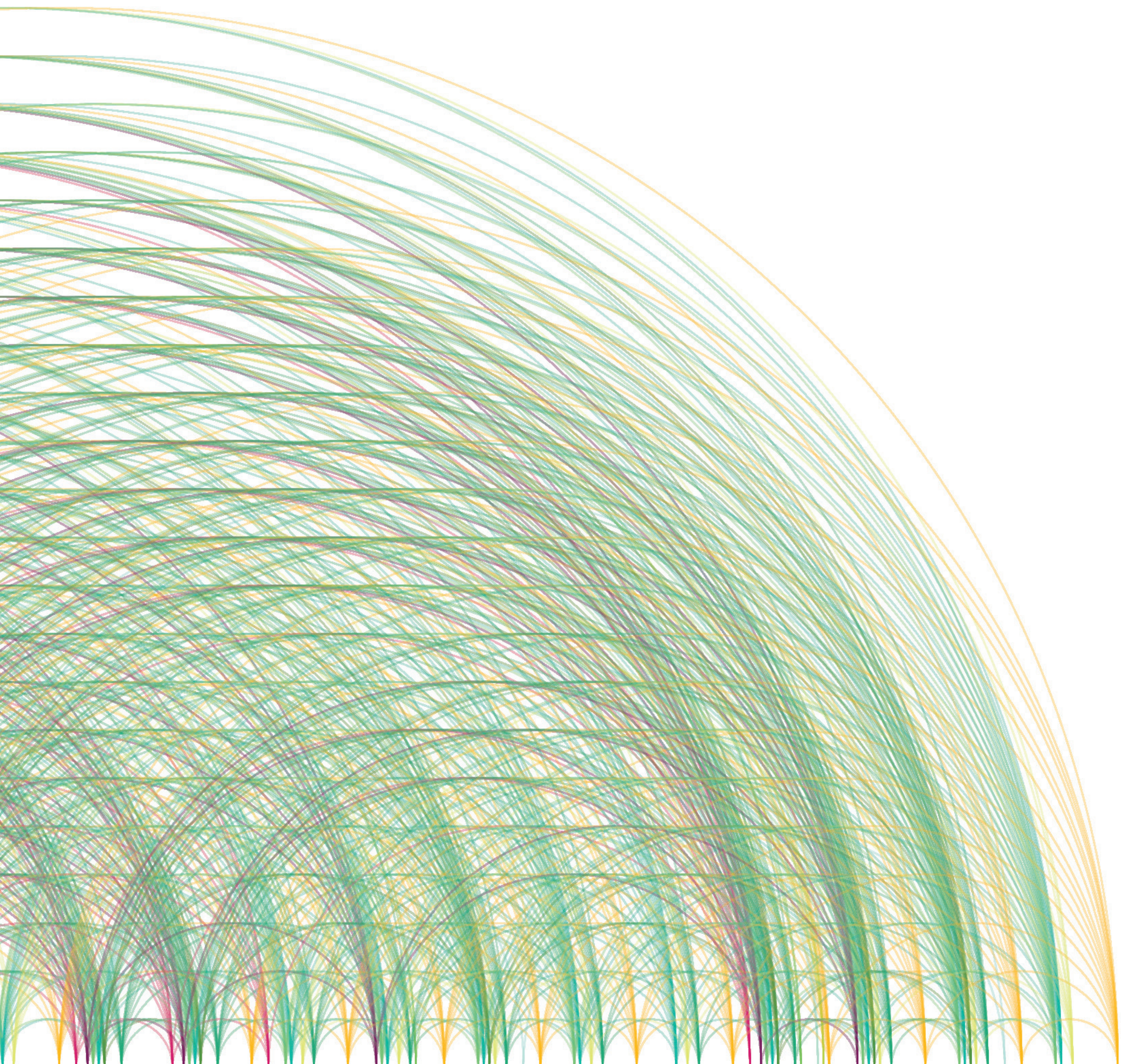
ARC

SPECIAL PUBLICATION

INNOVATIVE STRATEGIES TO REDUCE THE COST OF EFFECTIVE WILDLIFE OVERPASSES



> *"ARC is about building bridges; it's about reconciling conflict between roads and wildlife, people and animals, and getting us all where we need to go safely, at a lower cost."*
>
> NINA-MARIE LISTER
> Ecologist and Planner
> ARC Advisor

Highway crossing structures for wildlife have been shown to be one of the most effective means of reducing animal-vehicle collisions, while facilitating essential animal movement across the landscape. Yet the widespread implementation of such structures, especially wildlife overpasses, has been hindered by their perceived and actual expense.

This document compiles ideas and recommendations resulting from a facilitated workshop convened in October 2014, gathering prominent wildlife crossing practitioners from Canada and the United States to consider the unique nature of wildlife crossing structures, with the goal of identifying ways to reduce costs in order to improve the feasibility of widespread implementation. Recommendations for potential cost savings are presented in three categories: **(1)** planning, **(2)** design and construction, and **(3)** procurement, delivery method, and cost accounting considerations. These recommendations are intended to aid practitioners in considering ways and means to minimize costs or avoid additional expenditures during the design, construction and procurement of future wildlife overpass structures, without compromising their effectiveness. Taken together, the recommendations in this report offer a range of strategies to reduce costs through careful selection in materials, processes, design and construction — innovations that should not only maintain, but, in some cases, also improve the effectiveness of wildlife crossing structures.

People unfamiliar with wildlife crossing structures often ask if animals actually use them, and whether they reduce the risk of collisions with animals. The answer to both questions is an unequivocal yes!

Scientists around the world have documented hundreds of thousands of animals using crossing structures, including overpasses and underpasses.

These species vary from elephants to butterflies, from grizzly bears to crabs, even duck-billed platypuses! In Banff National Park, Alberta, for example, scientists detected more than 150,000 crossings by 11 large mammals over a 17-year period.

Studies have further confirmed that crossing structures with associated wildlife fencing work, in most cases, reducing collisions between motorists and wildlife by 85-100%.

“Most existing wildlife overpasses are heavy in terms of engineering and structure. No one has really looked at how to make these structures lighter, more adaptable, or at using recycled materials, which could lower their costs.”

TONY CLEVENGER
Wildlife Scientist
ARC Initiator and Competition Juror

Planning: is the process by which the implementation of a wildlife crossing is initiated and managed. This includes the selection of an appropriate site based on animal movement patterns, accommodating road redevelopment schedules, and establishing agreements among relevant agencies.

A well-planned site strategy is critical to the success of a wildlife crossing structure. Because every mitigation plan is different, in order to identify cost savings, decision-makers must carefully consider various site elements in the planning process. This includes but is not limited to: topography, road dimensions, vegetation, exposure and climatic conditions of the site, as well as the proper location of a planned crossing including impacts from human development, disturbance, and adjacent land use. In contrast to traditional highway infrastructure projects, planning transportation projects that involve and fully consider wildlife concerns poses unique challenges such as a need for collaboration across agencies and jurisdictional boundaries as well as coordination of funding schedules and agency missions.

To ensure that a finished wildlife crossing structure provides adequate strength and safety, transportation agencies typically set structural and other design requirements during the initial planning stage. The design requirements selected during planning, including design life, type of superstructure, highway geometric standards, structural loading, clearance box and site layout, will affect all future stages of the project, from conceptual design through construction, operation and final disposition. According to studies of manufactured products,although only 8% of the total product budget is spent by the time the product is designed, that design determines 80% of the product cost.[1] Regulatory standards typically govern geometric and structural loading requirements for highways that pass vehicular traffic. It is unclear, however, whether such standards apply to structures designed to pass wildlife. Thus, it may be beneficial to assess whether compliance with such standards is required or even necessary. Where appropriate, diminished regulatory requirements may lead to cost savings through the use of alternative designs and materials.

1. **Anderson, D. M. (2001).** Design for Manufacturability. Retrieved from Half Cost Products: http://www.halfcostproducts.com/dfm_article.htm#Design Determines

1 **Determine Target Species Movement Patterns:** Determine local movement pathways for all target wildlife species, and locate the crossing structure as close to those pathways as the surrounding topography and design considerations will allow *(Fig. 1)*.

2 **Provide Local-Scale Connectivity:** Provide local-scale connectivity at wildlife overpasses by ensuring that lands on both sides of the structure are conserved and managed in the long term for wildlife movement and population connectivity *(Fig. 2)*.

3 **Apply Integrated Design Approach:** Consider an integrated design approach that allows for the development of regional mapping tools and inclusion of ecological data, such as wildlife movement or linkage maps, during the earliest stages of transportation planning *(Fig. 3)*.

4 **Take Advantage of Economies of Scale:** Consider a programmatic approach that pools groups of structures or activities into one contract to benefit from economies of scale such as lower per-unit prices.

5 **Incorporate Wildlife Mitigation Early in the Planning Process:** Stay informed of planned local and regional highway projects and consider early on the need for wildlife structures in those projects.

6 **Integrate Mitigation into Other Highway Projects:** Take advantage of opportunities to incorporate or "piggy-back" wildlife-related mitigation measures into planned highway projects.

7 **Allow Creative Design Solutions:** Allow the designer flexibility to consider multiple solutions in how the required design standards are met.

8 **Evaluate Appropriate Design Life Spans:** Evaluate and select an appropriate design life for an overpass crossing based on its contextual location and other assumptions/requirements.

9 **Accommodate Anticipated Highway Standards:** Identify anticipated highway standards early in the planning process and develop a wildlife crossing that accommodates necessary geometrics, structural loading, and ecological requirements based on anticipated use by wildlife *(Fig. 4)*.

10 **Minimize Structural Fill:** Reduce the quantities of overburden and structural fill required for the overpass design through proper layout and siting. By selecting a location that takes advantage of grades adjacent to the road that are proximate to the height of the structure, graded transitions can be substantially reduced.

11 **Consider Single- Versus Multi-Span Clearance Boxes:** When developing requirements for crossings over multi-lane roads that cover longer distances, consider providing clearance boxes for two-span or multi-span structures. For shorter crossings, single-span clearance boxes can reduce foundation costs and simplify construction logistics *(Fig. 6 & 7)*.

12 **Consider Using Buried Bridges:** Consider using buried, rather than traditional, bridges where feasible and appropriate *(Fig. 5)*.

13 **Reduce, Reuse, Recycle:** Identify and assess materials available to be reused for wildlife crossings, including both structural and fill materials *(Fig. 8)*.

14 **Consider Dual Use Structures:** Consider co-locating an overpass with recreational, agricultural or vehicular interests *(Fig. 9)*.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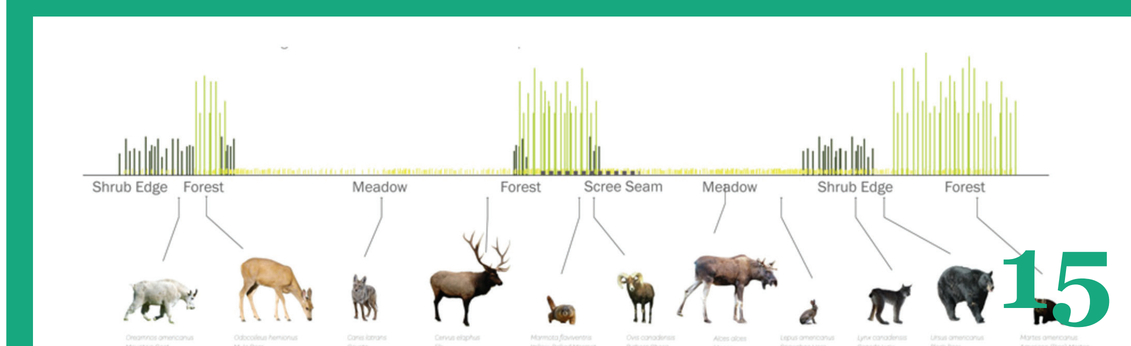

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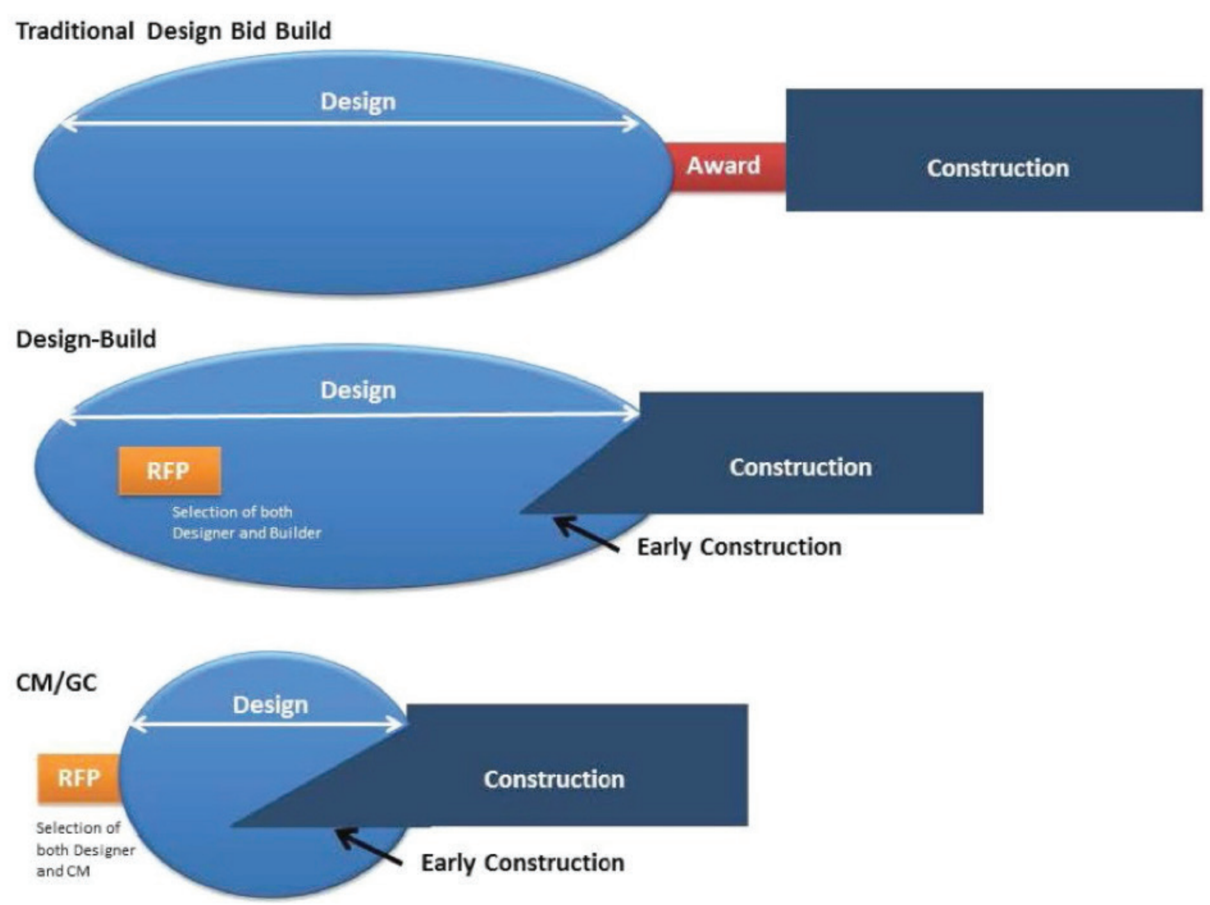

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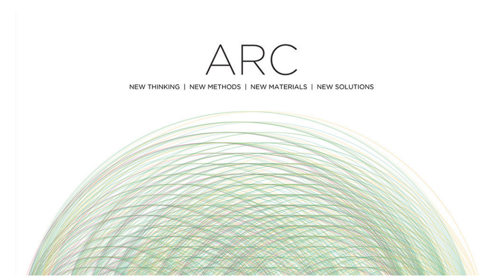

REMOVABLE POSTER

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1. Pronghorn antelope, native to western North America, must move long distances to meet their needs for food and water over the seasons. Roads and fences hinder their ability to move freely to meet these needs *(U.S. Forest Service)*.

2. Unlike the wide-ranging pronghorn, this rough-skinned newt moves relatively short distances in its search for food and mates. However, it must have precise habitat conditions or it will dry out and perish *(U.S. Forest Service, Betsy Howell)*.

3. Pronghorn using Trapper's Point wildlife overpass across US Hwy 191, near Pinedale, Wyoming, USA. This overpass was placed at a known traditional migration route for pronghorns, and the wide visibility and excellent placement of the structure enabled it to be used by migrating pronghorn within days of its completion *(Jeff Burrell/Wildlife Conservation Society)*.

4. Typical bridge style wildlife overpass crossing Ontario Hwy 69 between Parry Sound and Sudbury, Ontario, Canada *(Ontario Ministry of Transportation)*.

5. Typical buried style wildlife overpass crossing in Europe *(AIL Group of Companies)*.

6. Typical two span wildlife crossing over Trans-Canada Highway (TCH) in Banff National Park, Alberta, Canada *(AIL Group of Companies)*. The yellow box depicts the clearance box.

7. Typical one-span wildlife crossing, this is located on US 93 near Wells, Nevada, USA *(Contech Engineered Solutions)*.

8. Crews place large concrete box beams for the new path viaduct near the Willamette River in Oregon, USA *(Oregon Department of Transportation)*.

9. Mule deer walk through an underpass with an access road to Lava Lands Visitor Center on the Deschutes National Forest in Oregon, USA *(Oregon Department of Transportation)*. The twin underpasses under busy US 97 serve animals at night and in the off-seasons when the Visitor Center is closed.

10. Mechanically stabilized earth (MSE) and rock wall end treatment used on wildlife overpasses across I-80, near Wendover, Nevada, USA *(Contech Engineered Solutions)*.

11. Bevel end treatment *(AIL Group of Companies)*.

12. Geosynthetic reinforced soil (GRS) buried bridge during construction *(AIL Group of Companies)*.

13. Extruded polystyrene (EPS) geofoam embankment fill along I-15, near Salt Lake City, Utah, USA *(Geofoam Research Center, Syracuse University)*.

14. Cranes erecting concrete arches at Trapper's Point on US Hwy 191 near Pinedale, Wyoming, USA *(Contech Engineered Solutions)*.

15. Sample cross section of multiple habitat types targeted towards species local to Western Alpine region planted across width of crossing structure, submitted as part of the winning design for the ARC International Wildlife Crossing Infrastructure Design Competition *(HNTB & MVVA)*.

16. Vegetated wildlife overpass on Trans-Canada Highway (TCH) in Banff National Park, Alberta, Canada *(Alex P. Taylor, Parks Canada)*.

17. Three common procurement methods for highway construction projects: Design-Bid-Build (DBB), Design-Build (DB), Construction Manager/General Contractor (CM/GC) *(Minchin, 2014)*.

“We spend $8 billion a year running over wildlife. If we took that cost and quartered it, we could build 200 animal crossings a year, and the problem of roadkill would disappear within a generation.”

TED ZOLI
Bridge Engineer & MacArthur Fellow
ARC Competition Winner

Design & Construction: involves the technical design of all elements of the crossing structure including the substructure, superstructure and associated vegetation as well as the process of building and maintaining the wildlife crossing over its life span.

Routinely assessing new materials, technologies, products and methods developed for other applications to determine whether they apply or can be adopted to apply to wildlife crossing structures may offer structural design opportunities to reduce their costs.

Many wildlife crossings structures will be located in remote rural locations where specialized equipment and materials may not be readily available or may be expensive to transport and assemble on-site. However, an overpass structure does not have to be built on-site to be effective. Studies have shown that modular construction increases quality and construction site safety, while reducing construction time, overall costs, traffic disruption, material waste and impacts on the environment.[2] Modularity in the design of structures as well as planting configurations may also provide management flexibility and aid in adaptation as the range of some species may shift due to migratory route changes, in response to climate change or as a result of natural occurrences, such as forest fires.[3]

2. **FHWA (2012).** Prefabricate Bridge Elements and Systems (PBES). Retrieved from FHWA Every Day Counts: http://www.fhwa.dot.gov/everydaycounts/edctwo/2012/abc.cfm; **Rogan, A L-B (2000).** Better Value in Steel: Value and Benefits Assessment of Modular Construction. Retrieved from The Steel Construction Institute, London: http://www.designforhomes.org/wp-content/uploads/2012/03/ModularSteel.pdf

3. **Chen, I. H. (2011).** Rapid range shifts of species associated with high levels of climate warming. Science, 333 (6045), 1024-1026; **FHWA. (2015).** SHRP2 Innovative Bridge Designs for Rapid Renewal (R04) Accelerated Bridge Construction Toolkit. Retrieved from Strategic Highway Research Program: http://www.fhwa.dot.gov/goshrp2/Solutions/Renewal/R04/Innovative_Bridge_Designs_for_Rapid_Renewal; **Heller, N. Z. (2009).** Biodiversity Management in the Face of Climate Change: A review of 22 years of recommendations. Biological Conservation, 142, 14-32; **Mawdsley, J. O. (2009).** A review of climate change adaptation strategies for wildlife management and biodiversity conservation. Conservation Biology, 23 (5), 1080-1089.

15 **Minimize Foundation Costs:** Assess the possibility of minimizing foundation costs by allowing a higher tolerance for overall and differential settlement.

16 **Consider Bevel End Treatments:** Consider using bevels as end treatments if geological, soil, meteorological and other considerations permit *(Fig. 10 & 11)*.

17 **Explore New Materials and New Methods:** Consider new designs, technologies and products developed for other applications or alternative situations for potential applicability to wildlife crossing structures *(Fig. 12 & 13)*.

18 **Avoid Specialized Equipment:** When considering the design and construction of an overpass, minimize the need for costly specialized equipment and labor *(Fig. 14)*.

19 **Consider Transport Costs:** Consider the size and weight of fabricated structural members or components in relation to posted maximum loading for highways accessing the site.

20 **Utilize On-Site Supplier Expertise:** Take advantage of on-site supplier expertise, product knowledge and experience.

21 **Use Modular "Stackable" Components:** Explore opportunities to use modular (pre-fabricated) and "stackable" overpass construction materials.

22 **Limit Use of Complex Components:** Limit the number and complexity of structural components.

23 **Use Modularity to Optimize Adaptation:** Use modular elements that allow the structure to change depending on use.

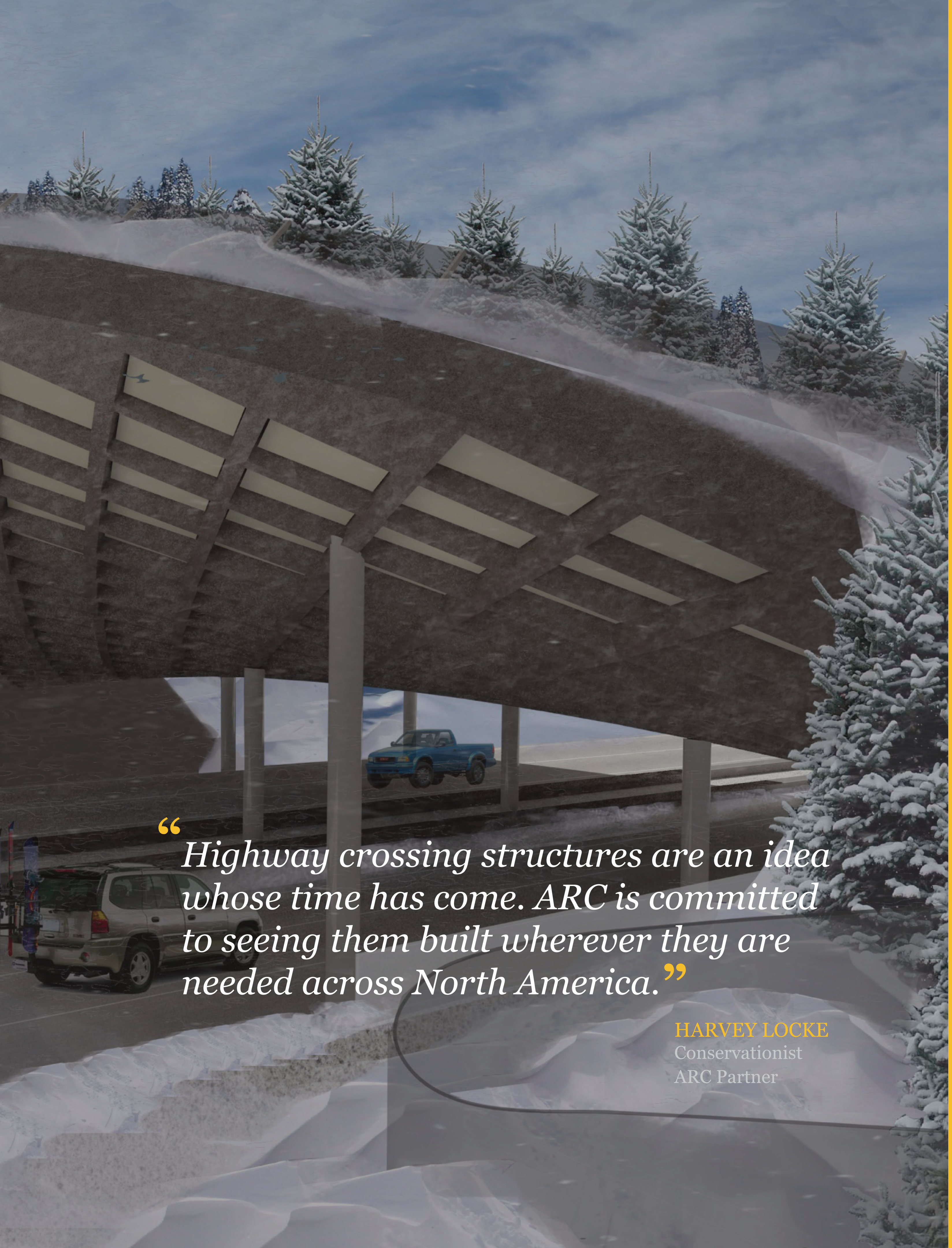
24 **Incorporate "Soil Pockets":** Consider "soil pockets" (areas of larger soil volume) to effectively use limited soil resources and reduce load on the structure.

25 **Consider Local Sources of Topsoil:** Consider locally-available materials suitable for topsoil.

26 **Use Locally-Adapted Native Vegetation:** Use locally-adapted planting material and locally-sourced vegetative cover *(Fig. 15 & 16)*.

27 **Explore New Technologies from Related Fields:** Consider utilizing technologies from related fields and integrating functions to reduce costs, such as technology originally designed for green roofs.

28 **Collect Surface Run-Off:** Consider grading surface topography to create low areas that collect surface run-off and planting in those moister micro-sites.



"Highway crossing structures are an idea whose time has come. ARC is committed to seeing them built wherever they are needed across North America."

HARVEY LOCKE
Conservationist
ARC Partner

Procurement, Delivery Method, & Cost Accounting: the process by which a construction project is comprehensively designed, planned and constructed. Project delivery methods are distinguished by the manner in which contracts between the agency (or owner), designers, and builders are formed, and the technical relationships that evolve among each party to those contracts.

The procurement process offers significant potential for reducing the costs of wildlife crossing projects, by considering alternative procurement processes and fostering collaboration among transportation agencies and their contractors. Currently, there are several types of project delivery systems available for use with publicly-funded transportation projects. The most common systems are Design-Bid-Build (DBB), Design-Build (DB), and Construction Manager/General Contractor (CM/GC), and Public-Private Partnerships (PPPs) may also play a role. No single project delivery method is appropriate or the "right one" for all wildlife crossing projects; rather, each project must be examined individually to determine how it best aligns with the attributes of each available delivery method. In addition, use of a life-cycle approach to accounting may allow decision-makers to more accurately determine the costs and benefits to society of wildlife crossing structures, based on the full value of such crossings over their life-time, rather than simply based on direct construction costs.

29 **Consider Alternative Procurement Practices:**
Identify alternative procurement practices such as Design Build (DB) and Construction Manager/General Contractor (CM/GC) that may facilitate cost savings, reduce risk and promote innovation *(Fig. 17)*.

30 **Foster Early Design Collaboration with Suppliers:**
Foster early and proactive design collaboration and invite superstructure suppliers into the pre-bid solution development team, regardless of procurement process.

31 **Explore Public-Private Partnerships:**
Explore public-private partnerships to help defray public costs.

32 **Use Full-Cost and Life-Cycle Accounting:**
Consider full-cost accounting and life-cycle costing when evaluating project costs, alternatives and potential savings to society.

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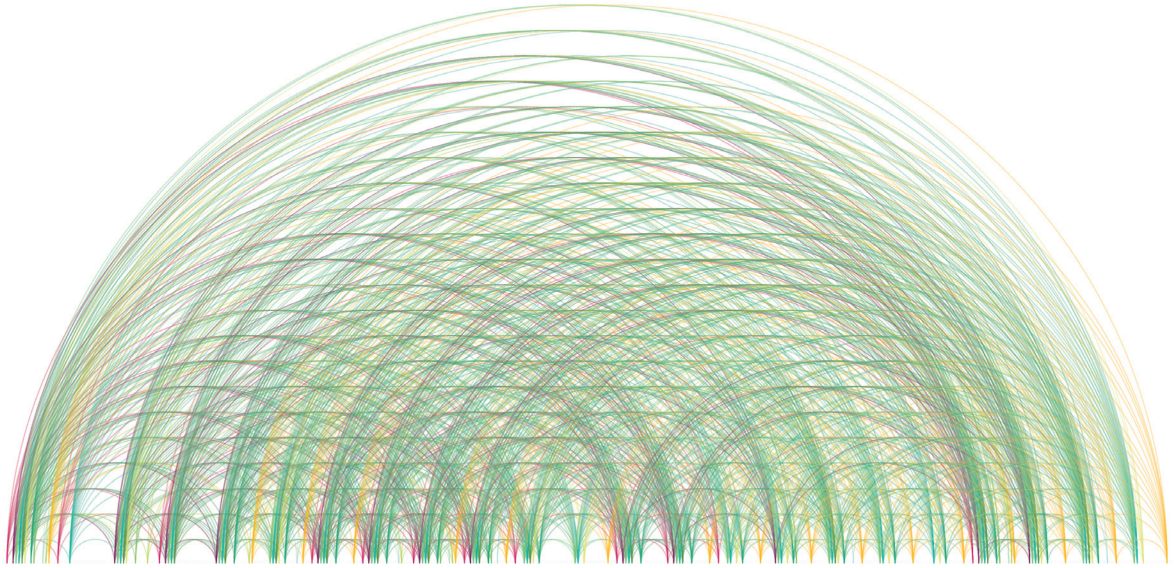
NEW THINKING | NEW METHODS | NEW MATERIALS | NEW SOLUTIONS



ARC Solutions is an international network whose mission is to identify and promote leading-edge solutions to improve human safety, wildlife mobility and long-term landscape connectivity. We do this by fostering innovation in the placement, design and construction of wildlife crossings. We know these are solutions that work, and we seek to share this knowledge to build support for safe passage.

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Workshop Participants
Rob Ament, *Montana State University, Western Transportation Institute*
Ron Begin, *U.S. Fish and Wildlife Service*
Renee Callahan, *ARC Solutions* and *Center for Large Landscape Conservation*
Whisper Camel Means, *Confederated Salish and Kootenai Tribes*
Pierre Chambefort, *Parks Canada*
Tony Clevenger, *Montana State University, Western Transportation Institute*
Nino DeLaurentis, *Alberta Transportation*
Dennis Dirks, *Contech Engineered Solutions*
Sue Higgins, *ARC Solutions* and *Center for Large Landscape Conservation*
Mike McGrath, *U.S. Fish and Wildlife Service*
Norris Dodd, *Arizona Dep't of Transportation*
Jeremy Guth, *ARC Solutions* and *Woodcock Foundation*
Sandra Jacobson, *U.S. Dep't Agriculture, Forest Service* (retired)
Nina-Marie Lister, *Ryerson University*
Darin Martens, *U.S. Dep't of Agriculture, Forest Service, Wyoming Dep't of Transportation*
Terry McGuire, *ARC Solutions* and *Parks Canada* (retired)
Paul Orbuch, *ARC Solutions* and *Orbuch Consulting LLC*
Jerry Stephens, *Montana State University*
Ryan Syme, *Parks Canada*
Robert Rock, *Living Habitats*
Roger Surdahl, *Federal Highway Administration*
Kevin Williams, *Atlantic Industries Limited*
Ted Zoli, *HNTB Corporation*

Editors
Terry McGuire, Rob Ament, Tony Clevenger, Sandra Jacobson, Renee Callahan, Jeremy Guth, Nina-Marie Lister

Marta Brocki, *Publication Design*

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