Better Best Practice Note

Highway Design for Net Environmental Benefit

Environmental excellence in rural highway planning will work best when it goes beyond the road reservation to consider climate, catchment and landscape context. This will help ensure connections for healthier habitat, waterways and community.

Consider the 'road-effect zone' as shown in Figure 1 below to better understand the ecological effects of roads and traffic into the adjacent landscape including noise, light and chemical pollution; disturbance effects; and habitat modification.

Legislated environmental impact assessments for road projects do not yet account for critical cumulative effects[1] arising from their landscape scale and impact.

This Better Best Practice Note sets out a wide range of environmental benefits that incorporate and stretch beyond the minimal compliance standards.

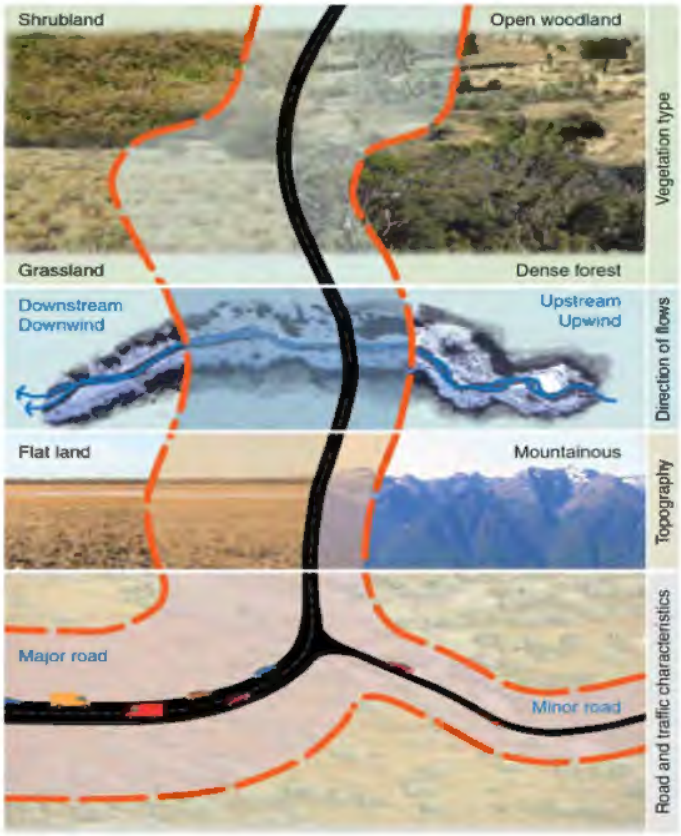

Fig 1: The 'road-effect zone' is impacted by wind, topography, landscape & traffic[2]

Step 1. Draw from Traditional Owner knowledge and from local community wisdom.

Integrate Traditional Owner knowledge of Country into early discussions and planning for road, water[3] and landscape planning.

Inviting early discussions on site can enable greater opportunities to reflect local indigenous culture in design and place. This will support the legislated cultural heritage and native title requirements applied in ongoing road design and construction works.

To respond best to the contributions from all local community members, retain the important understanding that the road design is equally about 'place' as much as 'movement'[4].

Community members who are very active, involved and quite often have roots in place going back over many decades are a critical source of local wisdom. These active members of society are 'experts in place' and will often have concerns and ideas that need to be addressed as early as possible[5]. Work together to explore all possibilities in design.

Actions:

Meet with the Traditional Owners as early as possible to better understand the land, and its ancient and ongoing culture.

Well prior to design concept, gain some understanding of existing community connections to the site. This can be done by looking online at social media, community group activities and community consultations policies and masterplans that may have already be done by local government for other projects in the area. Use this to inform ongoing stakeholder discussions with local government, community groups, residents and more.

Fig 2: Traditional Owner knowledge supporting better ecological outcomes[6]

Step 2. Baseline Data, Spatial Planning and Target Setting for Net Environmental Benefit

Baseline data helps us understand the existing flora, fauna, waterway, soils, climate and ecological values of a landscape. This information then helps inform design priorities, engage with the community with a sound evidence base to support conversations, and provide an important starting point for any new objectives.

It is important that baseline data be collected early and communicated as simply and as spatially as possible. Creating a 'shades of green map' prior to the first road alignment proposal will help the road designer to understand when alignment changes can best avoid areas of highest ecological value.

Once baseline data is known, model different solutions that enable the road project to achieve a net environment benefit. Figure 3 broadly sets out ways that highway design can 'leave the environment healthier than it was before' in many different ways.

Actions:

Map the existing environmental conditions of the area by investigating 'beyond compliance' to understand:

- *Terrestrial flora and fauna values. Go beyond regulatory requirements to include surveys to groundtruth the mapping of remnant vegetation (EVCs). Consider climate change when forecasting likely impacts of any road design and ecological restoration. List out flora and fauna species for each patch of remnant vegetation.*
- *Aquatic habitat and waterway values of landscape via the Index of Stream Condition and any additional studies on waterway health, aquatic habitat, erosion and flooding, Also groundwater dependent ecosystems.*
- *The existing stormwater system applied across the landscape, including pipes and culverts to determine the opportunity to reduce the number of stormwater outfalls directly entering and damaging water bodies. Model the amount and general location of potential stormwater that can be harvested from the road. Model the potential for stormwater to be used to support soil moisture and vegetation health.*
- *Tree health and ecological values going beyond significant trees to include all trees in designated sample areas*
- *Seed requirements and mapping for future restoration works.*
- *Community landscape values and mapping (Incorporating mapping of Aboriginal cultural heritage values.*
- *Greenhouse emissions using a greenhouse calculator such as Carbon Gauge, ISCA Rating Tool and equivalents*
- *Potential materials use and waste generation impacts.*

All reports to be submitted with an accompanying geospatial data layer in a standardised format aligned to other baseline information for the project. This spatial representation of date will better inform decisions, design, cross-links and can be linked to corporate information files for ongoing use of valuable ecological data.

Use baseline data and modelling to set SMART targets for better climate, water, canopy and pollution outcomes. SMART means Specific, Measurable, Achievable, Relevant and Timebound.

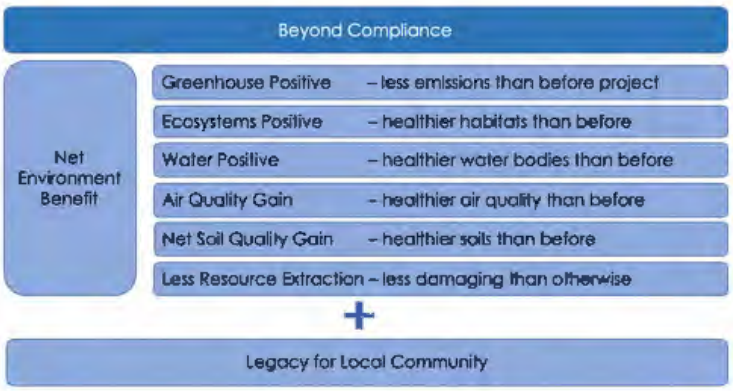

Fig 3: Multiple avenues for leaving the environment healthier than it was before the road upgrade project.

Step 3. Climate Change

Plan for a 'greenhouse positive' project. Road projects will often reduce greenhouse emissions over long term due to lower fuel use from improved efficiency through intersections. This positive outcome can be increased via use of low impact materials and construction techniques, sequestering carbon within the road reservation and sourcing renewable energy where possible.

Actions:

Apply greenhouse emission reduction solutions including design for smooth driving, design for cycling, use of low carbon materials, use of energy efficient lighting and fixtures, use of energy efficient and low pollution construction vehicles. Reducing traffic disruption during construction also helps reduce greenhouse gas emissions of a project[7] .

Maximise renewable energy for construction and operational energy needs. Futureproof road design by ensuring it supports electric vehicle use and charging.

Avoid sequestration loss by retaining tree, soil and wetland assets beyond business as usual. Apply new sequestration opportunities on site. This includes soil, vegetation, swale and wetland enhancement opportunities[8].

Apply climate risk assessment to ensure extreme weather events and sea level rise are included in design, construction and maintenance procedures.

Fig 4. As large public land owners, road authorities have great opportunities to sequester carbon to reduce climate change impacts

Step 4. Flora

Protecting and enhancing local vegetation communities can be achieved by restoring remnant habitats and creating new habitat areas.

Using flora species indigenous to the area supports local biodiversity outcomes and is encouraged. It is also noted that native species, seedlings and seeds may now need to be drawn from a wider provenance to account for changing climate which can impact the likelihood of plant survival. Some locations will be best suited to applying a mix of species including exotics to support pollinator activity and diversity.

Be sure to support vegetation whilst ensuring driver safety. This can mean wider setbacks for vegetation works but the benefits arising from reduced wildlife vehicle collisions are recognised as roadside habitats may act as ecological traps by drawing fauna closer to vehicles[9] .

A greater emphasis on roadside ecological restoration works will require preparation to ensure an ongoing supply of seed for current and future your projects. Work in partnership with other large land managers (road, rail, parks, farmers) to create a central seed database that helps manage supply and demand for of seeds and stock that is hard to source. For large projects, this can provide a valuable employment initiative by supporting community-run seed orchards.

Actions:

Undertake Ecological Restoration Planning to identify the best locations and methods for restoration based on species and habitat biodiversity significance, and likelihood of landscape restoration success. Ensure future vegetation opportunities are maximised in accordance with community expectations.

List environmental assets and maintenance needs into an evolving Sustainable Asset Management System. This will at least include trees and remnant vegetation areas (eg Ecological Vegetation Class (EVC)[10]).

Develop specifications that will form part of contractor bids and performance requirements for flora protection and enhancement. Use data to set quantifiable targets and link to best practice guidance documents.

Step 5. Fauna

Protection and enhancement of fauna supports two key objectives.

One is to improve survival and connectivity of indigenous species to increase breeding success and gene flow across the landscape. This movement of species also needs to be complemented by nearby habitat that is conducive to breeding[11] . This objective is best supported by wildlife crossing infrastructure such as rope bridges, underpasses and land bridges.at critical locations.

The other objective is to reduce wildlife vehicle collisions to reduce fauna mortality and injury as well as maintain a safe road. This objective is best supported by fencing and supported pathways at critical locations.

Consider the different impacts of a road on wildlife including:

Disruption of connectivity/movement

- Will the likely movement patterns of a species increase its likelihood of being impacted by the proposed road? Does the species undertake daily movements to get from sleeping location to food source, seasonal migration to get from one habitat to another, or is it a typically once-per-lifetime dispersal event when sub-adults move away from their birth area and encounter a road or roads?

Mortality due to direct collision with vehicles

- What species are most likely to be hit by vehicles and killed? Is it species attempting to cross the road, or when an individual is on the road or roadside to access resources, such as heat, moisture/green pick during drought or scavenging dead animals. This aspect is also critical for consideration of motorist safety.

Decline of species due to degradation of habitat

- Will the road design lead to habitat loss that will cause species decline? Is it directly due to the clearing of vegetation and/or due to indirect loss of habitat if wildlife do not occur within the road effect zone (which might extend, depending on the species, 1m to 1000m from the road edge due to such things as changes in vegetation, microclimate, noise, light etc)

Actions:

Undertake a fauna presence survey and consider the likely impact to determine priority species for protection and map their primary habitat areas along and adjacent to the alignment.

Determine opportunities along the reservation to implement protection fencing and crossings. Use above impact analysis to prioritise the likely effectiveness of different mitigation and protection infrastructure.

Develop specifications that will form part of contractor bids and performance requirements for fauna protection.

Step 6. Water

Roads can cause damage to nearby waterways and habitats. Rural road design has traditionally incorporated drains and culverts with the core objectives of flood management and stable soil moisture under pavements.

An environmental excellence approach moves beyond compliance to find ways that the road design can make local waterways and vegetation healthier than they were before.

This starts with an understanding of the wider water catchment that the road traverses. This includes pre-colonisation patterns and flow of water across the landscape, along with current waterways and water bodies including ephemeral bodies.

Road runoff can deprive fish of oxygen; reduce macro-invertebrate populations which are an important food source for fish; can introduce chemical spills, dust particles and car residue from roads; can alter surface water flow and groundwater flow and the interaction between them; and construction impacts can cause more intense damage and disruption[12]. Design and maintenance can minimise all of these impacts.

Studies have shown that the traditional design of culverts create a barrier to fish movement whey they are (i) are undersized and create excessive water velocity (ii) have insufficient water depth (iii) are physically too small for a species of fish (iv) have large outlet drops (v) are blocked by debris jams[13].

Actions:

Understand the wider catchment and ecological context

- *Identify which catchment management region the road traverses and its wider catchment and waterway goals. This will help to determine the sensitivity of the road placement in the context of waterway and biodiversity goals.*
- *Identify the ecological flooding regime that needs to be supported across the landscape. Identify any nuisance flooding that needs to be eliminated.*
- *Map the primary land uses in the catchment supporting the waterways.*
- *Identify and map any beneficial uses for the waterways as per SEPP Waters of Victoria (or equivalent). Such uses can range from water-dependent ecosystems to cultural water uses to agricultural and recreational water uses.*

Engage the community to understand local values in connecting to their waterways and vegetation in the region.

Undertake Water Protection Planning to ensure road design minimises waterway crossings and reduces the number and intensity of stormwater outfalls. If these must occur, design them to allow the long-term function of the waterway and its floodplain.

Undertake Waterway Enhancement Options analysis that seeks road locations that are sufficiently distant from waterways, and next best to provide natural or semi natural buffers to capture, store and process stormwater runoff to support subsurface movement of water to support vegetation and gentler baseflow support to waterways.

Link with flora and fauna planning to support aquatic habitat restoration initiatives within existing, enhanced, recreated or novel water bodies including creeks, wetlands, ponds, buffer zones and natural depression areas.

Step 7. Environmental Counterbalances

Biodiversity offsets can be controversial for several reasons including: the replacement vegetation is generally located far away from the affected community; the perception that offsets discourage efforts to protect existing vegetation[14]; and the debate that site by site decisions will accumulate to a net reduction for biodiversity.

In response to these concerns, it is important to avoid the need for offsets as the ideal outcome. It is also important that we continue to advocate for regulated offset frameworks to continually be improved.

Moving beyond compliance, all effort should be made to counterbalance local environmental losses with local gains. This cannot replace regulated Federal and State offset requirements, and instead would be seen as an additional 'legacy' initiative.

'Local offsets' (which we call 'environmental counterbalances' to differentiate them from legislated offset requirements) can include new environmental assets adjacent to the road reservation. For example, planting or wetlands may be funded by the road project and located on adjacent non-project land with a commitment for ongoing maintenance. These localised plantings will be associated with road but can now be set back outside of the road effect zone to prevent wildlife collisions and poor health.

Actions:

Comply with offset requirements for biodiversity and stormwater quality as per the Commonwealth's Environment Protection & Biodiversity Conservation Act 1999 and Victoria's Planning & Environment Act 1987

Engage and consult with community to understand the local environmental values and priorities.

Explore funding opportunities to support environmental legacy project/s that work towards a 'net positive environmental outcome' for the local community. For example, within 20 years there will be greater area of habitat, or greater canopy, or healthier waterways than existed prior to the commencement of the road project. Set these targets early and incorporate as project performance objectives and specifications.

Step 8. Sustainable Asset Management

Natural landscape elements need to be recognised as an environmental asset with an assigned financial value. This will help justify more maintenance funding which is critical in moving away from the 'set and forget' approach that is very often applied now.

Operation and maintenance of a road projects need to continue indefinitely. It is important to seek and justify increased funding for maintenance rather than designing to current low maintenance budgets (which have often started from a very low base that does not match community values).

Maintenance regimes need to be negotiated in project planning phase as part of a wider sustainable asset management approach. This will maximise the value of infrastructure and environmental assets owned by Government for both public and financial benefit.

One of the key elements of maintenance is managing the data and information in better systems that monitor and showcase natural assets.

Actions:

Discuss asset costs and maintenance requirements with all relevant teams and information stored in a central repository (and via geospatial data) allowing owners and managers to identify the net present value of an asset at any point in the life cycle.

Set out asset life cycle requirements and costs for a desired level of service and monitoring. Apply sustainable purchasing principles to support resource recovery and reduced offsite impacts of road construction.

Value environmental assets and include on the organisational asset register

Step 9. Design, Construct, Maintain & Monitor

Environmental assessment, planning and performance objectives can be compromised, or lessened, at any step in a road project when short term circumstances create challenges. It is critical to have measures in place to prevent this happening over time.

The best outcomes for a project can be achieved if (i) accurate ecological knowledge is available early: (ii) ecological requirements are stated so as to fit the actual planning or design questions considered during the planning process (iii) maintenance requirements of mitigation measures are considered in the design (iv) the accepted starting position in the road planning process is to try and improve ecological functioning[xv]

Changes requested during construction to simplify processes or reduce costs will generally be presented as short term project benefits, however this can undermine the long-term ecological value of projects. These changes are not to be supported unless alternative equivalent local ecological benefits are provided, documented and approved to the satisfaction of the environment team.

Actions:

Ensure multi-disciplinary connections. This can include: the creation of teams to include road planners, designers, engineers, managers and ecological experts to trial and standardise approaches; and cross-discipline checks to ensure there are no clashes among different design elements[16];

Use data collection and monitoring to set design and delivery performance-based specifications and contractual measures. This needs to be prepared in time to form part of the tender requirements. Examples include: ecological restoration works to apply to x% of area, all crossings of xxx waterway are to apply water sensitive urban design measures that benefit local aquatic species, environment staff with xx skills are on the core delivery team etc.

Ensure road design and delivery contracts any landscape subcontractors demonstrate their ability and commitment to meet all environmental excellence objectives and requirements of the project. The selection of the subcontractor and their work program is to be approved by project manager.

Require ongoing education and hold point requirements for environmental management. This includes training of environmental staff for planning and construction personnel as early as possible to present the ecological issues and why environmental protection is required[17].

Work with maintenance teams to develop a maintenance program for ecological features. Understand which maintenance procedures can be undertaken within budget, and which will require additional supporting budget. A maintenance program for ecological features of a road such as a wildlife crossing or revegetation area must be developed and implemented. Consists of four elements: an inventory of the asset; an inspection schedule; routine upkeep or repairs triggered by deterioration of condition; an adaptive response to new knowledge or understanding about maintenance standards and techniques[18] .

Due to the breadth of this topic, more detailed advice has not been included in this Better Best Practice Note. We plan to provide new Notes that will address flora, fauna, and greenhouse positive road design in more detail. Until then, please contact Loci E&P for further information.

1. *Stokes Ch 6 in van der Ree, Smith & Grillo (eds) 2015*
2. *Image: Zoe Metherill in van der Ree, Smith & Grillo (eds) (2015) Handbook of Road Ecology. Wiley Blackwell. UK*
3. *https://www.water.vic.gov.au/aboriginal-values/the-aboriginal-water-program*
4. *Department of Transport (2019) Movement and Place in Victoria. February 2019 at https://transport.vic.gov.au/our-transport-future/movement-and-place-in-victoria*
5. *Hansen R & Pauleit S (2014) From multifunctionality to multiple ecosystem services? A conceptual framework for multifunctionality in green infrastructure planning for urban areas. Ambio 43: 516-529*
6. *https://www.smh.com.au/environment/conservation/cultural-water-indigenous-water-claims-finally-on-darling-agenda-20190118-p50sa5.html*
7. *Hanson CS, Noland RB (2015) Greenhouse gas emissions from road construction: an assessment of alternative staging approaches. Transportation Research Part D. 40 97-103*
8. *Bouchard NR, Osmond DL, Winston RJ and Hunt WF (2013) The capacity of roadside vegetated filter strips and swales to sequester carbon. Ecological Engineering 54 227-232*
9. *Milton, Dean, Sielecki & van der Ree Ch 46 in van der Ree, Smith & Grillo (eds) (2015) Handbook of Road Ecology. Wiley Blackwell. UK*
10. *https://www.environment.vic.gov.au/biodiversity/bioregions-and-evc-benchmarks*
11. *Sunnucks & Balkenhol Ch 14 in van der Ree, Smith & Grillo (eds) (2015) Handbook of Road Ecology. Wiley Blackwell. UK*
12. *Wagner Ch 44 in van der Ree, Smith & Grillo (eds) (2015) Handbook of Road Ecology. Wiley Blackwell. UK*
13. *Ottburg & Blank Ch 45 in van der Ree, Smith & Grillo (eds) (2015) Handbook of Road Ecology. Wiley Blackwell. UK*
14. *Maron M, Brownlie S, Bull J, Evans M, von Hase A, Quetier F, Watson J, Gordon A (2018) The many meanings of no net loss in environmental policy. Nature Sustainability Vol 1. 19-27*
15. *Roberts and Sjolund Ch 4 in van der Ree, Smith & Grillo (eds) (2015) Handbook of Road Ecology. Wiley Blackwell. UK*
16. *Roberts and Sjolund Ch 4 in van der Ree, Smith & Grillo (eds) (2015) Handbook of Road Ecology. Wiley Blackwell. UK*
17. *En Chee Ch 7 in van der Ree, Smith & Grillo (eds) (2015) Handbook of Road Ecology. Wiley Blackwell. UK*
18. *Van der Ree and Tonjes Ch 17 in in van der Ree, Smith & Grillo (eds) (2015) Handbook of Road Ecology. Wiley Blackwell. UK*

LOCI Environment & Place

Better Best Practice Notes are designed to help practitioners strive for best possibilities in delivering city shaping and sustainability projects. We call them Better Best Practice Notes as a reminder that our best is always getting better.

Loci Environment & Place Inc. is a nonprofit body and welcomes your use of this Better Best Practice Note; only asking that we be acknowledged as the author. We openly welcome your feedback on ways we can keep improving the usability and application of these Notes. Just contact us via info@loci.melbourne

This Better Best Practice Note has been developed in partnership with MRPV, VicRoads, Wave Consulting, and Ecology and Infrastructure Internationals. Last updated June 2019.

Attach this Better Best Practice Note next time you request a quote, and ask bidders how they will incorporate best possibilities for your project.