Exploring development offsets as a tool for conserving ecosystem services

Paper 1

Ecosystem Services and Rural Residential Development – A Case Study of the Murrindindi Shire of Victoria

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This paper is the first paper in a series describing the impact of rural residential development on ecosystem services and outlining a market based approach to maintain and protect ecosystem services during rural residential development. Other papers in this series are:

- "Deciding on a management action – Why market based instruments and which kind?"
- "What are development offsets and how do they work – an introduction to development offsets"
- "Nesting in current institutions and frameworks – importance and issues"
- "Development offsets for Murrindindi Shire – challenges, opportunities and realities"
- "Development offsets for Murrindindi Shire – summary of research to date"

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Executive Summary

Land can be used for many purposes, including housing, roads and car parks, agricultural production and open public space (from public parks in urban areas through to remote conservation areas). Different land uses generate alternative sets of production goods and ecosystem services, some of which are well known to us whilst others are less so. For example, we commonly think of agricultural land as producing wheat for our bread, cotton for our clothes and fodder for farm animals. However, different mixes of land use, including agriculture, can also produce other goods and services with social, economic and environmental benefits such as clean air, vegetation and biodiversity conservation and good surface and groundwater quality. These other goods are often referred to as ecosystem services.

The mix of land use products is, in part, driven by the incentives, such as prices, provided to landowners for their products. For example, agricultural produce, such as wheat, is extensively traded in the market and as a result, prices for agricultural goods are both observable and widely known. The market and pricing of these products provides a means for consumers to signal their demand for these goods and an incentive for landholders to produce these products. But what happens when not all products from land use are priced in the market place?

The environmental outcomes of land use choices are a bundle of products which remain outside of the market and pricing framework. As a result their value cannot be observed as market prices, nor captured by landholders in exchange for their provision. With no market for goods such as ecosystem services, those who demand the production of these goods cannot signal this to the suppliers of the good, and those who can produce these goods are not rewarded for the benefits that they provide. As a result, environmental goods remain external to the production process and the provision of these goods is often less than what is desired.

Land use can also change. Native vegetation can be cleared to make way for more agricultural land, or agricultural land can be subdivided and sold off for housing. Many catchments across Australia are experiencing a rapid rate of land use change. A key driver in the neighbourhood of many Australian cities is a demand for rural residences and lifestyle farming opportunities (rural residential development). A change in land use generates a different mix of priced goods and unpriced ecosystem services. Thus land use change tends to favour production of priced goods and development options rather than production of ecosystem services.

Rural residential development (RRD) is described by the Murrindindi Shire Council as residential development catering for persons seeking a rural lifestyle based on a high level of rural amenity that may or may not involve agricultural activity (Habitat Planning, 2003). RRD commonly occurs in four different forms: low density rural residential development, lifestyle farms, hobby farms, and rural retreats. Whilst each of these types of RRD retains a non-urban character, the key to the impact of the development on surrounding properties and the environment is the spatial distribution of each land use and the purpose and type of land use (Archer, 1977).

One particular region experiencing RRD is the Murrindindi Shire, located in the upper foothills of the Goulburn Broken Catchment of Victoria. Whilst RRD is attracted to

the Murrindindi Shire by the provision of ecosystem services, this same RRD has the potential to negatively impact on the provision of these valued ecosystem services. This threat is heightened by the fact that ecosystem services are declining with current land management even before RRD takes place. The Murrindindi Shire Council along with the Goulburn Broken Catchment Management Authority understand the potential threat to ecosystem services of RRD, but also the potential of land use change as an opportunity to conserve ecosystem services. This paper is the first in a series of papers that explores the policy options that could be used to conserve the ecosystem services in an environment of rural residential development.

Binning *et al* (2001) notes that ecosystem services important to the production of housing in the Goulburn Broken catchment include life fulfilment, maintenance and regeneration of habitat, provision of shade and shelter, waste absorption and breakdown. RRD often impacts on the very ecosystem services that it demands. This impact occurs through a number of actions including the clearing of native vegetation, predation by domestic pets, and the fragmentation of habitat. At the same time RRD also impacts on ecosystem services that may not be demanded in the production of housing but are demanded by other agents in the catchment.

The impacts of RRD can be both positive and negative. When combined with declining ecosystem services associated with current land management, the result is more often than not a level of ecosystem services somewhere below what is provided before development.

This has a number of implications:

1. RRD purchasers, who buy land based on an expectation that current ecosystem services will continue, will not be expecting this decline or the consequent impacts on their welfare;
2. Because the net impact of RRD on the level of ecosystem services is uncertain, RRD could see a faster rate of decline in the natural asset base and the ecosystem services that these assets provide; and
3. RRD reduces the area of land available to meet broader ecosystem services targets in the future, this could potentially compound the problem of supply of ecosystem services into the future.

This research report is the first in a series of papers exploring the policy options available for the conservation of ecosystem services whilst also allowing for RRD. This paper explores the questions:

- What are ecosystem services?
- Which ecosystem services are impacted by rural residential development and why?
- Why are ecosystem services under threat in the context of rural residential and lifestyle farming land uses in the Murrindindi Shire?

This paper concludes that there are a number of gaps in the information required to fully describe the problem. These gaps are primarily associated with understanding

the cause and effect relationships between the type of rural residential development and the provision of ecosystem services. Some fundamental questions that need to be answered at this stage include:

1. What mix of RRD is expected in the Shire?

2. How will these types of RRD manifest on the ground?

3. How will the different expected types of RRD impact on ecosystem services?

4. What characteristics of these ecosystem services are valued? Are there overlaps or priorities?

It is important that these gaps in the information and relationships are filled in order to effectively manage the problem.

1 Introduction

A number of important ecosystem services are provided by the environmental assets in our catchments. These services include the provision of clean water and the maintenance of biodiversity and liveable climates.

Different land uses generate alternative sets of production and ecosystem service outcomes. Some of these products and services are priced in markets while others go unpriced. For example, agricultural produce, such as wheat, is extensively traded in the market and as a result, prices for agricultural goods are both observable and widely known. On the other hand, environmental outcomes of land use choices such as clean air, vegetation and biodiversity conservation, run off and surface and groundwater quality are generally 'externalities' to the production process. Because these environmental goods are not traded, their value cannot be observed as market prices nor captured by landholders in exchange for their provision.

A key driver of the range and quantity of ecosystem services produced is the use to which land is put. Land uses are rapidly changing in many catchments across Australia. A key driver in the neighbourhood of many Australian cities is a demand for the rural residences and lifestyle farming opportunities. These land use changes represent both a potential threat to the ecosystem services generated but also an opportunity to preserve the existing ecosystem services that are an important factor in the demand for land.

Murrindindi Shire, located within easy driving distance of Melbourne, is one area where land use is being converted from relatively low intensity, extensive grazing enterprises to lifestyle farming, hobby farming and rural residential areas. The growth in these land uses may change the scale and mix of ecosystem services generated within the catchment. For example, more intensive settlement may generate increased nutrients reducing water quality in the Goulburn Broken Catchment.

Murrindindi Shire Council has been investigating and improving broader planning framework within the Shire and is interested in the potential ecosystem services impacts of rural residential and lifestyle developments. Similarly the Goulburn Broken Catchment Management Authority (GBCMA) is concerned about ecosystem services impacts at the local scale as well as any downstream or catchment scale impacts.

As the first in a series of papers identifying the issues associated with the development of a market based instrument (MBI) to manage, maintain and enhance the ecosystem services of a catchment experiencing rural residential development, this paper explores the questions:

- What are ecosystem services?
- Which ecosystem services are impacted by rural residential development and why?
- Why are ecosystem services under threat in the context of rural residential and lifestyle farming land uses in the Murrindindi Shire?

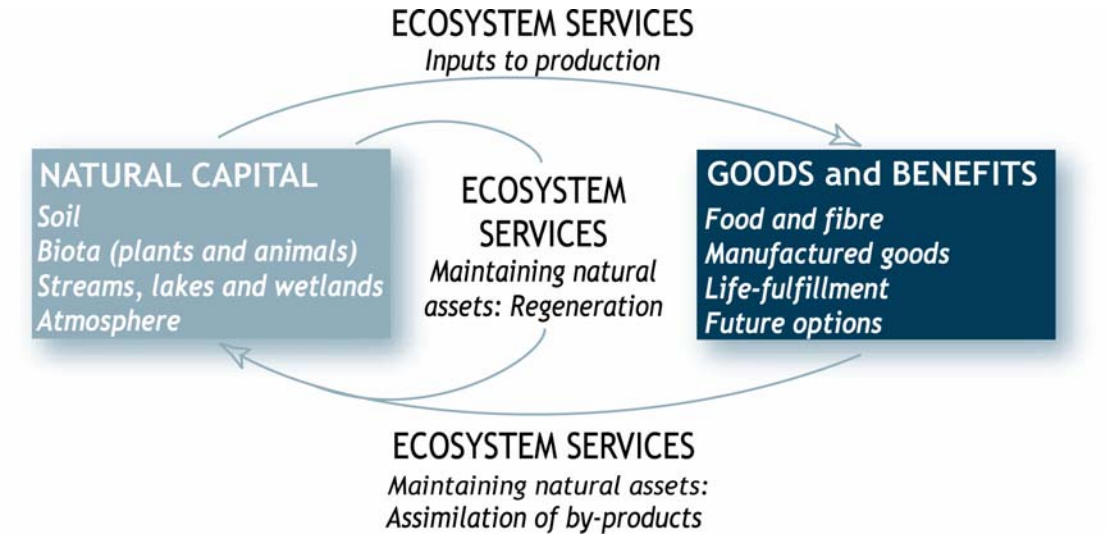
An explanation of ecosystem services, their importance to day to day life, and reasons for their decline is discussed in section 2. In section 3 an explanation of rural residential development is provided. In section 3 the ecosystem services demanded in the 'production' of rural residential development as well as the ecosystem services impacted on by rural residential development are also discussed. The case study for this project is introduced in section 4. Here a description of the key physical, economic and social characteristics of the Murrindindi Shire is provided. Section 4 also describes the nature of rural residential development in the Shire. Conclusions to this first paper, gaps in information found so far and an introduction to the second paper are provided in section 5.

2 Ecosystem Services

2.1 What are ecosystem services?

An "ecosystem" is commonly defined as the interactions among and between species and their surrounding environments (Binning *et al*, 2001). For example, below the ground, bacteria, worm–like animals, insects, fungi and many other tiny creatures need each other for food, to control one anothers numbers, and keep the soil fertile (Binning *et al*, 2001). Ecosystems provide many services from which humans benefit. A common perception of ecosystem services is that they transform natural assets or natural capital such as soil, biota, air and water into things that we value. For example, the fungi, worms and bacteria in our "ecosystem" example transform raw ingredients such as sunlight, carbon and nitrogen into fertile soil (Figure 1).

Figure 1: What are ecosystem services?



Source: Binning *et al* (2001)

Some examples of ecosystem services provided by natural assets include (Binning *et al*, 2001):

- Provision of clean water;
- Maintenance of liveable climates and atmospheres;
- Pollination of crops and native vegetation;

- Control of species that could become pests; and
- Fulfilment of intellectual, cultural and spiritual needs.

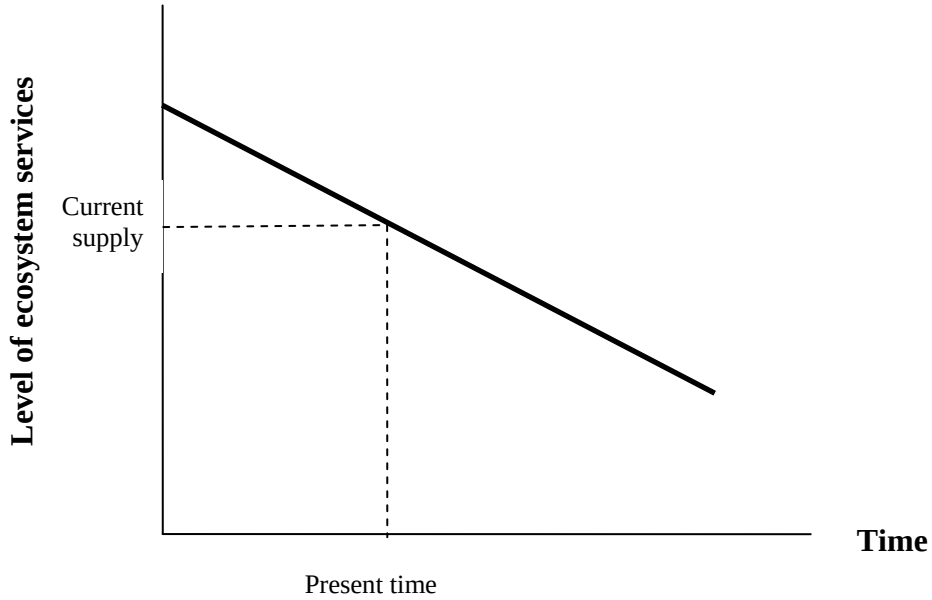
Ecosystem services therefore contribute to the economic and social well being in two ways (Binning *et al*, 2001):

1. Through the use of natural resources (derived from natural assets) they provide an input to the production of a good. For example, fruit production is dependent on the ecosystem service of pollination which in turn is dependant on the natural asset of biota to provide insect pollinators; and
2. By maintaining natural assets through two different pathways. One, by regenerating the natural assets. For example, maintaining soil health through nutrient recycling or maintaining native plants and animals through the regeneration of native habitat. Two, through the assimilation of by-products arising from production processes or from consumption of goods. For example the assimilation of carbon dioxide from industry.

2.2 Why are ecosystem services under threat?

Historically ecosystem services have been freely and widely available. However, their significance is not being recognised in our current operating frameworks. For example, whilst there is no shortage of markets for ecosystem service goods such as clean water or apples; the services underpinning the production of these goods (water purification and pollination) are essentially free in current market operation (Salzman *et al*, 2003).With no market for these services, those who produce ecosystem services are not rewarded for the benefits that they provide, whilst those who damage these services do so without bearing the cost that they impose on others (Murtough, *et al* 2002). Because of the "free" nature of these goods the level of provision is generally less than what is socially optimal and often in decline (Figure 2).

Figure 2: Hypothesised declining natural assets and ecosystem services even with current land management and no change.



3 Rural Residential Development (RRD) and Ecosystem Services

3.1 What is rural residential development?

Rural residential development (RRD) is described by the Murrindindi Shire Council as that catering for persons seeking a rural lifestyle based on a high level of rural amenity that may or may not involve agricultural activity (Habitat Planning, 2003).

Residential use of rural landscapes commonly occurs in four different forms: low density rural residential development, lifestyle farms, hobby farms, and rural retreats. Each of these types retain a non-urban character. Key to the impact of RRD on surrounding properties and the environment is the spatial distribution of each land use (Archer, 1977).

Low density rural residential developments tend to be clustered together and fringe existing urban centres (Sinclair, 2001). Property sizes generally range between 0.4 and 2 hectares but may be larger in areas with fewer agricultural production opportunities. Proximity to existing urban centres allows residents to commute to employment and therefore they generally have no productive requirement for the land they occupy other than to support some stock for recreational use.

Lifestyle farms require larger parcels of productive land for their operation in order for the economics of producing livestock or grain to provide reasonable contributions to family income. However, there will often be off-farm sources of income that support the farming operation.

Hobby farms also generate produce, but often not to the extent that maintains a reasonable income. The desire to generate produce either using traditional or novel agricultural methods also tends to focus hobby farms on areas of higher productivity, however land area of hobby farms tends to remain small.

Rural retreats tend to be located more distant from urban centres and often on less productive land. Such retreats might be used for weekend or retirement recreation (Victorian Department of Agriculture, 1991). Proximity to employment and services is of less concern to these residents. Consequently these developments are often co-located with large publicly owned remnants of native vegetation that have been left in less agriculturally productive parts of the landscape. This co-location with public native vegetation (Nelson, 1992; Beatley, 1994; Power, 1996) and remoteness from urban areas (Sengupta and Osgood, 2003) is likely to enhance the aesthetic and commercial value of such properties, as often residents are seeking a greater connection with the natural environment. This differs in emphasis from rural residential developments and lifestyle and hobby farms where residents desire the benefits of rural society and productive agricultural land.

The difference in purpose between each type of rural subdivision influences the placement of developments within the landscape, the productive potential and resilience of the land being used, the intensity of land management activities and also the relative dispersal of impacts across the landscape. That is, the purpose and the type of land use influences the nature and extent of the impact on ecosystem services.

3.2 Ecosystem services demanded by RRD

Ecosystem services and the resultant benefits important to RRD and catchment and Shire health have been identified in a number of reports including Binning *et al*, (2001), The Goulburn Broken Catchment Management Authority (GBCMA) Regional Catchment Strategy (RCS) (2003) and the Murrindindi Shire Council Rural Living Development Guidelines (RLDG) (2004). Ecosystem services and/or resultant benefits identified in each report are discussed below. From this discussion four key benefits from ecosystem services are identified for the Murrindindi Shire (discussed below).

3.2.1 Ecosystem services identified in Binning *et al,* (2001)

In 2001, CSIRO (Binning *et al*, 2001), along with catchment stakeholders identified the ecological, social and economic processes that currently affect ecosystem service provision inside and outside the Goulburn Broken Catchment (GBC). This study assessed the major land uses in the GBC and listed the key ecosystem services required to maintain these. Housing was one of the main 'production' activities identified for the GBC. Ecosystem services identified as important to the production of housing included:

- **Life fulfilment**: the provision of aesthetic beauty, cultural, intellectual and spiritual inspiration, a sense of place, existence value, scientific discovery and serenity.
- **Maintenance and regeneration of habitat**: the service of maintaining the biota through processes of regeneration; the maintenance of viable populations of fauna and flora; and the management of vegetation to facilitate production, dispersal and growth of seed.
- **Provision of shade and shelter**: the service provided by vegetation that ameliorates extremes in weather and climate at a paddock scale for plants, animals and structures.
- **Waste absorption and breakdown**: the roles played by various organisms in absorbing and breaking down waste.

Whilst the Binning *et al* (2001) report identified ecosystem services, catchment and Shire planning documents commonly relate to management interventions to maintain or enhance the ecosystem services rather than the ecosystem services themselves. For example, the ecosystem service of waste absorption and breakdown is reflected in catchment documents as targets for water quality.

3.2.2 Benefits of ecosystem services identified in the Goulburn Broken Catchment Management Authority (GBCMA) Regional Catchment Strategy (RCS) (2003)

The Goulburn Broken Catchment Management Authority (GBCMA) in the Regional Catchment Strategy (RCS) (2003) identified a number of key catchment goals for which they aim to make management improvements. These goals include:

- Targets and plans for reducing dryland salinity;
- Water resource management (nutrients and sediment) strategies and actions;
- Management for pest plants and animals; and

- Management for soils and biodiversity.

3.2.3 Benefits of ecosystem services identified in the Murrindindi Shire RLDG (2004)

In order to meet the GBCMA catchment goals, the Murrindindi Shire group rural development issues into a number of categories (below).

- Biodiversity
- Water quality
- Rural landscapes and significant ridgelines
- Roads and infrastructure
- On site wastewater management
- Dwellings, buildings and works
- Erosion and soil
- Pest plants and animals
- Agriculture and rural land conflict
- Dams
- Subdivision

Based on the ecosystem services and the identified benefits from ecosystem services addressed in CSIRO, catchment and Shire documents, the benefits from ecosystem services identified for the Murrindindi Shire can be described as follows:

- Aesthetics (includes pest plants and animal, ridgelines, agriculture and rural land conflict, subdivisions etc)
- Biodiversity (includes aspects such as quantity and quality of flora and fauna)
- Water quality (includes sediment and nutrients)
- Soil quality (erosion and salinity)

These benefits from ecosystem services are what are referred to as the ecosystem service goals in this and the remaining papers in this series.

3.3 RRD and effects on ecosystem services

RRD and its effect on surrounding lands is not a new issue. The Australian Industry Commission (1998) and Archer (1977) have all analysed aspects of RRD in Australia whilst extensive research has occurred on similar issues in the United States (for example, LaGro Jnr., 1996; Tyser and Worley, 1992 and Maetas *et al*, 2003).

RRD has both positive and negative effects on ecosystem services (Table 1).

Table 1: Potential positive and negative effects of RRD

Direction of effect	Action	Outcome
POSITIVE EFFECTS	Rural lifestylists with less or no stock result in less production pressure on the land	Degraded land rehabilitated
	Rural lifestylists may have a greater interest, time and capacity to revegetate land with native vegetation	Revegetation of cleared land
	Smaller parcels of land and increased financial and time capacity to manage pests	Improved pest and weed control
	Improved land management that results in improved groundcover and vegetation of riparian zones and stream banks	Improved water quality.
	Off farm income and new residents	Increased income in the local community, strengthened local community spirit and facilities. Increased investment maintaining local supplier viability
	Higher population density	Enhanced property security
	Increased property values	Significant capital gains to existing landholders
NEGATIVE EFFECTS	Poor land management – unsustainable stocking rates and poor pest control	Increased land degradation
	Clearing of native vegetation	habitat destruction and fragmentation
	Increased roads and driveways	soil disturbance and concentrated runoff, particularly on steep slop
	Increased paved surfaces	increased and concentrated runoff
	Degraded pasture leading to increased sediment in runoff. Increased fertilizer and sewerage resulting in increased nutrients.	Water quality decline
	Cumulative individual harvesting	Water quantity decline
	Increased small blocks	Loss of agricultural land and Conflict with operational commercial farms
	Increase in property value	may prohibit the expansion of commercial farms

Source: Habitat Planning 2003 from discussions with Murrindindi Shire Council

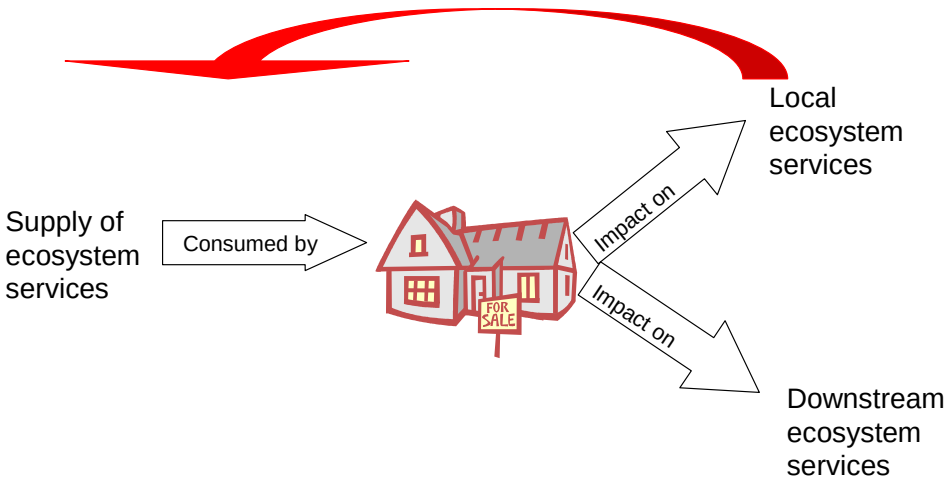
In general, the positive and negative effects of RRD occur on the quantity and quality of fauna, flora, water and aesthetics. There are several plausible pathways for the RRD impacts. These pathways include vegetation clearing or reestablishment and protection, predation by domestic pets, decline in species viability due to fragmentation of habitat; behavioural change in response to human activity; changed land use (increase or decrease in land intensity), increase in roads and paved surfaces and a change in the number of dams which all influence water quality, quantity and general aesthetics.

One significant positive effect from RRD is the ability of hobby farmers and rural retreatists to bring external funds onto their properties. The Australian Industry Commission (1998) quoted from a submission by the South Australian Farmers Federation that "*this type of land use had also been associated with increased capital investment and can often sustain higher levels of production*" and from a submission

by Environment Australia that "*because of their off-farm income, hobby farmers [lifestyle farms] often could afford to retain native vegetation and biodiversity and are more likely to enter into conservation agreements*".

Another important feature of the effect of RRD on ecosystem services is that they can be direct, occurring at the point of disturbance, or residual and long term as a result of land use change arising from the RRD. Further, effects of RRD can occur to the ecosystem services directly demanded in the 'production' of housing (listed in 3.2) or to ecosystem services demanded by other landholders and activities in the catchment (Figure 3). Binning *et al*, (2001) identified a number of ecosystem services that are important throughout the GBC. These included processes such as pollination, regulation of climate, water filtration and erosion control.

Figure 3: Demand and supply of ecosystem services



Overall, the nature and extent of the impact of RRD on ecosystem services and the resulting benefits depends on the location, density and infrastructure of development.

3.3.1 Impacts on fauna

The primary fauna impact of RRD is related to how close the development is to undeveloped environments. For example, in shrubby woodland vegetation in California some bird species are more likely to be found close to human development than other bird species which tend to cluster away from humans (Odell & Knight, 2001). Further, residential development also commonly attracts bird species that prey on other birds or that are nest parasites (Hansen *et al*, 2002). Odell and Knight (2001) found a similar effect for mammals with domestic pets such as dogs and cats in higher

abundance close to human development and red foxes and coyotes more abundant away from humans. Development could attract fauna that impacts on fauna in neighbouring undeveloped areas.

In contrast, the relative density of human development does not appear to impact on either avian and mammal communities. Odell and Knight (2001) found no difference in the relative abundance of either birds or mammals with regard to different densities of development[1]. However, there were significant differences between areas of development and non-development. That is, once humans are present there is an impact, but the number of humans after the first is irrelevant to the extent of impact.

The combined relationships of proximity to development and density of development suggest that rural subdivision would have the least negative impact on native biota if it was located in the least undeveloped areas (eg in agricultural land as opposed to virgin forest) and if it is concentrated in high density clusters leaving larger areas of rural land where development does not occur.

3.3.2 Impacts on flora

The impact of development on plant communities will depend on what the land was used for prior to development and the intensity of this use. If the land was untouched vegetation prior to RRD and requires extensive clearing, the impact on flora quantity and quality will be significant.

If the land was previously grazed, RRD could result in either an increase or decrease in quantity and quality of flora depending on the nature of the pre-existing grazing system. Maetas *et al* (2003) found that range grazing land in the United States had higher native plant species richness and cover than non-grazing subdivided land. Here, if not overgrazed, the diversity is maintained because grazing keeps the biomass of any given species low and thus allows many species to occupy the ground vegetation layer. The experience with grazing and biomass diversity is somewhat different in the Australian context. Because the temperate grazing systems of eastern Australia generally have high stocking rates, currently grazed land tends to have low native species diversity. Therefore, RRD in Australia can often result in an increase in the native species diversity in the ground vegetation layer (Maetas *et al,* 2003; Mack *et al,* 2000; Tyser and Worley, 1992).

Mack *et al* (2000), and Tyser and Worley (1992), also noted that heightened human activity can increase weed invasions. This can occur as a result of housing construction, movement of seed along roads and trails, and overgrazing by domestic pets and livestock. Weed management is an issue of concern for the Murrindindi Shire (Pers Comm Mike Dalmau, Murrindindi Shire Council, November 2004). At present the GBC has 70 species of declared noxious weeds and a number of emerging environmental and agricultural weeds that need to be continually managed.

RRD could result in either an improvement or worsening of weed management. Improvements could be seen if increased population and resources are available to physically manage weed populations. Reduced weed management could occur if new

[1] Rural residential development can further impact on fauna through increased road use and therefore road kill. This issue is not discussed here.

RRD residents lack the knowledge to identify and manage weeds, or if residents do not undertake ongoing weed management, for example, because they are absentee land owners and are not at the property regularly enough to manage the weeds.

3.3.3 Impacts on water quality

Nutrients

Disposal of sewage waste is a major issue in rural residential developments. This is especially the case as most residential development is occurring along river and lake shores, coastal areas or in proximity to ecosystems of significant aesthetic and conservation value (LaGro Jnr., 1996). The consequential potential for significant contamination of ground and river water systems is large.

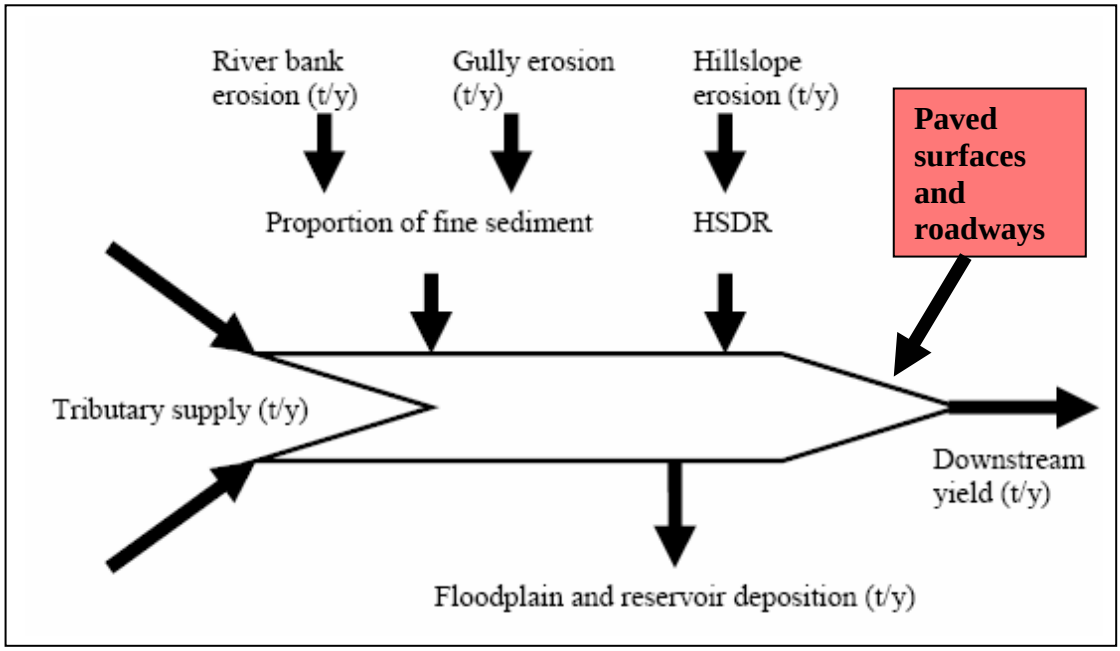
Evidence from the USA confirms the issue is not limited to poor management of individual septic sewage systems. Experience from New Mexico (Perkins & Hanson, 1990) indicates that groundwater degradation by septic sewage systems can result from the collective impact of all discharges in a community or subdivision. From this perspective, dispersal of rural residential development should be favoured as a means of diffusing contamination of ground water systems. However, while this would provide reductions in sewage impacts it has the potential to increase the impacts on biodiversity.

Whilst nutrient runoff is more widely studied in Australia, few studies could be found that provided a comparison of nutrient runoff between rural subdivisions and agricultural land uses. In two local studies nitrogen runoff was found to be 40-60% higher for rural residential areas than for grazed areas (DeRose *et al*, 2002 & 2003). DeRose *et al*, (2003) also found that in the Goulburn Broken similar increases occurred in a comparison to cropping. In comparison, in the semi-tropical regions, cropping produced more than 200% greater nitrogen loads than residential development (DeRose *et al*, 2002). In both studies phosphorous loads were equal or less in residential areas compared with land used for agricultural. While nitrogen loads from rural residential land use was higher than from cropping and grazing in the Goulburn Broken, both are significantly lower than the nitrogen loads exported from urban areas and irrigated crops and pasture.

Sediment

The Goulburn Broken Catchment (GBC) contributes 33% of the Murray River water flow above the Murrumbidgee but also contributes 58% of the turbidity (GBCMA 2003). Yea and Alexander in the Murrindindi Shire have been identified as a major source area for sediment in the GBC (De Rose *et al*, 2003; Pers Comm Scott Wilkinson March 2005). Whilst most in stream sediment currently originates as stream bank erosion (approx 45% of total current stream sediment) (De Rose *et al*, 2003). We postulate that rural residential development could change the origin of, or the level of sedimentation. This could occur as the area of paved surfaces increases and as driveways and private roads are constructed. Figure 4 illustrates a standard sediment budget. The impact of rural residential development is added to this budget as a shaded text box. It is important to note here however, that other sources of sediment supply may decline if land use intensity is reduced as a result of RRD.

Figure 4: Components of the sediment load budget



Source: Adopted from Wilkinson, S., Henderson, A., and Chen, Y. (2004).

A common response by local planning authorities to minimise sediment and nutrient runoff is to regulate that new RRD's must incorporate a dam at the bottom of the property catchment or the bottom of a catchment for a group of small lots. Where rural subdivisions are dispersed across the landscape as is often the case for lifestyle farms, hobby farms or rural retreats there might be potential for the spread of such dams to negatively impact on runoff volumes and therefore on downstream flows (discussed in 3.3.4). There is less risk of impact in RRDs where properties are concentrated in a single local catchment with one dam to manage runoff.

3.3.4 Impact on water quantity

Whilst one dam at the bottom of a RRD may effectively manage sediment and nutrient into water ways, the cumulative impact of many smaller properties, each property with a dam for stock and domestic use may potentially impact on the water quantity available for downstream users. The cumulative impact of farm dams on water quantity has been analysed in the Yass River catchment in NSW, a catchment that is also experiencing RRD (especially in the Shires close to Canberra such as Palerang and Yass). In the Yass River catchment the number of farm dams has increased from 491 in 1976 to 1402 dams in 1988. This increase in farm dams has seen an increase in storage capacity in the catchment from 1430 ML to 5022 ML. Over the period when farm dams were greatly increased (1976 to 1988) there has been a statistically significant (at the 5% level) reduction in streamflow of around 1,700ML each year. This reduction in streamflow corresponds to an approximate reduction in mean annual flow of 8% (Neal *et al*, 2002).

It was also found that farm dams in the Yass River catchment have a greater than proportional impact on flows. Here, a 1ML increase in storage corresponded to a

1.3ML reduction in stream flows (Neal *et al*, 2002). Table 2 illustrates the increase in farm dams in the Murrumbateman Shire of the Yass catchment. With the increase in farm dams to supply water for stock and domestic use (including uses such as watering of gardens), the amount of water harvested is exceeding the calculated sustainable harvest by 443% (Franklin and Parker, 2004).

Table 2: Farm dams and harvestable rights for Murrumbateman

Pre 1970		**As at August 2001**		**% Increase**		**Harvestable right (0.07ML per ha)**	
No. Dams	**Total Volume (ML)**	**No. Dams**	**Total Volume (ML)**	**% Dams**	**% ML**	**Total Allowance (MHRDC)**	**% Difference**
45	52	217	310	517	596	70	443% over

Source: Franklin and Parker, 2004.
Note: MHRDC is the maximum harvestable right dam capacity

It is likely that farm dams are already having an impact on water quantity in the Murrindindi Shire. For example, King Parrott Creek is already experiencing severely depleted flows due to increased consumption upstream from rural residential development (The Victorian Dept of Agriculture).

3.3.5 Impact on aesthetics

Landscape aesthetics describes a pattern rather than a process and refers to the diversity and spatial arrangement of land uses that define an area. Aesthetic, meaning 'visually pleasing', is a social construct pertaining to the appreciation of beauty and the resultant quality of life of residents. Aesthetics of land therefore integrates natural, agricultural and urban land uses. Because what is pleasing to one individual is not necessarily pleasing to another and what is pleasing today may not be pleasing in the future. Thus the aesthetic value of land is a complex bundle of values that are difficult to untangle and effectively measure. Some of these may include the quality and quantity of views (ie ridgelines free from houses), privacy, open space, balance of agriculture, vegetated areas and residential, and air quality.

The aesthetic values of RRD land are impacted on in two ways. First, aesthetic values are impacted on by ongoing agricultural production that may continue on surrounding undeveloped land. Impacts include odour, noise, chemical sprays, dust and smoke, weeds and pests and heavy equipment traffic on rural roads (Victorian State Government, 2004; Murrindindi Shire Council, 2004). Second, some aesthetic values are impacted on by RRD itself. For example, as more people are attracted to an area, they are likely to increasingly impact on each others aesthetic values such as quantity and quality of views, sense of privacy, open space and land use balance.

There is a vast amount of literature regarding the aesthetic values of land and landscapes (for example, Nohl, 2001; Lothian, 1999). The calculation of, and impacts on these values is a series of papers in itself and not further discussed here. While we will identify where aesthetic values are likely to be of importance, we largely assume that aesthetic values are managed and maintained through the permit, planning and zoning arrangements. However, we explicitly leave open the possibility that these may be included in future policies such as development offsets.

3.3.6 Relationships between RRD and ecosystem service impacts

From this discussion some relationships can be drawn with respect to the impacts of RRD on ecosystem services (Figure 5). These relationships are both positive and negative (some may even be both depending on the nature of the resultant land use, for example grazing impacts, as previously discussed)(Table 1).

Figure 5: Housing, ecosystem services and degrading processes

	Degrading Processes							
Important ecosystem services for housing and Murrindindi Shire	vegetation clearing	effluent disposal	domestic pets	increased bushfire risk	surface water harvest	human pressures on public lands	nutrient runoff	reduction of aesthetic values
Aesthetics	**X**	**X**	**X**	**X**		**X**		**X**
Biodiversity	**X**		**X**	**X**		**X**		
Water Quality	**X**	**X**		**X**	**X**		**X**	
Soil Quality	**X**	**X**	**X**				**X**	

Source: CSIRO, 2001, Archer (1977), Victorian Department of Agriculture (1991) and Sinclair (2001)

3.4 Concluding comment about RRD and ecosystem services

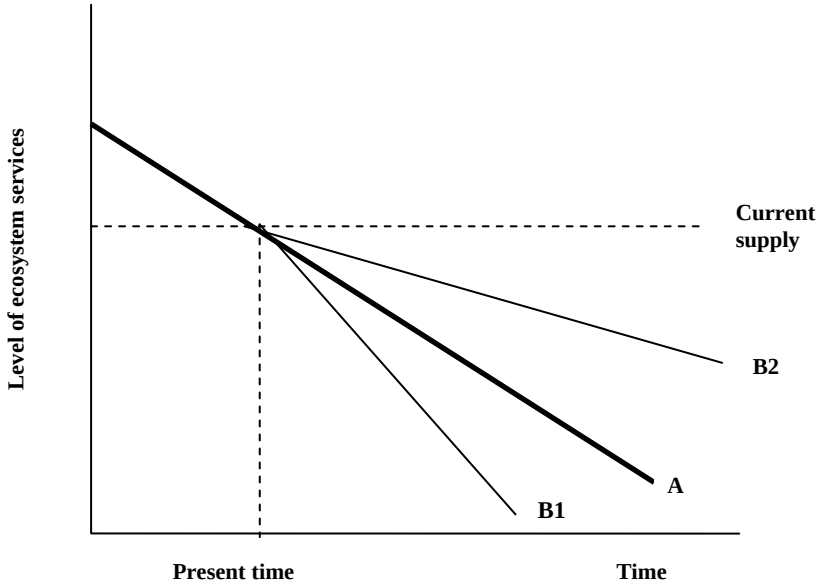
The complex interaction of impacts means that it is very hard to map what RRD may mean for the level of ecosystem services and the resulting benefits in any setting. However given that ecosystem services are already declining as a result of current land management it is not likely that RRD on top of unchanged current land management will result in the ongoing provision of ecosystem services at a sustainable level.

This has a number of implications:

1. RRD purchasers, who buy land based on an expectation that current ecosystem services will continue, will not be expecting this decline or the consequent impacts on their welfare. With no impact from RRD and with no change in current land management the provision of ecosystem services will continue down line A in Figure 6;
2. Because the net impact of RRD on the level of ecosystem services could be either positive or negative but is uncertain, RRD could see a faster or slower rate of decline in the natural asset base and the ecosystem services that these assets provide (lines B1 and B2 in Figure 6); and
3. RRD could potentially reduce the area of land available to meet broader ecosystem services targets in the future. That is, RRD could incrementally remove land from that which is targeted and available for ecosystem services conservation policies (for example, if policies are targeted to land areas of 40 or more ha's and RRD results in many properties of 15ha). Smaller properties may also be removed because of the increased policy transaction costs of negotiating with many small property owners rather than a few large property owners. By reducing the areas

available for ecosystem service conservation the problem of ecosystem service supply could potentially be compounded in the future.

Figure 6: Potential impacts of RRD on ecosystem services



Note on Figure 6:
A: is the hypothesised trajectory of ecosystem services into the future with no change in current land management and no impact from RRD (also equivalent to no RRD)
B1: is the hypothesised trajectory of ecosystem services with no change in land management and more negative than positive impacts from RRD
B2: is the hypothesised trajectory of ecosystem services with no change in land management and more positive than negative impacts from RRD

4 Case study: Rural Residential Development and Ecosystem Services in the Murrindindi Shire, Victoria.

4.1 The Murrindindi Shire

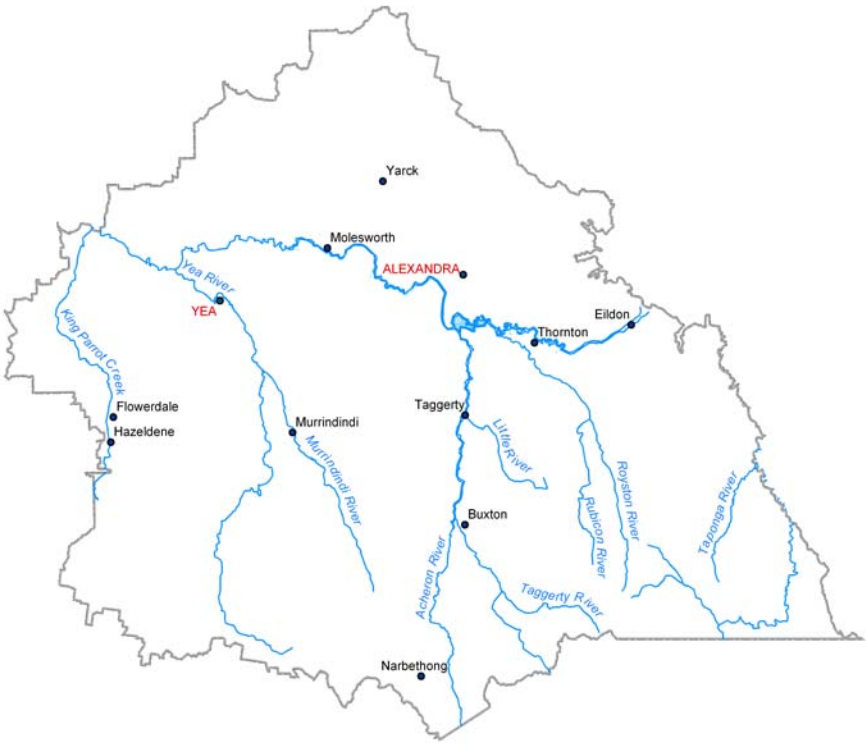
The Murrindindi Shire is located on the north fall of the eastern section of the Victorian Highlands. With the exception of a small area south of Kinglake, the entire of the Murrindindi Shire's area of 3,887 square km's is located in the foothills of the Upper Goulburn section of the Goulburn Broken Catchment (GBC) (Figure 7).

Within the Murrindindi Shire, Alexandra and Yea are the main service towns to the local agriculture and timber industries. These townships are also experiencing an increasing population of rural residents. Smaller townships and villages in the Shire include Narbethong, Buxton, Taggerty, Thornton, Flowerdale, Yarck, Hazeldene, Murrindindi, Eildon and Molesworth (Figure 8).

Figure 7: Map of the Goulburn Broken Catchment

Source: GBCMA

Figure 8: Murrindindi Shire



4.2 How is rural residential development occurring in Murrindindi Shire?

4.2.1 Population and population growth

Murrindindi Shire's estimated current population is 13,779 (Municipal Strategic Statement (MSS), Murrindindi Shire Council, 2004c). The region is experiencing significant population growth with an increase in population of 1,327 from 12,452 in the Census of 1996 (Murrindindi Shire Council 1999 and 2004c). This population growth has far exceeded projections made by the Victorian Department of Sustainability and Environment (DSE) in 2001. DSE projected that population of the Murrindindi Shire would increase to 13,882 by the year 2021 (Habitat Planning, 2003). In 2004, the Murrindindi Shire is already very close to this projection.

4.2.2 Type and rate of RRD

In 2001 there were 4,787 dwellings recorded for the Murrindindi Shire. For the period 2001 – 2021, the DSE projects that the total number of households in the Shire would increase to 7,915 (Habitat Planning, 2003).

The foothills of the GBC, in which Murrindindi Shire is located, were recorded to be the second most densely housed areas of the GBC (first were the irrigation areas). The foothills were reported to have 4.2% of land area used by housing whilst the irrigation region (Shepparton etc) recorded 6.2% and the plains region (Benalla etc) recorded 1.4% of total land used for housing (CSIRO, 2001). The desirability of living in the Murrindindi Shire is reflected by the increase in property values over recent years. Property values have increased by 10% each year since 2000 and rose on average across the Shire by 18% in 2003 (Murrindindi Shire Council 2004c).

In 2001 housing demand[2] for Murrindindi was projected to increase at a rate of about 60% per year over the period 2001 to 2021 (Habitat Planning, 2003). Whilst past growth of dwellings in the Murrindindi Shire, appears insignificant (Table 3), it is important to note that it is difficult to project future demand from past growth information as past growth figures have been constrained by zoning. A recent planning study has put forward a proposal to rezone large areas of the Murrindindi's rural areas such that they can supply land for RRD (C14 amendment to the Murrindindi Shire Municipal Strategic Statement (MSS))[3]. This amendment will open up the supply of rural land for rural living and facilitate RRD. Even before this rezoning is finalised, the Murrindindi Shire is experiencing an increase in the demand for housing on rural land. In 2004 the Murrindindi Shire received 400 permit applications for new dwellings. Over two thirds or just over 250 of these applications were to build houses on rural land (Pers Comm Matt Parsons, Murrindindi Shire Council, November 2004)[4].

Table 3: New Dwellings in the Murrindindi Shire 1990 - 1997

	Alexandra	Yea	Marysville	Eildon	Kinglake	Total
1990	25	7	10	8	22	72
1991	13	6	11	11	20	61
1992	15	5	6	4	20	50
1993	12	5	6	11	14	49
1994	9	6	4	9	12	40
1995	4	6	2	5	9	26
1996	9	9	4	4	12	38
1997	12	4	4	6	11	35
Total	101	45	47	58	120	371

Source: Murrindindi Shire Council 1999

Note: Dwelling growth over the reported period was restricted by supply due to zoning. Potential C14 amendments to zoning in the MSS will release a significant amount of rural land for rural residential development.

[2] This housing demand does not differentiate between spatial location of the housing, that is rural residential versus township dwelling.

[3] The C14 amendment to the MSS was not yet finalised at the time of writing.

[4] These permits are for house construction (permits required according to land size and construction type), not to subdivide land. C14 amendments will allow an increased capacity to subdivide land and construct houses on smaller blocks.

RRD in Murrindindi Shire is occurring in all the forms described in section 3.1 of this report. The categories of development and the previously specified form are described in Table 4.

Table 4: Forms of RRD in Murrindindi

Development in Murrindindi Shire	Category of RRD
Low density rural residential (lots greater than 0.4ha in size)	Low density RRD (lots 0.4 – 2 ha)
Rural and farming zone (lots greater than 40ha)	Lifestyle RRD (lots greater than 40ha)
Rural living zone (lots greater than 4ha and potentially 20ha in Alexander and Yea – negotiated as a part of C14 amendment)	Lifestyle and hobby farm RRD (lots greater than 40ha)
Environmental rural zone (lots greater than 40ha)	Rural retreats – less agriculture, more vegetation, residents attracted to the seclusion

4.2.3 The nature of RRD growth

As well as the rate of growth in the Murrindindi Shire, the nature of rural residential development growth in the Shire is significant to the outcomes of this growth.

The southern areas of the Shire are closely linked both socially and economically to the northern suburbs of metropolitan Melbourne. As a result, many new residents to the Shire are seeking to combine a rural lifestyle with ready employment access and services of Melbourne. This phenomenon is evident in the Murrindindi Shire labour force which totals 5,600 persons with only 2,332 employed within the Shire. The MSS (Murrindindi Shire Council 2004c) notes that this could be due to the limited employment opportunities within the Shire or the increasing appeal of a rural lifestyle close to Melbourne. The MSS (Murrindindi Shire Council, 2004c) notes that the lifestyle phenomenon is likely to increase in Murrindindi Shire as the development corridor between Murrindindi and Melbourne is progressed over the next 15 years (making it easier and more acceptable for more people to commute to Melbourne), and, as residents in the Southern end of the Shire seek “getaway” lifestyle blocks in more remote areas of the Shire.

The proximity to Melbourne increases the Murrindindi Shire’s appeal as a weekend getaway. As mentioned previously, this appeal is likely to increase as development at the southern ends of the Shire increases over the next 15 years. At present an estimated 25% of the Shires dwellings are owned by absentee landowners (holiday homes and rural retreats) (Murrindindi Shire Council, 2004c).

5 Conclusions and directions

This paper is the first in a series of short papers exploring the policy issues associated with ecosystem services and rural residential development. In this paper we “set the scene” for the series by describing key terms and outlining the impact of RRD on

ecosystem services. We also describe the nature and scale of RRD in the Murrindindi Shire of Victoria.

Already a number of gaps in the information have been revealed by describing the problem. These gaps are primarily associated with understanding the cause and effect relationships between the type of rural residential development and the provision of ecosystem services. Some fundamental questions that need to be answered at this stage include:

1. What mix of RRD is expected in the Shire?

2. How will these types of RRD manifest on the ground?

3. How will the different expected types of RRD impact on ecosystem services?

4. What characteristics of these ecosystem services are valued? Are there overlaps or priorities?

It is important that these gaps in the information and relationships are filled in order to effectively manage the issue. The context of these questions becomes clearer in later papers, particularly in reference to some of the design intricacies of a market based instrument.

The next paper, “Deciding on a policy approach – why market-based instruments (MBIs) and which kind?”, works through the process of deciding on a policy option to address the impacts of RRD on ecosystem services. In this paper we explore the alternative policy options available to assist with managing the ecosystem service impacts of development. We conclude that the use of a market based approach or market based instrument (MBI) for the Murrindindi case could offer advantages over alternative approaches available such as enhanced regulation or even grants or subsidies.

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