of panoramas and provided new means of presenting through slide shows on computer screen.

Computer Aided Design (CAD) has been a catalyst primarily for built environments. Initially perspectives were limited to isometrics in CAD. It was not until the 1970s that landscapes became a focus of computer simulation, when the Defence Mapping Agency in the United States developed digital terrain mapping with draped imagery (Faintich, 1980).

Photomontages have become a common technique for the creation of images being used as design communication tools, marketing material, consultation and in research related assessments (Bureau of Land Management, 1980). The emergence of computer graphics hardware and software, digital manipulation of images has provided an efficient way of cutting and pasting superimposed sections of images onto a base photograph. The ability to store images in a database and manipulate them with various graphic tools in vector and raster based applications, has provided a relatively high degree of

realism and geometric accuracy to perspective drawing. Consequently the digital revolution has superseded the traditional analogue process of cutting and pasting printed paper images (Lange, 1990; Orland, 1988).

Spatial analysis tools laid claim to the origins of three dimensional presentations, the Laboratory of Computer Graphics and Spatial Analysis at the Harvard Graduate School of Design. This was the start of various applications and techniques to present complex data in ways that were thought impossible. Geographic Information Systems (GIS) has become an integral research tool for scientists, ecologists, academics, natural resource management and cartographers to name but a few.

Evidently two different forms of visualisation have emerged, there is visualisation of data, models and associations and then there are visualisations of landscapes and changing environments.

Initially visualisation applications were only available on large, very expensive super computers. The advancement of computer hardware has meant that these applications are now available on home computers. As the sophistication of visualisations has

evolved, research into the validity of representation has been a key research question.

Of the key research questions there has been a recurrent theme, to decipher the validity of visual representations beyond cartography. Some contemporary research questions have sought to demarcate relationships between;

- Abstract and realistic presentations
- Dynamic and static views
- Immersive and non-immersive displays

The most recent innovation to advance the intelligence and access to visual simulations is the internet. With the progressive roll out of broadband (fast speed transmission) it is increasingly becoming plausible to transfer high quality simulations and 3 dimensional models via digital format. Interactivity with visual simulations is a key opportunity via data base internet survey tools.

### 7.4 ABSTRACT AND REALISTIC REPRESENTATIONS

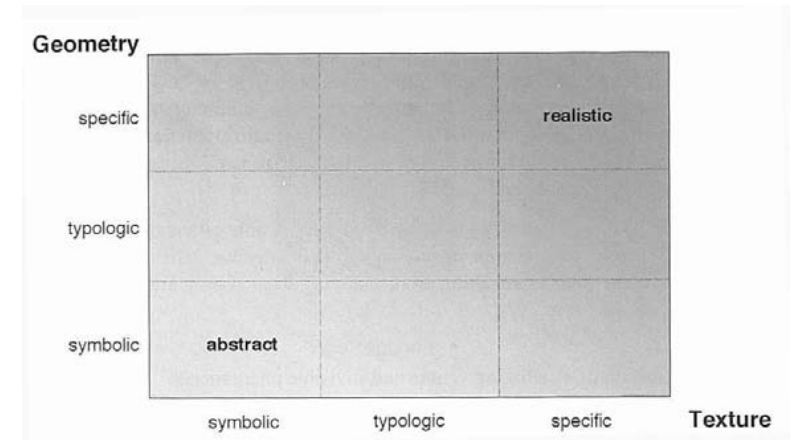
The development of computer graphic technology has primarily been in gaming and for military purposes. The economic feasibility of computer simulation has to date limited progress in

the modelling for research related perceptions studies. However the objectives remain the same in communicating the potential problems for experts and lay person to comprehend.

One of the constraints has been the ability to produce effective imagery with a sufficient degree of realism. The omission of a certain degree of reality produces a representative sterile environment that is not site specific. Landscapes are highly complex, requiring innovative ways of replicating the colours and textures visually evident in real life experiences.

From a representation point of view, the efficiency of communication is dependent on the geometry and textures. Danahy (1997) has described this model in the Figure 7.2.

**Figure 7.2** Visualisation degree of communication



The relative degree of realism versus abstraction is dependent on the scale and perspective from the viewpoint. For example a house sighted on a distant ridgeline is seen as a black silhouette as an abstract symbol, whereas up close the materials and form of the house will be perceived from a different angle with a different degree of clarity.

Still a key question that is commonly being investigated in research fields of visual enquiry is the validity of representational media and how detailed a visualisation needs to be.

More abstract representations appear to be inappropriate for determining landscape aesthetics/scenic beauty values. An important question for further research is to determine what representations are necessary and sufficient to achieve valid indications of the effects of particular environmental conditions and characteristics on specified behavioural, perceptual or valuation responses.

(Daniel & Meitner, 2000, p69)

The debate on the quality of visual media in environmental assessments has been a contemporary field of research specifically in spatial perception analysis. Appleton and Lovett (2003) have conducted studies using GIS software to question the level of detail required in landscape visualisations. This study and various other landscape related research topics have focused on the degree of realism and typically have reinforced the need for a certain level of realism. Contrary to this, Pietsch (2000) found that there is limited difference in perceived effects of visualisation detail in urban and architectural contexts.

The comprehension of abstract visual representation is understood to be relative to familiarities of landscape context

and the particular technique of media used to display. One example of a legible public consumed abstract visual tool is the static two dimensional maps.

The role that visualisations play in environmental decision making is becoming much more exposed to public critique. Hence the assumption that the public knows the landscape context prior to being engaged with representations is precarious. Hence visualisation media needs to be able to accommodate a sense of reality from numerous viewpoints. Langendorf (2001, p309) made four assumptions on the objectives of visualisation in planning assessments:

- in our complex world, to understand nearly any subject of consequence it is necessary to consider it from multiple viewpoints, using a variety of information:
- we are rapidly moving from an information-poor to an information-rich society;
- the understanding of complex information may be greatly extended if visualized; and
- problem solving and commitment to action in a complex world requires communication and collaboration among many participants, and visualisation aids this interaction

Bishop (1994) and Lange (1994) have both commented that the level of realism in landscape representation is important in effective public communication of proposed developments. The easiest form of visualisation for the public to comprehend is photographic before and after scenes as these are more typical of everyday visual experiences.

Research studies testing a combination of photo portrayals of the landscape with abstract icons representing proposed changes have been conducted by Krause (2001) and Hehl-Lange (2001). Both these studies and many more similar examples have not clarified a best practice approach to represent landscape contexts. There has been very limited research to date which directly seeks to qualify the validity of different visual representation media for specific landscape contexts.

### **7.5 THE DEVELOPMENT OF CARTOGRAPHY AS A LANDSCAPE ANALYSIS TOOL.**

Cartography has been utilised for centuries to help communicate and analyse difficult spatial questions as a means of orientation way finding, interpretations and experiences of landscapes.

During most of the long history of cartography, cartographers have been chiefly concerned with technical problems: acquiring and perfecting geographic data, devising ways of symbolizing it, and inventing methods of mechanically preparing and duplicating the physical map.

(Robinson & Petchenik, 1976, pviii)

Consequently cartography has formerly been a device to communicate cognitive thoughts through symbiotic representation. As we experience space, we construct representations, locating where objects are in relation to other forms and patterns of the landscape. Even if objects do not share any common characteristics, there is one thread which orchestrates the cognition of mapping and this is spatial location. Coincidentally mapping is grounded in the art and science of spatial analysis.

The fields of geography, semantics, psychology, anthropology, landscape architecture and architecture to name a few, have all succumbed to the process of mapping. Whether this is symbolising aspects of landscape, ideologies and concepts of

future visions or imaginative pasts, they all represent spatial cognition.

As previously stated cartography is but one form of mapping. The term 'mapping' is frequently used metaphorically in a non-cartographic sense to denote organising, planning, strategising, presenting and cognitive knowledge. Mapping has only recently been investigated as a process of information transfer, a chain between the mind and a form of communication.

Maps break down our inhibitions, stimulate our glands, stir our imagination, loosen our tongues. The map speaks across the barriers of language; it is sometimes claimed as the language of geography.

(Robinson & Petchenik 1976, p2)

Despite the fact cartography is arguably the most fundamental form of communication through visualisation tools, there is still very little research into the psychological effectiveness of maps and a philosophical discourse about mapping as a process.

Denis Cosgrove has been influential in deciphering meanings, uses and evolution of cartography as a design and analytical research tool. For example, *Mappings* (1999), edited by

Cosgrove provides a collection of essays in visualising, conceptualizing, recording, representing and creating spaces graphically- 'in short, acts of mapping' (Cosgrove, 1999, p1).

Maps have been and still are today a simple means of direction, orientation and representation of imaginative and real life experiences. Maps in this sense are not purely material and literal pen lines on paper, they can also be considered to encompass spiritual and emotional phenomena. Imaginative concepts of landscapes remembered from sensual associations and landscapes contemplated, envisaged from tertiary sources of information are all incorporated into the process of mapping.

The essays collated in *Mappings* (1999) demonstrate the heterogeneous nature of spatial comprehension, visualisation of landscape context and representation of the cognition of spaces. As stated by Cosgrove, maps 'deal with imagination and projection, efficacy and disruption; with processes of mapping rather than with maps as finished products' (Ibid, p1). Hence mapping is a process and a tool used to explore the acts and processes in which humanity has shaped conceptualisation of space through visual representation.

The resonance of maps as phenomenological representations can be communicated and measured through various ideological contexts. Maps have the ability to become dynamic informative databases, instating the evolution of landscape and spatial reorganisation. Furthermore the notion of maps as social, political or even moral pieces of evidence can be explored in terms of symbiotic permutations. Needless to say the experience and interactivity of landscape and maps can be 'material or immaterial', hence mappings are not merely forms of archival measurement and they 'include the remembered, the imagined, and the contemplated' (Ibid, p2). This indicates the multidisciplinary discourse of maps, crossing fields of cultural, social and mythology, each bearing different objectives in the process of landscape evaluation, data accumulation and documentation.

Mapping is a spatial, geographical representation format, which provides cultural symbols and subjective hermeneutics of landscape. To this effect landscape in a cartographic medium is a product of culture, accordingly an ideological representation of landscape as cultural product. Similarly mapping can be a process of representing community perception values of a particular geographic region. Hence experiential variables can

be collected during the mapping process and cartographically mapped (MacFarlane *et al*, 2004).

If we interpret maps as thought provoking design tools, then fundamentally the agency of mapping lies 'in neither reproduction nor imposition but rather in uncovering realities previously unseen or unimagined, even across seemingly exhausted grounds.' (Corner 1999 p213). In other words the landscape process; functional, spiritual and emotional characteristics are represented in a format which can be assessed for synergies or discrepancies.

Other academic theorists who have influenced the contemporary discussion of mapping are James Corner, Wytan Curnow and Ian McHarg.

James Corner has been active in discussing the agency of mapping, classifying the map as a dynamic tool to communicate new ideas of landscape. Corner (1999) discusses the agency of mapping in two forms, analogous and abstract.

Corner elaborates on two sided characteristics to decipher the agency and meaning of maps. The first characteristic is the objective analogous site specific data accumulation and

projection onto paper through points, lines and polygons. This form of mapping is equivocally inventory, tracing the existing physical character of the landscape into a transferable document. However the product of this form of mapping provides a source for further cognitive maps of spatial experience. By illustrating a dotted line on the cartographic document an itinerary can be envisaged of which four dimensional images flood the mind, fabricating a spatial cognitive response. The simultaneous nature of comprehension and imaginative psychological response promotes this form of mapping as an objective measure of the world in a pluralistic sense.

Throughout the twentieth century, mapping in design and planning has been undertaken conventionally as a quantitative and analytical survey of existing conditions made prior to the making of a new project. These survey maps are both spatial and statistical, inventorying a range of social, economic, ecological and aesthetic conditions. As expertly produced, measured representations, such maps are conventionally taken to be stable, accurate, indisputable mirrors of reality, providing the logical basis for future decision making as well as the means

for later projecting a designed plan back onto the ground. It is generally assumed that if the survey is quantitative, objective and rational, it is also true and neutral, thereby helping to legitimize and enact future plans and decisions.'

(Corner, 1999, p215)

The other characteristic of maps which is less tangible is the abstractness of symbolic representation. The process of thematic mapping is indicative of this characteristic. The selection and omission of information to be represented and means of graphically coding the information is subjective. Similarly the act of producing cartography has components which are abstract in the means of graphic representation. There is no uniformity to the process of mapping. Coincidentally the agency of mapping can be summarised as an investigation into a permutation of conventional rational thought and abstract pattern making.

Corner believes the act of mapping is a product and process of cultural intervention. In this sense mapping has a variety of synergies to the notion of cultural landscapes evolving from process and equivocally a product of ideological manifestations.



As previously discussed in previous Chapters the relationship between culture and landscape is founded in biology and intuition. Correspondingly the process of mapping is grounded in biological and intuitive variables. However Corner's preoccupation is not to decipher the means of mapping, but rather interrogate what the process actually implies to the planning and landscape design professions.

In relation to the utility of mapping in the design and planning process, it is quite evident that the act of mapping precedes design development and critique. This is brought forth by the fact that planning and landscape design typically assumes that the map is an objective product which scientifically identifies opportunities and constraints. Corner has eloquently stated that 'most designers and planners consider mapping a rather unimaginative, analytical practice, at least compared to the presumed inventiveness of the designing activities that occur after all the relevant maps have been made (often with the contents of the maps ignored or forgotten)' (Corner, 1999, p216).

In summary Corner believes the act of mapping should embark on a discourse of exploratory creativity. The process of mapping should be valued in the design process as a dynamic immersive

procedure. Complex factors of time, reality, identity and contingencies that surface from the interaction of these and many social variables need to be explored. The formality of current adopted models for planning does not permit the flexibility to incorporate less generic emotive variables of landscapes.

He believes that landscape design and planning disciplines should lead the way in exploring new methods and realities of mapping and its intended use.

Ian McHarg (1920-2001) was one of the true pioneers of the environmental movement in landscape research specifically in resolving a method which uses maps to analyse and illustrate the ecology of the landscape. McHarg's published work, *Design With Nature* (1969), is used as a universal reference for landscape site analysis theoretical techniques in schools of Landscape Architecture.

The objectives of McHarg's work stemmed from suburban sprawl and highway corridor construction. The publication *Design with Nature* (1969) reiterates a common trend of engineered solutions for development proposals in transitional

landscapes<sup>1</sup>. The notion of engineered solutions has been explained by McHarg as a lack of environmental concern where the 'task [of design] was given to those who, by instinct and training, were especially suited to gouge and scar landscape and city without remorse - the engineers.' Hence the common trend of suburb and freeway design has tended to be driven solely by financial and functional constraints with minimal environmental concerns.

McHarg's argument that form must follow more than just function but also respect the natural systems of the landscape was a ground breaking thought during the late 1960s. The need to evaluate the landscape for ecological value to be weighted against the economic functional costs of engineered solutions was one main driving factor of development and design critique.

An important reason why the environment played such a small role in planning and design stemmed from the lack of a method to quantify and display information about the natural environment in any efficiently useful and scientifically valid

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<sup>1</sup> Transitional landscapes can be described as the area on the fringe of rural agricultural and suburban landscape character. Similarly the fringe area between urban, city landscape and suburbia. This is typically a visual character assessment relative to spatial scale, density of built form and to some degree population.

manner. In the days before advanced computer technology, there was no way to store, process or present large amounts of spatial data. This inevitably became the catalyst for the theory of landscape overlay mapping.

McHarg believed the map was a tool which could graphically represent large amounts of spatial information in a concise manner. McHarg used a case study to demonstrate the process of evaluating maps for environmental factors in a controversial highway project in Staten Island, New York. The project team was led by engineers resulting in the most cost effective route and functional engineered solution. Social variables of the project slicing through neighbourhoods and cutting, scarring the landscape were not considered in the initial concepts. Alarming the local community were not consulted and valued in the design development stage.

For this reason a large community protest occurred and McHarg's firm was engaged to consult the local community and analyse the social values of the proposed concepts. By valuating the different concepts according to variables such as historic, water, forest, wildlife, scenic, recreation, residential, institutional, and land values the landscape was weighted and assessed for areas of significance. The method created

transparency maps for each factor, with the darkest gradations of tones representing areas with the greatest value, and the lightest tones associated with the least significant value.

All of the transparencies were then superimposed upon one another over the base line inventory map. The darkest areas showed the areas with the greatest overall social values, and the lightest with the least, following the format of each individual layer. The social value composite map was then compared with similar maps constructed for geology, existing infrastructure and hazard considerations, and the result was a clear picture of where to locate the development proposal. The conclusions of the study revealed that socially valuable forest and parks should be retained, implying a realignment of the road corridor would be required.

This process has been called 'multidisciplinary-based suitability analysis.'<sup>2</sup> The rigorous cohesion of the model laid the foundations for many more complicated studies which were to occur in research and landscape strategic planning decisions. Some people have considered and critically commented that the model was a reductionist form of landscape interpretation, mapping and strategising elements of the landscape as a sole

entity. McHarg addressed these comments in an interview at the conference 'GIS 1995 Vancouver, British Columbia, Canada':

Well the thing I'm doing is the very opposite. That is by starting with bedrock geology and then surficial geology, and then reinterpreting these to reveal groundwater hydrology; you explain physiography and also surficial hydrology. This then leads you inevitably to soils, which leads you to plants, which leads you to animals, which can lead you to land use. This isn't reductionist at all. As a matter of fact, every one of these steps is in fact either correcting or reinforcing. That is a great benefit of this accumulation of information. It is either reinforcing or makes information comprehensible. It adds meaning to the dataset, and I think that is what it is all about; to be able to understand the way it works and to be able to apply that understanding to manage it with intelligence and hopefully compassion. That's what I think GIS can do. Very little ecological planning is done as part of this great new capability.

<http://www.geoplance.com/gw/2001/0601/0601mem.asp>

(13th December 2006).

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<sup>2</sup> <http://www.geoplance.com/gw/2001/0601/0601mem.asp> (13th December 2006)

Currently maps are used in a cartographic medium in environmental impact studies to geographically locate development proposals. They are thematic in the sense that they typically identify spatial features such as population, climatic conditions, topography, road networks and open space networks are but some examples.

### 7.6 VISUAL INFLUENCE (ZVI) MAPPING TECHNIQUES.

A critical component of visual assessment studies has been visibility modelling and analysis. Mapping techniques which seek to graphically represent the landscape region and zones of potential visibility of a proposed development are used to cross reference areas of potential significant impact. This technique has commonly been used in the United Kingdom for a range of different project assessments from highway corridors to telecommunication towers and wind farms. It has become common practice in wind farm planning applications to apply such a tool.

The Zone of Visual Influence (ZVI) or what is sometimes called the Visual Envelope (VE), Visibility Analysis (VA) or Viewshed, is described as a cartographic map which highlights areas within the landscape that by line of sight one can see the proposed

development. In other words visibility analysis identifies those areas on a map that one can see a single or many specified objects, for example, wind turbines.

ZVI maps are produced from Digital Terrain Models (DTM) sometimes called Digital Elevation Models (DEM). Digitised data is used to create three dimensional models which project the elevation of the landscape onto a contoured map. By means of ray tracing a projected line from the highest surface point of the development form (in the case of wind turbines this is defined by the tip of the blade revolution), across the landscape surface for a 360 degree azimuth, areas of visibility are highlighted to occur when the line intersects the surface texture. Consequently ZVI maps correspond to topographic variations in the land form.

The maps indicate potential visibility only, that is, the areas within which there may be a line of sight. They do not convey the magnitude of visual impacts, for example whether visibility will result in positive or negative effects and whether these will be significant or not (University of Newcastle, 2002).

The following image illustrates a ZVI for a wind farm proposal in South Australia. Typical of ZVI produced imagery using specific wind farm software, the map represents categories of visibility

identifying the number of turbines visible from certain areas. This is a useful tool for desktop studies, enabling an indication of the regions needing more detailed field investigation.

**Figure 7.3** Zone of Visual Influence Courtesy Wind Farm Developments 2003

**NOTE:**  
This figure is included on page 293  
of the print copy of the thesis held in  
the University of Adelaide Library.

The ZVI is produced as an overlay of the base map, and is commonly one of the first stages in the process of visual assessment. As stated above it simplifies and classifies the landscape into regions for site specific detailed analysis, notifying how much of the development is potentially seen and the extent of the visibility. This also enables the assessor to identify possible vantage points of significance, which can be

discussed with local statutory authorities, municipal councils and stakeholders in the development program.

### 7.6.1 Zone of Visual Influence (ZVI) or Zone of Theoretical Visual Influence (ZTVI)

Zone of Visual Influence (ZVI) as defined above takes solely into account topographic variations in determining areas of visibility. Limitations of this mapping process are potential screening from vegetation and localised built forms are not considered in the process of assessment. Hence the concept of Zone of Theoretical Visibility has been discussed as an alternative.

Visibility maps represent where a development may be seen theoretically- that is, it may not actually be visible in reality, for example due to localised screening which is not represented by the DTM (University of Newcastle, 2002).

Accordingly the landscape character and visual patterning of vegetation within the region of the development form will have an influence on the field of view and quantity of visual change caused by the development. Furthermore the vegetation type will also affect the visibility, with different canopy forms, densities and the spacing density of plantation, providing mitigation screening or partial filtered views.

Hence the use of ZTV in planning assessment reports has been argued to be inconsistent and potentially incorrect in illustrating the severity of effect (it could be classified as worse case scenario). It has been recommended that a ZTV can be used for preliminary studies with supplementary field assessments to determine areas which have been designated to be exposed to potential effects.

### 7.6.2 The Effect of Distance and ZTV Extents

The distance of the observation points to a wind farm development will determine the significance of the visual effect. It can be assumed that the greater the viewing distance from the wind farm development, the less severe the visual effect. However recent research suggests the effect of distances beyond 3 kilometres to have minimal effect on the perceived quality of the landscape, hence the relationship between distance and visual effect is not directly associated (Lothian, 2004).

To evaluate the degree of landscape modification, the scale of both the wind farm development, in relation to the extent of the visual landscape character will need to be considered. For example a grazed pastoral landscape with minimal vegetative

cover and low lying topographic relief- common to wind farm development sites in South Eastern Australia, will provide open expansive views. Recent studies in the United Kingdom (Sinclair, 2001; University of Newcastle, 2002) have claimed that visibility ranges 30 kilometres- 35 kilometres for wind turbines 100-110 metres in height. From a physiological perspective the proportion of the horizontal and vertical view taken up by the WTG from a distance of 30 kilometres will be insignificant, it will predominantly be the effect of movement which will attract the acuity of the eye. Consequently it can be suggested that the degree of visual effect from a 30 kilometre distance will be minimal. However it is suggested and will be adopted for this thesis that the extent of the visual field is 30 kilometres. Hence a 30 kilometre circumference from the development site will form the case study boundary.

The relationship of distance and visual effect has been investigated by numerous research projects (Bishop 2002; Bishop & Shang 2000; Bishop & Miller 2007; Sinclair 2001; Lothian 2004; Benson 2002). The results all illustrate an exponential relationship of distance and visual effect.

Utilizing digital animations of turbines, Bishop (2002) conducted a research project, investigating the effect of turbine size,

distance and randomised sample of people's perceptions. Bishop found that the visual effect had a dramatic change at 4 kilometres in clear skies, was below 10% at 6 kilometres and at distances of 30 kilometres only 5% of the surveyed sample would recognize the turbines in the visual field. The WTG modelled for this assessment was a 50 metre tower with 26 metre long blades. Consequently the combined height of the turbine was 76 metres to the tip of the blade circumference. The current wind turbine generators used in Australia range to 110 metres tip of blade, considerably bigger in scale.

In addition Bishop (2002) evaluated the effect of differing atmospheric conditions. Threshold values were established for visual effect according to digital representations. Alterations to the base contrast of the turbines and the hue of the sky provided a testing ground for perceived recognition of turbines and atmospheric haze. This topic of contrast and visual acknowledgment has been previously investigated by Bishop and Shang (2000) who produced empirical quantifications of perceived contrast. The variance in lightness of pixel differentiation determined the effect of contrast and subsequently atmospheric haze. The objective nature of this research enabled a regression equation to be developed, which depicts the change in visual recognition relative to contrast.

According to Bishop's (2002; 2007) results the effect of haze will diminish the visual effect over distance. Turbine detection rates suggest a fall of recognition within 7-9 kilometres in a slight haze in comparison to 8-12 kilometres in clear skies which is quite significant. The conclusions of the experiment justified distances of up to 20-30 kilometres being assessed for the visual extent of the development site. However it has been suggested that due to atmospheric haze conditions occurring frequently in coastal regions that the visual effect beyond 20 kilometres will be uncommon; this will only occur in exceptional circumstances and clear skies. Furthermore Bishop (2002) commented that "Visual impact remains in the eye of the beholder but may well become minimal beyond 5-7 kilometres, even in clear air". These findings are important in the consideration of the relativity of field assessments and representational media. It could be suggested that typical atmospheric conditions for particular geographic locations should be represented in photomontages rather than high contrast blue sky which is commonly illustrated.

Another concern which is unique to wind farm visual effects is the dynamics of blade movement and the differential extent of visual recognition associated to static and moving imagery. Similar to previous research on contrast and distance, Bishop and Miller (2006) examined the relationship between distance

variables and WTG recognition with reference to static and dynamic animations. This study utilized an existing off-shore wind farm at North Hoyle (Wales) which consisted of 30 turbines. However the scope of this study only represented 18 WTG due to the theoretical horizontal field of view from an identified viewpoint. The turbines animated were typical of the Vestas V80 2 megawatt. The dimensions of the WTG comprised 100m towers, 40m blades combining to 140 metres to tip of blade revolution. This is somewhat bigger than the actual installed turbines of 67m towers<sup>3</sup>.

The assessment process was conducted as an online survey with a random sample of people. Moving and static images were used to assess recognition with respect to distance and atmospheric conditions. The results were compelling in identifying a preference for moving turbine blades. The degree of negative visual effect is consistently lower for animated moving blades. Bishop's (2007) results concluded that

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<sup>3</sup> This is bigger than the WTG to be assessed in this dissertation. The turbines analysed as a test ground for the methodology are varied in size from Chapter nine describes in detail the WTG installed at Lake Bonney.

the range of values is higher in the case of static blades (approximately 1.2 versus 0.5 at 4 km) suggesting that the difference between still and moving effect gets greater as the turbines become increasingly prominent (either closer or with higher contrast). This is particularly evident in the low variation in effect at low contrast levels for static blades. In these conditions the blades can be quite hard to see unless they are moving.

(Bishop & Miller, 2007,p825 )

Consequently movement has been suggested to have a significant effect for off shore developments within sub regional distances of 4-10 kilometres.

The issue of visual impact or significance of visual effect is a separate concern. Distance threshold ranges can be determined but are unable to categorically place a value on the change in significance of visual effect. Subsequently we are faced with the dilemma of associating relativity of particular observer's perceptions to normative values. The visual significance of landscape change is related to landscape context, cultural and biological factors and preconceived ideas on renewable energy, allegations of bird strikes, noise impacts and associated potential impacts. In simplified terms cognitive values will affect



sensitivity on the visual perception value installing of specific landscape viewpoints. The relationship between distance and visual perception can be ascertained by cross referencing threshold distances and preconceived scenic amenity values.

Still we are left with numerous questions on how perception and distance are interrelated. Consideration of various visual contexts and composition of landscape forms is fundamental to the interpretation of landscape absorption capability<sup>4</sup>. For example the distance ratio between foreground, mid-ground and background will vary depending on the topography, presence of built forms, pattern and scale of vegetation and observer's elevation. Hence the landscape absorption capability will impact the significance of visual effect irrespective of distance to the wind farm.

### 7.7 PHOTOGRAPHS

Photographs have become a standard format of landscape representation in environmental impact assessments.

Photographs enable viewers to immediately compare scenes from different viewpoints and from widely different contexts.

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<sup>4</sup> Landscape absorption capability refers the degree of vegetation and topographic relief which screens the development from a specific viewpoint.

The difference between photographs and field visual experiences of landscape is immediately apparent. A field observation is a direct transaction and experience, whereas photographs are a restricted view separated from the landscape context.

Field observations take time and are expensive to carry out for public perception research. On the other hand, photographs can depict changes in seasonal colour and be presented at one assessment survey presentation.

The limitations of photography are paramount in the deduction of sensual perception of the landscape context. A photograph represents two dimensions framed to a certain visual orientation. Landscape field observations encompass 360° and provoke sensual, emotional responses. These experiences are classified as four dimensional. Consequently the simplification of visual experience reduces the attention to directly correlate visual qualities.

The physiological difference between field observations and common 35mm photographs is also argued to be miss represent the landscape context. The field of view of the human eye is much larger than that contained within a 50mm lens 35mm film

photograph: the human eye views a cone of vision of 120-140° (with peripheral vision extending to 208°) compared with only half of this, 65°, for a wide angled 35m camera lens (Shuttleworth, 1980, p63). This restrictive view is further affected by a biased depiction of the landscape represented by the photo. In the field an observer is able to view the landscape from numerous aspects, whereas photos are orientated and frame a specific direction. The influence of the photo in community consultation preference surveys has had a compound effect by the composition of the landscape elements in a scene (Stilgoe, 1984). Stilgoe developed a list of criteria upon which photographs are composed. Some of these rules are to have a broad foreground with a tree, fence or road, and unimportant middle ground and having mountains, clouds or other features in the background. Industrial fabric in the photograph is a common omission or is avoided in the composition.

Several studies have been conducted into the suitability of photographs as visual surrogates for landscape field assessments.

Brown *et al* (1988) examined scenic ratings taken through field investigations compared to colour photographs of the same

area. The ratings indicated that field observations were significantly higher. Contrary to this study, Coughlin and Goldstein (1970) found that photo representations correlated to field observations. However this study has been criticised for its statistical validity as only two people were surveyed on site and eleven partook in the photo survey.

Zube *et al* (1975) reviewed a series of research projects relative to field versus surrogate assessments. Using a range of different analysis techniques (Q-sort, semantic scales and rank order) they found strong support for high correlations between field and non-field investigations.

Another study conducted by Dunn (1976) established support for photographic surrogates. The assessment found that on-site evaluations were invariably lower than photograph ratings, but the statistical variance was insignificant.

Shuttleworth (1980) performed an important research project to examine concerns with previous research assessment techniques and the credibility of their statistical findings. The main concern was the use of different samples of people for field and photographic surveys. Semantic differential and bipolar scales were used to assess rural and urban landscapes, to

depict any correlation between photographs and field studies. Various techniques were used to ensure randomness of the sequencing of assessment (changing the order of photograph and then field assessment between two sample groups). Shuttleworth found no significant difference between the group's responses and an insignificant difference between colour photographs and field observation ratings. The results 'indicated that there were very few differences of significance between the reactions to and perceptions of the landscapes either when viewed in the field or as photographs' (Shuttleworth, 1980, p74). Hence he concluded that photographs can be used as surrogates for field assessments providing they are colour and are wide- angled to provide lateral and foreground context.

Nassauer (1983) examined the perceptual response of 50mm slides and 35mm wide angle slides. She combined three 50mm lens photos stitched together to represent a panoramic scene and compared these with the wide angled view. The results indicated that the panoramic photos rated higher than the wide angle photos.

The conclusion from these various studies is that photographs are a valid representation for judgements about the visual

environment. The same can be said for scanned images from video source (Vining and Orland, 1989).

Several questions arise from this review of visual media validity. Firstly, to justify a comparison between field observations and photographic representation, the material of representation should reflect the corresponding human field of view notionally 120-140°?

Secondly, a photograph is static limiting interactivity and potential visual stimulation from perceived movement. Should photorealistic representations, specifically for wind farms which obtain a dynamic element, encompass simulation of the blades turning?

### 7.8 STATIC AND DYNAMIC DISPLAY

The following is a review of the discussion on contextual relationships between onsite visual experiences and simulated or surrogate representations, commonly classified as either static or dynamic. McKechnie (1977) has provided a generalist typology of landscape simulations for different objectives of perceptual and conceptual representations.

**Table 7.1** Typology of landscape simulations (Adapted from McKechnie, 1977)

	<b>Perceptual</b>	<b>Conceptual</b>
<b>Static</b>	Photographic -aerial -onsite -slides Photomontages Perspective drawings Physical Models Composite techniques	Functional diagrams Maps Site analysis plans and diagrams Site plans Working drawings
<b>Dynamic</b>	Animation Computer generated perspectives Movie Films -onsite -models Video	Computer analog models Computer maps Radar

Static representational media in the field of landscape architecture has profoundly been photography (McKechnie, 1977). Two forms of photography have been prevalent in literature research projects since the 1970's, these being aerial photography and on-site photograph surveys (Zube, 1987).

Aerial photography has been assessed for its application validity to landscape assessment and perceptive communicative qualities. Several studies have found that aerial photography is a superior tool over maps for landscape studies and site assessment (Keech, 1977; Steinitz, Rogers Associates, 1977). Similarly, research conducted by Zube (1974) and Blaut, McCleary and Blaut (1970), has supported a correlation between aerial photography comprehension and descriptive terminology.

On-site photography has been used in landscape management inventory assessment and planning research studies. Landscape research studies have addressed landscape methodological issues, perceptions of landscapes and assessments of amenity values. The use of photographs and slides has been integral to both managing and research. As discussed in previous chapters of this dissertation, their have been numerous landscape perception studies which have used photographs or slides as surrogates to evaluate landscape preferences, scenic beauty and various derivations of the effects landscape visual change.

As mentioned in previous chapters vision is a dynamic process which is composed of foveal and peripheral modes. To fully

decipher the complexity of landscapes one must experience the landscape with a combination of peripheral vision, binocular vision, movement and motion parallax. Even static images are perceived through a dynamic process of eye movements and light projection onto the rods and cones of the retina.

Foveal vision is the field of view that occupies the focus of concentration of the occupant. For example the representation of a landscape scene which contains wind turbines will be perceived by the foveal sense of vision. In this instance it is difficult to interpret the landscape character association if it is not incorporating peripheral vision. The peripheral system captures a wider field of view and also scans the field of view for any dynamic changes that may occur in the landscape as to which the foveal system will focus for cognition.

Binocular vision provides depth to the field of view which enables elements in the landscape to be perceived with scale. In other terms binocular vision is created by two eyes coming to a focus on a perspective view. Otherwise called stereopsis, the perceived depth of visual field can be provoked also by motion parallax. Motion parallax, is the change of perspective angle of two observations of a single object relative to each other as seen by an observer. In simple terms, it is the apparent shift of an object against the background that is caused by a change in

the observer's position. Seemingly, motion parallax is only permissible to the occupant moving through the landscape.

Evidently, humans move through real environments in an immersive experiential way. Consequently, moving images are a typical reference to the dynamics of landscapes and human perceptions. Danahy (2001) emphasises the importance of immersive environments arguing that the;

dynamic qualities of looking around, ...using one's peripheral vision, and focusing with foveal vision on objects of attention are fundamental to a person's visual experience in landscape

(Danahy, 2001,p125).

Dynamic display is a form of representation that is changing continuously, with or without intervention from the observer. In the early days of technological development of visualisation software, animations were a novelty, introduced as marketing tools to sell concept designs. Today they are increasingly becoming integral components of environmental assessment and spatial analysis.

Animations can incorporate movement of objects within a scene, movement of the camera through the scene or a combination of both.

Of recent times numerous scholars have investigated the use and efficiency of different forms of animations. Bishop and Rohrmann (2003) have conducted several experiments to validate animations as acceptable surrogates for real life experiences. The findings were inconclusive suggesting that sensual realism is a definitive objective of representational media.

In contrast, Heft & Nasar (2000) evaluated dynamic and static displays for environmental scenes to validate how readily responses correlated to in situ experiences. The results indicated that static displays do not parallel the perceptions of dynamic displays. Static representations rated much higher.

In realistic visualisations, dynamics more commonly refers to a change of viewpoint, typical of a fly through. In some circumstances temporal visual display is represented to illustrate the changes to a landscape over time, for example the movement of turbine blades. Alternatively temporal visual

dynamic display could be presented through cartographic presentation.

A critical theoretical question that arises from a review of dynamic and static displays of landscape is the extent to which photographic sampling of viewpoints is sufficient to be representative of landscape character units. Hence the validity of a photographic sample depends on the ability of the sample to capture the features and elements that are typical of the landscape context. Consequently a judgement about the proposed visual changes to a landscape should not be based on just one or two viewpoints but should account for several perspectives. Lange *et al.* (2004) in their research of traditional static versus three dimensional and four dimensional presentation found that animated sequences are by far the best form of communicating design responses.

One of the key limitations of modelling dynamic displays has been the time needed to create three dimensional models in cyber space. Constructing animations which traverse through the landscape requires three dimensions as the visual viewpoint will change the perspective. Hence, the level of detail required will increase fourfold. For landscape visualisation this is more profound. Modelling vegetation is a labour-intensive process

requiring thousands of polygonal surfaces. The degree of realism portrayed will also depend on the texture, colour and light and shade. An alternative approach which has become common in practice is to texture map four polygonal surfaces with a photograph of a tree or vegetation. This will provide a realistic visual impression of vegetation from designated perspective views.

Consequently due to wind farm developments being predominantly located in rural landscapes which are typically of regional visual scale and vegetated with scattered tree coverage, it is difficult to develop dynamic models that provide efficient credible depictions of predicted visual effects.

### 7.9 VIRTUAL ENVIRONMENTS

Even given continuing goodwill on the part of environment developers, we have very little experience to indicate how responses to virtual environments match those we might make in the real ones, so the validity of decisions developed in those settings must be suspect.

(Orland *et al* 2001, p148)

Virtual environments have been a progressive development to communicate design schemes in public consultation forums. It is increasingly becoming an integral component of large scale developments.

The origins of virtual environments came from the concept of people being located or observing a scene which would make one believe that they feel almost present in the landscape. Computer generated environments have become a common form of virtual environments, of which a series of common factors; immersion, interactivity and realism provide definition.

The degree of interactivity is also at question in virtual environments. There are two forms of interactivity, those that are sensory or body tracking and those that are object manipulation. The trade off between interactivity and realism is the dilemma we are currently faced with in developing tools for communicating landscapes.

Virtual Reality Modelling Language (VRML) is a technological development of three dimensional graphics. Using a three dimensional graphics in community consultation exercises provides legible communication media for interaction and assessment purposes. Virtual Reality (VR) is broadly defined as

a computer generated, three dimensional environment providing interactivity and immersion. Originating from aviation simulations, VR landscapes have advanced from video to various forms of technologies.

Some recent developments which have caught the eye of visualisation technicians and research projects are multi screen immersion tools such as CAVE (CAVE Automatic Virtual Environment). The CAVE is a single curved unit allowing panoramic views of the projected environments. The walls form a screen from floor to ceiling which is projected upon by panoramic views of the landscape scene at question. Multiple projectors are used in synchronised platforms from a computer with multiple output channels. A number of landscape research laboratories have the hardware capabilities to facilitate representation and perception research projects. The cost of this hardware has dropped dramatically in the early 21<sup>st</sup> century, becoming more accessible. Multiple output graphics cards have entered the hardware market providing an impetus of processing capabilities to graphic displays.

In addition, stereoscopic displays have been used in an array of community consultation research related projects. Stereoscopic display is defined by each eye receiving separate images which

are located from slightly different viewpoints. The separation of the viewpoints is relative to the distance between the human eyes and the need for the focal point to be calibrated upon each eyes retina for depth of field perception. For this to be represented the use of either a head mounted display or two different images projected onto the one screen at incremental times with control over access to process the images is required. Both processes require two separate images to be rendered limiting the refresh rate of the graphics card.

Passive stereo is provided by the occupant wearing light weight glasses which filter out the image of one eye from the other in intervals based on polarity. One lens accepts horizontal polarized light whereas the other vertical (Bishop, 2005).

Active stereo works in a similar fashion with the eyes comprehending different images at interval times controlled by the glasses which have a shutter effect synchronised with the interlaced graphics projection typically at a rate of 1/60 of a second. Various household display tools are available such as Nuvview™.

Nuvview™ is an image processor which can be plugged into a laptop or television to separate the image from DVD/ mpeg



projection into two interlaced images. Synchronised shutter glasses are provided to control the vision of the human eyes, which filters the view creating a depth of field and sense of immersion. This tool is capable of being used as a mobile unit with its minimal hardware and software requirements.

The next level of sensual VR is explained in a combination of real and virtual objects in a real environment by correct alignment, occlusion and lighting of virtual objects known as Augmented Reality (AR). Unlike VR the augmentation of real landscapes by means of a superimposition of synthetic objects shown by computer graphics in real world four dimensional scene (Azuma *et al.* 2000; Nakamae *et al.* 2001). The ability to visually animate and make changes to certain aspects of current conditions in real time has numerous strengths. Firstly it provides participants an opportunity to interact and manipulate the concept documenting opportunities and constraints. It also enables various scenarios to be assessed and experienced. These techniques are predominantly being developed in the military and medical profession, however with technological advances they will become more accessible to landscape planning applications.

Given the current limited commercial feasibility of VR tools for landscape planning purposes, we can only look with interest to the future dynamics of tools and procedures to engage community in decision making processes. However in today's current market tools such as simulated CAVE or AR are not applicable to wind farm visual impact assessment.

### **7.10 WIND FARM SIMULATIONS: GIS APPLICATIONS AND SOFTWARE**

Several software applications have been developed of recent past specifically for wind farm development applications. Based on Geographic Information System (GIS) they encompass analysis of wind velocity patterns, in association to topographic variance, this in turn is relative to potential turbine locations and feasibility of the project. The systems incorporate highly sophisticated mathematical equations to calculate the best locations for the turbines given set parameters such as development boundary, required distance between turbines, buffers around dwellings and landscape areas of conservation etc. Consequently the best case scenario for maximum energy production is based on mathematical equations.

Several software packages were sampled as part of this research project. Windpro™ (www.emd.dk) based on a modular package which consists of energy efficiency and economic feasibility modelling, environmental including visual and acoustic assessments, visualisation, and finally grid planning.

Figure 7.4 Windpro software architecture



The visualisation module of the software program provides calculation modelling of ZVI. Given the wind turbine locations and type (height design specifications), contour elevation data in digital form (.MAP or .dxf files), maps, reports and pie graphs can be illustrated to provide analysis of the likely effects.

The module Visual-Photo Montage is designated to generate artificial landscapes as a wire grid or with artificial surface textures. Equally, the visual module also generates photo realistic visualisations of a WTG project to be used in community consultation processes. By calibrating a photo with the rendered artificial landscape model, a viewpoint can be represented as a before and after scene.

Supplementary applications include the ability to animate the scene (producing GIF's), which are static viewpoints with moving turbine blades. The speed of the turbine blades can be adjusted to suit the specifications of the turbines average rotor revolution speed. In addition, three dimensional animations can be simulated in a VR model. The turbines are modelled as three dimensional objects on a surface textured digital terrain model. Trees, buildings and other obstacles are modelled as surface textures on polygon objects. This minimises the time required to render the scene, by limiting the number of polygons. This form of representation can be useful to illustrate the regional context of the proposed site and scale of development.

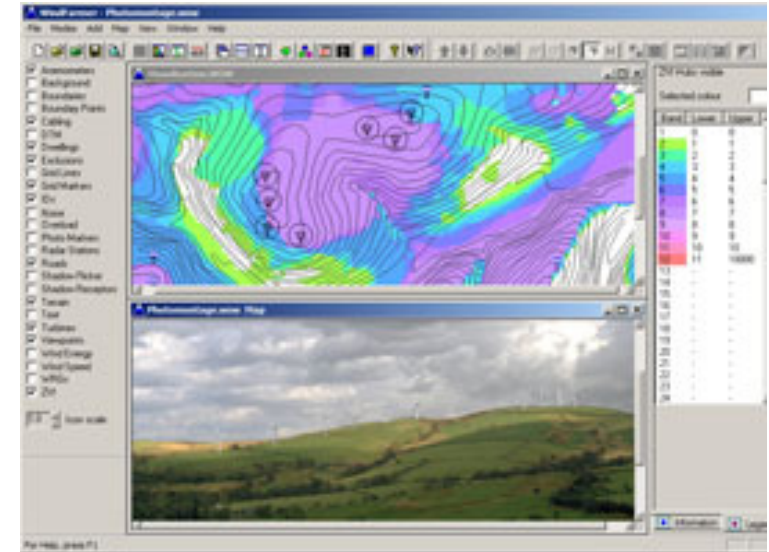
WindFarmer™ (Garrad Hassan & Partners, 2008), is a software package not too dissimilar. It combines all aspects of wind farm development inclusive of

## 7. Visual Representation Tools for Landscapes and Wind Farm Planning Assessments

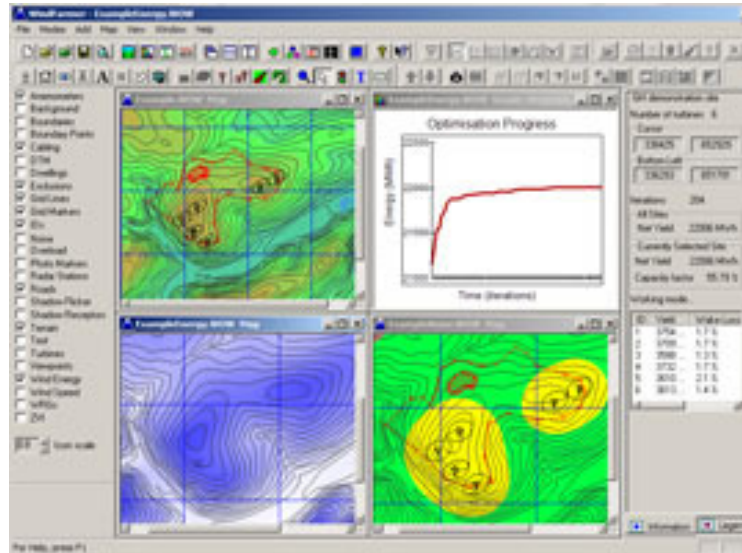
- Complete uncertainty calculations and levels of net energy yield.
- Compare turbine design parameters for turbulence effects.
- Create turbine ranking orders to predetermine the least productive turbines
- Automatic layout optimisation to optimise energy output with the least amount of environmental impact.
- Cumulative impact assessment
- High quality documentation for EIA (noise, shadow flicker, ZVI, radar and cumulative impacts)
- Visualisations both static and/or animated fly throughs and photomontages

The visualisation module within WindFarmer™ has a similar capability and methodology to WindPro™. Established in GIS, photomontages and animated sequences are produced in geographic references data. Hence, photos taken during field assessments can be superimposed onto a rendered artificial model of the landscape to represent the predicted likely views of the development proposed.

**Figure 7.5** Visualisation module interface (ZVI top- perspective montage bottom)



**Figure 7.6** Optimisation energy mapping

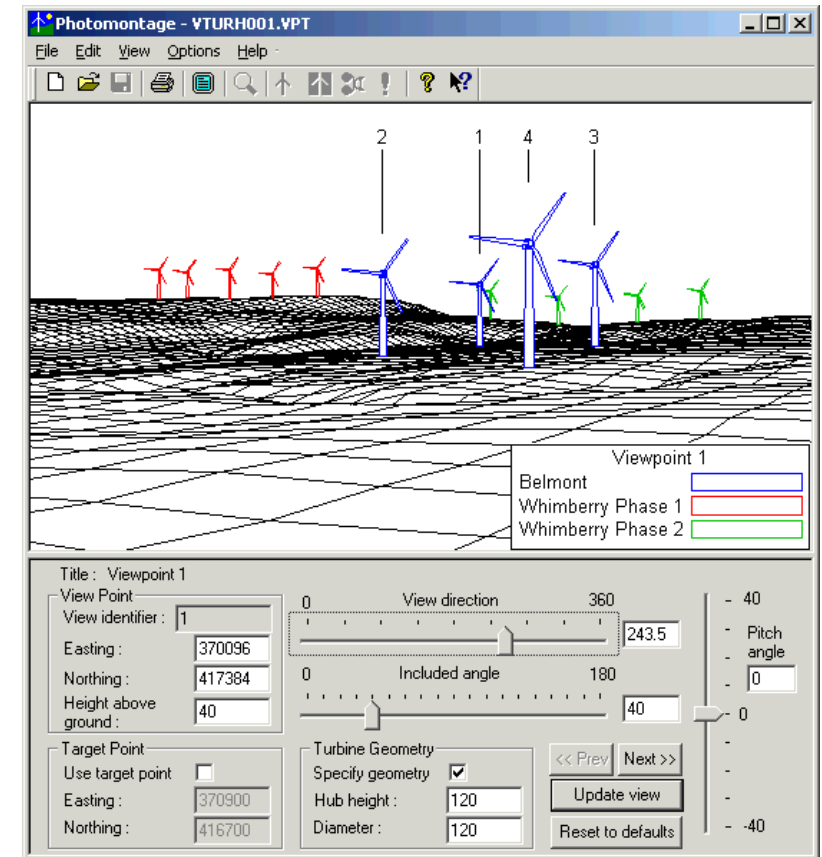


An alternative software package reviewed as part of this research was WindFarm™ ([www.resoft.co.uk](http://www.resoft.co.uk), 2007).

WindFarm™ is comparable to the previous software packages discussed, with the additional application of:

- Interaction with the turbine layout, moving turbines in the layout with reflective perspective views in an artificial model.
- Multiple wind farms in the wire frames including markers and numbering.

**Figure 7.7** Wire frame view of staged development proposal ([www.resoft.co.uk](http://www.resoft.co.uk), accessed November 2007)



### 7.11 VISUALISATION GUIDELINES

Numerous research projects have and are presently exploring the question of representation and validity (Orland, 1992; Stephen Shephard, 2001). Stephen Shephard (2005) has been proactive in developing a code of ethics in landscape visualisations.

The quickening pace of the entertainment industry through 'gaming' and animated movies promises rapid improvements in the capabilities of visualising landscapes. Shephard has focused his attention to the issue of quality, rather than on utility which is reliant on market actors such as efficiency and feasibility of manufacture and objectives of functional use.

The objectives of visualisation technology are to communicate ideas in an efficient, practical informed and defensible manner. Ethical conduct in this realm of consultation and communication is interpreted to be a conforming standard of rules which are applied as a set of principles. In order for the development of technologies to be applied to environmental and public interests, a code of ethics needs to provide validity, reliability and justification to decision making processes.

Professional preparers and presenters of realistic landscape visualisations are responsible for promoting full understanding of proposed landscape changes; providing an honest and neutral visual representation of the expected landscape, by seeking to avoid bias in responses (as compared with responses to the actual project); and demonstrating the legitimacy of the visualisation process.

(Shephard, 2005, p87)

Shephard (2005) proposed six principles for landscape visualisations:

1. Accuracy; realistic visualisations should simulate the actual or expected appearance of the landscape
2. Representativeness; visualisations should represent the range of views, conditions and time frames including the worst case scenario.
3. Visual clarity; the details and components of the visualisation should be clearly identified.
4. Interest; the visualisation should engage the identified audience, without overemphasising
5. Legitimacy
6. Access to visual information

These principles provide suggested guidance on the quality of visualisations at the pre-construction stage. Principles 1-3 relate to the issue of content validity, principle 4 refers to utility, principle 5 addresses credibility and principle 6 addresses equity or equal access for all stakeholders and the community.

To provide credibility and consistency to wind farm development EIS visualisation methodologies, a series of Best Practice Guidelines have been produced (University of Newcastle, 2002; Guidelines for Landscape and Visual Impact, 2002; Architech Animation Studios, 2007).

The University of Newcastle (2002) was engaged as consultants by the Scottish Natural Heritage to conduct research with the aim to:

- Advise on the purposes and uses of visibility maps and visualisations of wind farms, ensuring that their relevant strengths and limitations are understood;
- To advise on various methods of producing visibility maps
- To promote and encourage good practice in the production of computer generated visibility maps and visualisations;

- To ensure that the approaches, methods and techniques used in the production of visualisation tools and illustrations are technically sound and credible;

(University of Newcastle, 2002, p12)

The methodology proposed in the report elaborates on techniques of producing ZTV's. Usually one of the first steps of visual analysis, the ZTV's helps to inform the selection of the study area that will be potentially affected. In combination with a field assessment, the practitioner can review with wire line diagrams the potential effects.

The first stage is to produce a Digital Terrain Model (DTM), or tin in a GIS environment. The tin represents the ground surface as a mesh of points triangulated. It is preferable to use triangulated mesh rather than square grids as this provides more detail.

Some notable variables which are suggested to be included in the viewshed parameters are the Earth's curvature, elevation of the turbines above the ground surface (typically tip of blade). Furthermore it is recommended that the observation points (elevation above the Earth's surface is recorded as 1.8

meters (human eye level). Furthermore recommendations are that the distance zones of ZTVs are to correspond to the scale of the proposed turbines. The study area for turbines of up to 100 metres in height is recommended to be 30km.

Some limitations which are common in practice are the availability of detailed topographic data e.g. 5 meter contours. Furthermore as previously discussed ZTV do not include vegetation data and potential screening effects.

Subsequent to the guidelines produced by University of Newcastle (2002), a report was produced by Anitech Animation Studios (AAS) (2007), which reviews current planning application visual representations of wind farms with respect to camera lens requirements, viewing distances and the science of visualisation.

As impartial consultants to wind farm developments Anitech Animation Studio have been engaged by community reference groups to cross examine the production and presentation of photomontages. The report elaborates on the findings of various research projects.

The review of several planning applications found that visual representation in EIS planning reports is typically wide panoramic strips with a field of view in excess of 90 degrees (equivalent to a fish eye lens). This diminishes the visual scale and distance of the turbines in the landscape scene. The standard photomontage refers to a 50mm lens which has been accepted in many circles as representative of the human eye. A 50mm lens illustrates a landscape with a 40° horizontal field of view. A common fault of visual representation is to stitch together several 50mm lens photographs to depict the actual human horizontal field of view of 120°. Fundamentally this changes the representation lens to a fish eye reducing the scale of objects.

In planning development applications it is essential to provide valid information to the panel and public such that a realistic, scaled representation of the proposed development is assessed. The lens requirement is critical to this procedure. To illustrate a landscape with no scaled reference points such as buildings, houses, cars, the observer must be able to reference scale to distance, which can be difficult for wind turbines which are a scale not observed before for many people.

The notion of a viewing distance is critical to this discussion as it recommends a perspective focal distance at which the photomontage must be viewed. Some general practice has remarked that single frame 70-80mm lens photos printed on full size A3 paper provides the viewer with a realistic impression of scale and distance when viewed at normal reading distance (Benson, 2005). Scottish Natural Heritage supports this claim identifying 'a telephoto lens of around 80mm as more truly representative' (SNH, 2001). AAS believe that the flattening effect of photography onto a 2-dimensional plane can be compensated by slightly increasing the focal length of the camera lens. Through field investigations AAS found that a 70mm lens is more representative.

If we look through a single lens reflex camera fitted with a 70mm telephoto lens and split screen it with a real landscape, you will find that images are identical in terms of vertical scale.

(AAS, 2007, p5)

A key consideration of this theory is that the printed medium and presentation format is critical to the validity of perceptions. For example a 90° wide angle photo printed on A3 paper will

represent a different sense of scale to a 50mm single frame printed on the same paper. Figure 7.8 illustrates the differences.



**Figure 7.8** Differing representational formats. Source (AAS, 2007, p6)

NOTE:  
This figure is included on page 313  
of the print copy of the thesis held in  
the University of Adelaide Library.

**Figure 7.9** Differing representational formats. Source (AAS, 2007, p7)

NOTE:  
This figure is included on page 314  
of the print copy of the thesis held in  
the University of Adelaide Library.

Typically the developer or consultant will produce visualisations with a 50mm lens. Several photographs are taken with the 50mm lens and stitched together to represent 90°-120° horizontal. Paradoxically this is not truly representative of a 50mm lens photo as the image is shrunk down to a much smaller frame so that it incorporates the wider angle.

It has been discussed by University Newcastle (2002 and supported by Anitech (2007) that the viewing distance of the image is to replicate the area of visual focus which is relative to a A3 single frame 70mm lens photo with periphery photos stitched to the sides and held on a curve to replicate the curvature of the earth.

**Figure 7.10** Representational variance (Source: AAS, 2007 ,p8)

**NOTE:**  
This figure is included on page 315  
of the print copy of the thesis held in  
the University of Adelaide Library.

If wide angle images are to be used in the public forum then a stringent set of guidelines needs to be set in place so that a critical viewing distance is administered. It has been recommended that planning applications should make clear notice on image pages that 'this image can only be accurately assessed from the correct viewing distance'. The critical viewing distance has been stated to be approximately 25cm. Regulating the viewing distance is difficult to administer, as this is as much a problem of education as it is advancing techniques of presentation.

Ultimately there is no way that a camera can truly replicate what we see. We view stereoscopically in three dimensions, whereas a photograph is monoscopic in nature and devoid of distance and though there are information (depth of field). Furthermore 'our perception of size is more related to the actual size of an object in the real world rather than its size on our retinal image (a phenomenon known as size constancy)' (AAS, 2007, p2).

In summary the arguments posed by AAS (2007) and University of Newcastle (2002), have provided insight to the science of visualisation and validity of representation specifically in public forums.

### 7.12 CONCLUSION

Visualisations of landscape for planning and design professions have been used as a tool for communicating ideas, processes and inventory in a legible and efficient manner.

The primary sense of human information is visual, consequently visualisations of development proposals for either urban built form or predictive changes to landscape natural systems over time are vital tools for community engagement, research analysis and design development.

Visual tools have evolved over the years with the rapid development of computer technology specifically in gaming technology providing innovative developments from abstract representations to realistic immersive environments.

The transaction and depiction of landscapes through various means of direct and indirect transactions, implies a series of perceptive responses which ultimately will differ in meaning. To categorise or portray landscape compositions is to value the landscape in its entirety, with an understanding of how

people respond, reflect and comprehend representations of landscapes as opposed to real life experiences.

Site specific design and planning is fundamental to development applications and assessment processes. Spatial analysis is one form of geographic information which has been used in planning and design to provide contextual responses. Geographic Information Systems (GIS) have become integral to research and environmental impact assessments. Using fundamentals of McHarg's theory on opportunity and constraint landscape site analysis, GIS software provides graphical representations of analytical questions imposed on particular landscapes. For example wind farms occupy space on a landscape which may have a range of physical and cultural attributes which can be classified into environmental, social and economic characteristics. Data can be stored manipulated and superimposed in various formats to assess possible areas of conflict and those which possess opportunities for potential development.

Wind farm developments have used various visualization techniques with the intention to evaluate and site plan the development. In addition simulated images of the proposed development are used in community consultation and as

publicity for renewable energy. Cartographic representations produced in GIS have been used to plan wind farms with several specific wind farm development software packages developed to provide wind forecasting, feasibility and turbine layout and planning regulations in accordance to land titles and dwelling buffer zones.

Photomontages have been a common form of visualization, used primarily for community consultation and EIS visual assessment. As discussed in previous sections of this chapter montages have been developed to represent a wide angle of view (90°-120°) referring to the human field of view. The validity of the images has been debated in accordance to required photographic lens, viewing distance of the image and a series of guidelines considered.

In order for visual assessment methodologies to be credible and justified in the court of law, there is a requirement for visualisations to be more transparent to the community in their production techniques and interactivity which gives the observer greater control over the environment being viewed. The mode of presentation of any visualisation is clearly very important. The role of immersive display technology is still in its infancy requiring further research. Looking into the future,

immersive technologies which recreate the correct image size and field of view in a dynamic geographically referenced representation of the real world will provide the foundations for an integrative real time assessment tool.

## **PART THREE: CASE STUDY**

## 8 INTEGRATION OF QUANTITATIVE AND QUALITATIVE VISUAL ASSESSMENT METHODS

### 8.1 INTRODUCTION

Visual assessment for wind farms has historically been conducted as a subjective assessment on the basis of individual professional consultant judgments devoid of empirical quantification of visual effect. Methodologies have been developed based on the Visual Management System (VMS). This method was developed in the United Kingdom by Crowe (1966), and in the United States by Litton (1968) primarily for the United States Forest Service (1974) and the United States Bureau of Land Management (1980).

Although there is large body of methods and guidelines relating to landscape assessment, none of these assessment methodologies have yet been universally adopted, resulting in confusion and uncertainty about best practice in the community.

[http://www.auswind.org/auswea/downloads/Mediareleases/050616landscape\\_values.pdf](http://www.auswind.org/auswea/downloads/Mediareleases/050616landscape_values.pdf), Accessed 1/09/06.

This chapter outlines a new approach to assessing site specific wind farm proposals utilizing a combination of quantified measurement tools to define visual change in relation to physiology (what can be seen) and psychological (what can be perceived).

The principal objective of the method described below is to assess the visual effect in an objective, reliable, replicable, and measurable manner for comparative analysis of alternative regional wind farm development proposals and cumulative effects of numerous proposals, and be justifiable in a court of law.

The method is established from a combination of human perception and physiological human fields of view, providing a foundation to quantify the visual effects with respect to horizontal, vertical, landscape absorption, distance, and landscape sensitivity.

Sensitivity levels of landscape visual character are assessed as a parallel process based on surveying the general public, and statistically validating a coefficient for the degree of perceived visual change. Cultural associations and symbolic references to particular landscapes will not be directly incorporated into this



methodology as this study does not assess sociological landscape assessment for inherent culturally intuitive properties.

Using existing wind farms located at Lake Bonney (South East of South Australia) as a case study, this chapter provides reference to the suggested process and means of data capture. Existing wind farms were used in preference to proposed developments as it mitigated confidentiality agreements and implications on the accessibility of information.

The methodology will provide a quantified assessment of visual change within the landscape utilizing Global Positioning Systems (GPS), Geographic Information Systems (GIS), Zones of Theoretical Visibility (ZTV) and digitized calculations of landscape absorption screening using photomontages. The calculation of visual change will be superimposed with a weighted index of landscape sensitivity, assessed by surveying the general public's perception values of scenic beauty relative to before and after scenes of the development.

The foundations of this methodology are guided by Planning SA (2002) 'Advisory Notice Planning- Draft for Consultation 21. Wind Farms'.

**Figure 8.1** Planning SA (2002) Wind Farm suggested assessment process

**NOTE:**  
This figure is included on page 320 of the print copy of the thesis held in the University of Adelaide Library.

The suggested 'Advisory Notice' (2002) guideline is separated into four stages which presents a structured approach to conduct the assessment. Each stage of the process can be discussed in more detail describing techniques of data capture, analysis, illustration, recommendations and documentation.

The development of the model outlined below is attributed to a process of trial, refinement and technological and theoretical innovation. Based on the frameworks produced by Planning SA (2002) and Planisphere (2005), the model seeks to append quantified landscape sensitivity values and visibility criteria to a site specific development proposal. Hence the methodology is practical for development assessment given strategic regional planning considerations of cultural significant overlays and values of landscape. In other words the objectives of the methodology are to determine the visual effect of a site specific development and not to interpret suitability criteria of wind farms and landscape character zones which would require an interpretation and classification of visual character zones and surveyed responses of wind farm developments in accordance to project design variables such as scale, number of turbines, spacing etc.

The method proposed for this dissertation also aspires to accommodate an iterative procedure, providing empirical design advice

for site specific project development based on the findings of landscape sensitivity and visibility assessment.

### 8.2 METHODOLOGY

This section sets out the methodology used to assess the visual effects of an existing Wind Farm located at Lake Bonney in the South-East of South Australia. The assessment of visual effects was undertaken as a five staged process. The process is inclusive of desk top studies describing the project and related planning literature, definition of project visibility appearance and relationship to landscape context, field assessments and a detailed systematic assessment using the Grimke Matrix, internet survey sample of scenic beauty assessment and GIS mapping. The following tables document the stages of the process.

#### Stage 1 Preliminary Landscape Assessment

- 1a Desk top studies- review literature/ cartographic maps/ define scope of the proposed project.
- 1b Produce GIS based mapping, identifying distance zones of landscape representing buffer zones for local (1km circumference), sub-regional (1-5km) and regional (greater

- than 5km). Overlay regional landscape area with a grid cell matrix with centroids<sup>1</sup> in publicly accessible locations to objectively identify viewpoints for field assessment. Overlay Zone of Visual Influence (ZVI) to illustrate which viewpoints will have a visual effect and eliminate those that don't.
- 1c Landscape Character Assessment- Field study. Assessment of existing land use, topographic relief, vegetation pattern, built form/ infrastructure and significant cultural overlays.
  - 1d Identification of potential sensitive viewpoints and landscape character areas.
  - 1e Consultation with council and developer to clarify viewpoints for detailed assessment.
  - 1f Photographic illustrated report locating and classifying landscape character areas of the region and potential viewpoints of high amenity value.

<sup>1</sup> Centroids are the centre points of a grid cell which have a specific geographic coordinate. The grid cells are randomly placed as an overlay of the landscape regional zones relating to (regional 8km cells, sub-regional 4km and local 2km cells).

**Stage 2 Visualisation- montage production**

- 2a Take photos from identified viewpoints during the site visit. (Photos represent 120° horizontal field of view)
- 2b Construct computer simulated static photomontages using photos for each viewpoint. In addition construct animated wind turbine visualizations for each viewpoint to be used in an internet survey assessment to assess the effects rotational turbine dynamics as opposed to static representations.

**Stage 3 Detailed Visual Assessment**

Data collection and statistical analysis from identified viewpoints. Two separate evaluations, firstly the Grimke Matrix and secondly psychophysical analysis of people's perceptions from identified viewpoints.

**Table 8.1**

<b>Formal Aesthetic – GrimKe Matrix</b>	<b>Psychophysical-perceptions</b>
Field assessment- review montages	Internet Survey< 300 people
Vertical visual effect	Images rated for scenic beauty 1-10

## 8. Integration of Quantitative and Qualitative Visual Assessment Methods

Horizontal visual effect	-with turbines versus without
Landscape absorption capacity	-dynamic versus static
Distance	

### Stage 4 Quantified Visual Effect

4a GIS mapping of the visual effect

### Stage 5 Conclusions- design recommendations

5a Review of analysis. Possible design recommendations to reduce the visual effect

5b Conclusions

## 8.3 STAGE ONE: PRELIMINARY LANDSCAPE ASSESSMENT

The subject development is located predominantly within the Wattle Range Council and partly within the District Council of Grant in South-East South Australia. The development comprises of 123 Wind Turbine Generator (WTG) which have been installed in three separate development applications. Stage one, constructed in 2003 comprising of 46 WTG. Stage 2 to the south comprising of 54 WTG (not completed) and an unrelated development known as The Canunda Wind Farm, located between the two stages comprising

of 23 WTG (constructed). This dissertation will only take into account the developments which have been constructed as of the end of 2007, which accounts for 69 wind turbines.

### 8.3.1 Project Description

The wind farm developments are located on the Woakwine Range in two lineal arrays. The turbines used in the developments vary. Stage one consists of 46 Vestas (V66) three bladed turbines with a specification of;

- 67 metre hub height
- 100 metre tip of blade
- 33 metre rotational diameter.

The Canunda Wind Farm consists of 23, three bladed Vestas turbines (V90-1.8MW). The specification of the wind turbine is;

- Hub height of 80 metres
- Rotor diameter 90 metres
- Rotational speed of 9 to 15 revolutions per minute
- Base diameter of tower is 4.5 metres tapering to 2.5 metres at the top.

Other components of the developments include;

- Local site leveling for the construction of towers.

- A small built form structure with switch board and transformers, and control communications equipment.
- Underground cabling of electrical wiring connecting each tower and a 11 kv transmission line that passes through or along the boundary frontage of the properties.
- Guy masts that accommodate meteorological monitoring equipment. The guy masts have a height of 70 metres.

### **Development Application Process**

The wind farm along the Woakwine Range comprises of three separate staged developments. The first stage was proposed by Paul Hutchinson who was granted development approval from the Wattle Range Council (DA 894/088/99 (88/99)) for the development of 31 turbines. In subsequent planning applications a further 15 turbines were granted development approval. Hutchinson entered into an agreement with Babcock and Brown Wind Power Pty Ltd to facilitate establishment of the development. The subsequent applications revised the turbine specifications by raising them to 67 metres with a rotor blade swept path of 66 metres, equating to a maximum height of 100 metres to tip of blade. Associated infrastructure such as an 11kv transmission line, service road tracks, substation, maintenance work shop and switch room and wind monitoring guy masts were also granted development approval.

Supplementary to this development is a 23 turbine development (constructed in 2005) known as Canunda Wind Farm (formerly Lake Bonney Central Wind Farm). This development is located to the south of the stage 1 development.

A future stage was developed by Babcock and Brown consisting of a further 53 wind turbines (80m hub height, 120m tip of blade). This development extension has been proposed to be operational by the middle to late 2008. This dissertation will only assess the turbines installed prior to 2008 which does not include the stage 2 development. Hence the total number of turbines assessed is 69.

### **8.3.2 Landscape Character**

The wind farm developments are located approximately 20 kilometres north-west of Mount Gambier within the Limestone Coast region of South Australia. The development sites are located on two local ridgelines (known as the Woakwine Range) elevated approximately 20 to 40 metres above sea level (ASL) with peaks of approximately 50 metres. The ridgelines are orientated north-south parallel to Lake Bonney and the coast line. This provides optimal unobstructed access to prevailing south-westerly winds.

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The Woakwine Range is approximately 7 kilometres from the Southern Ocean adjacent to the east of Lake Bonney. The Lake is approximately 20 kilometres in length and over 4 kilometres in width. The Woakwine Range forms a visual and physical barrier between Millicent, Tantanoola and other small settlements located along the Princes Highway. The ridge lines upon which the wind farm is located form part of the Woakwine Range geological system, extending for over 20km in a north-northwest to south-southeasterly direction.

Millicent is a major rural settlement at a distance of approximately 6km to the closest turbine. Millicent represents a rural community with a population of 4771 (Census, 2006) which is associated predominantly to support the paper mill and timber/ forest industry located to the south and east of the town centre. The main street of Millicent is orientated in a north-south direction associated to the Princes Highway. Views are internalized to the small scale shopping and commercial precinct. Only from the western fringe of suburban areas of Millicent can the development be seen. Buildings and infrastructure associated to urban developments along the Princes Highway lineal corridor create internal views and provide reference to human modification. There is some existing large scale vertical infrastructure such as the paper mill and 132kv electricity transmission line, power station; TV telecommunications

tower atop of Mount Burr and radio mast at The Bluff. In addition there is a railway corridor aligned adjacent to the Princes Highway running between Millicent and Mount Gambier which seems to be decommissioned.

**Figure 8.2** Views of paper mill



Scattered throughout the region randomly dispersed dwellings, sheds and machinery which reflect a heavily grazed and human modified landscape. Most of the dwellings within the agricultural arable/ pastoral landscape are surrounded by trees and vegetation with some defined cadastral shelter belt planting of *Pinus*, *Callitris* and *Eucalyptus* species.

The rural centre of Tantanoola, located approximately 5km to the east of the wind farms, is characterised as a small rural community with a main street comprising of a general store and some other small commercial services. Tantanoola is reknown for its caves which are located approximately 4km to the south east within the confines of a pine plantation. The wind farm developments have no visual effects from the caves.

### **Regional landscape context (5-30km)**

The landscape character is defined to the east by the Burr Range, Tantanoola Forest and Mount Burr Forest. The Pine plantation located atop of Mount Burr Range extends for a visual extent of over 25km in a northwest to southeasterly direction providing a dense vertical landscape character. The major access traffic route through the forestry is along Plunket Terrace towards Mount Muirhead. Mount Muirhead represents a mesa form denude of vegetation. This forms an identifiable landmark due to the change in texture, colouration and landform with regards to the adjacent vegetation. Located directly adjacent to the south of Mount Muirhead is a lookout platform which has elevated panoramic views towards Lake Bonney and the coastline beyond. There are glimpsed views of the wind farm from this visual observation point.

The distance and atmospheric conditions limit the effect of scale and visual intrusion to the coastline beyond.

**Figure 8.3** Views towards site from Mount Burr



The Mount Burr Range is elevated above German Flat to an altitude greater than 200 metres. There are various road networks within the forestry plantations. Views from within the plantation are contained in sections by the dense canopy structures. Views are permitted towards the wind farm development and paper mill from localized sections where the plantation has been felled in large blocks. Consequently the visual experience traveling through the

## 8. Integration of Quantitative and Qualitative Visual Assessment Methods

regional landscape is likely to change over time with consideration of the felling and plantation schedule.

**Figure 8.4** Views of paper mill from regional area



The presence of the paper mill furnace stacks provides existing vertical scaled infrastructure. The dynamics of the smoke generated from the stack can be seen from great distances pending on atmospheric conditions. The close proximity of the paper mill to the Princes Highway dominates the visual character of the landscape to an industrial / urban context when traversing south towards Mount Gambier. The buildings associated to the paper mill

are also of a scale which dominates the visual field. Furthermore the presence of a television communication tower at Mount Burr, a radio mast at The Bluff and a 132kv transmission line adjacent to the Princes Highway corridor, all provide existing vertical features.

To the south of the development the forestry plantation around Tommy Dodd Flat, Pig Face Flat, Whawbe Flat and Long Gully creates a dense clustering of vegetation which limits distant views towards the north. The ordered structure of the grid plantation provides a sense of human modification which amplifies the agricultural and forestation land use that occurs within this character unit. This area has 4 wheel drive vehicular access to numerous small camping areas and to the Cape Banks Lighthouse

There is no visual effect created from rural communities further south of the plantation namely Blackfellows Caves, Pelican Point or Carpenter Rocks. These areas have views directed towards the south in and around localized fishing village settlements and small bays.

Directly adjacent to Carpenter Rocks to the north is Game Reserve and Bucks Lake which represent a coastal reserve with dense vegetation coverage and underlying dune system. Views within this area are contained by the vegetation.



**Figure 8.5** Views towards site from Carpenter Rocks



Only from Bucks Bay lookout, located adjacent to the Cape Banks Lighthouse, can the wind farm be visible. The elevated aspects of this observation point provide a narrow field of view between the dense coastal vegetation. The views from this observation point to the north and south along the coastline are dramatic, with views of waves crashing against the limestone headlands.

#### **Sub-regional landscape context (1-5km)**

To the west of the development is Lake Bonney which is a large water body of an average width of approximately 4km and length of 23km. To the west of the Lake is a dunal system and the Canunda National Park.

Canunda National Park is located 5km from the western boundary of the wind farm developments. The National Park represents a protected area of environmental sensitivity. Access to the Park is from the north via the Canunda Causeway. Canunda National Park provides four wheel drive access to recreational areas along the north western shores of Lake Bonney and to the south through Carpenter Rocks.

To the eastern side of the Woakwine Range is a relatively flat landscape used primarily for grazing. This landscape character zone extends for a distance of 12-15 km, with the main agricultural activities of sheep and cattle grazing and various crops evident.

Within the sub-regional location of the development there is an intricate network of roads which link the settlements and various scattered dwellings within the Lake Bonney area. The principal sealed roads within the area are Poonada Road and the Tantanoola-Kongorong Road and Canunda Frontage Road, the

remaining roads are unsealed. The major traffic routes being along the Canunda Frontage Road, parallel to the east of the Woakwine Range, Hookings Road and the southern stretch of Poonada Road.

The site and regional area is not a protected area of cultural or environmental significance at a national, regional or local level. Specifically there is no threat to any habitat value. However, the amenity value of views from the western side of Millicent and the western side of the Woakwine Range in and around Lake Bonney have been affected by potentially adverse visual effects. The question as to how much the wind farm development has influenced the landscape value is to be determined by qualitative and quantitative methods.

### **Local Landscape Context (0-1km)**

The Woakwine Range is an elevated landform consisting of two defined ridgelines that extend for over 30km dissecting the landscape character of Millicent, Tantanoola Paper Mill and the agricultural/ *Pinus* forestry land to the east from the agricultural coastal landscape of Lake Bonney to the west.

The two ridgelines have a pronounced elevation above the lower lying valley floor of German Flat to the east and Lake Bonney to the west. The ridgelines have a uniform agricultural grazed visual

character. Vegetation is limited to cadastral and shelter belt planting of *Callitris spp* with some remnant sporadic copse of *Eucalyptus spp* planting within field boundaries.

The ridgelines have an underlying complexity to the topography with more defined localized depressions forming wetland swamps and punctuated peaks such as Mount Elephant being slightly more pronounced land forms.

The two ridgelines are approximately 1km apart which varies towards the south as they gradually intertwine. The valley in between the ridges forms a lower lying basin of grazing landscape and small pockets of storm water detention swamp.

The land use of the development site still maintains its function of grazing around the turbines.

To the south of the development, towards Sugarloaf Hill, is a remnant stand of native vegetation which provides visual screening towards the north. Forestry to the west and south east of the native vegetation increases visual screening and defines the extent of the pastoral visual character of the development site from the forestry and coastal townships to the southwest.

To the west is Lake Bonney which forms a dominant visual element consuming the foreground to mid-ground field of view. The dune system rises approximately 40m above sea level, restricting any visual connection between Lake Bonney and the Southern Ocean. Lake Bonney is currently closed from any recreational activities due to the water being contaminated. For many years pollutants from the nearby Kimberly Clark paper mill were discharged into Lake Bonney. Recent environmental laws have mitigated this from occurring, gradually ameliorating the Lake's chemical imbalance.

**8.3.3 GIS Mapping**

As mentioned previously, digitization of data supports replication, efficiency and evaluation of numerous datasets holistically. Consequently the first stage of the process for collating, and production of baseline information was the collection of available digital information.

Geographically referenced information was sourced from Governmental departments with authorization to utilize the information for research purposes.

Digital geographic information consists of both raster and vector data. Compatible software files are required for insertion to a GIS

software package. The common file exchange to GIS software is outlined in the following table.

**Table 8.2** GIS file compatibility

<b>RASTER</b>	
ECW	Enhanced Compressed Wavelet
Geotiff	Tiff with metadata
IMG	Image file format
Jpeg2000	Open source raster
ESRI grid	Binary raster format used by ESRI
<b>VECTOR</b>	
Dxf	Contour elevation AUTOCAD compatible
Shapefile	ESRI interchange in SHP, SHX and DBF files
Map Info TAB Format	Mapinfo interchange using TAB, DAT, ID and MAP files

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Geographically referenced aerial photography is used to help locate density of vegetation coverage and land use patterning and provide contextual referencing to the sites location and scale. If aerial photography is not available it is still possible to digitize a scaled cartographic map and geo-reference it to coordinates using reference points. Typically in South Australia and Victoria, the projected coordinate system is WGS 1984.

For the case study at Lake Bonney an aerial photograph was not available for the site so a digitized copy of the 1:50,000 topographic series of South Australia topographic map was used.

The vector layers are point, line or polygon shapes, which identify the topography, landscape elements, inventory of services and land use zones to name a few. The data base available for the assessment of Lake Bonney was inclusive of:

- Contours
- Native vegetation
- Quarries
- Built up Areas
- Water bodies
- Cadastral boundaries
- Roads

- Coastline
- Turbine locations

A 30km buffer of the development was selected for the extent of required information. The 30km distance refers to the Thomas Sinclair matrix (Sinclair, 2001) as the extent of visual effect of the development. This also limits the size of the data for computing purposes.

Maps were produced to illustrate the landscape context and define the location, scale and areas of concern by means of potential conflicting land use or potential sensitivity to visual effects.

Using the turbine locations, buffer zones were created in GIS to document the local (<1km), sub-regional (1-5km) and regional (5-30km). This provided a framework to classify landscape character areas in accordance with distance which is proportionate to the degree of visual effect. This provided the foundations for landscape character zone mapping and photographic surveying of the site (Figures 8.5 & 8.6).

Using the 10m contour data a three dimensional terrain model was produced of the regional landscape. This model provides a graphic representation of the landforms, illustrating the geomorphology of

the landscape with undulating ridges, valleys, depressions and any notable landform features. It also gives an indication of the natural systems of the landscape illustrating drainage swales and the historical evolution of the landscape through erosion and development patterning (Figure 8.7).

Based on the digital terrain model (DTM) a Zone of Theoretical Visual Influence (ZTVI) map was produced. Given geographic positions of the turbines, elevation data as well as the height of the turbines, the development can be modeled in three dimensions and simulated. Using GIS software algorithmic calculations produce triangulated surface areas classifying where the wind farm can be seen and the number of turbines. The elevation to the tip of the turbine blades is factored into the equation as well as the approximate observation height of 1.7m above the ground surface (Figure 8.8 & 8.9).

As previously discussed in preceding chapters a ZTVI map has limitations in evaluating the degree of visual effect due to vegetation not being factored into the model. Furthermore, 10m contour data is not detailed enough to provide trustworthy information, as a consequence a site assessment is required to confirm the potential degree of visibility.

To provide an efficient method of objectively identifying viewpoints within the landscape to be reviewed during the site assessment a subsequent map was developed based on the ZTVI. A grid of cells was arbitrarily placed over the 30km data base. The cells were dimensioned as 8km x 8km (43 cells) and then subdivided for the sub regional area to 4km by 4km (16 cells) and subdivided again to 2km by 2km for the local landscape classified area 11 cells, (Figure 8.10).

For each of the cells a centroid was placed as a point source with geographic coordinates. This was then superimposed on the ZTVI indicating which grid cells will incur a potential visual effect. This provided a derivation of viewpoints for field assessment (Figure 8.11).

The centroids identified for field assessment were relocated to the nearest publicly accessible location and coordinates downloaded onto a hand held Global Positioning System (GPS) with an identification number.

Figure 8.5

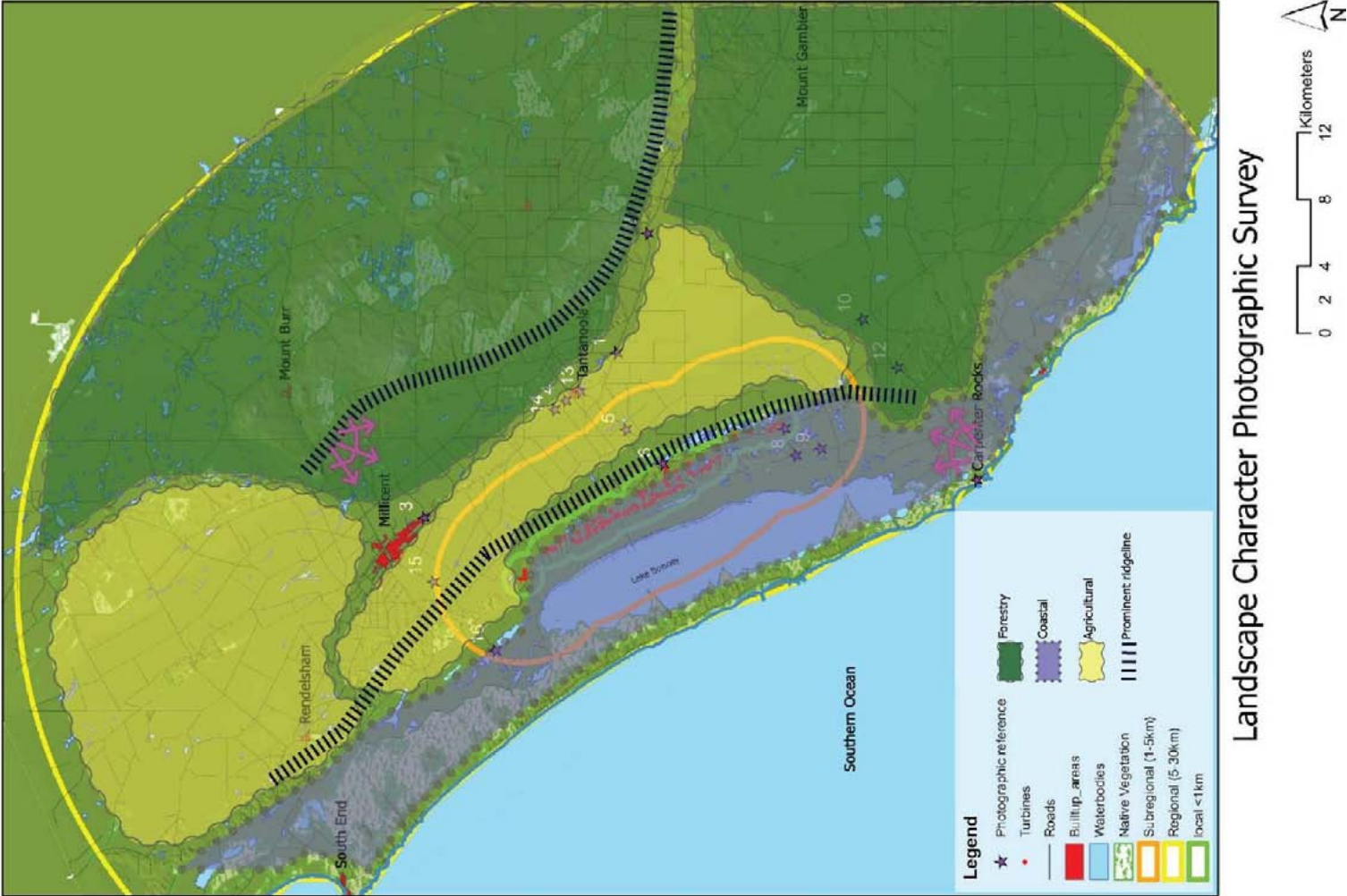


Figure 8.6





Figure 8.7

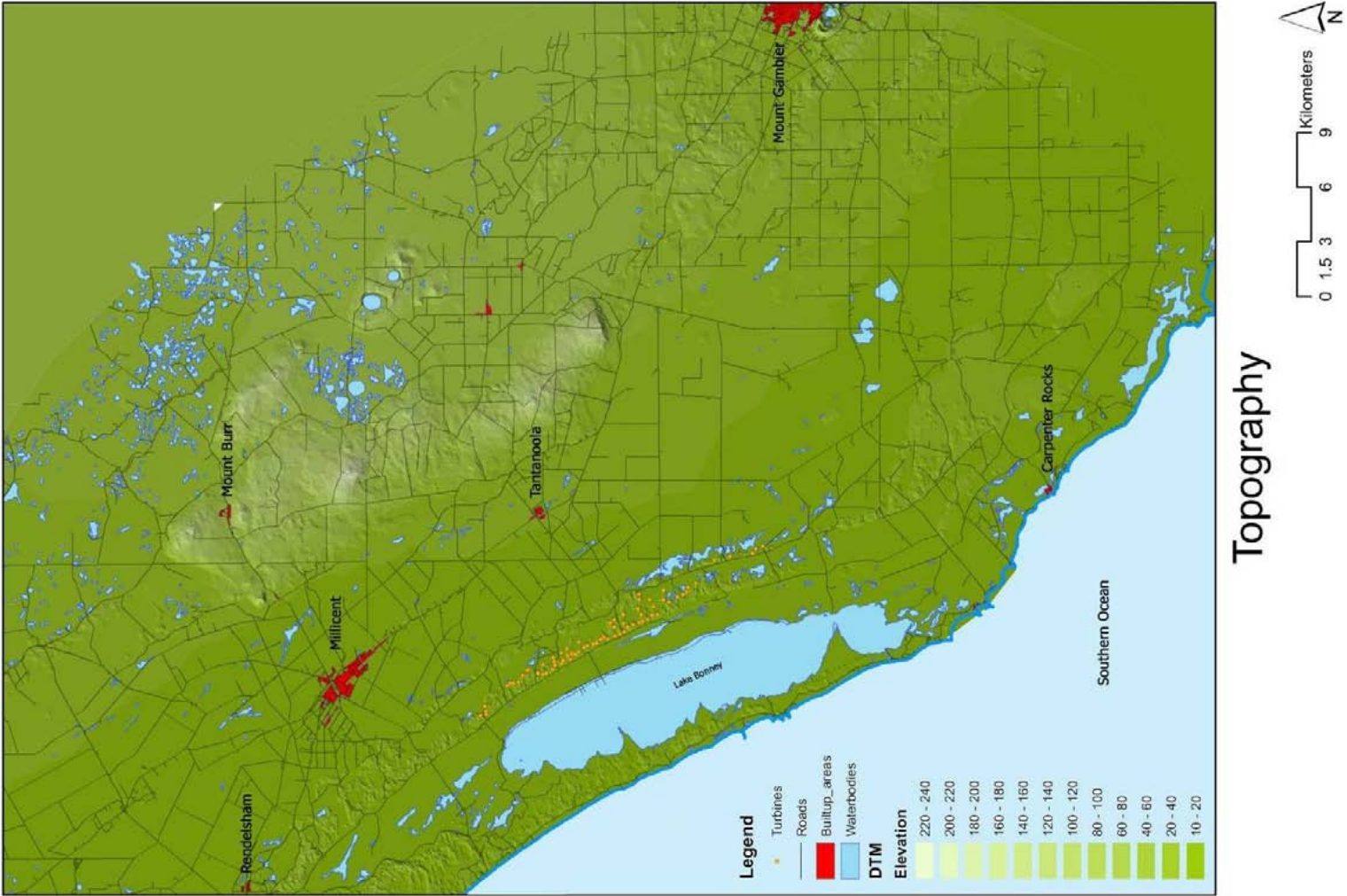




Figure 8.8

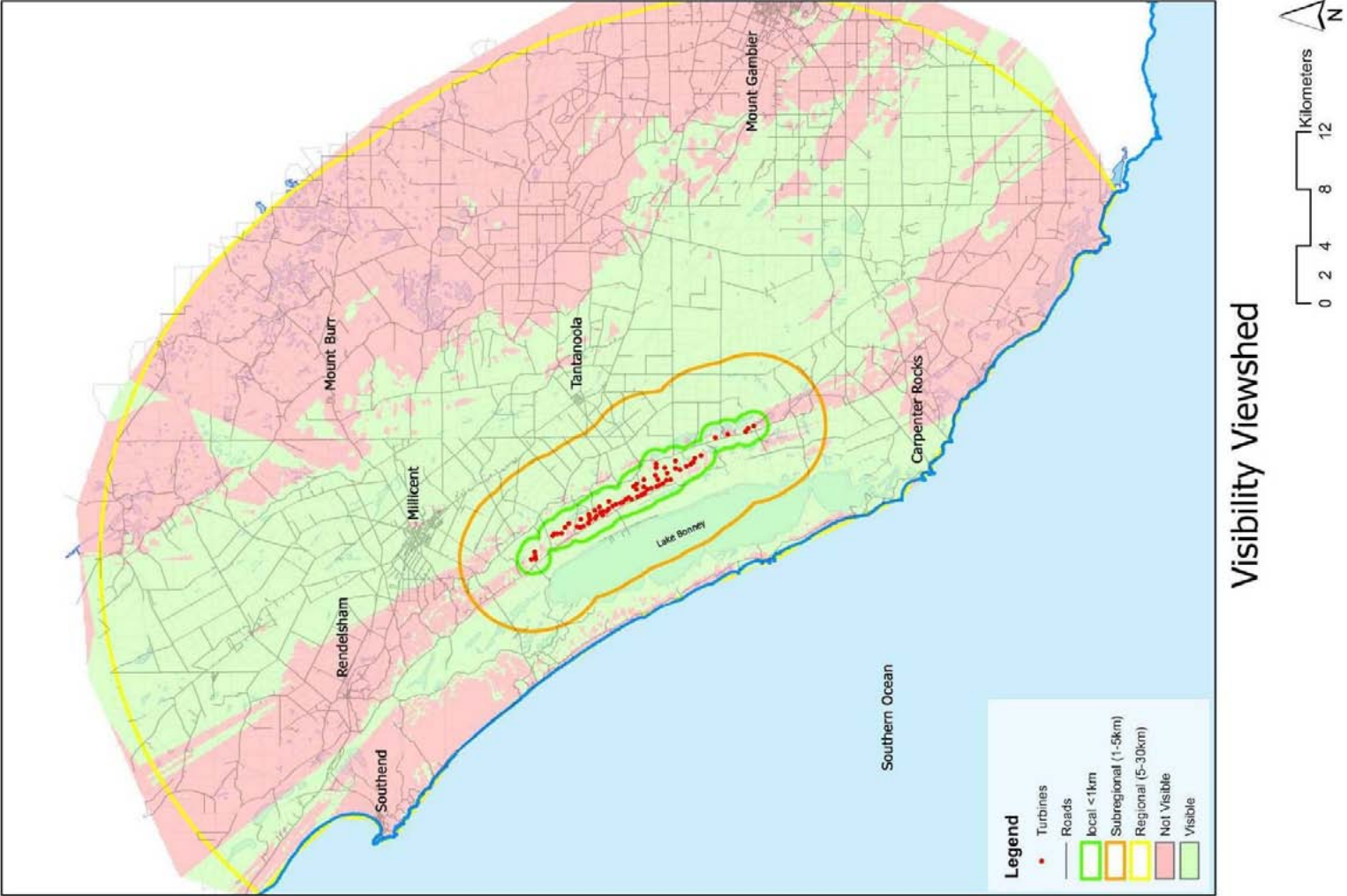


Figure 8.9

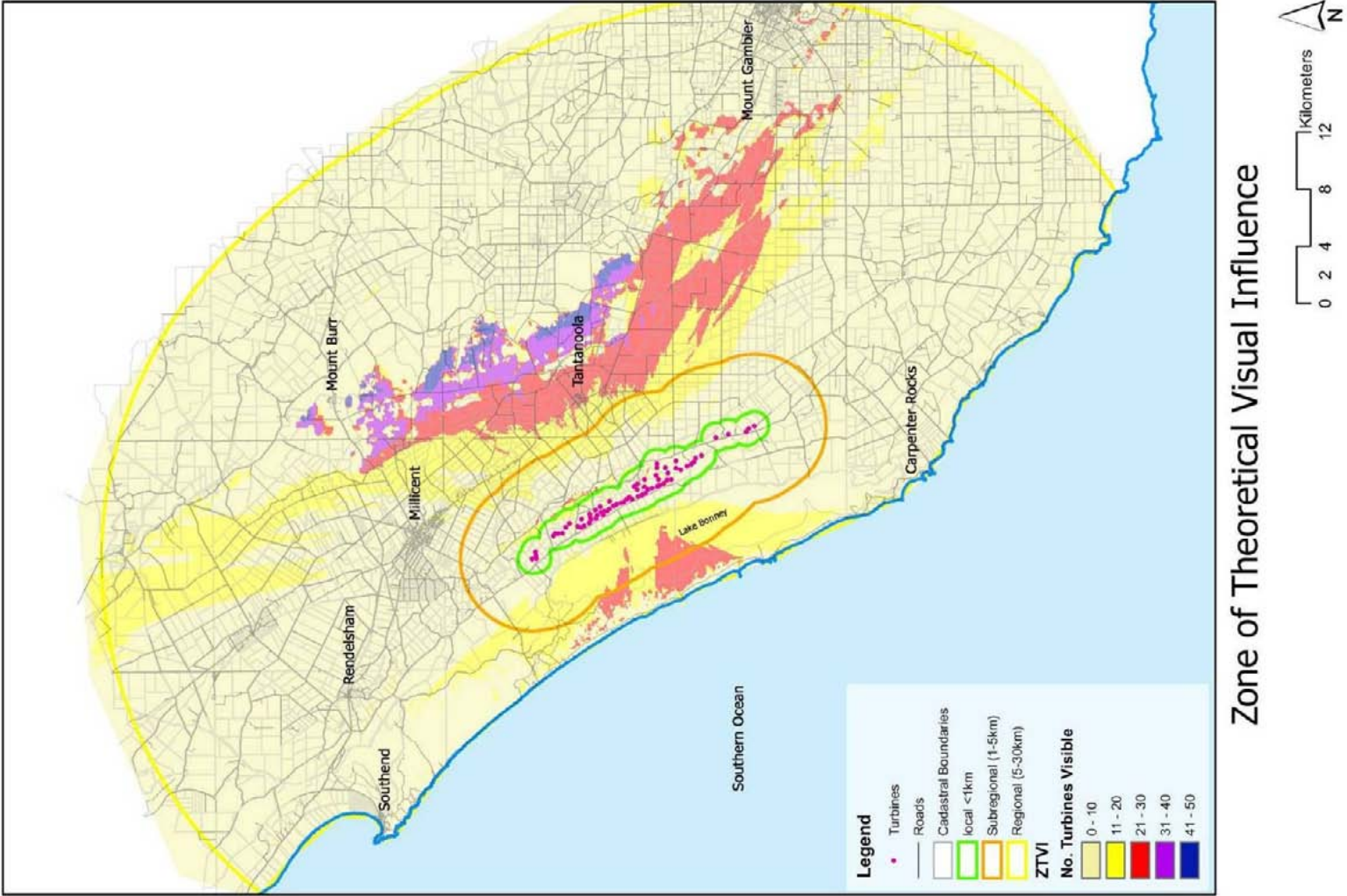


Figure 8.10

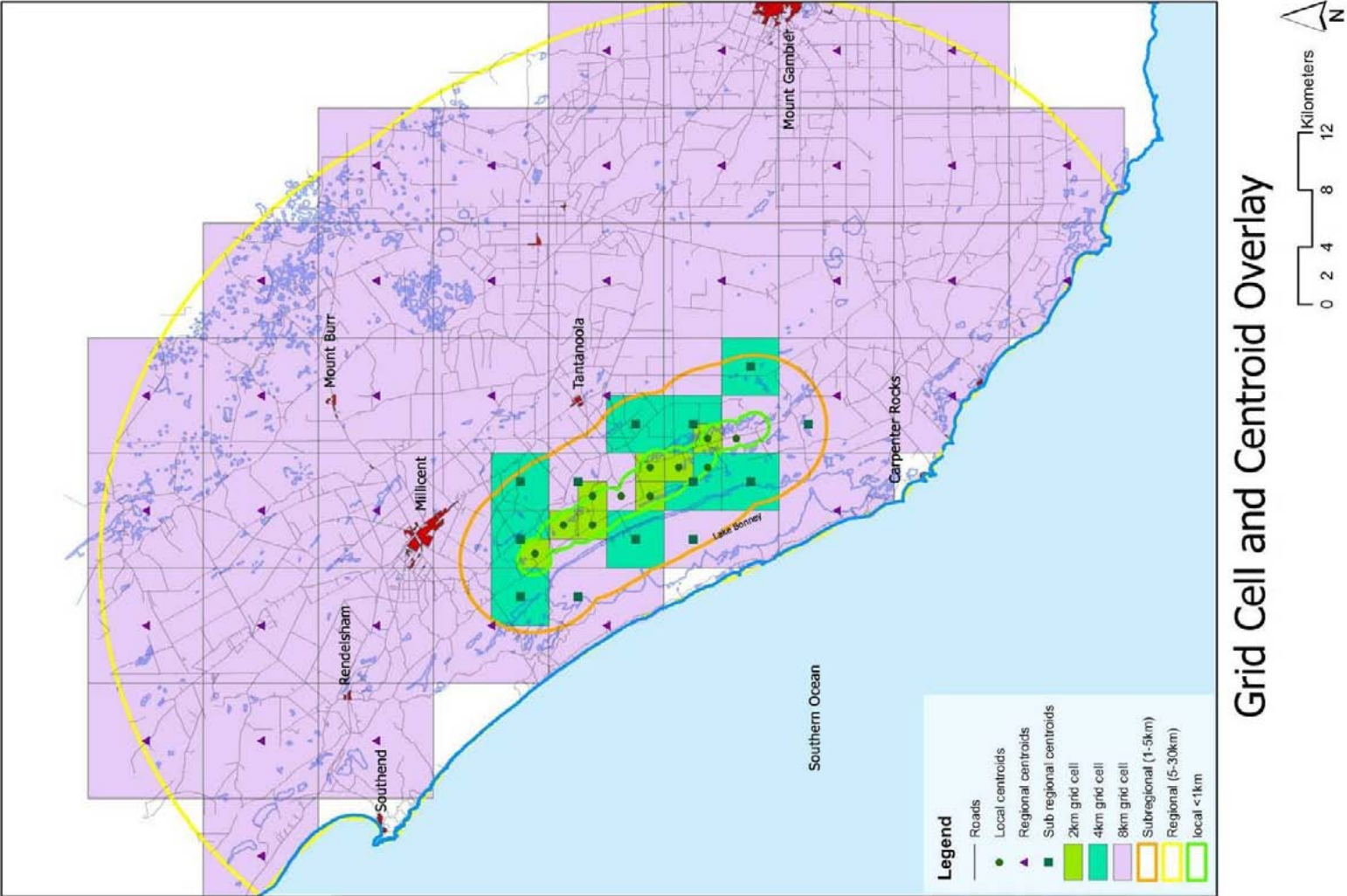
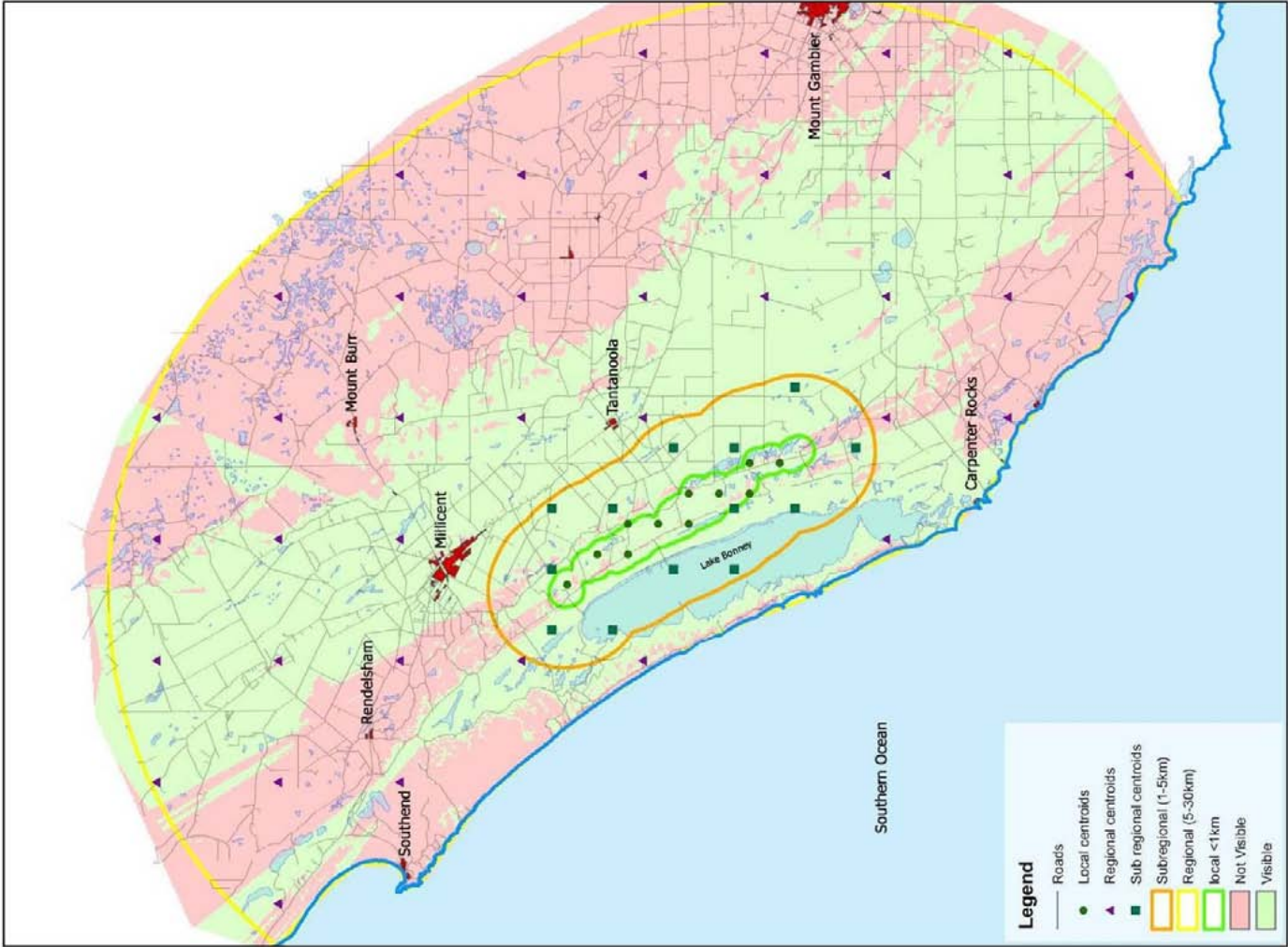


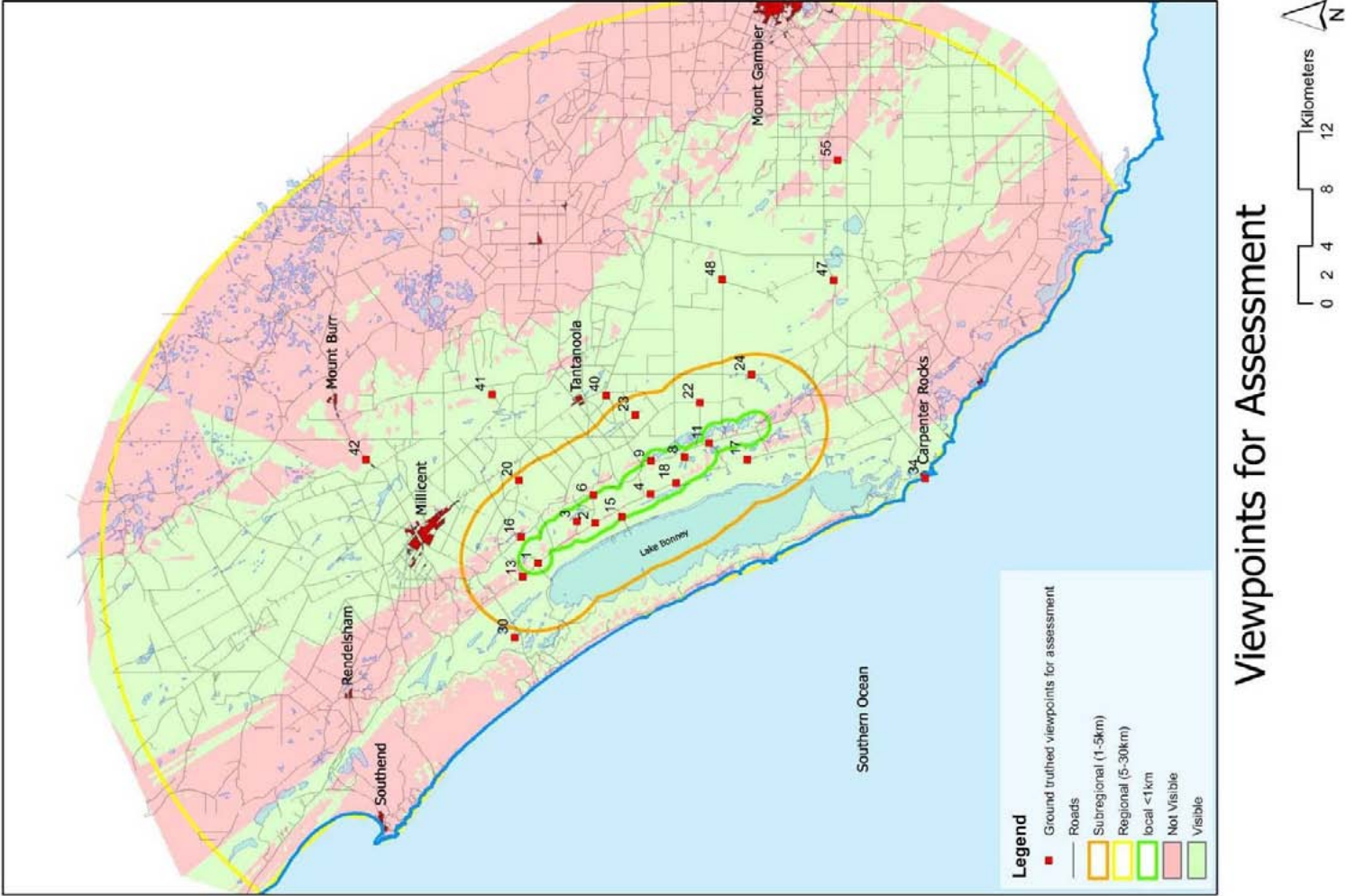


Figure 8.11



Viewpoint Identification- Selection Process

Figure 8.12



#### 8.3.4 Field Assessment (Grimke Matrix) - Visual Landscape Character Value (VLCV)

The initial site assessment is a quasi-objective measurement, with consideration of the visual landscape character of the site placing particular emphasis on the viewpoints identified. Driving to each of the viewpoints identified using the GPS, the viewpoint was first reviewed for vegetation screening and potentially moved to the closest accessible location which generalized the worse case visual effect for that particular character zone. If the observation point was relocated then the new coordinates were recorded on GPS. Each viewpoint was assessed in terms of:

- **Relief**  
The complexity of topographic variation with respect to the coherence and legibility that exists as part of the underlying landscape character.
- **Vegetation Cover**  
The extent to which vegetation is present and its potential to screen and filter views.
- **Infrastructure and Built Form**  
The change of development on landscape and visual character.
- **Cultural Landscape**  
Quantification of recognised planning overlays.

The visual landscape character value (VLCV) is the aggregate value from each of the assessment criteria. Either, as a value for each viewpoint or as a baseline value for the landscape surrounding the development. The VLCV was used to assess the percentage of visual change created by the introduction of the development within the landscape. The following tables illustrate the criteria used to assess the VLCV.

#### **Relief**

This involves an assessment of the landscape visual complexity in terms of the underlying topography. The relationship of relief assists in defining the landscape and the visual character of an area. This is relevant in terms of the position and elevation of a proposed development within the landscape and the viewpoint.

The topography was assessed both on site (from each viewpoint) and as part of a desktop review (topographic map). The assessment considers the topographical complexity in terms of foreground, mid-ground and background. Within each zone a quasi-objective value was assigned with respect to the complexity of topography, legibility, and coherence.

**Table 8.3** Relief

Assessment Zone	Value	Consideration of Relief and Complexity
Foreground	0	Negligible
	1	Limited
	2	Moderate
Mid-Ground	3	High
	0	Negligible
	1	Limited
Background	2	Moderate
	3	High
	0	Negligible
	1	Limited
	2	Moderate
	3	High
Average out of 9 and then expressed as a percentage		

The assessment was concerned with landscape complexity and how it changes on the visual character. The assessment considered landform patterns in the foreground, mid-ground and background and the ease of comprehension and coherence of

dominant elements as a composition. It has been suggested through empirical research that landscapes scenes which possess a degree of complexity and coherence, are highly valued (Bell, 2004; Appleton, 1975; Kaplan & Kaplan. 1982).

### Vegetation Coverage

Vegetation coverage is a measurement of the extent, character and frequency of vegetation that exists at each viewpoint and within the local, sub-regional and regional zones. The extent of vegetation provides the potential for screening and to reduce the visual effect of development. Conversely, a lack of vegetation results in an increase in the visual significance of a development.

This measurement responds to the potential visual absorption of the landscape.

**Table 8.4** Vegetation Coverage

Vegetation Coverage (expressed as percentage)	Description of Vegetation Coverage
80-100%	Natural or non-harvested <i>Eucalyptus</i> or <i>Pinus</i> forests. Significant areas of treed vegetation creating an arboreal landscape.
60-79%	Bushland or woodlands. Major areas of

	vegetation that define the landscape character of an area
40-59%	Tree groups, copse, screens, shelter belts. Defined areas of vegetation creating a layered landscape character.
20-39%	Sporadic trees producing a punctuated vegetation character.
0-19%	Low ground cover, no trees. Limited vegetation cover.

**Infrastructure and Built Form**

This assessment considers the interrelationship of landscape character and human development. The assessment considers how development and infrastructure can create a counterpoint to the existing landscape character (vegetation and topography). Alternatively, development within the landscape may assist with the assimilation of development.

**Table 8.5** Infrastructures and Built Form

<b>Infrastructure and Built Form (expressed as percentage)</b>	<b>Description of Infrastructure and Built Form</b>
0-19%	No objects within the landscape. The landscape has a high natural or remote rural character.
20-39%	Isolated objects in the landscape. Single elements with limited visual change on the landscape. Small farm building, telephone towers or houses.
40-59%	Small clusters of development. Increasing presence of development within the landscape.
60-79%	Medium scale linear infrastructure or development. More significant development within the landscape. Minor roads, culverts, warehouses, transmission lines and residential areas.
80-100%	Large scale infrastructure. The landscape is significantly affected by development. Freeways, power stations and open cut mining



## 8. Integration of Quantitative and Qualitative Visual Assessment Methods

The landscape character value is diminished by the presence of large scale industrial fabric. For this reason the Infrastructure and Built Form assessment is expressed as the reciprocal percentage value for calculating the aggregate VLCV.

### **Cultural Landscape Value**

The cultural landscape value is calculated in GIS by calculating the area of designated cultural landscape divided by the area of the regional landscape (30km radius of the development site). The measurement considers the recognised cultural, heritage, natural and social overlays that exist within the landscape. This assessment is predominantly a desktop survey and only measures recognised designations.

The measurement is then represented as a percentage based of the area of designation compare to the area occupied by the regional zone. This provides a quasi objective measurement of potential effects on designated cultural landscapes.

Within the regional landscape case study area there are National Parks and Conservation Parks which are designated planning overlays of cultural importance. The Canunda National Park accounts for the coastal stretch of land to the west of Lake Bonney.

The Tantanoola Caves are designated as a conservation park. The caves are filled with a spectacular array of limestone formations developed over thousands of years in one large dolomite cavern. Above ground, among the *Eucalyptus* spp are picnic facilities and a walking trail that provides views towards the coast.

**Table 8.6** Cultural Landscape values

<b>Cultural Landscape Value (expressed as percentage)</b>
80-100%
60-79%
40-59%
20-39%
0-19%

## 8. Integration of Quantitative and Qualitative Visual Assessment Methods

The assessment process took place onsite with a review of desktop mapping and calculations post field assessment. The VLCV is the aggregate value from each of the assessment criteria. Either, as a value for each viewpoint or as a baseline value for the landscape surrounding the development. This Landscape Value in

then used to assess the percentage of visual change created by the introduction of development within the landscape. The following tables document the values for each viewpoint for Visual Landscape Character Value.

**Table 8.7** Local Viewpoints Landscape Character Value

Viewpoint	Relief	Vegetation	Infrastructure & Built form	Cultural Landscape	VLCV	VLCV
				Canunda National Park and Tantanoola Caves Conservation Park	%	<b>Expressed out of 20</b>
<b>1</b>	<b>56%</b> Moderate foreground, limited mid ground, limited background	<b>55%</b> Dense mallee	<b>25%</b> Isolated farm dwellings within the field of view	<b>7.5%</b>	<b>48.38%</b>	<b>9.68</b>
<b>2</b>	<b>56%</b> Moderate foreground, limited mid ground, limited background	<b>45%</b> Scattered copse of mallee	<b>25%</b> Isolated farm dwellings within the field of view	<b>7.5%</b>	<b>45.88%</b>	<b>9.18</b>
<b>3</b>	<b>56%</b> Moderate foreground, limited mid ground, limited background	<b>25%</b> Defined shelter belt, limited vegetation coverage to the remaining portion of the view	<b>18%</b> View of remote rural area with no evidence of dwellings	<b>7.5%</b>	<b>40.13%</b>	<b>8.03</b>
<b>4</b>	<b>56%</b> Moderate foreground, limited mid ground, limited	<b>35%</b> Scattered copse of trees and native grass	<b>20%</b> limited visual effect of farm dwellings	<b>7.5%</b>	<b>44.63%</b>	<b>8.93</b>

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	background					
<b>6</b>	<b>56%</b> Moderate foreground, limited mid ground, limited background	<b>30%</b> Scattered copse of trees and native grass	<b>20%</b> limited visual effect of farm dwellings	<b>7.5%</b>	<b>43.38%</b>	<b>8.68</b>
<b>8</b>	<b>67%</b> Limited foreground, high mid ground, moderate background	<b>15%</b> Dryland grass and pastoral paddocks, limited to no tree coverage	<b>39%</b> Farm dwellings provide a focus to the foreground	<b>7.5%</b>	<b>37.63%</b>	<b>7.53</b>
<b>9</b>	<b>67%</b> High foreground, moderate mid ground, limited background	<b>15%</b> Dryland grass and pastoral paddocks, limited to no tree coverage	<b>25%</b> Transmission line adjacent road corridor	<b>7.5%</b>	<b>41.13%</b>	<b>8.23</b>
<b>11</b>	<b>56%</b> Moderate foreground, Moderate mid ground, limited background	<b>45%</b> Shelter belt planting around property boundary	<b>35%</b> Farm dwelling and associated built forms	<b>7.5%</b>	<b>43.38%</b>	<b>8.68</b>

**Table 8.8** Sub-regional Viewpoints Landscape Character Value

<b>Viewpoint</b>	<b>Relief</b>	<b>Vegetation</b>	<b>Infrastructure &amp; Built Form</b>	<b>Cultural Landscape</b>	<b>VLCV</b>	<b>VLCV</b>
				Canunda National Park and Tantanoola Caves Conservation Park	%	<b>Expressed out of 20</b>

## 8. Integration of Quantitative and Qualitative Visual Assessment Methods

<b>13</b>	<b>44%</b> Moderate foreground, limited mid ground, limited background	<b>70%</b> Eucalypt and native vegetation occupies the viewshed	<b>55%</b> close proximity to dwellings and road corridor forms a dominant element	<b>7.5%</b>	<b>41.63%</b>	<b>8.33</b>
<b>15</b>	<b>44%</b> Limited foreground, moderate mid ground, limited background	<b>35%</b> Sporadic trees punctuating the ridgeline	<b>20%</b> limited amount of farming equipment visible	<b>7.5%</b>	<b>41.63%</b>	<b>8.33</b>
<b>16</b>	<b>55%</b> Moderate foreground, moderate mid ground, limited background	<b>15%</b> limited vegetation coverage	<b>20%</b> limited amount of farming equipment visible	<b>7.5%</b>	<b>39.38%</b>	<b>7.88</b>
<b>17</b>	<b>44%</b> Limited foreground, moderate mid ground, limited background	<b>15%</b> limited vegetation coverage	<b>20%</b> fencing associated to paddock forms a moderate visual effect	<b>7.5%</b>	<b>36.63%</b>	<b>7.33</b>
<b>18</b>	<b>55%</b> Moderate foreground, moderate mid ground, limited background	<b>18%</b> limited vegetation coverage	<b>20%</b> fencing associated to paddock forms a moderate visual effect	<b>7.5%</b>	<b>40.13%</b>	<b>8.03</b>
<b>20</b>	<b>33%</b> Negligible foreground, limited mid ground, moderate background	<b>15%</b> limited vegetation coverage	<b>15%</b> Remote rural scene	<b>7.5%</b>	<b>35.13%</b>	<b>7.03</b>
<b>22</b>	<b>33%</b> Negligible foreground, limited mid ground, moderate background	<b>20%</b> limited vegetation coverage	<b>15%</b> Remote rural scene	<b>7.5%</b>	<b>36.38%</b>	<b>7.28</b>

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<b>23</b>	<b>33%</b> Negligible foreground, limited mid ground, moderate background	<b>25%</b> limited vegetation coverage	<b>15%</b> Remote rural scene	<b>7.5%</b>	<b>37.63%</b>	<b>7.53</b>
<b>24</b>	<b>22%</b> Negligible foreground, negligible mid ground, moderate background	<b>18%</b> low ground covers with limited tree coverage to the background	<b>20%</b> sealed road to the foreground with scattered dwellings in the background	<b>7.5%</b>	<b>31.88%</b>	<b>6.38</b>

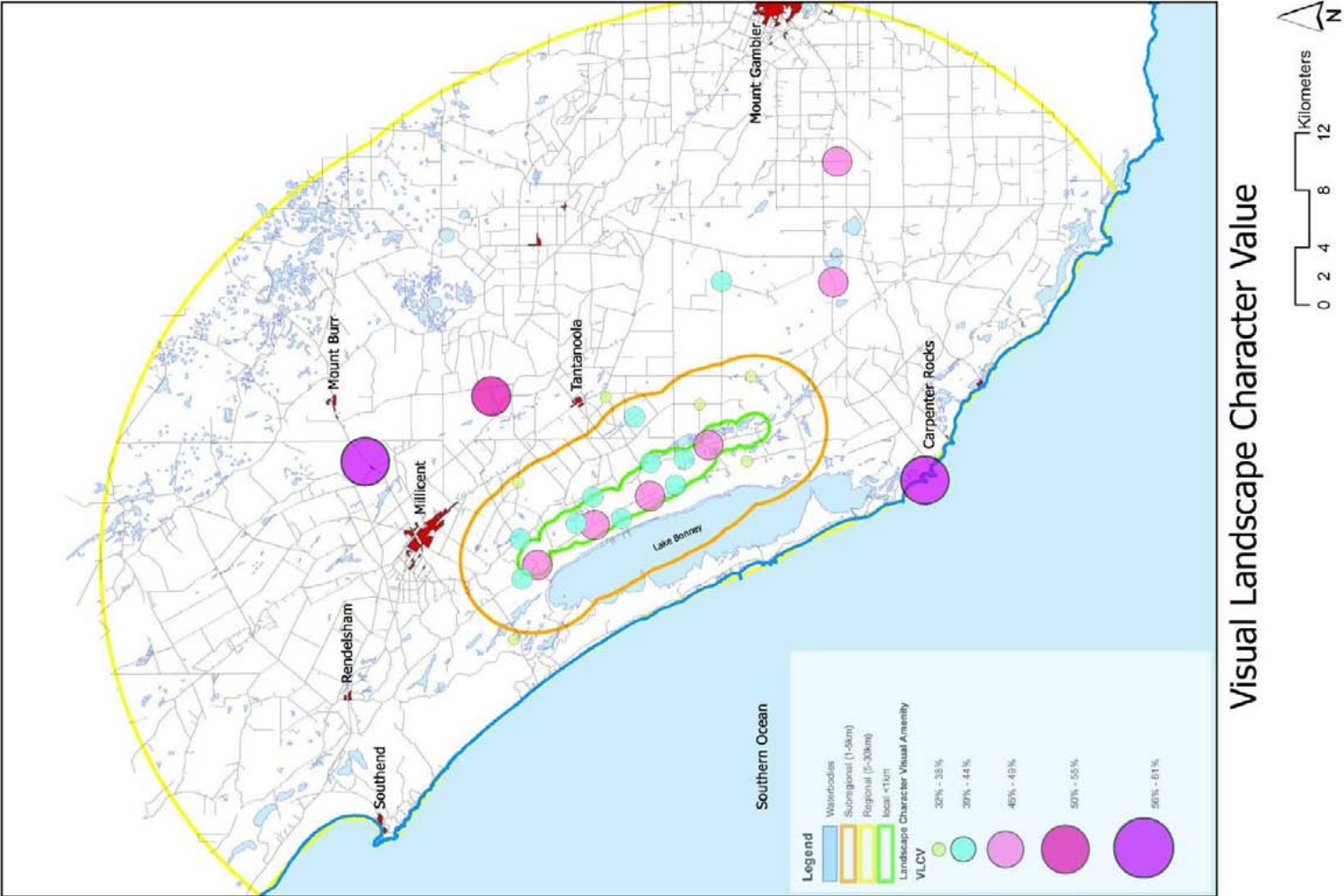
**Table 8.9** Regional Viewpoints Landscape Character Value

<b>Viewpoint</b>	<b>Relief</b>	<b>Vegetation</b>	<b>Infrastructure &amp; Built Form</b>	<b>Cultural Landscape</b>	<b>VLCV</b>	<b>VLCV</b>
				Canunda National Park and Tantanoola Caves Conservation Park	%	<b>Expressed out of 20</b>
<b>30</b>	<b>22%</b> negligible foreground, negligible mid ground, moderate background	<b>35%</b> Punctuated shelter belt planting to a proportion of the viewpoint	<b>35%</b> Small farm buildings evident to the foreground western side of the viewpoint	<b>7.5%</b>	<b>32.38%</b>	<b>6.48</b>
<b>34</b>	<b>66%</b> Moderate foreground, moderate mid ground, moderate background	<b>90%</b> Large area of remnant coastal vegetation	<b>20%</b> Singular transmission line in the centre of the field of view	<b>7.5%</b>	<b>60.88%</b>	<b>12.18</b>

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<b>40</b>	<b>22%</b> negligible foreground, negligible mid ground, moderate background	<b>35%</b> Sporadic copse of vegetation	<b>25%</b> Transmission line and small farm dwellings	<b>7.5%</b>	<b>34.88%</b>	<b>6.98</b>
<b>41</b>	<b>33%</b> negligible foreground, limited mid ground, moderate background	<b>75%</b> within the Mount Burr Forest Plantation (felling diminishes the character)	<b>10%</b> No visual evidence of dwellings or built form	<b>7.5%</b>	<b>51.38%</b>	<b>10.28</b>
<b>42</b>	<b>77%</b> High foreground, moderate mid ground, moderate background	<b>79%</b> Harvested forest plantations with pockets of remnant Eucalypt woodland	<b>25%</b> Glimpsed views of isolated built form in the landscape	<b>7.5%</b>	<b>59.63%</b>	<b>11.93</b>
<b>47</b>	<b>33%</b> limited foreground, limited mid ground, limited background	<b>55%</b> Layered view with copse of native vegetation	<b>20%</b> limited evidence of built form within the field of view	<b>7.5%</b>	<b>43.88%</b>	<b>8.78</b>
<b>48</b>	<b>22%</b> negligible foreground, limited mid ground, limited background	<b>45%</b> shelter belt planting to the road verge with plating on the ridge forming the horizon	<b>20%</b> limited evidence of built form within the field of view	<b>7.5%</b>	<b>38.63%</b>	<b>7.73</b>
<b>55</b>	<b>44%</b> Limited foreground, limited mid ground, moderate background	<b>50%</b> shelter belt planting to boundaries, scattered copse to the background	<b>20%</b> limited evidence of built form within the field of view	<b>7.5%</b>	<b>45.38%</b>	<b>9.08</b>

Figure 8.13

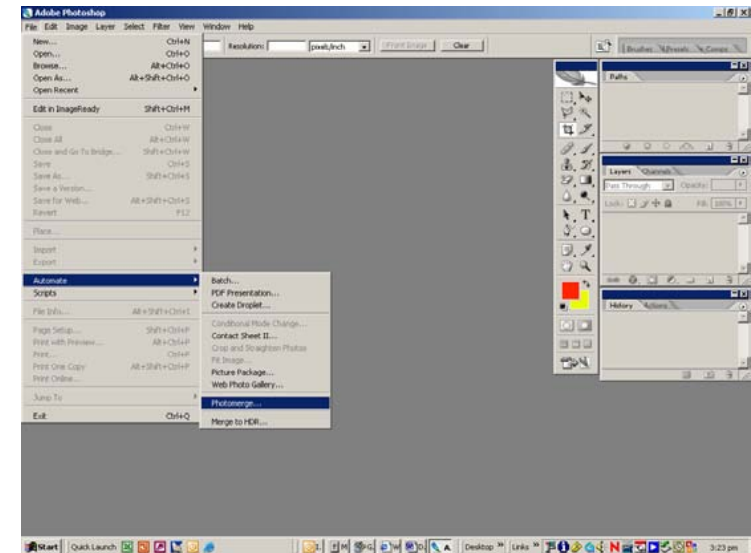


### 8.3.5 Photomontage Production and Animations

During the landscape character field study, photographs were taken for each identified viewpoint. A 35 mm Single Lens Reflex (SLR) camera was used with a 50 mm lens; this is commonly used due to its ability to replicate the angle and visual extent of the human eye.

To provide a photographic assessment similar to the human field of view a series of photos were taken to represent 120° horizontal visual effect. The bearing of the centre of the development from each viewpoint was recorded with GPS and photos were taken to represent 60° either side. A series of 4 photos were taken with overlap to provide sufficient context to stitch together the photos using Adobe Photoshop CS™. The following images illustrate the process of constructing the montages and animated gif files with moving turbine blades. The animated scenes were used in an internet survey in a subsequent assessment process.

Figure 8.14 Photomerge in Adobe Photoshop CS







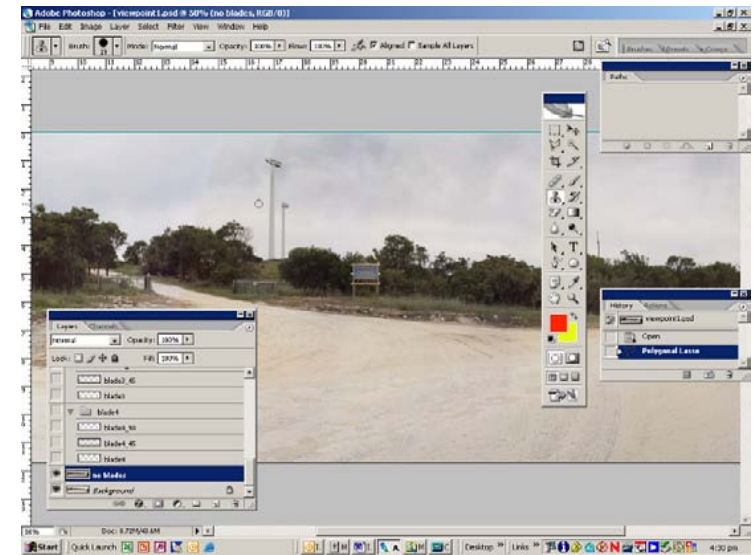
**Figure 8.17** Simulated wire line constructed in Arcview.



**Figure 8.18** Superimposed stitched photo to simulate wire line and match with known references

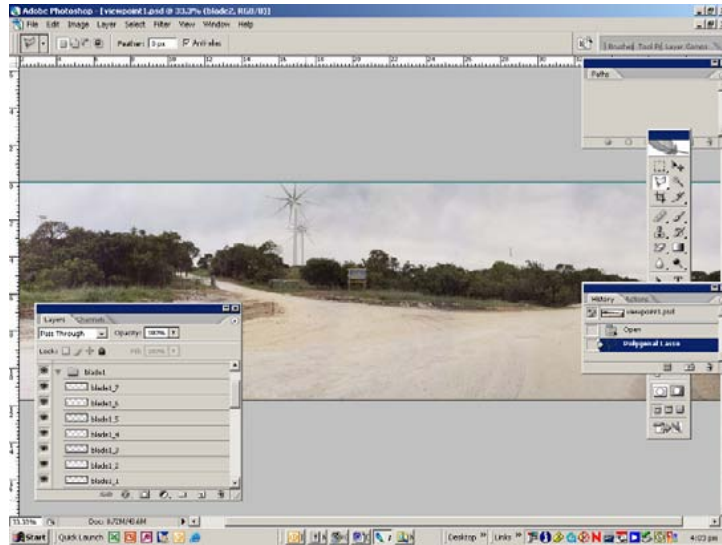


**Figure 8.19** Removal of turbines using Photoshop™ rubber stamp.

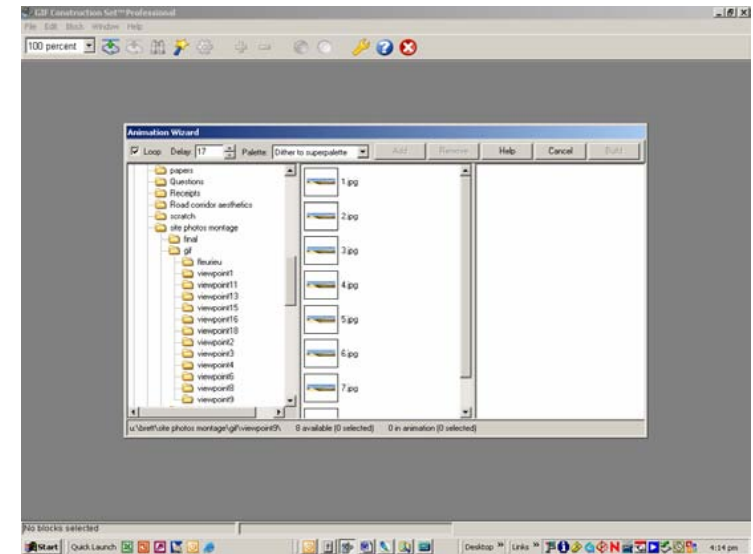


## 8. Integration of Quantitative and Qualitative Visual Assessment Methods

**Figure 8.20** Constructing animated sequences at 45 degree intervals of blade rotation.

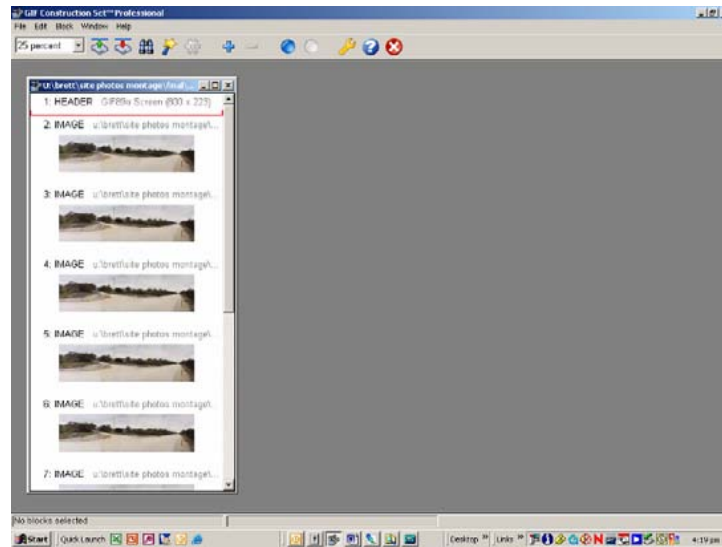


**Figure 8.21** Gif (Graphics Interchange Format) production using Gif Construction Set Professional (2006) selecting static images of viewpoint with 45 degree blade rotations.

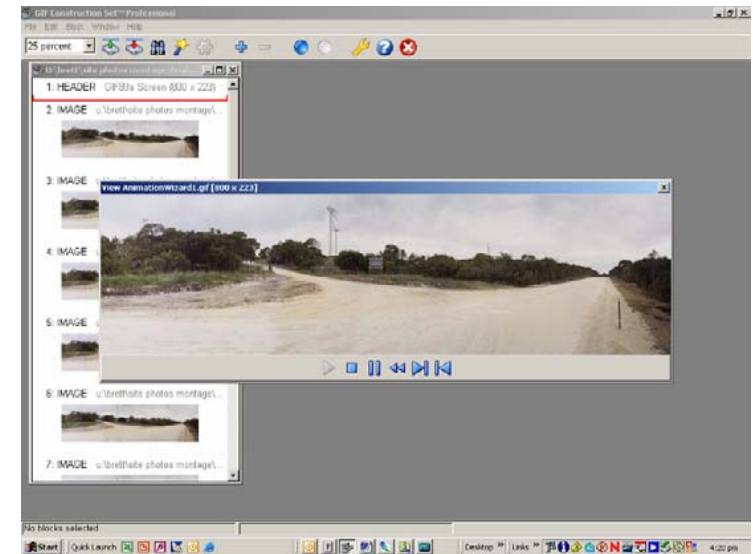


## 8. Integration of Quantitative and Qualitative Visual Assessment Methods

**Figure 8.22** Sequencing the animation file, setting the speed of frames per second (25) and creating a loop effect.



**Figure 8.23** Preview of file and save as Gif file for installation to web page survey.



Draft copies of the photomontages were taken for reference on the detailed field study when the detailed assessment was undertaken. Any inconsistencies with the location of the superimposed model and bearings of known physical elements were ground truthed.

### **8.3.6 Field Assessment (GrimKe Matrix) - Detailed Visual Effect of Development Form (VEDF)**

The extent of visual change was identified on site, using a GPS with a Wide Area Augmentation System (WAAS) that provides positional accuracy to within 3 metres. Using the GPS, the location and extent of the development was plotted as 'waypoints', using longitude and latitude, elevation and distances to provide geographic referenced data. The surrounding area was then surveyed with the GPS and a SILVA bearing compass to calculate the bearing and distance between the viewpoint and the subject area. This methodology was used to assess where the development is in the landscape and whether it is visible.

Each viewpoint was then assessed with respect to the following aspects of visual effect:

- **Percent of Landscape Absorption**

The landscape's ability to absorb and screen the development form.

- **Horizontal Visual Effect**

Percentage spread and extent of the development in the field of view.

- **Vertical Visual Effect**

Height of the development as a percentage of the field of view.

- **Distance of Visual Effect**

Distance between viewpoint and development.

Using the GrimKe matrix, the development will be quantified and aggregated to provide an assessment of the visual effect for each viewpoint.

### **Percent of Visual Absorption (PVA)**

This is an assessment of the landscape's ability to absorb or screen the visual effect. Due to the comprehension of the landscape and development being holistic, the area that is visually affected includes the entire horizontal and vertical extent of the development.

Using Adobe Photoshop™ the amount to which the landscape screens the development was described as a percent of pixel absorption. Foreground

## 8. Integration of Quantitative and Qualitative Visual Assessment Methods

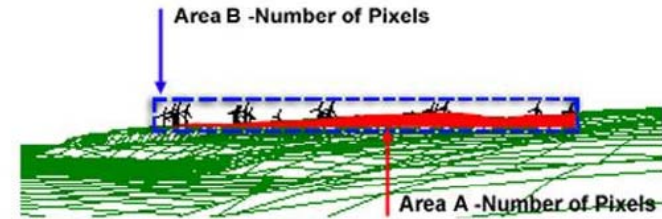
contrasting pixels were selected within the vertical and horizontal extents of the development (area A), Figure 8.26. This area was divided by the total area occupied by the development within the active field of view (area B) and expressed as a percentage of visual absorption. The assessment takes into consideration, visual sky lining and screening from existing vegetation and other physical forms.

**Figure 8.24** Photo with wire line model draped on top. Courtesy Wind Farm Developments (2004)

**Figure 8.25** Wire line of showing extent of photomontage. Adapted from Wind Farm Development (2004)

NOTE:  
These figures are included on page 357  
of the print copy of the thesis held in  
the University of Adelaide Library.

**Figure 8.26** Detailed view of the landscape absorption (area A) and development extents (area B).



**Table 8.10**

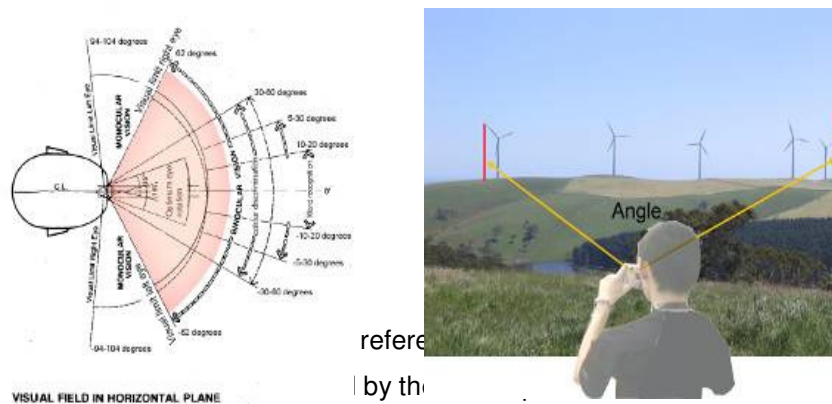
Percent of Visual Absorption (expressed as percentage of change)
80-100%
60-79%
40-59%
20-39%
0-19%

The calculations for visual absorption for each viewpoint assessed are illustrated in Appendix 8.

**Horizontal Visual Effect (HVE)**

The field of vision (FOV) experienced by the human eye is described as an angle of 200-208 degrees horizontally. This field of view includes the peripheral (monocular) vision, which is described as 40 degrees to each eye; within this zone colour and depth of field are not registered. For the purposes of the assessment the angle of peripheral vision was been subtracted from the field of view producing a binocular, ‘active field of view’ of 120 degrees.

**Figure 8.27** Active field of view is defined as the binocular field equating to 120-124 degrees (Panero & Zelnik, 1979). On the right is an illustration of horizontal measured angle as percent of active field 120 degrees. Photo Brett Grimm



centre of the development was established through GPS bearings and waypoint coordinates. Angles of 60 degrees each side of the centre of the field of view was defined. The overall assessment was made of the entire development, rather than of the individual objects that may form the proposal. The angle was measured using a GPS and a bearing compass with known waypoints (geographic coordinates). Using GPS the extent of the horizontal visual field was calculated by the difference in bearing between the widest waypoints from a particular viewpoint. This measurement of effect was then described as a percentage of the 120 degrees active field of view.

**Table 8.11**

Degree of Horizontal Visual Change (expressed as an angle of Change and percentage of change)	Value
80-100% of the panorama measure at 120°FOV	5
60-80% of the panorama measure at 120°FOV	4
40-60% of the panorama Measure at 120°FOV	3
20-40% of the panorama measure at 120°FOV	2
0-20% of the panorama measure at 120°FOV	1

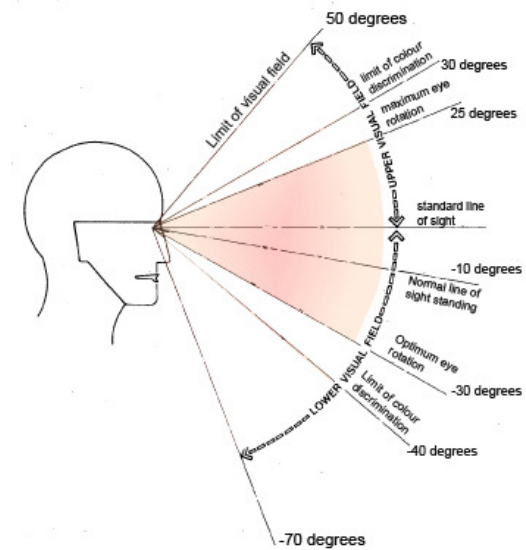
reference  
by the

**Vertical Visual Effect (VVE)**

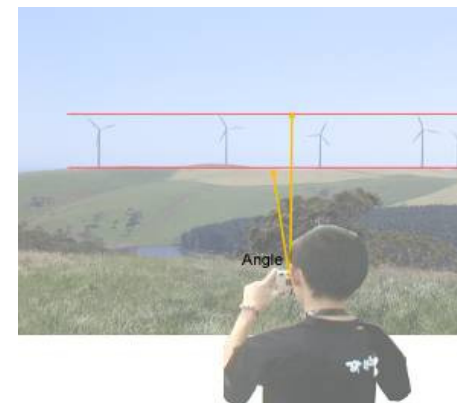
The vertical visual effect (VVE) was measured in a similar way to the assessment of horizontal visual effect, with the field of view described as 55 degrees (based on 25 degrees above the horizontal plane and 30 degrees below). This value takes into account the visual extent of maximum eye rotation, hence the direct line of site without head rotation. This is at variance to the vertical extent described in Appendix 6 and is more responsive to a static frame of the landscapes visual experience.

This assessment ensures that the visual effect takes into consideration the proximity and vertical scale of the proposed development. It was measured as the percentage change within the vertical field of view. This was relative to the maximum eye rotation of the occupant.

**Figure 8.28** Vertical field of view is described as 120 degrees (Panero & Zelnik, 1979). Illustration on the right shows the angle of measurement. Photo Brett Grimm



**VISUAL FIELD IN VERTICAL PLANE**





The angle is measured on site using a clinometer and the photomontages with known reference points in the landscape. Keeping both eyes open the instrument was placed in front of the reading eye. The hair line was targeted towards the baseline of the development and a measurement reading was taken. By raising the instrument until the hairline is sighted against the most elevated aspect of the development another measurement was recorded. The difference between the two measurements is the angle of affected view. This was then calculated as a percentage of the vertical field of view.

**Table 8.12** Vertical Visual Effect

Degree of Vertical Visual Change (expressed as an angle of Change and percentage of change)
80-100% of the panorama measure at 55°FOV
60-80% of the panorama measure at 55°FOV
40-60% of the panorama measure at 55°FOV
20-40% of the panorama measure at 55°FOV
0-20% of the panorama measure at 55°FOV

**Distance of Visual Effect**

Distance of Visual Effect is a measurement of how visual change is modified by distance. The distance to the development from each viewpoint was recorded using the GPS. Standing on site at each viewpoint the exact distance was calculated by selecting the closest waypoint function, (turbines were stored as waypoints in the GPS). The closest waypoint to the development was located referring to GPS bearings, of which the distance to the viewpoint was recorded. The distance categories were defined by the Sinclair Thomas Matrix which has informed 30 kilometres to be the maximum visibility of the visual effect for a wind farm development of approximately 130 metres in maximum height. Further site investigations have confirmed the validity of this technique (HASSELL 2003, 2004). Hence the categories have been divided between the values assigned.

**Table 8.13** Distance zones

Location of Development from viewpoint
0 to 6 km (80-100%)
7 to 12 km (60-80%)
13 to 18 km (40-60%)
19 to 24 km (20-40%)

25 to 30km km (0-20%)
-----------------------

**Final Aggregated Visual Effect**

The final aggregated visual effect is the aggregate sum of the matrix values for horizontal, vertical, landscape absorption capacity, and distance. It is recorded as a value out of 20 and expressed as a percentage.

**Table 8.14** Visual Effect Development Form

<b>VEDF</b>
(80-100%)
(60-80%)
(40-60%)
(20-40%)
(0-20%)

The assessment process took place on site with a review of desktop mapping and calculations post field assessment. The Visual Effect of the Development Form (VEDF) is the aggregate value from each of the assessment criteria. Either, as a value for each viewpoint or as a baseline value for the landscape surrounding the development. This value was then used to assess

the percentage of visual change created by the introduction of development within the landscape. The following tables document the values for each viewpoint for Visual Effect of the Development Form.

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**Table 8.15** Local Viewpoints

<b>Viewpoint</b>	<b>Horizontal degrees</b>	<b>Horizontal Percent</b>	<b>Vertical degrees</b>	<b>Vertical Percent</b>	<b>Distance closest</b>	<b>Distance Percent</b>	<b>Absorption</b>	<b>Percent</b>	<b>Absorption Reciprocal</b>	<b>VEDF</b>
1	102	85%	16.8	31%	330m	99%	12495 screening pixels/ whole effect 40988 pixels	31%	69%	<b>71.00%</b>
2	168	100%	14.3	26%	330m	99%	11595 screening pixels/ whole effect 52676 pixels	22%	78%	<b>75.75%</b>
3	110	92%	16.5	30%	350m	99%	822 screening pixels/ whole effect 33978 pixels	2%	98%	<b>79.75%</b>
4	164	100%	16.3	30%	370m	99%	6744 screening pixels/ whole effect 39308 pixels	17%	83%	<b>78.00%</b>
6	120	100%	5.4	10%	1.1km	96%	1591 screening pixels/ whole effect 14311 pixels	11%	89%	<b>73.75%</b>
8	174	100%	9.1	17%	750m	98%	2768 screening pixels/ whole effect 24257 pixels	11%	89%	<b>76.00%</b>
9	116	97%	15.9	29%	400m	99%	11131 screening pixels / whole effect 40330 pixels	28%	72%	<b>74.25%</b>
11	190	100%	7.8	14%	840m	97.2	220 screening pixels / whole effect 3685 pixels	6%	94%	<b>76.30%</b>
18	122	100.00%	18.4	33.00%	350m	99%	8121 screening pixels/ whole effect 38055 pixels	21%	79%	<b>77.75%</b>

**Table 8.16** Sub regional Viewpoints

<b>Viewpoint</b>	<b>Horizontal degrees</b>	<b>Horizontal Percent</b>	<b>Vertical Degrees</b>	<b>Vertical Percent</b>	<b>Distance</b>	<b>Distance Percent</b>	<b>Absorption</b>	<b>Percent</b>	<b>Absorption Reciprocal</b>	<b>VEDF</b>
13	11	9.00%	6.4	12.00%	1.3km	95.6%	3597 screening pixels/ whole effect 5149 pixels	70%	30%	<b>36.7%</b>
15	17	14.00%	6.7	12.00%	910m	97%	3038 screening pixels/ whole effect 27781 pixels	11%	89%	<b>53.0%</b>
16	66	55.00%	2	4.00%	1.91km	93.6%	553 screening pixels/ whole effect 7464 pixels	7%	93%	<b>61.4%</b>
17	78	65.00%	4	7.00%	1.66km	94.5%	302 screening pixels/whole effect 568 pixels	53%	47%	<b>53.4%</b>

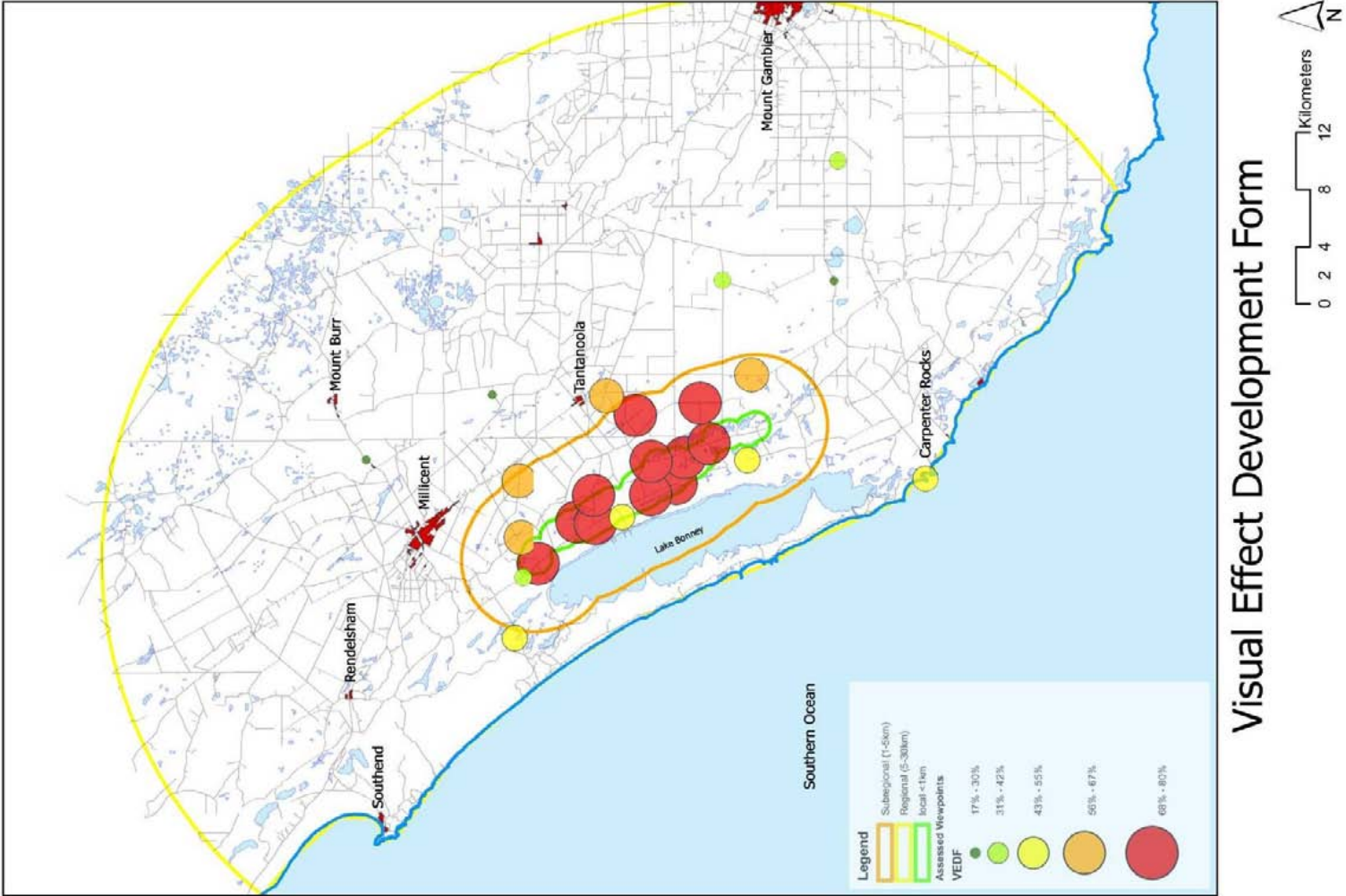
8. Integration of Quantitative and Qualitative Visual Assessment Methods

<b>20</b>	90	75.00%	2.5	5.00%	4.62km	84.6%	747 screening pixels/whole effect 3295 pixels	23%	77%	<b>60.4%</b>
<b>22</b>	119	99.00%	2.2	4.00%	2.70km	91.0%	1579 screening pixels/ whole effect 6786 pixels	23%	77%	<b>67.8%</b>
<b>23</b>	124	100.00%	2.5	5.00%	3.42km	88.6%	924 screening pixels/ whole effect 5006 pixels	18%	82%	<b>68.9%</b>
<b>24</b>	48	40.00%	2.1	4.00%	3.6km	88.0%	288 screening pixels/ whole effect 2092 pixels	14%	86%	<b>54.5%</b>

**Table 8.17** Regional Viewpoints

<b>Viewpoint</b>	<b>Horizontal degrees</b>	<b>Horizontal Percent</b>	<b>Vertical degrees</b>	<b>Vertical Percent</b>	<b>Distance</b>	<b>Distance Percent</b>	<b>Absorption</b>	<b>Absorption Percent</b>	<b>Absorption Reciprocal</b>	<b>VEDF</b>
30	34	28%	3.7	7%	5.11km	83.0%	222 screening pixels/ whole effect 614 pixels	36%	64%	<b>45.5%</b>
34	40	33%	1	2%	11.5km	61.7%	128 screening pixel/ whole effect 698 pixels	18%	82%	<b>44.7%</b>
40	109	91%	1.1	2%	6.2km	79.3%	2186 screening pixels/ whole effect 5328 pixels	41%	59%	<b>57.8%</b>
41	35	29%	1.8	3%	11.2km	62.7%	2581 screening pixels/whole effect 2722 pixels	95%	5%	<b>24.9%</b>
42	12	10%	1.4	3%	13.6km	54.7%	1218 screening pixels/ whole effect 1218 pixels	100%	0%	<b>16.9%</b>
47	11	9%	1.3	2%	11.6km	61.3%	237 screening pixels/ whole effect 285 pixels	83%	17%	<b>22.3%</b>
48	22	18%	0.9	2%	10km	66.7%	379 screening pixels/ whole effect 1002 pixels	38%	62%	<b>37.2%</b>
55	12	10%	0.6	1%	19.5km	35.0%	69 screening pixels/ whole effect 273 pixels	25%	75%	<b>30.3%</b>

Figure 8.29



**8.3.7 Visual Change on Landscape Character- Percentage of Visual Change (PVC)**

**Degree of Visual Change**

The degree of Visual Change is expressed as a coefficient of visual change to the baseline Landscape Character Value (VLCV) for each specified viewpoint. This calculation directly expresses the effect of the development on the landscape, the change to the visual character and the reciprocal visual Change.

Baseline Landscape Character (VLCV): express as a value out of 20

Coefficient of Visual Effect of the Development Form (VEDF): calculated as the ratio of the value ascertained (Stage 4) eg a value of 9 would equate to the division of 9 out of 20 equating to a coefficient of (0.45).

**Calculation of Percent of Visual Change**

Coefficient x landscape character value expressed as a percentage  
= Visual Change on Landscape Character

*Example:*

**Table 8.18** Visual Effect of the Development Form (VEDF)

Horizontal visual effect	28%
Vertical visual effect	7%
Absorption capacity reciprocal	64%
Distance	83%
Total visual effect	<b>45.55% (.455)</b>

8. Integration of Quantitative and Qualitative Visual Assessment Methods

**Table 8.19** Landscape Character Assessment (VLCV)

Relief	25%
Vegetation coverage	35%
Infrastructure built form	35%
Cultural landscape overlays	7.5%
Total landscape character	<b>32.38%</b>
Expressed as a value out of 20	<b>6.476</b>

(c)  $6.476 \times 0.455 = 2.94$

(d)  $2.94/20 =$  (relative value of landscape character change due to the visual effect)

(e)  $0.147 \times 100 = 14.7\%$  Visual Change (PVC)

Consequently the Percentage of Visual Change is suggested to be slight referring to the Table 8.20.

**Table 8.20**

Percentage of Visual Change	
80-100%	Extreme
60-80%	Severe

40-60%	Substantial
20-40%	Moderate
0-20%	Slight

The PVC is the aggregate value of visual change to the landscape character created by the installation of the wind farm from each of the viewpoints assessed. The following tables document the values for each viewpoint.

**Table 8.21** Local Viewpoints Percentage of Visual Change

<b>Viewpoint</b>	<b>Visual Effect Development Form (VEDF)</b>	<b>VEDF Coefficient</b>	<b>Visual Landscape Character Value (VLCV)</b>	<b>Percentage of Visual Change (PVC)</b>
1	71.0%	0.71	9.68	<b>34.4%</b>
2	75.6%	0.76	9.18	<b>34.9%</b>
3	79.8%	0.80	8.03	<b>32.1%</b>
4	78.0%	0.78	8.93	<b>34.8%</b>
6	73.4%	0.74	8.68	<b>32.1%</b>
8	76.0%	0.76	7.53	<b>28.6%</b>
9	74.2%	0.74	8.23	<b>30.5%</b>
11	76.3%	0.76	8.68	<b>33.0%</b>
18	77.8%	0.78	8.03	<b>31.3%</b>

**Table 8.22** Sub regional Viewpoints Percentage of Visual Change

<b>Viewpoint</b>	<b>Visual Effect Development form (VEDF)</b>	<b>VEDF Coefficient</b>	<b>Visual Landscape Character Value (VLCV)</b>	<b>Percentage of Visual Change (PVC)</b>
13	36.7%	0.37	8.33	<b>15.4%</b>
15	53.0%	0.53	8.33	<b>22.1%</b>
16	61.4%	0.61	7.88	<b>24.0%</b>
17	53.4%	0.53	7.33	<b>19.4%</b>



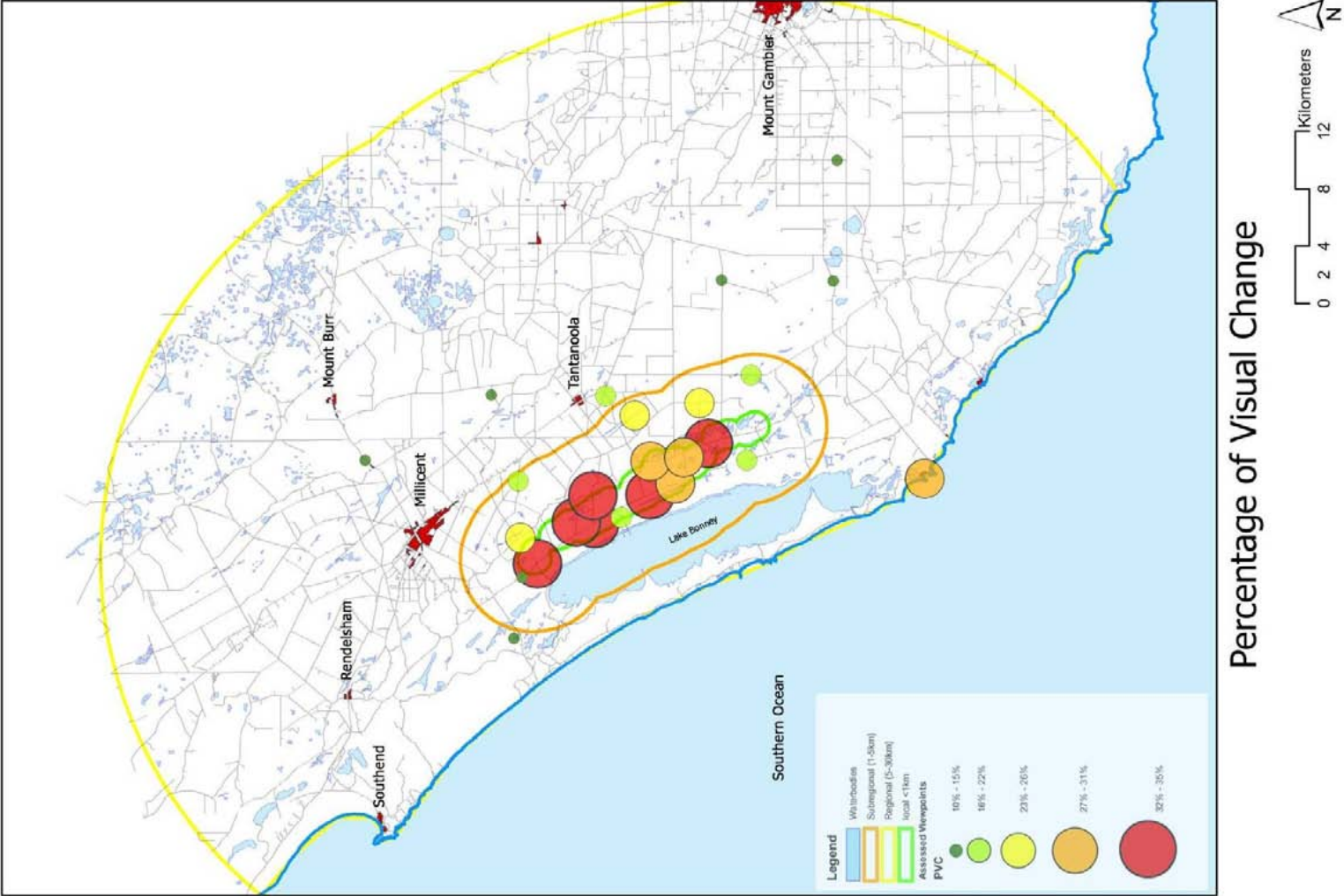
8. Integration of Quantitative and Qualitative Visual Assessment Methods

<b>20</b>	60.4%	0.60	7.03	<b>21.1%</b>
<b>22</b>	67.8%	0.68	7.28	<b>24.8%</b>
<b>23</b>	68.9%	0.69	7.53	<b>25.9%</b>
<b>24</b>	54.5%	0.55	6.38	<b>17.5%</b>

**Table 8.23** Regional Viewpoints Percentage of Visual Change

<b>Viewpoint</b>	<b>Visual Effect Development Form (VEDF)</b>	<b>VEDF Coefficient</b>	<b>Visual Landscape Character Value (VLCV)</b>	<b>Percentage of Visual Change (PVC)</b>
<b>30</b>	45.5%	0.46	6.48	<b>14.9%</b>
<b>34</b>	44.7%	0.45	12.18	<b>27.4%</b>
<b>40</b>	57.8%	0.58	6.98	<b>20.2%</b>
<b>41</b>	24.9%	0.25	10.28	<b>12.9%</b>
<b>42</b>	16.9%	0.17	11.93	<b>10.1%</b>
<b>47</b>	22.3%	0.22	8.78	<b>9.7%</b>
<b>48</b>	37.2%	0.37	7.73	<b>14.3%</b>
<b>55</b>	30.3%	0.30	9.08	<b>13.6%</b>

Figure 8.30



### 8.4 PSYCHOPHYSICAL ASSESSMENT- INTERNET SURVEY

In order to clarify subjective perceptions of the wind farm development, a survey was conducted validating values for scenic beauty of the landscape from the specified viewpoints, with and without turbines as well as animations of the turbines rotating. The aim of this assessment was to examine the effects of dynamics as a unique characteristic of wind turbines.

The methodology used to acquire and analyse the data comprises of the following elements;

- Independent variables, photographs and animations from specified viewpoints of assessment.
- Dependent variables, preferences of the survey sample realized through an internet survey.
- Statistical analysis depicting relationships between the preferences.
- Documentation, mapping the findings in a GIS data base.

As discussed in Chapter 3, there are numerous models which can be used to generate survey sample data and specifically for applications of scenic beauty assessment.

Research in Scotland (Wherret, 1997) has explored the effective use of internet as a tool for landscape studies. Conclusions to this research discussed the limited control of recipients. Further limitations were discussed with regards to data transfer speeds varying according to personalized computer setups, especially for graphics upload which can strain the tolerance of the participant.

Public opinion polls attempt to predict attitudinal variance. They are commonly used in academic research and market research for products and services. Predominantly in academia and in particular this dissertation, the survey was used to explain psychological aspects of social and cultural perceptions. It is a formative way of quantifying qualitative information.

Generating the survey material is probably the most important stage in a research project. The importance of the survey is understandably related to the aims of the intended research. Hence the phrasing of particular questions needs to be explicitly explained permitting ordinary members of the public to comprehend with no confusion.

The theory is that if all respondents are asked the same questions in the same manner and if they express a difference in opinion in reply to those questions, these

variations result from a 'true' difference of opinion, rather than as a result of how the question was asked or the context of the interview

(May, 1997, p84)

The structure of the questionnaire needs to be replicable. Hence it needs to be standardised to enable other researchers to apply the method and questioning at a later date. Furthermore it needs to be reliable in the sense that the results obtained will be the same or somewhat very similar when replicated and also valid in that it is measuring the intended variable.

A pilot study is needed to test the design of the questionnaire. Hence some initial fieldwork is required to identify a potential sample for testing which is representative of the potential sample source. Within this research a sample of Architecture and Landscape Architecture students were used to decipher the image material and format of the questionnaire. This was a valuable process and more importantly provided feedback on the clarity of the aims and objectives.

Techniques in applying the survey and collecting the data have transformed in recent years from, "the image of a person standing in a crowded shopping centre with a clipboard, stopping people,

asking them questions and then ticking boxes" (May, 1997, p81), to online web pages which ascertain the same data and accumulate the information onto the database, mitigating the middle person.

It is costly and time consuming to facilitate a consultation process involving a cross section of the population. Furthermore it is difficult to organise a sample of people required to validate the results minimum of 300 people (Lothian, 2000) into an auditorium for presentation and evaluation of photo material. Hence the question has been asked, "How can we utilise digital media to facilitate and organise an empirical assessment process, that is time efficient, valid, reliable and encompasses a broad cross section of participation without the laborious process of consultation meetings and evaluations? "

The evolution of digital media and dominance of on-line communication in today's society, could possibly aid in these deficiencies. The ability of the Internet to connect and transfer information by means of visual data has only recently been validated for its utility in these processes of communication (Bishop & Lange, 2005).

'Digital town halls' are becoming the way of the future. Communication of wind farm site design and consultation strategies are more frequently using the Internet as a media source. Other than project presentation visualisations, online participation can encompass design charrettes, community mapping (experiential perceptive responses) and visual preference assessments.

It can be assumed that the efficiency of constructing a web page with survey material will be more cost and time efficient given the correct procedure and software material. The advantages of using online surveys include the flexibility of assessment and automation of data collection. The participant can complete the survey when time permits, facilitating a broader regional cross section of the population being able to participate in the process. By providing flexibility of time, it is envisaged that a larger sample of people can be accommodated.

Due to the reliance on self-administered surveys, the survey material must be clearly legible and pragmatic in its description of how, why and what is being required from the assessor, limiting confusion and 'donkey votes'-drop outs. Other factors, which may influence the participant, are the competency of computer

technology and reliance on individual computer systems to have normative set ups, eg: screen size, broadband speed of modem, etc. Michael Roth has assessed all these factors in a recent study evaluating Internet survey techniques.

Roth's (2004) study evaluated the validity of online survey material in comparison to on-site and current photo surrogate visual assessment processes. The methodology employed by Roth was defined to evaluate (a) the objectivity, reliability and validity of visual landscape assessment gained through Internet surveys and (b) find out whether there are demographic, methodological or technical factors affecting the rate of the participants.

Roth concluded that online visual assessment is valid, efficient and reliable. To aid the conversion from practical formal aesthetic visual assessment process to psychophysical subjective evaluation, Roth concluded that online digital media can provide consultants with cost effective justified tools. Community participation has two main principal aims. First it is a way of involving the community in the decision making process by providing a medium in which the participant has a voice to discuss and resolve possible conflicts and faults in the design at a feasible

stage of the project. Second, it also provides the community with a sense of pride and ownership of the project (Sanoff, 2000).

Some of the techniques used in the Internet survey conducted by Roth that have been considered in this dissertation are:

- Privacy agreements were sought in the initial stage of the questionnaire;
- High-hurdle technique (collection of personal data at the beginning, decrease the amount of text per page). Participants had the option of filling in the demographic data or leaving it blank;
- Warm-up technique (practice of rating before the real experiment starts);
- One-item-one-screen design (each rating on a separate web page);
- Incentive (raffle of two gift certificates; used to motivate willingness to concentrate and participate without prejudice); and
- Response time measurement.

The methodology used by Lothian (2000) was an alternative process used as a precedent for this assessment process. As discussed in previous chapters the methodology used by Lothian

was to assess the scenic beauty of landscape scenes in South Australia as a strategic visual quality assessment tool. The vehicle of data accumulation in this process involved slide shows engaging participants in formalised meetings. Several presentations of the slides were presented to numerous different social groups representing community groups, work colleagues and students. Participants rated scenes for scenic beauty out of a 10 point rating scale (1 being low, 10 high).

### 8.4.1 Case Study- Internet Survey

The online assessment conducted as part of this dissertation considered the individual as the unit response. However an individual response is affected by various factors such as previous experience, familiarity, knowledge and preconceived ideas of the landscape context.

Consequently, to objectively measure the participant responses the participant's assessment needed to be independent of the results. Consequently mediation of participant responses was required. The responses were summated into group averages for each of the criteria of assessment being static turbines, dynamic turbines and scenes without the turbines. Inevitably the group results informed normative values and trends associated to each

of the criteria, which were cross referenced and compared objectively.

**Survey Design**

An Internet based survey of scenic beauty assessment was constructed for the same viewpoints identified in the preceding formal aesthetic model.

The information submitted for assessment was a compilation of montages of scenes with and without turbines and dynamic images of turbines with blades rotating for each viewpoint. A summarized sample of the survey is illustrated in Appendix 8.B.

A letter and email inviting people to participate was sent to local community groups around Millicent and Lake Bonney, landscape enthusiasts, government departments, landscape architects, students and academics. The information contained in the email is attached in Appendix 8.C.

The survey consisted of 58 images, each image on a separate page for assessment purposes. The assessment was based on scenic beauty with a rating scale of 1 to 10 (1 being low and 10 high scenic beauty). Interval rating scales were used as they

provided a ranking between classes and an equal spacing between them. An interval scale enables precision about the differences in magnitude of objects; one can state that one is twice that of the other. The 1-10 point rating scale provided a choice of 10 points, which derived the median between 5 and 6 which forces the participant to choose which side of the median they prefer.

The presentation order of the images comprised an initial informative introduction and welcome to the survey followed by an optional demographic and personalized data sheet.

**Table 8.24** Questionnaire structure

Characteristic	Categories
Gender	2
Age	4
Residence	2 questions (open)
Education	4
Familiarity wind farms	5 questions (mixture questions)

The next pages of the survey consisted of instructions which were brief and concise to mitigate any confusion as to how the survey was to be conducted. Example test pages of the survey followed, providing the participant with three samples of the survey

interface, the selective criteria, time for responses and how to respond to the images. The web page was designed so that as soon as test pages were being assessed the remainder of the survey images was being preloaded to minimize the effects of data transfer rates which could cause fatigue. The remaining images used in the assessment were randomized to limit any potential bias of landscape familiarity and direct comparison of scenes with and without turbines.

The survey was conducted for a period of 4 weeks (January/February, 2006) resulting in a total number of respondents being 464 with a total of 325 properly completed surveys, which equates to a 70% success rate.

The data was collated directly into a SQL command dataset on the University of Adelaide server. The ability to provide real time information data capture enabled a progressive review of the number of survey participants and also limited the inefficiencies of postal mail and manual data from entering respondent feedback forms into a data base which is laborious and potentially prone to errors.

### **Characteristics of Participants**

Participants provided details about themselves to enable a cross reference to any trends and particular references to landscape familiarity with particular residence and wind farm locations. The questions covered age, gender, education, resident location and general familiarity of wind farms. The following figures have been derived from the data from the 325 completed surveys.

Due to the survey being administered on the Internet and disbursed on a global network the demographics of the survey sample cannot be explicitly compared to the Australian Bureau of Statistics (ABS) data on the South Australian general community. However, a review of the likely impacts of the sample will be discussed.

#### **a) Gender**

The following table and graphic illustrates the number of respondents for each gender



**Table 8.25**

Sex	Number	%	South Australia pop %
Male	182	59	49
Female	122	40	51
Not disclosed	21		

ABS Census (2006)

Hence the dominant respondent was male which is considered a slight variance to the general population of South Australia, however not a significant difference.

Chi-square test was conducted to inform a null hypothesis that the frequency distribution observed in the sample is consistent with the South Australian census 2006 distribution (Table 8.26).

**Figure 8.31**

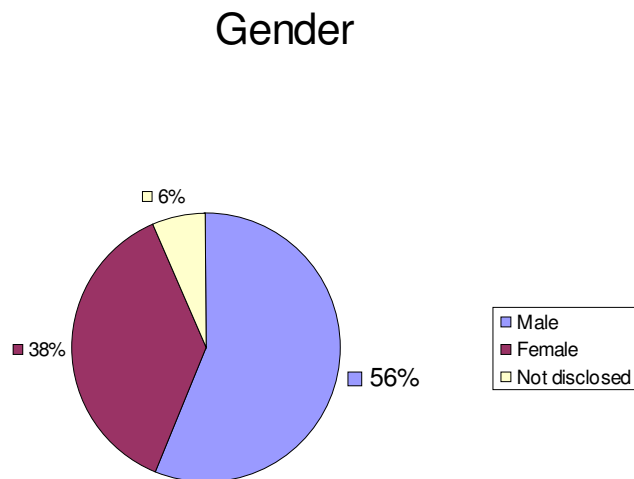


Table 8.26

Gender (www.censusdata.abs.gov.au- South Australian population 2006)

<b>Observed</b>				
		<b>Male</b>	<b>Female</b>	<b>Total</b>
	Survey	182	122	304
	South Australia	745209	769128	1514337
	Total	745391	769250	1514641

<b>Expected</b>				
		<b>Male</b>	<b>Female</b>	<b>Total</b>
	Survey	304	154	458
	South Australia	745241	769096	1514337

Calculated Chi-square value with continuity correction	13.390865
--	-----------

Degrees of freedom	1
--------------------	---

Chitest (probability) CHIDIST	0.000252853
-------------------------------	-------------

Chitest (probability) without continuity	8.1875E-14
--	------------

<b>Gender <math>\chi^2 = 13.39</math>, df 1, p &lt; 0.001</b>
---

**b) Age**

The following table illustrates the age characteristics of respondents. The different ages were classified into 4 categories.

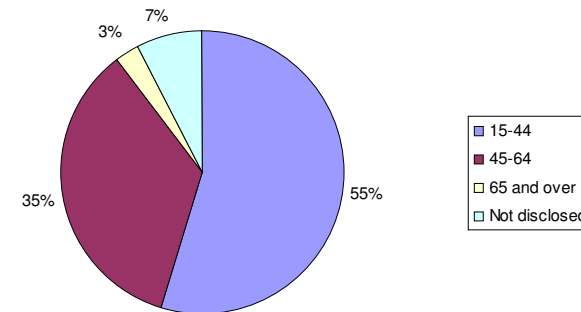
**Table 8.27**

Age Demographics	Number	%	South Australia pop %
15-44	178	59	40.8
45-64	114	38	25.6
65 and over	9	3	15.2
Not disclosed	24		

ABS Census (2006)

**Figure 8.32**

**Age Demographics**



The figures suggest that the majority of participants were between the ages of 15-44 which refers to the general workforce age bracket with the two categories 45-64 and 65 and over being primarily students and retirees respectively.

Chi-square test was conducted to inform a null hypothesis that the frequency distribution observed in the sample is consistent with the South Australian census 2006 distribution (Table 8.28).

Table 8.28

Age (www.censusdata.abs.gov.au- South Australian population 2006)

<b>Observed</b>		<b>18 - 44</b>	<b>45-64</b>	<b>65+</b>	<b>Total</b>
Survey		178	114	9	301
South Australia		544593	394710	233145	1172448
Total		544771	394824	233154	1172749

<b>Expected</b>		<b>18 - 44</b>	<b>45-64</b>	<b>65+</b>	<b>Total</b>
Survey		1647	1197	704	3549
South Australia		544337	395391	232721	1172448

<b>(Observed -Expected)^2/Expected</b>					
		1310.24	979.71	686.56	2972.53
		0.12	1.17	0.77	0.00

Chitest probability	0.000000000000000000000000
---------------------	----------------------------

Degrees of freedom	5
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Calculated Chi-square value	5951.10
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Probability from chi-square distribution	0.00000000000000000000
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<b>Age <math>\chi^2 = 5951.10</math>, df 5, p &lt; 0.001</b>
--

**C) Education**

A four level classification of education level attained was acquired.

The following Table 8.27 and Figure 8.33 illustrate the demographic education of the participants.

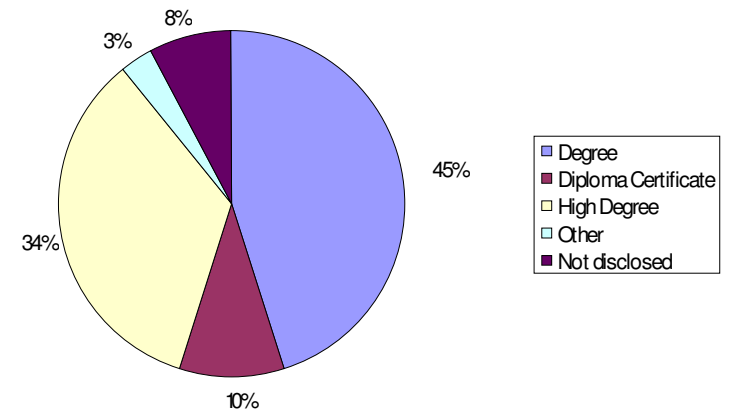
**Table 8.29**

Education	Number	%	South Australia pop %
Degree	144	48	18
Diploma Certificate	31	11	7
Higher Degree	110	37	5
Other	10	4	70
Not disclosed	25		

ABS Census (2006)

**Figure 8.33**

**Education**



The percentage of participants with a degree or higher degree is significant for this survey sample equating to 79%. This level is higher than what would be expected as a general representation of the South Australian community.

Table 8.30

**EDUCATION**

<b>Observed values</b>					
	no qual	Certificate/diploma	Degree	Higher degree	Total
Survey	35	31	114	110	3549
South Australia	143124	292280	120980	38996	595380
Total	143159	292311	121094	39106	598929

<b>Expected values</b>					
	no qual	Certificate/diploma	Degree	Higher degree	
Survey	848	1732	718	232	3530
South Australia	142311	290579	120376	38874	592140

(observed -expected)^2/expected	779.743765	1670.6662	507.663423	63.94254811	
	4.64797377	9.95867234	3.02613035	0.381155066	

chitest (probability)			0		
-----------------------	--	--	---	--	--

degrees of freedom			3		
--------------------	--	--	---	--	--



calculated chi-square value	3040.029866
-----------------------------	-------------

probability from chi-square distribution	0.000
--	-------

<b>Education <math>\chi^2 = 3040</math>, <math>df = 3</math>, <math>p &lt; 0.001</math></b>
---

**D) Residence**

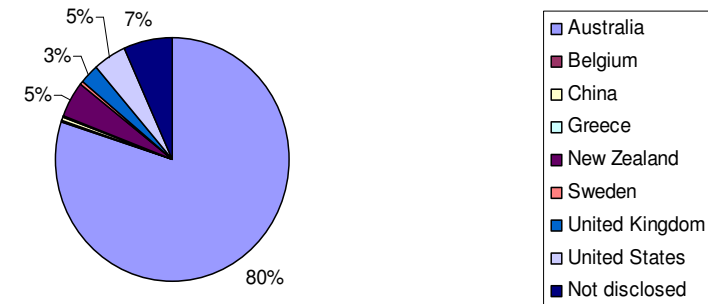
As mentioned the internet provides a tool to sample people's perceptions on a global forum. The country of residence of the survey participants is illustrated in the following table and figure.

**Table 8.31**

Country of Residence	Number
Australia	251
Belgium	1
China	1
Greece	1
New Zealand	15
Sweden	1
United Kingdom	8
United States	15
Not disclosed	21

**Figure 8.34**

**Country of Residence**



As was expected the greatest response rate was from Australia with 80% followed by New Zealand and the United States. Consequently the sample provides a thorough examination of Australian cultural perceptions of landscape and the introduction of wind farms to these landscape scenes.

**E) Have you physically seen a wind farm before?**

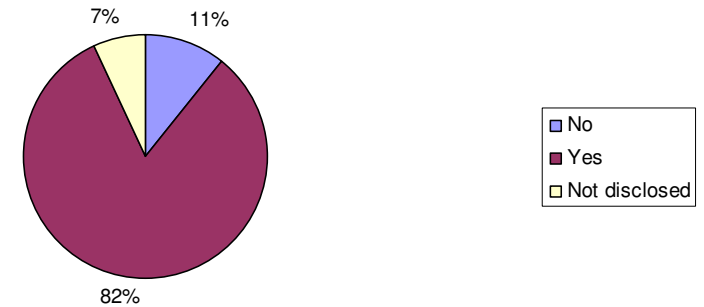
The following question was asked to understand the effects of preconceived ideas of wind farms from the media and past experiences. By analyzing the number of people who have seen a wind farm before as opposed to those that have not will provide an indication of familiarity.

**Table 8.32**

Have you physically seen a wind farm before?	Number
No	35
Yes	267
Not disclosed	23

**Figure 8.35**

**Have you physically seen a wind farm before?**



A large percentage of the survey sample had physically seen a wind farm before. Hence there is a high degree of familiarity with the scale and motion of the wind turbines.

**F) Did you specifically travel to see the wind farm?**

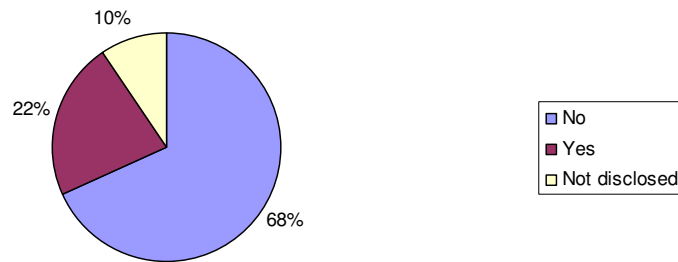
This question was derived to provide a validation of the number of people who have a common interest in wind farms as a tourist destination or possibility as a place of work. The following table and figure illustrate the samples response.

**Table 8.33**

<b>Did you specifically travel to see the wind farm?</b>	<b>No.</b>
No	222
Yes	72
Not disclosed	31

**Figure 8.36**

**Did you specifically travel to see the wind farm**



Consequently the majority of the survey sample have coincidentally traveled through a region and witnessed the presence of a wind farm. Hence a large percentage of the

participants in the survey do not have preconceived interest in wind farms as a destination point.

**G) Before your visit had you seen pictures of a wind farm?**

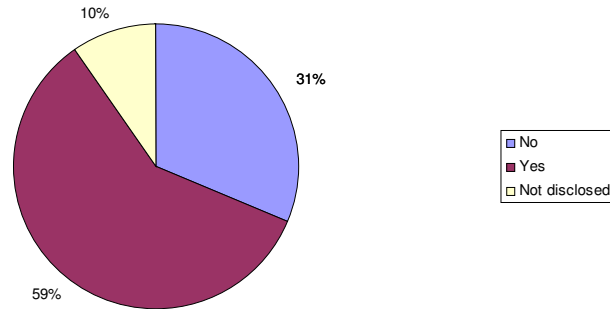
This question was put forward to gauge the level of influence images of wind farms have had on the participants of the survey. Referring to the transactional depiction model this question will provide an insight to the efficiencies of communicating and perceptions of landscape wind farm landscape representations.

**Table 8.34**

<b>Before your visit had you seen pictures of a wind farm</b>	<b>Number</b>
No	102
Yes	191
Not disclosed	32

**Figure 8.37**

**Before your visit had you seen pictures of the wind farm?**



The majority of the survey sample had seen images of a wind farm before, which could have provided a transactional symbiotic reference and familiarity of the landscape context.

**H) If yes, did your impression of the wind farm change in anyway as a result of your visit?**

This question was posed to provide a more rigorous analysis of the effects of imagery and real life experiences of wind farms. An open ended question was to follow to assess more detail on the

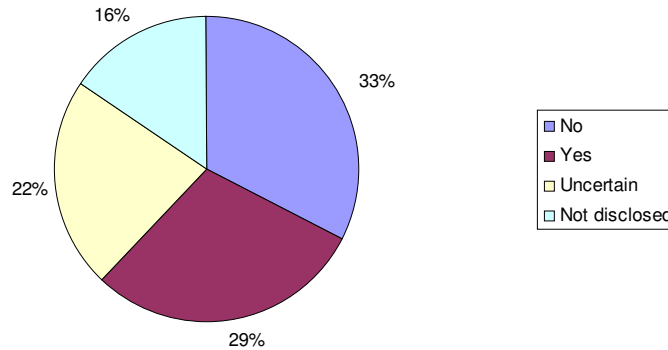
potential variances in perceptions of images and physical landscape visual experiences.

**Table 8.35**

<b>If yes, did your impression of the wind farm change in anyway as a result of your visit?</b>	<b>Number</b>
No	106
Yes	95
Uncertain	73
Not disclosed	51

Figure 8.38

**Had your perception of wind farms changed as a result of your visit?**



The results of this question do not establish a consensus on the effect of imagery. A proportion of 33% stated that their perceptions did not change. On the other hand 29% declared that the visual effect was different than they had anticipated and 22% were undecided. Hence the majority of the respondents thought there was a potential variance in the perceptions of images as opposed to physical experiences.

**l) If yes, please explain?**

This question was asked to gauge an understanding of the effects of scale and movement which are characteristics of potential variance in perceptions of images and real life experiences of wind farms. The following responses reflect the number of responses which classified scale as a major modification to visual perception.

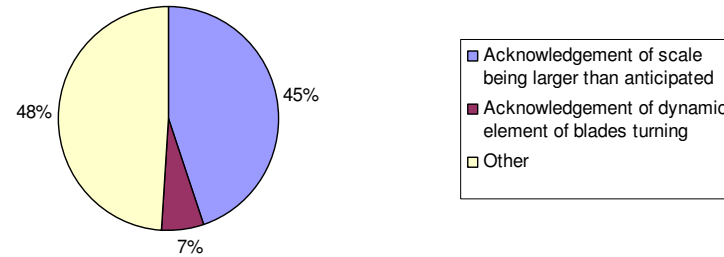
The other variable which is being considered in this dissertation is the dynamic quality of the turbines moving. The number of responses which referred to the motion of the turbines is illustrated below.

Table 8.36

<b>If yes please explain why they are perceived differently</b>	<b>Number</b>
Acknowledgement of scale being larger than anticipated	54
Acknowledgement of dynamic element of blades turning	8
Other	59

Figure 8.39

If yes, please explain why they are perceived differently



#### 8.4.2 Findings

The primary objectives of the survey assessment were to examine the visual effect of perceived landscape values from each of the identified assessment viewpoints without turbines, with turbines and an animated scene of the turbine blades moving.

The assessment rated the scenes for scenic beauty values on a rating of 1-10 (1 being low and 10 high). The following tables and graphs illustrate the mean values for each of the viewpoint scenes.

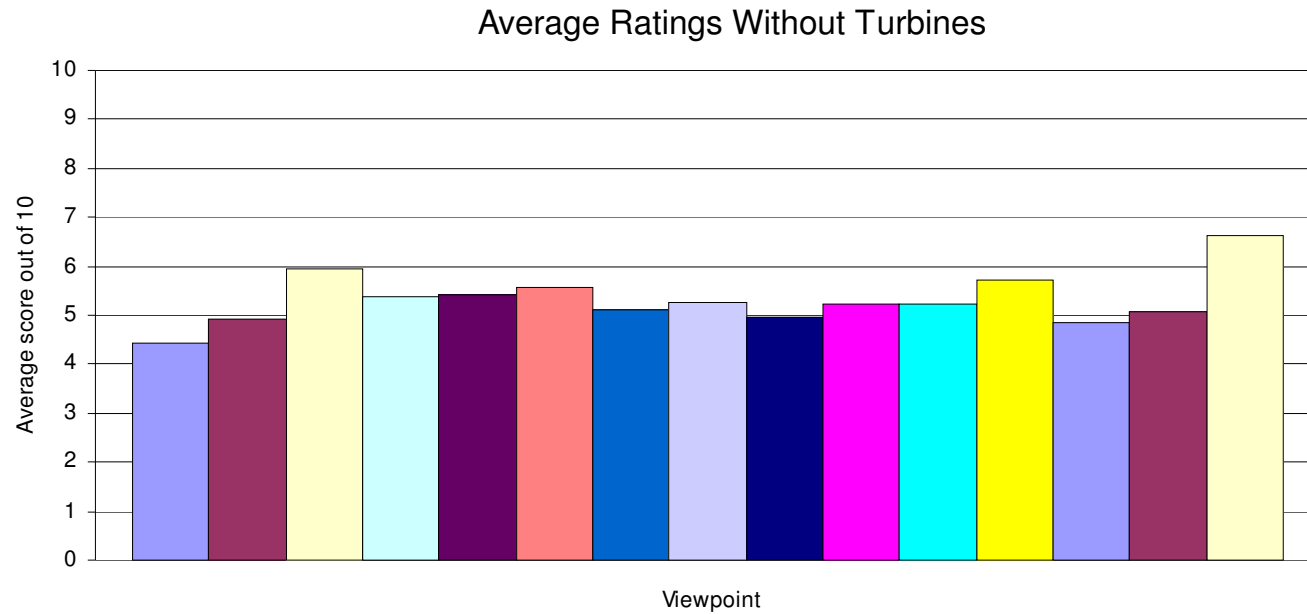
**A) Scenes without turbines**

**Table 8.37**

Image	vp01_out	vp02_out	vp03_out	vp04_out	vp06_out	vp08_out	vp09_out
Without turbines	4.42	4.94	5.95	5.36	5.41	5.58	5.11

Image	vp11_out	vp13_out	vp15_out	vp16_out	vp18_out	vp20_out	vp22_out	vp60_out
Without turbines	5.28	4.95	5.21	5.21	5.71	4.84	5.09	6.64

**Figure 8.40** Average Ratings Without Turbines





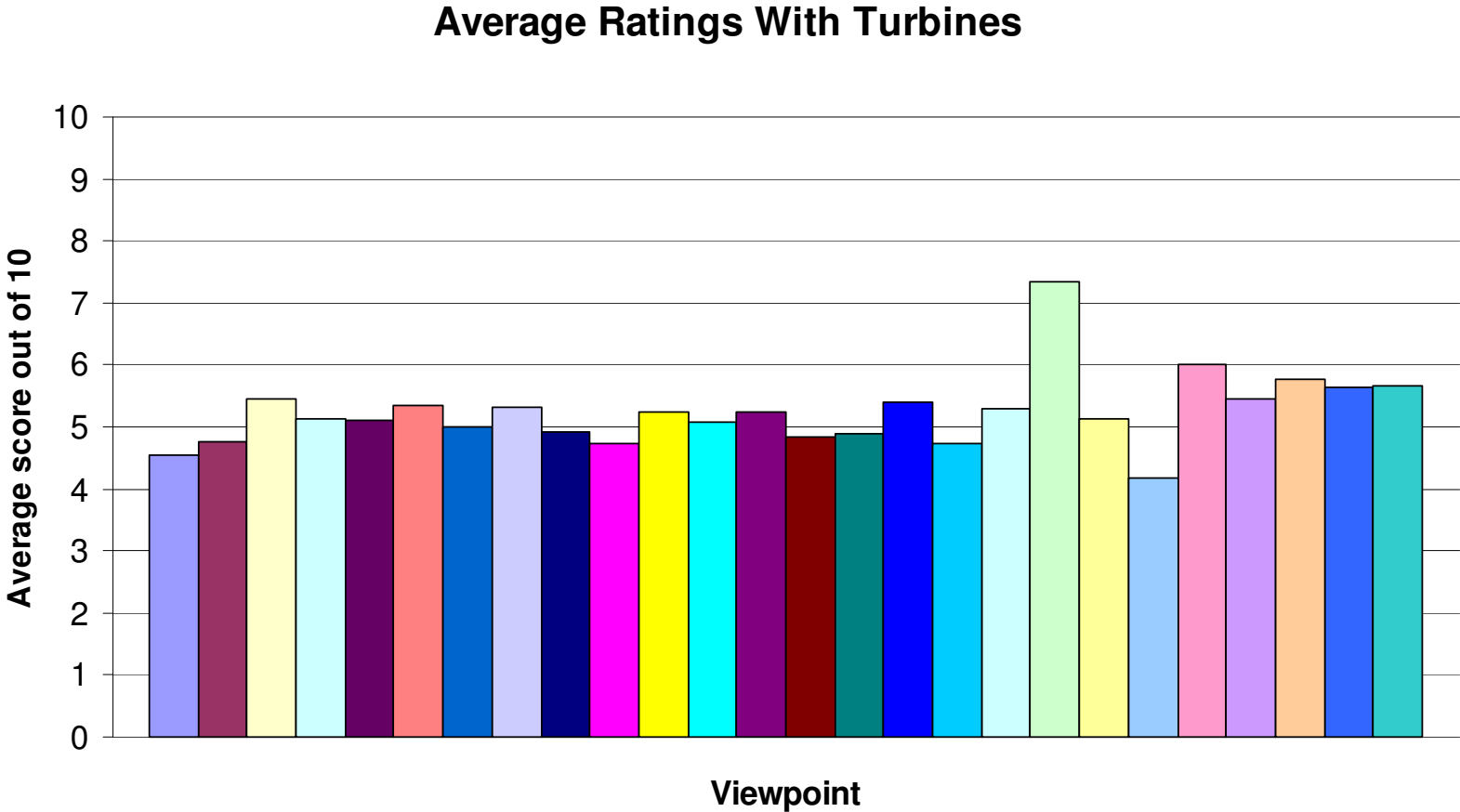
**B) Scenes with Turbines****Table 8.38**

Image	vp01_with	vp02_with	vp03_with	vp04_with	vp06_with	vp08_with	vp09_with	vp11_with	vp13_with
With Turbines	4.54	4.75	5.46	5.12	5.1	5.34	5	5.33	4.92

Image	vp15_with	vp16_with	vp17_with	vp18_with	vp20_with	vp22_with	vp23_with	vp24_with	vp30_with
With Turbines	4.73	5.24	5.09	5.25	4.85	4.9	5.39	4.73	5.3

Image	vp34_with	vp40_with	vp41_with	vp42_with	vp47_with	vp48_with	vp55_with	vp60_with	vp61_with
With Turbines	7.35	5.13	4.17	6	5.45	5.77	5.64	5.67	5.78

Figure 8.41 Average Ratings With Turbines



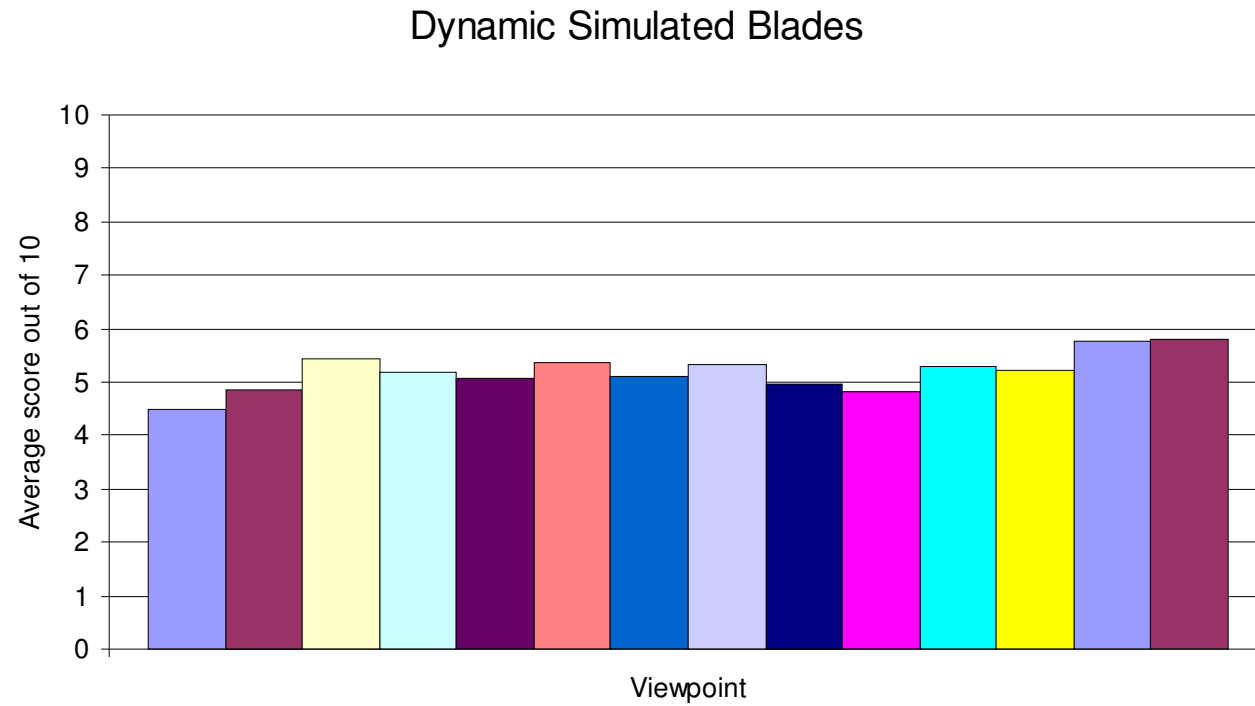
## C) Simulated Dynamic Scenes of Blades Turning

Table 8.398

Image	vp01_movie	vp02_movie	vp03_movie	vp04_movie	vp06_movie	vp08_movie	vp09_movie
Dynamic simulation	4.48	4.87	5.42	5.19	5.06	5.38	5.11

Image	vp11_movie	vp13_movie	vp15_movie	vp16_movie	vp18_movie	vp60_movie	vp61_movie
Dynamic simulation	5.33	4.95	4.8	5.3	5.23	5.75	5.81

**Figure 8.42** Average Ratings Simulated Scenes



**D) Comparison of scenes**

Due to the distance and visibility of the turbines from regional viewpoints being insignificant, there were no simulated images created and assessed for the following viewpoints.

**Table 8.40** Scenes with no simulated scenes

<b>Viewpoint</b>	17	20	22	23	24	30	34	40	41	42	47	48	55
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The following table and figure represent the findings of perceived landscape values for the scenes which had been assessed for dynamics, with turbines and without.

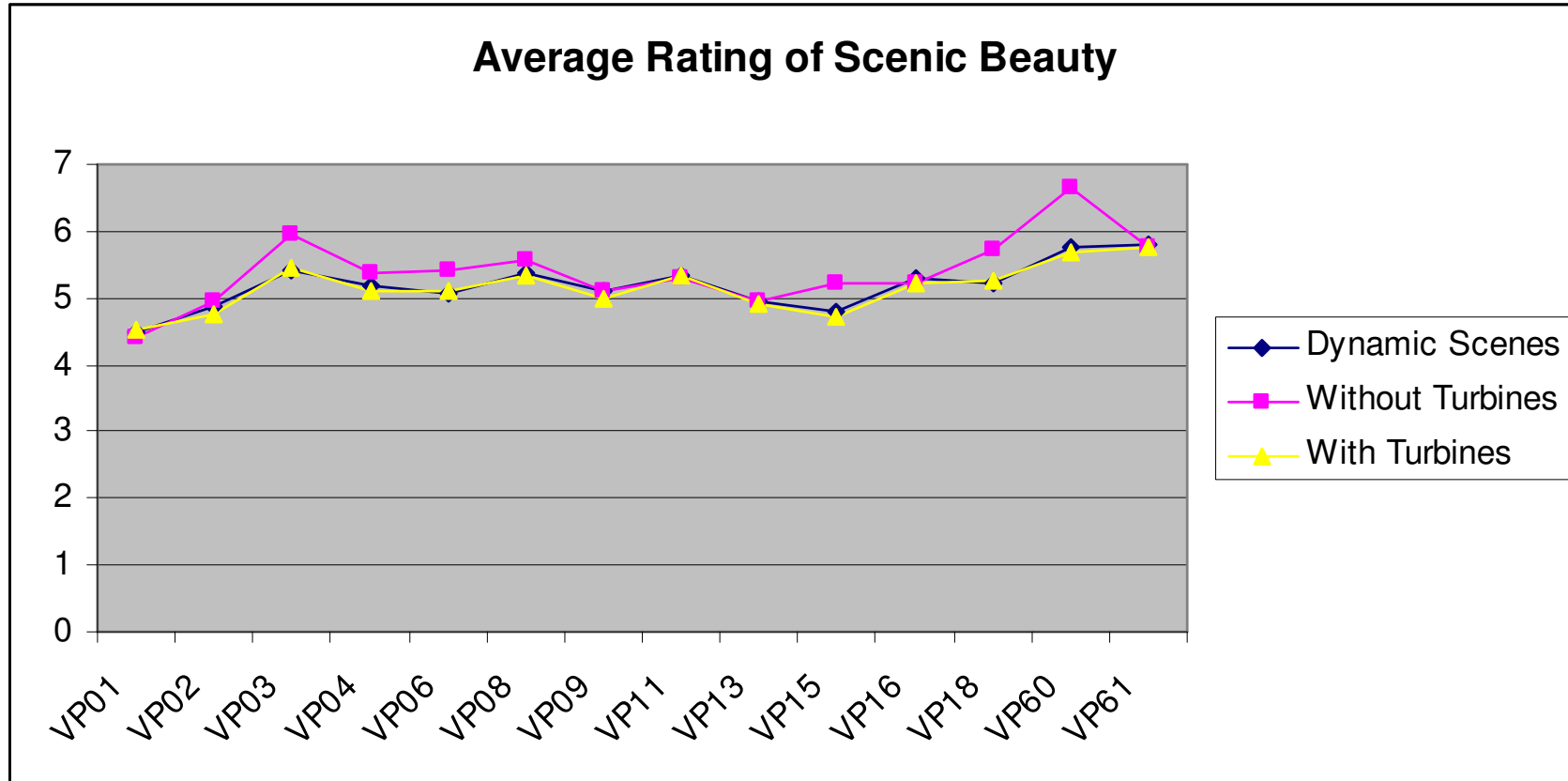
**Table 8.41** Assessed viewpoints for dynamic and static scenes

<b>Image</b>	<b>VP01</b>	<b>VP02</b>	<b>VP03</b>	<b>VP04</b>	<b>VP06</b>	<b>VP08</b>	<b>VP09</b>
<b>Dynamic simulation</b>	4.48	4.87	5.42	5.19	5.06	5.38	5.11
<b>Without turbines</b>	4.42	4.94	5.95	5.36	5.41	5.58	5.11
<b>With Turbines</b>	4.54	4.75	5.46	5.12	5.1	5.34	5

<b>Image</b>	<b>VP11</b>	<b>VP13</b>	<b>VP15</b>	<b>VP16</b>	<b>VP18</b>	<b>VP60*</b>	<b>VP61*</b>
<b>Dynamic simulation</b>	5.33	4.95	4.8	5.3	5.23	5.75	5.81
<b>Without turbines</b>	5.28	4.95	5.21	5.21	5.71	6.64	5.78
<b>With Turbines</b>	5.33	4.92	4.73	5.24	5.25	5.67	5.78

\*Viewpoint images were of a different wind farm development- Starfish Hill located at Cape Jervis, South Australia. These images were used to calibrate the effects of different landscape typologies and wind farm scenes.

**Figure 8.43** Comparison of ratings dynamic, static and without  
 The average value for each of the scenes is documented in Appendix 8.A.



The following Table 8.39 illustrates the paired samples test. The results of which identify the mean and significance for a confidence value of 95%. Significance values of less than 0.05 indicate a probability of variance

which is not by chance i.e. the perceived value. Hence the perceived value of variance of that particular landscape scene caused by the presence, absence or motion of the turbines would not be expected.

**Table 8.42** Paired Samples Test

		95% Confidence Interval of the Difference					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Vp01 out – Vp01 with	-.115	1.515	.084	-.281	.051	-1.361	321	.174
Pair 2	Vp01 movie – Vp01 with	-.053	1.044	.058	-.167	.062	-.907	321	.365
Pair 3	Vp01 movie – Vp01 out	.062	1.568	.087	-.110	.234	.711	321	.478
Pair 4	Vp02 out - Vp02 with	.177	1.843	.103	-.025	.379	1.723	321	.086
Pair 5	Vp02 movie – Vp02 with	.124	1.069	.060	.007	.241	2.085	321	.038
Pair 6	Vp02 movie – Vp02 out	-.053	1.945	.108	-.266	.160	-.487	321	.626
Pair 7	Vp03 out - Vp03 with	.509	1.959	.109	.294	.724	4.664	321	.000
Pair 8	Vp03 movie – Vp03 with	-.028	1.219	.068	-.162	.106	-.412	321	.681
Pair 9	Vp03 movie – Vp03 out	-.537	2.034	.113	-.760	-.314	-4.740	321	.000
Pair 10	Vp04 out – Vp04 with	.255	1.723	.096	.066	.444	2.652	321	.008
Pair 11	Vp04 movie – Vp04 with	.062	1.137	.063	-.063	.187	.981	321	.328
Pair 12	Vp04 movie – Vp04 out	-.193	1.776	.099	-.387	.002	-1.946	321	.053
Pair 13	Vp06 out – Vp06 with	.307	1.969	.110	.092	.523	2.802	321	.005

## 8. Integration of Quantitative and Qualitative Visual Assessment Methods

Pair 14	Vp06 movie – Vp06 with	-.043	1.096	.061	-.164	.077	-.712	321	.477
Pair 15	Vp06 movie – Vp06 out	-.351	1.935	.108	-.563	-.139	-3.255	321	.001
Pair 16	Vp08 out – Vp08 with	.214	1.695	.094	.028	.400	2.269	321	.024
Pair 17	Vp08 movie – Vp08 with	.040	1.163	.065	-.087	.168	.623	321	.534
Pair 18	Vp08 movie – Vp08 out	-.174	1.878	.105	-.380	.032	-1.662	321	.098
Pair 19	Vp09 out – Vp09 with	.112	1.642	.092	-.068	.292	1.221	321	.223
Pair 20	Vp09 movie – Vp09 with	.112	1.071	.060	-.006	.229	1.874	321	.062
Pair 21	Vp09 movie – Vp09 out	.000	1.810	.101	-.198	.198	.000	321	1.000
Pair 22	Vp11 out – Vp11 with	-.043	1.201	.067	-.175	.088	-.649	321	.517
Pair 23	Vp11 movie – Vp11 with	.003	.991	.055	-.106	.112	.056	321	.955
Pair 24	Vp11 movie – Vp11 out	.047	1.256	.070	-.091	.184	.666	321	.506
Pair 25	Vp13 out – Vp13 with	.022	1.003	.056	-.088	.132	.389	321	.698
Pair 26	Vp13 movie – Vp13 with	.025	1.050	.059	-.090	.140	.425	321	.671
Pair 27	Vp13 movie – Vp13 out	.003	1.104	.062	-.118	.124	.050	321	.960
Pair 29	Vp15 out – Vp15 with	.478	1.937	.108	.266	.691	4.431	321	.000
Pair 30	Vp15 movie – Vp15 with	.093	1.257	.070	-.045	.231	1.330	321	.184
Pair 31	Vp15 movie – Vp15 out	-.385	1.962	.109	-.600	-.170	-3.521	321	.000
Pair 32	Vp16 out – Vp16 with	-.040	1.467	.082	-.201	.120	-.494	321	.622
Pair 33	Vp16 movie – Vp16 with	.056	1.046	.058	-.059	.171	.959	321	.338
Pair 34	Vp16 movie – Vp16 out	.096	1.602	.089	-.079	.272	1.078	321	.282
Pair 35	Vp18 out – Vp18 with	.466	1.843	.103	.264	.668	4.536	321	.000



8. Integration of Quantitative and Qualitative Visual Assessment Methods

Pair 36	Vp18 movie – Vp18 with	-.016	1.060	.059	-.132	.101	-.263	321	.793
Pair 37	Vp18 movie – Vp18 out	-.481	1.880	.105	-.687	-.275	-4.595	321	.000
Pair 41	Vp60 movie – Vp60 with	.078	.881	.049	-.019	.174	1.582	321	.115
Pair 42	Vp60 movie – Vp60 out	-.898	2.293	.128	-1.149	-.646	-7.024	321	.000
Pair 44	Vp61 movie – Vp 61 with	.040	.873	.049	-.055	.136	.830	321	.407

**Table 8.43** Paired Samples with Significance

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 5	Vp02 movie – Vp02 with	.124	1.069	.060	.007	.241	2.085	321	.038
Pair 7	Vp03 out - Vp03 with	.509	1.959	.109	.294	.724	4.664	321	.000
Pair 9	Vp03 movie – Vp03 out	-.537	2.034	.113	-.760	-.314	-4.740	321	.000
Pair 10	Vp04 out – Vp04 with	.255	1.723	.096	.066	.444	2.652	321	.008
Pair 13	Vp06 out – Vp06 with	.307	1.969	.110	.092	.523	2.802	321	.005
Pair 15	Vp06 movie – Vp06 out	-.351	1.935	.108	-.563	-.139	-3.255	321	.001
Pair 16	Vp08 out – Vp08 with	.214	1.695	.094	.028	.400	2.269	321	.024
Pair 29	Vp15 out – Vp15 with	.478	1.937	.108	.266	.691	4.431	321	.000
Pair 31	Vp15 movie – Vp15 out	-.385	1.962	.109	-.600	-.170	-3.521	321	.000
Pair 35	Vp18 out – Vp18 with	.466	1.843	.103	.264	.668	4.536	321	.000

8. Integration of Quantitative and Qualitative Visual Assessment Methods

Pair 37	Vp18 movie – Vp18 out	-.481	1.880	.105	-.687	-.275	-4.595	321	.000
Pair 42	Vp60 movie – Vp60 out	-.898	2.293	.128	-1.149	-.646	-7.024	321	.000

The paired samples which are identified to be of significance are documented in Table 8.40. The findings of this table indicate that there is no correlation of perceived amenity loss or change relative to the motion of turbines and static representations. The only viewpoint which was identified to have any significance in perceived value was viewpoint 2 which is within 500m to an array of turbines. At this viewpoint the turbines are viewed as large dynamic elements.

The significance of scenes with turbines and without has a stronger relationship with paired samples for viewpoints 3, 4, 6, 8, 15 and 18 identified. Table 8.41 documents the significance values for these viewpoints.

**Table 8.44** Viewpoint significance

Viewpoint 3	t=4.664,df 321,p<0.001
Viewpoint 4	t=2.652,df 321,p<0.008
Viewpoint 6	t=2.802,df 321,p<0.005
Viewpoint 8	t=2.269,df 321,p<0.024
Viewpoint 15	t=4.431, df 321, p<0.001
Viewpoint 18	t=4.536, df 321, p<0.001

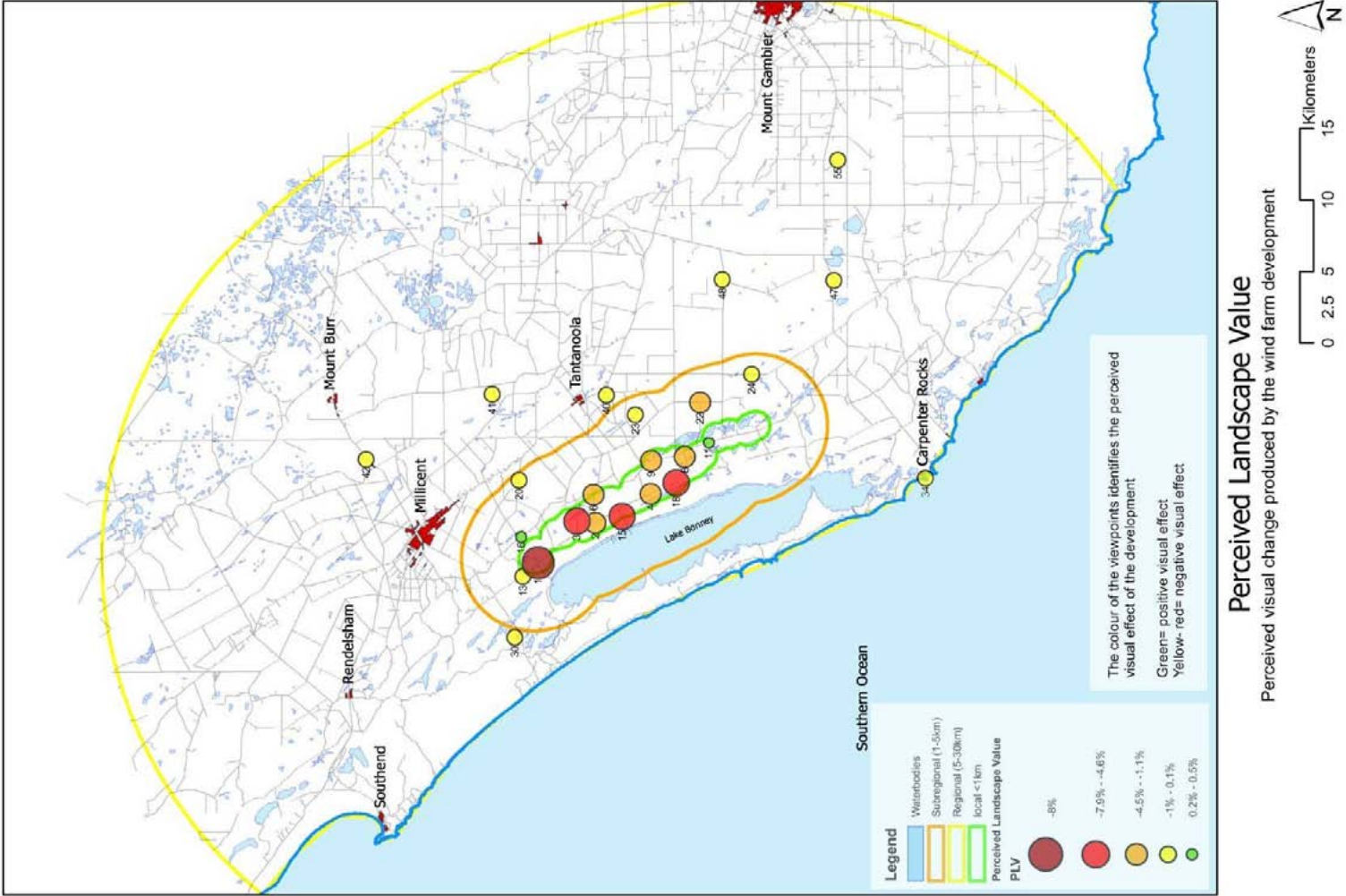
These viewpoints are located within the local landscape zone (<1km) highlighting that the distance of effect has a distinct connection to the probability of perceived landscape variance. Further analysis of the results highlights the significance of viewpoints 3, 6, 15 and 18 which have a variance in perceived value according to the presence of the turbines and moving blades. This correlation strongly suggests that viewpoints 3, 6, 15 and 18 provide a degree of sensitivity to change. Being located within the development site to the north, north-east, west and south-west, opportunities for strategic mitigation techniques will need to be localized to these viewpoints.

Figure 8.43 illustrates the correlation between dynamic scenes and those with turbines. The insignificance of perceived variance justifies static representation surrogates for surveys in lieu of dynamic displays. Consequently, this research has found that the effect of simulated scenes of wind farms has limited perceived variance as representational media. Furthermore the results of static versus dynamic, could possibly be explained by the concept of synaesthetics, because people know that turbines rotate they imagine the blades rotating even if they perceive static images.

The landscape value for scenes without turbines was greater for all but five viewpoints (VP01, VP09, VP11, VP13, and VP16). Given none of these viewpoints have a significant value of perceived change there is no correlation between the landscape value within the range of 4.42-5.28 and any aesthetic improvement. Given the landscape character of the region was an average of 5.21 which is classified as low to moderate, the degree of visual effect on the landscape imposed by the wind farm development would be expected to be minimal. Lothian (2008) found that the impacts of wind farms on inland scenes with a perceived value greater than 5.1 would generally detract, which holds true for viewpoints 3, 4, 6, 8, 15 and 18.

The following Figure 8.44 illustrates the perceived difference or what has been labeled Perceived Landscape Value (PLV). This illustrates the degree of variance between scenes without and with turbines.

Figure 8.44



### 8.5 VISUAL IMPACT: DIFFERENCES IN SCENIC BEAUTY EXPLAINED BY ACTUAL VISUAL CHANGE

As stated in previous chapters there are two schools of thought about visual assessment. The different schools of thought are defined by whether the landscape has inherent qualities which permeate visual amenity value or that visual amenity is determined by the eye of the beholder.

Within this case study two assessment processes have been conducted to validate a quantified measure of landscape visual modification in what has been referred to as the Percentage of Visual Change (PVC) and landscape sensitivity or Perceived Landscape Value (PLV).

This dissertation has considered both paradigms of visual assessment with theoretical reference to landscape perception studies (Bell, 2004; Appleton, 1975; Kaplan & Kaplan, 1982; Lothian, 2000)

The objective of generating a model based on the foundations of various theorems has driven the process to calculate two separate values, which provide quantification of what visual modifications

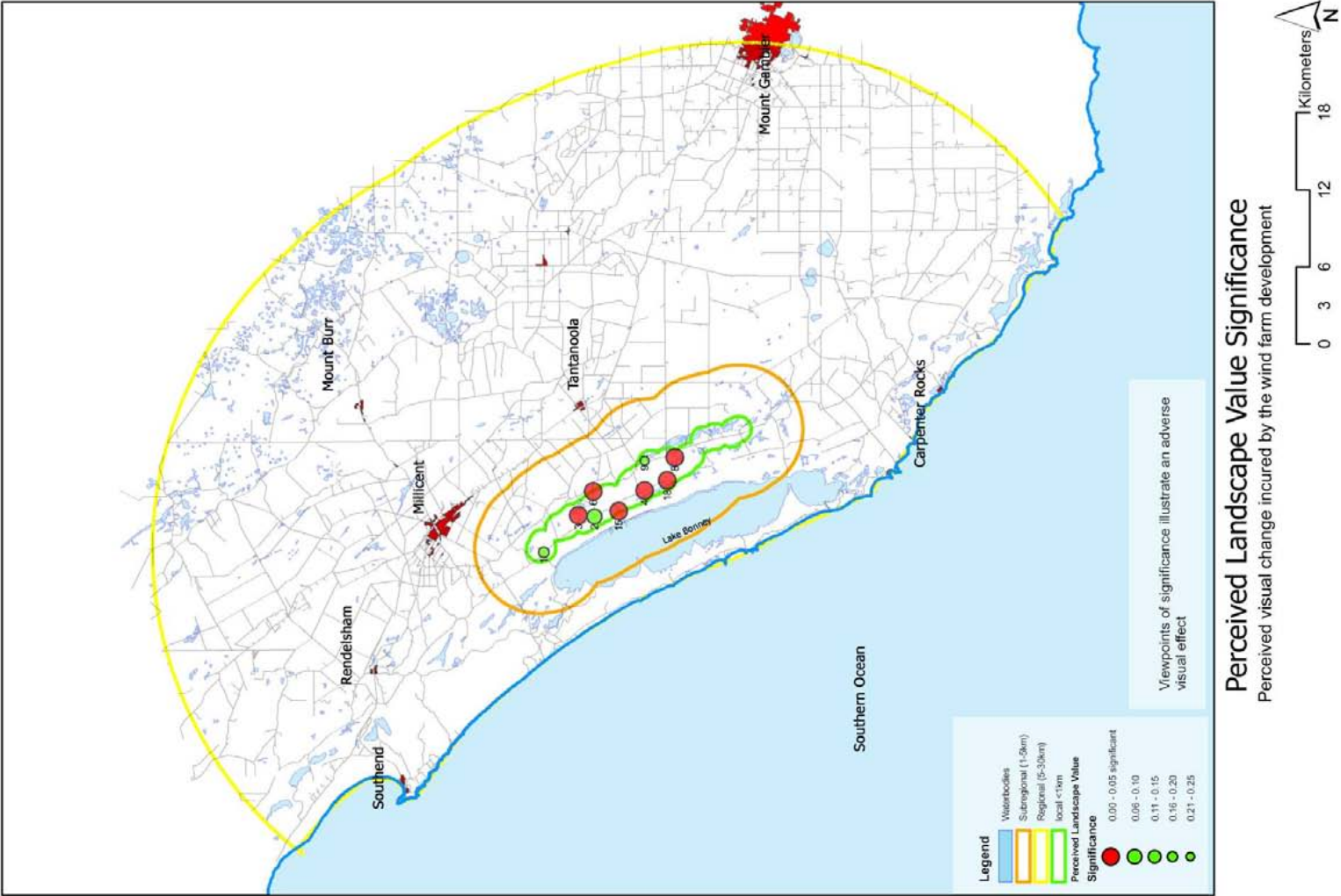
potentially transpire by development and also to substantiate certification on the degree of community value on a particular landscapes amenity value prior and post to development.

The values ascertained for each process of assessment cannot be aggregated to formulate a combined value of visual impact. Theory advocates a process in which both models are examined in isolation with geographic reference to specified viewpoints.

Consequently the visual impact assessment of a proposed development requires a mapping process of identifying areas of visual sensitivity using significant values for PLV and then overlaying values of assessment for PVC.

The identification of PLV is derived from a general cross-section of the population, removing any potential bias. The values provide an indication from each specified viewpoint of the likely impact or improvements to visual amenity caused by the development. Figure 8.44 illustrates the difference of perceived effect of turbines from the viewpoints, whereas Figure 8.45 illustrates the significance of effect interpreted through paired sample significance testing.

Figure 8.45



The classification of perceived significance of change provides a hierarchy for assessing particular viewpoint visual modification. For example viewpoints 3, 4, 6, 8, 15 and 18 all have a significant adverse impact. Table 8.42 documents the variance in visual change for these viewpoints.

**Table 8.45** Difference in mean values

Viewpoint	Without Turbines	With Turbines
3	5.95	5.46
4	5.36	5.12
6	5.41	5.1
8	5.58	5.34
15	5.21	4.73
18	5.71	5.25

These viewpoints can be analysed in more detail to interpret how the visual influence is created through horizontal, vertical, absorption capacity and landscape character value classifications. From the analysis a series of design mitigation recommendations can be discussed.

### **Viewpoint 3**

The visual change of the wind farm from this viewpoint is defined by the extensive horizontal field of view and limited absorption capacity. The linear array of the development extends to the south-west. Due to the elevated ridge and elevation of the viewpoint there is limited opportunity to mitigate the effect. The horizontal effect could be minimized by planting vegetation to the north-east array of the development. Due to the scale of the development being viewed as lower elements on the horizon, vegetation would absorb the development and reduce the horizontal field of view.

### **Viewpoint 4**

This viewpoint is characterized by a rising vegetated local ridge. Scattered copse of trees and native grass dominate the foreground to the south-east. Due to the close proximity to the wind farm there is limited opportunity to screen the vertical scale of the turbines. Furthermore, due to the close proximity the extent of the horizontal effect encompasses greater than 100% of the field of view. In conclusion the visual effect from this locality is significant with limited opportunity to reduce the effects.



### **Viewpoint 6**

The visual change of the wind farm is defined by an extensive horizontal field of view. Absorption capacity is limited by the lack of vegetation coverage with a canopy structure. From this observation point the development is seen as a series of clusters within a larger linear array. Due the scale of the development and open panoramic view, there is limited opportunity to mitigate the effects. A vegetation buffer to the cadastral boundary would only provide a local screen, with glimpsed views and similar effects experienced to the north and south of the eastern side of Woakwine Range.

### **Viewpoint 8**

The visual change of the wind farm from this aspect provides a panoramic view of several turbines on a ridgeline to the mid-ground. The landscape scene is characterized by the defined low lying ridge which limits the depth of field of view to approximately 750m. There is limited vegetation of human scale to the foreground which amplifies the visual effect of the wind farm. Due to the limited amount of vegetation and topographic variance to the foreground, the ability of the landscape to absorb the scale of the development is limited. Some suggested mitigation techniques

would be to plant shelter belts of native trees to the road verge providing a vertical oblique screen which dissects the horizontal field of view and provides absorption capacity.

### **Viewpoint 15**

The visual change from this observation point is defined by the extensive horizontal effect and limited landscape absorption. The effect transcends along the ridgeline to north-east. The clustering of the turbines to the north-east creates a complex overlay of flickering blades which limits the degree of legibility. Due to elevated ridgeline and limited vegetation to the foreground in the adjacent property the visual effect is considerable. To improve the visual character and limit the degree of visual impact from this viewpoint it can be suggested that native tree planting to the cadastral boundaries and roadside verge would screen and limit the degree of the horizontal.

### **Viewpoint 18**

The close location and extent of the horizontal field of view occupied by the development produces a significant visual change. Limited vegetation to the property boundary provides open panoramic views towards the north-east and south-east. The

scales of the turbines to the north-east are significant, dominating the field of view. From this aspect the relocation of the closest turbines further to the north-east would reduce the vertical scale, whilst additional vegetation to the property boundary would also provide some relief.

### 8.6 SUMMARY

The framework of this assessment process has been guided by the Planning SA (2002) 'Advisory Notice Planning- Draft for Consultation 21. Wind Farms' and the National Assessment Framework (2007). The assessment has considered two separate processes which are guided by different schools of thought.

The first stage of the process was to review existing literature and collate digital information for GIS mapping. The digital terrain model produced for the site enabled a ZTVI to be produced. The ZTVI is a valuable mapping technique to identify areas within the landscape of potential visual sensitivity to the development proposal.

The second process was to calculate a value of landscape visual change in a quasi-objective assessment. The GrimKe matrix was

used as a precedent in this process to validate a value for Percent of Visual Change (PVC).

The process of calculating the potential visual change to the landscape incurred by a wind farm proposal is guided by a staged process incorporating landscape character assessment in a base line amenity value referring to topography, vegetation, existing built form and known cultural references.

The second stage of the process was to manufacture representations of the landscape from selected viewpoints. Dynamic representations of the turbine blades rotating were produced for viewpoints within the sub-regional and local zones where the turbines were still clearly visible. These images were used in a subsequent survey assessment process.

The GrimKe matrix calculated values for the Percent of Visual Change (PVC) through an aggregate assessment of horizontal, vertical, distance, and landscape absorption capacity. The value took into account the physical visual changes incurred by the development.

The second phase of assessment was conducted as an objective evaluation of subjective responses. An Internet survey was

conducted to generate landscape perceived values for the identified assessment viewpoints. The survey sample was a generic cross reference of the public with invitations to participate distributed by mail, email, advertisements on web pages and word of mouth.

The results of the survey provided an objective value of the perceived visual change to the landscape incurred by the wind farm development. This value was either an adverse or beneficial effect to the landscape visual quality.

The results of the survey provided no indication of perceived significance or preference for or against dynamic images.

Further to the assessment process, the framework suggested by Planning SA (2002) 'Advisory Notice Planning- Draft for Consultation 21. Wind Farms' recommends the accumulation or adaptation of physical and perceived values of landscape visual effects are assessed and incorporated into a value of visual impact.

Due to the two separate assessment processes being based on different theoretical schools of thought, they cannot be empirically combined. Hence the process of assessing the subjective, social

interpretation of landscape values and objective values of the landscape physical change needs to be evaluated spatially. Technological tools such as GIS provide geographic databases which enable analysis of different theoretical methods in a new holistic approach to landscape evaluation.

GIS has been instrumental in the development of the method produced in this dissertation. The process has integrated both schools of thought into a holistic assessment which interprets public perceptions through a survey sample, evaluating landscape sensitivity values. The aesthetic response of the development is assessed as a positive or negative effect which enables a hierarchy of viewpoints to be evaluated.

Firstly the hierarchy of viewpoints determines the significance of aesthetic variance incurred by the implementation of the development and secondly for potential mitigation using the Grimke matrix as an analysis design tool. This process seeks ways of providing community engagement in the survey consultation and secondly to identify areas of negative visual effect which can be classified and a potential mitigation strategy recommended.

## 9 DISCUSSION & CONCLUSIONS

### 9.1 THEORY OF LANDSCAPE VISUAL ASSESSMENT

There are several aims and objectives of this research. They are to;

- Analyse the current theoretical discourse of visual impact assessment for wind farm proposals.
- Develop a reliable, credible, practical, flexible and efficient visual assessment methodology for wind farms which integrates tangible and intangible values of perceived and physical changes caused by development.
- Develop a visual assessment model which uses dynamic media and geographic information systems (GIS) to accumulate landscape visual sensitivity values and objective values of landscape visual change for wind farm developments.
- Utilise an existing wind farm developed at Lake Bonney, South East of South Australia to validate and test the model.

In a structured theoretical framework, this dissertation has researched the discourse of aesthetics, which has provided

foundations for a discussion on how and why people appreciate particular landscapes. Numerous theories have been discussed from empirical research, which have formed the majority of landscape aesthetic preference studies (Zube *et al* 1982).

Chapter 2 discusses the historical context of aesthetic philosophy elaborating on theories developed by Socrates, Plato, Aristotle and Kant. The notion of beauty and presence of aesthetic qualities inherent in objects and intangible qualities of aesthetic experience have been debated. The relationship between aesthetic experiences and landscapes is relative to sensual, cognitive and subliminal phenomena. Vision is but one form of a comprehension, interpretation of landscapes which provides an aesthetic response.

The notion of biological and cultural intuitive responses to landscapes stimulates the debate on whether landscapes have inherent qualities or are valued and perceived in 'the eye of the beholder'. The interaction of humans and landscapes and relationship of aesthetic experiences has been explored by numerous research topics. However, what has been lacking to date is a theoretical framework which crosses these boundaries seeking relationships between these two schools of thought about aesthetics.

In Chapter 2, the review of aesthetic philosophy and landscape preference studies highlights a piecemeal approach to research objectives and theoretical frameworks of landscape aesthetics. There is no uniform framework referring to a particular philosophical disposition. Consequently the theories that have been developed are incomprehensive, limiting the development of certified methodologies of landscape visual assessment.

The stimulation and comprehension of landscapes through a visual medium is associated to theories of perception. People perceive landscapes through all five senses; sound, touch, taste, smell and vision. Vision is the dominant interaction with landscapes. The former senses are more reflective of emotive experiences.

Chapter 3 reviewed Gestalt psychology illustrating the association of aesthetics and perception. The origins and laws of perception have been critiqued to explain theoretical constructs of visual assessment as a philosophical and practical tool in planning applications for development.

The concepts of proximity, similarity, symmetry, closure and continuation derive the tools of how we perceive and comprehend objects and landscapes. The landscape is perceived in its entirety, not as a piecemeal dislocation of its parts. Consequently it is believed that the brain seeks ways of organizing the elements of the landscape into a logical order for comprehension.

Further discussion on visual segregation of elements within landscape settings is explained by concepts of figure and ground. The interchangeable quality of figure and ground has provided an insight into how people perceive different mediums. This established principles of the object's shape as it belongs to the figure and not the ground. This is an inherent principle for later discussions on wind turbines as an aesthetic element.

The mechanics and physiology of vision is important to understand in deciphering a theoretical framework for the aesthetic perception of wind farms. Vision is a dynamic process of foveal and peripheral modes. Even static images are experienced in a dynamic process of light projection onto the cones and rods of the retina. The extent of landscape occupied within the visual field of view is a combination of peripheral and binocular vision which provides colour discrimination and depth of field. The depth of field is relative

to stereoscopic representation permeating a sense of scale and distance, when interpreting reference elements in the landscape. This enables the occupant to orientate themselves and comprehend the landscape with a sense of immersion.

Landscape aesthetic preference studies have considered how and why people perceive, immerse and comprehend aesthetic experiences. Numerous models have been developed over the years by researchers to explain the qualitative nature of aesthetic experiences.

Habitat theory explains inherent qualities in the landscape, whereas information processing theory argues that cultural intuition conveys aesthetic stimuli to certain landscape contexts. Nevertheless the debate continues, as no definitive dialogue has laid foundation for a uniform landscape aesthetic framework. Consequently methodologies for landscape visual assessment are limited in the theoretical integration of perception and the philosophy of aesthetics. It is imperative that in the future development of analysis tools, these theories are considered and tested.

Chapter 4 developed a detailed analysis and discussion on landscape aesthetic assessment and divergent research methodologies. The concept of landscape as a visual resource was discussed with connotations to various representations and surrogate forms. The process of pictorial representation and comprehension of landscapes through classification was described.

Landscape management of visual resources dates back to the 1960's where it was integrated into landscape preservation and conservation research. This field of research laid foundations for various practical methods and tools which were used to value landscape visual qualities.

Several schools of thought developed, namely Professional (Formal Aesthetic), Ecological, Behavioural, Psychophysical, Cognitive (psychological) and Experiential. These schools of thought differ in their explanation and association of landscapes and human experiences. Ecological and formal aesthetic are analogous to expert opinion whereas psychological and phenomenological are analogous to the cognitive and experiential. In other words there are two separate theoretical constructs of how landscape aesthetic responses are perceived; either as inherent qualities within the landscape or as intangible qualities in 'the eye of the beholder'.

These varying schools of thought have been reviewed and related to methodological frameworks for visual assessment of landscapes. The two current practical methods used for visual assessment of wind farms have been referred to the formal aesthetic and psychophysical.

The criteria to evaluate the success of a particular methodology can be referred to the model's reliability, sensitivity, validity and utility. These fundamental principles are considered in the conception of the model derived in this dissertation.

Various models have been used in practice to evaluate the visual quality of landscape. Some of these include the Visual Management System (VMS), Landscape Character Assessment, Law of Comparative Judgments, Scenic Beauty Estimation and Landscape Quality Assessment.

The omission of a unified methodological and theoretical approach to visual assessment has resulted in a series of questions allied to the assessment and development of the wind farm industry.

## **9.2 WIND FARMS A NEW TECHNOLOGY IN AN EVOLVING AUSTRALIAN VISUAL LANDSCAPE**

Wind Farms are but one form of renewable energy which is an economically feasible alternative or supplement to base load coal furnace electricity production. Wind turbines represent a vastly different industrial fabric with specific site requirements for efficient energy generation. Wind farms must be located where strong wind permeates and located close to the grid for connection. This typically is associated with rural, agricultural / coastal landscapes on the urban fringe of settlement. Generally these localities give rise to a number of potential issues including, scenic preservation of landscapes, noise concerns, avian activity, electromagnetic radiation interference, cultural and indigenous values, as a potential aviation obstacle, and lighting as a nocturnal visual effect.

The visual effects have commonly been referred to as the most unfavourable issue with consideration of the subjectivity of perception and assessment procedures.

Several studies of the visual effects of wind turbines have varied in their objectives. Primarily their objectives are to discuss the physical properties of wind turbines and the relationship of colour, scale, form and site design. Secondly, studies have been

conducted into the perception and acceptance of wind turbines on a broader global issue of renewable energy production.

Thirdly, studies have been conducted on a specific development assessment case by case, and this process has commonly been conducted as part of an Environmental Impact Assessment.

This dissertation has set out to devise a methodological framework which seeks to integrate quasi-objective procedures with the combined values of subjective perceived community responses in a site specific case by case assessment. The model seeks to provide flexibility to enable a comparative appraisal of sites identified for wind resource and efficiency of energy production. Further, the model has sought to address the capability to assess the site layout design in relation to perceived community response, topography, existing vegetation and the extent to which the development occupies the field of view.

### 9.2.1 Implementation of a National Assessment Framework

The Australian Wind Energy Association and Australian Council of National Trusts (2007) developed a framework for Wind Farms and Landscape Values. The intention of this framework is to provide guidance in a transparent, methodological assessment for evaluating and managing the impact of wind farms on landscape

values. However, upon review of the framework there is scope to adapt the process to suit different forms of development such as solar arrays, mining and large infrastructural forms.

This framework is also dependent upon many factors including the quality and independence of professional assessment with specific skills needed to value the landscape and potential impacts. Further, there is a need for skilled interpretation and evaluation of potential mitigation techniques. Landscape Architects can provide skills in landscape natural system comprehension and qualitative judgments on aesthetic values to provide an informed decision on whether the development is suitable.

The framework is connected to the development and regulatory assessment process by way of a two staged process:

- **Stage 1** Site selection and pre feasibility
  - Step 1 Assess Landscape Values
  - Step 1a Preliminary Landscape Assessment
- **Stage 2** Environmental Assessment conducted as part of the detailed development application.

Stage 1 necessitates the proponent deriving the locality and feasibility of the project before proceeding into the expense of detailed landscape assessments, wind monitoring and various



other impact assessments. The framework recommends the identification of potential community and stakeholder values of the landscape or known significant landscape features. This would typically be reviewed as desk top studies with a potential broad-brush site assessment. During the early stages of site identification, the framework should incorporate a review of a strategic environment assessment (SEA) because there is no reference to national strategic guidance based on research which identifies qualitative landscape aesthetic values for landscape character regions. The provision of a map which identifies areas of significance, high aesthetic value, conservation or 'no go zones' would be a valuable document in the initial stages of site identification. Methodologies have been developed to conduct this research.

Lothian (2000) developed a process of qualifying the values of landscape visual amenity as a SEA for landscapes in South Australia. SEA can determine the environmental, social and cultural suitability of land use and potential developments. This process and the landscape value assessment could be an essential component of the preliminary identification of landscape character regions suitable for wind farm developments. This guidance would provide proponents with a streamlined preliminary identification of any potential major visual amenity concerns.

Further, the development of a SEA would provide informative guidance on the sensitivity of the landscape context which could highlight concerns on cumulative effects of numerous developments within a landscape region. Hence threshold values of development could be assessed for potential saturation of the character and amenity of the landscape.

The development of an SEA would need to be conducted as a government-based independent, planning assessment. It could be conducted within each state and territory or as a Federally funded consultancy. The objectives would be to produce a landscape quality map of Australia which identifies values of particular geographic regions, based on a statistically non-biased community response. The maps could be used for further development assessment guidelines for each state and territory.

If the landscape quality of a particular region is relatively high, with strong community interests, a decision to proceed to Stage 2 (detailed site assessment) may require further investigations. In these areas of high landscape amenity value it is critical that a more detailed process is conducted.

Stage 2 of the assessment framework has been divided into several steps. The process is derived to assess the effects of a sole development. The steps are as follows:

- **Step 1b:** Full Landscape Assessment
- **Step 2:** Describe and Model the Wind Farm in the Landscape
- **Step 3:** Assess the Impacts of the Wind Farm on Landscape Values
- **Step 4:** Respond to Impacts

Visual assessment is but one form of landscape assessment. Natural and cultural values of landscape can be attributed to varying factors which can be inherent or intuitive. These variables need to be assessed as separate assessments with the need to evaluate and compare values geographically. The model developed in Chapter 8 has provided a process and tools which enable the visual assessment of a proposed development to be examined as a holistic opportunities and constraints evaluation. Using Geographic Information Systems provides a data base tool to develop assessment procedures.

### 9.2.2 Modeling the Visual Effects of the Wind Farm

The model developed in Chapter 8 has responded to the National Assessment Framework specifically to steps 1b, 2, 3 and 4. The main aim was to provide objectivity which enables reliability and validity to be ascertained. Within this process several objectives have also informed the development of the methodology:

- **Reliability**

The model has been developed to be replicated by different consultants with the same conclusions. This eliminates inconsistencies in subjective interpretations of potential visual effects.

- **Validity**

The model is credible due the evaluation process referencing what is seen within the landscape and statistically non-biased landscape values. The visual effect is measured as the visual change from a particular viewpoint being assessed and reviewed against the statistical deviation of subjective values of the scene before and representations of the scene post construction.

- **Sensitivity**

The model is sensitive to changes in the properties of the development that is being assessed. Hence the model is able to review changes to the design of the turbine site layout or turbine

size and calculate potential landscape visual capacity to eliminate adverse effects. The model also accommodates community sensitivities to landscape values, thus providing guidance on positive and negative visual effects.

- **Utility**

The process developed in Chapter 8 involves two separate assessment procedures conducted in parallel. Due to the differing theoretical paradigms of assessment the two methods cannot be combined empirically, however can be geographically referenced for site assessment opportunities and constraints mapping in a GIS cartographic analysis.

The GrimKe matrix used to evaluate the Percentage of Visual Change (PVC) is an efficient, practical and flexible process which is reasonably low cost to employ. The method is also flexible in that it can be used to assess varying development forms such as mine expansions and various different landscape contexts. The model also provides flexibility in its ability to review design changes to the proposed project and calculate various different design schemes for best visual design outcomes.

The Perceived Landscape Values (PLV) assessed by means of an internet survey of landscape representations, is also an efficient

process. This method of assessment used to be laborious in nature due to the number of consultation surveys required to realise a statistically valid survey sample. It was also time consuming to collect the data and process into a respectable form for analysis. However, technological advances with the internet have enabled a vehicle for autonomous data presentation, collection and processing.

Further, the survey study provides a tool to explore the perceived values of dynamic representations. Turbines are a dynamic element without a precedent scale. The survey assessed viewpoints with static turbines, without turbines and with an animated representation of the blades rotating. The findings of the survey imply that dynamic images do not have a significant perceived variation to static imagery.

### 9.2.3 Limitations of the Model

Limitations of the model can be attributed to the viewpoint selection not being supported by the local community. The objective selection of viewpoints using a grid cell matrix with reference to the ZTVI is an efficient process of identifying localities within the local, sub-regional and regional areas as well as from the north, south, east and west. However it does not engage community and all

specific cultural reference points. An alternative approach could be adopted in the initial stages to engage the community in an iterative mapping exercise identifying viewpoints.

An important finding in the development of the National Assessment Framework (2007) was that direct community input is either essential or recommended in each step. The framework acknowledges that any community engagement must encompass a broad stakeholder identification and communications plan.

The communications plan should incorporate transparency of information in relation to the latest design, construction techniques, wind farm life span and landscape management, and a decommissioning plan.

Another limitation of the model is the relative inflexibility of the Perceived Landscape Value (PLV) assessment in valuing potential changes to the design layout of a proposed project. It would be an inefficient laborious task to conduct a second survey for a revised design layout.

The integration of dynamic images into an internet survey can have technical inconsistencies. The speed of the internet server bandwidth and file sizes can hinder the quality of the visualization. The

time it takes to load an animation and the speed to which it is processed can alter the dynamics and perceived quality. Hence the findings of the survey are not comprehensive. Further research needs to investigate whether dynamic visual representations of wind farms affect people's perceptions.

### 9.3 ACHIEVEMENT OF DISSERTATION

The derivation of the model developed in Chapter 8 has referred to theories of aesthetics, gestalt, physiology, psychology and landscape preference studies. The process of using two separate parallel models as a combined holistic geographically referenced evaluation reinterprets an aesthetic school of thought to encompass tangible and intangible qualities of landscape. The GrimKe matrix uses homogenous inherent qualitative measurements, whereas the perceived visual change examines intangible values of landscape visual properties objectively.

Landscape preference studies have been referenced in the development of the preliminary field assessment and Visual Landscape Character Value. Topographic relief, vegetation cover and the presence of existing built form identifies landscape patterning. These elements of landscape are reviewed from the

identified viewpoints with regards to complexity, coherence, legibility and mystery (Kaplan & Kaplan 1982).

The main objective of this dissertation was to provide a reliable, credible, practical, flexible and efficient visual assessment methodology for wind farms which integrates tangible and intangible quantitative values of perceived and physical changes caused by development.

The model in Chapter 8 has achieved this aim by producing a theoretically derived, efficient, credible, reliable and sensitive assessment process which utilises several new technologies in a geographically referenced data base.

The model derived and tested in Chapter 8 is flexible enough to be adapted to assess numerous large scale development forms. Mining, solar arrays, transmission lines, telecommunication towers, electricity sub stations, desalination plants are but some of the developments that can be assessed for potential visual effects. It is increasingly imperative to assess the visual impacts of mining developments for the potential changes to landforms both as a reduction and addition. The methodology provides a baseline

referenced assessment of landscape character value and a subsequent evaluation of the visual changes in accordance to physical alterations. Hence it is possible to assess the degree of visual effect that has occurred due to a mine expansion at various stages of its development.

As discussed in Chapter 8 several tools are used to evaluate the visual effect of the proposed development. Of these tools visual representations of wind farms are critical to the validation and credibility of the assessment process. Consequently a secondary research question reflected the hypothesis;

*Static representations and methods of presentation for wind farm visual assessment are inadequate in depicting the dynamics of rotating blades and the resulting impacts on aesthetic values.*

This hypothesis was not verified through the statistical analysis of the survey sample. There is no correlation between dynamic representation and aesthetic values of wind farms.

## 9.4 FURTHER APPLICATION

The model developed has been used primarily as a process for site specific assessment within this dissertation. The next stage of research would be to examine the integration of real time virtual reality geographic information systems (GIS) to engage community responses and values whilst automated values of the degree of visual change can be cartographically mapped. The concept of developing three-dimensional or vertical mapping that illustrates the degree of visual change perceived and physiologically seen, in panoramic scene, could provide a tool for an iterative process of community consultation. This would enable best visual design outcomes to be realised.



**Figure 9.1** Dynamic visual effect representations

This model is useful as a design tool during the initial stages of development. This would be a critical advance in the process of site identification and mitigation of potential visual concerns.

### 9.4.1 Technology

Community participation is a catalyst for the integration of visualisation into the design process. Rather than visualisations being produced merely as glossy advertising images visual tools

should be utilised to engage the public in debate and finally resolution of common goals. Numerous techniques are being established with augmented displays and immersion or stereoscopic displays.

The fundamentals of visualizations are spatial data collection. Concepts of three dimensional GIS representation and analysis have been introduced to assessment processes, highlighting the importance of geo-referenced data.

Opportunities for collaborating with software engineers to manufacture gaming engines for use in interactive consultation processes for various landscape settings are also currently being explored which provide advances in graphic realism and immersion.

#### **9.4.2 Cumulative Assessment**

One critical component of site specific assessment that is not currently resolved in development application assessments and visual assessment methodologies is the potential effects of numerous developments within the same regional locality.

As the wind power industry expands into regional landscapes, the land available with wind resource will become scarce. The number

of turbines within areas of consistent wind resource will at some stage reach a point of landscape character saturation. In other words the visual effect imposed by the development will impede detrimentally on the landscape amenity.

The model developed in Chapter 8 provides the foundations to assess threshold values of landscape sensitivity with an indication of the degree of visual change. Hence, a research study could be conducted to regulate the number of turbines that can be absorbed within a particular geographic locality, providing guidance for landscape amenity preservation and the development of sustainable energy generation.

### **9.5 FUTURE RESEARCH QUESTIONS**

As conservation of visual landscapes becomes more prevalent in determining development applications for numerous large scale infrastructure projects such as wind farms, solar farms, transmission lines and mining, the need to assess and assist in developing decommissioning plans and landscape management plans is imperative.

Future research topics could review the visual effects of development decommissioning with regards to social and cultural perceptions. In addition a review of community engagement and consultation processes and visual assessment of landscape management plans could provide impetus for a proactive iterative design approach to development assessment. Consequently the following research questions have been derived:

- Can landscape management decommissioning plans for wind farms and mine proposals be assisted by the GrimKe matrix or similar site specific visual assessment model?
- Can an iterative internet design charette, utilising the GrimKe matrix or similar model, be incorporated into the planning of site specific wind farm or mining proposals?