



SUSTAINABLE LIVING IN BUILT ENVIRONMENT: HOW FAR LOCAL ATTRIBUTES ARE COUNTED FOR GREEN TRANSPORT IN PERTH, WESTERN AUSTRALIA

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Abstract : Transport infrastructure is a pivotal pillar to facilitate and impede social, economic, and environmental aspects worldwide and influence Government and international agencies' decision-making. Every continent is combating to make sustainable transport adopting versatile action, policy and governance such as net zero-emission, zero waste, zero harm, vision zero and many more to save life and earth. Europe, America, Australia, and many other countries adopt green transport to improve the environmental footprint, health and wellbeing, protect the economy, and efficiently meet the future sustainable demand for the human being. However, a tiny contribution is hardly exposed to literature about the neighbourhood animals fearlessly associating with humans affected in Built Environment. The study brought a few cases about the fauna crossing of the major urban projects from the City of Cockburn; a Western Australian growing local government where state and major local projects are currently being implemented. The study has mapped the major road infrastructure by exploring historical data and aerial imagery and document analysis in Cockburn. Secondly, it has examined the road design consideration and design approaches to how the built environment could be more friendly and sustainable for all human and living beings using design instruments, audit reports, project report. The study showed that road authorities are building infrastructure to meet the community's growing demand; however, with a little contribution in fauna crossing that makes our environment more green and vibrant green community. The study concludes that the findings will be useful to fill literature gaps through a context-sensitive approach towards sustainable Built Environment from Perth, Western Australia. The closing analysis and discussion will also offer some potential tonics for Environmental impact assessment, protection and mitigation.

Keywords- Built Environment, Sustainable Transport, Possum Bridge, Environmental Impact, Western Australia

I. INTRODUCTION

Sustainable, safe and efficient transport infrastructure is vital for the Australian economy. In a current pandemic, the Australian Government has stimulus and shovel-ready transport infrastructure project to keep the economy and secure job in Built Environment and managed environmental impacts by offsetting, landscaping, revegetation, rehabilitation, and many ways. From the literature review, it is highlighted that to achieve a sustainable living built environment should focus on achieving the highest quality of natural lifecycle that is the best need for the environment for the safety of human being, flora and fauna. Moreover, the cities' built environment requires to explore the social and cultural identity and civilisation as a way of *life* that can contribute to the implementation of such outcomes (Furlan and AlMohannadi, 2016). The built environment affects traffic safety; the combination of fast-moving and auto-oriented street design is not always safer for living creatures (Frank and Kavage, 2008). A close interaction among planners, decision-makers and stakeholders should be emphasised (Biral, Da Lio, and Bertolazzi, 2005). To increase or achieve this awareness; the *built environment* can play a role in safety attention and proactive intervention for safety

planning in the suburban area through the theoretical and empirical models for a better explanation (Cho et al., 2009). It is evidence that road width, parking advantages, roadside height, and human activities increase crash risk dependency on other living habitats in the road-built environment; therefore, the road-built environment should be improved and context-sensitive action to reduce accidents and impact. More thoughtfulness and preemptive involvements are appropriate in suburban areas beyond high crash rates (Stephan and Newstead, 2016). In Transport modelling, four steps of models have been adopted to make the built environment sustainable, which contributes to understanding the relationship between the environment and nature (Vardaki et al., 2015). The built environment has a direct and indirect effect on the choice of the travel route. By increasing the chances of walking and cycling, it is possible to form a community that supports less motorised travel (Ding et al., 2017) and more environmentally friendly outlook and green transport.

In this regard, this study explained a case example as a shred of evidence for academic and practitioner. The first section describes the case study from available information state government project (Main Roads Western Australia) and

Local Government Projects mainly the City of Cockburn. The second section has detailed environmental sensitivity, adaptation and community response outcome through fauna crossing due to road widening, where author practically worked as a road designer in the City of Cockburn, a growing local government in Perth Metropolitan, Western Australia. The study shows the Australian Map, Western Australia location, location Perth Metro, and City of Cockburn's geographical location in Perth Metro below;



Figure 1: Australian Map showing States and Territories



Figure 2: Location of Perth in Western Australia



Figure 3: Perth Metro Councils



Figure 4: City of Cockburn, South Metropolitan

II. CASE STUDY

This study detailed a few cases below where the impact and action were carried out in the detail projects in Perth, Western Australia according to *Environmental Protection Act 1986* and under the *Local Government Act 1995* to reduce the project implication, where the subject matter of this study has creates an example to explain how to achieve a more green transport outcome;

1. **Beelihar Drive duplication from Dunraven drive to Kemp Road**

To improve the community and vulnerable road users' safety and ease traffic congestion; the City of Cockburn duplicated

Beeliar Drive from Dunraven drive to Kemp road in 2012. Road width was increased from 10m to 35m for a 2-kilometre stretch, noted that from 1974 aerial imagery, it was exposed that the road was not built and after 1980, the single carriageway was the first built. Due to this duplication the Yangebup and Kogolup Lakes with Beeliar Drive cutting through the middle with a wider gap to accommodate 30000 Vehicle per day (vpd) with a growing heavy vehicle 10%. The council environmental officer also witnesses that the fauna was crossing the existing single carriageway in a couple of occasions that was a critical threat to their daily life. They spend a reasonable amount of time on the ground foraging when faunas are likely to get attacked by predators and struck by vehicles. The widening of the road might have more consequences to these habitats since animals need to start breeding with animals on the other side of the road. To mitigate this issue; the project considered a fauna crossing to make the safe passage and ensure the best suit location in relation to the weather and climate context along with many man-made hurdles. The following figures show the existing site of both lakes and section of the underpass, where it was built during the duplication;



Figure 5: No road between Yangebup and Kogolup lake, Source: Aerial photo from IntraMapping in 1974



Figure 6: Beeliar Drive has divided Yangebup and Kogolup lake, Source: Aerial photo from IntraMapping in 2012

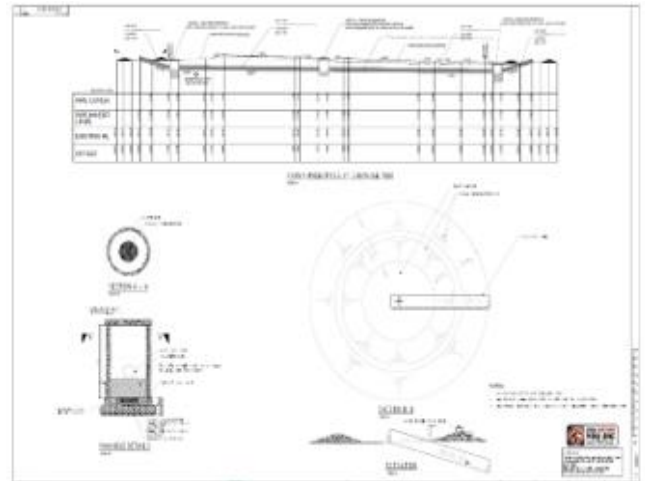


Figure 7: Fauna underpass at Beeliar Drive, Source: Sectional detail of tunnel, drawing no. 2956B10-12, dated; October 2011, from project construction drawing

In recent year, the City's environmental team was determined that the native possums being killed by both predators and heavy traffic at these sensitive wetlands. The City of Cockburn installed a cable tensioned rope net bridge in 2019 to serve the native habitat of brushtail possums towards increased the species' long-term survival by disbanding their population due to recent incident that possums were run over vehicles. The net bridge was hooked between two large trees on a crest along Beeliar Drive so that the possums can safely enter on to the bridge and exit off without needing to go down to the ground, where foxes, cats and dogs can predate on them



Figure 8: Possum rope Bridge, hooked between two wooden poles, Source: Photo captured on 18 January 2021



Figure 9: The possum was left blind after being attacked by predators in the Beeliar wetlands area, Source: Photo from ABC News: Gian De Poloni, June 2019

It was highlighted by Wildlife rehabilitation group Native Arc in Bibra Lake to ABC News that there were more than thirty possums injured in the last eighteen months. The rehabilitation coordinator said that "The majority of those were from predator attacks or vehicle accidents and a lot of those were female possums with joeys,". She believes that "The bridge will absolutely reduce the injury rate and death rate of possums in the area."

2. Hammond Road duplication from Brach Circus to Bartram Road

The City of Cockburn recently scheduled Hammond Road duplication from Branch Circus to Bartram Road in October 2020 to meet the community and vulnerable road users' demand to alleviate congestion. Road width was increased from 11m to 35m for a 1.9-kilometre stretch. The single carriageway was the first built-in 1950. Due to this duplication, the wetland reserve will be a wider gap to accommodate 25000 vpd with a growing heavy vehicle 9%. As per City's application to clear native vegetation to widened this road under the *Environmental Protection Act 1986*, *The Native Vegetation Regulation*, *Department of Water and Environmental Regulation (DWER)*. The DWER would like to get further information about the 'offer' by the City regarding mitigating against clearing native vegetation following each mitigation hierarchy step (avoid, minimise, mitigate, rehabilitate) applied to address direct and indirect impacts. DWER highlighted it;

"Construction of the Hammond Road Duplication Project (with a dual carriageway) has the potential to isolate further two reserves managed for conservation purposes (Principle h). Further isolation of these reserves may restrict aquatic fauna (e.g. frogs, fish and turtles) and terrestrial fauna dispersal between the two conservation areas. Note that a deceased Priority 4 Quenda (*Isoodon fusciventer*) (presumably roadkill) was identified in this immediate area during the site inspection (DWER 2020). Dependant upon final design, construction could also alter the hydrological flows of the Conservation category sumpland (Principle f). Indirect impacts associated with the construction process also has the potential to

negatively impact these adjacent conservation areas in terms of impacts to wetlands (Principle f) as well as surface water (Principle i)."

Due to high groundwater, the project considered a possum rope bridge crossing to make the safe passage and ensure the best suit location in relation to the weather and climate context. The following figures show the location and section of the rope bridge;



Figure 10: Proposed Hammond Road duplication, Source: Aerial photo from IntraMapping in 2020

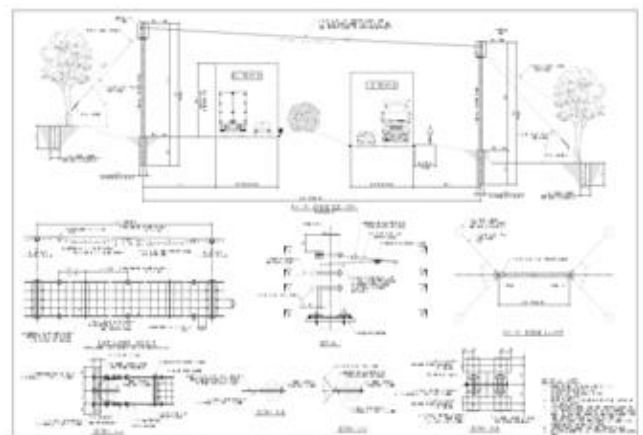


Figure 11: The sectional plan of proposed Possum Bridge, Design and drawn by the future Engineering and communication has designed this Possum Bridge, Source: Hammond Road duplication, construction drawings

The estimated cost for the proposed rope bridge, as shown above, was AUD 60k. Beside additional cost also allocated to alter the road's colour, turtles are more obvious and install traffic calmings in the area; such as electronic signage similar to what we see at school zones alerting drivers of turtles/ other fauna in the area leading up to the AUD 20k. The design

maintained a minimum clearance over the road of 6.5 meters as required for District Distributor Road. The City of Cockburn conducted public consultation among 3214 property owners were notified by mailmerge. One on one with the resident meeting was provision for booking with council engineer at the operation centre Monday to Friday, 7 am to 3 pm. The City's Facebook media, where 725 people viewed, 134 responded/commented, and 266 people share this adaptation for environmental mitigation.

3. Tonkin Highway Extension near Maralla Road in Ellenbrook (MRWA),

The state MRWA was constructing \$1 billion Northlink WA project's central section of Tonkin Highway near Maralla Road in Ellenbrook. The project also considered fauna underpasses and fully vegetated fauna overpass to allow the native animal to cross the primary distributor. It was highlighted that *"The purpose of the fauna bridge and fauna underpasses is to allow native animals access to habitat that has been fragmented by the construction of Tonkin Highway,"*

The following figures show the schematic detail of the overbridge;



Figure 12: Tonkin Highway construction in Ellenbrook, Source: WAtoday, Hamish Hastie,



Figure 13: The newly build an overpass on Tonkin Highway in Ellenbrook, Source: NearMap image on 21 November 2020,

4. Logan Motorway, Queensland

Logan Motorway construction was completed in 2000. It is a 29.1-kilometre road linking the Gateway, Pacific, Centenary and Ipswich motorways. It combines Brisbane, Logan, and Ipswich's communities to maintain freight productivity and community for safe, efficient and quick travel among these cities.

The project added extra lanes, upgraded ramps, interchanges along sections of the Logan and Gateway motorways, and added new on and off-ramps on the Gateway Motorway at Compton Road. The world biggest toll road operator (*Transurban*) Queensland bought this road in 2014. It is highlighted that 62.5 per cent Transurban owned this Motorway and is under concession until 2051.

Moreover, the *significant improvements* were to made where environmental impacts are mitigated primarily adopting fauna connectivity in the area that includes building a new wildlife bridge on Illaweena Street to get animals out of the way of busy and high speed traffics. Prof Darryl Jones from Griffith University said that the animal passes the busy road and interchanges without hindering the networks and users. And Andrew Richardson from Transurban also highlighted the vegetation will mature in some time; then it will be looking the back the green and nature again. From 9 News video, it was observed that animals are using the underpass as well, during construction before opening the underpass and overpass, few scenarios have observed and explained in the following figures.

The following figures show the schematic detail of the environmental impact and alternative for a sustainable green transport outcome;

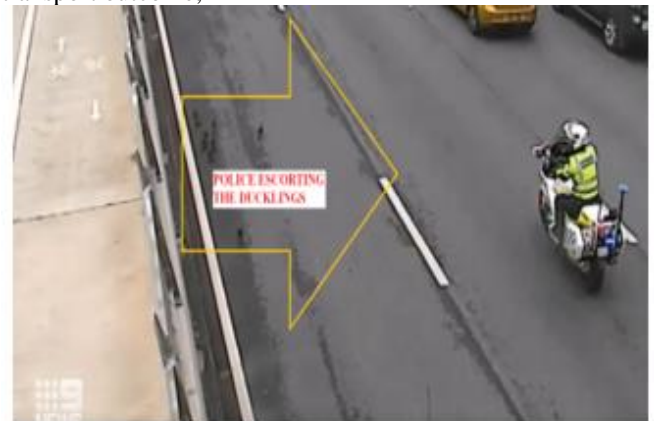


Figure 14: Ducks and baby ducks came on top of Motorway, due to the environmental impact that 29.1 Km road has created a barrier in crossing. Police were escorting the ducklings. Source: 9 News Adelaide; Ducks cross the road, 15 May 2019



Figure 15: The duck on highspeed Logan Motorway, Source: 9 News Adelaide; Ducks cross the road, 15 May 2019



Figure 16: The possum came on Logan Motorway, Police rescuing the possum, Source: 9 News Adelaide; Ducks cross the road, 15 May 2019



Figure 17: The Motory considered overpass and underpasses to mitigate these sensitive environmental impacts. Source: 9 News Adelaide; Ducks cross the road, 15 May 2019



Figure 18: The witness that the fauna is using the underpass. The Motory considered overpass and underpasses to mitigate these sensitive environmental impacts. Source: 9 News Adelaide; Ducks cross the road, 15 May 2019



Figure 19: The Motory considered artworks to make sustainable built environment outlook at the overpass, Source: 9 News Adelaide; Ducks cross the road, 15 May 2019

5. Caves Road near Busselton, WA

A possum bridge was constructed on Caves Road, Kealy, WA 6280 by Main Roads Western Australia (MRWA) in 2013 about 9km west of Busselton. It was supported by 8.5m tall wooden poles each side of the road. The width of the rope bridge was 300mm wide and 26.5m in length. This study conducted a literature review regarding Western Australia context. The literature reveals that the University of Western Australia (UWA) monitors the critically endangered western ringtail possums' movements across the South West bridges. The UWA research team used photographic data from 270 nights of monitoring from August 2013 to May 2014 for further analyses. The UWA research revealed that the possums were crossing comparatively a smaller amount in windy and warm nights due to risk of blown away and heat stress (McCafferty et al. 2011). Another bridge was constructed on the Bunbury Outer Ring Road. The estimated cost for the bridges was AUD 100000.

The following figures show the schematic detail of the possum impacts and UWA results towards an alternative for a sustainable green transport outcome;



Figure 20: Location of Possum Bridge on Caves Road, Kealy WA. Source: Aerial Photo from IntraMap, City of Busselton, March 2020

The Roads and Maritime, New South Wales have been spending two decades refining and improving connectivity measures for all native fauna, approximately 200 monitoring events carried out in past decades. Thus, the Australian community and agencies help mitigate and minimise the impacts in all critical infrastructure projects in the Built Environment context in various State and territory locations

III.DISCUSSION

The above case studies are brought from Australia's different states and territories to discuss mitigation action and consideration. Here this discussion was primarily for possum crossing and habitat crossing alternatives. The various project may need further treatment as per the environmental impact and policy of the places. It is not a relaxation or needless need for the projects. These projects bought a thought of how and why required this consideration in the specific projects. For instance, in Saudi Arabia, the roadside fence has erected both sides of the Motorway (Makkah Madinah Highway) because the animals are

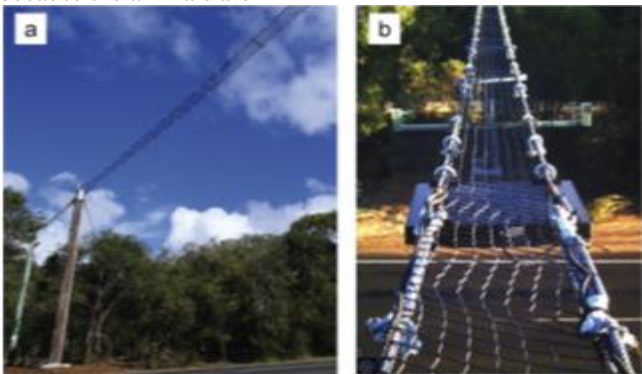


Figure 21: Schematic photographic detail of Possum Bridge on Caves Road, Source; (Kaori and Roberta 2015, p.82)

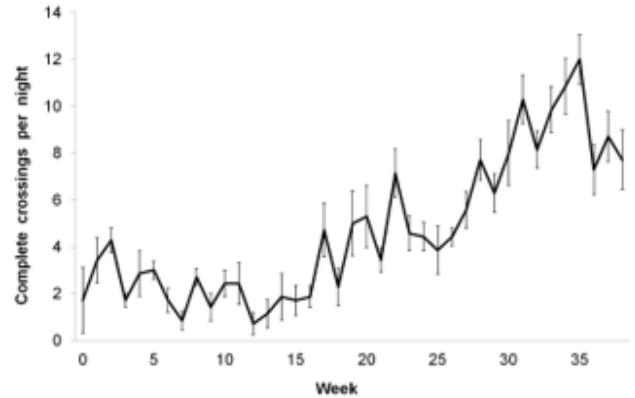


Figure 22: Weekly averages of the number of Possum crossings, Source; (Kaori and Roberta 2015, p.86)

crossing abruptly causes severe casualties for road users and animals (this information received from a senior engineer who worked under this road construction project). However, this study tried to explain here, designer, planner and decision-maker should consult and verify the action need from the soul or root cause rather than a technical solution. For the above crossing background, there are two different types of possum bridge primarily are used and available in the Australia wide such as;

- Box type: a ridged box type which helps possum to protect from falls and safe crossing
- Ladder Type: this is a lighter design to the box type bridge as durable as box type but the flat bridge

The following image detailed for further understanding of types of rope bridges are in use;



Figure 23: Possum and Fauna crossing (Box type), Source: Nationwide Netmakers Pty Ltd



Figure 24: Cross-section of Possum and Fauna crossing (Box type), Source: Nationwide Netmakers Pty Ltd



Figure 28: camera detection of Possum and Fauna crossing (ladder type), Source: Nationwide Netmakers Pty Ltd

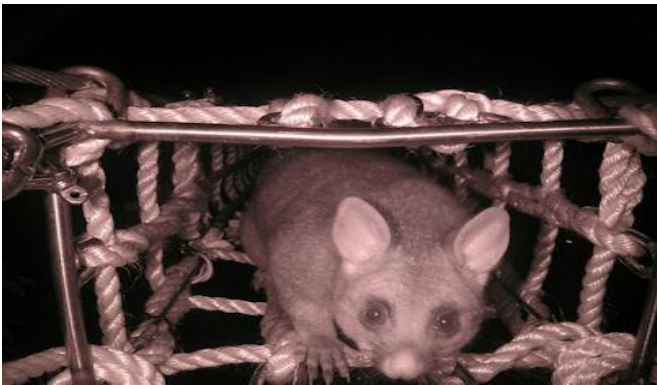


Figure 25: Possum and Fauna crossing (Box type), camera detection of possum, Source: Nationwide Netmakers Pty Ltd



Figure 26: Rope net hooked between two poles, Possum and Fauna crossing (ladder type), Source: Nationwide Netmakers Pty Ltd



Figure 27: Installation of Rope net hooking between two poles, Possum and Fauna crossing (ladder type), Source: Nationwide Netmakers Pty Ltd

Literature shows that in Australia, minimal research has been undertaken about fauna crossing. Although kangaroos and bandicoots related literature about their presence under the road bridges and culverts, the population impacts and dynamics have limited research (MRQld, 2003). From the literature review and document analysis, it is summarised that there are a variety of mitigation measures and techniques are available such as; underpass, overpass, culverts, signages, fences, funnels, tunnels, bridges, reflectors used based on the type of species. The selection of mitigations is based on site-specific, cost-effectiveness and viability (MRQld, 2003).

IV. CONCLUSION AND RECOMMENDATION

This study aimed to discover the factors significant driving difficulties seen from environmental mitigation measures and assess their relative importance using the cases from an extensive review. Due to this significant highway expansion, upgrade and widening in greenfield, brownfield and infill, the environment has a substantial impact in many ways in Australia. One of the effects is native vegetation clearing in Perth, Western Australia. However, the state government has a strict policy and acts to protect vegetation through the *Environmental Protection Act 1986*. This study tried to reflect an example of how the transport system can be more environmentally friendly. It is unavoidable that infrastructure development will have no impact on the natural environment, but the context-sensitive approach and measure can significantly reduce the Built Environment. This study acknowledges that different country also has other consideration to manage the environmental aspects. The author believes that bring such thinking it is possible to make infrastructure more green and safe in many cases. Although these additional scopes result from high cost, maintenance to the asset management context, there needs an urgent policy and good governance to make our environment more resilient instead of creating concrete jungles. It is unavoidable that the road infrastructure creates negative impacts on wildlife and arboreal species. However, there are solution and mitigation to mitigate this impact and provide safe passages. This study shows that rope bridges, underpasses has a high potential for effective mitigation measures against the negative or any harmful impact such as abolish species, losses the native

habitats or trees. The study believes that there needs research to find more alternative, cost-effective measures so that low-cost projects or infrastructure development can adopt more cost-effective sustainable mitigation measures towards green environment outcome. The study results provide evidence of collective actions on EIA and the mitigation approach in sustainable development in the context of green environments. In conclusion, the study highlighted certain patterns of difficulties in consideration and mitigation where community participation and engagement associated combined decision may be imposed that may merit special attention to perceptions of flora and fauna difficulties and problems. Use underpass or overpass does not necessarily ensure that the fauna population is protected. Population study is essential to ensure the sub-population of a metapopulation is connected appropriately with the constructed bridges. The study has collated the following recommendations;

- Infrastructure project should care about the loss of habitat and ecological connectivity (habitat/population fragmentation),
- Ensure the safety to eliminate or mitigate the risks of fire, disease, predation due to loss of shelter,
- Protect the fauna injuries or killing by construction machinery during construction or vegetation clearing,
- The revegetation scheme should consider as part of offset due to loss of vegetation by development works,
- Detail flora and fauna survey or investigation must be considered in the correct season of the year to get the real catchment of effects,
- Ensure good practise monitoring program to identify the direct and indirect impacts occur for each species,
- Identify and priorities the action and mitigation based on the risk-based approach,
- Mobile or temporary fauna crossing should consider during construction or clearing,
- Possum fencing or obstruction such as noise wall, screen wall should exclude during construction or operation of the road,
- Minimise the unnecessary clearing or established sensitive clearing practices,
- The dieback management plan must be considered and make sure the correct mapping was done or examined.
- Ensure the street light not spills in the bush or not affecting the species/ fauna during the night,
- A post clearing survey should undertake immediately after the clearing operations to ensure permit application and clearing has done correctly,
- Ensure the project has considered the *Environmental Management Plan (EMP)*, *Construction Environmental Management Plan (CEMP)* as per the state and local environmental regulation,
- An Environmental Management Action Plan (EMAP) should develop based on EIA addressing the impacts to control and protect the natural, social environment reducing the adverse effects at an acceptable level according to the respective country's Environmental

Conservation rules or funding agency's concerned guidelines,

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