4th Construction Specialty Conference
4e Conférence spécialisée sur la construction

Montréal, Québec
May 29 to June 1, 2013 / *29 mai au 1 juin 2013*

Applying Context Sensitive Solutions for Environmental Protection on Highway and Infrastructure projects

Thomas M. Korman[1], Ph.D., P.E., P.L.S., M.ASCE, and Na Lu[2], Ph.D.
[1]Associate Professor, Department of Construction Management, California Polytechnic State University, San Luis Obispo, 1 Grand Avenue, San Luis Obispo, CA 93407-0284; PH (805) 756-5612; FAX (805) 756-5740; email: tkorman@calpoly.edu
[2]Assistant Professor, Engineering Technology, University of North Carolina, Charlotte, 9201 University City Blvd, Charlotte, NC 28223; PH 704-687-2718; nlu2@uncc.edu

Abstract: Since the early 1970s, environmental factors have become an important consideration during the planning, development, construction, operations and maintenance processes of transportation projects. New federal and state environmental laws, regulations, judicial decisions and administrative interpretations have added new requirements to these processes over the past three decades demanding greater accountability and compliance. State departments of transportation have adjusted to these new mandates and enhanced their environmental knowledge and capabilities to meet the challenge and to become better stewards of the environment. Context sensitive solutions (CSS) is a collaborative, interdisciplinary approach that involves all stakeholders in providing a transportation facility that fits its setting. It is an approach that leads to preserving and enhancing scenic, aesthetic, historic, community, and environmental resources, while improving or maintaining safety, mobility, and infrastructure conditions. The concept of context sensitive solutions (CSS) has been evolving in the transportation industry since the National Environmental Policy Act of 1969 required transportation agencies to consider the possible adverse effects of transportation projects on the environment. This paper presents several examples from recently completed projects where the context sensitive solution design philosophy has been successfully applied to protect the environment on highway and infrastructure projects.

1 Introduction

Since the early 1970s, environmental factors have become an important consideration in the planning, development, construction, operations and maintenance processes for transportation projects. New federal and state environmental laws, regulations, judicial decisions and administrative interpretations have added new requirements to these processes over the past three decades demanding greater accountability and compliance. State departments of transportation have adjusted to these new mandates and enhanced their environmental knowledge and capabilities to meet the challenge and to become better stewards of the environment. Central to this new approach has been the recognition and adoption of a publicly enunciated and acknowledged environmental ethic for the policy and decision-makers and the employees of these organizations.

Context Sensitive Solutions is a design approach which has been applied to transportation planning and project development that recognizes the wide societal impacts of transportation. Context Sensitive Solutions has been pioneered by a number of state Departments of Transportation -- with support of the Federal Highway Administration (FHWA) and transportation professional organizations. The emerging national-consensus definition of Context Sensitive Solutions is: “A collaborative, interdisciplinary approach that involves all stakeholders to develop a transportation facility that fits its physical setting, and preserves scenic, aesthetic, historic and environmental resources, while maintaining safety and mobility” (FHWA).

An important aspect of highway design that makes every project unique is its geographic setting. The setting and character of the area, the values of the community, the needs of the infrastructure, and the challenges and opportunities are unique factors that planners and engineers must consider with each infrastructure project. For each potential project, planner and engineers are faced with the task of balancing the need for the highway improvements with the needs to safely integrate the design into the surrounding natural and human environments. There are a number of options available to designers to aid in achieving a balanced road design and to resolve these issues. These include the following:

- Flexibility within the established design standards.
- Recognition that design exceptions are appropriate where there are environmental consequences.
- Evaluation of decisions made in the planning phase.
- Decreased design speed when appropriate.
- Maintaining a roadway horizontal and vertical geometry and cross section and undertake only resurfacing, restoration, and rehabilitation (3R) improvements.
- Consideration of the development of alternative standards for scenic roads.
- Recognition the safety and operational impact of various design features and modifications.

2 Essentials of Context Sensitive Solutions (CSS)

Context Sensitive Solutions (CSS) embraces the idea of designing transportation systems compatible with nature. Context Sensitive Solutions uses collaborative planning, stakeholder involvement, environmental consciousness and appreciation coupled with natural designs to find transportation solutions that become sustainable. Appling CSS design approach can affect all design elements; therefore project costs may increase, decrease, or be unchanged as compared to the traditional design approach. Cost issues must still be addressed during project development, which is the case with all technical and environmental constraints. The underlying purpose of the CSS design approach is that it adds value to the process by helping to identify and work with stakeholders to develop projects that are sensitive to their context. The Context Sensitive Solutions approach does not imply that there will always be unanimity among stakeholders. Therefore, the essential principles and practices of CSS include the following:

Engage stakeholders	Involve stakeholders, builds partnerships, and recognizes community values.
Utilize an interdisciplinary team	Use a wide range of professionals in an integrated approach to get comprehensive results.
Embrace a multimodal approach	Integrate all modes of transportation including pedestrians, bicycles, transit, motor vehicles, trains, ferries, ships, and airplanes.
Serve and respect the environmental and social context of the transportation network	Transportation must serve society and respect the constraints and opportunities provided by the natural and cultural environments that form its context.
Provide a safe and efficient transportation system	Safety and efficiency are a necessary and a primary goal of the transportation system.
Apply to all of the activities of the transportation agency	CSS will be applied to all work from planning and design through construction and into operations and maintenance.

When faced with social, economic, or environmental consequences, it is sometimes necessary for designers to consider alternative options. The design exception process is one such alternative. In other cases, it may be possible to reevaluate planning decisions or rethink the design.

3 Case Study No. 1: California State Route 46

California State Route 46 (SR 46) is an east–west state highway in the State of California. It is a major crossing of the Coast Ranges, connecting SR 1 on the Central Coast near Cambria and US 101 in Paso Robles with SR 99 at Famoso in the San Joaquin Valley. Although the highway is eligible to be designated as a State Scenic Highway to date is has been not, but is still considered “environmentally-sensitive." SR 46 was built during the 1920’s and has received numerous improvements over the years aimed at increasing safety and capacity.

The most recent improvements were completed in 2010, when $30 million was spent to improve and widen a roughly five-mile section of Hwy. 46 from Airport Road to Geneseo Roads near Paso Robles in San Luis Obispo County. During the design phase, the California Department of Transportation (Caltrans) emphasized that that the environment would be a major priority during the design and construction of the improvements.

In the section of highway being improved, it had been noted that deer collisions were a major problem. According to Caltrans officials, consultants and studies have identified kit fox have been identified to be present in or near the Highway 46 East corridor, along with other wildlife including deer. As part of both a safety measure to decrease collisions with motorists and deer and to better enable the movement and preservation of wildlife across the freeway, the project includes construction of two wildlife crossings underneath Highway 46 that will allow animals such as deer and kit fox to freely cross under the highway without interfering with vehicle traffic.

After construction was completed, deer footprints can be visibly been in the mud around the wildlife crossings. To enhance the wildlife crossings, the crossing were hydro seeding and a wetland area with native plants was specifically constructed to help preserve and enhance the state's environmental resources.

4 Case Study No. 2: Maine Route 112

State Route 112 is part of Maine's system of numbered state highways, running from U.S. Route 1 in Saco to Route 114 in Gorham. From its southern terminus in Saco, Route 112 runs north, concurrent with Route 5 for 0.4 miles. From the route's formation until 1937, Route 112 had its northern terminus at Route 4A, then known as Route 111. In 2008, Route 112 had its northern terminus extended from Route 25 to Route 114, as a bypass route to allow traffic to avoid the intersection of Routes US-202/SR-4/25 and 114.

Maine Department of Transportation (MaineDOT) developed the Gorham Bypass project to alleviate traffic in downtown Gorham, which has worsened over time due to an influx of commuters traveling through Gorham to Portland, Maine's largest city. The DOT evaluated several project alternatives to improve traffic flow and ultimately decided to extend Route 112 from northwest Gorham to Route 114, allowing travelers to bypass downtown Gorham. This alternative effectively addressed the traffic problems in Gorham, but created another challenge. The challenge then became how to construct a road in a predominantly undeveloped area while minimizing potential disruptions to wildlife habitats.

To accommodate small animals crossing near vernal pools, MaineDOT constructed 4-foot culverts, which served both as wildlife passages and drainage pipes to direct stormwater from adjacent properties to lower lying areas. MaineDOT also installed water-permeable silt fences to help funnel small animals to the culverts.

Using this habitat assessment, MaineDOT identified local wildlife species that would benefit from passages, including deer, turkeys, beavers, porcupines, salamanders, and frogs. MaineDOT also looked at the topographic features of the surrounding area to help determine the road geometry and identify locations for potential wildlife crossings early in the planning stage of the project. Two locations were also identified that contained deep streams, which are ideal for large mammal crossings. These places were likely to remain undeveloped due to regulatory protections and topographical challenges, including steep grade and deep streams, and therefore would serve as effective long-term habitats for area wildlife. The lack of development in these areas also allowed MaineDOT to construct a half-mile fence around each wildlife bridge crossing to funnel the animals toward the crossings. The DOT also identified locations for eight 4-foot culvert crossings, including two near vernal pools. Culverts are appropriate for the movement of small mammals, amphibians, and reptiles. Vernal pools are temporary pools that often form during the spring. Several types of amphibians travel to and from vernal pools for breeding purposes.

MaineDOT considers the wildlife crossings along the Gorham Bypass a major success because there are lower animal-vehicle collision rates on this road relative to comparable roads. Between 2008 and 2011, there was one animal-vehicle collision on the Gorham Bypass, compared to 12 animal-vehicle collisions on the adjacent Route 114, a similarly sized road that is east of the bypass, which does not have fencing or wildlife passages.

5 Case Study No. 3: Florida State Route 46

Florida State Road 46 is an east–west route in central Florida, running from US 441 in Mount Dora to US 1 in Mims. Along the way, it crosses the St. Johns River near the Econlockhatchee River. During the most recent SR 46 Widening and Reconstruction and Realignment Project, biologists and engineers from the Florida Department of Transportation (FDOT) and the Florida Fish and Wildlife Conservation Commission (FWC) designed incorporated the state's first underpass for black bears on a stretch of State Route 46 in Lake County.

Biologists knew bears had been using similar crossings built for Florida panthers on Interstate I-75, also known as “Alligator Alley”). This sub-species of the American black bear is black with a brown muzzle. Males weigh about 350 pounds; females, approximately 150. They live in forests and eat mostly vegetable matter. A female's home range averages 11 square miles (28.5 km2); a male's can reach 66 square miles (171 km2), making male bears particularly vulnerable to roadkill. Florida black bears have been on the state's list of threatened species since 1974. There used to be 12,000 in the state; now there are 1,500 or fewer. More than 50 bears are killed on Florida roads each year.

They had also observed that bears routinely traveled across the targeted section of SR 46 near County Road 433 to get to habitat within central Florida's Wekiva River Basin. To confirm their observations, more than 20 years of data were collected and analyzed on black bear roadkill data. Fifteen (15) locations were identified and prioritized based on the findings that within seven counties represented at least thirty-nine (39) percent of Florida's bear roadkills. The data confirmed that bears were being hit by vehicles more often at this spot on SR 46 than at almost any other spot on the highway. State Route 46 was elevated over this bear underpass so crossing animals could clearly see from one side of the road to the other.

To ensure bears could easily access the underpass from the south, the FWC purchased a 40-acre (16-ha) tract of land in the bears' travel corridor - a private "inholding" within Rock Springs Run State Park. The SR 46 underpass built by FDOT is a bear-friendly, dirt-floor box culvert, 47 feet- (14.3 m-) long by 24 feet- (7.3 m-) wide by 8 feet- (2.4 m-) high. Work crews elevated the two-lane road over the crossing to give skittish animals a clear view across to the other side. Rows of pine trees were also planted in the open pasture on one side of the road to guide bears to the culvert entrance.

Bears did indeed use the SR 46 crossing. In fact, post-project research revealed that bears plus 12 other species, including bobcats, gray foxes, and whitetail deer, crossed through it. This project demonstrated that the SR 46 crossing as an important step in connecting bear habitat. The Florida black bear needs a half million acres of connected habitats to survive. The SR 46 underpass helps meet that challenge.

6 Conclusions and Opportunities for Future Research

Implementation of the Context Sensitive Solutions approach takes time, education, experimentation, commitment, awareness of changing values and attitudes, and a constant reassessment of the best ways to provide for the public benefit through the development and implementation of transportation systems. A successful approach will pay dividends in terms of cost savings, greater public acceptance, and expedited programs.

Wildlife crossings on highways and local roads provide benefits for animals and road users by reducing habitat fragmentation and animal-vehicle collisions. Wildlife crossings are specially designed bridges, underpasses, culverts, or tunnels that provide safe crossings tailored to fit the needs of local animal populations and the surrounding communities. Roadway projects that include wildlife crossings are often eligible for Federal transportation funding. They can also help to preserve wetlands while reducing highway costs.

In addition to early assessment and planning of the crossing locations, design for wetland preservation is another important element for future projects. Future questions, become how to incorporate the most effective wildlife crossing designs that accommodate both wetland preservation and stormwater management objectives and still meet the main goal to maintain habitat connectivity. For example, planners and engineers may consider how to use concrete culvert boxes as wildlife crossings as an alternative to constructing bridge passages.

Using CSS is one strategy that can be used to assess the habitat impacts from the proposed projects and construct roadway surfaces to be as porous as possible to minimize its impacts to wetlands and animal movements. Input from the Fish and Wildlife Service on wildlife passages throughout the design process to ensure the road would have minimal wetland and wildlife impacts.

Documentation of existing wildlife use of the bridges and culverts, using wildlife cameras and field observations of animal tracks leading to and from the passages can also be used to support future wildlife passage designs. Developing new ways to protect wildlife for other animals should also be considered, i.e., modified culvert designs that contain a concrete shelf that allows small animals to cross over water drainage and debris that sometimes collects at the bottom of the culvert.

7 References

Cui, Qingbin, and Zhu, Xinyuan (2011), “Green Contracting in Highway Construction: State of Practice” Transportation Research Board 90th Annual Meeting, Washington, D.C. January 23-27, 2011.

Demich, Gary and Messer, Jack (2011), “Sustainable Highway Construction” is NOT an Oxymoron”, International Conference on Sustainable Design and Construction Proceedings, Kansas City, Mo. March 2011

Gambatese, J.A. and Rajendran, S. (2005). “Sustainable Roadway Construction: Energy Consumption and Material Waste Generation of Roadways.” Proceedings of the Construction Research Congress 2005, San Diego, CA, April 5-7, 2005. Reston, VA: ASCE, 104-110.

Kibert, C. (2005). Sustainable construction: Green building design and delivery, Wiley, Hoboken, N.J.

Korman, Thomas M., Na, Lu, and Simonian, Lonny, “Context Sensitive Solutions for Infrastructure Projects”, 2012 International Conference on Sustainable Design, Engineering, & Construction, November 7th - 9th, 2012, Fort Worth, TX.

Korman, Thomas, and Lu, Na, “Heavy Civil Construction Operations: Increased Sustainability through Legislation, Codes, and Certifications.” 2011 Canadian Society of Civil Engineers Annual General Meeting and 3rd International/9th Construction Specialty Conference Ottawa, Ontario, June , 2011.

Lu, Na and Korman, Thomas, ”Review of Current Legislation, Codes, and Certifications Increasing the Sustainability Standards for Construction Operations, International Conference on Sustainable Design and Construction, Hyatt Regency Crown Center Hotel, Kansas City, Mo. March 23–25, 2011

Ndungu, Peter, Tsao, Cynthia and Molavi, Jeffery (2011). “Sustainable Construction: Comparison of Environmental Effects on Two Construction Methods”, International Conference on Sustainable Design and Construction Proceedings, Kansas City, Mo. March 2011

Pocock, J.B., Kuennen, S.T., Gambatese, J., and Rauschkolb, J. (2006). “Constructability State of Practice Report.” Journal of Construction Engineering and Management, ASCE, 132(4), 373-383.

Rajendran, S., Gambatese, J.A., and Behm, M.G. (2009). “Impact of Green Building Design and Construction on Worker Safety and Health.” Journal of Construction Engineering and Management, ASCE, 135(10), 1058-1066.

Robichaud, Lauren Bradley and Anantatmula, Vittal S. (2011), “Greening Project Management Practices for Sustainable Construction” Journal of Engineering and Management, ASCE, January 2011, pp. 48-57.