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Incorporation of Wildlife Crossings into TxDOT's Projects and Operations

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16. Abstract

Each year close to 8,000 crashes involving wild or domestic animals are reported in Texas. Roughly 20 people die each year on Texas roadways in these crashes, many more sustain injuries, and thousands of animals lose their lives. Reduction of animal-vehicle collisions (AVCs), especially wildlife-vehicle collisions (roughly 70% of the total AVC count), is a TxDOT goal and a key objective of this study. To reduce AVCs, it is important to provide opportunities for wildlife to cross beneath or above roadways via special crossing structures. This project reviewed all options for animal-vehicle conflict mitigation and provides guidance for all DOTs. This report summarizes national and state-level efforts to reduce animal-vehicle conflict, analyzes Texas's AVC data, explains how to identify AVC hot spots, and provides benefit-cost ratios for various AVC mitigation efforts across the TxDOT highway system.

To help ensure wildlife crossing considerations can become routine part of state DOT project development processes, this work also recommends specific language modifications to 18 TxDOT manuals and provides a new manual on wildlife crossing structures. The project findings demonstrate that data-driven, carefully planned, and well-designed wildlife crossing structures can enhance traffic safety significantly, are cost-effective across much of the TxDOT network, and help ensure that TxDOT can play a meaningful role in preserving human and animal lives and property for the benefit of current and future Texans.

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List of Acronyms/Initialisms

AASHTO	American Association of State Highway Transportation Officials
AVC	animal-vehicle collision
WVC	wildlife-vehicle collision
BCR	benefit-cost ratio
BRG	Bridge Division of TxDOT
CRIS	Crash Records Information System
DCIS	Design and Construction Information Systems
DOT	department of transportation
ENV	Environmental Affairs Division of TxDOT
GPS	global positioning system
HSIP	Highway Safety Improvement Program
LRFD	Load and Resistance Factor Design
MUTCD	Manual on Uniform Traffic Control Devices
NEPA	National Environmental Policy Act
OLS	ordinary least-squares
PS&E	Plans, Specifications and Estimate Manual
TMUTCD	Texas Manual on Uniform Traffic Control Devices
TPWD	Texas Parks and Wildlife Department
TxDOT	Texas Department of Transportation
UC	University of California
UDOT	Utah Department of Transportation
USFWS	US Fish and Wildlife Service
VMT	vehicle miles traveled
WSDOT	Washington State DOT
WVC	wildlife-vehicle collision

Executive Summary

Each year close to 8,000 crashes involving wild or domestic animals are reported in Texas. Roughly 20 people die each year on Texas roadways in these crashes, many more sustain injuries, and thousands of animals lose their lives. The crash data are limited, however, in that they only represent crashes where a police report is created. Many more animal-vehicle collisions (AVC) occur where an individual might not either report the crash or file a claim on their insurance, and the animal may be hurt but moves away into cover, or may be killed but not noted through the official police process. The number of animals killed could be five to ten times higher (Olson, 2013; Donaldson and Lafon, 2008). To reduce these collisions, and make Texas roads safer for the traveling public, it is important to provide opportunities for wildlife to cross beneath and above the road via wildlife crossing structures.

This project reviewed the state of the practice in animal-vehicle conflict mitigation options and provided guidance. This research project summarized national and statewide efforts to reduce animal-vehicle conflicts, analyzed the animal-involved crash data in Texas, developed methodology to identify AVC hot spots, and evaluated the benefits and costs of developing certain wildlife crossing structures. To make consideration of wildlife crossings a routine part of the TxDOT project development procedure, this project also recommended language modifications to 18 TxDOT manuals and developed a new manual on wildlife crossing structures. The project findings demonstrate that data-driven, carefully planned, and well-designed wildlife crossing structures can enhance traffic safety significantly, are cost-effective, and ensure that TxDOT plays a considerable role in preserving wildlife for the benefit of future Texans.

Developing wildlife crossing structures or other mitigation strategies is a complicated process. It needs to be supported by detailed data analysis and its success is highly dependent on the collaboration within and among different divisions within TxDOT and also other relevant wildlife and resource agencies. The findings and final products of this project are expected to help make wildlife crossing structure consideration and creation a regular part of TxDOT's project development procedure and contribute to TxDOT's role as a leading state in reducing animal-vehicle conflict issues.

This report is organized as follows:

- Chapter 1 summarizes the results of the literature review. The literature review was conducted through several online surveys and through team members' knowledge of the literature most suitable for assisting TxDOT in pursuing wildlife crossing mitigation. This chapter details how mainly western U.S. states are creating and analyzing data on AVC, planning for wildlife mitigation, how the structures and fences are created, and how these types of infrastructure are maintained in conjunction with research that helps to adaptively manage the infrastructure. More detailed results of the literature review can be found in Appendix B.

- To correlate Texas's needs with findings from the literature review and synthesize TxDOT's institutional knowledge of actions in the past (and potentially in the future) to reduce animal-vehicle conflicts, the research team interviewed and conducted a survey of TxDOT personnel to gain insights into how wildlife needs can be brought into TxDOT's planning and daily operations processes. Chapter 2 summarizes the findings from the interviews and the survey.

- In Chapter 3, the research team presented how crash data can be analyzed to assist the wildlife crossing mitigation planning. Texas crash data from 2010 to 2016 are used to demonstrate the process of performing the descriptive analysis, regression analysis, and hot spot analysis. Crash data analysis reveals that most Texas AVCs occur at night (typically 8:00 PM) in unlit locations, usually on rural roads with very low traffic volumes, in October, November and December. Another peak occurs around sunrise, in those same months. AVC heat maps show the San Antonio metro area (and Tyler, to a lesser degree) has the greatest number of wildlife-involved AVCs, while the McAllen-Brownsville region hosts the most hot spots for AVCs with domestic animals. Using ordinary least-squares (OLS) regression analysis across Texas's 254 counties, this study finds that less densely populated, rural counties, and those counties with fewer vehicle miles traveled (VMT) per capita but more lane-miles per capita, tend to experience the greatest number of AVCs per VMT after controlling for average annual rainfall, share of VMT on TxDOT-managed roadways, job densities, and vehicle ownership levels.

- Intervention options for reductions in and mitigation of AVCs are numerous and diverse. In Chapter 4, the research team demonstrated the procedure of conducting benefit-cost analysis using information regarding the costs and effectiveness of different wildlife intervention options. This benefit-cost analysis is based on the crash data analysis and some other assumptions. The analysis results presented in this chapter revealed that overpasses and culverts, along with wildlife fencing (which can funnel animals to safe crossings), show promising results for both AVC reduction and habitat connectivity. Longer-term, mobile reporting by DOT employees, smartphone users, intelligent cameras and other devices, plus real-time information dissemination (tied to existing navigation apps), can enable safer driving along specific roadway sections where animals are present.

- In Chapter 5, a legal analysis presents various cases and history of law pertinent to Texas's potential liability as wildlife crossing structures and other mitigation practices become standard policy. In addition, analysis of the responsibilities of TxDOT under NEPA Assignment are assessed through the lens of case law. A table of various state laws pertinent to wildlife crossings is also presented.

- In the last chapter, the research team relays the recommended language modifications/additions to sixteen TxDOT current manuals so that wildlife mitigation consideration can be incorporated into TxDOT's planning and operation procedures. These recommended changes are based on what the research team learned from this project and the state of practice of other states. The research team also developed new guidelines for reducing animal-vehicle conflicts and promoting wildlife connectivity (for TxDOT's internal use). This guidance will provide TxDOT personnel a highly useful tool for identifying wildlife crossing structure needs, and then planning, designing, and constructing these structures.

Chapter 1. Synthesis of Existing Literature and State of the Practice in Wildlife Crossing Structures

1.1. Introduction

This chapter presents, in a condensed form, five main actions state transportation agencies take to create wildlife mitigation along transportation corridors. TxDOT divisions that invest in these actions include Environmental, Bridge, Planning and Programming, Design, Construction, and Maintenance, among others, as well as the environmental staff in the 25 TxDOT districts. The typical practices for placing wildlife crossing structures are presented in Figure 1.1, categorized into five steps—Data, Planning, Design, Construction, and Maintenance—with the main TxDOT divisions that will be involved in such actions in Texas.

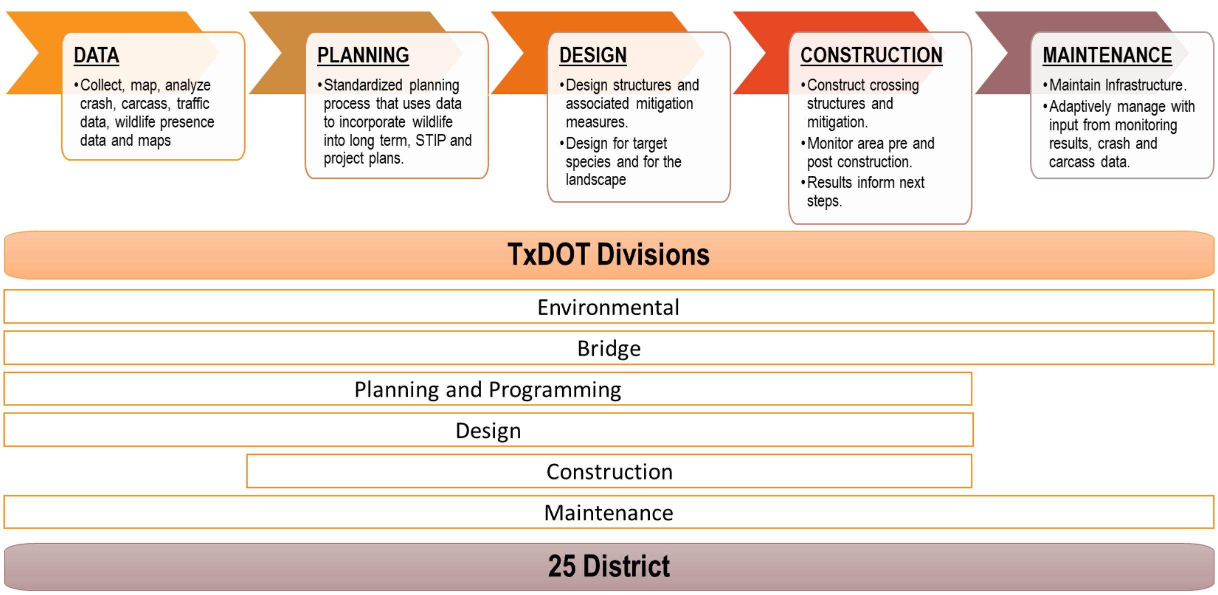

Figure 1.1 Steps to Mitigate Effects of Transportation Infrastructure for Wildlife and the Relevant TxDOT Divisions

1.2. Data

To solve a problem, it first needs to be established. In the Data step the transportation agencies collect crash data and researchers, traffic safety staff, and environmental staff access the database to query for reported collisions with wildlife and livestock. In most states' departments of transportation (DOT), wildlife carcass data are collected and analyzed by DOT staff. Traffic volume data can also be analyzed to examine wildlife conflict zones. Regular analyses of these data, mapping the locations of crashes and carcasses, and identification of the problem areas for wildlife-vehicle conflict are all means to guide transportation planning with an eye to addressing

AVC concerns. Other data that can guide transportation planning includes wildlife locational data sent by Global Positioning Systems (GPS) locator tags on wildlife, habitat maps created by ecologists, and known population locations. Preventing conflict with wildlife is in the best interest of the DOTs, as such conflicts can create transportation project delays and cost increases if these concerns are not addressed up front.

All states have standardized crash data collection from traffic safety officers such as sheriff's deputies, police, and state highway patrol. In fact, this is the only kind of AVC data that are reliable enough to make comparisons among places and over time. However, the amount of detail on the location of the crash, the animal involved and other factors varies among states. Crash locations should be accurate with the use of GPS units in officer vehicles, but sometimes the GPS location is taken as the location where the report is entered in the vehicle computer, which can be some distance from the site. Also, many states only identify the type of animal involved in a collision as either wild or livestock/domestic. In Nevada, the officers have 14 species to select from (provided via a pulldown menu in the reporting software), which includes wildlife and domestic animals. The more detailed information on the location of the crash, species, and other factors, the greater accuracy the DOT and wildlife agency can have in creating solutions to these collisions.

The options for collecting carcass data range from paper data sheets filled out in the field to smartphone apps with instant uploads to internet mapping sites. The future is most certainly electronic collection of carcass location, species, and other information. Utah has a smartphone app that is used by their carcass contractors, Utah Department of Transportation (UDOT) personnel, highway patrol, and Utah Division of Wildlife Personnel (Olson et al., 2015). This app automatically records the GPS location of the user when the app is first initiated. The user only has to identify the species of animal, the gender, and the age. The location, if not immediately uploaded, is taken and the full record is uploaded to an interactive website once the user is within cell-phone range. The data are immediately available for mapping and analyses on that website[1], although the mapping function is user protected. Washington has software for carcass collection on maintenance worker iPads, which are then uploaded to the Washington State DOT (WSDOT) workbench online. South Dakota created a smartphone carcass app in a matter of days, using ArcGIS 123 Survey, and after testing in 2017, moved to require all carcass contractors to use the app in picking up carcasses.

The more common method for reporting carcasses is through websites rather than phone-based apps. Web-based applications were first made available to the public in California and Maine in 2010[2] (Shilling and Waetjen, 2015), through the University of California (UC) at Davis, Road Ecology Center. Users can upload carcass data and photos. The Idaho Game and Fish Department

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[1] https://mapserv.utah.gov/wvc/desktop/index.php

[2] http://wildlifecrossing.net

has a website developed in conjunction with the Idaho Transportation Department[3]. The Idaho site allows for information upload (no photos) and downloads. These sites are beneficial in that they allow anyone to map carcasses online at any time and with different filters. All systems require software upgrades on a monthly to annual basis. Overall, immediate electronic upload of data, with a GPS location, is the future of carcass collection.

Analyses and mapping of the crash, carcass, and traffic volume data are done to some degree in most states. Mapping efforts can involve either static maps or 'on the fly' mapping whenever an agency employee needs to map crash and carcass data. Utah has an in-house mapping system, using the software Numetric[4], which allows mapping of crash data with many filter options. As mentioned above, Utah also has a mapping function that works in conjunction with carcass data. Idaho allows any member of the public to use its carcass mapper for the state. UC Davis has a mapping function for the public or agencies to use to locate carcasses.

The analysis of the crash, carcass, and traffic volume data is not routinely conducted by various divisions of personnel within a DOT. Crash analyses in conjunction with other data analyses are commonly part of what traffic safety engineers do for upcoming projects. Some states bring in the results of carcass data collection to see if there are wildlife needs within an already planned transportation project. Typically though, there is no dedicated task of analyzing the wildlife crash, carcass, and other data to seek priority areas for planning actions to reduce these collisions with wild animals. States looking to standardize the process of creating wildlife crossing structures have completed studies with team member, Dr. Cramer created standardized annual or anytime mapping of the crashes and carcasses in Idaho (Cramer et al., 2014), South Dakota (Cramer et al., 2016), and Nevada (Cramer and McGinty, 2018). Montana created a Wildlife Accommodation Process (Harris and Traxler, 2018), and Colorado will complete a process report in 2019 (P. Basting, personal communication on the Colorado West Slope Study, 2019). Table 1.1 gives an overall summary of western state efforts for collecting, mapping, and analyzing data on wildlife-vehicle conflict.

Wildlife locational data are used to assist in transportation planning. This helps prevent future potential delays and cost overruns if there are important and legitimate wildlife concerns in the transportation area. It also helps to protect motorists and wildlife from wildlife-vehicle conflict. State wildlife agencies, the U.S. Fish and Wildlife Services (USFWS), and academic institutions typically monitor wildlife with GPS collars and locators. These projects are also funded by DOTs. Data on these animals' locations can help to determine the need for wildlife crossing structures. Nature Serve, the Natural Heritage Program, and wildlife agencies in each state also maintain maps and plans that delineate important wildlife habitat. Every state has a Wildlife Action Plan as a

[3] https://fishandgame.idaho.gov/species/roadkill

[4] https://udot.numetric.com/#/

starting point to learn of potential wildlife concerns in future transportation plans. Taken together these data, maps, and plans can inform the following planning and design steps.

Table 1.1 States' Efforts to Collect and Map Wildlife-Vehicle Collision (WVC) Data

State	Carcass Collection Protocols	Carcass or Crash Mapping
Arizona	No standard protocol, AZDOT maintenance	None regularly done, past static map available.
California	Caltrans Maintenance –sporadic, not uniform reporting. Also, UC Davis Road Ecology Center's California Roadkill Observation System, URL: http://www.wildlifecrossing.net/california/. REC.	No Caltrans statewide effort. Carcasses (2009–2017) and WVC (2015–2017) mapped by UC Davis Road Ecology Center. UC Davis 2017 Effort: http://www.wildlifecrossing.net/california/files/xing/CROS-CHIPs_Hotspots_2017_Report_fin.pdf
Colorado	Maintenance workers collect carcasses and data, compliance voluntary, thus not uniform, but efforts underway to enforce compliance.	Once, older map created, See Crooks et al. (2008) in references. URL: http://warnercnr.colostate.edu/~sharonbm/docs/CDOTconnectivityfinalreport.pdf. Look for the Colorado West Slope study results in 2019 and later.
Idaho	Maintenance workers collect carcasses and data, input into state system. Public inputs carcass data in open website: https://fishandgame.idaho.gov/species/roadkill	Mapping of carcasses can be done in real time via the website. Crash mapping can be done by agency personnel on IPLAN website, a planning tool. Cramer et al. created static map in 2014.
Montana	Maintenance workers collect carcasses and data. Somewhat compliant compared to other states, but still spotty.	Mapping can be done by MDT personnel, with their ArcGIS tools on their desks. Crash data are available to the public for individual crash mapping.
Nebraska	No systematic method to collect carcass data.	No known maps, but see Deer-Vehicle Information Kit available for county tables of intensity of deer-vehicle crashes: http://roads.nebraska.gov/media/6502/dvcinformationkit.pdf
Nevada	Maintenance workers collect data, has been inconsistent, but it is hoped new reporting requirements hope to rectify. Certain maintenance districts collect carcass data rigorously, others, not at all.	In 2010, Chris Wright created statewide map of WVC crashes plus carcass data. Cramer and McGinty (2018) mapped crash and carcass data and created priority hotspot/heat maps. Also created a method to allow NDOT personnel to map on the fly.

State	Carcass Collection Protocols	Carcass or Crash Mapping
New Mexico	Maintenance workers gather data. NM house Memorial 1 established that NMDOT and NM Game and Fish look into establishing a citizen monitoring program for carcass data.	2003 priority map was created, and there is a more recent map. Not available on internet at this time, but was in past. State working toward a collaborative effort with New Mexico Fish and Game and non-profit groups.
Oregon	Maintenance workers fill out forms for carcass collection. Not sure of statewide accuracy.	Created static map in 2007, see: ftp://ftp.odot.state.or.us/techserv/Geo-Environmental/Webs/Wildlife_Movement/Wildlife/wchs.htm. An updated crash hotspot map was created in January 2019.
South Dakota	Contractors hired jointly by SDDOT and SD Game and Fish filled out forms. Updating as a result of Cramer et al. (2016) recommendations, to smartphone app reporting.	Crash and carcass data mapped in 2016 (Cramer et al. 2016). Cramer recommended future annual mapping. With the 2017 new carcass reporting upload from apps, mapping is available on the fly to SDDOT and wildlife agency personnel.
Utah	Contractors required to upload data to carcass Phone app.	WVC reporter uploads carcass data points immediately to protected website, and anyone with access can at any time map WVC carcass data: https://mapserv.utah.gov/wvc/desktop/
Washington	Maintenance workers record carcasses on iPads that were placed into service in 2015.	No official map because WSDOT personnel have access to the data through the intra-agency Environmental Workbench which allows them to map WVC crash and carcass data as needed. There are maps of crash hotspots available.
Wyoming	Maintenance crews collect carcasses and data. Reports submitted to be entered into state database. Variability in compliance.	WYDOT Highway Safety Program produces maps upon request. No statewide WVC map at this time. A wildlife and highways summit in 2016 results in an expert opinion hotspot map.

1.3. Planning

The states most active in creating wildlife crossing structures have methods within the planning processes to include wildlife's need to move. This involves the above data on WVC, as well as wildlife agency data on where wildlife are known to reside and areas where they are believed to move across the landscape, known as wildlife linkages. There are champions for wildlife mitigation within almost all DOTs. These champions get wildlife mitigation infrastructure created in their districts or regions at higher rates than their colleagues across the state. While these champions execute and maintain wildlife mitigation, their DOTs are beginning to realize there is a need to create standardized, transparent processes to identify problem areas for AVCs, and to create cost-effective solutions that are defendable to the public. Wildlife crossing champions within the Washington and Arizona DOTs created protocol that could serve as standard processes for prioritizing the actions necessary to reduce WVCs. Other states have hired outside consultants to create these standardized processes. Table 1.2 presents western states' efforts to map wildlife linkages and create a process for prioritizing WVC reduction solutions.

Table 1.2 Western States' Efforts to Map Wildlife Linkages and Create a Process for Prioritizing WVC Reduction Solutions

State	Wildlife Linkage Mapping	Planning and Prioritization Process
Arizona	Premier state effort. URL: https://www.azdot.gov/docs/planning/arizona_wildlife_linkages_assessment.pdf?sfvrsn=7 See Arizona Wildlife Linkages Working Group in References.	Dodd (2014) created a score card, GIS info, AADT, % of crashes that are WVC, species maps. Not known how to what extent it is used.
California	Several different efforts. See California Dept. of Fish and Wildlife Site: https://www.wildlife.ca.gov/Conservation/Planning/Connectivity	No standardized Process. Jim Henke, a senior wildlife biologist at Caltrans was recently quoted in press: "The problem with getting these interventions up in California is that, in governmental jargon, they need to have a transportation nexus." "The funding has to come from a transportation need," says Henke, instead of a conservation demand. "If there's a project that triggers a mitigation need for wildlife movement, then that's where we see an opportunity to install and plan for those types of crossings," he adds.
Colorado	2005 Effort, Linking Colorado's Landscapes. URL: http://rockymountainwild.org/linking-colorados-landscapes. Current project is underway (2017).	Look for the Colorado West Slope Study to be published in 2019.
Idaho	Workshops in 2005 and 2007 resulted in linkage maps: https://fishandgame.idaho.gov/ifwis/portal/opendata/idaho-highway-wildlife-linkages	First State to create standardized prioritization. See Cramer et al. (2014) in references. URL: http://idahodocs.cdmhost.com/cdm/ref/collection/p16293coll3/id/251412
Montana	Montana Fish, Wildlife & Parks, Crucial Areas Planning System (CAPS): http://fwp.mt.gov/fishAndWildlife/conservationInAction/crucialAreas.html	Currently, every 2 years MDT meets with MT Fish Wildlife and Parks to review STIP. see: Harris and Traxler (2018) MDT Wildlife Accommodation Process. Final Report to Montana Department of Transportation. Report No. FHWA/MT – 18-002/5896. URL: http://www.mdt.mt.gov/research/.
Nebraska	None	None, mostly ESA and Nebraska law requirements are the only time wildlife are considered.
Nevada	The non-profit Nevada Wilderness Project identified 20 wildlife linkages, but not easily found on web anymore.	Cramer and McGinty (2018) Prioritization of wildlife-vehicle conflict in Nevada. Final Report to Nevada Department of Transportation.

State	Wildlife Linkage Mapping	Planning and Prioritization Process
New Mexico	Multiple concurrent state efforts, but no official map. December 2016 Upper Rio Grande Wildlife Connectivity Workshop is most recent and most science-based effort. URL: https://nhnm.unm.edu/Wildlife_Movement_Workshop.	House Joint Memorial 10, in 2012 dictated many actions to reduce WVC, but not finding proof of compliance. URL: https://www.nmlegis.gov/lcs/handouts/WNR%20101512%202.%20HJM%2010%20Report%20Final_June20%202012.pdf
Oregon	Oregon Dept. of Fish and Wildlife and Oregon DOT worked together w/ others on the Oregon Wildlife Movement Strategy: https://nrimp.dfw.state.or.us/DataClearinghouse/default.aspx?p=202&XMLname=806.xml	None statewide.
South Dakota	No efforts.	Cramer et al. (2016) recommended creating a process in the future. South Dakota DOT and DOW have begun creating the data collection, analyses, and mapping stages.
Utah	None. Cramer proposed initial plan to UDOT in March of 2017. Utah Division of Wildlife Resources started a wildlife migration initiative in 2017 which may lead to linkage maps.	No standard statewide, except for Utah Division of Wildlife Resources habitat managers meeting annually with UDOT representatives to review upcoming projects and make recommendations. Cramer started a research project to standardize this in 2018. Look for report in 2019-2020.
Washington	Washington Wildlife Habitat Connectivity Working Group identified priority wildlife linkages: http://waconnected.org/statewide-analysis/	The Habitat Connectivity Investment Priorities Method was developed in WSDOT by K. McAllister. The method is still being accepted and worked into WSDOT practices across the state.
Wyoming	None statewide. WYDOT uses different data sources to bring data together, such as WY Interagency Spatial Database and Online Management System (WISDOM), WY Game and Fish data, etc.	No formal process. WY Game and Fish and WYDOT have close working relations. They feel there is not a need for such a process.
Western Governors' Association	Crucial Habitat Assessment Tool: http://www.westgov.org/wildlife-corridors-and-crucial-habitat and http://www.wafwachat.org/	

1.4. Design

The states with the more progressive programs to mitigate their roads for wildlife have standardized designs for types of wildlife crossing structures, fences, escape ramps, and deterrents for different types of wild animal species. Typically these designs are for the larger target species such as mule and white-tailed deer, elk, and bighorn sheep. There are different designs for smaller animals such as ocelots (in Texas), tortoises, and turtles. Figures 1.2 through 1.18 provide example designs, plans, and schematics from other states for wildlife crossing structures, wildlife exclusion fences, escape ramps, and other components of wildlife crossing mitigation for large animals.

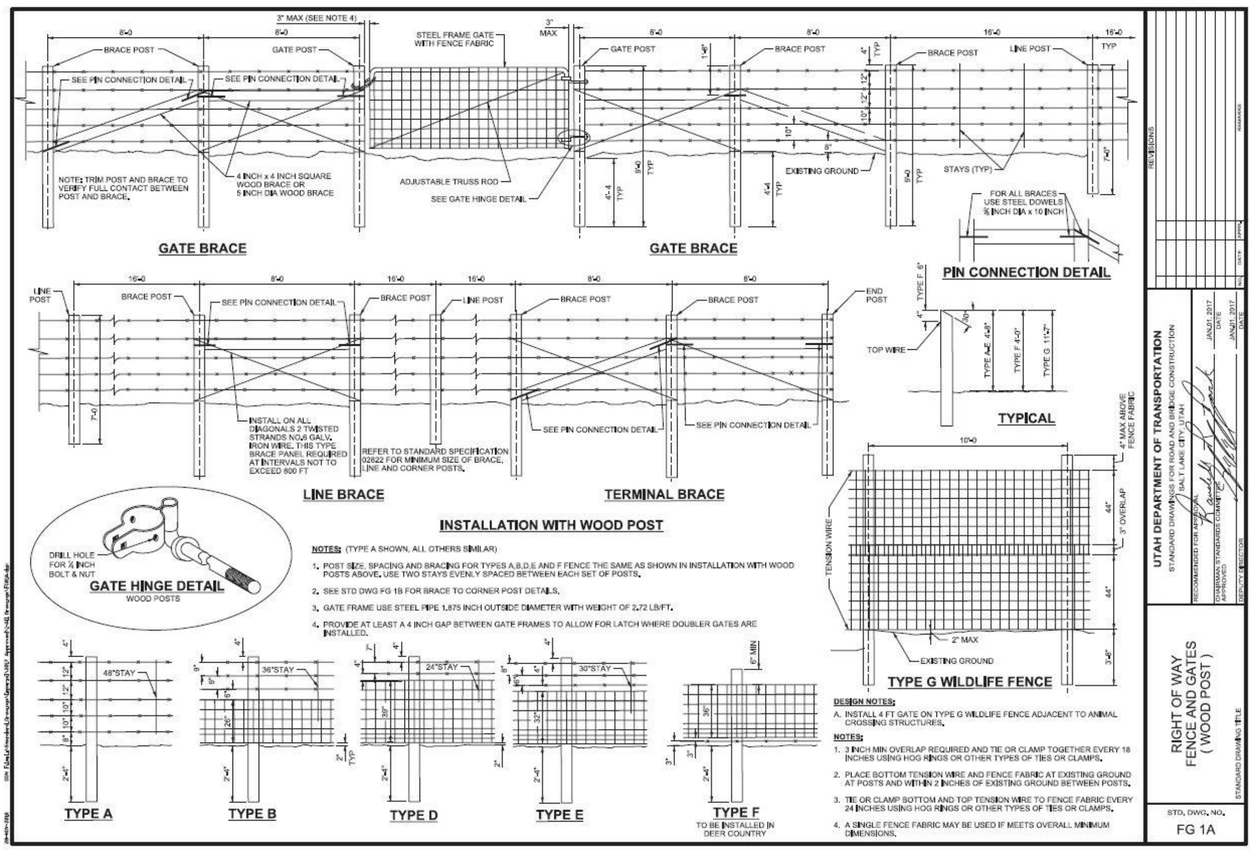


Figure 1.2 Utah DOT Plans for Wildlife Exclusion Fencing and Gate

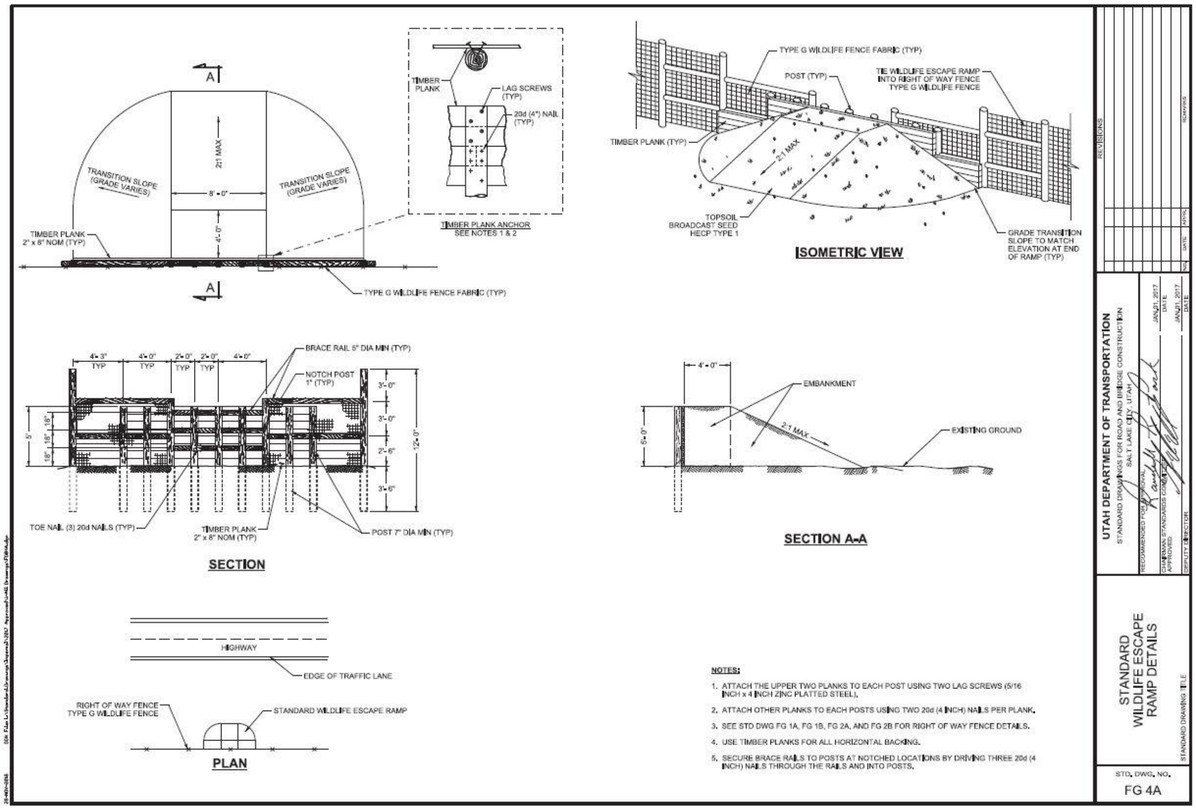


Figure 1.3 Utah DOT Standard Wildlife Escape Ramp. Note no fence on top of ramp.

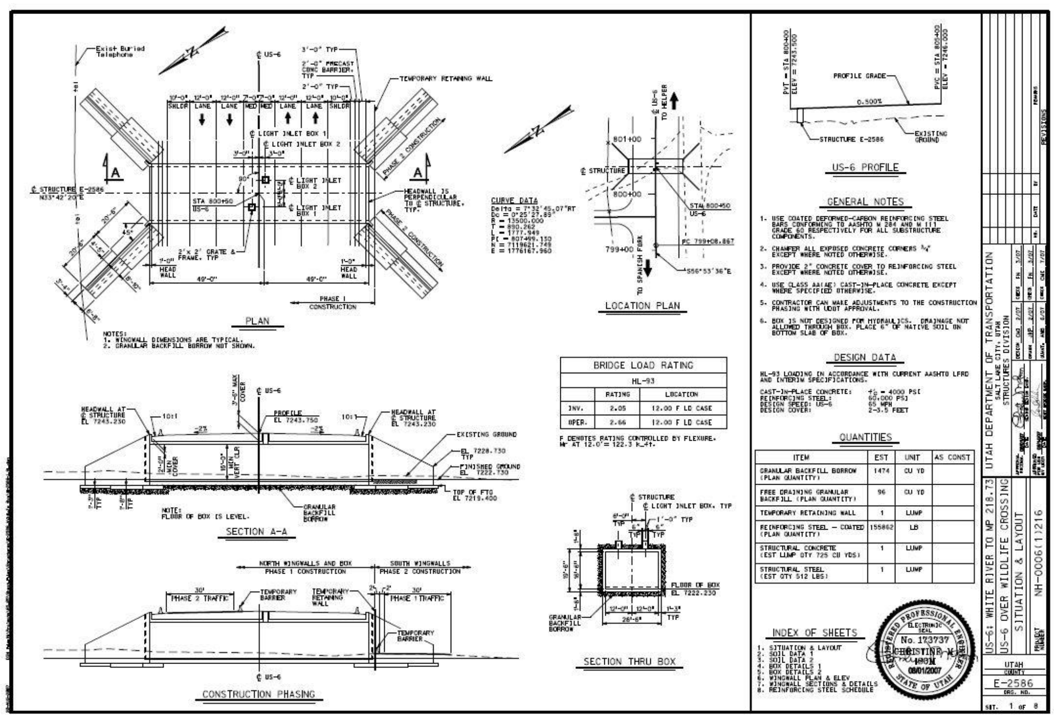


Figure 1.4 Utah DOT Plan for Wildlife Crossing Box Culvert under Five Lanes of Traffic for US 6

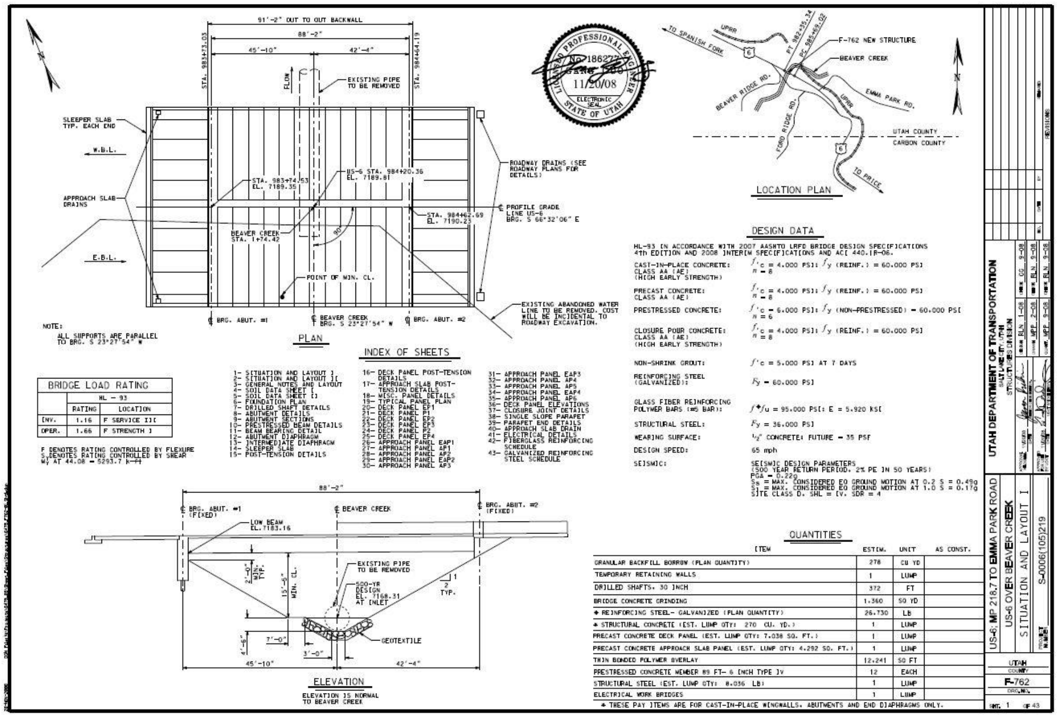


Figure 1.5 Utah DOT Plan for Wildlife Crossing Bridge under Five Lanes of Traffic (Also Accommodates Water Feature under US 6)

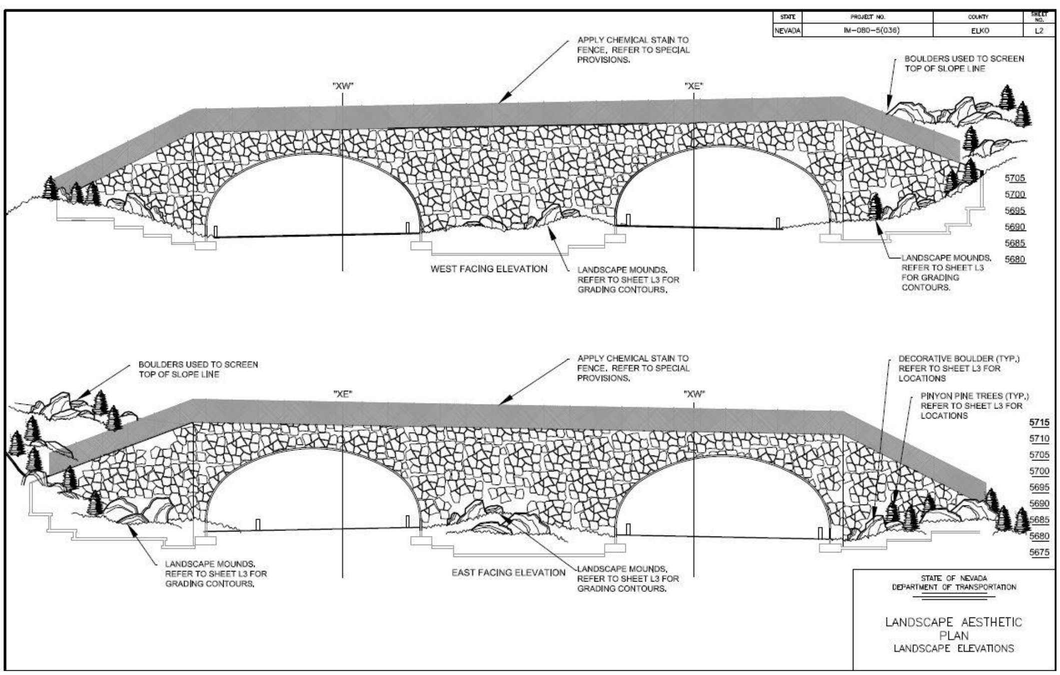


Figure 1.6 Nevada DOT Plan for Overpass on I-80, Four-Lane Divided Highway

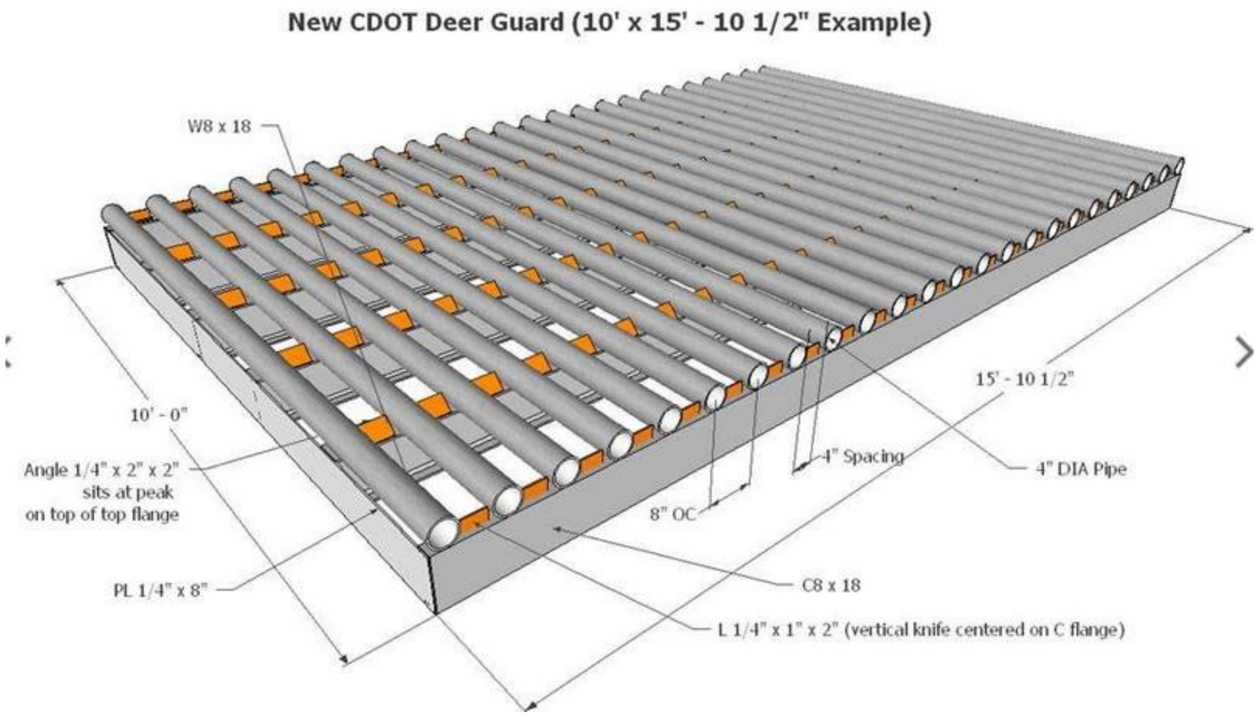


Figure 1.7 Colorado DOT Design for Round Bar Deer Guards (Double Cattle Guard)

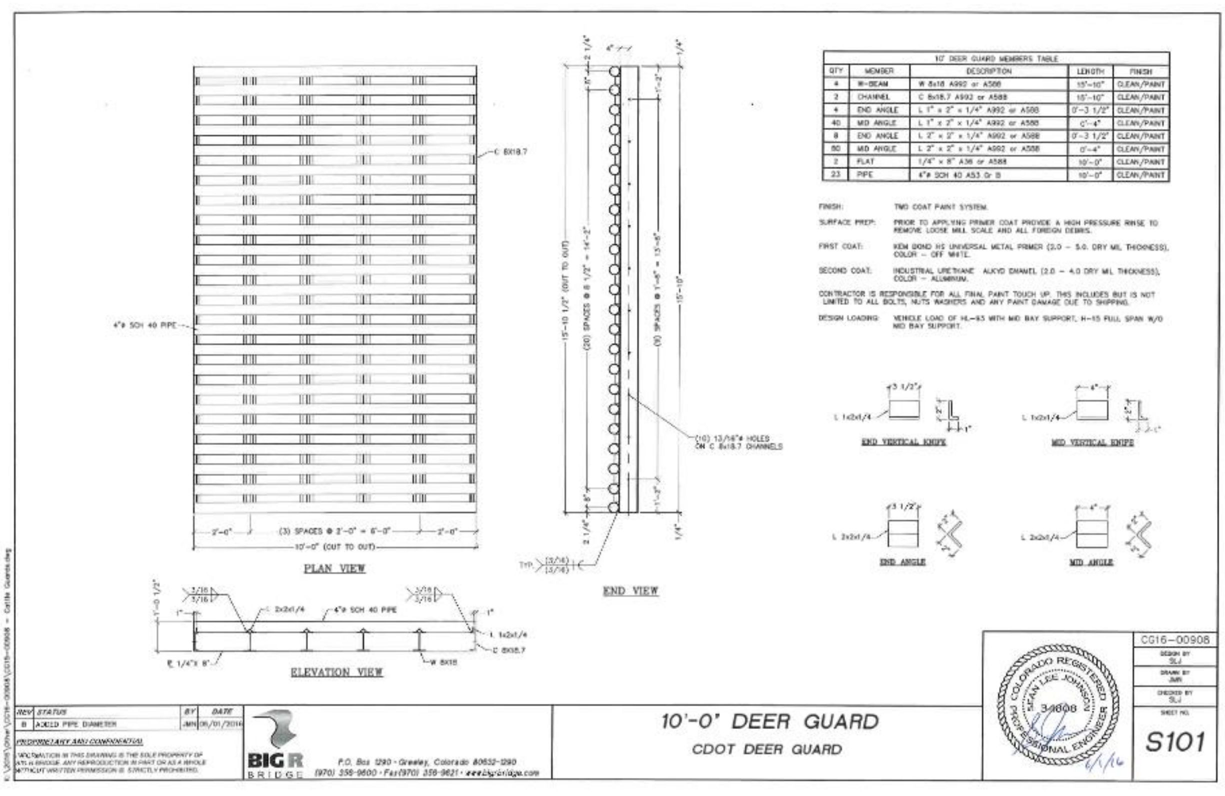


Figure 1.8 Colorado DOT Deer Guard 10'-0" Design for SH 9

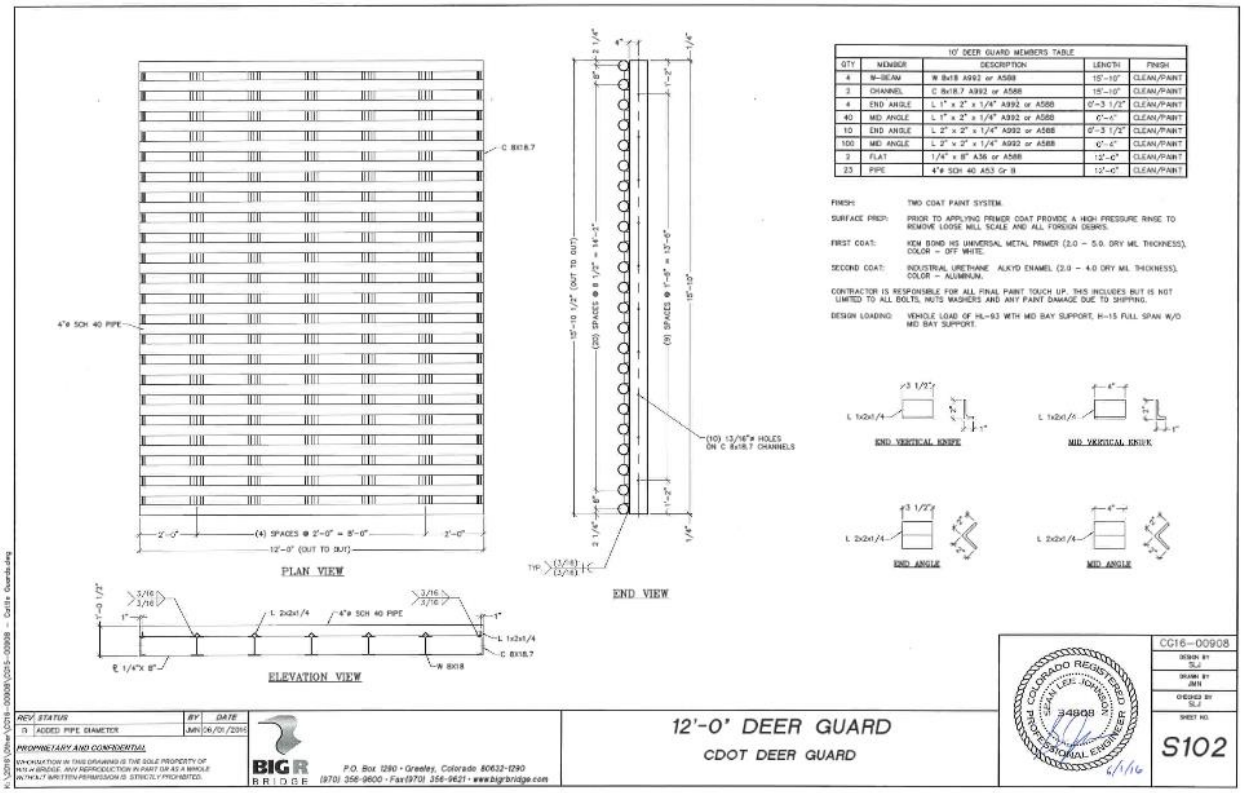


Figure 1.9 Colorado DOT Deer Guard 12'-0" Design for SH 9

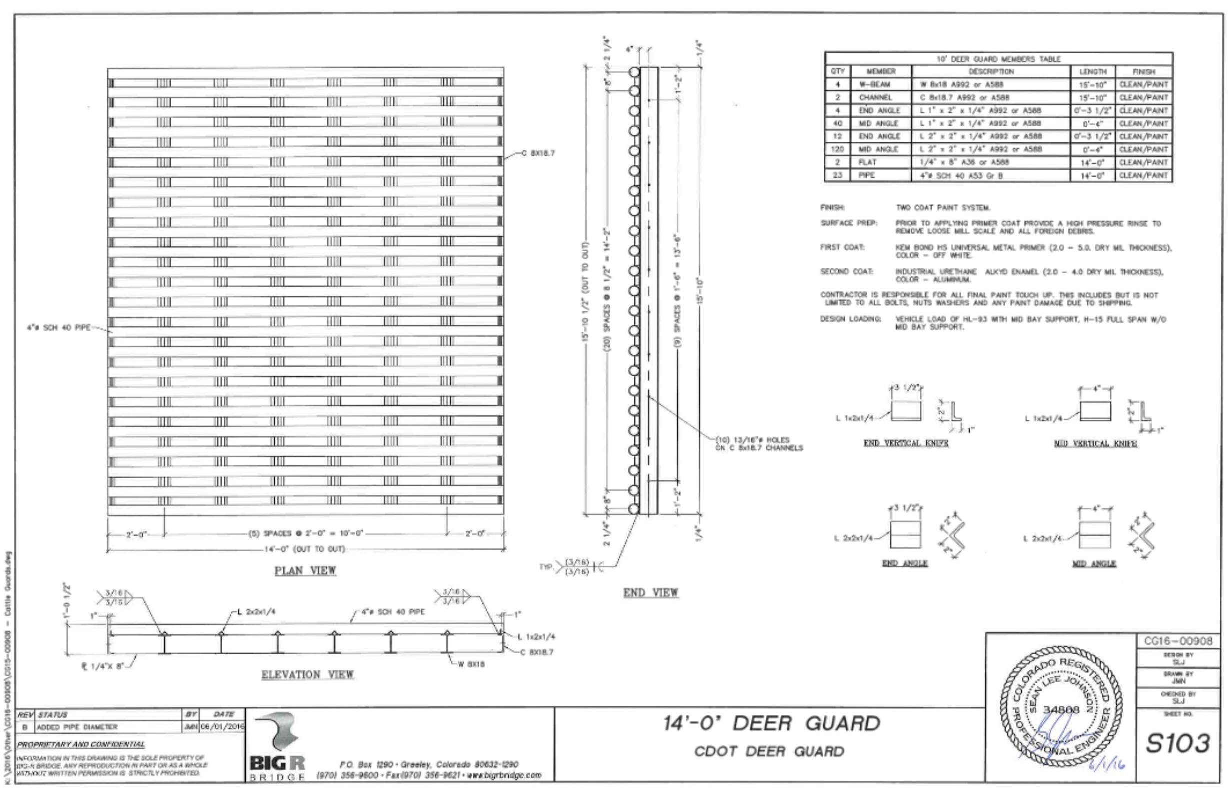


Figure 1.10 Colorado DOT Deer Guard 14'-0" Design for SH 9

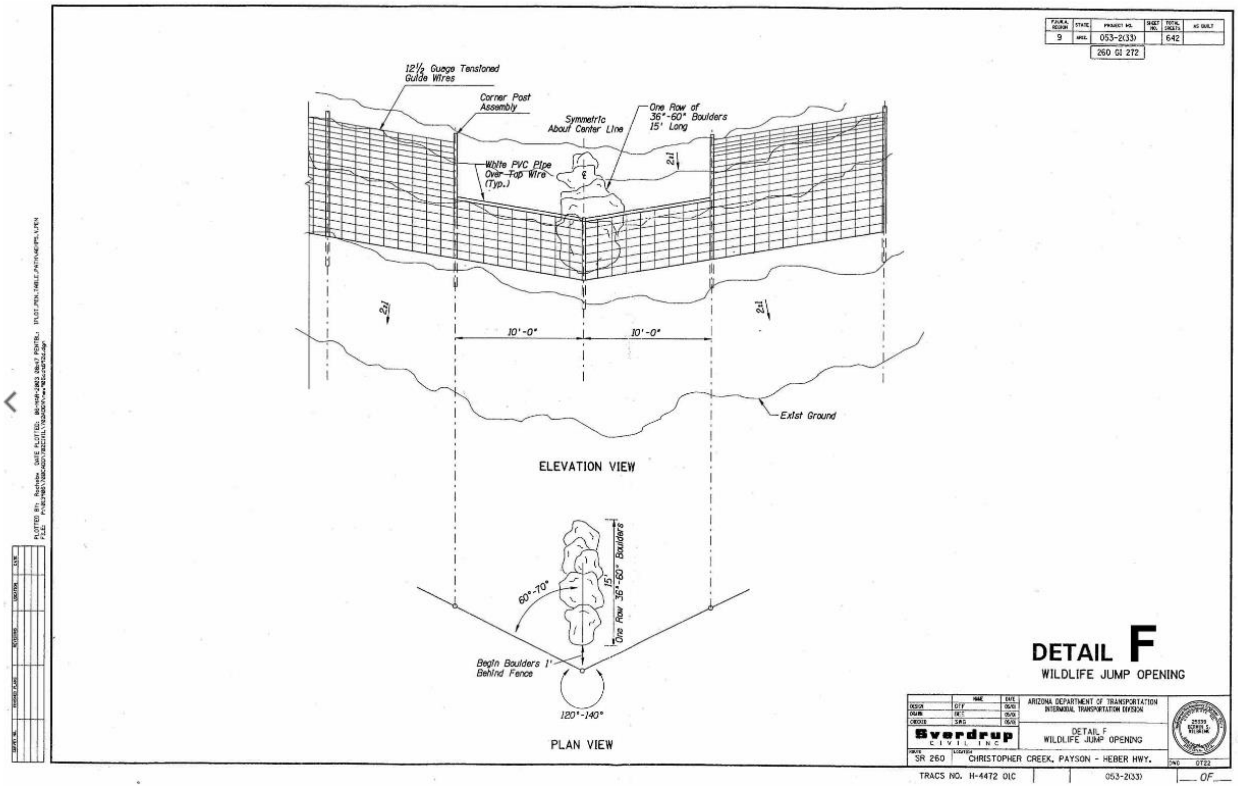


Figure 1.11 Arizona DOT Wildlife Escape Ramp Opening

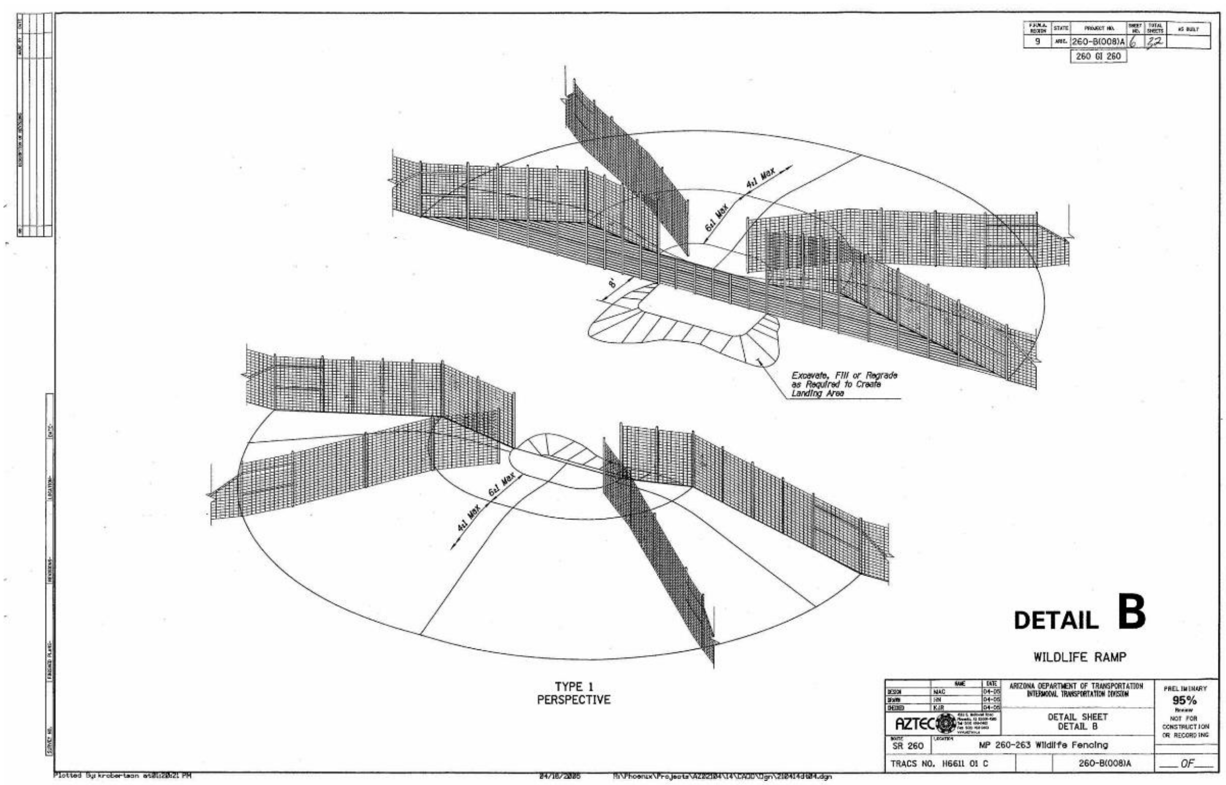


Figure 1.12 Arizona DOT Wildlife Escape Ramp and Fencing

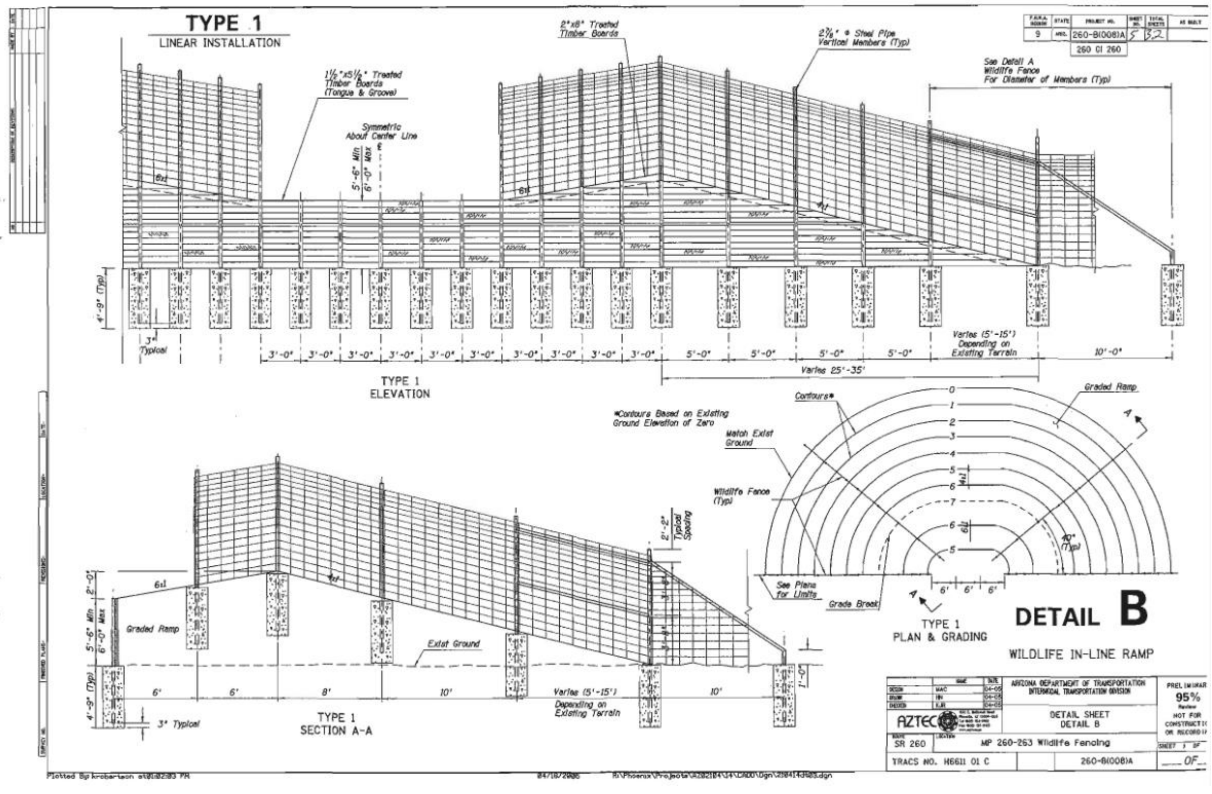


Figure 1.13 Arizona DOT Wildlife Escape Ramp Fencing

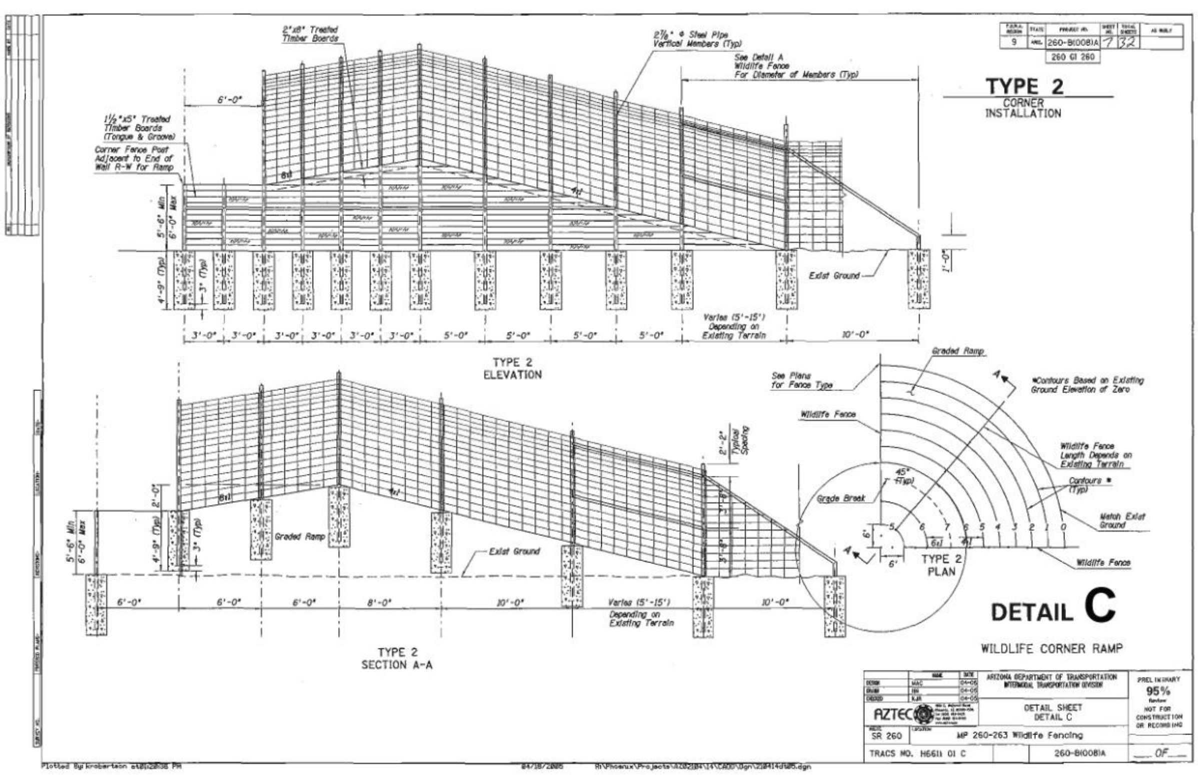


Figure 1.14 Arizona DOT Wildlife Escape Ramp Fencing

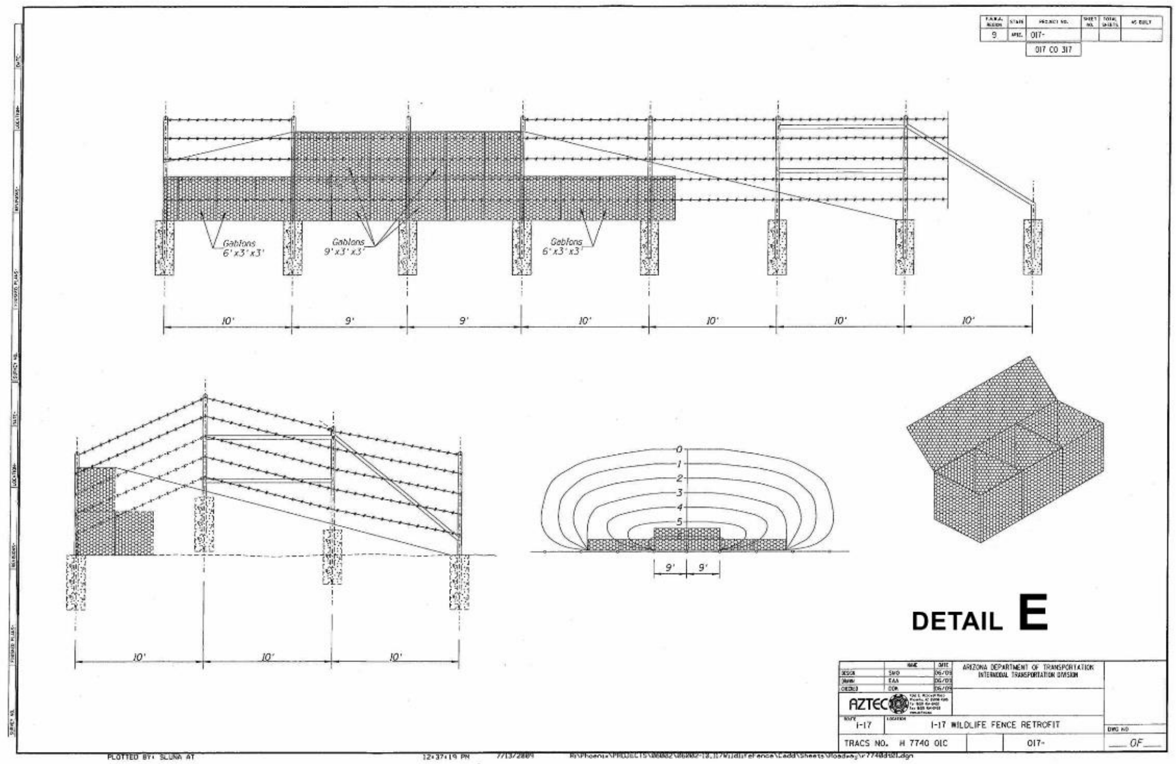


Figure 1.15 Arizona DOT Wildlife Fence Gabions Retrofit for Wildlife Escape Ramp Diagram

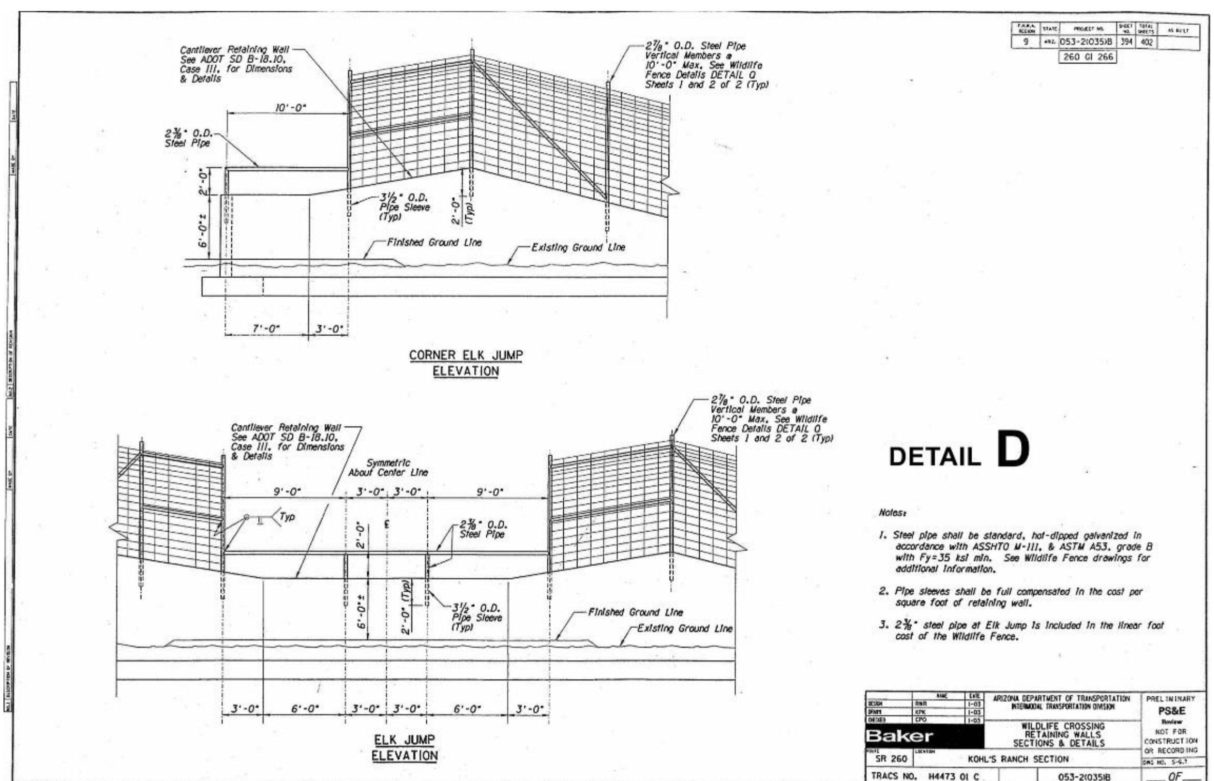


Figure 1.16 Arizona DOT Wildlife Crossing Structure Entrance Retaining Wall Section

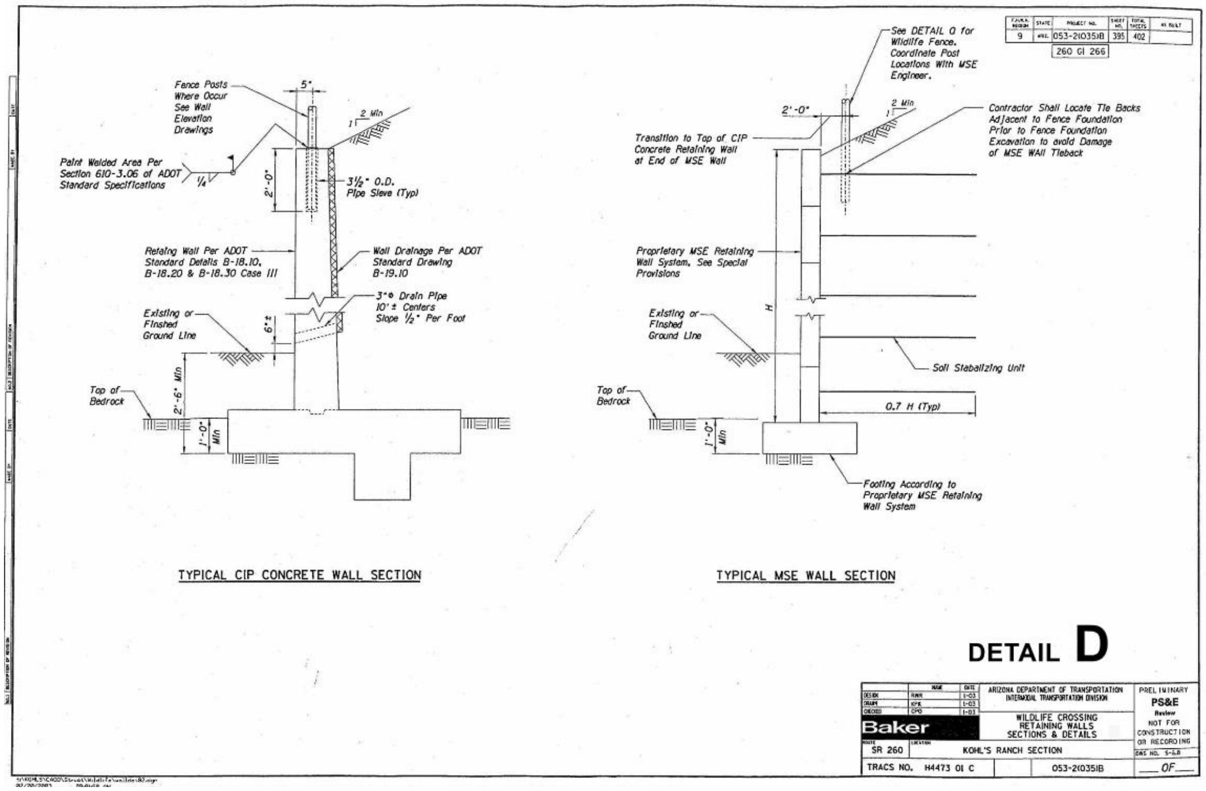


Figure 1.17 Arizona DOT Wildlife Crossing Retaining Walls Section

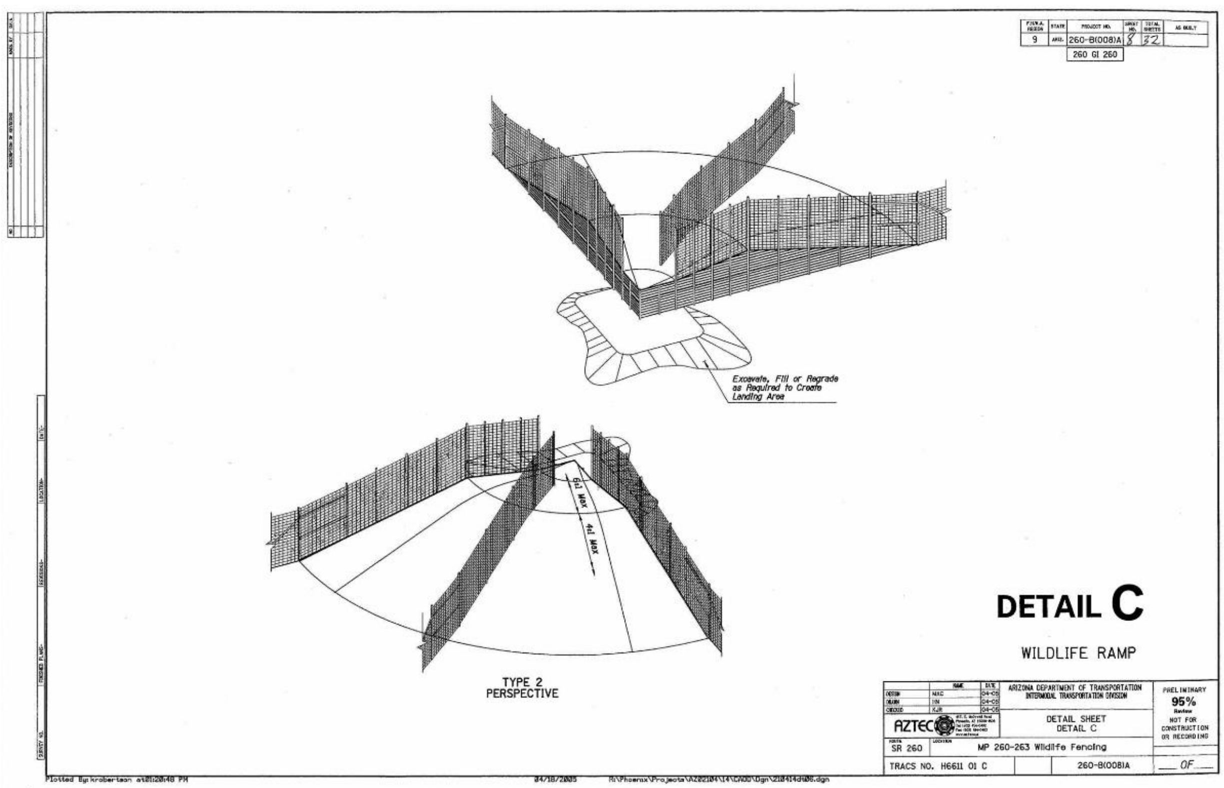


Figure 1.18 Arizona DOT Wildlife Escape Ramp Fencing

The study team also gathered cost estimates of wildlife mitigation from Colorado DOT colleagues for a project constructed in 2015 and 2016. These estimates, presented in Figures 1.19 through 1.23, along with additional state DOT estimates, are used as a base for the benefit-cost analyses described in Chapter 4.

COLORADO
Department of Transportation

Project Number: STA 009A-034
Sub Account Number: 19910
Road Number & Milepost: SH 9, MP 134.42
Work Description: Wildlife Game Ramps
Location: SH 9, Grand County

Bid Cost

Game Ramps

Contract Item Number	Contract Item Description	Unit	Unit Cost	Notes
Roadway Items (Cat. 0200)				
607-60002	Game Ramp	Each	$12,500.00	2:1 Slopes / Bid Item
607-60002	Game Ramp / (3:1 Slopes with Fence) - CO #013	Each	$13,378.18	Change Order
607-60002	Game Ramp / (3:1 Slopes without Fence) - CO #013	Each	$13,006.70	Change Order
607-60103	3 Ft Gate - CO #008	Each	$565.23	Change Order

Updated 8/5/16

Figure 1.19 Colorado Department of Transportation Cost Estimates for Wildlife Escape (Game) Ramps on SH 9

COLORADO
Department of Transportation

Project Number: STA 009A-034
Sub Account Number: 19910
Road Number & Milepost: SH 9, MP 134.42
Work Description: Wildlife Deer Guards
Location: SH 9, Grand County

Bid Cost

Game Ramps

Contract Item Number	Contract Item Description	Unit	Unit Cost	Notes
Roadway Items (Cat. 0200)				
611-00017	16 Foot Deer Guard	Each	$34,000.00	Bid Item
611-00021	20 Foot Deer Guard	Each	$40,000.00	Bid Item
611-00025	24 Foot Deer Guard	Each	$45,000.00	Bid Item
611-00029	28 Foot Deer Guard	Each	$50,000.00	Bid Item
611-00033	32 Foot Deer Guard	Each	$56,000.00	Bid Item
611-00041	40 Foot Deer Guard	Each	$68,000.00	Bid Item
Cost for New Grate and installing new Grate (Not Cost for complete Deer Guard)				
900-00007	Added Item (Each) / 20 Foot Deer Grate - CO #009	Each	$19,536.64	Change Order
900-00007	Added Item (Each) / 24 Foot Deer Grate - CO #009	Each	$21,230.41	Change Order
900-00007	Added Item (Each) / 28 Foot Deer Grate - CO #009	Each	$22,723.27	Change Order
900-00007	Added Item (Each) / Remove & Replace Deer Grate (Temp) - CO #009	Each	$1,903.86	Change Order
Estimated Cost for Deer Guards with New Round Tube Design				
611-00017	16 Foot Deer Guard	Each	$40,000.00	with round tube design
611-00021	20 Foot Deer Guard	Each	$46,200.00	with round tube design
611-00025	24 Foot Deer Guard	Each	$51,000.00	with round tube design
611-00029	28 Foot Deer Guard	Each	$55,000.00	with round tube design
611-00033	32 Foot Deer Guard	Each	$62,000.00	with round tube design
611-00041	40 Foot Deer Guard	Each	$74,000.00	with round tube design

Updated 8/5/16

Figure 1.20 Colorado Department of Transportation Cost Estimates for Double Cattle Guards (Deer Guards) on SH 9

COLORADO
Department of Transportation

Project Number: STA 009A-034
Sub Account Number: 19910
Road Number & Milepost: SH 9, MP 134.42
Work Description: Wildlife Fence
Location: SH 9, Grand County

Bid Cost

Cost for Wildlife Fence (1 mile, both side of road)

Contract Item Number	Contract Item Description	Quantity	Unit	Unit Cost	Total Cost
Roadway Items (Cat. 0200)					
607-00015	End Post (Special)	0.00	Each	$270.00	$0.00
607-00020	Corner and Line Brace Post (Special)	30.00	Each	$390.00	$11,700.00
607-11350	Fence Deer	10,560.00	LF	$7.50	$79,200.00
607-60002	Game Ramp	2.00	Each	$12,500.00	$25,000.00
607-60117	16 Foot Gate (Special)	1.00	Each	$2,050.00	$2,050.00
625-00000	Construction Surveying	1.00	LS	$3,000.00	$3,000.00
626-00000	Mobilization	1.00	LS	$5,000.00	$5,000.00
				Roadway Category (Cat. 0200) Total	$125,950.00
				Total CE and Indirect Charges (22.10%)	$27,834.95

Updated 8/5/16 Total Costs: $153,784.95

Figure 1.21 Colorado Department of Transportation Cost Estimates for Wildlife Fence per Mile on SH 9

COLORADO
Department of Transportation

Project Number: STA 009A-034
Sub Account Number: 19910
Road Number & Milepost: SH 9, MP 134.42
Work Description: Wildlife Underpass
Location: SH 9, Grand County

Bid Cost

Underpass Structure on SH 9 STA 629+20 / MP 136.03 / Structure # D-15-BN

Contract Item Number	Contract Item Description	Quantity	Unit	Unit Cost	Total Cost
Roadway Items (Cat. 0200) - Items Directly Related to the Underpass Structure					
203-00060	Embankment Material (Complete In Place)	0.00	CY	$8.00	$0.00
207-00205	Topsoil	480.00	CY	$8.00	$3,840.00
207-00210	Stockpile Topsoil	480.00	CY	$4.00	$1,920.00
208-00002	Erosion Log (12 Inch)	400.00	LF	$4.00	$1,600.00
208-00045	Concrete Washout Structure	1.00	Each	$1,000.00	$1,000.00
208-00070	Vehicle Tracking Pad	2.00	Each	$2,000.00	$4,000.00
208-00103	Removal and Disposal of Sediment (Labor)	15.00	Hour	$67.00	$1,005.00
208-00106	Sweeping (Sediment Removal)	10.00	Hour	$150.00	$1,500.00
208-00206	Erosion Control Supervisor	35.00	Day	$300.00	$10,500.00
212-00006	Seeding (Native)	0.90	Acre	$860.00	$774.00
212-00032	Soil Conditioning	0.90	Acre	$3,000.00	$2,700.00
213-00012	Spray-on Mulch Blanket	0.90	Acre	$3,750.00	$3,375.00
240-00000	Wildlife Biologist	2.00	Hour	$100.00	$200.00
304-01005	Aggregate Base Course (Class 1)	1,383.00	CY	$25.00	$34,575.00
304-06007	Aggregate Base Course (Class 6)	593.00	CY	$27.00	$16,011.00
403-34701	Hot Mix Asphalt (Grading SX) (75)	1,175.00	Ton	$36.00	$42,300.00
411-03352	Asphalt Cement Performance Grade (PG 58-28)	44.65	Ton	$560.00	$25,004.00
411-03355	Asphalt Cement Performance Grade (PG 58-34)	22.33	Ton	$700.00	$15,631.00
411-10255	Emulsified Asphalt (Slow-Setting)	712.00	Gallon	$3.10	$2,207.20
606-00301	Guardrail Type 3 (6-3 Post Spacing)	725.00	LF	$24.00	$17,400.00
606-00710	Guardrail Type 7 (Style CA)	100.00	LF	$140.00	$14,000.00
606-01370	Transition Type 3G	4.00	Each	$3,600.00	$14,400.00
606-02005	End Anchorage (Flared)	4.00	Each	$2,200.00	$8,800.00
607-00020	Corner and Line Brace Post (Special)	12.00	Each	$390.00	$4,680.00
607-01055	Fence Wire with Treated Wooden Posts	0.00	LF	$2.60	$0.00
607-11350	Fence Deer	430.00	LF	$7.50	$3,225.00
607-11525	Fence (Plastic)	0.00	LF	$1.50	$0.00
607-60002	Game Ramp	2.00	Each	$12,500.00	$25,000.00
607-60120	20 Foot Gate	0.00	Each	$375.00	$0.00
607-60121	20 Foot Gate (Special)	2.00	Each	$2,000.00	$4,000.00
621-00430	Detour	2,088.00	SY	$24.50	$51,156.00
625-00000	Construction Surveying	1.00	LS	$15,000.00	$15,000.00
626-00000	Mobilization	1.00	LS	$80,000.00	$80,000.00
626-01000	Public Information Services	1.00	LS	$5,000.00	$5,000.00
630-00000	Flagging	80.00	Hour	$37.00	$2,960.00
630-00007	Traffic Control Inspection	12.00	Day	$250.00	$3,000.00
630-00012	Traffic Control Management	35.00	Day	$800.00	$28,000.00
630-80341	Construction Traffic Sign (Panel Size A)	2.00	Each	$70.00	$140.00
630-80342	Construction Traffic Sign (Panel Size B)	16.00	Each	$81.00	$1,296.00
630-80343	Construction Traffic Sign (Panel Size C)	2.00	Each	$94.00	$188.00
630-80359	Portable Message Sign Panel	94.00	Day	$155.00	$14,570.00
630-80360	Drum Channelizing Device	20.00	Each	$20.00	$400.00
630-80363	Drum Channelizing Device (With Light) (Flashing)	2.00	Each	$25.00	$50.00
630-80364	Drum Channelizing Device (With Light) (Steady Burn)	6.00	Each	$32.00	$192.00
630-80370	Concrete Barrier (Temporary)	900.00	LF	$105.00	$94,500.00
630-80380	Traffic Cone	50.00	Each	$20.00	$1,000.00
				Sub-Total:	**$557,099.20**
Structure Items (Cat. 306)					
206-00000	Structure Excavation	2,700.00	CY	$12.00	$32,400.00
206-00100	Structure Backfill (Class 1)	1,455.00	CY	$32.00	$46,560.00
206-00200	Structure Backfill (Class 2)	775.00	CY	$17.00	$13,175.00
206-01785	Shoring (Area 5)	1.00	LS	$125,000.00	$125,000.00
601-14000	Concrete Footing (Type 1)	132.00	LF	$1,500.00	$198,000.00
603-74214	42x14 Foot Concrete 3-Sided Culvert (Precast)	66.00	LF	$3,000.00	$198,000.00
603-77001	Culvert Headwall (3-Sided Culvert) (Type 1)	580.00	SF	$70.00	$40,600.00
603-77011	Culvert Wingwall (3-Sided Culvert) (Type 1)	1,240.00	SF	$60.00	$74,400.00
				Sub-Total:	**$728,135.00**
				Roadway Category (Cat. 0200) Total	**$557,099.20**
				Structure Category (Cat. 0306) Total	**$728,135.00**
				Sub-Total:	**$1,285,234.20**
				Total CE and Indirect Charges (22.10%)	**$284,036.76**

Updated 8/5/16

Total Costs: $1,569,270.96

Figure 1.22 Colorado Department of Transportation Cost Estimates for one Underpass Structure, Concurrent Fence, Guard Rail, and Vegetation Restoration on SH 9

COLORADO
Department of Transportation

Project Number: STA 009A-034
Sub Account Number: 19910
Road Number & Milepost: SH 9, MP 134.42
Work Description: Wildlife Overpass
Location: SH 9, Grand County

Bid Cost

Overpass Structure on SH 9 STA 542+75 / MP 134.42 / Structure # D-15-BM

Contract Item Number	Contract Item Description	Quantity	Unit	Unit Cost	Total Cost
Roadway Items (Cat. 0200) - Items Directly Related to the Overpass Structure					
203-00060	Embankment Material (Complete In Place)	4,472.00	CY	$8.00	$35,776.00
207-00205	Topsoil	1,020.00	CY	$8.00	$8,160.00
207-00210	Stockpile Topsoil	1,020.00	CY	$4.00	$4,080.00
208-00002	Erosion Log (12 Inch)	600.00	LF	$4.00	$2,400.00
208-00045	Concrete Washout Structure	1.00	Each	$1,000.00	$1,000.00
208-00070	Vehicle Tracking Pad	2.00	Each	$2,000.00	$4,000.00
208-00103	Removal and Disposal of Sediment (Labor)	5.00	Hour	$67.00	$335.00
208-00106	Sweeping (Sediment Removal)	20.00	Hour	$150.00	$3,000.00
208-00206	Erosion Control Supervisor	35.00	Day	$300.00	$10,500.00
212-00006	Seeding (Native)	1.90	Acre	$860.00	$1,634.00
212-00032	Soil Conditioning	1.90	Acre	$3,000.00	$5,700.00
213-00012	Spray-on Mulch Blanket	1.90	Acre	$3,750.00	$7,125.00
240-00000	Wildlife Biologist	2.00	Hour	$100.00	$200.00
606-00301	Guardrail Type 3 (6-3 Post Spacing)	700.00	LF	$24.00	$16,800.00
606-00710	Guardrail Type 7 (Style CA)	200.00	LF	$140.00	$28,000.00
606-01370	Transition Type 3G	4.00	Each	$3,600.00	$14,400.00
606-02005	End Anchorage (Flared)	4.00	Each	$2,200.00	$8,800.00
607-00020	Corner and Line Brace Post (Special)	12.00	Each	$390.00	$4,680.00
607-01055	Fence Wire with Treated Wooden Posts	550.00	LF	$2.60	$1,430.00
607-11350	Fence Deer	620.00	LF	$7.50	$4,650.00
607-11525	Fence (Plastic)	184.00	LF	$1.50	$276.00
607-60002	Game Ramp	2.00	Each	$12,500.00	$25,000.00
607-60120	20 Foot Gate	4.00	Each	$375.00	$1,500.00
607-60121	20 Foot Gate (Special)	2.00	Each	$2,000.00	$4,000.00
625-00000	Construction Surveying	1.00	LS	$15,000.00	$15,000.00
626-00000	Mobilization	1.00	LS	$100,000.00	$100,000.00
626-01000	Public Information Services	1.00	LS	$5,000.00	$5,000.00
630-00000	Flagging	600.00	Hour	$37.00	$22,200.00
630-00007	Traffic Control Inspection	12.00	Day	$250.00	$3,000.00
630-00012	Traffic Control Management	35.00	Day	$800.00	$28,000.00
630-80341	Construction Traffic Sign (Panel Size A)	2.00	Each	$70.00	$140.00
630-80342	Construction Traffic Sign (Panel Size B)	16.00	Each	$81.00	$1,296.00
630-80343	Construction Traffic Sign (Panel Size C)	2.00	Each	$94.00	$188.00
630-80359	Portable Message Sign Panel	94.00	Day	$155.00	$14,570.00
630-80360	Drum Channelizing Device	20.00	Each	$20.00	$400.00
630-80363	Drum Channelizing Device (With Light) (Flashing)	2.00	Each	$25.00	$50.00
630-80364	Drum Channelizing Device (With Light) (Steady Burn)	6.00	Each	$32.00	$192.00
630-80370	Concrete Barrier (Temporary)	400.00	LF	$105.00	$42,000.00
630-80380	Traffic Cone	50.00	Each	$20.00	$1,000.00
				Sub-Total:	$426,482.00
Structure Items (Cat. 305)					
206-00000	Structure Excavation	1,350.00	CY	$12.00	$16,200.00
206-00100	Structure Backfill (Class 1)	3,100.00	CY	$32.00	$99,200.00
206-00200	Structure Backfill (Class 2)	1,950.00	CY	$17.00	$33,150.00
601-14002	Concrete Footing (Type 2)	200.00	LF	$1,100.00	$220,000.00
601-40300	Structural Concrete Coating	1,445.00	SY	$12.50	$18,062.50
603-76624	66x24 Foot Concrete 3-Sided Culvert (Precast)	100.00	LF	$6,400.00	$640,000.00
603-77002	Culvert Headwall (3-Sided Culvert) (Type 2)	1,330.00	SF	$60.00	$79,800.00
603-77012	Culvert Wingwall (3-Sided Culvert) (Type 2)	2,560.00	SF	$60.00	$153,600.00
				Sub-Total:	$1,260,012.50
				Roadway Category (Cat. 0200) Total	$426,482.00
				Structure Category (Cat. 0305) Total	$1,260,012.50
				Sub-Total:	$1,686,494.50
				Total CE and Indirect Charges (22.10%)	$372,715.28

Updated 8/5/16 * Does not include new asphalt under the overpass **Total Costs: $2,059,209.78**

Figure 1.23 Colorado Department of Transportation Cost Estimates for Overpass Structure and Concurrent Mitigation on SH 9

1.5. Construction

The fourth step in developing wildlife crossing structures is the actual construction of the infrastructure, and monitoring the area pre- and post-construction, to evaluate according to performance measures and determine whether additional infrastructure is called for. There is no single approach to the construction of wildlife crossing structures, but several generalities can be made. The standardized designs for mitigation help consultants create tested structures, fences, escape ramps, and deterrents. Some wildlife mitigation projects are put in during one period of time, and some are part of phased construction over several years. The phased approach along with monitoring of the infrastructure can allow for adaptive management of the designs and construction of the following phases (Kintsch et al., 2019).

1.6. Maintenance

The personnel who care for wildlife mitigation infrastructure over the long term are critical to a successful project. Yet these on-the-ground workers are often not included in planning the locations for or configurations of wildlife crossings structures or in helping to create cost-effective solutions. Many of the wildlife-crossing success stories share a common element: maintenance personnel were involved long before the structures were constructed.

Maintenance personnel's adaptive management of structures and fences is critical. Their collection of carcasses and efforts to input the carcass data information are also key to locating WVC areas. When the wildlife crossing structures and other infrastructure are monitored before and after construction, the results often give the DOT and other stakeholders opportunities to adaptively manage for proper solutions, and the maintenance personnel are often those who enact those actions.

1.7. Summary

The state of the practice of wildlife crossing structures and other mitigation is varied among states, but often can be summarized in five common steps: data, planning, design, construction, and maintenance. This chapter provided an overview of the commonalities among the western U.S. states with more progressive programs for creating wildlife crossing structures. This information formed the base for the research team's recommendations to TxDOT on adapting its practices to achieve a similar level of progressiveness with respect to both reducing WVC and providing wildlife connectivity.

Chapter 2. Texas Needs Assessment

The research team surveyed TxDOT personnel to gain insights into how wildlife needs can be brought into TxDOT's planning and daily operations processes. The survey helped reveal TxDOT's institutional knowledge of actions in the past (and potentially in the future) to reduce WVC and create and maintain wildlife mitigation strategies. The results were then correlated with the knowledge gained of other state actions to help inform later tasks that resulted in recommendations for TxDOT manual updates. The results of these manual assessments are summarized in Chapter 6. The results of Task 3, to correlate Texas needs with the synthesis findings and to synthesize TxDOT's institutional knowledge are presented below.

2.1. TxDOT Personnel Interviews

The research team interviewed TxDOT research panel members Stirling Robertson, Jane Lundquist, Gregg Turco, and Robin Gelston in January 2018 to help identify positions within TxDOT districts and headquarters where the personnel could best answer survey questions. The staff members in those positions would be the best positioned to help incorporate within the planning and design processes recognition of the need to reduce WVC and promote wildlife connectivity; see Figure 2.1. From this information, the survey was developed for various TxDOT personnel in the positions identified at the 25 districts and headquarters.

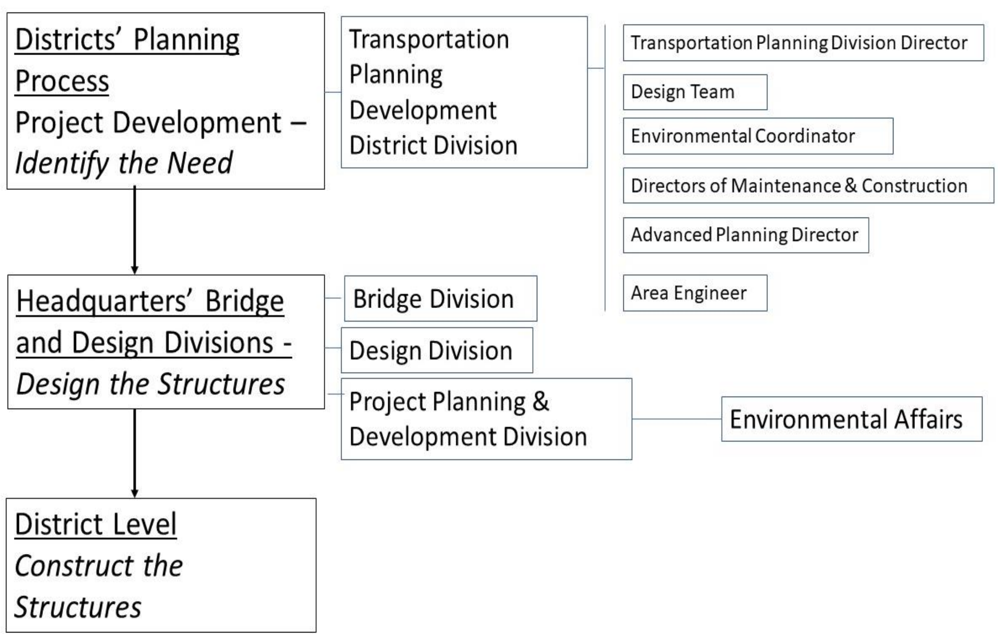


Figure 2.1 TxDOT Project Development Flowchart and Positions Involved at the District and Headquarters Level that Could Incorporate Wildlife Concerns

Based on the information obtained from these interviews, the research team also compiled a list of Texas wildlife crossing structures and other wildlife mitigation. The list can be found in Appendix C.

2.2. TxDOT Personnel Survey

2.2.1. Survey Methodology and Development

An online survey was created in conjunction with TxDOT project panel members over February and March of 2018. Eight position-specific surveys were developed for TxDOT personnel at the Headquarters' Divisions and District levels. The survey included questions about changes to TxDOT manuals, which the study team formulated from the review of 20 TxDOT manuals. After review of these manuals, it was decided that the manuals for Maintenance Management, Traffic Safety Program, Transportation Planning Process, and Transportation Programming and Scheduling would not be included in the survey. This was in part to present the most pertinent manuals to survey participants and to help minimize the size of the list they reviewed (see Table 2.1 for the final list of manuals included in the survey).

The manuals the research team reviewed have sections pertaining to practices that could be updated to help reduce AVC, and better plan for, construct, and maintain wildlife mitigation. Several questions in the surveys referred directly to text in these manuals. The objective of these questions was for the participants to assist the research team in developing recommendations for manual updates that are relevant and specific to the needs of TxDOT practitioners. The survey questions can be found in Appendix D.

In March 2018 the TxDOT project manager invited TxDOT personnel to complete the survey; the response window closed in early April. Different survey versions were designed for specific positions. Respondents clicked on the position title that matched theirs, and a link took them to the questions tailored to their area of expertise and knowledge of TxDOT processes. Dr. Cramer extracted all the results; they are summarized below.

2.2.2. Survey Results Summary

A total of 79 TxDOT participants took the survey, and 54 finished. The respondents indicated that they hold the following **position titles**:

- 29 District Environmental Coordinator Staff;
- 37 TxDOT District Area Engineers/District Engineers/District Directors of Planning and Development/Transportation Planning and Programming Division Director/Director of Project Planning and Development/Director of District Operations/Traffic Engineer/Transportation Planning and Programming Engineer;

- 2 TxDOT Headquarters' Roadway Design Section, Design Division;
- 1 District Director of Maintenance;
- 10 non-responses to this question.

Respondents gave multiple suggestions for data collection, planning, changes to the planning process, and adaptations to TxDOT manuals to standardize consideration of wildlife mitigation and reduction of wildlife-vehicle conflict. Several consistent themes emerged:

- A top-down approach to getting the message out that wildlife mitigation consideration should become part of most TxDOT job descriptions.
- Work to create procedures for and regular data collection of animals involved in crashes, collected as carcasses, and as potential live animals along the road that need to be protected from traffic.
- Plan early in the design process for wildlife.
- Establish plenty of guidelines for best practices. For example, the respondents gave examples of adding amphibian fencing to culverts, adding terrestrial pathways under bridges (both new and retrofit), creating communication between headquarters and the districts, and establishing statewide standards.
- Take advantage of multiple opportunities for getting the word out about these new changes to manuals and as a matter of doing business. Support and suggestions were offered for educating TxDOT personnel through meetings with Texas Parks and Wildlife Department (TPWD) or possibly the US Fish and Wildlife Service (USFWS), at already established conferences, and at district-level meetings.

The results of the survey guided the following steps of the research. Participant suggestions were developed into this project's final recommendations.

2.2.2.1. Environmental Staff Questions and Answers

Asked if there were **wildlife crossing structure projects** in their districts, only two projects were given, and both were for ocelots.

Asked if they had suggestions on **how to evaluate and integrate potential wildlife crossing needs into TxDOT's existing planning/designing process,** the respondents' answers can be summarized as the following suggested actions.

- Collect data on crashes and bird strikes, including pelicans;
- Collect data on wildlife movement and presence near roads;

- Widen bridges to beyond stream banks to accommodate heavier water flows, thereby including terrestrial movement pathways;
- Identify sensitive species and high-risk collision areas;
- Provide encouragement from the top down to incorporate measures during the planning/designing process.

The answers to the question "What suggestions do you have for monitoring the effectiveness of these measures once they have been put into operation?" can be summarized by the four major steps:

- Monitor wildlife use of area or structure with cameras:
- Keep crash or strike counts;
- Conduct roadkill carcass surveys;
- Ensure there is sufficient funding to hire consultants to conduct roadkill carcass surveys and other information collecting in a systematic, scientifically rigorous manner.

Environmental staff were asked **if the consideration of wildlife connectivity should be conducted during the federally required National Environmental Policy Act (NEPA) process.** Eight respondents said yes, eight said no, one said they didn't know. There were additional comments as to how this could be done.

Environmental staff were asked **if TxDOT district Environmental Affairs Division section staff should have a specific milestone in the process where they review data and consider these needs.** Five said yes, five said no, three said they don't know. Overall, the respondents want to see milestones incorporated with existing ones found in the schematic phase and in the engineering design phase, as well as early in the design/planning process.

Asked **if they ever consult crash or carcass data**, three respondents said yes, 12 said no, one said they didn't know.

In response to the question asking **if their district has entered into agreement with TPWD or USFWS to cooperatively work to reduce WVC**, three said yes, 12 said no, one said they didn't know. Similarly, when asked **if there were reports or documentation of specific places of interest for wildlife movement in their districts**, none said yes, eight said no, eight said they didn't know.

When asked if they could **recommend best practices and strategies to help reduce AVC**, only two constructive comments were received. One was to recommend that during crash data analysis, the engineers do bring it up in their project meetings. The other respondent suggested increasing bridge length to include suitable areas for crossings below the bridges.

2.2.2.2. All Respondents' Ranking of Manuals Best Suited for Updates

All respondents were presented with a list of 16 potential TxDOT manuals selected by the researchers as most likely to be suitable for updates that included wildlife considerations. All respondents were asked to select **which TxDOT manuals should include guidance when considering the needs of wildlife to traverse transportation infrastructure**, and how to integrate these concerns into daily operations. Table 2.1 presents the ranking of the manuals respondents said should be amended.

Table 2.1 Survey Participants Responses on Manuals Best Suited for Updates

Manual	Number Indicated Yes	Survey Respondents' Comments
1. Roadway Design	14	Addresses species movement other than across the travel surface
2. Project Development Process	12	Identify species, location, and mode of travel (flying, walking, etc.) Relate to proposed project.
3. Bridge Design	10	
4. Bridge Project Development	9	
5. Landscapes and Aesthetics Design	9	
6. Maintenance Operations	8	
7. Highway Safety Improvement Program	8	
8. Roadside Vegetation Management	8	
9. Transportation Planning	7	
10. Plans, Specifications and Estimate Development	7	Addresses species movement other than across the travel surface
11. Access Management	5	
12. Procedures for Establishing Speed Zones	3	
13. Construction Contract Administration	1	
14. Design and Construction Information Systems (DCIS)	1	
15. Maintenance Management	1	
16. MUTCD	0	

All respondents were asked this question: "When considering AVC reduction measures, what would be the most effective way to ensure guidance from TxDOT manuals gets clearly communicated both within TxDOT and to non-TxDOT entities, such as consultants?” The responses included the following:

- Write instructions into the contract.
- Place guidance in the appropriate manuals and ensure the changes are incorporated into the training/refresher courses.
- Provide webinars, add sections to planning and design training, and establish it as a topic for discussions at the yearly TxDOT conferences where consultants usually attend.
- Have a memo from the Division Director or above discussing the new requirements and guidance available.
- A likely route would be through TxDOT specifications and manuals, and in consultant contractual documents.
- Send notification via email, Crossroads[5], etc. Include in online toolkits.
- Establish mandatory training.
- Trainings through events like the Environmental Coordinators Conference.

The survey asked respondents this question: “What needs to be done to ensure these considerations are conveyed over the life of the facility, from the planning phase through construction and beyond?” Responses included the following:

- You need buy-in from the top.
- Effective communication is necessary among all involved, especially the Environmental Affairs Division, Design Division, and area offices; careful planning is also necessary.
- Make sure it gets carried through the Plans, Specifications and Estimate (PS&E) Development Manual and conveyed to maintenance after construction. Include in maintenance plans.
- Issue an executive memo indicating the policy and then specific locations, in addition to statewide planning map and other shapefile information provided for use in GIS mapping.
- Include these aspects in the Environmental Management System (EMS) process.

[5] TxDOT’s intranet site.

- Use a management plan or include in roadway information documentation.

2.2.2.3. Landscape Architects' Responses to Manual Changes

The landscape architects were also surveyed. The first question respondents were asked concerned the Landscape and Aesthetic Design Manual, but there were no responses from this group. It may be because no respondent identified themselves as a Landscape Architect. Nine other survey respondents did say this manual should receive updates for inclusion of wildlife mitigation needs.

2.2.2.4. All Respondents' Questions and Answers

An important question for all respondents was the following: "At what point in the transportation planning process should TxDOT manuals instruct personnel to consider wildlife concerns?" The overall response was "As early as possible." Multiple comments mentioned that such concerns should be included at the schematic level of preparation phase. Other points in the process were mentioned as well:

- Many respondents mentioned this should be done in the environmental considerations phase, when environmental documents are prepared.
- Initial project survey during development.
- At the scoping meeting.
- Preliminary design phase, BEFORE the schematic approval. (Several respondents supported this idea.)
- 30% PS&E. (Another respondent said 30% review or earlier.)
- During the project identification/planning phase.
- Have the information before the Programming Decision Committee (PDC) to discuss impacts.
- At project initiation.
- Before the project gets development authority and goes into the Unified Transportation Program and Statewide Transportation Improvement Program.
- Advance planning stage.
- Pre-design, when the staff involved know the scope of the project.
- During project planning/scoping.

- At the project concept.
- Part of the Pre-Assembly Activities (Chapter 1 of the PS&E manual) that fall under Environmental Requirements, the form of a simple question about whether wildlife crossing concerns need to be taken into consideration.

The question "Would planners and designers benefit from guidelines on when to place wildlife crossings?" had 31 yes responses, one no, and two "don't know." Potential guidelines for benchmark values of crash and other data were then presented and participants were asked if these were believed to be pertinent to initiating consideration for wildlife mitigation. The benchmarks and responses are presented below. Upon examination of each participant's responses, it was found that a respondent typically gave the same rating to each benchmark. This resulted in similar rankings for the degree of helpfulness for each benchmark.

Overall the respondents were not convinced that benchmark threshold numbers are enough to initiate consideration of wildlife in transportation planning. They are experienced enough to consider many factors in responding to AVC, rather than accounting only for fatalities, or treating injury crashes differently than property-damage-only crashes. However, there appears to be no central place within TxDOT where they can look at multiple layers over one area to identify the potential AVC hot spots. One useful method to synthesize the insights gained from the survey responses would be to combine a safety map with an ecological map as an overlay that indicates species' locations and habitats.

Following is a recap of responses to suggested benchmarks:

- **"Wildlife crossing structures are highly recommended if AVC reported crashes $\geq$ 3 per mile per year."** Responses: 13 said yes, appropriate; 4 said too high; 10 said too low; 5 said not helpful or pertinent.
- **"Wildlife crossing structures are highly recommended if 1 or more human fatality due to AVC that occurred in the past 5 years in any mile of the segment of road under consideration."** Responses: 15 said yes, appropriate; 3 said too high; 4 said too low; 9 selected not pertinent.
- **"Wildlife crossing structures are highly recommended if 2 or more injury related AVC per mile in the previous 3 years."** Responses: 13 said yes, appropriate; 3 said too high; 7 said too low; 9 said not pertinent.
- **"Wildlife crossing structures are highly recommended if Texas Parks and Wildlife (TPWD) or US Fish and Wildlife Service (USFWS) have identified threatened and endangered listed species of wildlife near the road and their presence may delay or affect the transportation project."** Responses: 13 said Yes, appropriate; 3 said no, too high; 7 said no, too low; 9 said not appropriate.

Respondents gave the following verbatim answers to this question: **"Are there other factors you think should be considered for placement of wildlife crossing structures?"**

1. Fencing at specific locations to get wildlife to underpass.
2. Wildlife crossing structures should have brush/cover to allow animals to want to cross in that area.
3. Are we looking at standard crossing structures as far as material, size, shape, etc., or can the design vary based on the species? What animals benefit from a crossing structure?
4. Funds should be spent on teaching drivers how to scan the road ahead of them rather than on structures.
5. I think there needs to be more of an established history of animal migration patterns through an area versus animal-vehicle crash rates over a long time frame.
6. Signage should be considered even before a hit occurs in areas with human development.
7. Wildlife crossings structures should be placed only where drainage is needed, and design those drainage structures for wildlife.
8. Near or at stream crossings, they see incidents where wildlife follow a creek and go up and over road.
9. Working closely with USFW and Texas Parks and Wildlife
10. Effectiveness of the structure. (2x)
11. Cost, feasibility, and constructability
12. One respondent didn't know structures worked and wanted proof.
13. Fencing is needed in conjunction with structures and is TxDOT going to maintain the fence, since Maintenance sections are overloaded now.
14. If the height of the structure changes the parameters of the project from PM or 2R to a major 3R or 4R, then there are higher design guidelines, costs, etc. This can be managed if identified as early as possible in the project development process.
15. Benefit-Cost analysis.
16. Design, Constructability and Maintenance requirements for said structures.
17. Density of wildlife in the area.
18. Location of structure. A set of criteria needs to be worked out and agreed on. Also needs to be kept simple and doable. This will be the most difficult part of the work. An example would be a location works out great for wildlife but

would be extremely problematic for the transportation system (Bridge, Road, Rail... etc.) and vice versa.

All respondents were asked to evaluate the potential methods that could improve communication. The methods presented in the survey are provided below, along with responses.

1. **Training classes on AVC, wildlife mitigation, planning, resources, and personnel who can help:** 18 said useful; 5 said not useful; 8 said don't know.
2. **Training classes in conjunction with TPWD on protected species and how to account for these species in transportation planning and design:** 20 said useful; 3 said not useful; 6 said don't know.
3. **Presentations on communication and coordination on wildlife mitigation, wildlife connectivity, and AVC, presented at annual meetings for Design, Construction, and Maintenance Divisions:** 21 said useful; 1 said not useful; 7 said don't know.
4. **Presentations on AVC, wildlife connectivity and mitigation solutions to TxDOT Administration at either TxDOT Short Course, or Center for Transportation Research (CTR) Annual Symposium:** 20 said useful; 4 said not useful; 6 said don't know.

When asked for other suggestions on improving coordination and communication between districts and headquarters to improve the flow of information to help mitigate roads for wildlife, respondents provided the following thoughts (verbatim):

1. Districts depend on environmental coordinators and planners for this information. They need to examine what issues are not being addressed and how information is flowing.
2. Districts should notify headquarters when projects are identified.
3. It would be helpful to obtain evidence of the structures' effectiveness, with statistics on percentage decreases of AVCs after structure was built.
4. Mitigation structures are needed only for endangered species. For the rest of the animals, it is not practical. To minimize AVCs, place signs for motorists and keep the right-of-way mowed.
5. TPWD could make presentations on this issue during one of the quarterly District Engineers meetings.
6. Have a meeting with the Traffic Division to determine how a wildlife accident mitigation program can be incorporated into the Highway Safety Improvement Program's call for projects.
7. Continue communication between the Environmental Affairs Division and TxDOT districts.

8. If each geographic region had maps of the types of wildlife that should be protected, the designers could start thinking of possible mitigation strategies during project development.
9. Training needs to be simple, concise, and short, and should target the personnel who need it. Environmental Affairs Division personnel, along with Design Engineers, Traffic Engineers, and Design staff, should get in-depth training (such as a one-day in-person session). Area Engineers and Construction staff should receive more of an overview training (less than a half-day, perhaps a webinar or online format).

2.2.2.5. Maintenance Personnel

Only one maintenance personnel responded to the survey. Asked **if they collected carcass removal data**, the answer was no. Most of the maintenance questions went unanswered. When asked "**What area office of your district has the higher costs for carcass removal?"** the response was that "Rural areas tend to have the higher costs and concentrations."

When the maintenance person was asked **"Could you give us your best estimate for the TxDOT maintenance district cost for carcass removal on a lane-mile, monthly, or annual basis?**" the response was that "There are too many variable with the above question to determine the cost."

We then asked if this respondent had suggestions for **how to communicate to maintenance personnel the benefits of mowing vegetation along wildlife exclusion fencing, and culvert and fence upkeep;** they suggested the following: "Photo shots of the animals using the crossings."

2.2.2.6. Engineers' Responses to Manual Changes

The engineer respondents did not respond to the questions about changes to be made to the Roadway Design Manual, the Access Management Manual, or the Bridge Design Manual. No responses were tallied in the questions about updating the crash reporting software, or regular analyses of crash data.

2.3. Interviews with Survey Respondents

All survey respondents were asked to provide their contact information if they were interested in discussing their responses further with the researchers. Dr. Cramer called and emailed 11 survey respondents who provided insight into their district's wildlife mitigation efforts, to learn of how their districts incorporated wildlife needs into specific bridge and culvert designs in transportation projects. Those contacted were from the following TxDOT districts: Amarillo, Austin, Corpus Christi, Dallas, Fort Worth, Laredo, Lubbock, Lufkin, Pharr, San Antonio, and Waco. The results of these interviews helped the research team make the final recommendations for TxDOT manual updates.

2.4. Summary

The 79 TxDOT survey respondents' answers helped the research team to better understand TxDOT's needs for improvement in the practice of wildlife mitigation, and provided input as to how TxDOT manuals could be updated to consider, plan, build, and maintain wildlife crossing structures.

Dr. Cramer synthesized the survey and interview responses to arrive at a five-step approach TxDOT can use to most efficiently and effectively change practices to accommodate wildlife and help reduce WVC.

1. Establish a Problem

A problem has to be established in order to solve it. Collect crash data and analyze it regularly at headquarters and within districts, and conduct carcass surveys where there is knowledge of a problem. The data collected can establish that a problem exists; then the planning begins.

2. Plan Early and Establish Redundancy

The engineer professionals emphasized the importance of instituting early planning. Responses also indicated the need to plan for wildlife at multiple levels (which can be characterized as redundant planning); establish the need to consider wildlife in all staff's manuals.

3. TxDOT Plan and Execute a Big Win Project

Despite the success of the few wildlife crossing structures already in place, not everyone is convinced of the need for the structures. TxDOT may need to consider savvy wildlife crossing structure planning, targeting locations with a demonstrated need and a high potential for success. Monitor and document the situation pre-construction, with both crash and carcass statistics, traffic volume, and wildlife cameras near the right-of-way (ROW), then complete the same monitoring post-construction. A substantial wildlife crossing structure mitigation project with photos to document its effectiveness can create a success story, which can build momentum within the agency and with the public.

4. Establish Multiple Guidelines for Best Practices

Establish best practices overall to standardize inclusion of low-cost, high-impact changes to projects. Following are two such changes:

- Add amphibian fencing to culverts and bridges where these animals can cross underneath the road. It may be difficult to engender interest in amphibian populations—in either the public or among transportation professionals—but small changes can be made part of doing business and have enormous consequences across Texas for these smaller species populations.

- Create standardized terrestrial pathways on both sides of the body of water that a bridge spans. These pathways can accommodate both wildlife and humans traveling along the shore.

5. Educate TxDOT Personnel

Educate the environmental staff. Not all the staff members are steeped in the science of transportation ecology, and not all are convinced wildlife crossings work. Those that do need to become champions of the cause and convey their enthusiasm to their peers within the agency. Without knowledgeable champions, wildlife crossing structures will not happen in their district.

Finally, one consistent point arose in the interviews and in discussion with lead members of the panel: there is a lack of communication among the districts and headquarters, and among the divisions within headquarters and their counterparts within the districts. For example, essential personnel working at TxDOT headquarters are reactive to questions about needs for wildlife crossing structures, rather than proactively educating districts and divisions on wildlife mitigation. Furthermore, communication is very limited during the implementation of the process. The interview findings indicated a need for district staff to reach out to Headquarters' Environmental Affairs Division for help on wildlife crossings.

The overall recommendations can be summarized in the advice to plan early, provide guidelines, and communicate needs and results to TxDOT personnel. The recommendations in Chapter 6 incorporate these recommendations into suggested manual changes and updates.

Chapter 3. Crash Data and Hot Spot Analysis

The CTR research team obtained 2010–2016 Texas crash data from TxDOT's Crash Query Tool. Based on the First Harmful Event, the research group identified all the AVCs (involving both wild and domestic animals). By analyzing these crash data, the research team was able to obtain valuable information regarding the characteristics of AVCs.

By mapping these collisions, the research team also conducted a hot spot analysis to demonstrate how to identify locations with high frequency of wildlife or domestic AVCs.

3.1. Crash Data Analysis

Total reported crashes with wild and domestic animals from 2010–2016 are presented in Table 3.1 The number of crashes involving domestic animals stayed on a somewhat consistent level through the seven years, while wildlife-related vehicle collisions displayed an increasing trend—23% higher in 2016 than in 2010.

Table 3.1 Number of Crashes Involving Domestic and Wild Animals in Texas (2010–2016)

	2010	2011	2012	2013	2014	2015	2016
Animal on Road - Domestic	2440	2412	2393	2177	2019	2162	2287
Animal on Road - Wild	4098	4453	4277	4586	4602	5144	5760
Total	6538	6865	6670	6763	6621	7306	8047

The researchers next analyzed the number of animal-related crashes in relation to number of crashes per VMT. Results are shown in Figure 3.1. The same trends presented in Table 3.1 can be observed: the rate for domestic-animal-involved crashes decreased slightly while the rate for wildlife-vehicle crashes increased.

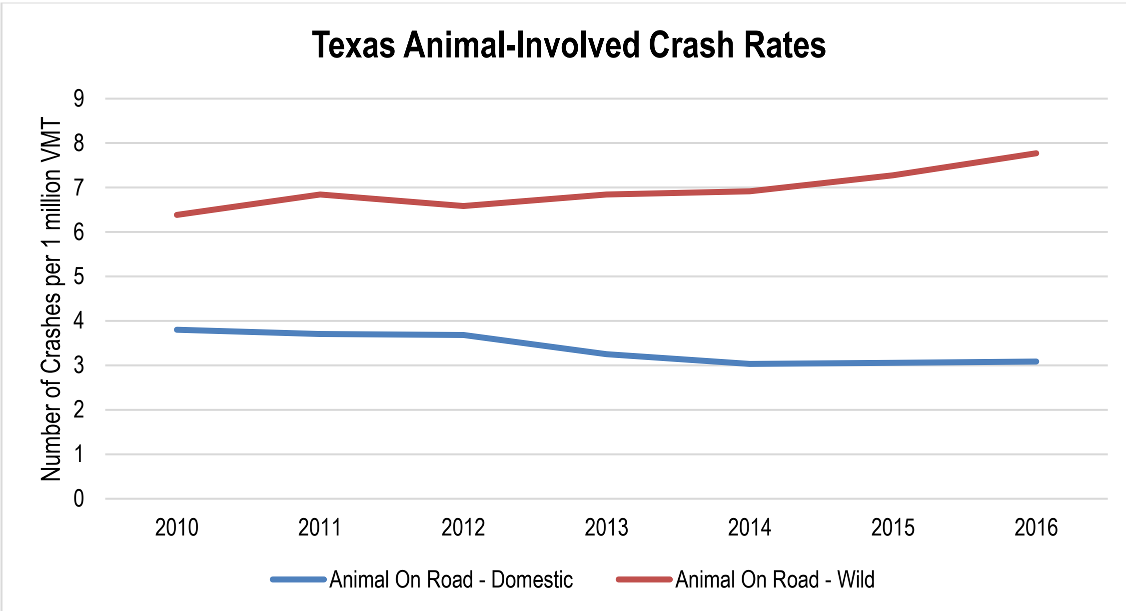
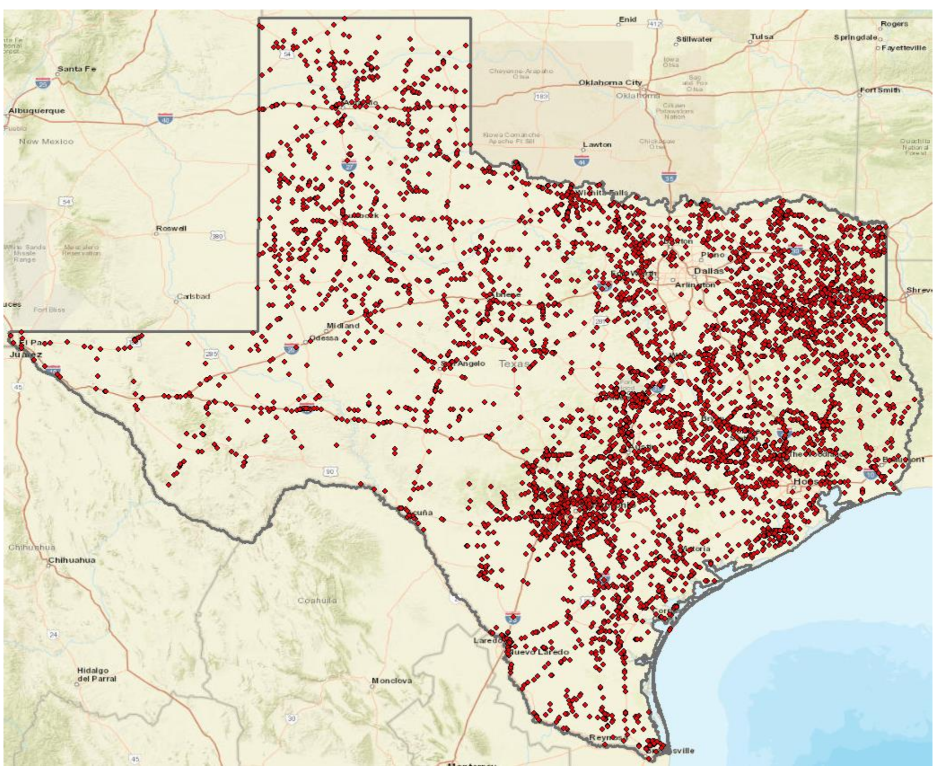
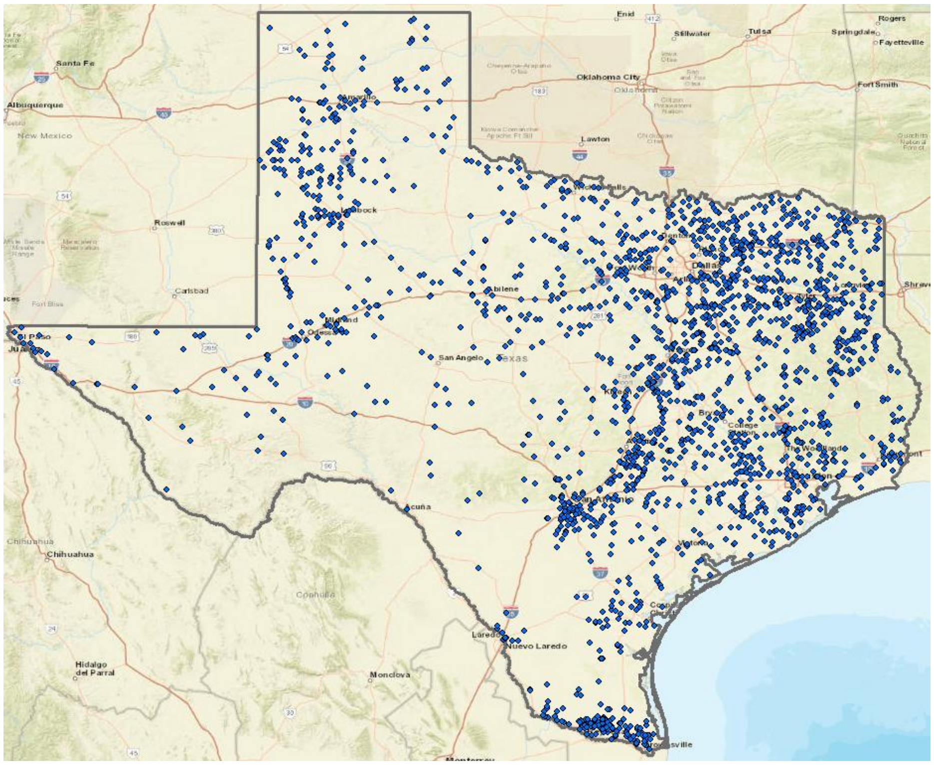


Figure 3.1 Texas Animal-involved Crash Rates from 2010 to 2016

Researchers plotted the reported 2016 crashes with wild animals and livestock separately (Figure 3.2).



(a) Wildlife-Vehicle Reported Crashes in Texas 2016



(b) Domestic Animal Vehicle Reported Crashes in Texas, 2016

Figure 3.2 Location of Texas 2016 Reported Crashes with Animals

Researchers calculated the percentage of AVCs as related to total crashes for each county (Figure 3.3). The percentage of AVCs among all crashes are higher in those counties in the Panhandle area even though the absolute number of crashes are lower compared with those counties on the east side of the state.

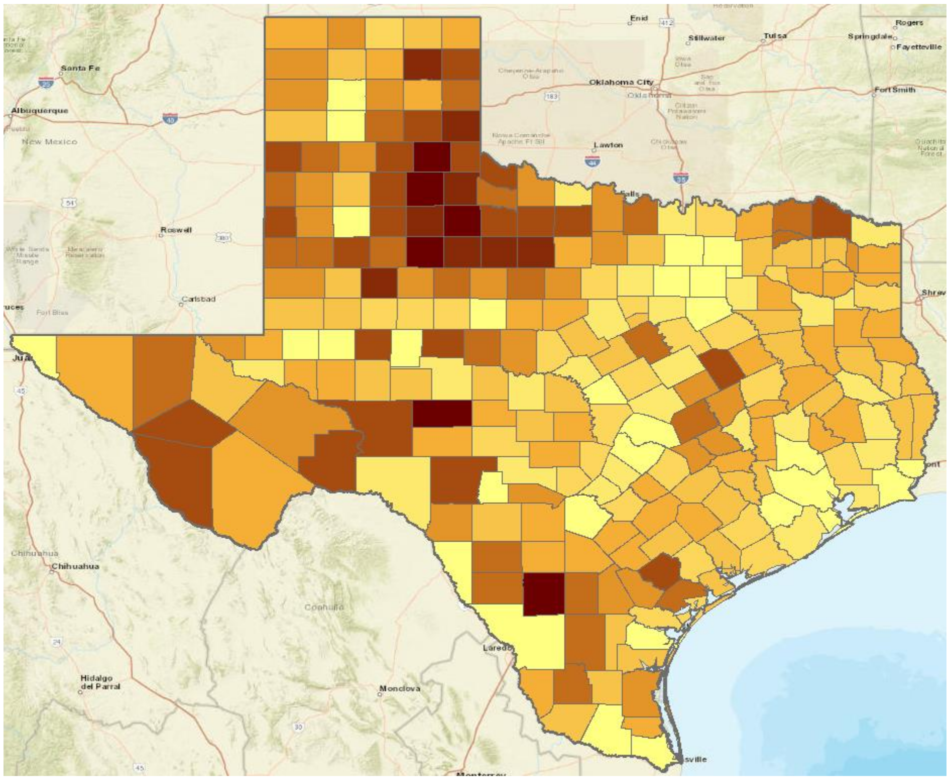


Figure 3.3 Percentage of AVC among All Crashes for Each County in Texas, 2016

Researchers calculated the number of AVCs per million VMT in each county in 2016 (Figure 3.4). This rate considers the traffic exposure and provides a more "fair" comparison between counties with a different level of traffic movements. The overall results are similar to Figure 3.2. Motley County, Kent County and some of their neighboring counties in the northwest Texas area had higher AVC ratios.

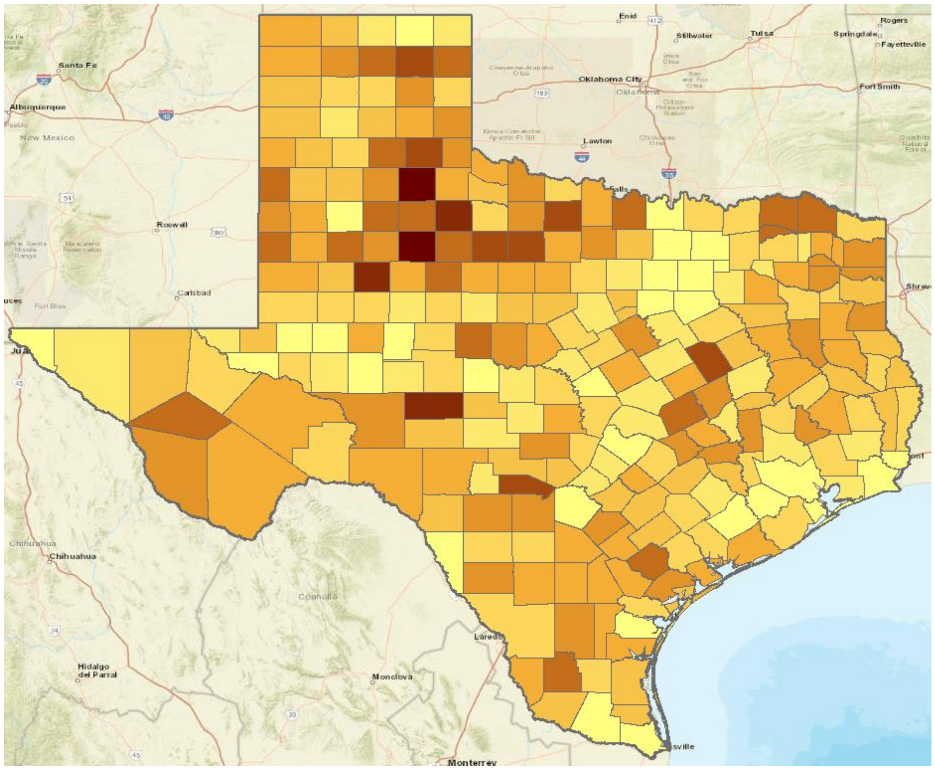


Figure 3.4 AVC per million VMT for each county in Texas, 2016

3.1.1. Crash Time of Day

As shown in Figures 3.5 and 3.6, AVCs peak twice a day: between 5:00 and 8:00 AM and from 6:00 PM to midnight, with heavy peaking at 6:00 or 6:30 AM and 8:00 or 9:00 PM. When the time of day is adjusted (Figure 3.5) for daylight savings time shifts, the evening peak consolidates further (vs. Figure 3.4's wide evening peak). Since travel or VMT demand does not peak at the same time of day (with morning peak usually between 7:00 to 10:00 AM and afternoon peak between 4:00 to 7:00 PM) or in quite the same way, AVC peaking implies that animal movement choices are key. In fact, many Texas mammals, including deer, rabbits, possum, and ocelots, are crepuscular species, meaning they are most active around dusk and dawn[6]. Roughly this time period falls within the hours of 5:00 to 7:00 AM and 7:00 to 9:00 PM, depending on the time of year. Similar temporal activity patterns have even been observed in stray dog populations (Beck, 2002). Such observances of animal activity can provide key insight into the peaks in crash activity seen in these figures. Generally, animal behavior is regulated by the sun's position, while human behavior is more frequently dictated by clock time (for work and school start and end times, for example), as well as day of week (with Friday and Saturday nights often involving late-night socializing and the associated return travel). Interestingly, domestic animals tend to experience more crashes earlier in the day than wild animals do (e.g., a 5:00 or 6:00 AM peak).

[6] Based on information obtained from austintexas.gov

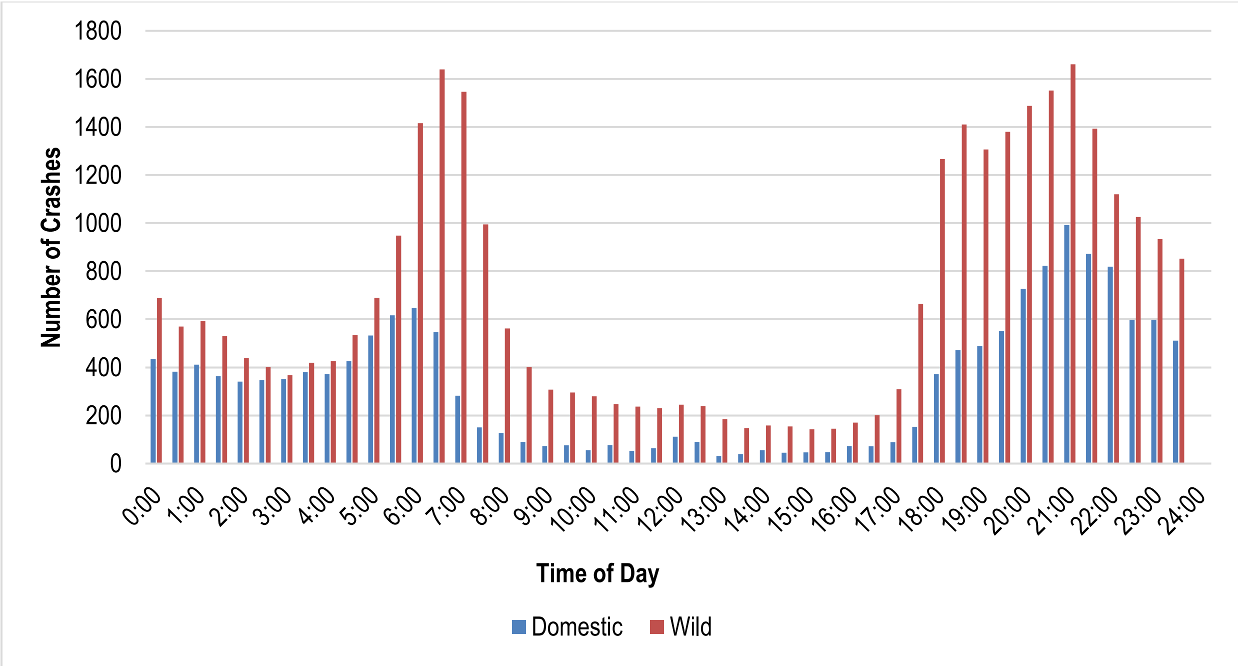


Figure 3.5 Crash Counts by Time of Day (Texas AVCs, 2010–2016)

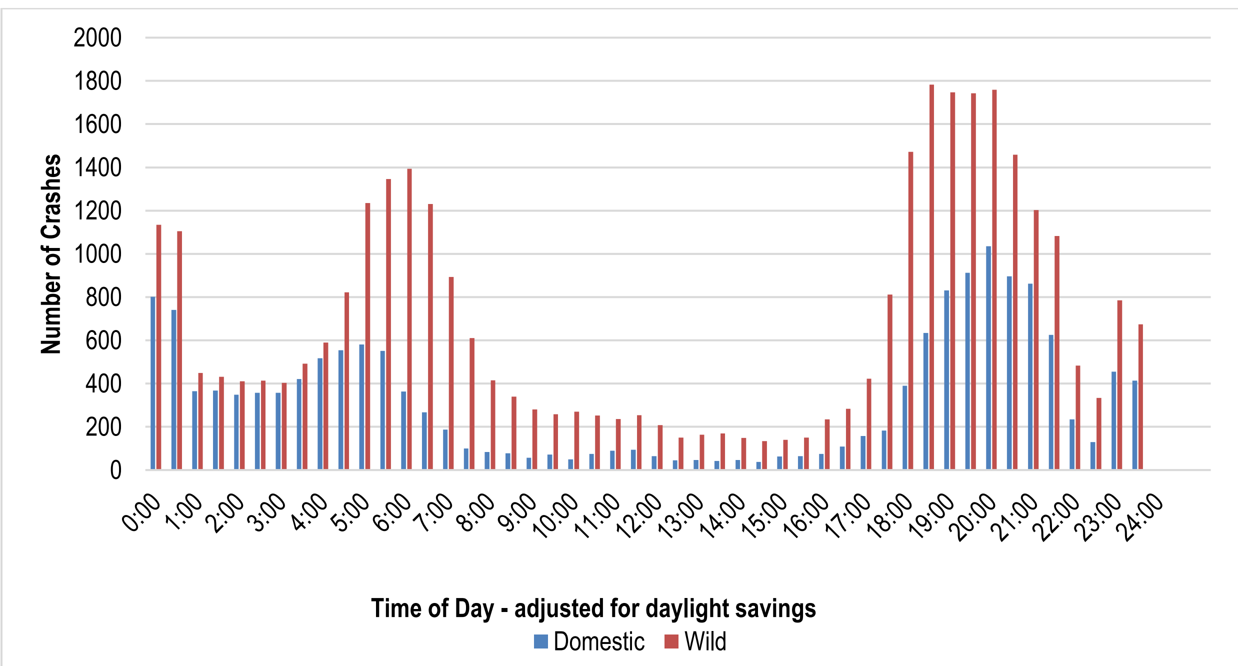


Figure 3.6 Crash Counts by Adjusted Time of Day (to Eliminate Daylight Savings Time Effects, Texas AVCs, 2010–2016)

3.1.2. Time of Year

State Farm indicates that drivers are more than twice as likely to have a collision with a deer, elk, or moose during the months of October, November, and December (State Farm, 2015). Texas AVC data delivers similar results, as shown in Figure 3.7.

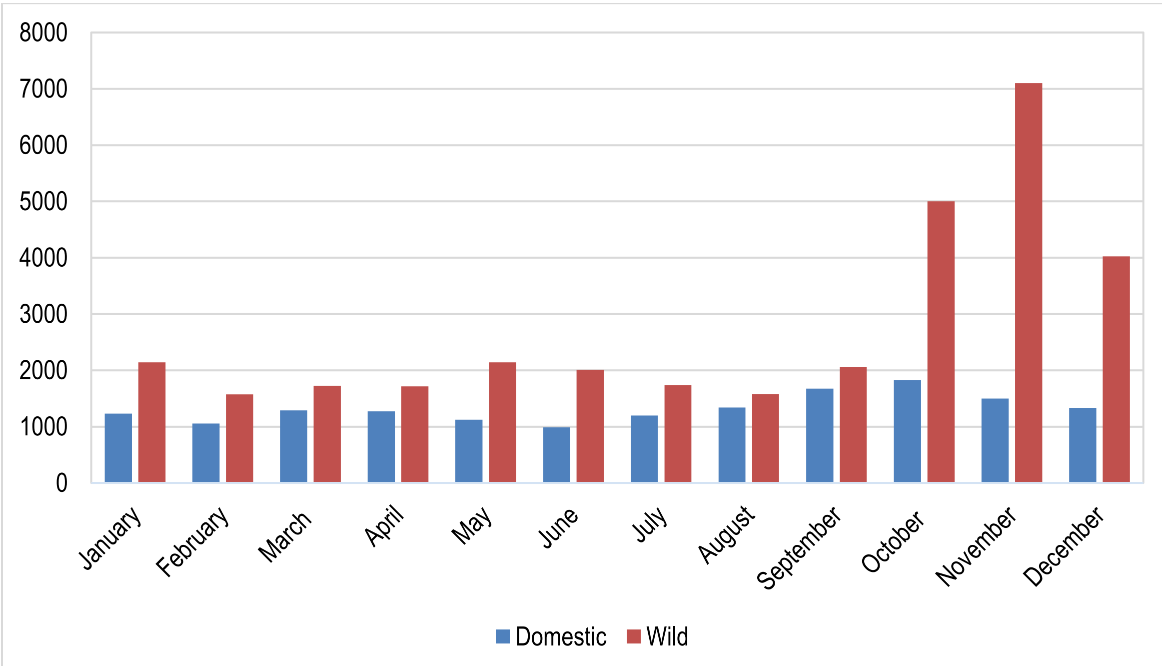


Figure 3.7 Crash Counts by Month of Year (Texas AVCs, 2010–2016)

3.1.3. Light Condition

Most AVCs occur at night in unlit locations. Unlike cars and trucks, which are equipped with headlights, animals running across the road are unlit. Crash frequency is also much higher in dark settings, as shown in Figure 3.8. Such settings can be especially problematic for smaller animals, such as turtles, armadillos, raccoons, possums, and the endangered Texas ocelot. It is difficult to know the rates of such incidents because crashes involving small animals are rarely detected by the involved motorists (unless they are riding a motorcycle, for example) and almost never reported. A Swedish research report notes how the higher collision risk for moose is “largely due to low light and poor road surface conditions rather than to more animal road-crossings” (Neumann et al., 2011).

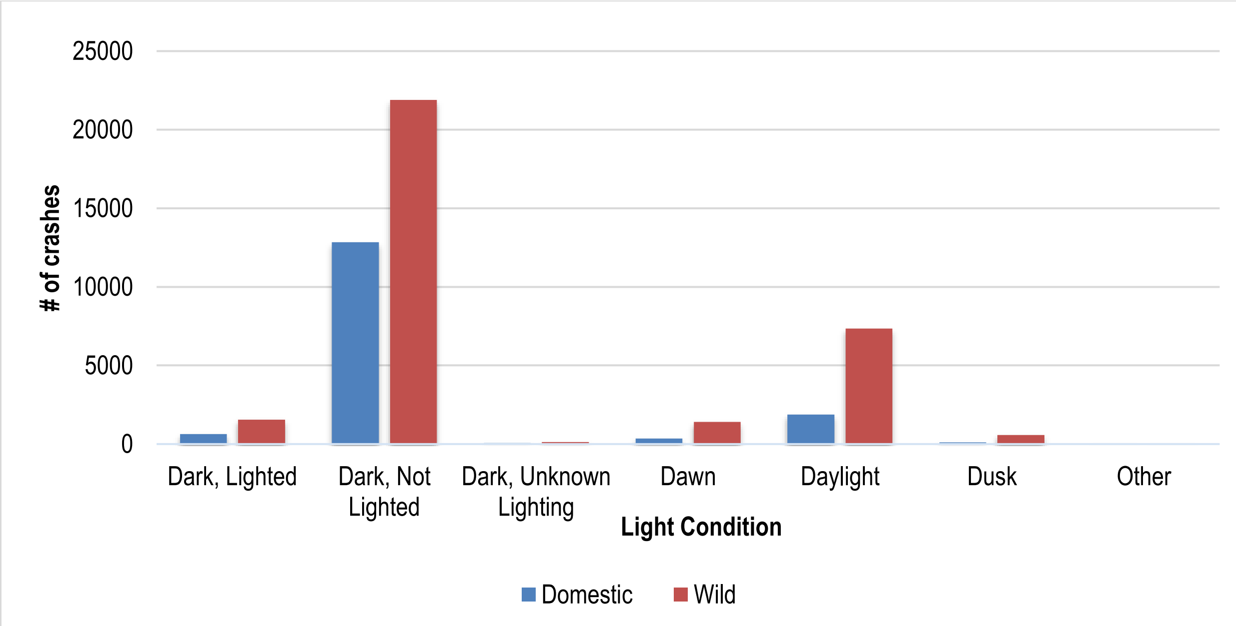


Figure 3.8 Number of Crashes by Light Condition (Texas AVCs, 2010–2016)

3.1.4. Vehicle Type

Based on observations from TxDOT's Crash Records Information System (CRIS) data shown in Figures 3.9 and 3.10, during the years 2010–2016 motorcycles comprised only 2.2–3.5% of total reported AVCs, yet accounted for at least half of all fatal or injurious crashes. These animal-motorcycle collisions are especially deadly, as the driver has no physical protection between himself and the animal. Compared to other vehicle types, motorcycles see a large spike in AVCs on Saturdays and Sundays, likely due to those using motorcycles as recreational vehicles on the weekends.

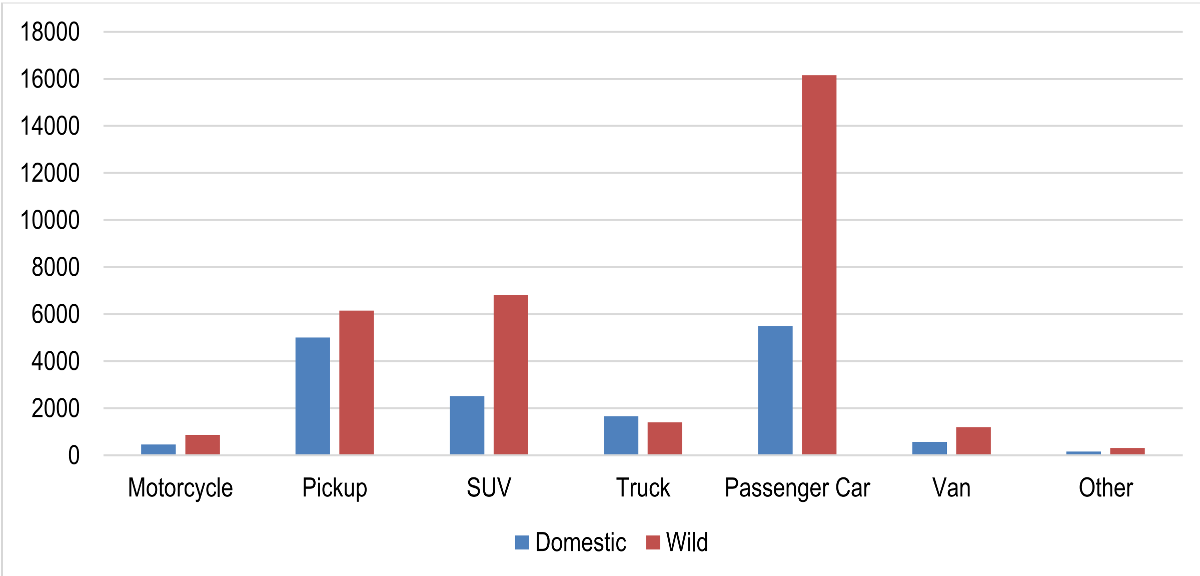


Figure 3.9 Number of Crashes by Vehicle Type (Texas AVCs, 2010–2016)

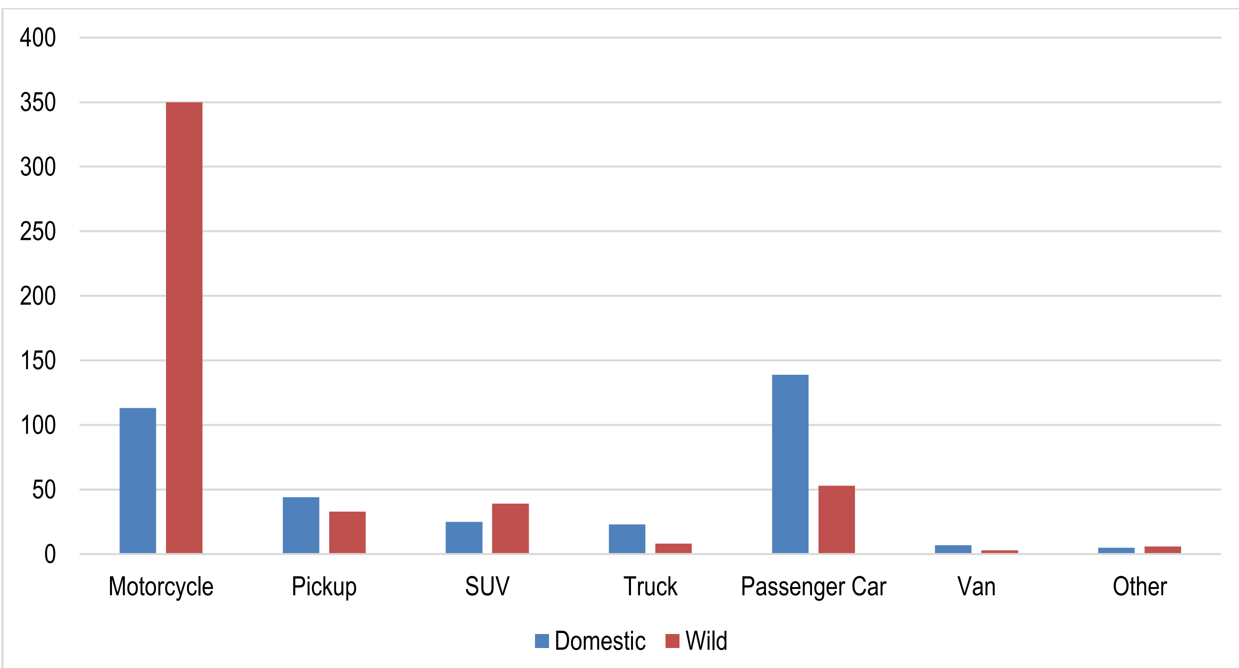


Figure 3.10 Number of Fatal or Injurious Crash Reports by Vehicle Type (Texas AVCs, 2010–2016)

3.1.5. Location and Density

Between 2010 and 2016, 51,522 collisions with wild animals were reported by Texas law enforcement, including 254 human fatalities, 6,914 human injuries, and thousands more animal deaths. Most of these crashes happened on rural roads with very low traffic and high speed limits, as demonstrated in Figures 3.11–3.13.

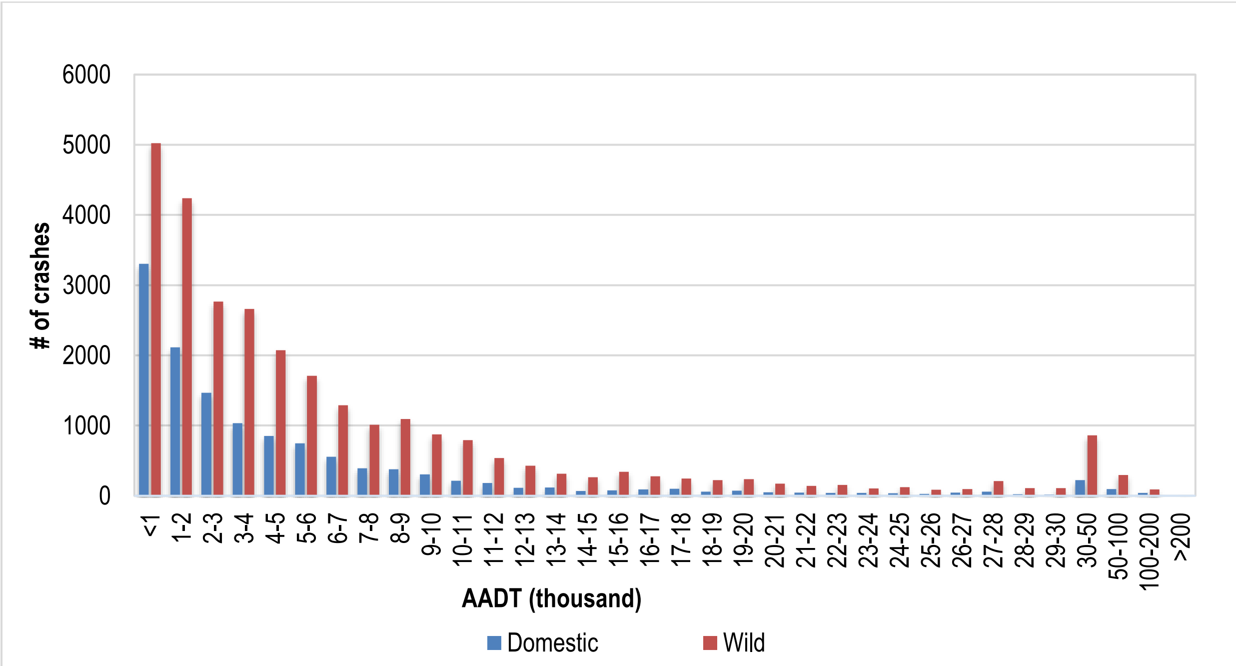


Figure 3.11 Crash Counts by Average Annual Daily Traffic (Texas AVCs, 2010–2016)

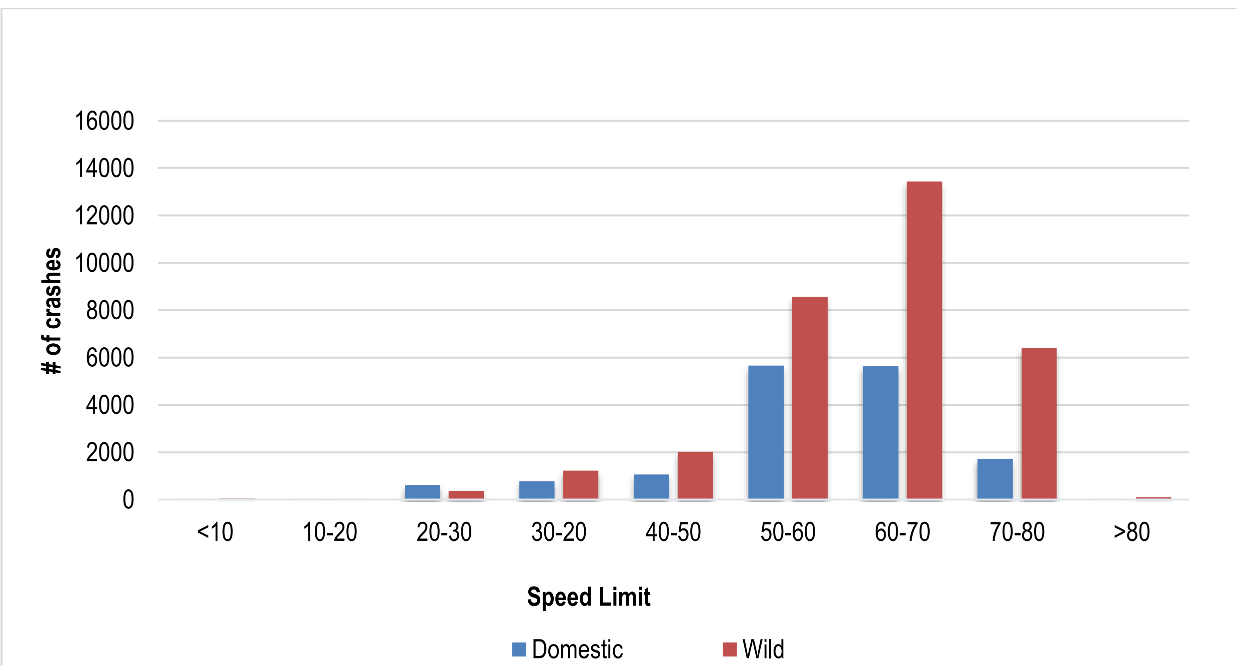


Figure 3.12 Crash Counts by Speed Limit (Texas AVCs 2010–2016)

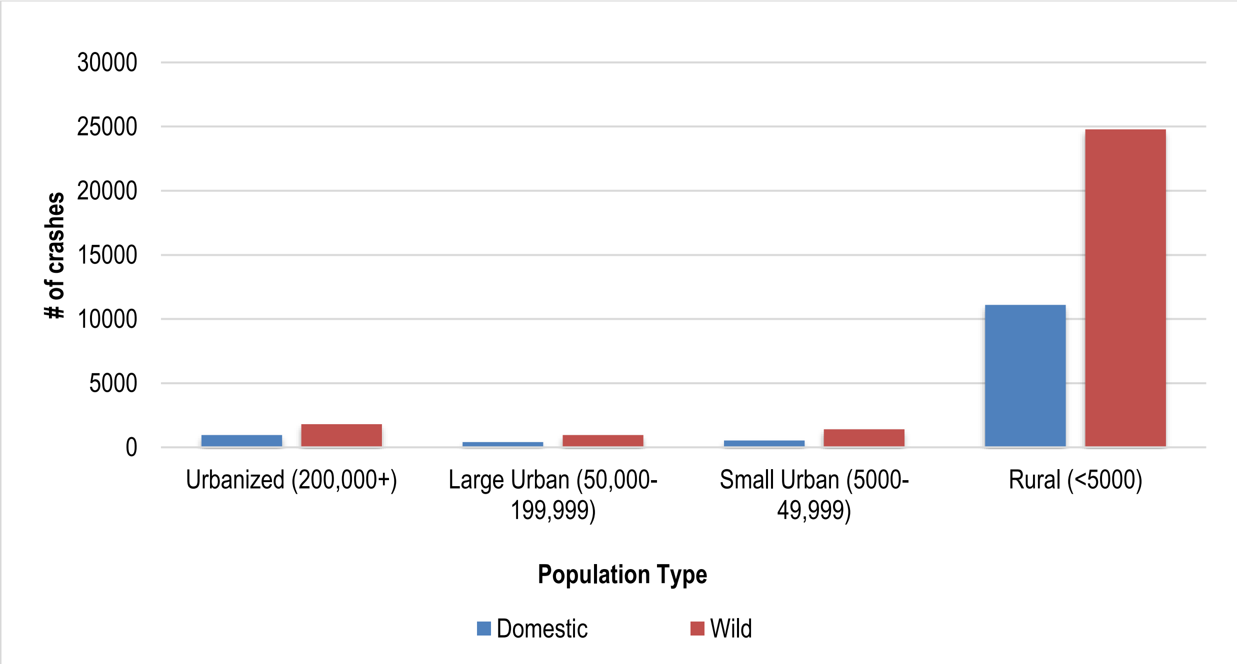


Figure 3.13 Number of Crashes by Land Use Type (Texas AVCs 2010–2016)

3.2. Hot Spot Analysis

Beyond identifying typical characteristics of AVCs, it is important to pinpoint where in the state they are occurring most frequently. Figure 3.2 depicts all of these such collisions, each displayed as a point on the map. However, such basic representations cannot give the best idea of true crash density, as the overlapping points make it hard to distinguish between areas of high and very high density.

It is possible to develop a generic heat map based on the respective concentrations of the data points shown in Figures 3.14 and 3.15. A bright yellow spot indicates a very dense collection of data points whereas a light blue area suggests that crashes are fewer and farther between. The heat maps for all AVCs indicated that the San Antonio metropolitan area had the most concentrated AVCs. This is consistent with a 2018 report by the National Insurance Crime Bureau, which stated that San Antonio and Austin are the top two cities for animal loss claims across the whole U.S. (NICB, 2018).

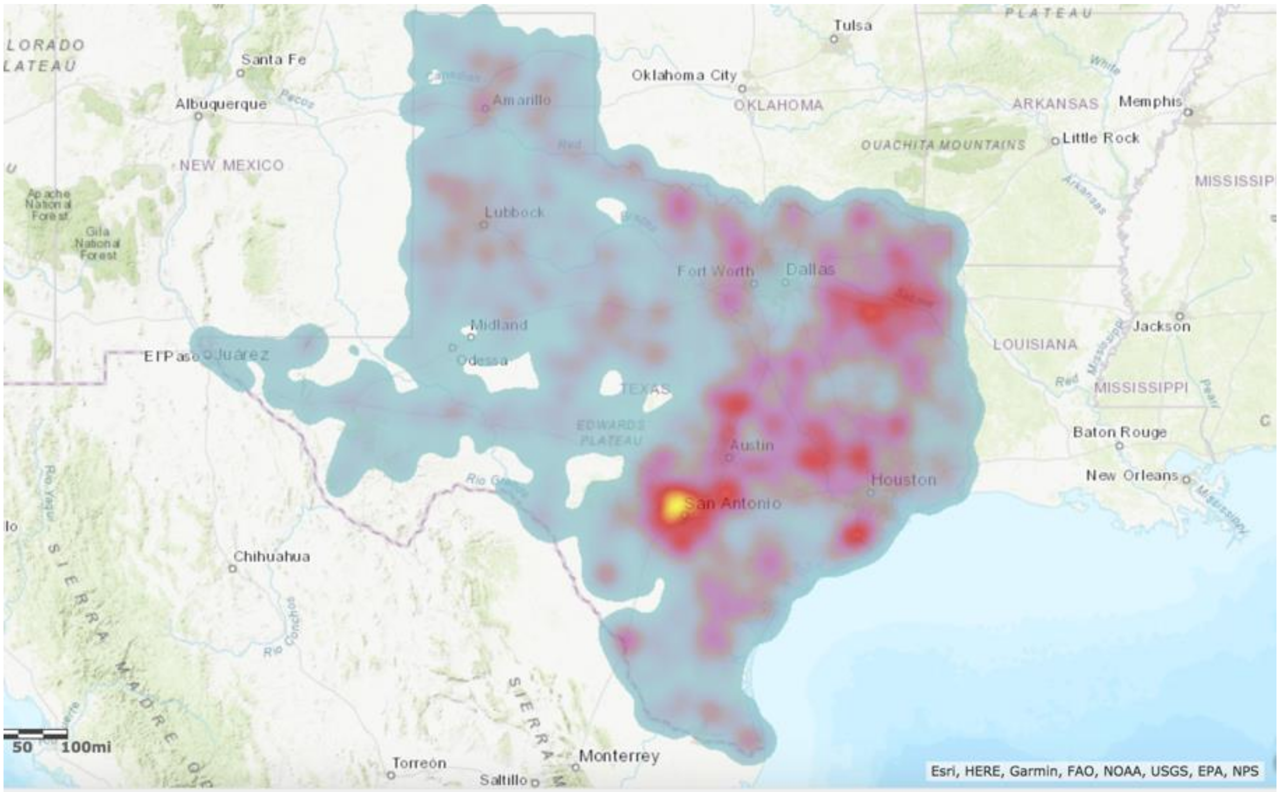


Figure 3.14 Crash Count Heat Map for Wild Animals (Texas AVCs, 2010–2016)

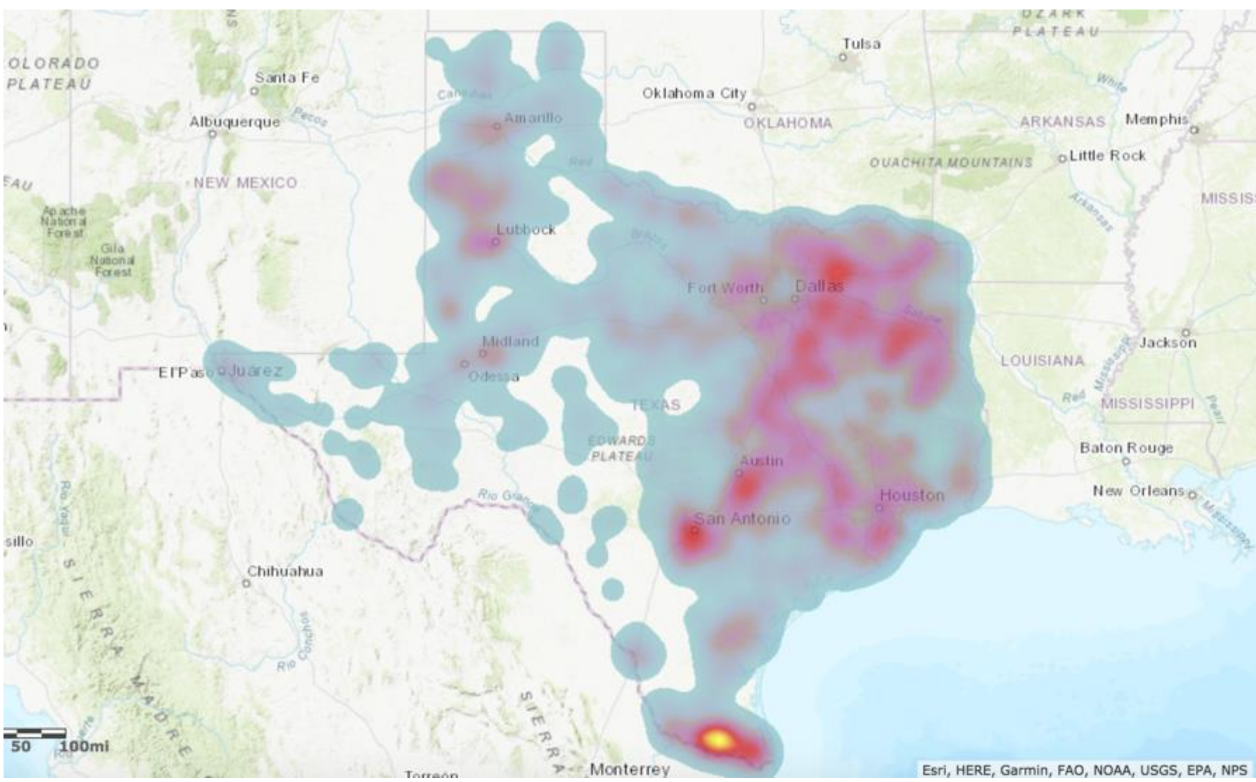


Figure 3.15 Crash Count Heat Map for Domestic Animals (Texas AVCs, 2010–2016)

Though collisions with domestic animals make up a smaller proportion of total reported crashes than collisions with wild animals and are researched less often, they are not to be discounted. Out of the 51,522 AVCs reported in the state of Texas between 2010 and 2016, 15,890 (31%) of these can be attributed to collisions with domestic animals and 32,920 (64%) with wild animals[7].

The heat maps developed in Figures 3.14 and 3.15 are very helpful in visualizing the density of crash occurrence. However, the results of such a process are dependent upon user-defined "class and cell ranges to set up the gradient," and therefore are highly subjective (Dempsey, 2014). Developing a hot-spot map, however, "uses statistical analysis in order to define areas of high occurrence versus areas of low occurrence" (Dempsey, 2014). Since the resulting areas are statistically significant, they are much less subjective.

Figures 3.16 and 3.17 were created in ESRI's ArcGIS software, using crash rates calculated by average Texas WVC for the years 2010–2016 and 2016 VMT data. Figure 3.16 shows the results of using the ArcGIS Optimized Hot Spot Analysis Tool for the entire state and Figure 3.17 displays the results for the San Antonio and Austin area. The software uses the Getis-Ord Gi* statistic to create a map of statistically significant hot spots or crash clusters. This tool offers a statistical enhancement of the heat maps shown in Figure 3.14 and 3.15, since specific road segments are identified (rather than broad regions).

[7] The rest 5% are not identified as wild or domestic in the CRIS system.

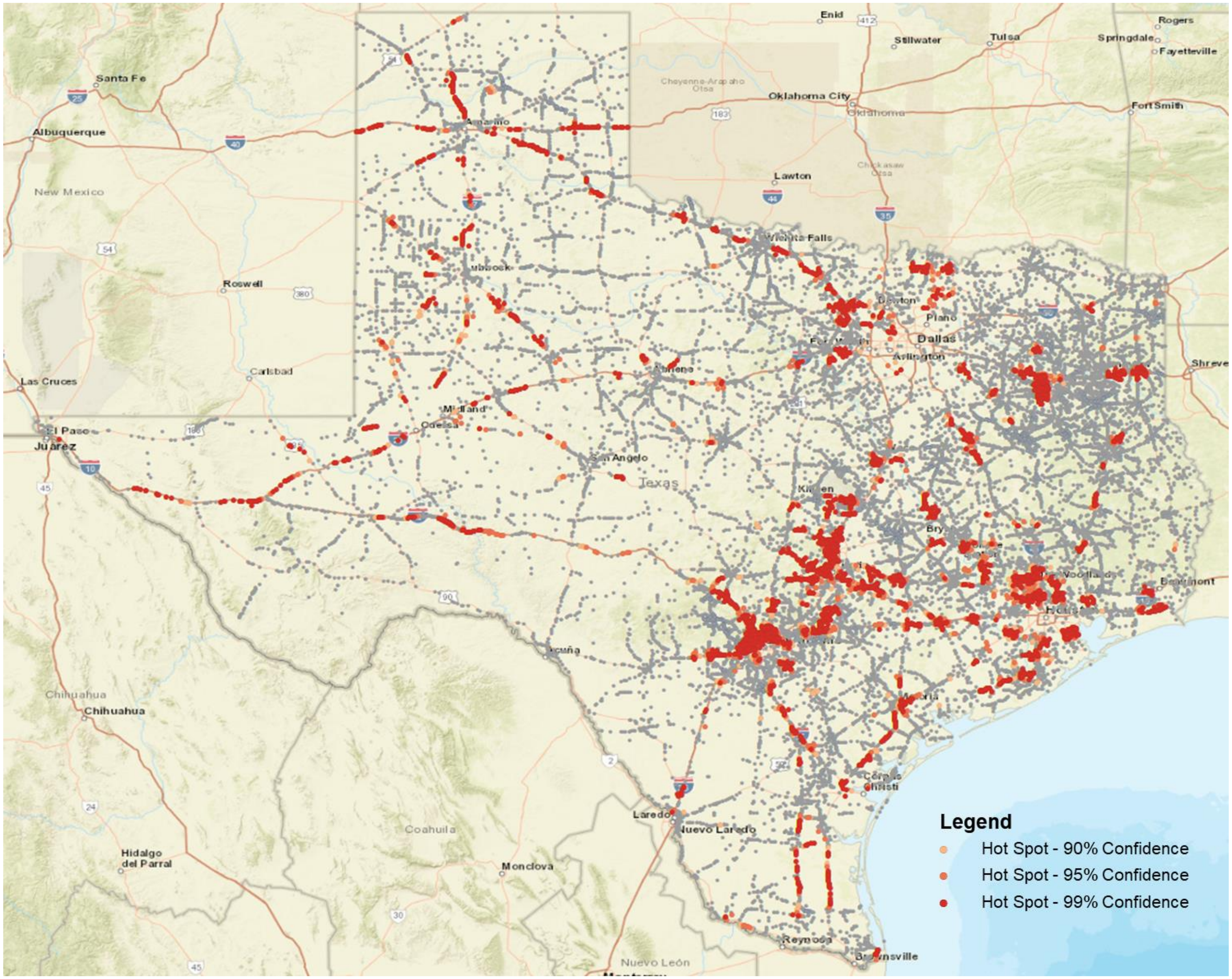


Figure 3.16 ArcGIS Optimized Hot Spot Analysis Results with Wildlife-Vehicle Crash Rate

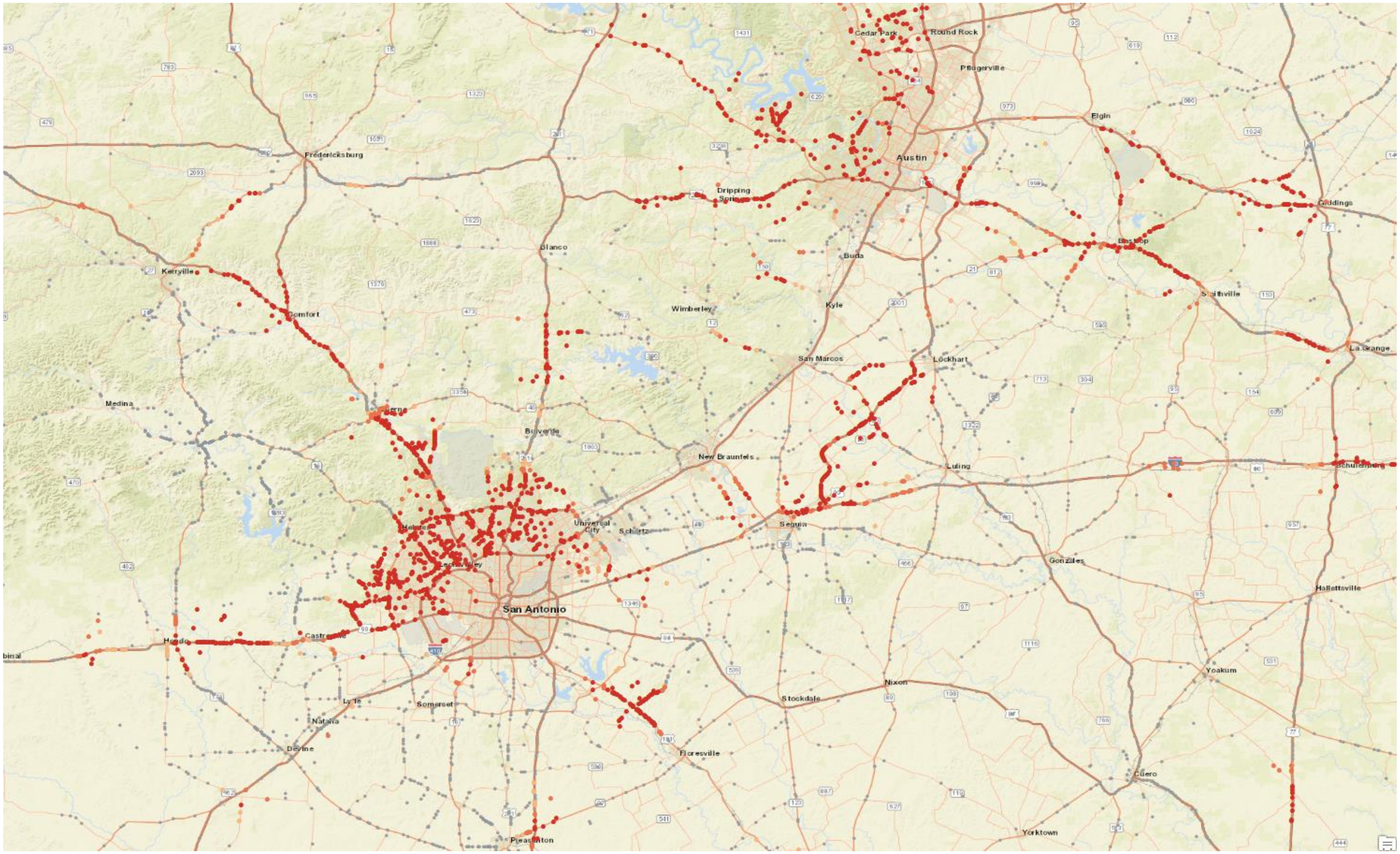


Figure 3.17 ArcGIS Optimized Hot Spot Analysis Results with Wildlife-Vehicle Crash Rate in the San Antonio and Austin Area

3.3. Regression Analysis

It may be helpful to determine not only the hot spots where collisions are currently a problem, but also identify a series of explanatory variables that can influence the development of future hot spots.

Using ordinary least-squares (OLS) regression across *n*=254 Texas counties, the following analysis highlights county attributes that are strong predictors of AVC crash rates (per VMT in each county). For further investigation, similar methods can be implemented at a link-based level, to identify problematic road segments.

Table 3.2 summarizes key statistics for the explanatory variables used in this analysis. Collision data were averaged over the 7-year data set (Texas AVCs 2010–2016 CRIS data). Table 3.3 provides the OLS regression results.

Table 3.2 Summary Statistics for Texas County Data

Variable	Description	Min	Max	Mean	SD
AVC/VMT	AVC per million annual VMT	1.17E-03	0.60	0.11	0.08
POP DENS	Population per square mile	2.6E-04	4.62	0.18	0.53
VMT/CAP	Average annual VMT per capita	498.53	312,372	18,948	33,402
VEH/CAP	Vehicles registered per capita	0.04	8.81	1.21	0.78
LANEMI/CAP	Lane-miles per capita	4.59E-03	2.10	0.19	0.27
RAINFALL	Average annual rainfall (in inches)	9.10	60.57	31.39	11.93
ON SYSTEM	% VMT occurring on TxDOT managed-roadways	34.60	180.66	88.96	12.61
RURAL POP	Proportion of population that lives in rural areas	0.00E+00	2.53	0.063	0.24
JOBS DENS	Employees per acre	0.0069	1.00	0.56	0.32

Table 3.3 OLS Regression Results for Y = AVC per Million-VMT Prediction

Explanatory Variable	Coef. Estimates	Std. Error	t Stat	p-value	Std. Coef.
Intercept	0.08	0.04	2.26	0.02	
POP DENS	-0.03	0.03	-0.91	0.36	**-0.18**
VMT/CAP	-1.1E-06	1.7E-07	-6.66	1.7E-10	**-0.45**
VEHICLES/CAP	-0.01	0.01	-1.40	0.16	**-0.08**
LANEMI/CAP	0.15	0.03	6.01	6.7E-09	**+0.48**
RAINFALL	4.0E-04	4.2E-04	0.95	0.34	**+0.06**
ON SYSTEM	-2.9E-04	3.9E-04	-0.75	0.45	**-0.04**
RURAL POP	0.09	0.02	4.60	6.8E-06	**+0.33**
JOBS DENS	0.01	0.07	0.16	0.87	**+0.03**

A standardized coefficient (STD COEF) is a valuable way to compare the predictive strength of different explanatory variables. This coefficient refers to how many standard deviations the dependent variable (AVC/VMT) will change following a one-standard-deviation increase in the associated explanatory variable.

When a county's rural population rises, or the number of lane-miles per capita rises, the AVC rate rises (per VMT), with everything else held constant. Conversely, some variables have the opposite effect, such as the percentage of VMT that occurs on-system. This table indicates that overall, the counties experiencing the greatest number of crashes have less VMT/capita and more lane miles per capita, and are less dense and more rural. Lane miles per capita are particularly concerning as wide-ranging animals will encounter many opportunities for road-crossings and subsequent collisions. This result supports preceding studies that showed that higher road density leads to increased wildlife mortality rates in a non-linear manner due to an enhanced risk of collisions (Frair et al. 2008 ref. in Neumann).

Chapter 4. Benefit-Cost Analysis of Wildlife Crossing Structures and Other Mitigation

While heat mapping and an OLS regression can alert certain districts to a potential issue or even show a fairly specific idea of where the problems are located, a more local method is required to identify specific problem areas on a roadway. In this report, benefit-cost ratios (BCRs) are calculated at the link-based level for four kinds of potential mitigation to accomplish this identification as well as to quantify which of these problem areas could benefit the most from mitigation.

4.1. Wildlife Crossings

A wildlife crossing structure refers to either a bridge or culvert constructed over or under a road, respectively, to allow for the safe crossing and promote habitat connectivity of wildlife species. At 2 to 10% of total roadway project construction costs, the cost of implementing wildlife crossings is relatively low when compared to the costs absorbed by DOTs and the public for retrofitting facilities, fixing/replacing damaged vehicles, and health care.

4.1.1. Culverts

A study in Utah (Cramer, 2013) regarding mule deer populations has indicated that culverts that are wider, higher, and shorter in length have the most success in providing safe passage for animals. Specifically, it was recommended that culverts be kept shorter than 120’ in length.

4.1.2. Bridges

A study in Utah found that wildlife crossing bridge designs reduced AVC counts by 89 to 98%, though bridges do come with a high initial cost. It is much more economically viable to include these in initial constructions than it is to retrofit. For example, a project in Montana responsible for building more than 40 wildlife crossings in the reconstruction of a 56-mile segment of US 93 added only $9 million to the $133 million project (Jones et al., 2013).

4.1.3. Fencing

Fencing alone can significantly decrease the number of animals accessing a roadway but can also have adverse consequences, such as the disruption of habitat connectivity. Some faults in the efficacy of fencing often can come from the cattle guards implemented at the fence’s required breaking points (Cramer and Flower, 2017). Wildlife fencing may perform at its best when used in combination with other kinds of mitigation; several studies indicate that the presence of wildlife exclusion fencing enhances the effectiveness of crossing structures (Cramer, 2013). Wildlife exclusion fencing in combination with crossing structures is widely regarded to be the most effective crash mitigation measure.

4.1.4. Animal Detection Systems

Animal detection systems consist of a group of sensors that are able to detect large animals on the road and subsequently activate dynamic warning signs that urge drivers to be alert and reduce their speed (Huijser et al., 2009). While annual maintenance costs for these systems are high and their lifespans are short, their initial costs are relatively low when compared to other strategies with a similar success rate.

There are many more possible mitigation strategies for AVCs but research is often inadequate to obtain reliable quantitative results, so the strategies assessed in this report are the most well-tested. Only obvious monetary benefits and cost values were included. However, it is also important to acknowledge the many costs and benefits that are consequences of AVCs that cannot be easily quantified. Such costs include but are not limited to disruption of habitat continuity, time lost to work, traffic congestion and disruptions, and impacts on public perception.

The benefit-cost analysis of AVC collisions was performed separately for *each link* in the Texas roadway network to determine the extent to which 640,123 individual sections of roadway could benefit from AVC mitigation. These segments were determined by TxDOT in the 2016 Roadway Inventory Data[8]. This inventory was utilized for the shape of this network as well as attributes of each link including length, speed limit and number of lanes.

These BCRs reflect lifetime benefits for a structure divided by the lifetime cost for that structure over a 20-year period.

Whereas much of this report includes both wild and domestic AVC data, the benefit-cost analysis utilizes only the 31,677 WVC as that is what the mitigation structures are intended to target. Further, that figure also does not include the few collisions which were classified as ‘wild’ in CRIS data but lacked latitude and longitude.

As shown in Figure 4.1, most of the 640,123 network segments (including both on-system and off-system links) are under 0.5 miles in length. In fact, the average segment length is 0.49 miles, while the standard deviation is 0.90 miles.

[8] https://www.txdot.gov/inside-txdot/division/transportation-planning/roadway-inventory.html

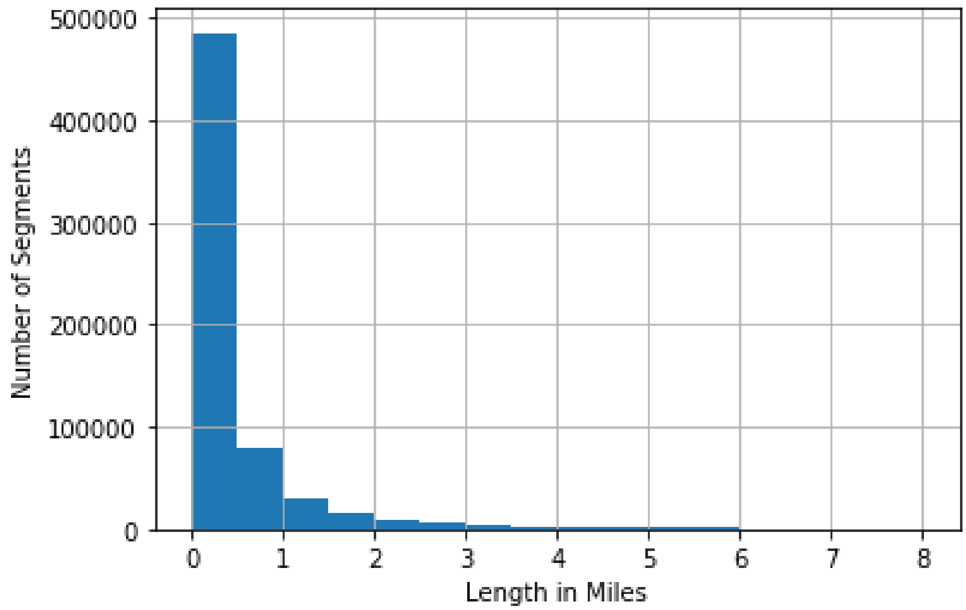


Figure 4.1 Histogram of Texas Network Segment Lengths

4.2. CRIS Crash Records Data

In all, 31,677 total AVCs in the CRIS 2010–2016 data set were mapped by latitude and longitude and overlaid with TxDOT's 2016 Roadway Inventory Routed Network. Each collision data point was matched to its closest link to ultimately obtain total collision counts for each of the 640,123 links in the network, sorted into six categories as defined by the CRIS reports: Killed (K), Incapacitating Injury (A), Non-Incapacitating Injury (B), Possible Injury (C), No Injury (O), and Unknown (Table 4.1).

Table 4.1 Relative Percentages of Crash Types in CRIS AVC Data

Type of Crash	# of Crashes	% of Total AVC
K	60	0.19 %
A	407	1.28%
B	1276	4.03%
C	1491	4.71%
O	28317	89.39%
Unknown	126	0.40%
TOTAL	31,677	

4.3. BCR Formula and Discount Rate

The following formula was used to calculate the BCR:

$$BCR = \frac{\sum_{i=0}^{i=n}\left(\frac{B_{ij}}{(1+\mathrm{d})^{i}}\right)}{\sum_{i=0}^{i=n}\left(\frac{C_{ij}}{(1+\mathrm{d})^{i}}\right)}$$

where B_{ij} represents the benefits of the project in year *i* for mitigation strategy *j* and is calculated for each network link as follows:

$$B_{ij} = \frac{\left[\sum_{k=KA}^{k=O}(N_{ik} * C_k)\right] * (E_j)}{7}$$

where N_{ik} is the number of collisions of type *k* in year *i*, C_k is the average cost for collision type *k* (as detailed in Table 4.3), and E_j represents the effectiveness of mitigation strategy j. Additionally, the term C_{ij}, or the costs of the project in year *i* for mitigation strategy *j*, is equal to the initial cost of the structure for year *i*=0, and is equal to the annual maintenance cost for all consecutive years *i*=1 through *i*=*n*. Finally, *d* represents the discount rate, to bring all future crash costs and treatment maintenance costs into present dollars.

Estimation of C_{ij} consists of imposing a baseline cost for shorter segments by assuming 1-mile and 2-mile fencing minima, on both sides of the highway, for animal-crossing underpasses and overpasses, respectively. The assumed treatment costs rises linearly with segment length for those segments greater than 1 mile in length. This approach may favor longer segments.

The following BCR results assume a discount rate of 7%, which is the same rate used by the Army Corps of Engineers for BCRs, as established by the Office of Management and Budget (OMB) Circular A-94, "the 7% rate is intended to reflect the pretax rate of return on capital in the private sector" (Economagic.com, 2015).

4.4. Costs Estimation

4.4.1. Initial Construction and Annual Maintenance Costs

The costs of wildlife crossing structures are highly dependent on the specifications of the structure and the local environmental conditions. The study team used the initial costs and annual maintenance costs of different types of mitigation structures from past projects across the United States for demonstrating the procedure of conducting benefit-cost analysis (Table 4.2).

Four design treatments were identified as both effective and well-tested in the literature and in practice. These are fencing with double cattle guards, fencing in combination with overpass structures, fencing in combination with underpass structures, and animal detection systems. Their assumed costs and effectiveness are shown in Tables 4.2 and 4.4, respectively. Note that in Table

4.2, the fencing costs are listed as a separate item, but fences are always implemented on overpasses or underpasses designed for wildlife mitigation.

Table 4.2 Initial Cost of Mitigation Strategies

Wildlife Items	Initial Cost (USD$ 2015)	Annual Cost (USD$ 2015)	Units	Source and Year
Overpass	$2,059,210	$3,363	Each	CDOT project STA 009A-034, 2016
Underpass	$1,569,271	$3,363	Each	CDOT project STA 009A-034, 2016
Deer Fence	$153,785	$1,657	Miles	CDOT project STA 009A-034, Huijser et al., 2009
Double Cattle Guard[9]	$45,000	0	Each	Cramer and Flower, 2017
Animal Detection System	$135,000	$17,800	Miles	Huijser et al., 2006

4.4.2. Collision Costs

Crash costs used here for benefit-cost analysis are based on FHWA's 2018 Crash Costs for Highway Safety Analysis report. Due to the very rare nature of fatal (K-type) collisions, K and A (incapacitating injury crashes) counts were summed into one category, with one average cost (Table 4.3).

Table 4.3 FHWA-based Crash Costs

Severity	Comprehensive Crash Unit Cost (2016 Dollars)
K + A (Fatal and Serious injury)	$2,244,210[10]
B (Non-incapacitating injury)	$198,500
C (Possible injury)	$125,600
O (Property damage only)	$11,900

[9] Little information is available regarding the costs of installing such a design. The initial cost of $45,000 was inferred as an average of the $30,000–$60,000 estimate provided in Cramer & Flower (2017). A maintenance cost of $0 was inferred from the following reference to the same report: "double cattle guards and wildlife guards require minimal post-installation maintenance."

[10] K+A cost is a crash-weighted average of the K and A costs ($11,295,400 & $655,000) separately.

This analysis assumes that an AVC always resulted in the eventual death of the animal, so the value of the animal's life was added to each type of collision cost. Because the data also lacks specificity as to which animal caused the collision, the value used was $4,990—the value assigned to deer by the Nevada Department of Transportation (Stewart, 2015). To account for the gap between reported and actual collisions, additional factors were added when calculating total collision costs per link. First, all costs attributed to O-type crashes were multiplied by a factor of 2, since property-damage-only crashes often go unreported (Munro, 2011). Secondly, the cost attributed to species value was multiplied by factor of 8.5, as it is reported that 8.5 carcasses are counted on the road for each collision reported (Donaldson, 2018).

4.5. Treatment Effectiveness

The treatment effectiveness assumptions are also based on the information found in the literature regarding the percent of crash count reductions from past projects (Table 4.4).

Table 4.4 Assumed Effectiveness Rates of Intervention Options

Mitigation Strategy	Crash Count Reduction	Additional Notes	Source	Location	Species
Overpass + Fencing	90%		Stewart, 2015	Nevada	
Underpass + Fencing	70%		Cramer, 2014; Olsson et al.	Utah	Mule Deer
Animal Detection Systems	80%	1 mile hypothetical segment was used to determine effectiveness	Huijser et. al., 2006	Arizona	Deer
Fencing + Double Cattle Guards	94%	Eliminates habitat connectivity	Cramer and Flower, 2017	Utah	Mule Deer

4.6. Model Results

4.6.1. Overpass Structure with Wildlife Fencing

When assessing the possibility of implementing an overpass structure, this report assumes a frequency of one structure every two miles. Figures 4.2–4.6 reflect characteristics of the 100 network links that returned the highest BCRs from the analysis. The figures reflect the analysis conducted with the crash costs established by the FHWA, as they account for lower-level crash types and yield more diverse results.

The average number of crashes per segment was 0.15 K-level crashes, 0.88 A-level crashes, 0.14 B-level crashes, .05 C-level crashes and 1.85 O-level crashes. The average length of the section was 1.15 miles with a standard deviation of 0.54 miles. The BCRs of these top 100 segments ranged from 1.32 to 2.82 and were located in the areas highlighted in red in Figure 4.2.

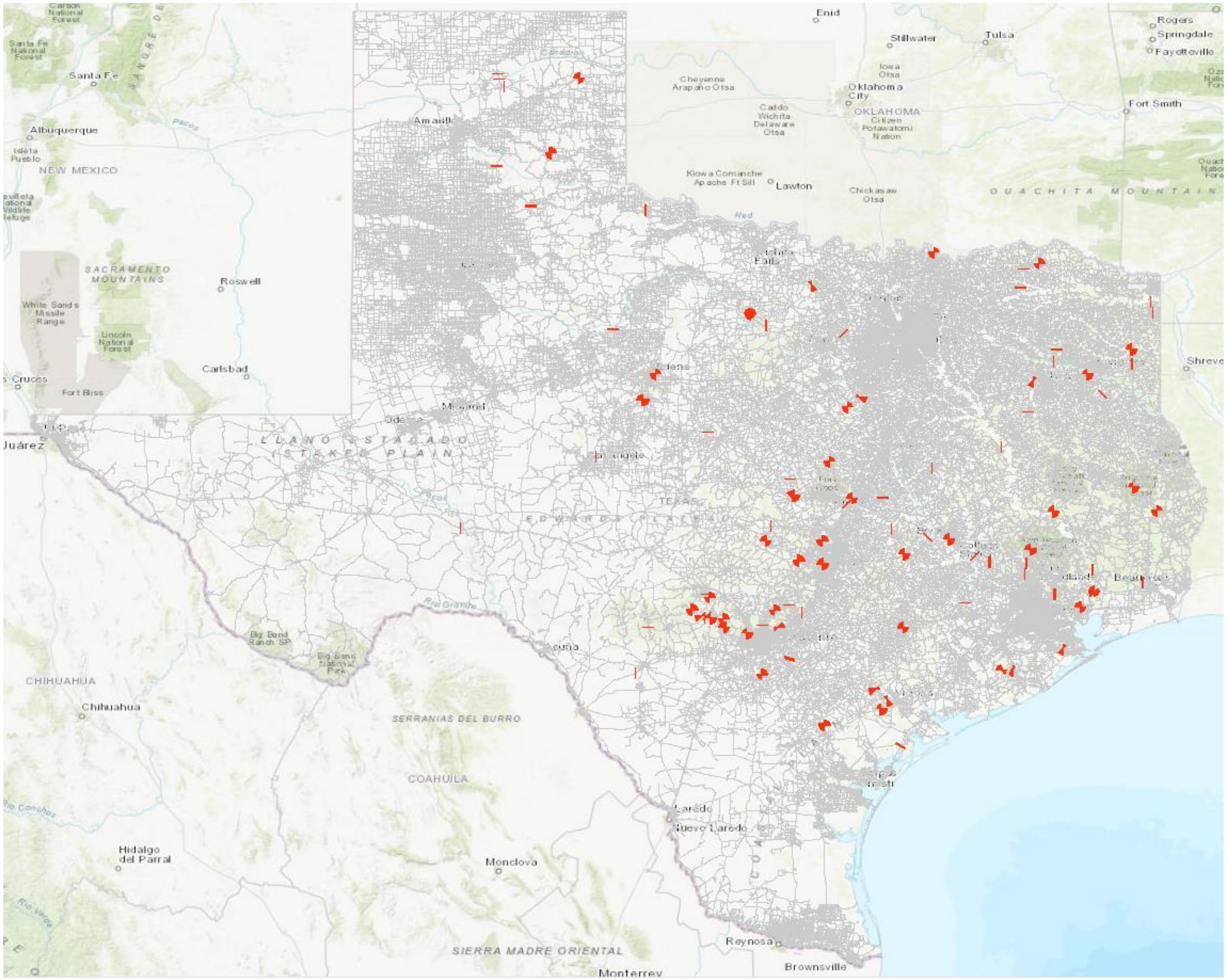


Figure 4.2 Positions in the Texas Roadway Network That May Benefit Most from Intervention in the Form of an Overpass Structure

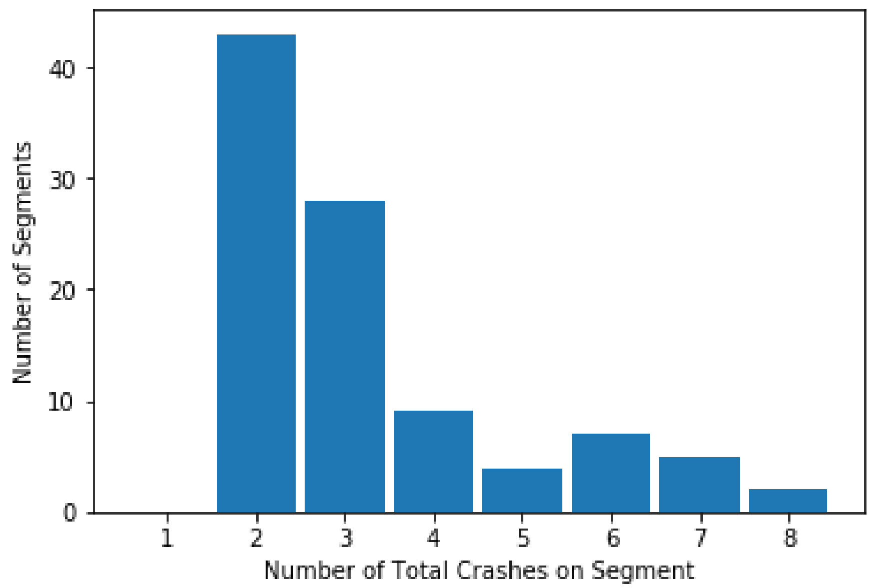


Figure 4.3 Number of Total Crashes across the 100 Segments That May Benefit Most from Intervention in the Form of an Overpass Structure

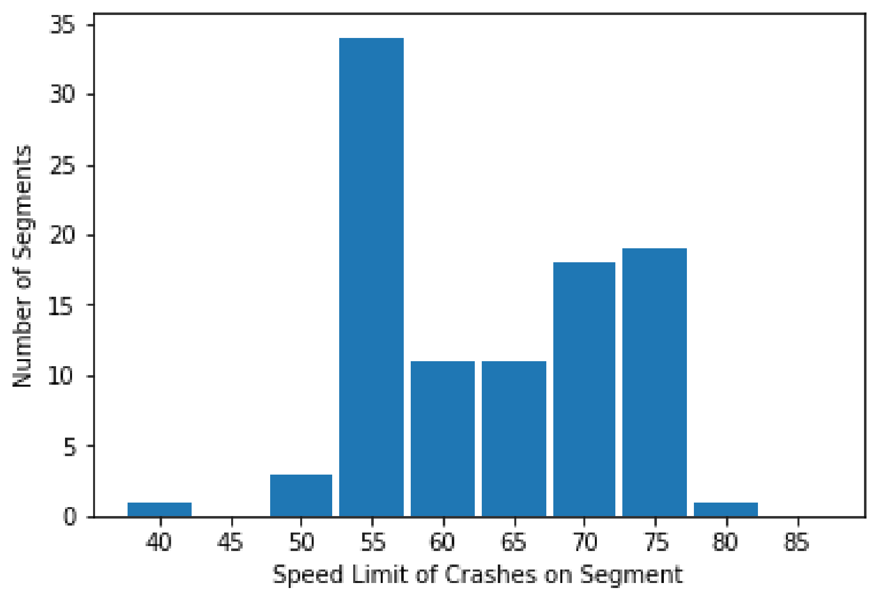


Figure 4.4 Speed Limit across the 100 Segments That May Benefit Most from Intervention in the Form of an Overpass Structure

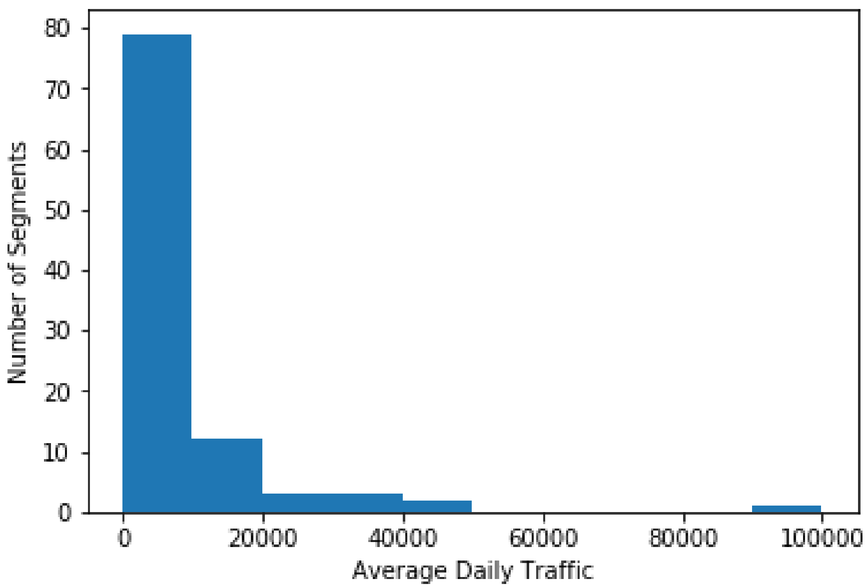


Figure 4.5 ADT across the 100 Segments That May Benefit Most from Intervention in the Form of an Overpass Structure

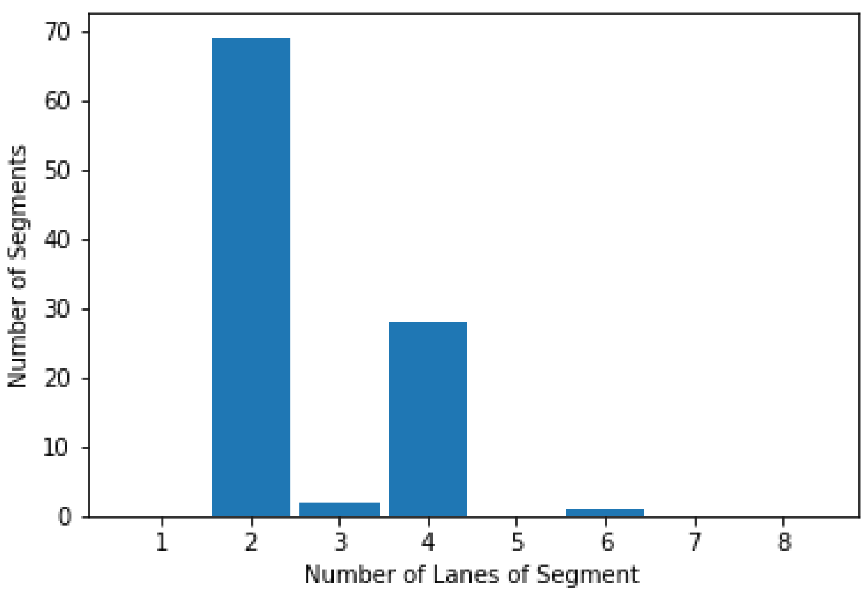


Figure 4.6 Number of Lanes across the 100 Segments That May Benefit Most from Intervention in the Form of an Overpass Structure

4.6.2. Underpass Structure with Wildlife Fencing

When assessing the possibility of implementing an underpass structure, this report assumes the placement of one structure every mile. The figures and statistics in Figures 4.7 through 4.11 reflect characteristics of the 100 network links that returned the highest BCRs from the analysis. The figures reflect the analysis conducted with the crash costs established by the FHWA, as they account for lower-level crash types and yield more diverse results.

The average number of crashes per segment was 0.07 K-level crashes, 0.98 A-level crashes, 0.14 B-level crashes, 0.058 C-level crashes, and 1.46 O-level crashes. The average length of the section was 1.43 miles with a standard deviation of 0.42 miles. The BCRs of these top 100 segments ranged from 1.46 to 2.97 and were located in the areas highlighted in red in Figure 4.7.

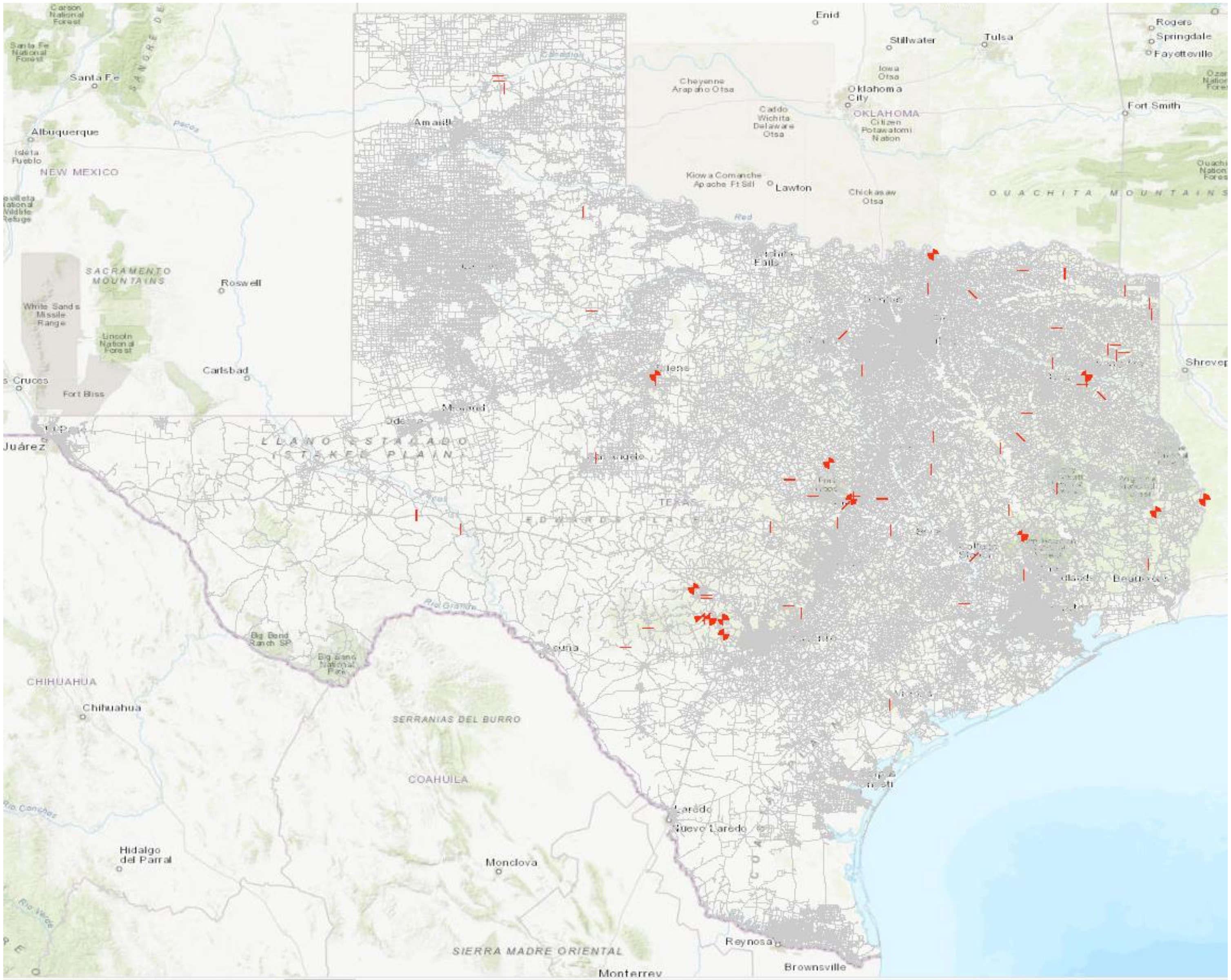


Figure 4.7 Positions in the Texas Roadway Network That May Benefit Most from Intervention in the Form of an Underpass Structure

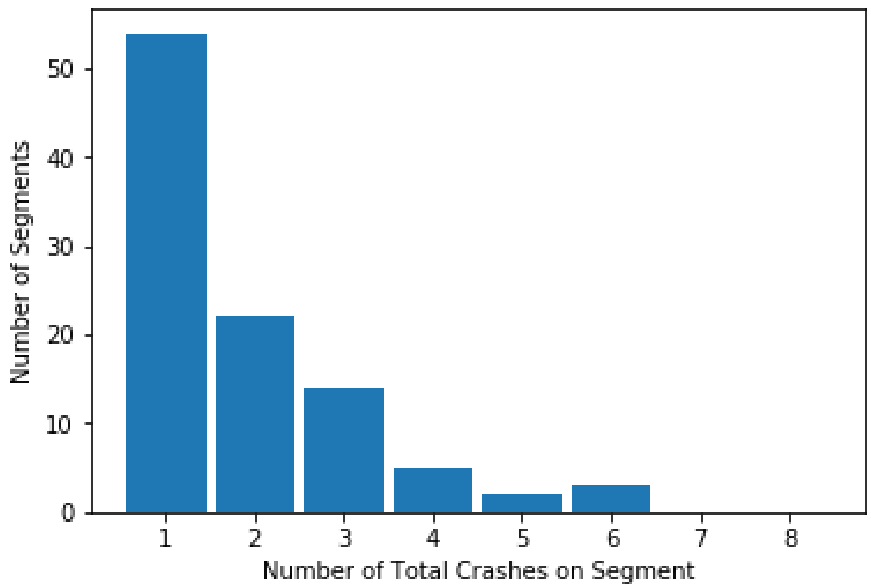


Figure 4.8 Number of Total Crashes across the 100 Segments That May Benefit Most from Intervention in the Form of an Underpass Structure

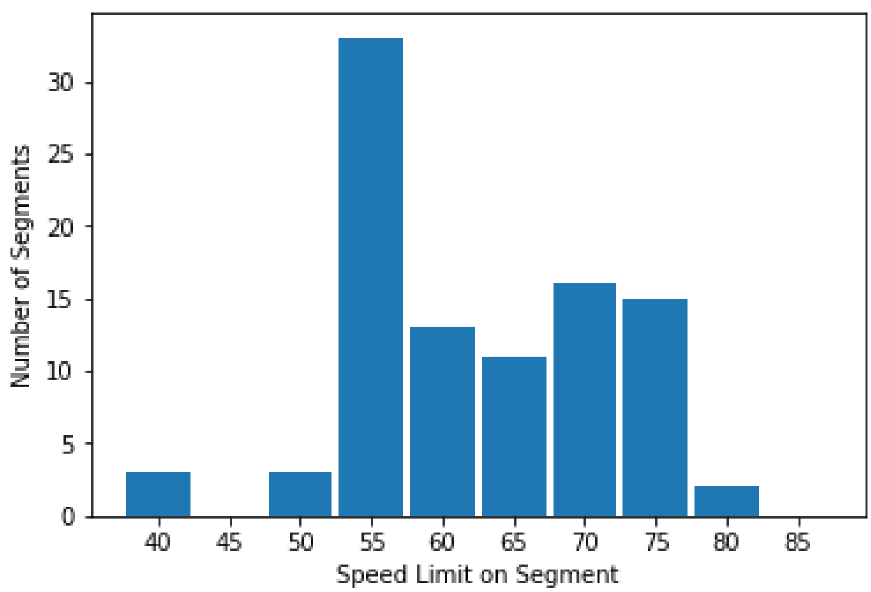


Figure 4.9 Number of Total Crashes across the 100 Segments That May Benefit Most from Intervention in the Form of an Underpass Structure

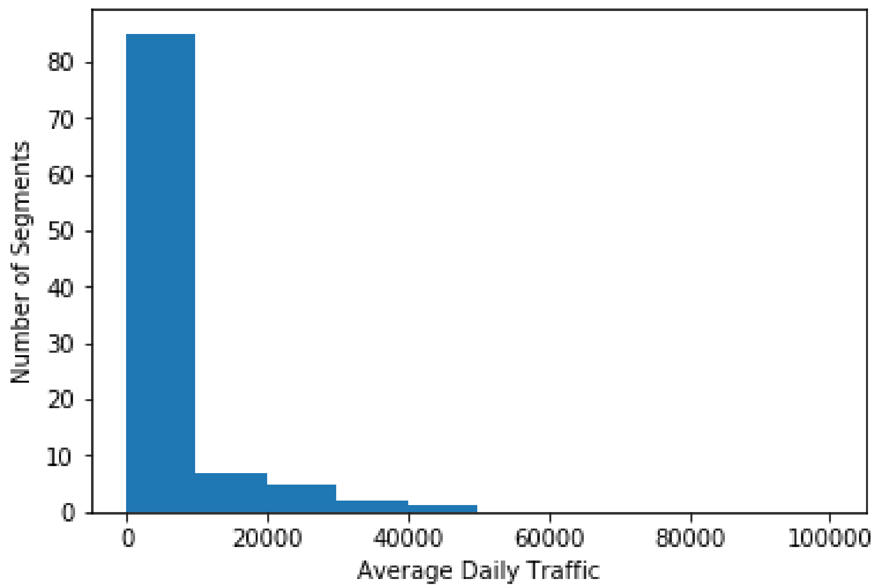


Figure 4.10 Number of Total Crashes across the 100 Segments That May Benefit Most from Intervention in the Form of an Underpass Structure

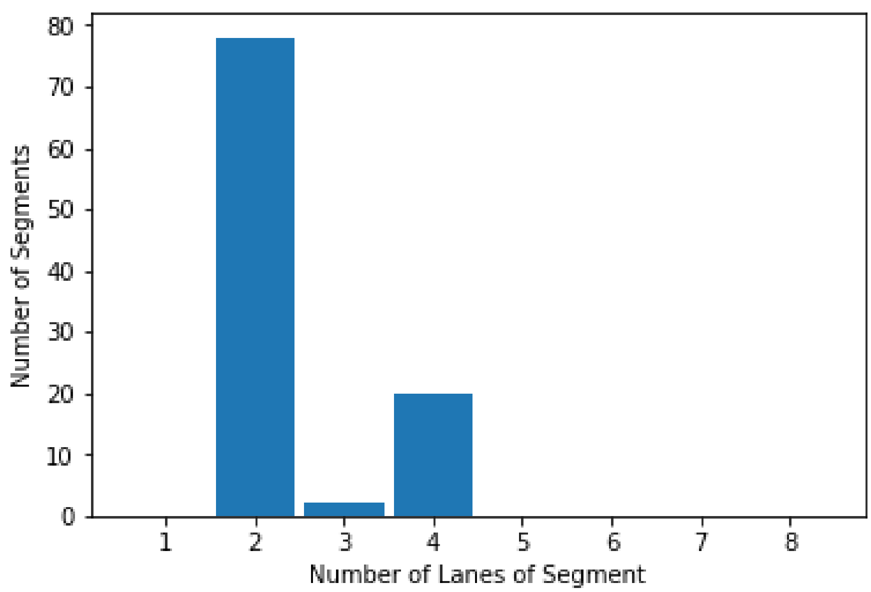


Figure 4.11 Number of Total Crashes across the 100 Segments That May Benefit Most from Intervention in the Form of an Underpass Structure

4.6.3. Fencing with Cattle Guards & Animal Detection Systems

Due to their similar costs, cattle guards and animal detection systems provided near-identical results in the benefit-cost analysis, with the exception of the scale of the BCRs. While this would seem to suggest an advantage for the fencing option, it is critical to be aware of the loss of species' habitat connectivity that comes with the implementation of a total barrier of fencing.

For the purpose of avoiding very large ratios for very short segments, a minimum of 1 mile of treatment was assumed, with costs scaling upward for segments longer than 1 mile. Figures 4.12–4.16 reflect characteristics of the 100 network links that returned the highest BCRs from the analysis. The figures reflect the analysis conducted with the crash costs established by the FHWA, as they account for lower-level crash types and yield more diverse results.

The average number of crashes per segment was 0.21 K-level crashes, 0.82 A-level crashes, 0.06 B-level crashes, 0.02 C-level crashes, and 0.73 O-level crashes. The average length of the section was .54 miles with a standard deviation of 0.30 miles. For the animal detection system, the BCRs of these top 100 segments ranged from 7.16 to 14.55 and were located in the areas highlighted in blue in Figure 4.12. Those same segments, for the strategy of animal fencing in combination with cattle guards, have BCR values ranging from 14.59 to 29.65.

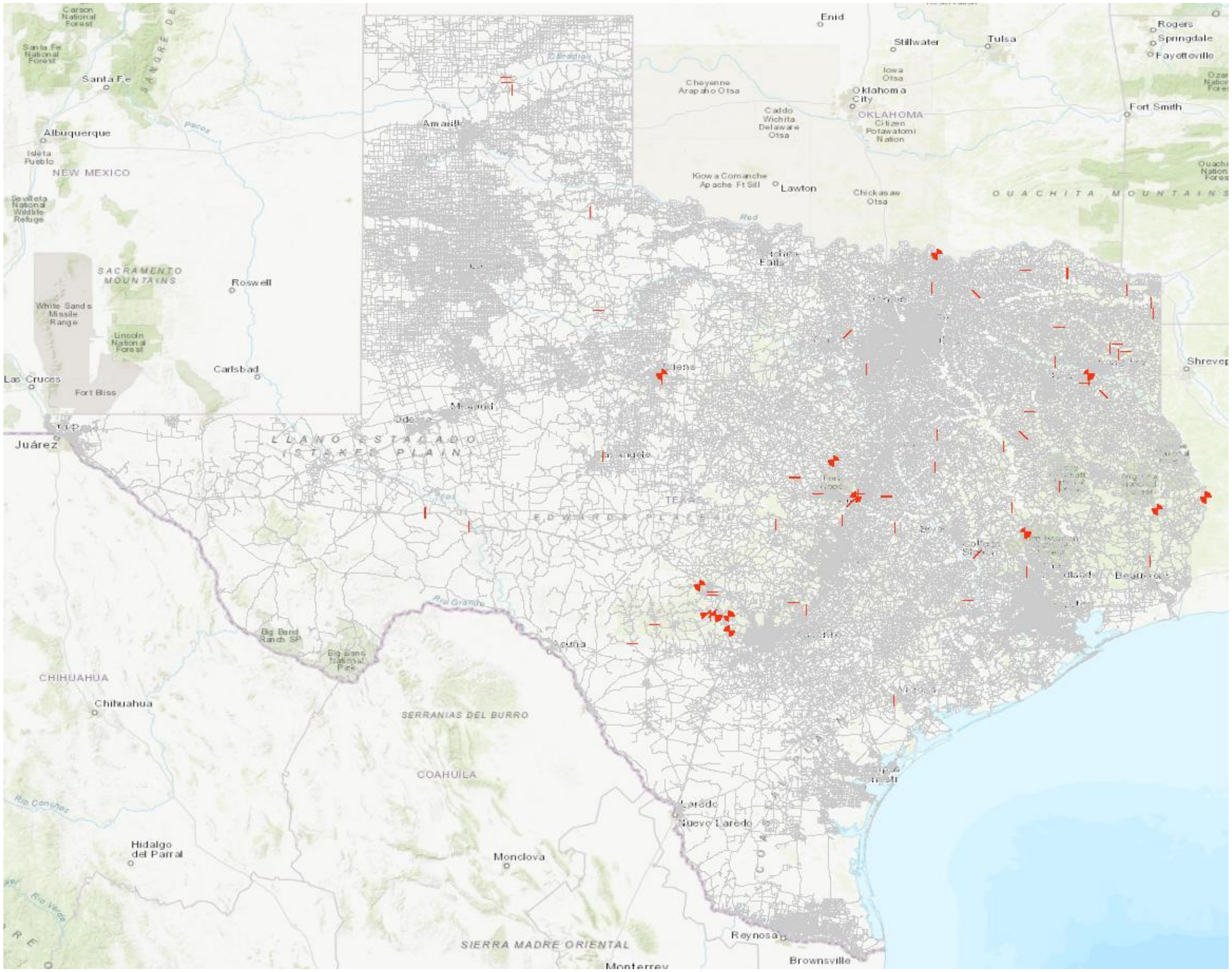


Figure 4.12 Positions in the Texas Roadway Network Which May Benefit Most from Intervention in the Form of Fencing or Animal Detection Systems

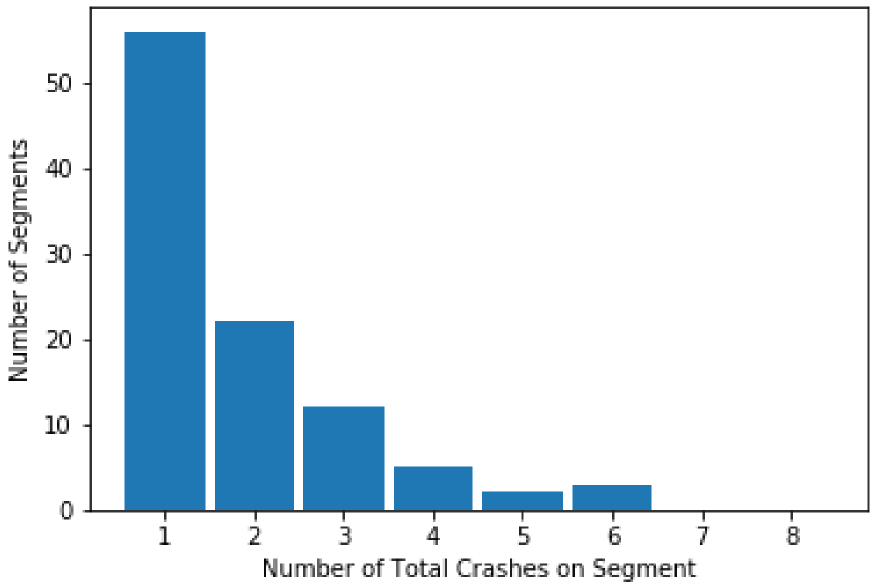


Figure 4.13 Number of Total Crashes across the 100 Segments That May Benefit Most from Intervention in the Form of Fencing or Animal Detection Systems

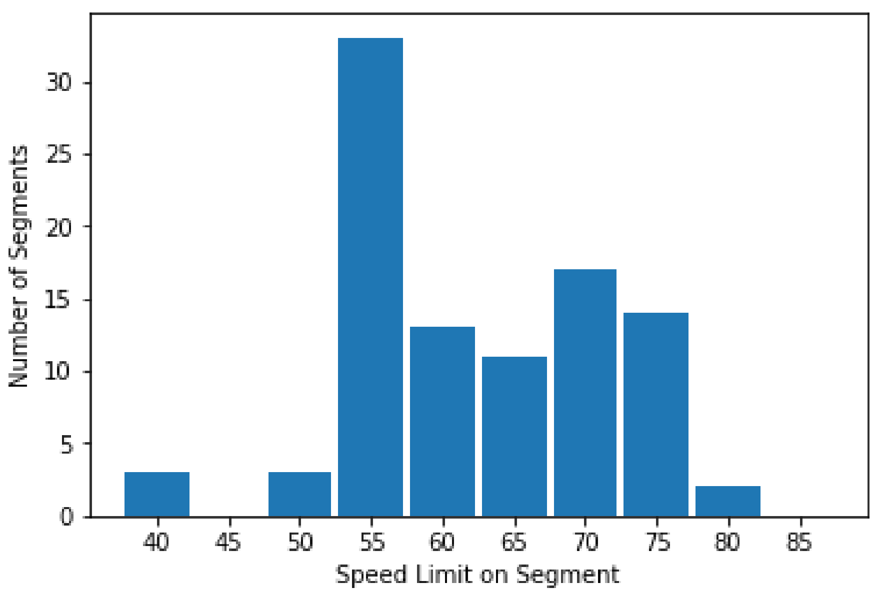


Figure 4.14 Speed Limit across the 100 Segments That May Benefit Most from Intervention in the Form of Fencing or Animal Detection Systems

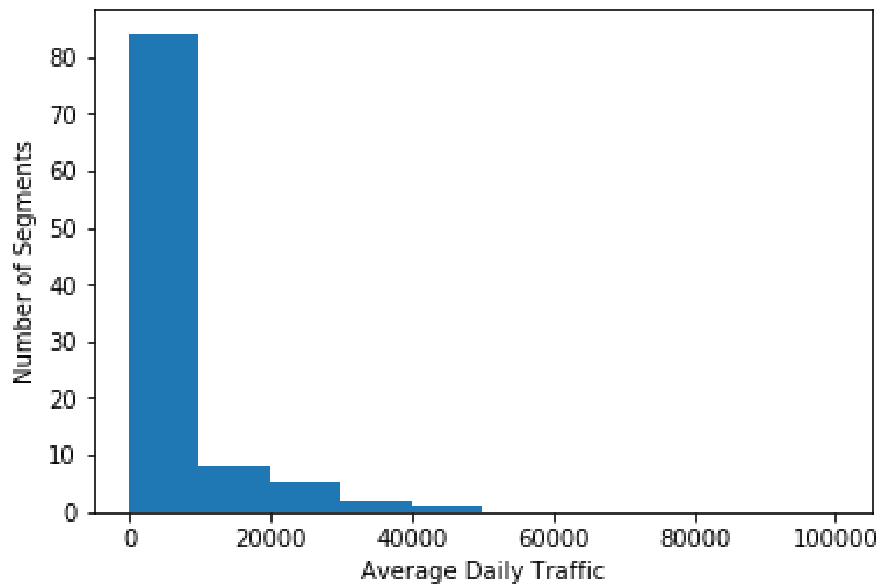


Figure 4.15 Average Daily Traffic across the 100 Segments That May Benefit Most from Intervention in the Form of Fencing or Animal Detection Systems

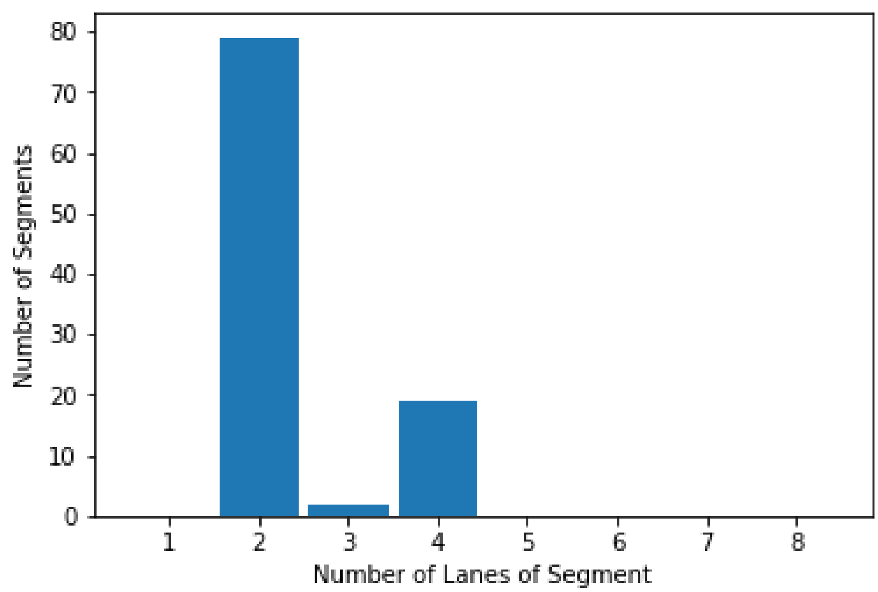


Figure 4.16 Number of Lanes across the 100 Segments That May Benefit Most from Intervention in the Form of Fencing or Animal Detection Systems

4.7. Implementation

For actual BCR determination, reduction calculations should be based on actual deer-related crashes reduced over a minimum of two years. Determining of the most effective method of collision mitigation also must be considered in the grander scheme effects of the ecosystem in the animal inhabits. Each mitigation strategy functions uniquely separately and have has distinctly disparate unique impacts on their animals' respective environment and populations. Ungulates like deer and elk tend to prefer overpass structures, while feline species prefer to cross through underpasses (FHWA, 2008). The translation of effectiveness rates to Texas roadways certainly requires further investigation as Texas's wildlife composition varies from that of the locations of in previous studies.

The options detailed here offer possible partial solutions and mitigation strategies that are most likely to reduce AVCs. Long-term monitoring is necessary to ensure the effectiveness of any mitigation technique for the in an area and to determine local species' specific preferences for such devices. It is important to remember that this analysis makes many assumptions and there are still many variables to explore.

4.7.1. External Factors and Driver Attitudes

There is evidence to suggest that driver attitudes and many other non-animal-related conditions may have a large impact on crash density, as in the case of light conditions. Therefore, solutions such as improved lighting or driver awareness of road conditions conducive to AVCs should be considered.

So far, there is only ambiguous evidence to support a cause-and-effect relationship between AVC rates and lighting conditions. Though there have been a few studies conducted to analyze roadway lighting's effect on AVCs, one of these studies reported no observable reduction of AVCs in the presence of new lighting. However, Sullivan et al. (2009) used a logistic regression model to find that night vision enhancement "may provide valuable assistance in helping drivers avoid animal-vehicle collisions."

Both static and dynamic signage (warning signs that are initiated at the detection of an animal's presence) can impact the mindset of drivers and encourage them both to be alert and to reduce speed, possibly preventing and certainly lessening the impact of a collision were it to occur or preventing it entirely (Sullivan, 2009). In Florida, Roadside Animal Detection Systems (RADS) are in development for the protection of an endangered species of panther (Grace et al., 2015). RADS sensors are largely infrared but may also include thermal or motion-activated sensors (Grace et al., 2015). These systems are designed to activate driver warning signs only when an animal has been detected. This system encourages more acute driver awareness than does static signage as it suggests with certainty that an animal is near. Using a driving simulator, Grace et al. (2015) found that "in twilight conditions, a RADS reduced the likelihood of the subject colliding with the deer by either 6.29 or 14 times, depending on the design of the warning signage." Beyond simulation studies, further research and long-term monitoring into how RADS implementation in Texas would reduce AVCs may prove beneficial to TxDOT. Given the anticipated popularity of autonomous and connected vehicles, RADS has the potential for widespread expansion. The system could be integrated into vehicle-to-infrastructure communications, where the image processor from the RADS could communicate wirelessly to the in-vehicle processor and trigger an indicator on the dashboard (Druta, 2015).

In the case of domestic animal collisions, it is recommended that cities and states cultivate encourage a culture where dogs are spayed and neutered. City animal control agents should have the appropriate resources delegated so that they can actively and effectively keep these animals off the road. Sharpshooting to reduce the abundance of deer populations has been considered (DeNicola et al., 2008), but has distinct drawbacks including population impacts and negative public perception.

Looking to the future, some experts believe that the proliferation of sensing-enabled vehicles, which may be able to thoughtfully avoid or at least notify drivers of the presence of an obstacle, will greatly reduce the number of AVCs and may even result in a "rewilding" of the predators that have been methodically killed off by AVCs over the last 100 years (Wollan, 2018). Connected vehicles may also provide awareness of hot spots for migrations of all animal types, even ones that will not harm cars or their occupants, which may encourage a driver to reroute around that critical path for the day. The car manufacturer Volvo is spearheading connected and autonomous vehicle efforts to combat AVCs through the introduction of a software known as Large Animal Detection. This software is part of the City Safety system, provided in several Volvo models released after 2014, including the S90 and V90 (Jasko, et al., 2017; Magnusson, 2016). Volvo's system senses moving objects through a radar sensor and a camera positioned behind the windshield and can trigger automatic emergency braking (AEB) "within .05 seconds of detection" (Magnusson, 2016). In an analysis of deadly moose-vehicle collision data in Sweden, Ydenius et al. (2017) determined that 18 out of 47 lives (~40%) could have been saved with an AEB system.

4.7.2. Improving AVC Reporting

One major problem of conducting a benefit-cost analysis is the possibility of beginning with inaccurate data. In the case of AVCs, that problem comes in the substantial amount of missing data, from vastly underreported collision counts.

Mobile reporting, both from DOT employees and the average smartphone user, shows potential for increased frequency and specificity of AVC reporting. The Washington State Department of Transportation (WSDOT) and the South Dakota Department of Transportation (SDDOT) have both created mobile applications for employees to report carcasses upon spotting them. In Malaysia and Israel, government and non-profit organizations, respectively, are working with popular navigation app Waze to show WVC hot spots on their maps so that drivers may be alerted and consider slowing down as they approach these areas (Udasin, 2017; Clean Malaysia, 2018). WIRES, a wildlife rescue app based in Australia, claims to have rescued over 68,000 animals in 2014 with the help of mobile reporting from citizens (Inverell Times, 2014). These promising applications demonstrate that ordinary citizens may be eager to download and utilize wildlife reporting apps.

Some researchers point to more detailed crash reports as simple strategy for fostering an environment of reliable data-gathering regarding AVC and its mitigation in the future. In the state of Nevada, officers reporting WVCs "have 14 species to select from a computer software pull down menu of species options, which includes wildlife and domestic animals" (Olson et al., 2014). Such detailed reporting provides transportation and wildlife departments with more accurate data to use in planning future mitigation strategies (Loftus-Otway et al., 2017).

4.8. Conclusions

The study team looked at the typical attributes and spatial frequency of AVCs in Texas over a 7-year period. Each of the methods presented can suggest expectations of what future crashes will look like or where they will happen. That being said, it may be helpful to consider a variety of strategies when making decisions about the placement of AVC mitigation. Long-term monitoring is necessary to ensure effectiveness of any mitigation strategy for the area and to determine local species' specific preferences for such devices.

AVCs are a rising share of crash counts, but can be thoughtfully addressed by recognizing their specific locations and the times of day and year that animals are most likely present, as well as employing meaningful crossings, lighting, and/or real-time warnings. Best-practice projects, including infrastructure changes and behavioral strategies, are lowering such crash rates while raising driver awareness of AVCs. Communities and authorities can address these issues by not only looking to infrastructure investments of the past, but also to innovations of the future. This includes implementations such as radar detection, image processing on cameras, vehicle connectivity to smartphones and smarter cars and trucks—ultimately shifting crash reduction responsibilities to motorists. Intelligent investments, designs, and applications can save many lives and much property, while enabling longevity of endangered and near-endangered species in Texas.

Chapter 5. Legal Issues Surrounding Animal Vehicle Conflicts

5.1. Outline

As part of the literature review, the attorney on the research team conducted a review of case law, statutes, and other materials to assess potential liability that may accrue if TxDOT actively pursues a policy and practice of integrating wildlife crossing structures and mitigation into its regular operations.

This chapter reviews case law that has occurred regarding DOT liability for WVCs that result in major injuries or death. It reviews state sovereign immunity under the Texas Torts Claims Act, and provides a review of current Texas statutory law regarding any potential liability that TxDOT may face due to design, inspection and maintenance, as well as reviewing the Manual on Uniform Traffic Control Devices (MUTCD) on tort liability of TxDOT for traffic signs and devices. The transportation Research Board has produced two Legal Research Digests that also provide data and analysis across the U.S. on liability of state departments of transportation for design errors (TRB, 2017) and the effect of MUTCD on tort liability of government transportation agencies (TRB, 2014).

In addition a review of case law activities across the U.S. was also undertaken and key cases are highlighted where liability was found. Searches on LexisNexis were performed using key terms, including crash, state DOTs, animal, deer, pronghorn, sovereign immunity, and liability. It should be noted that the case law indicated that a finding of liability by the courts is an extremely rare occurrence, because of the blanket immunity that many states provide for the acts of state agencies in pursuant of their statutorily authorized activities.

5.1.1. The Public Trust and Wildlife

Across the U.S. wildlife is for the most part held in trust for the benefit of the public thorough the state's department of wildlife or natural resources. The Supreme Court in Martin v. Waddell 41 U.S. 16 Pet 367 (1842) held that wildlife resources are not owned by an individual, but rather are to be held in trust by government for the benefit of present and future generations, and set the foundation from U.S. common law for future laws governing wildlife (TPWD, hunter education course, chapter 9, not dated).

In Texas the Texas Constitution at Article 16, § 59(a) states that:

> The conservation and development of all of the natural resources of this State, and development of parks and recreational facilities, including the control, storing, preservation and distribution of its storm and flood waters, the waters of its rivers and streams, for

> irrigation, power and all other useful purposes, the reclamation and irrigation of its arid, semiarid and other lands needing irrigation, the reclamation and drainage of its overflowed lands, and other lands needing drainage, the conservation and development of its forests, water and hydro-electric power, the navigation of its inland and coastal waters, and the preservation and conservation of all such natural resources of the State are each and all hereby declared public rights and duties; and the Legislature shall pass all such laws as may be appropriate thereto. Tex. Const. Ann. art. 16, § 59(a).11

States are usually not responsible or liable for the actions of wildlife on or over its real property. Courts have been reluctant to find liability for states for the action of wildlife. In Rubenstein v. United States, 338 F.Supp 654 (N.D. Cal. 1972) the government was found not liable for a bear attack, where notice had been given in usual warning brochures, but park official had no knowledge of bears in the area or campsite. The court held that the government could not be held liable for the completely unforeseeable actions of wild animals.[12]

The same rationale has been applied for DOTs or local government jurisdictions for WVC damages. In Mann v. State 47 N.Y.S.2D 553 (N.Y. Ct. Cl. 1944) the state was found not liable for damages to a car caused when a deer ran across the highway. The court held that the State not liable for failure to erect fences and warning signs where the plaintiff did not allege that the state had actual or constructive notice of a dangerous situation.

However, there have been a few cases where the courts have held that states might have duty to post warning signs. For example Morrison v. State, 123 N.Y.S.2d 105 (N.Y. Ct. Cl. 1952) where the court held that the state *might* have a duty to post a warning sign where it *knows* of wildlife dangers. In Ryan v. New Mexico State Highway & Transp. Dep't 125 N.M. 588; 1998-NMCA-116; 964 P.2d 149; 1998 N.M. App. LEXIS 95; 37 N.M. St. B. Bull. 39 (June 12, 1998) where a plaintiff in had struck an elk that had suddenly appeared in their line of travel, the court reversed the trial courts summary judgement to the department and against the victims and remanded the case back to the lower courts for a jury determination on whether the department had (i) actual or

[11] See State v. Bartee, 894 S.W.2d 34, 43 (Tex. Ct. App. 1995) ("The power of the state agency is to be exercised like all other powers of government as a trust for the benefit of the people and not as a prerogative for the advantage of the government or for the benefit of private individuals. The very purpose of the wildlife conservation act "is to provide a comprehensive method for the conservation of an ample supply of wildlife resources on a statewide basis to insure reasonable and equitable enjoyment of [*1503] the privileges of ownership and pursuit of wildlife resources."); Dobie v. State, 48 S.W.2d 289, 290 (Tex. Crim. App. 1932) ("The ownership of wild game, so far as it is capable of ownership, is in the state for the benefit of all its people in common."). But see Corpus Christi v. Pleasanton, 276 S.W.2d 798, 803 (Tex. 1955) ("In August of [1917] the people adopted the Conservation Amendment, Article XVI, [section] 59, to the Constitution declaring the conservation of the state's natural resources, including water, to be a public right and duty. But the Amendment was not self-enacting."). Cited in Blumm, C and Paulsen, A. The Public Trust in Wildlife, 2013 Utal L. Rev 1437.

[12] See also: Martin v. United States, 564 F.2d 1355 (9th Cir.1976), cert. denied, 432 U.S. 906, 97 S. Ct. 2950, 53 L. Ed. 2d 1078 (1977); Ashley v. United *975 States, 215 F. Supp. 39 (D.Neb. 1963), aff'd per curiam, 326 F.2d 499 (8th Cir.1964).

constructive notice that wild animals crossings created a dangerous condition and the location of the accident, (ii) whether the department breached that duty, and (iii) whether victim's injuries were foreseeable.

The next section of this chapter discusses sovereign immunity and the Texas Tort Claims Act which provides a limited waiver of immunity under specific circumstances.

5.2. Sovereign Immunity Overview

Historically state governments, agencies, and local jurisdictions were immune from suit under historical precedents set out in English law that gave the sovereign total immunity.

A more modern-day approach emerged in the twentieth century regarding liability for activities or actions that states, agencies and local jurisdictions undertook. This led to the federal government, who were followed by the states to waive immunity under certain circumstances, and where common law would provide a remedy under torts law.

5.3. Sovereign Immunity: Federal

In 1946 the United States passed The Federal Tort Claims Act (FTCA) 28 U.S.C. §2674. The FTCA provides a limited waiver of the federal government's sovereign immunity when its employees are negligent within the scope of their employment. Under FTCA, the government can only be sued under circumstances where the United States, if it was a private person, would be liable to the claimant in accordance with the law of the place where the act or omission occurred (28 U.S.C. § 2672 and 28 U.S.C. §1346 (b).

Many state legislatures followed the federal government's law and enacted statutes that defined their limits of immunity for state government entities and their employees. Currently most states fall into two categories:

- Those that follow the FTCA and have a general waiver of immunity with certain exceptions,
- Those that have reenacted immunity and have limited waivers that only apply to certain types of claims.

The National Conference on State Legislators has assessed that 33 states[13] have Acts that cap or limit monetary damages that can be recovered in a judgment against the state or its employee in

[13] Colorado, Florida, Georgia, Idaho, Illinois, Indiana, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Minnesota, Mississippi, Missouri, Montana, Nebraska, Nevada, new Hampshire, New Mexico,

the course of their job functions. Twenty-nine states (usually in combination with the cap) prohibit judgment against a state to include punitive or exemplary damages (NCSL, 2010)[14].

5.4. Texas Sovereign Immunity

Texas in 1969 enacted its own waiver of sovereign immunity in passing the Texas Tort Claims Act (TTCA) (Tex. Rev. Stat. Art 6252-19 as originally enacted, now at Tex. Civ. Prac. & Rem. Code Ann. §101.01 et. seq.). This section outlines the major elements of the section of initial relevance for discussing wildlife vehicle interactions and potential state liability.

Shaunessy (Shaunessy, 2002) notes that:

> "The Act imposes liability based upon the condition or use of real and personal property and common law standards of liability (Tex. Civ. Prac. & Rem. Code Ann. § 101.021). At the same time, where the Act does not specifically waive governmental immunity from suit, common law sovereign immunity remains the rule of law (See id. § 101.025). Therefore, understanding the extent and basis for liability under the Act requires an understanding of both sovereign immunity and common law premises liability."

The Texas Municipal League (TML) notes that prior to enactment, courts had held that the state could not be held liable for property damages, personal injury, or death arising from a governmental function. However, governments were liable for damages, injuries or death that arose from a proprietary function. The courts had treated municipalities, for example, in the same fashion as a private entity, and subject to the same risks. TML notes that:

> Trying to distinguish between governmental and proprietary functions based on a reading of court cases was difficult, if not impossible. Generally, governmental functions were those which the municipality was required by state law to perform in the interest of the public. Proprietary functions were those which the municipality chose to perform when it believed it would be in the best interest of its inhabitants (TML, not dated).

North Carolina, North Dakota, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Utah, Vermont, Virginia, Wisconsin, Wyoming.

[14] The states are Alabama, Alaska, Arizona, Arkansas, California, Colorado, Georgia, Idaho, Indiana, Kansas, Maine, Maryland, Mississippi, Missouri, Montana, Nevada, New Hampshire, New Jersey, New Mexico, North Dakota, Oklahoma, Oregon, Pennsylvania, South Carolina, Tennessee, Texas, Utah, Virginia, Wisconsin, and Wyoming.

5.5. Texas Tort Claims Act

The TTCA is a partial waiver of the sovereign immunity of governmental units of the state (Evans, et al, 2014). It is found within Texas Civil Practice and Remedies Code (TCPRC), which defines a government unit at §101.001 (3) as:

A. this state and all the several agencies of government that collectively constitute the government of this state, including other agencies bearing different designations, and all departments, bureaus, boards, commissions, offices, agencies, councils, and courts;
B. a political subdivision of this state, including any city, county, school district, junior college district, levee improvement district, drainage district, irrigation district, water improvement district, water control and improvement district, water control and preservation district, freshwater supply district, navigation district, conservation and reclamation district, soil conservation district, communication district, public health district, and river authority;
C. an emergency service organization; and
D. any other institution, agency, or organ of government the status and authority of which are derived from the Constitution of Texas or from laws passed by the legislature under the constitution.

An employee is defined at TCPRC §101.001 (2) as a person, including an officer or agent, who is in the paid service of a governmental unit by competent authority, but does not include an independent contractor, an agent or employee of an independent contractor, or a person who performs tasks the details of which the governmental unit does not have the legal right to control.

Scope of employment is defined at TCPRC §101.001 (5) as performance for a governmental unit of the duties of an employee's office or employment and includes being in or about the performance of a task lawfully assigned to an employee by competent authority.

State Government is defined at TCPRC §101.001 (6) as an agency, board, commission, department, or office, other than a district or authority created under Article XVI, Section 59, of the Texas Constitution, that: (A) was created by the constitution or a statute of this state; and (B) has statewide jurisdiction.

Government units may purchase insurance policies protecting the unit and employees against claims under this chapter, to the extent that the unit is authorized or required to do so under other law (TCPRC §101.027 (a)). Policies may relinquish to the insurer the right to investigate, defend, compromise, and settle any claim under this chapter to which the insurance coverage extends (TCPRC §101.027 (b)).

5.5.1. Liability Defined

Section 101.021 (TCPRC) defines that a governmental unit in the state is liable for:

- property damage, personal injury, and death proximately caused by the wrongful act or omission or the negligence of an employee acting within his scope of employment if:

  (A) the property damage, personal injury, or death arises from the operation or use of a motor-driven vehicle or motor-driven equipment; and

  (B) the employee would be personally liable to the claimant according to Texas law; and

- personal injury and death so caused by a condition or use of tangible personal or real property if the governmental unit would, were it a private person, be liable to the claimant according to Texas law.

The duty owed by a state entity according to TCPRC Section 101.022: is

a) Except as provided in Subsection (c), if a claim arises from a premise defect, the governmental unit owes to the claimant only the duty that a private person owes to a licensee on private property, unless the claimant pays for the use of the premises.
b) The limitation of duty in this section <u>does not apply</u> to the duty to warn of special defects such as excavations or obstructions on highways, roads, or streets or to the duty to warn of the absence, condition, or malfunction of traffic signs, signals, or warning devices as is required by Section 101.060.
c) If a claim arises from a premise defect on a highway, road, or street, the governmental unit owes to the claimant only the duty that a private person owes to a licensee on private property.

5.5.2. Limitation on Liability of State Government

TCPRC Section 101.023 limits liability of the state government to money damages in a maximum amount of $250,000 for each person and $500,000 for each single occurrence for bodily injury or death, and $100,000 for each single occurrence for injury to or destruction of property. Lower cap limits are set for units of local government and for municipalities. Exemplary damages are not authorized under Section 101.024.

5.5.3. Permission to Sue

Under TCPRC Section 101.025 (a) sovereign immunity to suit is waived and abolished to the extent of liability created by the chapter. Section 101.025 (b) authorizes that a person having a claim under this chapter may sue a governmental unit for damages allowed by this chapter.

5.5.4. Discretionary Powers

The TTCA does not apply to claims based on the failure of a governmental unit to perform an act that the unit is not required by law to perform; or a governmental unit's decision not to perform an act or on its failure to make a decision on the performance or nonperformance of an act if the law leaves the performance or nonperformance of the act to the discretion of the governmental unit (TCPRC §101.056).

5.5.5. Traffic and Road Control Devices

TCPRC §101.060 details traffic and road control devices. Under §101.060 (a)(2) the chapter does not apply to failure to place a traffic or road sign as a result of a *'discretionary'* action by the governmental unit (i.e., TxDOT or local jurisdiction).

(a) This chapter does not apply to a claim arising from:

1) the failure of a governmental unit initially to place a traffic or road sign, signal, or warning device if the failure is a result of discretionary action of the governmental unit;
2) the absence, condition, or malfunction of a traffic or road sign, signal, or warning device unless the absence, condition, or malfunction is not corrected by the responsible governmental unit within a reasonable time after notice; or
3) the removal or destruction of a traffic or road sign, signal, or warning device by a third person unless the governmental unit fails to correct the removal or destruction within a reasonable time after actual notice.

(b) The signs, signals, and warning devices referred to in this section are those used in connection with hazards normally connected with the use of the roadway.
(c) This section does not apply to the duty to warn of special defects such as excavations or roadway obstructions.

5.5.6. Conduct of Public Servants: State Liability

For cases that are based upon conduct that is outlined in Section 104.002 the state will indemnify for actual damages, court costs, and attorney's fees that may be adjudged against:

(1) an employee, a member of the governing board, or any other officer of a state agency, institution, or department
(2) former employees, members or officers, and other identified individuals (§104.001).

The conduct covered under §104.002 includes indemnification if damages are based on an act or omission by the person in the course and scope of the person's office, employment, or contractual performance for or service on behalf of the agency, institution, or department and if:

> the damages arise out of a cause of action for negligence, except a willful or wrongful act or an act of gross negligence; (3) indemnification is in interest of the state, determined by the Attorney General.

Recoverable damages are capped at Section 104.003 and cannot exceed $100,000 to a single person indemnified and, if more than one person is indemnified, $300,000 for a single occurrence in the case of personal injury, death, or deprivation of a right, privilege, or immunity; and $10,000 for each single occurrence of damage to property.

5.5.7. Limitation of Liability for Public Servants

Section 108.001 TCPRC defines a public servant as a public official elected or appointed to serve a governmental unit and acting in that capacity when the act or omission on which the damages were based occurred or a person covered under Section §104.001 (as noted above) or §102.001 (local government employee).

The next section of this chapter discusses case law in Texas regarding tort liability claims for a highway defect and the TTCA as a highway defect statute.

5.6. Texas Liability Case Law

This section will review case law and discuss key issues that should be considered as triggers for either considering the installation of a wildlife crossing, and ensuring regular maintenance and review takes place such that a special defect does not occur.

The courts in Texas, once a plaintiff has established that their claim: (i) arises from a governmental function of the entity, as opposed to a proprietary or discretionary function, and (ii) specifically falls under the TTCA or other waiver of sovereign immunity, will review whether a government entity is subject to liability actions for premises defects from the use of state-owned property.

The courts will analyze a series of elements in determining whether sovereign immunity attaches, and if not if there is any liability these include:

- What law controls TTCA or common law
- What type of claim can be brought
- What duties are owned; the standard of care test
- Special defects that create a requirement of a duty to warn
- What entities recovered by the TTCA
- The extent of waiver of sovereign immunity
- Specific provisions for traffic control devices
- Exclusions that are authorized for policy decisions, including a subset of law that specifically provides immunity for highway construction, design and maintenance.

5.6.1. Case Law on Liability

As noted above Texas agencies, including TxDOT, municipalities and counties, generally enjoy immunity for planning and governmental functions. This includes road design and also the dissemination of information. While Texas has not waived immunity for design errors, the state does not have a discretionary defense for claims that involve a defective plan or design. The case law outlined below provides a review of how the courts have reviewed the bulleted list in at the beginning of section 3.5; many of the cases are specific to TxDOT to provide the reader with a more nuanced understanding of how the courts have addressed TxDOT's actions or activities. Where other cases provided further clarification on a specific point of law they are noted. This section is not a complete treatise on sovereign immunity nor of liability and should not be construed as legal advice by TxDOT. The object of undertaking this legal review was to provide TxDOT with a concept of the types of cases that have arisen regarding wildlife vehicle conflicts, and in absence of these specific types of cases, a view of how the courts in Texas have assessed activities such as placement of signs, defects in structures either due to design or some other interceding event, the standards that a court will use for review, and how the courts will review the motorist's actions and attention to the road.

5.6.1.1. What Law Controls: TTCA or Common Law

A first issue that the courts will review is whether the TTCA or common law controls in a case. A plaintiff bringing suit under TTCA will need to plead and provide that their claims fit within the Act's waiver of immunity. The scope of the Act's waiver was laid out in a test created by the San Antonio Court of appeals in Medrano v. City of Pearsall, 989 S.W.2d 141, 144 (Tex. App.--San Antonio 1999, no pet.).

Under the test in Medrano, for immunity to be waived under the TTCA, the claim must arise under one of the three specific areas of liability where immunity is waived, and cannot fall under one of the exceptions from waiver. The three specific areas of liability for which immunity has been waived are found in §101.021 and are (i) injury caused by an employee's use of a motor-driven vehicle; (ii) injury caused by a condition or use of tangible personal or real property; and (iii) claims arising from premise defects.

Finding liability against TxDOT for a wildlife vehicle crash—from TxDOT's perspective—could arise from a condition of real property itself or a premise defect claim where a mitigation activity or structure led to a premise's defect. Plaintiff's will still have to bear the burden establishing either that their claim falls within the TTCA or some other waiver of sovereign immunity.[15]

5.6.1.2. Liability for Premises Defect

Under Section 101.022 of the TCPRC the courts will undertake a series of test to determine if the claim arises from a premises defect or the use or condition of the property, and then will look at the standards of liability for premises defects, for ordinary premise defects and special defects.

[15] See University of Tex. Med. Branch v. York, 871 S.W.2d 175, 177 n.3 (Tex. 1994); see also Federal Sign v. Texas S. Univ., 951 S.W.2d 401, 405 (Tex. 1997)

Two different waivers of immunity are created by the TTCA for determining whether a suit should be based upon either a condition or use of the property or a premises defect.

1. For claims that fall under condition or use of the property, the liability standard is applied as if the government unit were in fact a private person.
2. For premises defects immunity waiver is very limited as is the extent of any liability owed.

The duty owned for premise and special defects at Section 101.022 does not create a government liability in itself, and merely limits the duty that may be owed by the government. According to Hawley v. State Dep't of Highways & Pub. Transp., 830 S.W.2d 278, 281 the language of §101.022 still creates limitation on liability created under §101.021 and does not create a separate cause of action measured by the ordinary care standard.[16]

In determining where a suit should fall, the courts will look at common definitions of premises and defect. Premises have been commonly defined as a building, or part of, and grounds or other appurtenances. For objects that cause an injury the court will look to see whether these are permanent or temporary. In Texas Department of Transportation v. Henson, the court found that an injury from a barrel sign did not constitute a premises liability claim.[17] Here the injury was found to have arisen from the condition or use of the property rather than a premises defect. A premises defect has been held to be something other than a condition normally connected with the use of the premises which creates an unreasonable risk of harm.[18] In determining whether a particular set of circumstances creates a 'dangerous condition' has usually been held to present a fact issue for the jury.[19]

5.6.1.3. Premises Liability at Common Law

Once a plaintiff bears the burden that the claim falls within TTCA and immunity is waived, the court will then turn to review common law premises liability. Premises liability law provides that landowners or those that control land and buildings can be held liable for injuries that occur because of a condition on or of the premises. This area of law derives from over 500 years of British common law that had given a preferential status to land owners, and was set to not discourage land ownership and development of real estate. A possessor of land was obligated

[16] See Hawley v. State Dep't of Highways & Pub. Transp., 830 S.W.2d 278, 281 (Tex. App.--Amarillo 1992, no writ)

[17] Texas Dep't of Transp. v. Henson, 843 S.W.2d 648, 652 (Tex. App.--Houston [14th Dist.] 1992, writ denied)

[18] See Payne, 838 S.W.2d at 237; Barron v. Texas Dep't of Transp., 880 S.W.2d 300, 303-04 (Tex. App.--Waco 1994, writ denied);

[19] (Blankenship v. County of Galveston, 775 S.W.2d 439, 441 (Tex. App.--Houston [1st Dist.] 1989, no writ)).

ensure that the use of the land did not represent an unreasonable risk of harm to others. This area of law is also distinct from a typical negligence case.[20]

Premises liability is a limited liability and the duty owed (known as standard of care) by the owner of the premises or the occupier is determined by the status of the complaining party. Three types of status, trespasser, licensee or invitee have been set by the courts. For TxDOT's purposes, the standard of care here would be owned to a licensee.[21] A licensee enters with permission of the landowner for their own convenience or for business not associated with the owner. Consent can be either express or implied. The duty owned is not to injure him through willful, wanton or gross negligence. The exception to this rule is where the occupier knows of a dangerous condition but the licensee does not know of this. Here because of the dangerous condition the landowner has *actual knowledge*, and therefore has a *duty to warn of* the defect, or a *duty to make* the premises *reasonably safe*.[22]

For example, in State v. Gonzalez 82 S.W.3d 322; 2002 Tex. LEXIS 98; 45 Tex. Sup. J. 925 (June 27, 2002) the Texas supreme court reversed a court of appeals judgment that centered on notice of defect and duty to warn. In this instance notwithstanding multiple instances of vandalism of a sign, at the time the accident occurred TxDOT did not have actual notice that the signs had been removed. While a passing motorist testified that the signs had been down on Sunday morning, she had not notified TxDOT, and TxDOT had not received any reports that the signs were down again, after being replaced on the Friday before. The court concluded:

> …that there is no evidence to support a finding that TxDOT had actual notice that the stop signs were down before the accident occurred.[23] Gonzalez did not introduce any evidence showing that anyone had reported the signs were down before the accident.[24]. And the evidence that TxDOT knew the signs had been repeatedly vandalized does not indicate, either directly or by reasonable inference that TxDOT actually knew the signs were down before the accident occurred.

The standard of conduct required of a premises occupier toward his invitees is the ordinary care that a reasonably prudent person would exercise under all pertinent circumstances. The courts have held that liability depends on whether the owner acted reasonably in light of what he knew or should have known about the risks accompanying a premises condition (Mendoza v. City of Corpus Christi, 700 S.W.2d 652, 654 (Tex. App.--Corpus Christ 1985, writ ref'd n.r.e). the distinguishing factor that is required within a premises liability case is that a licensee has to

[20] See W. Page Keeton et al., Prosser and Keeton on the Law of Torts § 57, at 386 (5th ed. 1984).

[21] See State Dep't of Highways & Pub. Transp. v. Payne, 838 S.W.2d 235, 237 (Tex. 1992)

[22] Id.

[23] See Bradford, 48 S.W.3d at 754.

[24] See Donovan, 768 S.W.2d at 909

establish the existence of the dangerous condition and that the defendant therefore had a duty to act. [25]

Not all conditions within a premise that cause an injury are construed as a dangerous condition.[26] The courts have held that to constitute a dangerous condition, a premises defect must meet two conditions.

1. The premises must constitute an unreasonable risk to the licensee or invitee.[27]
2. The condition must have been one that a plaintiff should not have anticipated under the existing circumstances.[28]

In discussing how to determine this, the court in Brownsville Navigation District v. Izaguirre 829 S.W.2d at 160, where the plaintiff fell under a trailer he was loading, when its front supports that were resting on a board for support on soft and muddy ground from a rain, that slipped, causing the trailer to roll over on Izaguirre, noted that it was common knowledge that dirt becomes soft and muddy when wet.[29] Therefore, the premises owner should not have to warn of or make reasonably safe a condition that a reasonable and prudent person would have anticipated encountering under the applicable conditions.[30]

In instances where TxDOT may currently place signage or other mitigation elements to reduce wildlife vehicle incidents, under current law, a plaintiff would have to first show that immunity was waived, and then under current premises liability show notice (actual or reasonably inferred due to multiple incidents) that TxDOT knew of the wildlife moving a highway, that this was not something commonly known or that a prudent person would anticipate, and that they did not take steps to either warm or remedy the situation. It is highly likely that each case will have specific circumstances, that if liability is found, it will be distinguished due to the specific facts of the case.

5.6.1.4. Special Defects

Under the TTCA in certain circumstances, a governmental entity has a greater duty to the public than a licensor owes to a licensee. One instance where this greater duty is owed is when the premises defect involved constitutes a special defect. A special defect eliminates the requirement

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[25] 829 S.W.2d 159, 161 (Tex. 1992), see also H.E. Butt Grocery Co. v. Resendez, 988 S.W.2d 218, 219 (Tex. 1999); Meeks v. Rosa, 988 S.W.2d 216, 217 (Tex. 1999); Seideneck v. Cal Bayreuther Assoc., 451 S.W.2d 752, 754 (Tex. 1970).

[26] Brownsville Navigation District v. Izaguirre 829 S.W.2d at 160

[27] See Seideneck, 451 S.W.2d at 754.

[28] See State Dep't of Highways & Pub. Transp. v. Kitchen, 867 S.W.2d 784, 786 (Tex. 1993) (per curiam).

[29] See Izaguirre, 829 S.W. 2d at 161

[30] Id

of actual knowledge before the government occupant is obligated to act, and the plaintiff gains the status of an invitee.

Special defects on the roadways, such as excavations and roadway obstructions can lead to potential liability of governmental entities if these defects are not addressed in a reasonable way—e.g., with signage, fencing, etc., (TCPRC § 101.060(c)).[31]

Texas Supreme court decisions establish five principles to be considered in determining whether a condition on the premises constitutes a special defect. However, determining what is a special defect is made on a case-by-case basis.

1. Most property defects are ordinary premises defects and not special defects[32]. So special defects are an exception and not the rule.[33]
2. A special defect does not need to have been created by the governmental unit itself[34].
3. The special defect *unexpectedly* and *physically* impairs a cars ability to travel on the road[35].
4. The defect must present an *unexpected* and unusual danger to *ordinary users* of road-ways[36]
5. To find a special defect, the premises condition *must* be on a highway, road, or street.[37]

The cases below highlight examples of premises conditions that have been found to be special defects, as well as examples of premises conditions that have been found not to be special defects.

In County of Harris v Eaton, the Supreme Court held that an abnormally large hole was a special defect, and that the county had the duty to warn, in the same fashion of the duty one owes to an

[31] "A special defect" under § 101.060(c) is "an excavation or roadway obstruction [that is a] present '[] unexpected and unusual danger to ordinary users of roadways.'" *State v. Rodriguez*, 985 S.W.2d 83, 85 (Tex. 1999). See also *Morse v. State*, 905 S.W.2d 470, 475 (Tex. App.—Beaumont 1995, writ denied) (holding that ten-inch drop-off along shoulder that prevented car's left wheels from reentering the roadway once they had slipped off was a special defect); see, e.g., *State Dep't of Highways v. Kitchen*, 867 S.W.2d 784, 786 (Tex. 1993) (holding that ice on bridge during winter was not a special defect because it is not unexpected or unusual).

[32] State Dep't of Highways & Pub. Transp. v. Payne, 838 S.W.2d 235, 238 (Tex. 1992); Horrocks, 841 S.W.2d at 416.

[33] Payne, 838 S.W.2d at 238

[34] County of Harris v. Eaton, 573 S.W.2d 177, 179 (Tex. 1978) (stating that a "special defect" need not have been created by the government itself, but could conceivably result from a natural occurrence such as an obstruction created by an avalanche or from the act of a third party)

[35] State Dep't of Highways & Pub. Transp. v. Zachary, 824 S.W.2d 813, 819 (Tex. App.--Beaumont 1992, writ denied); Morse v. State, 905 S.W.2d 470, 475 (Tex. App.--Beaumont 1995, writ denied).

[36] Also State Dep't of Highways & Pub. Transp. v. Kitchen, 867 S.W.2d 784, 786 (Tex. 1993) (per curiam) ("When there is precipitation accompanied by near-freezing temperatures…an icy bridge is neither unexpected nor unusual").

[37] Barker v. City of Galveston, 907 S.W.2d 879, 885 (Tex. App.--Houston [1st Dist.] 1985, writ denied).

invitee. Here the oval shaped hole varied from six to ten inches and depth, and extended over ninety percent of the width of the highway.[38] The hole was at some parts four ' wide, and at other's nine ', and was construed to have reached the proportions of a ditch across a highway, such that a person could not stay on the pavement and miss it.

In State v Nichols, the Waco Court of Appeals similarly held that a washout or caved-in portion of a state highway, three to four feet wide, and extending across the entire highway was a special defect.[39] In State v. Williams the Tyler Court of appeals held that a large metal sign lying face down on one land of a road was a special defect as a matter of law.[40] In TxDOT v. Fontenot 151 S.W.3d 753; 2004 Tex. App. LEXIS 11367 (December 16, 2004) the court held that standing water on a road was neither outside the ordinary course of events not contrary to routine expectation, and did not constitute a special defect under TTCA §101.022.

In Villegas v. Tex. DOT, 120 S.W.3d 26; 200 Tex. App. (August 13,2003) the plaintiff's here brought a suite for wrongful death against TxDOT and a contractor alleging that the water on the road was a special defect and that TxDOT had failed to use reasonable to care to keep the premises safe. The court held that the mowing contractor did not exercise sufficient control over the road to incur the duties of a possessor occupier, and that the large pool of water within the culvert did not constitute a special defect. They further asserted claims of negligence/gross negligence against a contractor that had a contract with TxDOT to mow grass, and whom the plaintiffs alleged had failed to mow the vegetation and grass on the shoulder and culvert along Highway 755 thereby causing improper drainage of the culvert. The court noted that:

> "In this case, a pool of water that accumulated on the road caused by rain throughout the day is not unexpected nor unusual to a motorist under such conditions. The summary judgment evidence showed that it had rained all day in the area on the day the accident occurred. The water on the road was open and obvious and a condition that an ordinary motorist could have anticipated due to the weather conditions. See id. Therefore, we hold that the water on the road was a premise defect and not a special defect."

The court in its argument also distinguished plaintiffs use of State Department of Highways and Public Transportation v. Zachary, 824 S.W.2d 813 (Tex. App.-Beaumont 1992, writ denied) to argue that water on the road was a special defect and that the determination of this fact issue should be determined by the jury. The court cited Supreme court case law that noted that whether a condition is a premise defect or a special defect is a question of law (Payne, 838 S.W.2d at 238), and that a trier of fact only makes such a determination if the underlying facts are disputed

[38] 573 S.W.2d at 180

[39] See State v. Nichols, 609 S.W.2d 571, 574 (Tex. App.--Waco 1980, writ ref'd n.r.e.).

[40] State v. Williams, 932 S.W.2d 546, 550 (Tex. App.--Tyler 1995), writ denied, 940 S.W.2d 583 (Tex. 1997) (per curiam).

(McCreight, 940 S.W.2d at 288). In this case the court held *Zachary* was inapplicable as the facts were undisputed.

In assessing what this means for TxDOT in creating and maintaining wildlife crossings, the agencies could cumulatively, face a higher maintenance burden, or at least a more extensive maintenance challenge, once wildlife crossing treatments are in-place, if these might create a special defect.

5.6.2. Road and Traffic Signals and Related Equipment

In Texas, the installation and operation of traffic-control devices, signs, warnings, and other signals installed by governmental entities (both State and municipal) are partially protected by governmental immunity (TCPRC § 101.060 (see also § 101.0215(a)(21) and (31)). Traffic signs, signals, and control devices where this section applies are used in connection with hazards normally connected with the use of the roadway, and not to special defects.[41]

While the decision to place a sign or control device is discretionary (TCPRC § 101.060(a)(1); *City of Grapevine v. Sipes*, 195 S.W.3d 689, 693 (Tex.2006)), once that signal is in place, the government can be liable for malfunctions, stolen or missing signals, or defects in these devices, with some exceptions (id. at § 101.060(a)(2)). However, this liability is imposed, only if notice is received and they government did not make repairs within a reasonable time.[42]

The significance of the Texas-specific Manual on Uniform Traffic Control Devices (TMUTCD) was not considered to be significance until the early 2000s. Texas Transportation Code[43] authorizes TxDOT to place signs on state highways in a manner conforming to the manual. Under the TMUTCD the application of a sign is mandatory, advisory, or permissive. The Texas supreme court has held that even for signs where placement is mandatory is still a discretionary act and subject to exemption from liability provided under 101.060 (a) of the TCPRC.[44] Shaunnessy (Shaunnessy, 2001) notes that “The supreme court noted that the Manual itself declares that it is no substitute for engineering judgment and that the statute authorizing adoption of the Manual affords the State discretion in placing traffic control devices.”[45]

[41] See Palmer v. City of Benbrook, 607 S.W.2d 295, 300 (Tex. Civ. App.--Fort Worth 1980, writ ref'd n.r.e.).

[42] In the case of destruction of the signal or device by third parties, the government must receive “actual” notice; this “actual notice” includes a “subjective awareness of fault” that goes well beyond the collection of data or even the results of a safety inspection. TxDOT v. Anderson, WL 186868, at *4 (Tex.App—Tyler, 2008).

[43] See Tex. Transp. Code Ann. § 544.001 (Vernon 1999). n529 Id. § 544.002(a). n530 Id. §544.002(b).

[44] See State Dep't of Highways & Pub. Transp. v. King, 808 S.W.2d 465, 466 (Tex. 1991).

[45] Id.

Section 101.060(a)(1) of the TCPRC exempts from liability the initial failure to place signs, signals, or warning devices, assuming the failure is a result of discretionary action.[46] However, other traffic sign and signal manuals containing language similar to the TMUTCD have been found to not override the exemption from liability created by section 101.060 TCPRC.[47]

5.6.2.1. Looking to the Future: Connected Traffic Signals and Signs

Roadside equipment or other related infrastructure needed to provide connected roadways, that could be utilized in the future by TxDOT to notify motorists of wildlife in proximity, could also fall within the terms of this partial immunity for road and traffic signals. An assumption could be made that connected infrastructure (whether signals or signs that communicate with a vehicle [vehicle to infrastructure (V2I)] or the data itself between V2I and then [vehicle to vehicle (V2V)]) could fit within the general concept of traffic and road control devices of §101.060. However, if this is not the case, additional analyses will need to be undertaken as to whether they are personal or real property under the exemption afforded in TCPRC at §101.060.

If connected signals and signs are not afforded immunity under §101.060 then the standards for reasonableness for the typical premises defect case in which the agency would not be liable may present over time more of a moving target, particularly for hazards that may be created by the installation of crossing treatments, that might utilize information from connected vehicles or other roadside devices to warn motorists of wildlife in proximity to their location.

With respect to malfunctions of digital or "connected" signals, it is also not currently clear how "notice" under subsection (a)(2) will be triggered for purposes of the Act. As Wagner and Loftus-Otway noted in TxDOT project 0-6838 (Kockelman et al., 2017).

> "Connected roadway devices will presumably involve real time communications not only between the device and vehicles, but also as between the device and the government operating the signal. In theory, then, the government may receive instantaneous "data" revealing a problem with a signal; this immediate message is not available for non-digital signs and signals.[48] The courts could thus determine that notice occur immediately—when the malfunctioning signal is sent. Or notice could be triggered once an employee has reason

[46] See Villarreal v. State, 810 S.W.2d 419, 420-21 (Tex. App.--Dallas 1991, writ denied).

[47] See Bellnoa v. City of Austin, 894 S.W.2d 821, 827 (Tex. App.--Austin 1995, no writ) (holding that provisions of the City of Austin School Safety Manual similar to the Manual "does not impose a non-discretionary duty on the City").

[48] See, e.g., *Alvarado v. Lubbock*, 685 S.W.2d 646, 649 (Tex. 1985) (several pieces of evidence from other police citations revealing that the city knew of the discrepancy between the posted speed limit, and the speed limit authorized by ordinance was enough to cause an issue of material fact.); State v. Gonzalez, 82 S.W.3d 322, 329-330 (Tex. 2002) (city did not have actual notice that stop sign disappeared, because even though it knew the stop sign was prone to being stolen the city had just replaced the sign); *City of Midland v. Sullivan*, 33 S.W.3d 1, 12 (Tex. App.—El Paso 2000 pet. dismissed) (city had notice of defective traffic condition by way of faded pavement markings).

to discover the defect from the incoming data. As a result of the future legal uncertainty, which presumably could discourage the government from utilizing connected or digital technologies for fear of greater liability, legislative clarification of the notice requirement would be beneficial.

It is also possible, however, that since connected infrastructure malfunctions occur with respect to the transmittal of "data or information," the courts might exempt malfunctions in connected infrastructure from liability altogether. This exemption would occur if the digital infrastructure is categorized in this context as "data" devices rather than "personal" or "real property" (§ 101.021). (See, e.g., Univ. of Tex. Med. Branch v. York, 871 S.W.2d 175, 178-179 (Tex. 1994) holding that information is an "abstract concept, lacking corporeal, physical or palpable qualities," and thus intangible.[49]

5.6.2.2. Liability for Actions or Omissions Before and After 1970

The TTCA exempts from liability actions taken before January 1, 1970. It expressly provides that it does not apply to and a government entity cannot be held liable for an act or omission that occurred before January 1, 1970. So for infrastructure that was designed and constructed prior to 1970 where a WVC occurs as a consequence of a premises defect, or because new engineering practices would design and construct in a different way, TxDOT will not be held liable at suit. The next sub-section discusses this, but notes that there a few rare exceptions that it should be aware of. These exceptions include for the most part work that was conducted on the infrastructure after the effective date of the TTCA that contributed to the premises defect, such that immunity is waived and liability attaches.

Section 101.061 bars suits where the plaintiffs premises liability cause of action is based upon design and construction of a road completed prior to January 1970.[50] In Maxwell v. Texas Dep't. of Trnsp., the Austin Court of Appeals held that "If the [governmental defendant] proves that the culvert was completed before 1970 and has remained in the same condition since that time, then, as a matter of law, the [governmental defendant] is entitled to immunity under section 101.061."[51]

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[49] See also: *Univ. of Tex. Health Sci. Ctr. v. Dickerson*, 2014 Tex. App. LEXIS 1889, *19 (Tex. App.—Houston [14th Dist.] 2014, no pet.) ("[T]he use of computers, telephones or records to collect and communicate information is not a use of tangible personal property under [the Tort Claims Act,]" and "cannot provide the basis for a waiver of immunity under the [Act]."); *Dear v. City of Irving*, 902 S.W.2d 731 (Tex. App.—Austin, 1995 writ denied) ("The Supreme Court has specifically held that the Tort Claims Act does not eliminate governmental immunity for injuries resulting from the misuse of information."); *Axtell v. Univ. of Tex. at Austin*, 69 S.W.3d 261, 263 (Tex. App.—Austin, 2002 no pt.) ("The tangible personal property exception of the Act does not encompass an injury resulting from the disclosure of confidential information, however that information is transmitted.")

[50] See Shives v. State, 743 S.W.2d 714, 716 (Tex. App.--El Paso 1987, writ denied); Burnett v. State Dep't of Highways & Pub. Transp., 694 S.W.2d 210, 211 (Tex. App.--Eastland 1985, writ ref'd n.r.e.).

[51] Maxwell v. Texas Dep't of Transp., 880 S.W.2d 461, 465 (Tex. App.--Austin 1994, writ denied).

The courts will look to see if there was a duty to improve or warn for premises constructed prior to this time, but these cases can be distinguished. This pre-1970 immunity can extend to failure to improve roadways built before 1970. The section, at 101.061 bars a suit based solely on an act or omissions that occurred before the effective date of the TTCA, or upon a failure to make improvements thereafter. The act or omission is the actual building of the structure according to Maxwell v. Texas Dep't. of Trnsp. The failure to provide additional safety features and devices was held under Maxell to not constitute an act or omission within the meaning of this section.

In Tarrant County Water Control & Improvement District No. One v. Crossland the court looked at this precise issue. Here the plaintiffs argued that their cause of action was based on an act or omission that occurred after the effective date of the TTCA. The court here found that the failure to take action after 1970 could not form the basis of the claim under TTCA. The court held that when the bridge and reservoir were completed the state did not provide instructions or warnings and signs, so these omissions occurred prior to 1970. After 1970 the state continued to leave undone the installation or warnings, so the omissions continued to exist and appellees did not identify any new act or omission that occurred after 1970.[52] The courts of appeals have consistently followed this rationale in refusing to find liability based upon the failure to improve premises completed before 1970.

Where the courts have found that work was conducted after the effective date of the TTCA they typically look to see if the actions contributed to the premises defect to determine if liability can be attached.

5.6.2.3. Exclusions for Exercising Discretionary Powers

Finally in looking to determine liability the TTCA also provides exclusions for exercising discretionary powers. This area is extremely important for TxDOT as it begins to develop a wildlife crossing policy within the agency's policy making powers, and within manuals and other instructive documents. If TxDOT can show that while it is not required by law to implement wildlife vehicle crossings per se, once it chooses to do so, it will not be held liable for a decision to act, or not act under this section of TTCA.

Section 101.056 of the Act entitled "Discretionary Powers" provides the following:

> [The TTCA] does not apply to a claim based on:
>
> 1) the failure of a governmental unit to perform an act that the unit is not required by law to perform; or
> 2) a governmental unit's decision not to perform an act or on its failure to make a decision on the performance or nonperformance of an act if the law leaves the performance or nonperformance of the act to the discretion of the governmental unit.

[52] Crossland, 781 S.W.2d at 430

This discretionary powers exemption is to avoid judicial review of governmental policy decisions. Governmental entities cannot be held liable for policy decisions regardless of the activity involved according to TCPRC §101.056. This exclusion applies to a failure to act or an omission as well as positive acts of government entities.[53]

However, once a government decides to perform a discretionary act, the act must be performed in a non-negligent manner.[54] So if TxDOT, for example places a sign, or designs a culvert to be used as a wildlife crossing structure, but does so negligently, it could be held liable for this ‘negligent’ behavior.

Finding a bright line test to determine whether an activity is a discretionary decisions made at a policy making level rather than a decision on implementation of policies made at the operational level is not easy to discern from case law.

The cases in this area have broken into two categories:

1) governmental functions
2) discretion in design, construction and maintenance of roadways, bridges, and highways.

The courts will often focus on whether the matter requires exercising judgment that is discretionary, rather than caring out an obligation mandated by law where no discretion is left to the officer implementing this.[55] Shaunnessy notes that “At the same time, the exercise of professional judgment does not fall within the ambient of the discretionary act protection.”[56]

The next section discusses how the courts have determined the type of activity that the agency is conducting and how this may, or may not fall under the policy making exclusion of TTCA.

5.6.2.4. Government Functions

Governmental entities cannot be held liable for policymaking decisions or decisions made at a policymaking level. They are liable only for the negligent implementation of policy, which are often called operational level decisions. The courts have held that a series of decisions are a reflection of governmental policy and, therefore, cannot form the basis of liability these include

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[53] See Bellnoa v. City of Austin, 894 S.W.2d 821, 823 n.3 (Tex. App.--Austin 1995, no writ) (citation omitted).

[54] Cortez v. Weatherford Indep. Sch. Dist., 925 S.W.2d 144, 149-50 (Tex. App.--Fort Worth 1996, no writ).

[55] See State v. Rodriguez, 985 S.W.2d 83, 85 (Tex. 1999).

[56] Citing Texas Parks & Wildlife Dep't v. Davis, 988 S.W.2d 370, 374 (Tex. App.--Austin 1999, no pet.) (holding that the park manager’s decision not to remove the bench was the implementation of a policy level decision for which the Department could be held liable).

for our purposes: the decision regarding the training and supervision of personnel[57], the decision to raise a speed limit[58], the decisions regarding the placement of a stop sign, subject to the provisions of section 101.060.[59]

5.6.2.4.1. Discretion in Highway and Bridge Design, Construction Maintenance

There were two seminal decisions in 1999 where the Texas Supreme Court made it clear that the design of roads, bridges, and highways and decisions regarding improvement of public works are policy level decisions under section 101.056.

The first is State v. Miguel, 2 S.W.3d 249, 251 (Tex. 1999) and the second is State v. Rodriguez, 985 S.W.2d 83, 85 (Tex. 1999). State v. Miguel held that decisions about highway design and about the type of safety features to install are discretionary policy decisions. State v Rodriguez held that Design of any public work, such as a roadway, is a discretionary function involving many policy decisions and the governmental entity responsible may not be sued for such decisions.[60]

Shaunessy (Shaunessy, 2002) notes that:

> "Specifically, suit cannot be based upon the following: (1) the dangerous condition that arises from the government's regulation of traffic and parking and the width of traffic lanes

[57] See County of Brazoria v. Radtke, 566 S.W.2d 326, 330 (Tex. Civ. App.--Beaumont 1978, writ ref'd n.r.e.).

[58] See Bellnoa v. City of Austin, 894 S.W.2d 821, 827 (Tex. App.--Austin 1995, no writ).

[59] See Miller v. City of Fort Worth, 893 S.W.2d 27, 32-33 (Tex. App.--Fort Worth 1994, writ dism'd by agr.).

[60] For other decisions in this area see also Harris County v. Demny, 886 S.W.2d 330, 335-36 (Tex. App.--Houston [1st Dist.] 1994, writ denied) (O'Connor, J., dissenting) (arguing that the county was entitled to the definition that stated it could "not be found negligent for design defects or for the failure to include safety features in the design of a roadway even though the design may be a 'dangerous condition.'"); Maxwell v. Texas Dep't of Transp., 880 S.W.2d 461, 463 (Tex. App.--Austin 1994, writ denied) ("A governmental entity's discretion in the design of roads and bridges, which includes the installation of safety features such as guardrails and barricades, is protected from liability by section 101.056(2) of the Tort Claims Act."); Tarrant County Water Control & Improvement Dist. No. One v. Crossland, 781 S.W.2d 427, 433 (Tex. App.--Fort Worth 1989, writ denied) ("It is well established that the design of roads and bridges is a discretionary function, and the State will not be liable for such decisions."); Shives v. State, 743 S.W.2d 714, 717 (Tex. App.--El Paso 1987, writ denied) (holding that the State could not be liable for discretionary acts of not reducing the speed limit, failing to add a traffic light, and not properly installing a stop sign); Burnett v. Texas Highway Dep't, 694 S.W.2d 210, 212 (Tex. App.--Eastland 1985, writ ref'd n.r.e.) (holding that the Highway Department could not be liable for the discretionary decision to use a rigid barrier instead of a metal beam guard fence); Stanford v. State Dep't of Highways & Pub. Transp., 635 S.W.2d 581, 582 (Tex. App.--Dallas 1982, writ ref'd n.r.e.) (holding that the decision not to add guardrails was discretionary, thus the Department could not be liable). But see City of Tyler v. Likes, 962 S.W.2d 489, 501 (Tex. 1997) (holding that while the City's pre-1970 decision on whether to construct public improvements are exercises of governmental powers for which it cannot be held liable, the construction and maintenance of a storm sewer before 1970 was a proprietary function for which the City could be held liable); City of Fort Worth v. Adams, 888 S.W.2d 607, 613-14 (Tex. App.--Fort Worth 1994, writ denied)

or the width of streets, [61] (2) the design of an overpass, [62] (3) the decision regarding whether to install guardrails or to erect a barricade, a warning sign, or similar warning de-vices,[63] (4) the decision on whether to improve or upgrade roadways or bridges,[64] (5) the decision on whether to add safety devices or warning signals to a culvert located off a roadway,[65] (6) the decision on whether to raise or lower the speed limit,[66] (7) the design of roadway detours,[67] and (8) the decisions regarding materials used to warn of premises defects.[68]"

5.6.2.5. Decisions in Design of Roadways are Policy Level Decisions

The courts in interpreting 101.056 (2) of TTCA have distinguished between policy level decisions and professional or occupational discretion involved in the implementation of policy level decisions.

Currently only policy level decisions are protected from liability. A professional or occupation discretion that is applied in the implementation of the actual policy decision is not protected from liability under §101.056 (2) However, in Maxwell v Texas Department of Transportation the court found that a roadway design decision, made by an individual, inherently involved policy level decisions and was thus covered by immunity. The appellant here argued that the trial court had erred in basing its judgment on immunity for discretionary acts "because the Department's decisions regarding the placement of the culvert and its safety features involve professional or occupational discretion not protected under the Act." The court however disagreed noting actions involving occupational or professional discretion are devoid of policy implications.

The court in Maxwell noted that:

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[61] See Palmer v. City of Benbrook, 607 S.W.2d 295, 298-300 (Tex. App.--Fort Worth 1980, writ ref'd. n.r.e.).

[62] See City of El Paso v. Ayoub, 787 S.W.2d 553, 554 (Tex. App.--El Paso 1990, writ denied).

[63] See Barron v. Texas Dep't of Transp., 880 S.W.2d 300, 302-03 (Tex. App.--Waco 1994, writ denied); Wenzel v. City of New Braunfels, 852 S.W.2d 97, 100 (Tex. App.--Austin 1993, no writ); Stanford, 635 S.W.2d at 582.

[64] See Crossland, 781 S.W.2d at 433; Burnett, 694 S.W.2d at 212 (holding that the decision to change the median barrier is discretionary and one upon which liability cannot be predicated). But see Zambory v. City of Dallas, 838 S.W.2d 580, 582 (Tex. App.--Dallas 1992, writ denied) (holding there is an area of potential liability for negligent implementation of a design).

[65] See Maxwell, 880 S.W.2d at 463-64

[66] See Bellnoa v. City of Austin, 894 S.W.2d 821, 827 (Tex. App.--Austin 1995, no writ); Shives v. State, 743 S.W.2d 714, 715 (Tex. App.--El Paso 1987, writ denied). But see Garza v. State, 878 S.W.2d 671, 675 (Tex. App.--Corpus Christi 1994, no writ) (holding that a 45 mile-per-hour speed limit sign misled the public into believing that it was reasonable and safe to drive 45 miles-per-hour when this speed was actually excessive for that portion of the roadway).

[67] See State v. Rodriguez, 985 S.W.2d 83, 85-86 (Tex. 1999).

[68] See State v. Miguel, 2 S.W.3d 249, 250-51 (Tex. 1999).

> “Decisions regarding the design of a highway and the installation of safety features, however, do not fall into this category. It is not proper for a court to second-guess the agency's decision that some other type of marker or safety device would have been more appropriate . . . or that the culvert was placed too close to the highway. To do so would displace the authority of the agency responsible for making such decisions. Contrary to [the appellant's] argument a "professional," such as an engineer, may use his or her skills in designing adequate safety features for a highway without subjecting the process to judicial review as an occupational or professional class of agency action. Thus, even though the Department may have used engineering expertise and discretion in the planning and design of the culvert, the action remains in the informed discretion of the agency and exempt from liability under section 101.056(2) [of the TTCA].”[69]

So processes or decisions made at a ‘policy-level’ regarding the triggers and other components that constitute TxDOT’s decision to implement a wildlife crossing, or other mitigating treatment could fall within the act’s exception sections. For example creating a policy within a long range plan, or developing a process in an environmental review document, or another type of policy document decision making process, would provide protection for TxDOT in determining the ‘how’ and ‘when’ to put crossings or treatments in place. According to Maxwell’s dicta the discretion exemption will drill down all the way to the design process of TxDOT as well.

It should be noted though, that under this discretionary defense, the duty to maintain is not discretionary. Maintenance of roadways and other premises is considered ministerial and non-discretionary. So a government unit can be held liable for the failure to properly maintain a public roadway. Presumably this duty will follow through to maintenance of structures or other mitigation elements, excluding signs, for wildlife crossing treatments and crossing structures which fall within a separate section of TTCA. The determination of whether a discretionary act exclusion of liability is a question of law and will be for a court to decide.

5.6.3. Initial Conclusions

As can be seen from the aforementioned discussion, TxDOT will need to analyze both statute and case law to determine whether it may be liable for its actions in implementing, or not implementing wildlife crossing structures.

However, under section 101.056 of TCPRC, if TxDOT creates a policy for why, when and how it will install wildlife crossing structures, this in itself will be exempt from liability. Case law under this exclusionary section of TTCA and under the general provisions of TTCA may provide a fairly robust defense to the creation of a wildlife crossing policy and decision making process. This will run down to the level of discretionary decision of an individual engineer in determining where to place, and how to design, construct and maintain a crossing structure or mitigation component.

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[69] See Maxwell, 880 S.W.2d at 461 and 464.

The case law analysis and review of sovereign immunity under the TTCA has shown that if TxDOT creates a robust and detailed policy on wildlife crossings that the agency may find immunity comfort at multiple levels under the TTCA for both policy decisions, and staff design, construction and maintenance activities that are not conducted in a negligent fashion.

The final portion of this section provides a brief snapshot of wildlife vehicle conflict case law in the U.S. and the most notable case that found DOT liability in Arizona.

5.7. Wildlife Vehicle Conflict U.S. Case Law

Only in an extremely limited number of cases has a DOT been found to be liable for death/injury as a consequence of a wildlife vehicle crash. In Carlson v. State of Alaska 598 P2d 969; 1979 (August 24, 1979) the Supreme Court of Alaska noted that:

> "there is a surprising dearth of case law not only in Alaska but also in other states and in the federal courts on the issue of liability for damage caused by a wild animal when the animal is not under the control of the defendant." [70]

The most notable case in recent history where liability was found against a DOT is Booth v. Arizona, 207 Ariz. 61; 83 P.3d 61 (Ariz. Ct. App. 2004)[71]. The facts of this case concerned a motorist who was severely injured when the car he was driving collided with an elk carcass that was lying on the highway. The Booths sued the state alleging that I-40 was not reasonably safe due to the presence of elk on the highway. At trial, he contended that the state negligently had failed to evaluate the known hazard of elk crossing the highway, use appropriate fencing, clear cut vegetation, or reduce the speed limit. The state moved for summary judgment, arguing that it could not be held liable for an injury caused by a wild animal not in the state's possession or control. The trial court denied the motion, and the jury returned a substantial verdict in favor of the Booths.

The state argued[72] that in setting the outer limits of what could be considered a negligent act the court should adopt the doctrine of *ferae naturae* and hold as a matter of law that the state cannot be held liable for injuries caused by indigenous wild animals.[73]

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[70] Carlson v. State of Alaska 598 P2d 969; 1979 (August 24, 1979)

[71] DOT is Booth v. Arizona, 207 Ariz. 61; 83 P.3d 61 (Ariz. Ct. App. 2004)

[72] At appeal the County Supervisors Association appeared as amicus curiae for the case and urged the court to adopt the state's position as a matter of public policy.

[73] According to the court: Ferae naturae means "of a wild nature or disposition." See Black's Law Dictionary 635 (7th ed. 1999). The doctrine of animals ferae naturae relates primarily to property rights. See Nicholson v. Smith, 986 S.W.2d 54, 60-61 (Tex. App. 1999). A wild animal, ferae naturae, as opposed to a domesticated animal, [**65] [*65] domitae naturae, is owned by the state or the people at large. An individual [***7] does not acquire property rights in an animal ferae naturae as long as the animal remains wild, unconfined, and undomesticated. Id. Even a

The court noted, however, that:

> "The state cites no case in which a court has categorically barred negligence claims based on injuries caused by wild animals. Rather, in negligence cases, courts have used the term ferae naturae as shorthand for the general proposition underlying the doctrine--that wild animals exist throughout nature, they are generally not predictable or controllable, and therefore, without more, they are neither the property nor the responsibility of the owner or occupier of land on which they are found. Thus, the doctrine has not been historically applied so as to alter the traditional analysis of a negligence claim."[74]

The court's reasoning at appeal noted that the case did not involve statutory sovereign immunity or excerptions thereto[75] and because Arizona DOT had not acted uniformly in installing mitigation measures, and had not explained its decision to not uniformly apply mitigation treatments. The court noted that there had been a substantial increase in the elk population within the area, with 168 vehicle collisions with elk or deer over a seven year period. Additionally, the state DOT had installed wildlife mitigation measures on another highway that had considerably fewer WVCs than I-40.

The court noted that*:*

> "the state also argues that it should be relieved from liability on public policy grounds because of 'the tremendous cost and futility of trying to animal-proof our highways.' But…the state's briefs direct did not direct us to any facts in the record which establish that such costs are either tremendous or unreasonable. Furthermore, the state does not dispute that it has undertaken substantial measures to prevent collisions with large animals on SR-260 and that such measures can be ninety-six percent effective. Such actions suggest that the state itself has concluded that protecting our citizens from collisions with large animals is neither prohibitively expensive nor futile."

Utilizing this evidence the court concluded that as the DOT had done 'nothing other than post additional warning signs regarding elk in the area of Booth's accident' it could therefore be held liable for its failure to take action to prevent the harm to booth. The court thus utilized the traditional common law duty of care standard under negligence theory. The court noted that based on the testimony and exhibits offered by both sides, including the collision data presented at trial, a jury could reasonably conclude that the state had ample notice of a dangerous condition on this portion of I-40. A jury could also reasonably conclude that the state had breached its duty of reasonable care based on, among other things, the additional measures taken to prevent the same harm in an area that presented only about half the risk. Under these particular facts, the trial court

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landowner does not acquire property rights to the wild animals naturally existing on his or her land unless they are reduced to actual possession and control. Id at 7.

[74] Id at 8

[75] Id at 12.

did not err in submitting the Booths' negligence claims to the jury. The appeals court upheld the jury verdict against the State DOT and in its closing noted that:

> "In the absence of any persuasive public policy reason for immunizing the state from liability for all injuries caused by wild animals, no matter how foreseeable the risk or how feasible the remedy might be, and in the absence of any expression of legislative intent to limit state liability in this arena, we decline to expand the common law as the state ... suggest."[76]

Moreover, *the court caveated* its decision and conclusion to note it did not mean that governmental agencies must 'animal proof all highways' or suggest that any particular action should be taken. A DOT that acts uniformly, or explains differences in approaches for particular sites may be able to avoid lability.[77]

The Booth case however, should be distinguished, both on facts of the case and because it has not been followed in subsequent decisions within the U.S. A LexisNexis sherardization (that provides a list of all the authorities citing a particular case, statute, or other legal authority in the U.S.) that this case has not been followed in subsequent cases and therefore had a negative treatment explainer added to it.

5.8. NEPA Considerations

5.8.1. NEPA Assignment

SAFETEA-LU (23 United States Code §327(h)) created the Surface Transportation Project Delivery Program (continued under MAP-21, and the FAST Act) whereby federal transportation law authorizes delegating the National Environmental Policy Act (NEPA) review and approval processes to state DOTs. The Texas Department of Transportation (TxDOT) became the second state DOT to assume responsibility for determinations of categorical exclusions (CEs), environmental assessments (EAs), and environmental impact statements (EISs) in 2014.

TxDOT and FHWA entered into an MOU on December 16, 2014, that approved TxDOT's application to participate in the Surface Transportation Project Delivery Program. Under this program, FHWA assigned TxDOT the USDOT Secretary's responsibilities for environmental review and other actions required under federal environmental law.

Part 3 of the MOU addresses responsibilities and roles assigned to TxDOT and FHWA. TxDOT is assigned "all of the USDOT Secretary's responsibilities for compliance with the National

76 Id at 23.

77 Id at 21

Environmental Policy Act of 1969" (FHWA Tx Division 2014, p. 2) for highway projects. Federal law also permits the assignment of railroad, transit, and multimodal projects[78] at the state's request. TxDOT has not requested nor been assigned NEPA responsibilities for these categories of projects. In addition to NEPA duties, the MOU lists numerous federal environmental laws for which TxDOT is now also responsible. Part 3.2 of the MOU lists these legal responsibilities in detail. Table 5.1 summarizes assumed responsibilities that should be reviewed when considering or developing wildlife crossings.

[78] 23 USC §327(a)2(B)(ii)

Table 5.1 Federal Environmental Responsibilities Other than NEPA Assigned to TxDOT

Topic	CE Assignment MOU	Full NEPA Assignment MOU
Wildlife	Marine Mammal Protection Act, 16 U.S.C. 1361	Marine Mammal Protection Act, 16 U.S.C. 1361-1423h
Water Resources and Wetlands	Clean Water Act, 33 U.S.C. 1251-1377 (Sections 404, 401, 319)	Clean Water Act, 33 U.S.C. 1251-1387 (Sections 404, 401, 319, 402, 408)
	Coastal Zone Management Act, 16 U.S.C. 1451-1465	Coastal Zone Management Act, 16 U.S.C. 1451-1466
	Safe Drinking Water Act, 42 U.S.C. 300f–300j–6	Safe Drinking Water Act (SDWA), 42 U.S.C. 300f–300j–26
	--	General Bridge Act of 1946, 33 U.S.C. 525-533
	Section 10 of the Rivers and Harbors Act of 1899, 33 U.S.C. 401–406	Rivers and Harbors Act of 1899, 33 U.S.C. 401–406 (all)
	Emergency Wetlands Resources Act, 16 U.S.C. 3921, 3931	Emergency Wetlands Resources Act, 16 U.S.C. 3921
	Flood Disaster Protection Act, 42 U.S.C. 4001–4128	Flood Disaster Protection Act, 42 U.S.C. 4001–4130
Parklands and Other Special Land Uses	Land and Water Conservation Fund (LWCF) Act, 16 U.S.C. 4601-4	Land and Water Conservation Fund (LWCF) Act, 16 U.S.C. 4601-4—4601-11
FHWA Specific	--	Planning and Environmental Linkages, 23 U.S.C. 168
	--	Programmatic Mitigation Plans, 23 U.S.C. 169

Source: CE Assignment MOU (December 2013) and Full NEPA Assignment MOU (December 2014)

TxDOT is also responsible for ensuring that projects are consistent with various long-range transportation planning documents.

The FHWA retains responsibility for government-to-government consultation, Section 4(f) of the DOT Act approvals, air quality conformity determinations of the Clean Air Act, Section 106 of NHPA, Section 7 of ESA, and projects involving certain federal lands.

To make the MOU legally possible, the State of Texas waived its 11th Amendment right to sovereign immunity and can be sued for decisions and approvals made while carrying out federal environmental responsibilities. Part 6 of the MOU assigns all responsibility and liability to TxDOT, including all costs associated with a lawsuit. No responsibility now is placed with FHWA or USDOT. While TxDOT is the only liable party, the FHWA and the Department of Justice (DOJ) must be consulted or notified throughout the litigation process. Figure 5.1 provides the reader with a quick guide to the MOUs sections.

Part 1: Purpose

This MOU officially approves TxDOT's participation in the Surface Transportation Delivery Program, and it replaces the CE Assignment MOU.

Part 2: [Reserved]

Reserved for future use.

Part 3: Assignment of Responsibilities

TxDOT is assigned federal responsibility for NEPA and other federal environmental requirements for highway projects. Excluded project types are also listed.

Part 4: Acceptance of Jurisdiction

TxDOT commits to ensuring funding and qualified staff to carry out these duties. It accepts federal court jurisdiction, and it certifies it has the legal ability to do so.

Part 5: Applicability of Federal Law

Other federal laws also apply to TxDOT in carrying out these responsibilities, including executive orders, USDOT orders, and other federal guidance.

Part 6: Litigation

TxDOT is solely liable and responsible for carrying out assumed responsibilities. During litigation, it must coordinate closely with FHWA and DOJ.

Part 7: Involvement with Other Agencies

Procedures and processes for interagency coordination must be formally documented to ensure proactive coordination, particularly with the EPA.

Part 8: Involvement with FHWA

FHWA will not provide assistance or intervene unless deemed necessary. Monitoring and oversight with provide a regular feedback loop. FHWA retains CAA.

Part 9: Withdrawal of Responsibilities

Either TxDOT or FHWA may initiate withdrawal. Impact on projects and rationale will be examined to determine responsibilities to be withdrawn.

Part 10: Performance Measures

TxDOT must collect and maintain data to show progress toward four primary performance measures. Eight sub-measures are also listed.

Part 11: Audits

TxDOT and FHWA each have a coordinator to schedule and execute semiannual audits. Consultants as well as federal and state agencies may be invited.

Part 12: Training

FHWA provides initial training. TxDOT and FHWA develop and update training needs plans annually to address gaps.

Part 13: Term, Termination, and Renewal

The term of the MOU is five years, and may be updated per regulations at the time of renewal. Procedures for termination are also included.

Part 14: Amendments

Amendments can be added at any time upon mutual agreement. If responsibilities beyond TxDOT's current application are requested, and a supplement is needed.

Source: Loftus-Otway et al., 2017

Figure 5.1 MOU Quick Guide

In TxDOT Project 0-6866 Loftus-Otway et al. created Table 5.2 to assist TxDOT staff with determining who has appropriate signature authority per project type.

Table 5.2 Potential Signature Authority Matrix

Determining Class of Action	Federal- Assigned[79]
CE	PS
EA	DEM*
EIS	DEM*
CE Approvals	
Prepare Project File for Signature	PS
Sign CE Determination Form – (c)	Reviewer and DD
Sign CE Determination Form – (d)	Reviewer and DE/A
EA Approvals	
Prepare FONSI Package	CT and PS
Review FONSI Package	PDD or E-SPS
Sign FONSI	ED
EIS Approvals	
Draft EIS (DEIS)	ED
Public Hearing	CT*
Final EIS (FEIS)	PDD or E-SPS*
Record of Decision (ROD)	ED
Section 4(f) Approvals	ED*; submits to
Reevaluation Approvals	
No additional documentation	DD*
Additional Documentation	ED*
**TxDOT is still updating its toolkits to reflect NEPA*	
Abbreviations/Glossary:	
EA- Environmental	**CE- Categorical Exclusions**
EIS- Environmental Impact	**FONSI- Finding of No**
DEM- Division	**PS- Project Sponsor**
DE/A- District	**DD- Department Delegate**
PDD- Project Delivery	**CT- Core Team**
ED- ENV Director	**E-SPS- ENV Strategic**

Source: TxDOT EIS Handbook (2014), EA Handbook (2014), FONSI Guidance (2015), CE Handbook (2015)

[79] Projects that are not assigned by the TxDOT MOU are to be signed by the assigned authorization but submitted to the FHWA for review and final approval.

5.8.2. Why Review Case Law?

Assessing the impact of how case law impacts TxDOT's duties under NEPA Assignment is instructive on many fronts, and for ensuring that suits are not brought for decisions made around wildlife crossing analysis or implementation. For those wishing to learn more about NEPA in general, we would refer the readers to TxDOT report 0-6701-1 *(Linking Long-Range Transportation Planning with Project Planning in Support of the Environmental Review Process)* and for NEPA assignment to TxDOT project 0-6866-1 (*NEPA Assignment in TxDOT: Analysis, Review, and Training Modules*) that also details case law and its relation to TxDOT's authority for environmental documentation under NEPA Assignment. In addition AASHTO's Center for Environmental Excellence holds a database of NEPA case law[80] and is a useful resource on many elements of NEPA.[81] What is clear from the analysis is that TxDOT, under its NEPA Assignment duties and obligations, must ensure that staff members at all levels are cognizant of how their actions may impact litigation, as litigation can impact, or delay project outcomes.

This section outlines major elements to be considered as TxDOT begins to integrate decision making components for wildlife crossings within TxDOT's planning process under NEPA assignment through the lens of case law.

5.8.3. Background and History of NEPA

The National Environmental Policy Act (PL 91-190) (NEPA) 42 USC §4331 was signed into law in 1970. Title I of NEPA requires federal agencies to integrate environmental values into decision making processes using a systematic, interdisciplinary approach that considers the environmental impacts of proposed agency actions and reasonable alternatives for those actions. The NEPA legislation established the CEQ within the Executive Office of the President. The CEQ oversees federal agency implementation of environmental impact assessment and also acts as a referee if agencies disagree over the adequacy of assessments. In 1978, the CEQ issued binding regulations that set the requirements necessary for agencies to fulfill their NEPA obligations (CEQ, 2007).

Where state agencies utilize federal funds they are required to follow NEPA's administrative process and ensure that decisions regarding projects are not made in an arbitrary and capricious fashion.

5.8.3.1. The NEPA Statute

NEPA is a procedural statute and not a substantive statute; in Crenshaw v LA County Metro Transportation Authority the court noted that *"NEPA does not mandate particular substantive*

[80] See: https://environment.transportation.org/clue/

[81] See https://environment.transportation.org/

results, but instead imposes only procedural requirements." [82] Under NEPA the procedural requirement is for agencies to analyze the environmental impact of their proposals and actions. *"NEPA requires agencies to follow a set of action-forcing procedures that require that agencies take a hard look at environmental consequences and that provide for broad dissemination of relevant environmental information."*[83] NEPA does not require an agency to reach any particular conclusion; rather it requires engaging in an environmentally conscious process that may not reach an environmentally friendly result[84]. Under NEPA Assignment, this means that TxDOT must ensure that their delegated authority comports with federal rules regarding the management, oversight, and processes behind conducting NEPA analysis. This requires that TxDOT will base all NEPA decisions on detailed information regarding significant environmental impacts—*"It is not this court's role under NEPA to referee expert disputes when the agency reasonably evaluates the relevant factors."*[85] According to case law "*NEPA merely prohibits uninformed—rather than unwise—agency action.*"[86] A reviewing court must ensure that the agency has examined the relevant data and articulated a satisfactory explanation for its actions.[87] While courts have noted that this standard is highly deferential, it does not reduce judicial review to a rubber stamp of agency action.[88]

5.8.4. NEPA Process

Once a proposed action is developed, an agency will begin an analytical approach to determine which of three processing and environmental documentation options it will undertake. The three options are a categorical exclusion (CE); an environmental assessment (EA); and an environmental impact statement (EIS). The NEPA process is outlined in Figure 5.2.

[82] Crenshaw Subway Coalition, v. Los Angeles County Metropolitan Transportation Authority 2015 U.S. Dist LEXIS 143642

[83] Coliseum Square Ass'n, Inc. v. Jackson, 465 F.3d 215, 224 (5th Cir. 2006).

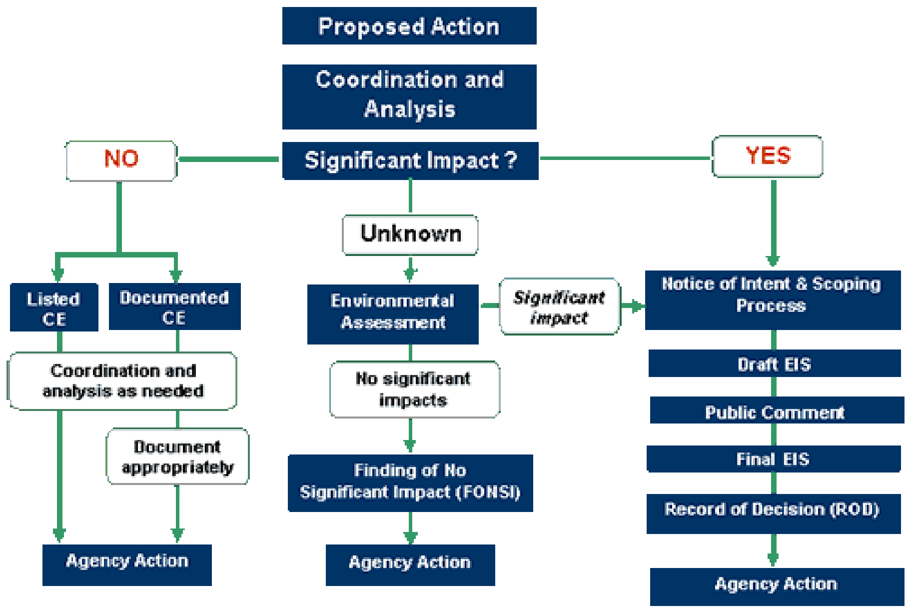
[84] Robertson v. Methow Valley Citizens Council, 490 U.S. 332, 350, 109 S. Ct. 1835, 104 L. Ed. 2d 351 (1989).

[85] Clean Air Carolina, North Carolina Wildlife Federation and Yadkin Riverkeeper v. North Carolina Department of Transportation, 2015 U.S. Dist LEXIS 120634

[86] Robertson, Methow Valley Citizens Council, 490 U.S. 332, 350, 109 S. Ct. 1835, 104 L. Ed. 2d 351 (1989) at 350

[87] N.C. Wildlife Fed'n, 677 F.3d at 601

[88] Friends of Back Bay v. U.S. Army Corps of Eng'rs, 681 F.3d 581, 587 (4th Cir. 2012)



Source: AASHTO, NEPA Process

Figure 5.2 The NEPA Process

Table 5.3 briefly outlines these categories of activities.

Table 5.3 NEPA Activity Categories

Type	Description of Activity
Categorical Exclusion (CE)	Activity that the agency determines does not individually or cumulatively have a significant effect on the quality of the environment. Agencies must check to ensure no extraordinary circumstances exist that can cause the proposed action to have a significant effect in a particular situation. Examples include effects to/on wetlands, endangered species or protected cultural sites. If there are no such effects the agency can proceed with the action, after posting notice in the federal register. If the proposed activity does not fall in the CE list the agency must prepare either an EA or EIS.
Environmental Assessment (EA)	Required to determine the significance of the environmental effects and review alternatives that can be undertaken to achieve agency's objective. The EA is usually a concise document and must provide sufficient analysis and evidence to determine whether to prepare an EIS.
Environmental Impact Statement (EIS)	Required when the activity proposed is a major federal action that will significantly affect the quality of the human environment. There are multiple requirements for an EIS compared to a CE or EA. Key elements within the EIS include the purpose and need statement, identification and analysis of alternatives that could meet the purpose and need of the proposed action, and analysis of direct, indirect and cumulative impacts.

Source: Loftus-Otway et al. 2017

5.8.5. Cases after NEPA Assignment

Three cases for litigation that has occurred since a State DOT has been authorized with NEPA Assignment show that the courts analysis under the Administrative Procedures Act, will still most likely find in favor of an agency's decision making processes.

5.8.5.1. The Center for Biological Diversity v. California Department of Transportation (2011)

The Center for Biological Diversity and Sierra Club sued Caltrans (California's Department of Transportation) under NEPA, alleging that the Agency and U.S. Army Corps of Engineers (USACE) violated the Clean Water Act by adopting a four-lane highway bypass along U.S. Highway 101 through an ecologically sensitive redwood grove and creek in Willits, CA. The plaintiffs argued that Caltrans' adoption of four lanes, as opposed to two lanes, as the least environmentally damaging practicable alternative from project re-evaluation did not take into full account the direct and indirect cumulative impacts. The U.S. District Court found with Caltrans and USACE (Caltrans, 2011).

This case did not directly challenge Caltrans assumption of NEPA authority, but was the first case where Caltrans was challenged as the authorizing agency under Section 6005 of SAFTEA-LU (AEP, 2011). The case details the changing nature of leadership and interagency agreements under Assignment, with particular reference to disagreements between USACE and Caltrans over Section 4(f) considerations. Caltrans had to modify the project design to resolve a conflict with USACE on the project's purpose and need statement. Once USACE agreed with the CalTrans effort, the final decision on the project became defensible.

The case brought to light the need for state DOTs to become more involved with traditional FHWA duties when assuming authority as Lead Agency (AEP, 2014). NEPA Assignment mandates the state DOT to fully assert its role as leader as the authorizing agency. This requires a broad scope of consultation across departments to expand the Agency's stewardship and oversight with key regulatory level organizations on complex environmental reviews and projects (AEP, 2014).

5.8.5.2. National Resources Defense Council, Inc. v. California Department of Transportation (2013) & National Resources Defense Council, Inc. v. U.S. Department of Transportation (2014)

The Natural Resources Defense Council and two citizen groups (East Yard Communities for Environmental Justice and Coalition for a Safe Environment) sued Caltrans under NEPA, challenging the approval of the final environmental document for the State Route 47 Alameda Corridor Truck Expressway Project within the Ports of Los Angeles and Long Beach.

Upon federal appeal, the U.S. Department of Transportation, FHWA, and Caltrans are the defendants in the NEPA case. The Alameda Corridor Transportation Authority is the real party of interest. The lawsuit challenges the air quality conformity determination, climate change analysis, adequacy of the EIS, and range of alternatives evaluated. The 9th District Court ruled in favor with the State and regulatory agencies, asserting that the "hard look" and "hot-spot analysis" conducted by Caltrans District 7 complied with the Clean Air Act (CAA) and was neither subjective nor arbitrary (Caltrans, 2013).

This case raised many of the same issues as Center for Biological Diversity. When a DOT becomes the Lead Agency, it takes full rein in demonstrating compliance with all the environmental statues beyond NEPA. CalTrans had to demonstrate air quality conformity to the FHWA California Office Division just like it would do a wetlands permit with USACE or an Endangered Species Section 7 consultation with the US Fish and Wildlife Service (USFWS). The state FHWA Division Office thus becomes effectively a "regulatory agency" for any statutory requirements that are not delegated to the DOT.

5.8.5.3. Pacificans for a Scenic Coast v California Department of Transportation (2016)

This case was brought by a nonprofit and surrounded the widening of Part of Highway 1 that was adjacent to two Golden Gate National Recreation Area units that were habitat for two listed species under protection.[89] Caltrans acting under its NEPA Assignment program consulted with USFWS to ensure that the project would not jeopardize these listed species and their critical habitat. Caltrans prepared a mitigation measures document. This included preserving a 5.14-acre parcel that was owned by the city of Pacifica, and enhancing this by preserving a tract of 5.46 acres within the Golden Gate National Recreation Area to create a corridor that would encourage snakes and frogs to move between this parcel and their habitat near Sharp Park. USFW issued a Biological Opinion (BO) that concluded that the project would not jeopardize the species. Caltrans later learned it was already legally obligated to preserve the 5.14 acre tract, but it did not reinitiate a consultation. A FONSI was issued under the EA prepared for the project. Figure 5.3 shows a snapshot of the project and mitigation elements as detailed within the courts judgement.

[89] Pacificans for a Scenic Coast v. Cal. DOT, 204 F. Supp. 3d 1075 (September 2, 2016)

Source: Pacific v Caltrans 2016

Figure 5.3 Snapshot of Mitigation Projects

The Plaintiffs argued that:

- Caltrans and USFWS violated the state's NEPA statute (ESA)
- Inaccurately described the project
- The BO was flawed as it relied on inaccurate information
- Agencies should have reinitiated consultation after learning that one mitigation measure was impossible.
- Two further issues regarding the Coastal Zone Management Act and the Section 4 (F) consultation.

The plaintiffs argued that the adequacy of the EA and the decision to issue a FONSI was flawed as a consequence of these elements.

The court found in favor of the plaintiffs for the ESA claims and held that the BO violated the Administrative Procedure Act. The court held for Caltrans for the NEPA, CZMA and Section 4 (f) claims.

In assessing the alleged discrepancies between the project Caltrans had described in the Biological Assessment and the project Caltrans described in other documents after the Biological Assessment was submitted, the court noted that Not "every modification of or uncertainty in a complex and lengthy project" implicates the Endangered Species Act.[90] The court noted that *most of the discrepancies (to the extent they are real at all) are inconsequential, and do not amount to a violation of the Endangered Species Act. Nevertheless, one discrepancy — concerning whether Caltrans' project includes a proposed mitigation measure to offset adverse effects on listed species and their habitat — is significant enough to fatally undermine the Biological Assessment.*[91]

The court in its analysis distinguished between Caltrans role as a State DOT and its role acting on behalf of the FHWA, under which it now required to comply with obligations under the Endangered Species Act. The court noted

> "Recall that Caltrans plays two roles with respect to the proposed project. Caltrans, acting on its own behalf as a state transportation agency, is responsible for widening Highway 1. Separately, Caltrans — acting on behalf of the Federal Highway Administration — is responsible for [**17] approving Caltrans' widening of Highway 1, for purposes of federal environmental laws. The fact that Caltrans has assumed the role of the Federal Highway Administration (a federal agency) is the reason that Caltrans is subject to Endangered Species Act section 7 (which applies only to federal agencies) in the first place: having assumed the role of the Federal Highway Administration, Caltrans has an obligation to ensure that any action "authorized" or "funded" by the Federal Highway Administration complies with the Endangered Species Act. 16 U.S.C. § 1536(a)(2). When it comes to Caltrans' obligations under section 7, the relevant action agency is Caltrans in its capacity as the Federal Highway Administration, not Caltrans in its capacity as Caltrans."

In assessing the decision making process regarding the parcel the court noted, that:

> It may well be that the Fish and Wildlife Service could re-analyze Caltrans' project with the understanding that the 5.14-acre parcel is already preserved, and still come to a similar conclusion about the project's overall effects on listed species. But Caltrans' project description was arbitrary and capricious because it ignored "an important aspect of the problem" — the fact that the 5.14-acre parcel was already preserved. This resulted in a faulty Biological Opinion, which in turn resulted in an invalid approval of the project under the Endangered Species Act by Caltrans (standing in the shoes of the Federal Highway Administration). The plaintiffs are therefore entitled to a declaration that Caltrans breached its procedural obligations under section 7 of the Endangered Species Act."

As TxDOT begins to implement further use of wildlife crossings and mitigation techniques, its role under NEPA Assignment will also need to ensure that it complies with provisions of ESA in its stand in role for FHWA.

[90] Conservation Cong. v. Finley, 774 F.3d 611, 619 (9th Cir. 2014).

[91] Pacificans for a Scenic Coast v. Cal. DOT, 204 F. Supp. 3d 1075

5.8.6. NEPA Case Law

NEPA case law has developed precedent on the application, administration, and implementation of NEPA. Most cases are brought by communities and nonprofit entities that question NEPA processes, usually especially regarding decision or arbitrary decision making, project purpose and need, indirect and cumulative impacts, alternatives analysis and the administrative record.

The Council on Environmental Quality (CEQ) (which develops all regulations on NEPA) conducted surveys on NEPA litigation between 2001 and 2015 (CEQ Obama Administration website, not dated). In 2013 (now the *latest data available*[92]), there were 96 cases filed, and 14 injunctions and remands issued. Across the U.S. Department of Transportation (USDOT) agencies (Federal Highway Administration (FHWA), Federal Transit Administration (FTA), Federal Aviation Administration, Surface Transportation Board, and Federal Motor Carrier Safety Administration), 4 lawsuits were filed out of the 96 in total. No injunctions or remands were issued on these 4 cases. The preponderance of NEPA cases were brought by public interest groups and individual citizen associations (75 out of the 96). Tables 5.4 and 5.5 show how dispositions broke down across all the 2013 cases.

Table 5.4 Basis of NEPA Dispositions in 2013 (Source: CEQ, 2013)

Decision type	No. of Cases
Jurisdictional – Plaintiff Prevailed	0
Jurisdictional – Defendant Prevailed	7
NEPA not required	4
NEPA is required	0
CE adequate	0
CE not adequate	2
EA adequate	5
EA not adequate	1
EIS adequate	8
EIS not adequate	1
Supplemental EIS needed	0
SEIS not needed	0
TOTAL	96

[92] CEQ's website has removed all historical data on this issue. A January 2018 search of website found none of the reports, regulations, policy memos, or analysis that had hitherto been on this site. A search of the Wayback Machine site at http://archive.org/web would need to be conducted to find further data on the surveys.

Table 5.5 Plaintiffs in NEPA Cases Filed in 2013 (Source: CEQ, 2013)

Plaintiff	Cases filed
Public interest group	65
Individual/Citizen association	10
Local Government	2
Business group	6
Indian tribe	1
Multiple plaintiff types	12

The NEPA cases filed between 2010 and 2012 break down thusly:

- 2012 – 88 cases filed, with 10 injunctions and remands. Of these 88 cases, 7 were filed against USDOT agencies.
- 2011 – 94 cases filed, with 21 injunctions and remands. Of these 94 cases, 20 were filed against USDOT agencies.
- 2010 – 87 cases filed, with 16 injunctions and remands. Of these 87 cases, 15 were filed against USDOT agencies.[93]

5.8.7. NEPA Case Law Analysis

Specific areas from case law that TxDOT staff should be cognizant of, as a consequence of NEPA assignment and the state's waiver of sovereign immunity, include the Administrative Record (AR), Alternatives Analysis (AA), Arbitrary and Capricious Decision Making (ACD), Purpose and Need (P&N), Predetermination of a Favored Outcome (PFO), and the Determination of using a CE, EA, or EIS.[94]

The past 48 years, has seen the U.S. courts develop many tests to determine whether certain aspects of NEPA decision making have been fulfilled. This section utilizes a selection of case law to showcase how TxDOT's new responsibilities should be considered in the aforementioned causes of action, as they determine decisions on when, how, and why to install wildlife crossings.

[93] Please note that CEQ's website has no information on this issue any more. 2013 data is the most up to date data, as reproduced in TxDOT Project 0-6866 NEPA Assignment.

[94] As noted earlier, a legal analysis of case law was undertaken during TxDOT Research Project 0-6701 and 0-6866, if readers wish to further familiarize themselves on NEPA case law.

5.8.7.1. Federal Court Role

The federal courts have jurisdiction over NEPA under the Administrative Procedure Act (APA) under 5 U.S.C. §551–59 & §701–06. The APA stipulates that any agency decision that is *"arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law"* shall be set aside (5 U.S.C. §706(2)(A)). Courts cannot substitute their judgment (or some might say analysis of a specific act or process) for that of an agency. Once an agency has made a decision subject to NEPA's procedural requirements, the courts only role is to ensure that the agency has considered the environmental consequences and has done so in a clearly defined way.[95]

5.8.7.2. Administrative Record

The AR is extremely important to the NEPA process based upon case law precedent. This is because judicial review under the APA judicial review is limited to the AR that is *in existence*. The AR is created from the administrative file created by an agency: the AR is NOT the administrative file ion itself, but rather the record of the process that connects the decision making documents. The AR is the document that is reviewed to determine P&N, ACD, PFO, AA, and the determination on whether the project is assessed as a CE, EA or EIS.

Courts may allow new evidence to be introduced in very limited circumstances, so the administrative file is a critical item for TxDOT to maintain in an orderly fashion for construction of an AR. Given that the decisions to implement wildlife crossing structures, and the utilization of what some may deem 'scarce resources' may be politically charged it is extremely important that as TxDOT begins to implement AVC's they ensure that a coherent and demonstrable decision making process is created.

The AR should afford the reader (which in a court case is the judge) with clear documentation, and an explanatory process, to understand how the decision was made, i.e. showcasing a rational, *evidence-based* decision making processes. The strong AR will provide a defensible decision by the agency. A weak or incomplete AR, on its face, renders the agency's decision less confident. The AR should be created by TxDOT's General Counsel Division, the Attorney General of Texas, or TxDOT's Outside Counsel. They will examine and identify documents in the project file and will instruct on how to compile the AR.

Figure 5.4 shows the main documents/items that should be in the AR, with items bolded that will be of particular importance for wildlife crossing amelioration, while Figure 5.5 shows what should not be included in the AR.

[95] Strycker's Bay Neighborhood Council, Inc. v. Karlen, 444 U.S. 223, 227, 100 S. Ct. 497, 62 L. Ed. 2d 433 (1980).

What SHOULD be in the AR?	
Draft Environmental Impact Statement (DEIS), Final Environmental Impact Statement (FEIS), Record of Decision (ROD), (Environmental Assessment (EA) and Finding of No Significant Impact (FONSI) Technical reports Manuals or guidance documents Field visit summaries Modeling results Correspondence, including telephone memoranda Meeting summaries Comment responses Reference documents, treatises and Scholarly works	Any document that connects the decision making document

Source: TxDOT Environmental Coordinators Conference 2015

Figure 5.4 The Types of Content to Include in the AR

What SHOULD NOT be in the AR
Privileged documents
Drafts of documents
Deliberative documents
Personal notes
Procurement documents
Extraneous emails, e.g., meeting minutes

Source: TxDOT Environmental Coordinators Conference 2015

Figure 5.5 The Types of Content to Exclude from the AR

5.8.7.2.1. So Why Is the Administrative Record so Important?

In the case of creating an AR around an EA, EIS, or even a CE, for a decision to create a wildlife crossing as mitigation, or to locate a route in a specific area with or without mitigation, ensuring that the items detailed in Figure 5.4 are enshrined in the AR will be critical to ward off any potential suits.

This is also because in a NEPA lawsuit in Texas the following processes would not occur:

- Discovery
- Depositions

- Review of documents
- Trial
- Witnesses or cross-examination
- Jury
- May not even be a hearing by the judge

As a result, if there is not a robust AR, TxDOT may be unable to rely on the APA to work in its favor if a plaintiff brings a case arguing deficiency within the AR or the decision making processes. Without the ability to find information through discovery and depositions, along with cross examination of witnesses, all the judge has to rely on is the AR.

Case law also bears out the importance of keeping a robust AR. In Coalition for the Advancement of Regional Transportation v. FHWA 576 Fed. Appx 477, 2014 the court noted the following: *"in considering challenges to agency action under the APA, the focal point for judicial review should be the administrative record already in existence, not some new record made initially in the reviewing court."*[96] Courts will only allow the introduction of new evidence in an APA hearing under four limited circumstances:

1. It is necessary to determine if the agency considered all relevant factors and explained its decision.
2. The agency relied upon documents not in the record.
3. Supplementing the record is necessary to explain complex subject matter or technical terms. Although courts prefer a contemporaneous record with the project file.
4. The agency acted in bad faith.

As the AR is the only element reviewed by courts in the majority of NEPA cases, constructing a tidy AR that is (i) easy to follow and (ii) ensures that your arguments in motion do not conflict with the AR *is extremely important*. Two cases show the courts approach to a "messy" AR versus a "tidy" AR. A third case shows how an AR can be held against a defendant if the AR runs counter to defendant's arguments in court.

5.8.7.2.2. The Messy AR

In Latin Americans for Social and Economic Development v. FHWA U. S. Dist. LEXIS 84582,[97] the court reviewed the AR for a proposed international bridge crossing in Detroit. The plaintiffs

[96] Coalition for the Advancement of Regional Transportation v. FHWA 576 Fed. Appx 477, 2014 U.S. App. LEXIS 15331

[97] Latin Americans for Social and Economic Development v. FHWA U. S. Dist. LEXIS 84582 (August 18, 2010).

claimed that defendants failed to comply with NEPA when they issued the Record of Decision (ROD). The court found that it could not grant the plaintiffs' motion for discovery, because it was unable at the time to make an informed decision because of *"the current state of the AR."* The court held that the AR was insufficient and because of this the court was not persuaded that it was in a position to make a decision regarding the completeness of the AR. During the case, FHWA had issued a new certified AR with errata sheets. This was contained on 14 DVDs, divided into three indices that according to the court had *"no discernible organizational structure."* The court noted that the FHWA had given the court *"little detail regarding its methodology in compiling the AR."* The court stated that "*[t]he AR includes the DEIS, the FEIS, and the ROD along with approximately 130,000 pages of emails, notes, reports, records of meetings, and other materials. It does not explain how it (FHWA) selected which emails, notes, reports, records of meetings, and other materials would be included in the AR and which would be excluded."*

The court held that until the FHWA fully described the process by which the AR was compiled, it could not determine or assess whether the process was sufficient and whether the FHWA was entitled to a presumption of regularity. The court noted *"the current state of the AR renders it virtually impenetrable."* In this lawsuit the plaintiffs asked the court to set the ROD aside as it was an arbitrary and capricious decision. The court noted that to do so, it must determine whether the FHWA complied with the procedures set forth in NEPA and Section 4(f) by engaging in a *"thorough, probing, in depth"* review within the AR. The FHWA provided *"an index en-mass to the AR comprising three volumes and 435 pages. There is no discernable organizational structure as to the dates, types of documents, or subject matter of the materials included in the AR. Further, there is nothing in the indices to indicate the DVD on which a given document is located. The Court is not in a position to engage in a 'thorough, probing, in-depth review' of the AR if it cannot effectively identify and locate relevant documents within the record."*

5.8.7.2.3. The Tidy AR

In 2014 the United States Court of Appeals for the Sixth Circuit [98] reviewed the AR for the Ohio River Bridges project in Louisville Southern Indiana. The court noted that the mammoth AR, which spanned over 20 years and included in excess of 150,000 pages chronicling the history of the project in exhaustive detail, "*compels a reasonable factfinder to conclude that the Project was motivated by the nondiscriminatory purpose of improving cross-river mobility, not racial animus."*

The court found that the AR chronicled the sequence of events and decision making: "*The need to construct additional bridges for cross-river mobility has been recognized for nearly fifty years, and the Purpose and Need Statement substantiates the acute and growing need to address cross-river traffic congestion and safety and inefficient cross-river mobility for population and employment growth in the region. Also, the alternatives evaluation demonstrates that the*

[98] Coalition for the Advancement of Regional Transportation v. FHWA 576 Fed. Appx 477, 2014 U.S. App. LEXIS 15331

Modified Selected Alternative was chosen because it best addresses the identified needs, not because of any intentional discriminatory impacts." The court noted that *"No reasonable jury would find anything about the 'sequence of events' leading up to the Project's approval suggestive of discriminatory purpose."*[99]

5.8.7.2.4. AR Conflict with Arguments Made in Court

In 2015 the United States District Court for the Eastern District of North Carolina, Western Division[100] found that a defendant's argument ran counter to the AR. The court vacated the ROD, noting that the *"Defendants' argument contradicts the administrative record. Indeed, the administrative record establishes that the defendants' growth and impact projections in the No Build scenario explicitly relied on socioeconomic data that assumed construction of the Garden Parkway."*

The court referred to an email among the defendants' employees that noted concern about the agencies buying into the theory that overall growth does not change with or without the project—it just redistributes. The court found "*In sum, defendants made an unsupported assumption that growth in the Metrolina region would remain constant regardless of whether the Garden Parkway was built. In so doing, they failed to take a 'hard look' at the environmental impacts of the proposed Garden Parkway and violated NEPA and the APA by preparing an inadequate EIS."* [101]

5.8.7.3. Arbitrary and Capricious Decision Making

Challenges to an agency's compliance with NEPA are reviewed under standards set out in the APA. Under the APA an agency's decision can be set aside only if it is arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law (5 U.S.C.S. §706(2)(A)) In determining whether an agency decision is arbitrary or capricious, the court must determine if the decision was based on consideration of the relevant factors and, if there has been a clear error of judgment.[102] Under this standard, the court must assure itself that (i) the agency considered relevant factors in making its decision, (ii) the agency's action bears a rational relationship to the statutes purpose, and (iii) there is substantial evidence in the record to support this action

In an early 1971 case[103] the court held that while the standard of review was to be narrow, the court's enquiry should be searching and careful. A 1989 case held that a court cannot substitute its own judgment for that of an agency. The court only needs to determine if the agency adequately

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[99] Ibid

[100] Catawba Riverkeeper v. North Carolina DOT 2015 U.S. Dist LEXIS 31429

[101] Ibid

[102] Marsh v. Or. Nat'l Res. Council, 490 U.S. 360, 377-78, 109 S. Ct. 1851, 104 L. Ed. 2d 377 (1989).

[103] Citizens to Preserve Overton Park, Inc. v. Volpe, 401 U.S. 402, 416, 91 S. Ct. 814, 28 L. Ed. 2d 136 (1971).

reviewed the issue[104]. Courts give agencies wide latitude concerning scientific matters within their area of expertise.[105] If experts on both sides disagree on technical conclusions, the court must defer to the agency's qualified experts (even if a court may find the opposing [plaintiff] views more persuasive).[106] In a 2011 case[107] a court noted that judicial review of an agency's NEPA compliance does not include "flyspecking the agency's decision-making process."[108]

Under NEPA plaintiffs bear the burden of showing decisions are arbitrary and capricious. Court decisions have not always favored the agency defendant. In a 2011 case[109] the 9th Circuit Court found for plaintiffs who had asserted that the EIS failed to consider alternatives, including using existing resources, which the court held were reasonable alternatives. In its reasoning, the court held that FHWA failed to consider reassigning vessels as a project alternative; as a result, the EIS failed to examine a viable and reasonable alternative. FHWA could not provide justification for this omission in the EIS and the existence of a viable, but unexamined alternative, rendered the EIS inadequate. The court held that the EIS's explanation of FHWA's consideration of the No Action Alternative was cursory. *"Three brief paragraphs first describe the No Action Alternative as an updated 1997 plan for ferry usage, then assert that using more ferries would reduce service elsewhere (without explaining the comparative needs for such services) and finally note that under the No Action Alternative AMHS could add ferries in the future but would not build anything.*" The court held that this explanation does not represent the *substantial treatment* required by NEPA's administrative regulations to non-construction alternatives.

In 2010 the United States District Court for the Northern District of California also found a plaintiff's argument persuasive. The court issued a preliminary injunction to stop development of a highway through old growth redwood trees, because the EA was deemed arbitrary and capricious.[110] The court held that the plaintiffs had demonstrated that irreparable harm is likely and, there were serious questions on the merits of conducting an EIS rather than the EA that was developed. The court noted that agencies cannot avoid preparing an EIS by making conclusory assertions that an activity will have only an insignificant impact on the environment. The court held that in this instance that "*there is too much evidence, that the impact would be significant."* Caltrans proposed activities would have taken place within the root zones of redwoods. There court found that there was reason to believe there would be a significant injury; the court noted that

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104 Neighbors Organized to Insure a Sound Env't, Inc., v. McArtor, 878 F.2d 174, 178 (6th Cir. 1989).

105 Nat'l Wildlife Fed'n v. EPA, in 2002286 F.3d 554, 560, 351 U.S. App. D.C. 42 (D.C. Cir. 2002).

106 Marsh v. Or. Nat'l Res. Council, 490 U.S. 360, 377-78, 109 S. Ct. 1851, 104 L. Ed. 2d 377 (1989).

107 N.C. Wildlife Fed'n, 677 F.3d at 601

108 N.C. Wildlife Fed'n v. N.C. DOT 2011 U.S. Dist. Lexis 123085.

109 Southeast Alaska Conservation Council v. FHWA in 2011 (649 F.3d 1050, 2011 U.S. App. Lexis 9097, 72 ERC (BNA) 1705, 41 ELR 20169.

110 Bair v. Caltrans 2011 U.S. Dist, Lexis, 72294; 41 ELR 20242 July 6, 2011 Filed.

plaintiffs had shown inconsistencies in the EA's data analysis that might be found *"so implausible that it could not be ascribed to a difference in view or the product of agency expertise."*[111]. The EA did not map all the trees where the construction would occur—including a redwood with a 91-inch diameter—and also miscalculated the diameters of several trees. According to the court, *"Such discrepancies are not merely differences in methodology for which deference would be given to agency experts. They are examples raising serious questions about whether defendants truly took a 'hard look' at the effects of the project."*

While the courts do give extreme deference to agency decision, they do undertake a rigorous assessment of the relevant factors. As an example in 2015, the court held that *"the magnitude of the Flyover Project far surpasses the scope of highway projects envisioned by § 771.117(d).*[112] *As a result, Defendants were required by NEPA and FAHA to prepare either an EA or an EIS. Defendants failed to do so, rendering their 2012 confirmation of the Flyover Project as a CE arbitrary and capricious."*

5.8.7.4. Purpose and Need

In developing the EIS agencies must develop a Purpose and Need statement—usually one to two paragraphs—that details the rationale for the project, and should include the underlying reasons to which the agency is responding in its proposed alternatives and proposed action. Under NEPA, agencies must look hard at the factors relevant to the definition of purpose[113]. In 1991 a court held that *"An agency may not define the objectives of its action in terms so unreasonably narrow that only one alternative from among the environmentally benign ones in the agency's power would accomplish the goals of the agency's action, and the EIS would become a foreordained formality."*[114]

Agencies cannot frame their goals in terms *so unreasonably broad*[115] such that many alternatives would accomplish the goals. Case law in 2014 took a similar stand. The court assessed a plaintiff's assertion that the Purpose and Need statement was crafted without a rational basis and held: *"the Purpose and Need Statement at issue in this case is not arbitrary and capricious. The defined purpose—'to improve cross-river mobility between Jefferson County, Kentucky, and Clark County, Indiana'—was based on five distinct needs… Moreover, because defendants justifiably found the various cross-river mobility needs between Jefferson County and Clark County to be*

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[111] Lands Council, 537 F.3d at 987.

[112] RB Jai Alai LLC v. Sec'y of the Fla DOT (2015) U.S. Dist LEXIS 84807

[113] Citizens Against Burlington, Inc. v. Busey, (Burlington) 938 F.2d 190, 196, 290 U.S. App. D.C. 371 (D.C. Cir. 1991).

[114] Id

[115] Id

intertwined, they reasonably defined the Purpose and Need Statement for the Project to be regional in scope."[116]

However, in 2015 the U.S. District Court for the Northern District of Illinois, Eastern Division, found a purpose and need was developed in an arbitrary and capricious manner noting: "*the purpose and need for the Illiana Corridor identified in the EIS are derived directly from the faulty 'no build' analysis. Because that analysis does not substantiate the purpose and need, the FHWA's approval of the ROD and final EIS is arbitrary and capricious and in violation of NEPA."*[117]

5.8.7.5. Alternatives Analysis

A major component within an EIS is the alternatives analysis (40 C.F.R. §1502.14). CEQ regulations specify that to satisfy NEPA, agencies must rigorously explore and objectively evaluate all reasonable alternatives and briefly discuss reasons for any alternatives being eliminated (§1502.14(a)). The District Court for the Central District of California in 2015[118] noted *"Agencies enjoy considerable discretion in defining the purpose and need of a project, but they may not define the project's objectives in terms so unreasonably narrow, that only one alternative would accomplish the goals of the project."*[119] Here the court was reviewing plaintiff's assertions that FTA had not considered alternative configurations in a light rail project. The court noted in reviewing previous case law that every alternative must be reviewed, noting *"that is not to say an agency must ceaselessly review alternatives to include every alternative device and thought conceivable by the mind of man."* The courts have held that alternatives an agency considers should be *"bounded by some notion of feasibility."*[120] However, the Fifth Circuit in 1974 held that while an agency may prefer one alternative from the outset, it "*must proceed to perform its environmental tasks with good faith objectivity."*[121]

In looking at alternatives analysis, and potential wildlife impacts, or decision making to choose a route that may not provide as much wildlife connectivity, the courts give considerable deference to an agencies role in setting policy and its expertise in subject matters. A an example, In a 2015

[116] Coalition for the Advancement of Regional Transportation v. FHWA 576 Fed. Appx 477, 2014 U.S. App. LEXIS 15331

[117] Openlands, Midewin Heritage Association, and Sierra Club, v. United States Department of Transportation 2015 U.S. Dist. LEXIS 77508

[118] Crenshaw Subway Coalition v. Los Angeles Country Metropolitan Transportation Authority, 2015

[119] HonoluluTraffic.com, 742 F.3d at 1230

[120] Vt. Yankee Nuclear Power Corp. v. Natural Res. Def. Council, Inc., 435 U.S. 519, 551, 98 S. Ct. 1197, 55 L. Ed. 2d 460 (1978).

[121] Envtl. Def. Fund, Inc. v. Corps of Eng'rs of the U.S. Army, 492 F.2d 1123, 1129 (5th Cir. 1974).

case[122] where plaintiffs argued that the defendant should have reevaluated possible alternatives to a bypass in light of the improved traffic situation, the United States District Court for the Eastern District of North Carolina found that the plaintiffs had not met the burden of showing that the defendants failed to take a sufficient hard look at the alternatives. The defendant DOT argued that they had taken the necessary hard look at reasonable alternatives in light of the current conditions, but rejected them as unable to sufficiently reduce projected congestion. In its reasoning the court cited a 1990 case that spoke to the deference afforded to an agency's alternatives analysis: *"the court engage[s] in both of these inquiries—whether an agency's objectives are reasonable, and whether a particular alternative is reasonable in light of these objectives—with considerable deference to the agency's expertise and policy-making role."*[123]

However, courts may overturn a ROD because of faulty alternatives analysis, notwithstanding deference to agency expertise. So this should be considered in determining route choice and how wildlife crossing structures or ameliorative techniques could be utilized within the different choices. In 2015[124] the United States District Court for the Northern District of Illinois reviewed alternatives analysis for a proposed toll corridor between Illinois and Indiana. Plaintiffs here had argued that the agencies had prematurely limited their analysis of reasonable alternatives by only comparing their proposed route with a no action alternative, and had not rigorously explored and objectively evaluated all reasonable alternatives. In addition the plaintiffs further argued that the alternatives analysis was premised upon population forecasts that conflicted with local MPO forecasts yielding baseline and no-build forecasts that were premised on the assumption of the project being built.

The court did not that *"Given the MPOs' legal mandate to develop long-range transportation plans for their areas and the influence they wield over local land use decisions through those transportation plans, it would seem unwise for the Agencies to reject the MPOs' population forecasts."* The court found that plaintiff had not cited any legal authority that required the use of agencies to accept these forecasts: *"Because the Agencies have articulated reasonable, if not persuasive, reasons for their decision not to use the MPOs' forecasts, that decision is not arbitrary within the meaning of the APA."* However the court held that the approval of the Tier 1 final EIS was arbitrary and capricious. This was because the purpose and need for the corridor was derived directly from the faulty no-build analysis. The court held that the analysis did not substantiate the purpose and need; which led to a flawed no-build analysis which eviscerated the direct effects analysis of the corridors impacts in the ROD and EIS.

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[122] Clean Air Carolina, North Carolina Wildlife Federation and Yadkin Riverkeeper v. North Carolina Department of Transportation, 2015 U.S. Dist LEXIS 120634

[123] N. Buckhead Civic Ass'n v. Skinner, 903 F.2d 1533, 1541 (11th Cir. 1990)

[124] Openlands, Midewin Heritage Association, and Sierra Club, v. United States Department of Transportation 2015 U.S. Dist. LEXIS 77508

5.8.7.6. Predetermination of a Favored Outcome

Predetermination of a favored outcome is another area in which TxDOT NEPA specialists should be cognizant of how concurrent activity—that may be taking place while an EA or EIS is being undertaken—might be used by a plaintiff looking to stop a project, or to change the project to include wildlife crossing treatments or other ameliorative treatments.

As an example, in 2015 the U.S. District Court for the District of Minnesota received a case where a state statute required a process to occur while the EIS was being developed. Plaintiffs argued that this closed off available options before the environmental process was completed. Plaintiffs action against the FTA charged it violated NEPA by using the municipal consent process to close off available options before the environmental review process was complete.[125] The plaintiffs argued that the defendants violated NEPA by proceeding with the municipal consent process on the SWLRT before the completion of a full environmental review. The plaintiff further alleged that the defendants violated the state's municipal consent statutes by failing to provide a DEIS that analyzed the routes the cities voted on when giving municipal consent.[126]

In its analysis, the court noted that CEQ regulations require an EIS to be prepared early enough so that it can serve practically as important contribution to the decision making process—not to rationalize or justify decisions already made (40 C.F.R. §1506.1(a)(2); and §1502.5). However, the court also noted that Section 1506.1 states that it *"does not preclude development by applicants of plans or designs or performance of other work necessary to support an application for Federal, State or local permits or assistance"* (directing federal agencies to integrate the requirements of NEPA with other planning and environmental review procedures required by law so that all such procedures run concurrently rather than consecutively). In addition, federal regulations permit an agency to choose its preferred alternative and indicate as much in the DEIS (§1502.14(e)), noting that an EIS may identify the agency's preferred alternative or alternatives.

The court found that there had not been an irreversible and irretrievable commitment to a specific SWLRT route, and that the plaintiff had not shown it was entitled to judgement as matter of law on the record. The court, however, did note that this would not end the case:

While the agency in charge can state a subjective preference, the unique nature of the municipal consent process in Minnesota for light rail projects, and the significant drumbeat of support the Met Council assembled for a single route, certainly comes close to having the practical effect of

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[125] Lakes and Parks Alliance of Minneapolis v The Metropolitan Council 2015 U.S. Dist LEXIS 102695

[126] The proposed project was Southwest Light Rail Transit's (SWLRT) construction of a light rail in the southwestern Twin Cities suburbs. After an agency completes the DEIS and a Supplemental Draft Environmental Impact Statement (SDEIS), Minnesota statute requires a municipal consent process to be undertaken for light rail transit projects (Minnesota Statute §473.3994). This statute requires that each city and county in which a light rail transit route is proposed must hold a public hearing and vote to approve or disapprove the physical design component of the preliminary design plans for the project (Minn. Stat. §473.3994).

limiting the available options, such that the remaining federal environmental review is meaningless. Indeed, by signing an agreement with St. Louis Park that all but guarantees freight rail will stay in the Kenilworth Corridor, the Met Council has come dangerously close to impermissibly prejudicing the ongoing environmental review process. Given the importance of a searching environmental analysis of each of the available options, the remaining steps in the process of securing municipal consent and finalizing environmental review—by both the Met Council and the FTA—should provide that searching analysis in order to comply with NEPA's twin aims of informing decision makers and involving the public.

5.8.7.7. EIS/EA or CE?

There has been a long history of case law regarding the sufficiency or adequacy of EISs since NEPA’s inception. There is also a sub-set of case law that is also instructive to TxDOT in looking at potential projects impacts and where or how, to consider wildlife crossings. This focusses around the determination of conducting an EA instead of an EIS, and most importantly the choice of using a CE.

NEPA requires federal agencies to prepare an EIS when they engage in **major** Federal actions **significantly affecting** the quality of the human environment (42 U.S.C. § 4332(2)(C)). The EIS must include:

- the environmental impact of the proposed action,
- any adverse environmental effects that cannot be avoided should the proposal be implemented, (in our case here, wildlife connectivity or safety),
- alternatives to the proposed action,
- the relationship between local short-term uses of man’s environment and the maintenance and enhancement of long-term productivity, and
- any irreversible and irretrievable commitments of resources that would be involved in the proposed action should it be implemented.

The 5th Circuit in 2000[127] created three criteria for reviewing adequacy of an EIS:

- Whether the agency in good faith objectively has taken a hard look at the environmental consequences of a proposed action and alternatives;

[127] Westphal, 230 F.3d at 174 (5th Cir. 2000)

- Whether the EIS provides detail sufficient to allow those who did not participate in its preparation to understand and consider the pertinent environmental influences involved; and

- Whether the EIS explanation of alternatives is sufficient to permit a reasoned choice among different courses of action.

The 5th Circuit noted that any conclusions upon which the EIS/EA is based must be supported by the evidence in the AR. One could argue that these three criteria should also be criteria for environmental analysis undertaken by TxDOT under its NEPA Assignment status, as it considers whether there may be a need for wildlife crossings.

For example, a 2015 case from Florida is useful to look at how the court will review a case where argument centers on the choice to use a lesser analysis than EIS. The dispute in this case arose out of the construction of a highway project in Casselberry, Florida (the Flyover Project).[128] The Flyover Project consists of changing an existing at-grade intersection to an above-grade, elevated highway overpass that will allow traffic to cross over without interruption. The Flyover Project also involved adding frontage roads; road to include additional left-turn lanes; and improving sidewalks, bicycle lanes, drainage systems, and landscaping. Numerous studies and a public hearing of the potential impacts the Flyover Project may have on the environment were conducted.[129] All of these studies concluded that the project would not significantly impact the environment and in 2004 it was approved as a CE. The project was reevaluated twice after this. In 2005 a re-evaluation was conducted to consider the environmental impacts of minor changes to safety and traffic flow issues. These design changes didn't make any significant impact on the environment, and so affirmed its CE status. A second re-evaluation was undertaken in 2012 because of design changes to the length of the overpass and to the width of a median. Again these changes were found to have no significant impact on the environment, affirming for the second time CE status. Construction for the Flyover Project began on October 10, 2013.[130]

Plaintiffs in this case alleged that the defendants violated NEPA by failing to adequately consider the Flyover Project's environmental impacts. The plaintiffs additionally allege that the defendants violated the Federal Aid Highway Act by approving federal funding for a project that did not comply with NEPA. Plaintiffs argued that the 2012 reevaluation failed to address new and changed circumstances to land use patterns, traffic patterns, contaminated sites, and impacts to wetlands.

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[128] RB Jai Alai LLC v. Sec'y of the Fla DOT (2015) U.S. Dist LEXIS 84807

[129] This included a Cultural Resource Assessment Survey, an Endangered Species Biological Assessment, an Air Quality Report, and a Noise Quality Report.

[130] According to the court, to date, more than 80% of construction is complete and more than 96% of federal funds allocated to the highway project have been spent.

The United States District Court for the Middle District of Florida, Orlando Division,[131] found that Florida DOT had improperly categorized a project as a CE. The Court asked the defendants to explain why the Flyover Project was classified as a d-list CE and to provide case law in support of this assertion. According to the court, the Flyover Project "*does not fall within nor is it remotely similar to, any of subsection (d)'s listed actions... Although the Flyover Project undoubtedly involves installing traffic signals and lighting, it cannot be said with any degree of sincerity that building a massive highway overpass is similar in scope."*

The court held that *"Despite a valiant effort, the Court finds Defendants' arguments unavailing and concludes that the initial classification of the Flyover Project as a d-list CE violated NEPA's procedures and comparisons to other cases leads to the inescapable conclusion that the Flyover Project cannot be categorically excluded under NEPA."*

As the aforementioned section shows, now that TxDOT has NEPA Assignment authority, and as it begins to implement wildlife crossing recommendations through this project, the Agency will need to factor in how, when, where and why it may choose to include a wildlife crossing within its NEPA analysis.

5.9. States with Wildlife Vehicle Statues/Regulations

A search was conducted in Westlaw and LexisNexis to determine if any states had statutes or regulations regarding wildlife crossings specifically, or other statutes that referenced wildlife crossings. In addition statutes were reviewed for any criteria to be utilized within state environmental policy, transportation or other acts. Table 5.6 provides a list of these statutory and regulatory elements, date it was created or amended, and state.

[131] Id

Table 5.6 State Statutes regarding Wildlife Crossings

STATE	STATUTE & DATE CREATED OR AMENDED	REGULATION	TEXT
CO	CRS 42-4-118 Added 2010 by HB 10-1238		Establishment of wildlife crossing zones - report (1) The department of transportation created in section 43-1-103, C.R.S., in consultation with both the Colorado state patrol created pursuant to section 24-33.5-201, C.R.S., and the division of parks and wildlife created pursuant to section 33-9-104, C.R.S., in the department of natural resources, may establish areas within the public highways of the state as wildlife crossing zones.(2) (a) If the department of transportation establishes an area within a public highway of the state as a wildlife crossing zone, the department of transportation may erect signs:(I) Identifying the zone in accordance with the provisions of section 42-4-616; and(II) Establishing a lower speed limit for the portion of the highway that lies within the zone.(b) Notwithstanding the provisions of paragraph (a) of this subsection (2) to the contrary, the department of transportation shall not establish a lower speed limit for more than one hundred miles of the public highways of the state that have been established as wildlife crossing zones.(3) (a) The department of transportation may establish an area within the federal highways of the state as a wildlife crossing zone if the department of transportation receives authorization from the federal government.(b) If the department of transportation establishes an area within the federal highways of the state as a wildlife crossing zone pursuant to paragraph (a) of this subsection (3), the department of transportation may erect signs:(I) Identifying the zone in accordance with the provisions of section 42-4-616; and(II) Establishing a lower speed limit for the portion of the highway that lies within the zone.(4) If the department of transportation erects a new wildlife crossing zone sign pursuant to subsection (2) or (3) of this section, it shall ensure that the sign indicates, in conformity with the state traffic control manual, that increased traffic penalties are in effect within the wildlife crossing zone. For the purposes of this section, it shall be sufficient that the sign states "increased penalties in effect".(5) In establishing a lower speed limit within a wildlife crossing zone, the department of transportation shall give due consideration to factors including, but not limited to, the following:(a) The percentage of traffic accidents that occur within the area that involve the presence of wildlife on the public highway;(b) The relative levels of traffic congestion and mobility in the area; and(c) The relative numbers of traffic accidents that occur within the area during the daytime and evening hours and involve the presence of wildlife on the public highway.(6) As used in this section, unless the context otherwise requires, "wildlife" shall have the same meaning as "big game" as set forth in section 33-1-102 (2), C.R.S.(7) Repealed.(8) Notwithstanding any other provision of this section, the department of

STATE	STATUTE & DATE CREATED OR AMENDED	REGULATION	TEXT
	CRS 42-4-616, added 2010 by HB 10-1238		transportation shall not establish any area of any interstate highway as a wildlife crossing zone. Wildlife crossing zones - increase in penalties for moving traffic violations (1) Except as described by subsection (4) of this section, a person who commits a moving traffic violation in a wildlife crossing zone is subject to the increased penalties and surcharges imposed by section 42-4-1701 (4)(d.5).(2) For the purposes of this section, "wildlife crossing zone" means an area on a public highway that:(a) Begins at a sign that conforms to the state traffic control manual, was erected by the department of transportation pursuant to section 42-4-118, and indicates that a person is about to enter a wildlife crossing zone; and(b) Extends to:(I) A sign that conforms to the state traffic control manual, was erected by the department of transportation pursuant to section 42-4-118, and indicates that a person is about to leave a wildlife crossing zone; or(II) If no sign exists that complies with subparagraph (I) of this paragraph (b), the distance indicated on the sign indicating the beginning of the wildlife crossing zone; or(III) If no sign exists that complies with subparagraph (I) or (II) of this paragraph (b), one-half mile beyond the sign indicating the beginning of the wildlife crossing zone.(3) (a) If the department of transportation erects a sign that indicates that a person is about to enter a wildlife crossing zone pursuant to section 42-4-118, the department of transportation shall:(I) Establish the times of day and the periods of the calendar year during which the area will be deemed to be a wildlife crossing zone for the purposes of this section; and(II) Ensure that the sign indicates the times of day and the periods of the calendar year during which the area will be deemed to be a wildlife crossing zone for the purposes of this section.(b) In erecting signs as described in paragraph (a) of this subsection (3), the department of transportation, pursuant to section 42-4-118, shall not erect signs establishing a lower speed limit for more than one hundred miles of the public highways of the state that have been established as wildlife crossing zones.(4) This section shall not apply if:(a) The person who commits a moving traffic violation in a wildlife crossing zone is already subject to increased penalties and surcharges for said violation pursuant to section 42-4-614 or 42-4-615;(b) The sign indicating that a person is about to enter a wildlife crossing zone does not indicate that increased traffic penalties are in effect in the zone; or(c) The person who commits a moving traffic violation in a wildlife crossing zone commits the violation during a time that the area is not deemed by the department of transportation to be a wildlife crossing zone for the purposes of this section.

STATE	STATUTE & DATE CREATED OR AMENDED	REGULATION	TEXT
FL		62-330.447, F.A.C.	62-330.447 General Permit to the Florida Department of Transportation, Counties, and Municipalities for Minor Activities within Existing Rights-of-Way or Easements. A general permit is granted to the Florida Department of Transportation, counties, and municipalities to conduct the activities described below. (c) Culvert placement, replacement and maintenance associated with existing roadways, provided that construction does not cause scour in the downstream waters or increase the velocity of the water downstream, does not reduce existing flood conveyance of the stream for the 100-year flood flow and does not reduce existing flood storage within the 10-year flood plain. The material excavated or deposited as fill shall not exceed 1,000 cubic yards in wetlands and other surface waters. The cross sectional area of the culvert shall not be reduced, unless the reduced cross section provides an equal or greater discharge capability. *In the case of a culvert replacement as a wildlife crossing, the cross sectional area shall not be reduced.*
KY			The Commonwealth's duty to protect and conserve wildlife does not include a common law duty to safeguard the public against damages that result from wild deer crossing roadways or marauding crops. OAG 90-70.
NV		NAC 504.105 – added 2016	504.105 Wildlife highway crossings. (NRS 501.105, 501.181) 1. Except as otherwise provided in subsection 2 and NRS 202.287, 503.010 and 503.175, a person shall not: (a) Hunt or take any big game mammal within one-half mile of a wildlife highway crossing. (b) Discharge a firearm from, upon, over or across a wildlife highway crossing. 2. The provisions of this section do not apply to an officer, employee or agent of the Department acting in his or her official capacity. *3. As used in this section, "wildlife highway crossing" means any overpass or underpass designed and constructed to facilitate the safe passage of wildlife across a highway.*
WA			WSDOT Executive Order 1031 (2008) Protections and Connections for High Quality Natural Habitats: Washington State Department of Transportation, in partnership with other agencies, organizations, and the public, must assure that road and highway programs recognize, together with other needs, the importance of protecting ecosystem health, the viability of aquatic and terrestrial wildlife species, and the preservation of biodiversity". ***This has been repealed***.

STATE	STATUTE & DATE CREATED OR AMENDED	REGULATION	TEXT
		Chapter 468-12 WAC	468-12-660 Substantive authority and mitigation. (1) It is the policy of the department that significant adverse economic, social, and environmental effects relating to any proposed department action should be fully considered in planning and implementing such action, and that final decisions on such action should be made in the best overall public interest, and taking into consideration (a) the need for fast, safe, efficient, and economical transportation and public services reasonably responsive to the public's preferences, (b) the adverse environmental, social, and economic effects of the proposed action and alternative courses of action, and (c) the costs of eliminating or minimizing such adverse effects. (2) The provisions of this chapter shall be interpreted in accord with this policy. This policy shall also govern substantive decisions made by the department. [Statutory Authority: RCW 43.21C.120 and chapter 197-11 WAC. WSR 84-19-030 (Order 90), § 468-12-660, filed 9/14/84.]

STATE	STATUTE & DATE CREATED OR AMENDED	REGULATION	TEXT
		Chapter 197-11-960 WAC	197-11-960 Part 11 Forms. The Environmental Checklist: *Purpose of checklist:* The State Environmental Policy Act (SEPA), chapter 43.21C RCW, requires all governmental agencies to consider the environmental impacts of a proposal before making decisions. An environmental impact statement (EIS) must be prepared for all proposals with probable significant adverse impacts on the quality of the environment. The purpose of this checklist is to provide information to help you and the agency identify impacts from your proposal (and to reduce or avoid impacts from the proposal, if it can be done) and to help the agency decide whether an EIS is required. B Environmental Elements 5 Animals a. List any birds and other animals which have been observed on or near the site or are known to be on or near the site. Examples include: Birds: Hawk, heron, eagle, songbirds, other: Mammals: Deer, bear, elk, beaver, other: Fish: Bass, salmon, trout, herring, shellfish, other: b. List any threatened and endangered species known to be on or near the site. c. Is the site part of a migration route? If so, explain. d. Proposed measures to preserve or enhance wildlife, if any: e. List any invasive animal species known to be on or near the site.

STATE	STATUTE & DATE CREATED OR AMENDED	REGULATION	TEXT
WY	Wyo. Stat. § 9-15-410 added in 2009		9-15-410. Baggs Deer Crossing. (a) Authorization is granted for funding of the following large project as provided in this section.) Project: Baggs Deer Crossing: (i) Project sponsor: Wyoming game and fish commission; (ii) Project purpose: To eliminate or reduce vehicle/wildlife collisions in order to: (A) Reduce or eliminate loss of life and property due to vehicle/wildlife collisions; (B) Reduce or eliminate loss of wildlife resources that result from vehicle/wildlife collisions; and (C) Maintain traditional wildlife migration corridors. (iii) Project description: Construction of a highway underpass structure and associated fencing to allow mule deer passage; (iv) Total project budget: One million three hundred fifty-two thousand dollars ($ 1,352,000.00) over an anticipated period of approximately three (3) years; (v) Project grant: The Wyoming wildlife and natural resource trust account board is authorized to grant to the sponsor two hundred fifty thousand dollars ($ 250,000.00) over a period of not more than three (3) years for the purposes specified in this subsection; (vi) Appropriation: There is appropriated from the income account to the board two hundred fifty thousand dollars ($ 250,000.00) or as much thereof as is necessary to carry out the purpose of this subsection. Unexpended and unobligated funds appropriated under this subsection shall revert to the income account on June 30, 2012.

5.10. Legal Review Conclusions

While the Booth case may seem to have changed the landscape regarding lability for wildlife vehicle crash injuries, the case can be distinguished, and it has not been followed by other states as probative dicta. In addition, notwithstanding Booth, a major hurdle that most plaintiffs must overcome in bringing a case for DOT liability for a wildlife vehicle accident, if sovereign immunity does not attach, falls here in Texas under common law premises liability, and in some rare cases common law negligence.

As noted, premises liability has a standard of care set by the status of the party entering the property and requires proof of permission to enter/occupy the land. The owner of the land or supervisor of the premises then has a duty to not injure through willful, wanton or gross negligence occurring. If the owner knows of a defect or a condition, and they do not fix through either a warning or by curing, to make the premises reasonably safe. Then common law negligence will be in play. This will require proof by the plaintiff party that four elements occurred: duty, breach, foreseeability, and causation.[132]

The case law indicates that a prudent approach would be to adopt a standard practice for determining the application of a mitigation activity or process for determining when/where to install a wildlife crossing, appurtenance or sign, to reduce potential liability. The DOT should create policy for key issues that should be considered as triggers for either considering the installation of a wildlife crossing, or ensuring regular maintenance and review takes place such that a special defect does not occur. It is anticipated that this research product will provide the necessary analysis and review to implement this type of approach.

[132] See Van Gorder v. Grand Trunk W.R.R., Inc., 509 F.3d 265, 269 (6th Cir. 2007); Brown v. CSX Transp., Inc., 18 F.3d 245, 249 (4th Cir. 1994); Gottshall, 512 U.S. 544-49.

Chapter 6. Recommended TxDOT Manual Modifications

6.1. Introduction

The research team developed and drafted language modifications to current TxDOT manuals based on the work described in previous chapters. The team identified practices in U.S. state DOTs where the science of transportation ecology had led to the successful planning and implementation of wildlife crossings, integrated seamlessly into the transportation network. The states leading the way in these practices were noted, and representatives of several of these states were interviewed. The research team developed and issued to TxDOT personnel a survey regarding their knowledge of potential TxDOT manuals that could be amended to include information on wildlife crossings. Survey topics included identification of where the planning processes could begin to employ data on WVC and where mitigation could include planning and building wildlife crossing structures.

The research team also conducted an initial review of TxDOT manuals (listed in Table 6.1) by searching for the following keywords: *environmental*, *wildlife*, *wildlife crossing*, *animals*, *fish*, *cattle guard*, *deer guard*, *culvert*, *fencing*, *vegetation*, and *mitigation*. The research team also investigated manuals based on experience with DOT practices that involved vegetation management, culvert maintenance, contract specifications in creating structures and fences, planning, construction specifications, effectiveness of speed zones, and other transportation practices. After the initial review, the research team performed a more thorough reading of each manual to determine where any amendments or cross-references to Environmental Affairs Division manuals were needed. The research team elected not to suggest any changes to the Transportation Planning Process Manual because it was largely flow diagrams that were extremely difficult to read due to poor image quality. All other manuals are included in the recommended changes.

Table 6.1 TxDOT Manuals Reviewed

Access Management	Plans, Specifications and Estimate Development
Bridge Design	Procedure for Establishing Speed Zones
Bridge Project Development	Project Development Process
Construction Contract Administration	Roadside Vegetation Management
Design and Construction Information Systems	Roadway Design
Highway Safety Improvement Program	Traffic Safety Program
Landscape and Aesthetics Design	Transportation Planning
Maintenance Management	Transportation Planning Process
Maintenance Operations	Transportation Programming and Scheduling
Manual on Uniform Traffic Control Devices (MUTCD)	

6.2. Draft Language for TxDOT Manuals

This section consists of recommendations for changes to the following 18 TxDOT manuals (Section 6.2.1–6.2.18):

- 6.2.1 Access Management Manual
- 6.2.2 Bridge Design Manual
- 6.2.3 Bridge Project Development Manual
- 6.2.4 Construction Contract Administration Manual
- 6.2.5 Design and Construction Information Systems (DCIS) Manual
- 6.2.6 Highway Safety Improvement Program Manual
- 6.2.7 Landscape and Aesthetics Manual
- 6.2.8 Maintenance Management Manual
- 6.2.9 Maintenance Operations Manual
- 6.2.10 Plans, Specifications and Estimate Development Manual
- 6.2.11 Procedure for Establishing Speed Zones Manual
- 6.2.12 Project Development Process Manual
- 6.2.13 Roadside Vegetation Management Manual
- 6.2.14 Roadway Design Manual
- 6.2.15 Traffic Safety Program Manual
- 6.2.16 Transportation Planning
- 6.2.17 Transportation Programming and Scheduling Manual
- 6.2.18 Manual of Uniform Traffic Control Devices

This section is structured by manual in alphabetical order, and contains recommendations for where either new language or a cross-reference could be inserted. ***The recommended text is placed into boxes for ease of the reader, and the language additions are formatted with bold and italic type*** (other text in the box that is not in bold and italic is directly from existing manual). The research team expects that the PMC will determine an approach to integrating these suggested additions once this project is completed, as they will be the pace-setters in their divisions and districts who will work to include the suggested language into manual updates. The research team also anticipates that as TxDOT grows its experience in all facets of reducing animal-vehicle conflict that further language will be developed by TxDOT and added to manuals.

6.2.1. Access Management Manual

The Access Management Manual ensures that proper access management protects the public investment in the transportation network.

Add at Chapter 1 *Access Management General*, Section 2 *The Benefits of Access Management* under *Overview*, at page 1-4:

- Delaying or preventing costly highway improvements,
- Improving roadway safety conditions (reduced crash rates),
- Reducing traffic delay and congestion, which has a positive economic effect on market areas (as seen in Figure 1-4),
- Promoting properly designed access and circulation systems for development,
- Improving the appearance of transportation corridors and increasing the area available for landscaping, which can help attract investment and enhance the image of an area,
- Providing property owners and customers with safe access to roadways,
- ***Reducing animal-vehicle conflict, and improving safety for the traveling public,***
- Reducing air pollution, and
- Making pedestrian and bicycle travel safer.

Add at Chapter 2 *Access Management Standards*, Section 2 *Definitions* after “ADT” at page 2-6:

ADT: The average daily traffic volume. It represents the total two-way traffic on a roadway for some period less than a year, divided by the total number of days it represents, and includes both weekday and weekend traffic. Usually, ADT is adjusted for day of the week, seasonal variations, and/or vehicle classification.

Animal-Vehicle Conflict: The phenomenon of animals and roads and vehicles and the negative interactions for animals and motorists. This term encompasses not only reported crashes, but the fragmentation of habitat, animal avoidance of the road area, motorists swerving to avoid animals in the road, and any other interactions with animals at the road interface.

Add at Chapter 2 *Access Management Standards,* Section 2 *Definitions* after "TxDOT" at page 2-6:

TxDOT: Texas Department of Transportation

Wildlife Corridor: A movement pathway humans have hypothesized is important for wildlife movement from one large core area of habitat to another. These can be on land, in water, or in the air. This is a term that can be defined in width from 'to hundreds of miles wide. A wildlife corridor is typically defined for a target species or several species and may not be as functional for all types of species. For example, a corridor designated for terrestrial species may easily accommodate a white-tailed deer, but not as easily accommodate a turtle.

Wildlife Crossing: A verb rather than a noun, this term describes wildlife moving over or under something.

Wildlife Crossing Structure: A bridge, culvert, or overpass built specifically for wildlife or modified during planning and construction to accommodate wild animals.

Add at Chapter 2 *Access Management Standards,* Section 4 *Driveway Permits, Design, and Materials* under *Permits* at page 2-16:

To obtain a permit to construct a driveway or to revise any existing driveway, the applicant should contact the local District TxDOT office. The applicant shall complete and submit to TxDOT a Form 1058, *Permit to Construct Access Driveway Facilities on Highway Right of Way*, which must include a description of the proposed work ***(including any pertinent details if a wildlife guard or double cattle guard, and fencing is to be used to stop animals from easily entering the right of way),*** the applicant's name, mailing address, telephone number and location of the proposed driveway. Applications for permits shall be made by the property owner or their authorized representative, who shall represent all parties in interest. Applications for permits shall be made only for the bona fide purpose of securing or changing access to the owner's property, but not for the purpose of parking or servicing vehicles on state highway rights of way.

Add at Chapter 2 *Access Management Standards*, Section 4 *Driveway Permits, Design, and Materials* under *Drainage* on page 2-18:

Access driveways shall be constructed to match the grade of the highway pavement edge or the shoulder edge if a shoulder is present. The driveway shall be designed and constructed in such a manner as to not impede the flow of water away from the highway pavement. ***The design should also take into consideration the ability of wildlife to use this new driveway to enter the right-of-way in an attempt to cross the highway. If there is wildlife exclusion fence along the road, the design should develop options for including wildlife guards and fencing. Examples of cattle guards and fencing along with construction costs can be obtained from ENV Natural Resources Management Section and District Environmental Coordinators.***

Access driveways shall be constructed to match the grade of the highway pavement edge or the shoulder edge if a shoulder is present. The driveway shall be designed and constructed in such a manner as to not impede the flow of water away from the highway pavement. ***Consideration should also be given to installing a wildlife crossing structure or fencing if wildlife uses this area as a natural pathway.*** If the driveway is approved to be constructed at grade through the roadside ditch or natural grade of the roadside, the driveway shall be paved with a stabilized all weather surface material acceptable to TxDOT to conform to the cross section shape of the ditch or other natural grade of the roadside to form a stable driveway. An exception to using stabilized new surface may be approved by TxDOT if the roadside or ditch is naturally stabilized with rock which may be driven on without eroding or rutting in all types of weather.

Add at Chapter 3 *Administrative Procedures,* Section 3 *Engineering Analysis* under *Questions to Consider* at page 3-5:

When determining the need for and level of detail of an engineering study, the following questions should be considered:

- Do the proposed driveway(s) meet the minimum spacing requirements per Tables 2-1 and 2-2 (or local requirements, as applicable)?
- Will the proposed driveway(s) require a deceleration or acceleration lane? If so, refer to the TxDOT Roadway Design Manual for lengths and other design criteria.
- Are there any sight distance or physical obstructions that will result in a safety problem?
- Are there any environmental or hydraulic issues associated with the proposed driveway(s)? ***For example, does wildlife use this area frequently, or have wildlife vehicle conflicts occurred frequently and led to safety issues or crashes?***

6.2.2. Bridge Design Manual

The Bridge Design Manual describes the American Association of State Highway Transportation Officials (AASHTO) Load and Resistance Factor Design (LRFD) Bridge Design Specifications for TxDOT engineers to follow.

It is recommended that Bridge Division add to Chapter 5 *Other Designs* a new section titled *Wildlife Crossing Structures* as a new Section 5 at page 5-11 to provide guidance and discussion on how bridges can provide ample opportunities for the development of various types of wildlife crossing structures. For example, lengthening a bridge can provide a passage alongside a creek or river for animals to safely cross underneath the roadway. As this is an extremely technical subject, and must comport to AASHTO LRFD bridge design specifications, the research team suggests that the Environmental Affairs Division work with the Bridge Division to further develop this language and specifications, including any design pictures.

An example of language that was passed on to the research team from Lufkin District personnel could be used as an example in the new section 4 in Chapter 5 to provide a concrete example of where TxDOT has considered and developed a longer bridge design to provide a wildlife crossing structure.

Section 5

Wildlife Crossing Structures

There are many examples, within both TxDOT and the U.S., where lengthened bridge spans have been used to provide adequate space for wildlife to cross under a roadway and avoid water bodies and existing paved areas under the bridge and thus reduce the propensity for wildlife-vehicle collisions. As bridge designers are developing bridge designs, consult with the local District Environmental Coordinator and Environmental Affairs Division to identify opportunities to enhance road safety.

Example: Extended Bridge on SH 21 in Lufkin District

"On SH 21 at the Attoyac River and its relief was a bridge project where the district lengthened spans to provide adequate space for wildlife species to cross underneath. This is an on-system roadway where two bridges were a short distance apart—one bridging the Attoyac and the other bridging the relief. The district decided to construct a single structure spanning both the river and the relief, providing ample space for large terrestrial species and avoiding impacts to the floodplain. On the plan and profile and bridge layouts, the new structure overlaid on the existing structure provides a view of how a district can estimate the additional area provided beneath the bridge. The new bridge is close to 1200 feet long"— Matt Bukingham, Lufkin District.

The following pictures provide details on the bridge at SH 21.

90% SUBMITTAL

INDEX OF SHEETS

SEE SHEET NO. 2 FOR INDEX OF SHEETS

STATE OF TEXAS

DEPARTMENT OF TRANSPORTATION

PLANS OF PROPOSED STATE HIGHWAY IMPROVEMENT

FEDERAL AID PROJECT NO.

SH 21

SAN AUGUSTINE COUNTY

CSJ	ROADWAY		BRIDGE		TOTALS	
	FT	MI	FT	MI	FT	MI
0118-10-057	2614	0.495	1196	0.227	3810	0.722

LIMITS: SH 21 AT ATTOYAC RIVER (CSJ 0118-10-057)

FOR THE CONSTRUCTION OF BRIDGE REPLACEMENT
CONSISTING OF REPLACE BRIDGES AND APPROACHES

FUNCTION CLASS: RURAL MINOR ARTERIAL
CSJ: 0118-10-057
DESIGN SPEED: 60 MPH
ADT (2018): 3,100
ADT (2038): 4,200

FED.RD. DIV.NO.	PROJECT NO.	SHEET NO.
6		1

STATE	STATE DIST.	COUNTY
TEXAS	LFK	NACOGDOCHES/ SAN AUGUSTINE

CONT.	SECT.	JOB	HIGHWAY NO.
0118	10	057	SH 21

FINAL PLANS

LETTING DATE: ________
DATE CONTRACTOR BEGAN WORK: ________
DATE WORK WAS COMPLETED: ________
DATE WORK WAS ACCEPTED: ________
FINAL CONSTRUCTION COST: ________
CONTRACTOR: ________

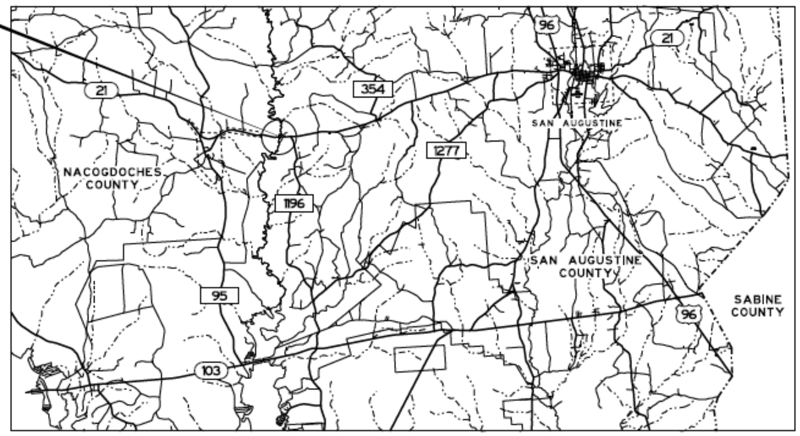
CONSTRUCTION WORK ON THIS PROJECT WAS PERFORMED IN ACCORDANCE WITH PLANS, CONTACT AND APPROVED CHANGE ORDER.

________ DATE: ________

INCIDENTAL CONSTRUCTION
IN NACOGDOCHES COUNTY

PROPOSED BRIDGE SH 21
CSJ 0118-10-057 @ ATTOYAC RIVER
BEGIN PROJECT STA 100+00.00
REF MRK =
LAT: 4173502 50' 9.6"
LONG: 10563142 13' 15.6"
END PROJECT STA 138+20.00
REF MRK =
LAT: 4177301 8' 9.6"
LONG: 10563158 39' 49.68"

PREVIOUS PROJECT TIE:
PROJECT No. STP 2009(737)SB
CSJ: 0118-10-052, ETC
TIE-IN STATION STA 01+32.60



BARRICADES AND WARNING SIGNS

PROVIDE AND ERECT BARRICADES AND WARNING SIGNS IN ACCORDANCE WITH THE BARRICADE & CONSTRUCTION STANDARDS, TCP STANDARDS, THE "TEXAS MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES" AND AS DIRECTED.

DOCUMENT IS FOR INTERIM REVIEW AND NOT INTENDED FOR CONSTRUCTION BIDDING, OR PERMIT PURPOSES.
WALLY R. BURNS, PE
44162
TEXAS SERIAL NO.
12/18/2014
DATE

0 10,000 20,000'
SCALE: 1" = 20,000'

NO EXCEPTIONS,
NO RAILROAD CROSSINGS

RECOMMENDED FOR LETTING: ________

DISTRICT DESIGN ENGINEER

SUBMITTED FOR LETTING: ________ APPROVED FOR LETTING: ________

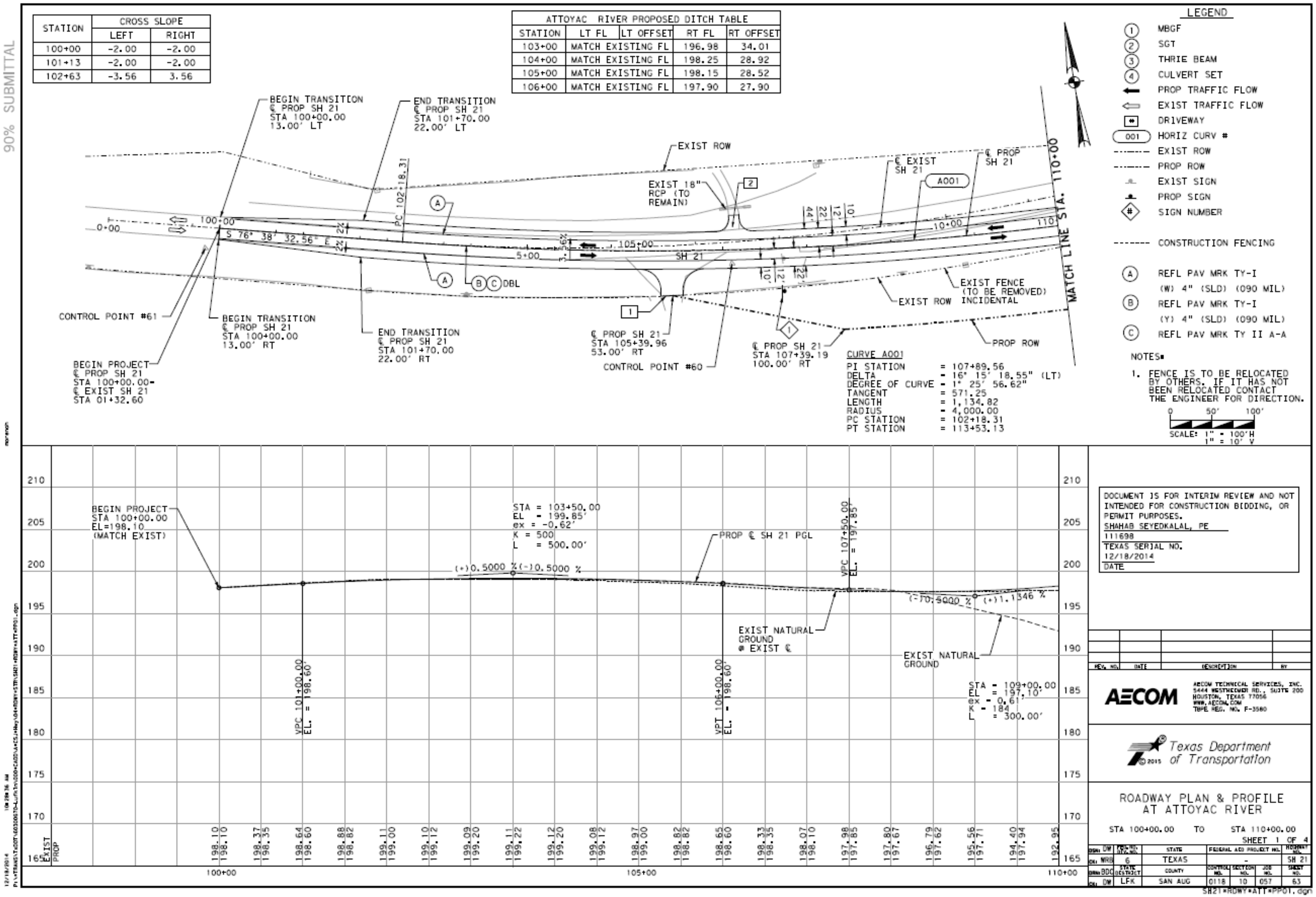
PROJECT MANAGER AECOM

DISTRICT ENGINEER

SPECIFICATIONS ADOPTED BY THE TEXAS DEPARTMENT OF TRANSPORTATION, NOVEMBER 1, 2014 AND SPECIFICATION ITEMS LISTED AND DATED AS FOLLOWS, SHALL GOVERN ON THIS PROJECT: REQUIRED CONTRACT PROVISIONS FOR ALL FEDERAL-AID CONSTRUCTION CONTRACTS (FORM FHWA 1273, MAY 2012).

COUNTY NACOGDOCHES/SAN AUGUSTINE PROJECT NO. ____
HWY. NO. SH 21 LETTING DATE ____
DATE ACCEPTED ____

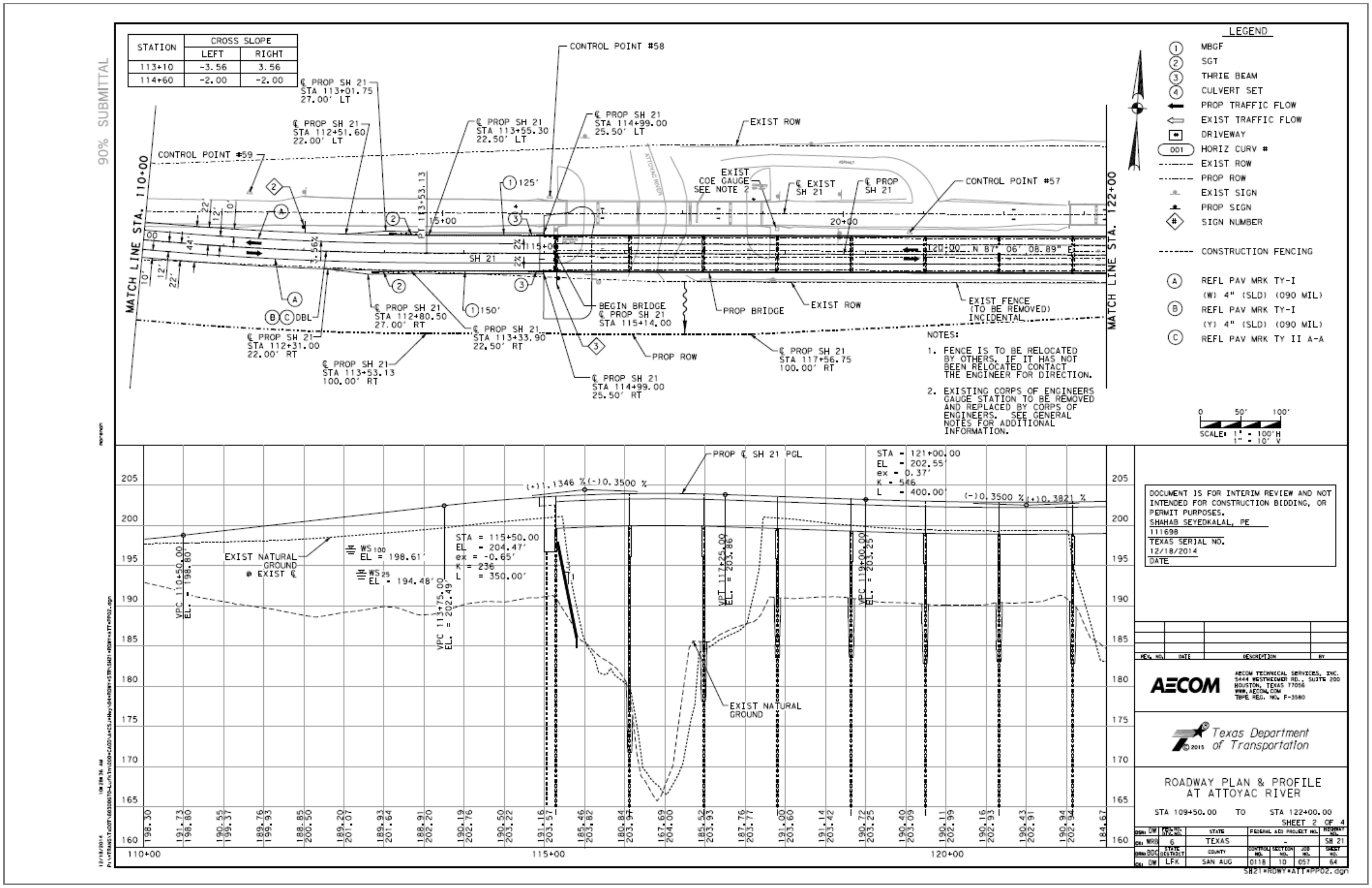
SH21 ATT_COV01.dgn

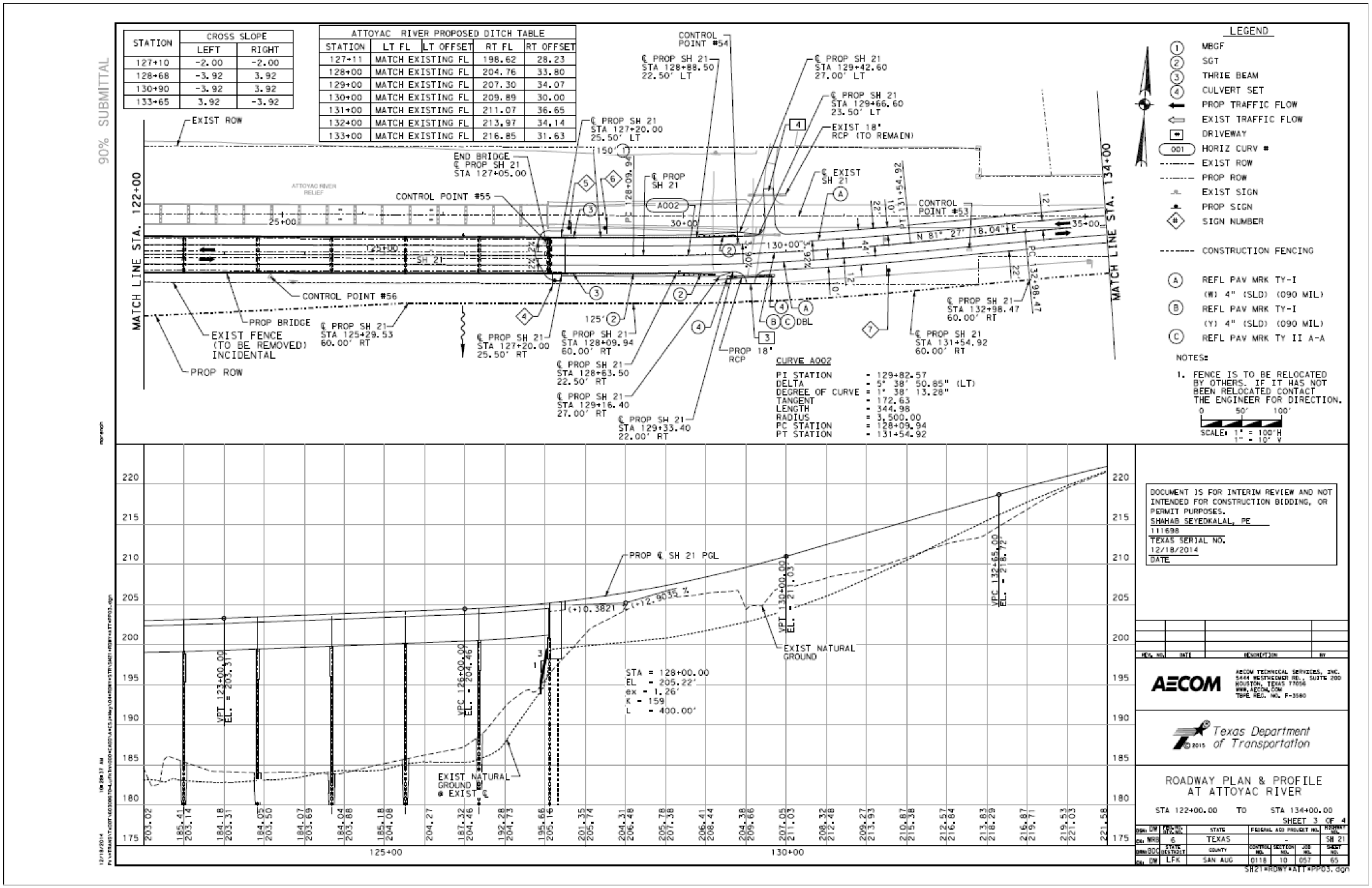


STATION	CROSS SLOPE LEFT	CROSS SLOPE RIGHT
100+00	-2.00	-2.00
101+13	-2.00	-2.00
102+63	-3.56	3.56

ATTOYAC RIVER PROPOSED DITCH TABLE

STATION	LT FL	LT OFFSET	RT FL	RT OFFSET
103+00	MATCH EXISTING FL		196.98	34.01
104+00	MATCH EXISTING FL		198.25	28.92
105+00	MATCH EXISTING FL		198.15	28.52
106+00	MATCH EXISTING FL		197.90	27.90

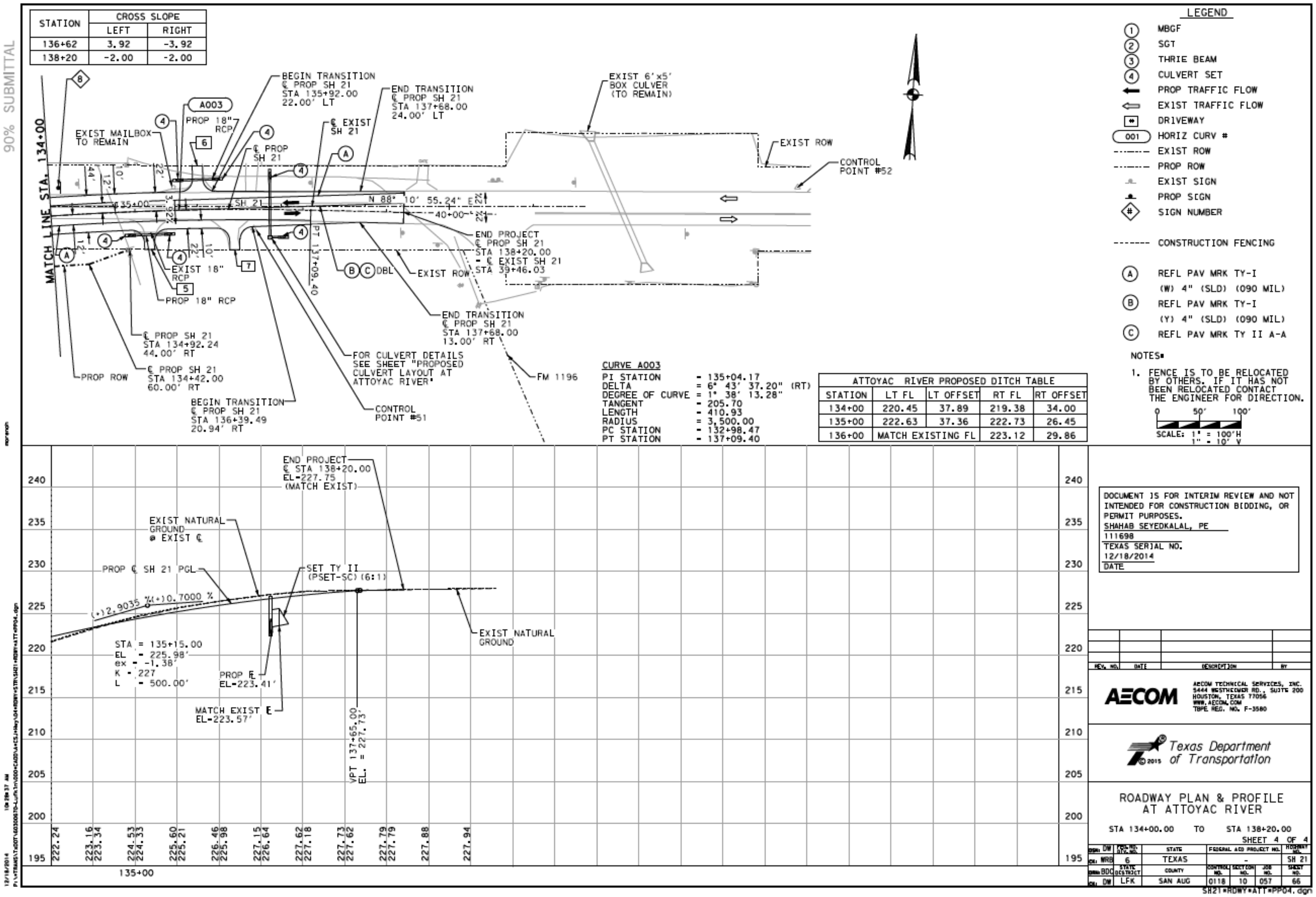

90% SUBMITTAL
STATION
CROSS SLOPE
LEFT
RIGHT
113+10 -3.56 3.56
114+60 -2.00 -2.00
CONTROL POINT #58
CONTROL POINT #59
CONTROL POINT #57
EXIST ROW
PROP ROW
PROP BRIDGE
BEGIN BRIDGE
EXIST FENCE (TO BE REMOVED) INCIDENTAL
MATCH LINE STA. 110+00
MATCH LINE STA. 122+00
LEGEND
MBGF
SGT
THRIE BEAM
CULVERT SET
PROP TRAFFIC FLOW
EXIST TRAFFIC FLOW
DRIVEWAY
HORIZ CURV #
EXIST ROW
PROP ROW
EXIST SIGN
PROP SIGN
SIGN NUMBER
CONSTRUCTION FENCING
REFL PAV MRK TY-I (W) 4" (SLD) (090 MIL)
REFL PAV MRK TY-I (Y) 4" (SLD) (090 MIL)
REFL PAV MRK TY II A-A
NOTES:
1. FENCE IS TO BE RELOCATED BY OTHERS. IF IT HAS NOT BEEN RELOCATED CONTACT THE ENGINEER FOR DIRECTION.
2. EXISTING CORPS OF ENGINEERS GAUGE STATION TO BE REMOVED AND REPLACED BY CORPS OF ENGINEERS. SEE GENERAL NOTES FOR ADDITIONAL INFORMATION.
SCALE: 1" = 100'H 1" = 10' V
PROP ℄ SH 21 PGL
EXIST NATURAL GROUND @ EXIST ℄
EXIST NATURAL GROUND
STA = 115+50.00 EL = 204.47' ex = -0.65' K = 236 L = 350.00'
STA = 121+00.00 EL = 202.55' ex = 0.37' K = 546 L = 400.00'
DOCUMENT IS FOR INTERIM REVIEW AND NOT INTENDED FOR CONSTRUCTION BIDDING, OR PERMIT PURPOSES.
SHAHAB SEYEDKALAL, PE
111698
TEXAS SERIAL NO.
12/18/2014
DATE
AECOM
AECOM TECHNICAL SERVICES, INC.
Texas Department of Transportation
ROADWAY PLAN & PROFILE AT ATTOYAC RIVER
STA 109+50.00 TO STA 122+00.00
SHEET 2 OF 4
TEXAS
SH 21
SAN AUG
LFK
SH21+RDWY+ATT+PP02.dgn



STATION	CROSS SLOPE	
	LEFT	RIGHT
127+10	-2.00	-2.00
128+68	-3.92	3.92
130+90	-3.92	3.92
133+65	3.92	-3.92

ATTOYAC RIVER PROPOSED DITCH TABLE

STATION	LT FL	LT OFFSET	RT FL	RT OFFSET
127+11	MATCH EXISTING FL		198.62	28.23
128+00	MATCH EXISTING FL		204.76	33.80
129+00	MATCH EXISTING FL		207.30	34.07
130+00	MATCH EXISTING FL		209.89	30.00
131+00	MATCH EXISTING FL		211.07	36.65
132+00	MATCH EXISTING FL		213.97	34.14
133+00	MATCH EXISTING FL		216.85	31.63



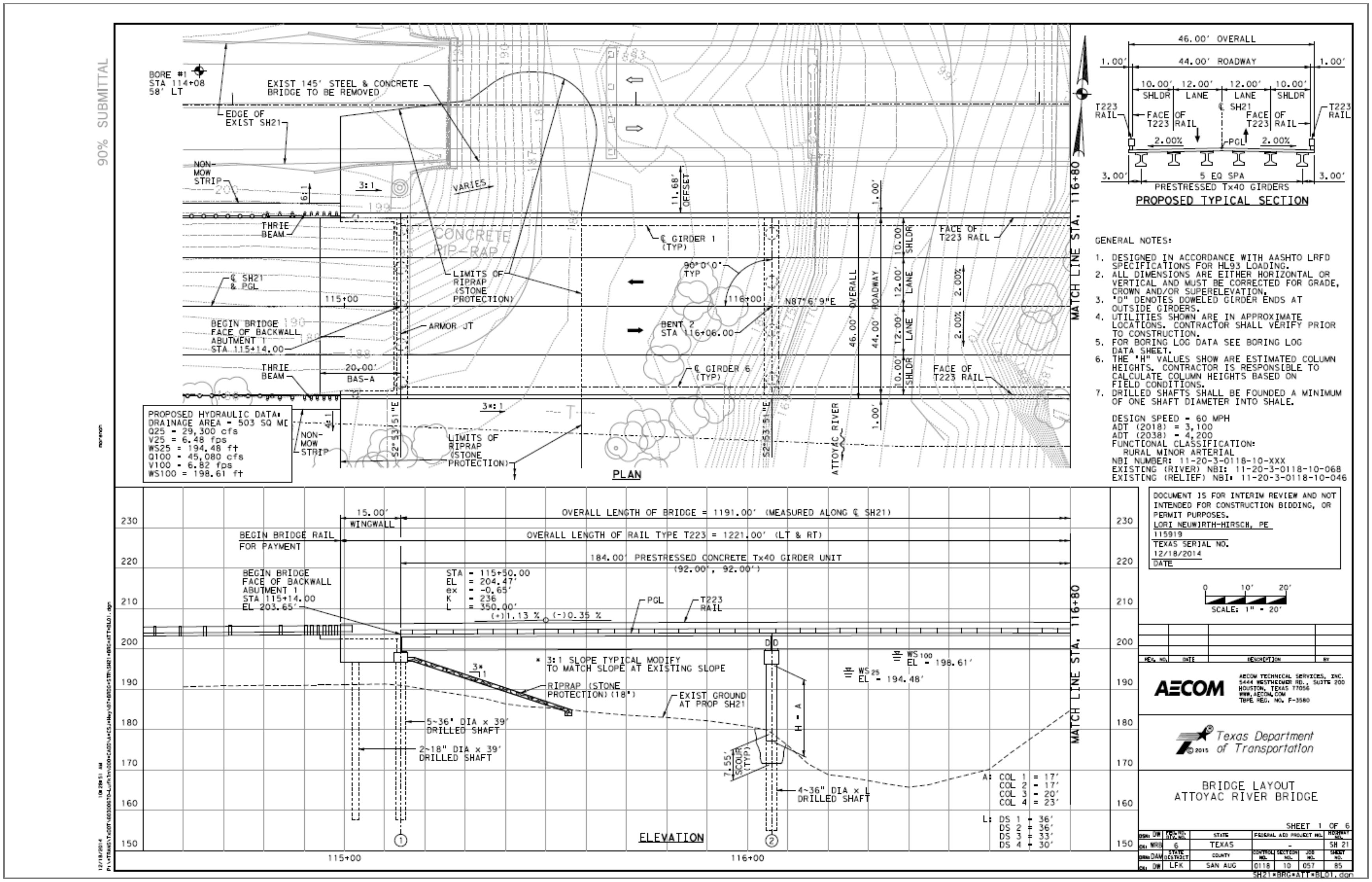
STATION	CROSS SLOPE LEFT	CROSS SLOPE RIGHT
136+62	3.92	-3.92
138+20	-2.00	-2.00

CURVE A003

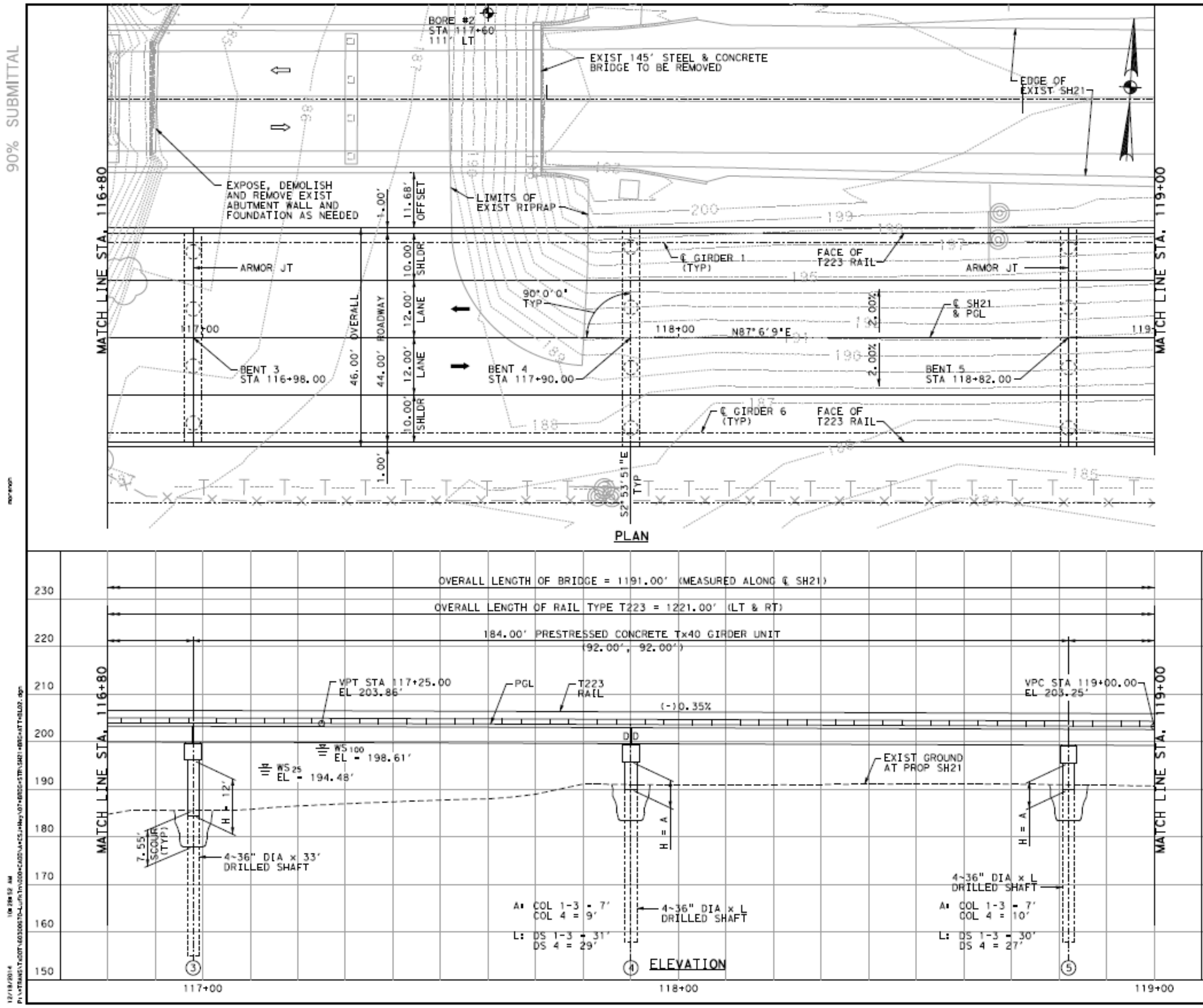
PI STATION	=	135+04.17
DELTA	=	6° 43' 37.20" (RT)
DEGREE OF CURVE	=	1° 38' 13.28"
TANGENT	=	205.70
LENGTH	=	410.93
RADIUS	=	3,500.00
PC STATION	=	132+98.47
PT STATION	=	137+09.40

ATTOYAC RIVER PROPOSED DITCH TABLE

STATION	LT FL	LT OFFSET	RT FL	RT OFFSET
134+00	220.45	37.89	219.38	34.00
135+00	222.63	37.36	222.73	26.45
136+00	MATCH EXISTING FL		223.12	29.86



90% SUBMITTAL
PROPOSED TYPICAL SECTION
46.00' OVERALL
44.00' ROADWAY
PRESTRESSED Tx40 GIRDERS
GENERAL NOTES:
1. DESIGNED IN ACCORDANCE WITH AASHTO LRFD SPECIFICATIONS FOR HL93 LOADING.
2. ALL DIMENSIONS ARE EITHER HORIZONTAL OR VERTICAL AND MUST BE CORRECTED FOR GRADE, CROWN AND/OR SUPERELEVATION.
3. "D" DENOTES DOWELED GIRDER ENDS AT OUTSIDE GIRDERS.
4. UTILITIES SHOWN ARE IN APPROXIMATE LOCATIONS. CONTRACTOR SHALL VERIFY PRIOR TO CONSTRUCTION.
5. FOR BORING LOG DATA SEE BORING LOG DATA SHEET.
6. THE "H" VALUES SHOW ARE ESTIMATED COLUMN HEIGHTS. CONTRACTOR IS RESPONSIBLE TO CALCULATE COLUMN HEIGHTS BASED ON FIELD CONDITIONS.
7. DRILLED SHAFTS SHALL BE FOUNDED A MINIMUM OF ONE SHAFT DIAMETER INTO SHALE.
DESIGN SPEED = 60 MPH
ADT (2018) = 3,100
ADT (2038) = 4,200
FUNCTIONAL CLASSIFICATION: RURAL MINOR ARTERIAL
NBI NUMBER: 11-20-3-0118-10-XXX
EXISTING (RIVER) NBI: 11-20-3-0118-10-068
EXISTING (RELIEF) NBI: 11-20-3-0118-10-046
PROPOSED HYDRAULIC DATA:
DRAINAGE AREA = 503 SQ MI
Q25 = 29,300 cfs
V25 = 6.48 fps
WS25 = 194.48 ft
Q100 = 45,080 cfs
V100 = 6.82 fps
WS100 = 198.61 ft
PLAN
ELEVATION
OVERALL LENGTH OF BRIDGE = 1191.00' (MEASURED ALONG ℄ SH21)
OVERALL LENGTH OF RAIL TYPE T223 = 1221.00' (LT & RT)
184.00' PRESTRESSED CONCRETE Tx40 GIRDER UNIT
MATCH LINE STA. 116+80
DOCUMENT IS FOR INTERIM REVIEW AND NOT INTENDED FOR CONSTRUCTION BIDDING, OR PERMIT PURPOSES.
LORI NEUWIRTH-HIRSCH, PE
115919
TEXAS SERIAL NO.
12/18/2014
AECOM
Texas Department of Transportation
BRIDGE LAYOUT
ATTOYAC RIVER BRIDGE
SHEET 1 OF 6



CONTROL ELEVATIONS			
BENT	SHAFT	DS TIP EL	CALCULATED DRILLED SHAFT LOAD (TONS/DS)
1	ALL	157.594	91
2	DS 1 & 4	142.549	174
	DS 2 & 3	142.789	
3	DS 1 & 4	150.491	169
	DS 2 & 3	150.731	
4	DS 1 & 4	157.122	166
	DS 2 & 3	157.362	
5	DS 1 & 4	157.780	166
	DS 2 & 3	158.020	
6	DS 1 & 4	160.514	166
	DS 2 & 3	160.754	
7	DS 1 & 4	160.497	166
	DS 2 & 3	160.737	
8	DS 1 & 4	160.512	166
	DS 2 & 3	160.752	
9	DS 1 & 4	158.620	170
	DS 2 & 3	158.860	
10	DS 1 & 4	158.942	170
	DS 2 & 3	159.182	
11	DS 1 & 4	158.355	170
	DS 2 & 3	158.595	
12	DS 1 & 4	160.706	170
	DS 2 & 3	160.946	
13	DS 1 & 4	161.013	170
	DS 2 & 3	161.253	
14	ALL	161.027	92

DOCUMENT IS FOR INTERIM REVIEW AND NOT INTENDED FOR CONSTRUCTION BIDDING, OR PERMIT PURPOSES.
LORI NEUWIRTH-HIRSCH, PE
115919
TEXAS SERIAL NO.
12/18/2014
DATE

SCALE: 1" = 20'

AECOM

AECOM TECHNICAL SERVICES, INC.
5444 WESTHEIMER RD., SUITE 200
HOUSTON, TEXAS 77056
WWW.AECOM.COM
TBPE REG. NO. F-3580

Texas Department of Transportation
©2015

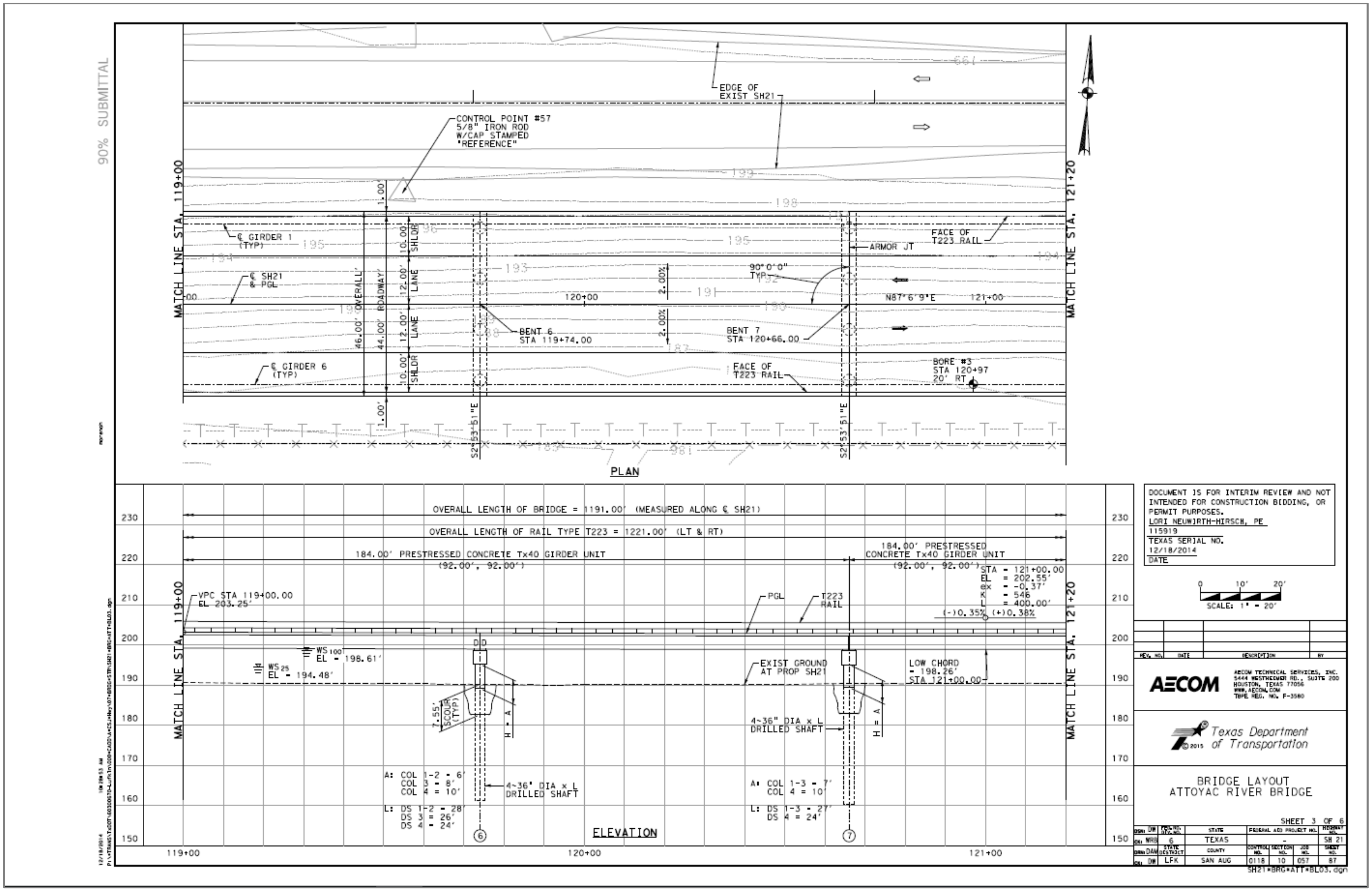
BRIDGE LAYOUT
ATTOYAC RIVER BRIDGE

SHEET 2 OF 6

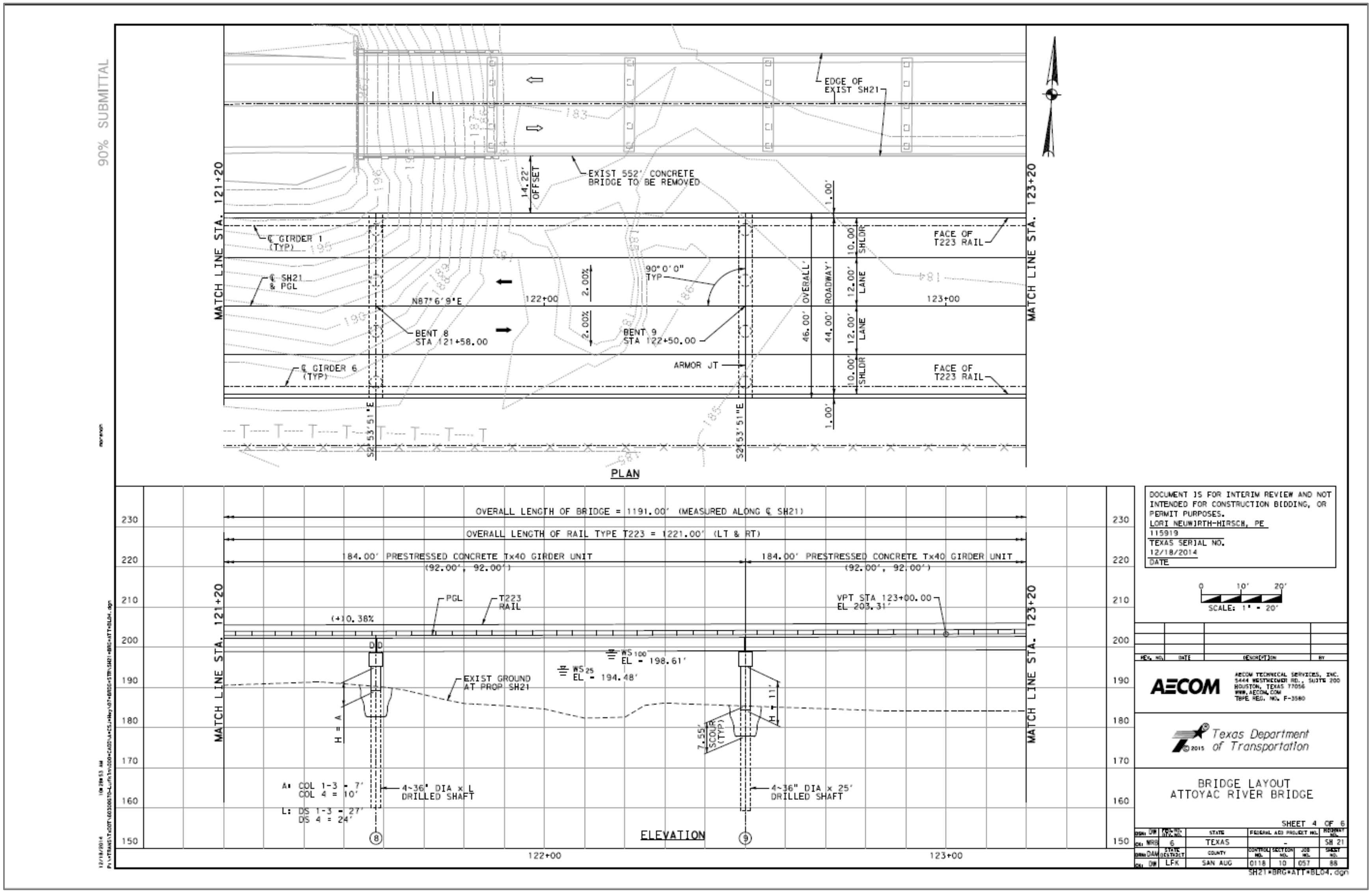
STATE	FEDERAL AID PROJECT NO.	HIGHWAY NO.
TEXAS	-	SH 21

STATE DISTRICT	COUNTY	CONTROL NO.	SECTION NO.	JOB NO.	SHEET NO.
LFK	SAN AUG	0118	10	057	86

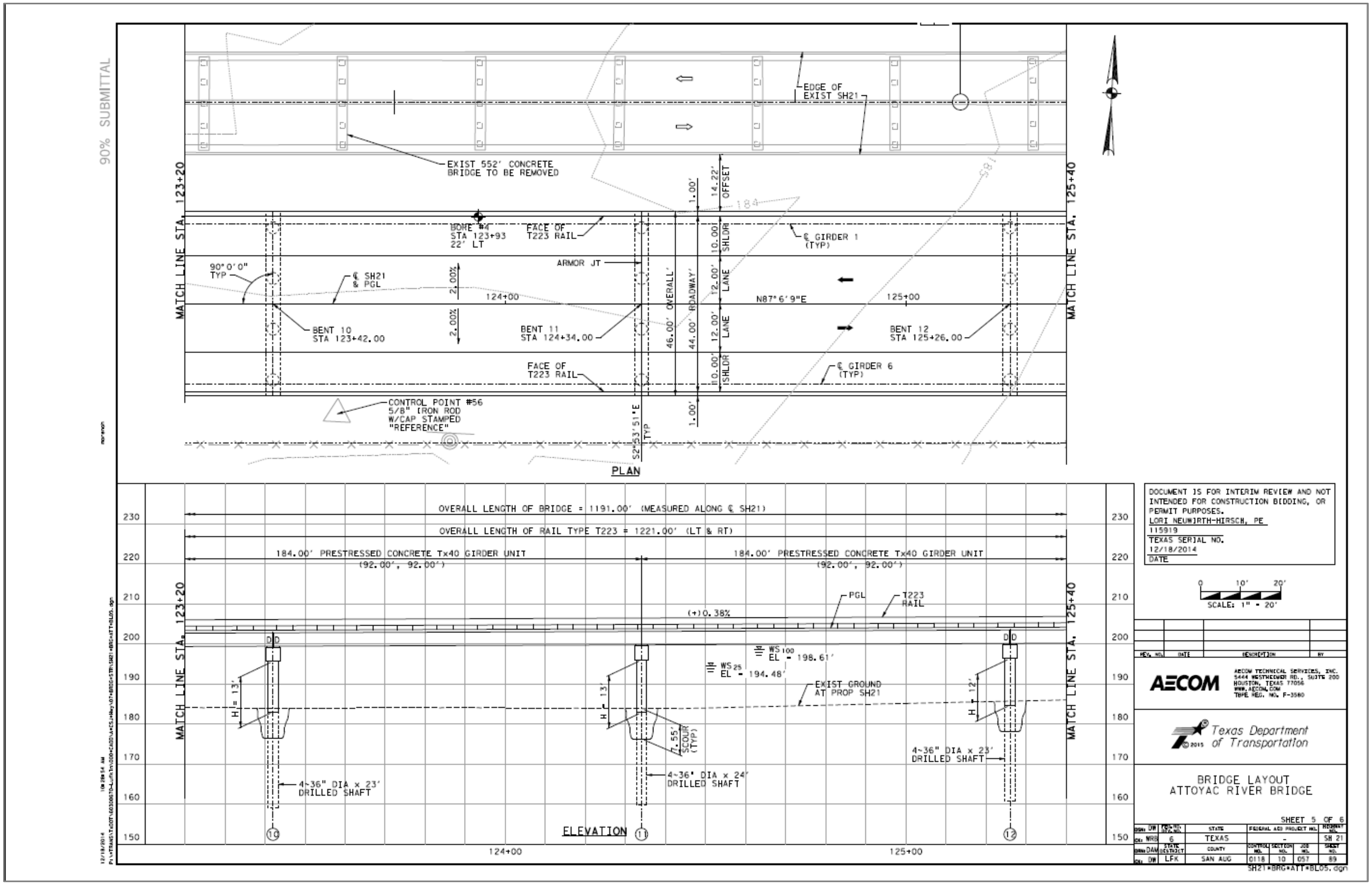
SH21+BRG+ATT+BL02.dgn



90% SUBMITTAL
EDGE OF EXIST SH21
CONTROL POINT #57 5/8" IRON ROD W/CAP STAMPED "REFERENCE"
MATCH LINE STA. 119+00
MATCH LINE STA. 121+20
℄ GIRDER 1 (TYP)
℄ SH21 & PGL
℄ GIRDER 6 (TYP)
46.00' OVERALL
44.00' ROADWAY
10.00' SHLDR
12.00' LANE
12.00' LANE
10.00' SHLDR
1.00'
1.00'
2.00%
2.00%
120+00
121+00
90°0'0" TYP
ARMOR JT
FACE OF T223 RAIL
N87°6'9"E
BENT 6 STA 119+74.00
BENT 7 STA 120+66.00
FACE OF T223 RAIL
BORE #3 STA 120+97 20' RT
S2°53'51"E
S2°53'51"E
PLAN
OVERALL LENGTH OF BRIDGE = 1191.00' (MEASURED ALONG ℄ SH21)
OVERALL LENGTH OF RAIL TYPE T223 = 1221.00' (LT & RT)
184.00' PRESTRESSED CONCRETE Tx40 GIRDER UNIT (92.00', 92.00')
184.00' PRESTRESSED CONCRETE Tx40 GIRDER UNIT (92.00', 92.00')
VPC STA 119+00.00 EL 203.25'
STA = 121+00.00 EL = 202.55' ex = -0.37' K = 546 L = 400.00'
(-)0.35% (+)0.38%
PGL
T223 RAIL
WS100 EL = 198.61'
WS25 EL = 194.48'
EXIST GROUND AT PROP SH21
LOW CHORD = 198.26' STA 121+00.00
7.55' SCOUR (TYP)
H = A
4~36" DIA x L DRILLED SHAFT
4~36" DIA x L DRILLED SHAFT
A: COL 1-2 = 6' COL 3 = 8' COL 4 = 10'
L: DS 1-2 = 28' DS 3 = 26' DS 4 = 24'
A: COL 1-3 = 7' COL 4 = 10'
L: DS 1-3 = 27' DS 4 = 24'
ELEVATION
119+00
120+00
121+00
DOCUMENT IS FOR INTERIM REVIEW AND NOT INTENDED FOR CONSTRUCTION BIDDING, OR PERMIT PURPOSES.
LORI NEUWIRTH-HIRSCH, PE
115919
TEXAS SERIAL NO.
12/18/2014
DATE
SCALE: 1" = 20'
AECOM
AECOM TECHNICAL SERVICES, INC. 5444 WESTHEIMER RD., SUITE 200 HOUSTON, TEXAS 77056 TBPE REG. NO. F-3580
Texas Department of Transportation
BRIDGE LAYOUT
ATTOYAC RIVER BRIDGE
SHEET 3 OF 6
TEXAS
SAN AUG
SH 21
0118 10 057 87
SH21+BRG+ATT+BL03.dgn



90% SUBMITTAL
EDGE OF EXIST SH21
EXIST 552' CONCRETE BRIDGE TO BE REMOVED
14.22' OFFSET
MATCH LINE STA. 121+20
MATCH LINE STA. 123+20
℄ GIRDER 1 (TYP)
℄ SH21 & PGL
N87°6'9"E
122+00
123+00
90°0'0" TYP
BENT 8 STA 121+58.00
BENT 9 STA 122+50.00
ARMOR JT
℄ GIRDER 6 (TYP)
FACE OF T223 RAIL
46.00' OVERALL
44.00' ROADWAY
10.00' SHLDR
12.00' LANE
2.00%
1.00'
S2°53'51"E
PLAN
OVERALL LENGTH OF BRIDGE = 1191.00' (MEASURED ALONG ℄ SH21)
OVERALL LENGTH OF RAIL TYPE T223 = 1221.00' (LT & RT)
184.00' PRESTRESSED CONCRETE Tx40 GIRDER UNIT (92.00', 92.00')
PGL
T223 RAIL
(+10.38%
VPT STA 123+00.00 EL 203.31'
WS 100 EL = 198.61'
WS 25 EL = 194.48'
EXIST GROUND AT PROP SH21
H = A
H = 11'
7.55' SCOUR (TYP)
A: COL 1-3 = 7' COL 4 = 10'
L: DS 1-3 = 27' DS 4 = 24'
4-36" DIA x L DRILLED SHAFT
4-36" DIA x 25' DRILLED SHAFT
ELEVATION
DOCUMENT IS FOR INTERIM REVIEW AND NOT INTENDED FOR CONSTRUCTION BIDDING, OR PERMIT PURPOSES.
LORI NEUWIRTH-HIRSCH, PE
115919
TEXAS SERIAL NO.
12/18/2014
DATE
SCALE: 1" = 20'
AECOM
AECOM TECHNICAL SERVICES, INC. 5444 WESTHEIMER RD., SUITE 200 HOUSTON, TEXAS 77056 WWW.AECOM.COM TBPE REG. NO. F-3580
Texas Department of Transportation
BRIDGE LAYOUT
ATTOYAC RIVER BRIDGE
SHEET 4 OF 6
TEXAS
SAN AUG
SH 21
0118 10 057 88
SH21-BRG-ATT-BL04.dgn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EXIST 552' CONCRETE BRIDGE TO BE REMOVED
EDGE OF EXIST SH21
MATCH LINE STA. 123+20
MATCH LINE STA. 125+40
BORE #4 STA 123+93 22' LT
FACE OF T223 RAIL
℄ GIRDER 1 (TYP)
ARMOR JT
90°0'0" TYP
℄ SH21 & PGL
124+00
N87°6'9"E
125+00
BENT 10 STA 123+42.00
BENT 11 STA 124+34.00
BENT 12 STA 125+26.00
℄ GIRDER 6 (TYP)
CONTROL POINT #56 5/8" IRON ROD W/CAP STAMPED "REFERENCE"
S2°53'51"E TYP
PLAN
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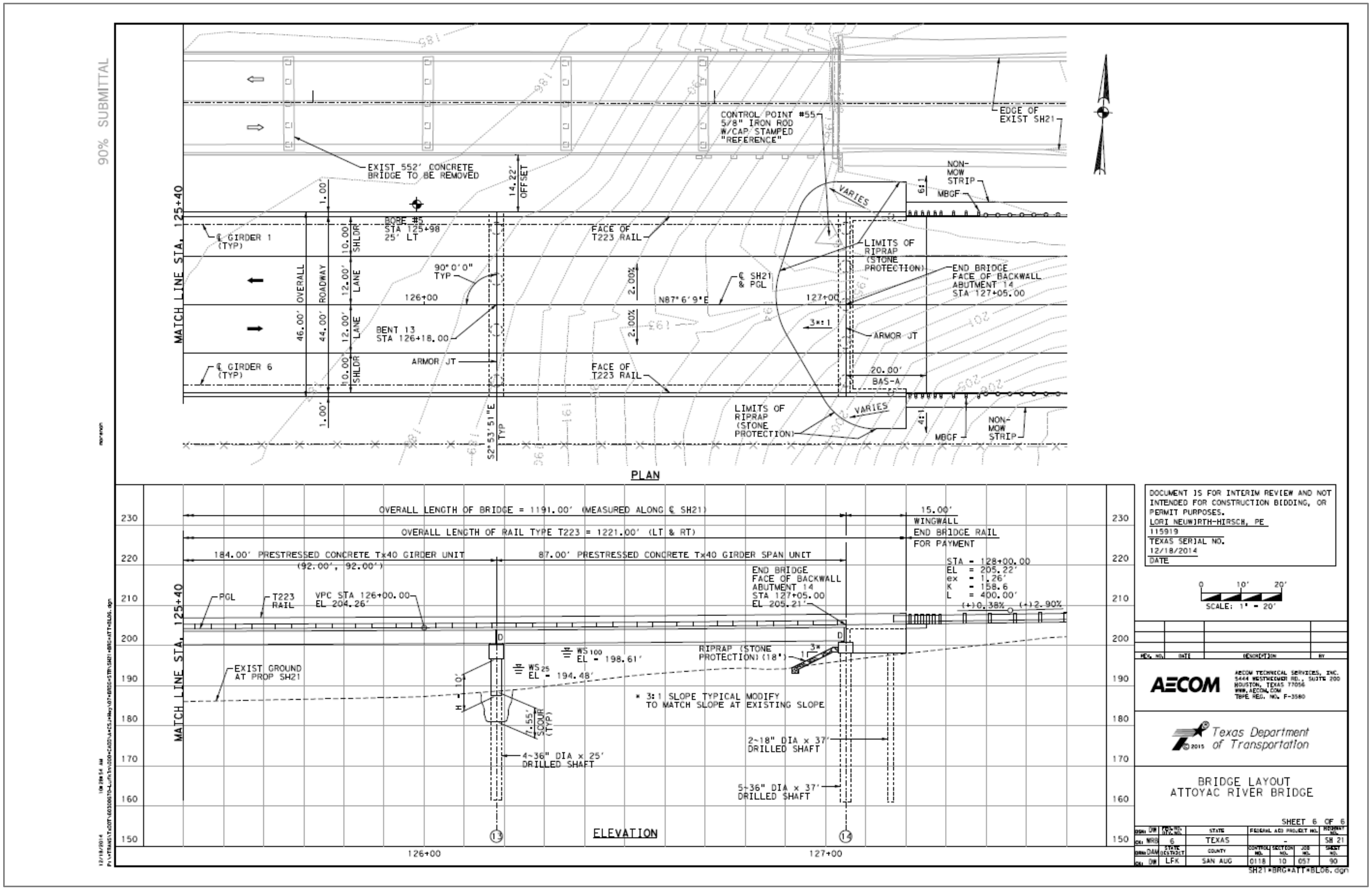
OVERALL LENGTH OF RAIL TYPE T223 = 1221.00' (LT & RT)
184.00' PRESTRESSED CONCRETE Tx40 GIRDER UNIT (92.00', 92.00')
184.00' PRESTRESSED CONCRETE Tx40 GIRDER UNIT (92.00', 92.00')
PGL
T223 RAIL
(+)0.38%
WS 100 EL = 198.61'
WS 25 EL = 194.48'
EXIST GROUND AT PROP SH21
H = 13'
2.55' SCOUR (TYP)
4~36" DIA x 23' DRILLED SHAFT
4~36" DIA x 24' DRILLED SHAFT
4~36" DIA x 23' DRILLED SHAFT
ELEVATION
DOCUMENT IS FOR INTERIM REVIEW AND NOT INTENDED FOR CONSTRUCTION BIDDING, OR PERMIT PURPOSES.
LORI NEUWIRTH-HIRSCH, PE
115919
TEXAS SERIAL NO.
12/18/2014
DATE
SCALE: 1" = 20'
AECOM
Texas Department of Transportation
BRIDGE LAYOUT
ATTOYAC RIVER BRIDGE
SHEET 5 OF 6
TEXAS
SAN AUG
SH 21
SH21+BRG+ATT+BL05.dgn


90% SUBMITTAL
PLAN
ELEVATION
OVERALL LENGTH OF BRIDGE = 1191.00' (MEASURED ALONG ℄ SH21)
OVERALL LENGTH OF RAIL TYPE T223 = 1221.00' (LT & RT)
184.00' PRESTRESSED CONCRETE Tx40 GIRDER UNIT (92.00', 92.00')
87.00' PRESTRESSED CONCRETE Tx40 GIRDER SPAN UNIT
EXIST 552' CONCRETE BRIDGE TO BE REMOVED
CONTROL POINT #55 5/8" IRON ROD W/CAP STAMPED "REFERENCE"
EDGE OF EXIST SH21
BORE #5 STA 125+98 25' LT
BENT 13 STA 126+18.00
END BRIDGE FACE OF BACKWALL ABUTMENT 14 STA 127+05.00
MATCH LINE STA. 125+40
DOCUMENT IS FOR INTERIM REVIEW AND NOT INTENDED FOR CONSTRUCTION BIDDING, OR PERMIT PURPOSES.
LORI NEUWIRTH-HIRSCH, PE
115919
TEXAS SERIAL NO.
12/18/2014
DATE
AECOM
Texas Department of Transportation
BRIDGE LAYOUT
ATTOYAC RIVER BRIDGE
SHEET 6 OF 6

6.2.3. Bridge Project Development Manual

The Bridge Project Development Manual provides guidance and outlines uniform procedures and policies for administering and developing projects involving bridges.

Add at Chapter 3 *Preliminary Design Features*, Section 1 *General Features* under *Bridge and Span Lengths* at pages 3-2:

Bridge and Span Lengths

In planning stages the length of the bridge is an approximation based on available preliminary information which becomes more refined as the project progresses. The length of the bridge depends on such factors as existing topographical conditions at the side, the width of the obstruction to be crossed (other roads, waterway, railroad tracks, etc.), the roadway alignment, highway design criteria (sight distance, maximum grades, etc.), economics and plans for future development. In addition, an opportunity exists at this juncture to enhance safety within the vicinity of the bridge by providing opportunities that allow wildlife to cross underneath the bridge rather than over the roadway. When determining preliminary bridge lengths, set the "begin bridge" point and "end bridge" point at whole station numbers and on a tangent alignment, if possible. This geometry can be accommodated by moving the point of curvature (PC) or the point of tangency (PT) off the bridge, if allowable.

The number of spans, length of spans, and bent locations can be determined once the preliminary bridge length is set. Where bridge geometry and site conditions allow, place bents such that interior span lengths are equal. If possible, locate the bents at whole station numbers. If the bridge is crossing a stream, spanning the channel is recommended to decrease the probability of future scour issues.

Span length requirements limit the available options for superstructure. Select the most economic superstructure type that meets span length requirements, ***and if a wildlife crossing structure is included, provides terrestrial movement pathways free of water inundation***, and satisfies aesthetic needs at the site. Recommended span lengths, approximate depths, and associated bridge costs for various super-structure types can be found on the TxDOT Bridge Division (BRG) website. ***Specific bridge designs that accommodate wildlife movement can be found within ENV and BRG Divisions. Additional guidance can be taken from ENV Natural Resource Management Section, District Environmental Coordinators and the BRG Divisions, all of whom may have specifications and drawings that can be utilized for promoting wildlife movement beneath bridges. Simple retrofits can be introduced to existing bridge structures and plans for future bridges that will facilitate animal and human movement beneath the roadway.*** The process of setting bridge geometry consists of iterative steps that take place during development of preliminary bridge layouts. During this process, the district and divisions coordinate to develop a plan for an economically feasible, aesthetically pleasing structure that serves its design purpose.

This type of short introduction to wildlife crossings within the *Bridge Standard Drawings* section would alert a planner and designer of opportunities to design and include wildlife crossings.

Add at Chapter 3 *Preliminary Design Features*, Section 2 *Features Based on Bridge Location* under *Structures Over Streams* at page 3-13/14:

Information in the following section provides general reference on common design features of structures over streams. Refer to the Hydraulic Design Manual whenever planning and developing a structure over a stream.

In addition, when planning and developing a structure over a stream, consider opportunities to determine if the bridge has potential to be utilized as a wildlife crossing structure. Designers and planners can confer with staff in Environmental Affairs Division, and their district environmental coordinator to determine this functionality and find out further information on designs and schematics that have been utilized, to maximize the bridge's designs to accommodate wildlife.

Add at Chapter 4 *Advanced Planning*, Section 1 *General Considerations* under *New Bridges* at page 4-2:

Superstructure. The superstructure is critical in the performance and cost effectiveness of a bridge. Many types of superstructure are used by TxDOT. Choosing an appropriate superstructure depends on factors such as:

- Span length
- Vertical clearance
- Hydraulics (freeboard)
- Speed of construction
- Economics
- ***Wildlife movement opportunities beneath the roadway***
- Aesthetics

Add at Chapter 4 *Advanced Planning*, Section 1 *General Considerations* under *Environmental Concerns* at Page 4-10:

Environmental Concerns

FHWA is responsible for assuring that the projects it funds do not have significant environmental impacts or, if they do, that appropriate action is taken. The following Environmental Affairs Division assessments, listed in order of investigative detail from least to most, may be requested:

- Categorical Exclusion (CE)
- Environmental Assessment (EA)
- Finding of No Significant Impacts (FONSI)
- Environmental Impact Statement (EIS)

For more information, see the Environmental Management System Manual and the Hazardous Materials in Project Development Manual, ***or refer to ENV Natural Resource Management Section and District Environmental Coordinators***.

In addition, the bulleted list of types of NEPA documentation needs to be amended to include the following:

- Categorical Exclusion (CE)
- Environmental Assessment (EA) and Finding of No Significant Impacts (FONSI)
- Environmental Impact Statement (EIS) and Record of Decision (ROD)

Further, within the *Environmental Concerns* section, add the following text after *Mitigation of Environmental Impacts* at page 4-13:

Wildlife Connectivity Impacts.

Bridge projects may reduce wildlife-vehicle conflict by providing safe crossing points for wildlife below and above grade. The District Environmental Coordinator can conduct assessments and work with the Bridge Division to evaluate wildlife vehicle conflict concerns. This coordination should occur as early as possible in the project development process. The ENV Natural Resources Management Section is also available to provide guidance and examples of how bridges can accommodate wildlife movement.

The bridge may be replacing an existing structure that was not built for wildlife connectivity beneath the road, or it may be a new structure. Regardless, the existence of wild animals in the area, or the potential existence of federally or state-listed species with elevated protection status in the area, should be considered when bridge dimensions are being decided. If the bridge can be located with terrestrial pathways along a waterway, or

pathways at least ten to fifteen feet wide with bank stabilization materials (rip rap) pulled back to accommodate wildlife, and at heights where the animals of concern can pass beneath, then wildlife connectivity will be improved.

The effort of making bridges more compatible with wildlife movement can help reduce wildlife-vehicle conflict and collisions, and improve motorist and pedestrian safety. The decision to make the span of the bridge longer to accommodate terrestrial pathways has, in some instances, moved the structure out of a floodplain, and reduced the need for a number of permits. This can speed up project permitting and improve environmental compliance for bridges in federally protected waters.

Add at Chapter 4 *Advanced Planning,* Section 3 *Agreements and Permits* under *Navigation Districts, Water Districts, Irrigation Districts, Water and River Authorities* at page 4-32:

Where the State, Navigation District, Water District, Irrigation District, Drainage District, or Water and River Authority undertake construction that affects the rights of another, the Bridge Division project manager negotiates a satisfactory agreement setting forth the financial responsibility and commitments of each party involved.

Wildlife crossing structures may be placed in drainage districts right of way. The BRG Division and respective District will be involved in developing plans and construction and assigning financial responsibility and commitments of each party involved.

6.2.4. Construction Contract Administration

This manual is designed to provide instruction on the proper administration of construction contracts. Often contractors have never built or retrofitted wildlife crossing structures and fences, and can seriously jeopardize the effectiveness of the infrastructure if they are not aware of specifications necessary to ensure wildlife use the structures and stay off the road.

Add at Chapter 12 *Environmental Issues,* Section 2 *Biological Resources,* paragraph on U.S. Fish and Wildlife Service (USFWS) and Texas Parks and Wildlife Department Reviews (TPWD):

Ensure the contractor adheres to any USFWS or TPWD recommendations included in the contract. The recommendations would include avoidance and minimization measures stated in the plans, such as avoidance of sensitive wildlife and wildlife habitats in the project area. Ensure the contractor has the necessary information to identify and recognize sensitive wildlife and wildlife habitats. ***Ensure any existing wildlife crossing structures, fences, wildlife guards, escape ramps, and other mitigation are not moved, cut, or altered in any activities that may allow wildlife to access the road right of way, or impede their finding and moving through the structures. If wildlife crossing structures, fences, and other features are part of the contract, ensure all infrastructure elements***

are exactly to specifications, with fences completely buried or at the soil level with no holes, escape ramps to the correct heights and slope ratios, wildlife crossing structures completely open and accessible to wildlife and not blocked by any fences, no barb wire placed on any fences, and other wildlife considerations in the contract. Contact the environmental coordinator for specific project information.

Add at Chapter 12 *Environmental Issues*, Section 3 *Water Resources, Inspections*:

Include the following project areas in the inspection:

- disturbed areas of the construction site that have not been finally stabilized
- areas used for storage of materials that are exposed to precipitation
- structural control for evidence of, or the potential for, pollutants entering the drainage system
- sediment and erosion control measures identified in the SWP3 to ensure correct operation
- locations of site vehicle entrance or exit for evidence of off-site sediment tracking
- ***areas where fence is down and wild animals, from deer to turtles, may be accessing the road***
- ***areas where equipment, moved earth, and other activities may have blocked wild animal access to culverts and bridges that are used to move beneath the road***

6.2.5. Design and Construction Information Systems: User Manual

This manual is designed to support a broad group of users in the districts and in the Austin Headquarters office. It should help new and occasional users understand DCIS, while supporting the existing needs of engineers, technicians and others, who have worked with DCIS for many years.

At Appendix B *Project Classifications* on page B-1/2, TxDOT may want to add to the table listing the classifications a new row at the bottom to include Wildlife Crossing Structure (WCS):

WCS	***Wildlife Crossing Structure***	***Creation of a wildlife crossing structure—either new construction or retrofit on an existing roadway, bridge, culvert, or driveway***

6.2.6. Highway Safety Improvement Program Manual

The Highway Safety Improvement Program (HSIP) Manual highlights the various guidelines and data collection tools TxDOT uses to report collisions.

Add at Chapter 1 *Highway Safety Improvement Program*, Section 6 *Obtaining Crash Data* at page 1-14:

> Crash data are one of the tools used by engineers and roadway safety professionals to identify potential highway safety improvement projects. Once locations of concern have been identified, crash data ***(including the magnitude and frequency of wildlife vehicle reported crashes) and carcass collection data,*** along with traffic and roadway geometric data, is reviewed to determine appropriate countermeasures.

In Chapter 1 *Highway Safety Improvement Program,* Section 8 *Preventable Crash Decoding* on page 1-17 in the section *First Harmful Event* is a table titled “Collision of motor vehicle with:”—add here a new subset of data elements if the box for “Animal” (number 6) is checked. Providing this data element would increase TxDOT’s ability to address the problem of AVCs by targeting the preventive measures to the specific animal types in an area. This new table of sections would include the following species:

- ***Domestic Animal Pull-Down Menu***
  - ***Cattle/Cow***
  - ***Domestic Sheep***
  - ***Horse***
  - ***Domestic Dog/Cat***
- ***Wild Animal Pull-Down Menu***
  - ***Coyote***
  - ***Ocelot or Bobcat***
  - ***Deer***
  - ***Pronghorn Antelope***
  - ***Bighorn Sheep***
  - ***Nilgai Antelope***
  - ***Javelina/Pig***
  - ***Mammal – with space to write in species***

- ***Bird – with space to write in species***
- ***Reptile (Snake/Turtle/Tortoise)***

Later in this same section is a table at page 1-20 titled "Objects Struck"—add here these two rows:

Vehicle hit wild animal

Vehicle hit domestic animal

This addition would align this table to the *First Harmful Event* table titled "Collision of motor vehicle with:" on page 1-17, and subsequent tables where animals are noted. Differentiating between wild and domestic animals is helpful because crash severity may be markedly different, and local jurisdictions may need to be involved to enforce leash policies or ordinances in areas that have high collision rates with domestic animals. At a bare minimum, providing this distinction between wild and domestic animals involved in a collision should be required, even if the list of individual species is not used.

These elements would also elevate the identification of AVC as a tool to be used consistently in developing plans to address this issue and constructing projects. In addition, if the Environmental Affairs Division rolls out policies and procedures for collecting and reporting carcass data as a standardized procedure, this will provide further data to identify areas that need safety improvements. Most AVCs go unreported due to limited damage to vehicles. Reporting animal carcass data can provide further, more nuanced data on where wildlife is coming into conflict with vehicles to develop the HSIP.

6.2.7. Landscape and Aesthetics Design Manual

The Landscape and Aesthetics Design Manual provides guidance for a transportation designer to fit the highway or other facility into the adjacent landscape in a way that is complementary to, and enhances, the existing landscape. Achieving this goal requires consideration of natural, ecological, aesthetic, economic, and social influences related to that landscape.

Add at Chapter 1 *Introduction to Landscape and Aesthetics Design*, Section 4 *Highway and Transportation Corridors* under *Urban Corridors* at the subtopic *Environmental Mitigation* at page 1-13:

Environmental mitigation embraces a broad scope of activities dealing with issues of air quality, water quality, wetlands, noise and vibration, ***wildlife crossing structures***, and environmental justice. Environmental mitigation requires a variety of structural features that can be incorporated as land-scape and aesthetic assets at no additional cost.

Add at Chapter 1 *Introduction to Landscape and Aesthetics Design*, Section 7 *Policy and Authorities Impacting Landscape and Aesthetic Design* under *Regulations* at page 1-23:

This section identifies the body of regulation and policy that establishes departmental responsibilities in the area of landscape and aesthetics design. It also provides basic information on the programmatic tools available to affect landscape and aesthetics responsibilities. For more information on the individual regulations listed here, see Chapter 5, Section 4, 5280: Design landscape/aesthetic plans of the Project Development Process Manual.

There are a variety of federal, state, and departmental acts and directives that mandate TxDOT design and maintenance activities related to landscape and aesthetics design. While there are numerous citations, the combined impact of these requirements can be summarized as follows:

- The landscape and visual aesthetic qualities of a transportation corridor are an environmental characteristic that, by law, must be considered in the design process and, where possible, enhanced.
- The landscape disturbed by the construction of a highway must be reestablished for environmental and aesthetic reasons. The revegetation process is to be accomplished with appropriate native and adapted species.
- To the extent possible, plants used for revegetation of rights-of-way should be low water use (xeric) plant materials.
- ***To the extent possible, the revegetation of rights-of-way should not use highly palatable plants that may attract animals to cross the road for food and thus affect traffic safety.***
- ***To the extent possible, native plants should be used to induce animals to utilize crossing structures and, within the wildlife crossing structure itself, to provide cover for specific specifies to encourage them to use the crossing structure.***
- Where a transportation project must disturb an environmentally sensitive landscape, wetland, historic site, established residential neighborhood, or scenic landscape, appropriate actions must be taken to mitigate visual and adverse environmental impacts. TxDOT recognizes the need for developing highways with acceptable visual quality and has developed several proactive programs that encourage and assist the development of such transportation corridors. These include the Transportation Enhancements Program, Transportation Alternatives Program, Cost Share Program, the Governors Community Achievement Awards, Green Ribbon Landscape Improvement Program, and Landscape Partnership Program.

In Chapter 2 *Assessment, Planning, and Design,* Section 2 *Landscape and Aesthetic Assessment*, add a numbered item in Step 5 *Develop a Landscape and Aesthetics Statement* under "2. Inventory of Corridor" at page 2-7:

2. Inventory of Corridor

    a. Identification of corridor (indicate whether corridor runs beyond project limit)

    b. Inventory of physical properties

        2.Visual Geometry of Highway Corridors

        3. Landform

        4. Area's wildlife species that may use the corridor

        5. Neighborhood Context

        6. Cultural or Ephemeral (short lived) Context

Add at Chapter 2 *Assessment, Planning, and Design,* Section 3 *Landscape and Aesthetics Master Plan* under *Plant Materials Palette* at page 2-12:

Plant materials should be divided into two sections. The first section would have recommendations for basic erosion control as well as appropriate landscape enhancements for the purpose of minimizing maintenance, and ensuring a safe, sustainable roadside***. In addition, to help reduce wildlife-vehicle conflict the plant materials selected should not encourage wildlife to loiter on the roadside or cross the road. Where a wildlife crossing is present, plant materials should be used to direct and encourage wildlife to use the crossing structure. Where possible, the use of native plants is recommended.***

All erosion control logs and mats shall be biodegradable. No plastic or synthesized materials shall be placed. Please refer to ENV division for standards of these biodegradable mats.

Add at Chapter 2 *Assessment, Planning, and Design*, Section 4 *Landscape Design* under *Non-mow Areas* at page 2-20:

The designer should be aware that the removal of regular mowing might allow weeds previously held in check to proliferate and present an unkempt appearance. The non-mow option is not synonymous with "restoration," "habitat creation," or "naturalization," ***but is to avoid habitat destruction. No mowing, however, may provide preferred habitat for some mammals, birds, and invertebrates, thereby encouraging them to move into the right of way and cause a safety hazard.*** Likewise, the adjacent land use must be considered. Mowing may be required to control invasive species that could proliferate on the right-of-way and invade the adjacent land. ***Maintenance staff should consult with the District Environmental Coordinator to determine if a non-mow or restricted mowing location option has been developed to protect endangered plants. The use of signs that indicate "Restricted or no mow" have been used in the Pharr District and can be placed to assist with these areas.*** These conditions are most often encountered on rural rights-of-way.

Add at Chapter 2 *Assessment, Planning, and Design*, Section 4 *Landscape Design* under *Restoration, Habitat Creation, and Naturalization* at page 2-21:

Restoration, Habitat Creation, and Naturalization

The use of the roadside for specialized environmental goals should be carefully considered to be sure that the safety ***(including limiting inducement for wildlife to come into close proximity to right of way)***, sustainability, and life-cycle costs of the project meet department goals and resources. ***Selective choice in plant selection, including native vegetation and natural water flow, can be used by the landscape architect to encourage movement to and use of bridges and culverts that are designed for safe wildlife movement over or under right of way and provide pollinators opportunities to feed.***

Restoration - Restoring a site to the topographic shape, hydrologic function, and plant community that existed in historical times before disturbance by man. This practice is expensive and requires detailed knowledge and constant management.

Habitat Creation – Designing and managing plant communities for use as habitat by birds, mammals, reptiles, or insects. Habitat creation involves providing one or all of cover, food, or water to a targeted species and requires detailed planning and development funding. Where general habitat for wildlife is a goal, the preservation of existing sites is preferable to the development of new habitat. ***The landscape architect and other staffers should work with their District Environmental Coordinator to reduce the propensity to induce wildlife to enter a habitat area in close proximity to a roadway. The landscape architect can also utilize native vegetation, as well as restoring access to water in close proximity to wildlife crossing structures to encourage wildlife use of these structures.***

Naturalized Areas – The preservation or establishment of native plant communities either as an aesthetic program or as part of habitat creation. Naturalization seeks to promote or re-introduce native plants to minimize maintenance or improve the aesthetics of the roadside. This will usually involve the seeding or planting of desirable plants and periodic management to assist in their survival or it may focus on preserving threatened or endangered species. See Figure 2-4 for an example of a natural growth area.

Some portions of the right-of-way may be suitable as part of a re-naturalization project or to remove large areas from routine maintenance. These are usually large areas beyond the minimum distances from pavement edges that do not require regular maintenance and meet aesthetic and management goals, ***and do not induce wildlife to congregate and move onto or across the right of way.*** Most often these areas are found in large interchanges. In these projects, plant material that would not normally be appropriate for use in other roadside applications may be desirable as a part of urban reforesting programs, wildlife habitat, or storm water quality programs. The establishment of naturalized areas in the roadway will often entail specialized management techniques, ***collaboration with the District Environmental Coordinator and Environmental Affairs Division to ensure such areas do not encourage wildlife to cross through a large interchange to access water or other food sources***, and scheduling that may require special specifications and contracting procedures. These needs should be carefully considered in determining the appropriate use and design of these features.

Add at Chapter 2 *Assessment, Planning, and Design*, Section 4 *Landscape Design* under *Plant Selection Criteria* at page 2-24:

Plants for the right-of-way must also be selected based on their anticipated maintenance needs and their adaptability to the roadside environment. The placement of plant material along the roadway is of critical importance because of its potential effect on driver safety ***either through reduction in cone of vision, or because wildlife will cross over right of way to reach a food source. The landscape architect and other staff should also work with their District Environmental Coordinator to reduce planting of vegetation that entices wildlife to move across the road to reach planted food sources.***

Add at Chapter 3 *Project Development Process*, Section 2 *Preliminary Design* under *Conduct Preliminary Design Conference (2000)* at page 3-3:

environmental constraints that require design modification such as noise sensitive properties, wetlands, endangered habitat or plant species, or ***specific points that have served as crossing points for many years for wildlife***, cultural and historic resources

Add at Chapter 3 *Project Development Process*, Section 2 *Preliminary Design* under *Conduct Early Coordination with Stakeholders (2110)* at page 3-4:

The landscape architect should be alert for:

- resource agency demands that will require physical changes in the landscape, particularly such elements as deep cuts, elevated sections of roadway, complex interchanges, or ramps
- activities that require taking of right-of-way
- any activities that will impact wetlands or vegetation associated with vulnerable habitat, ***which may cause wildlife to move into right of way to find food or water or escape construction activities***
- established neighborhoods that will be significantly impacted

Add at Chapter 3 *Project Development Process*, Section 2 *Preliminary Design* under *Perform Preliminary Planning for Bridges (2580)* at page 3-12:

The landscape architect should be alert for:

- opportunities to preserve existing vegetation to minimize clearing, grading, revegetation, and long-term maintenance costs
- areas that will be difficult to revegetate or maintain vegetation cover
- areas that can serve as permanent wetlands, areas where ***wildlife need to move across the landscape or waterways,*** storm water management and pollution control structures
- areas that will require special architectural or landscape treatment to meet erosion control, reforestation, or to increased sustainability

Add at Chapter 3 *Project Development Process*, Section 3 *Environmental Design* under *Collect Environmental Data (3030)* at page 3-18:

Action items

- Collect historic maps, drawings, and photographs. Public libraries and historical societies are primary resources.
- Obtain copies of reports and plans prepared by federal, state, and local agencies.
- Perform visual analysis to identify the potential aesthetic or landscape conflicts that may be caused by project construction. Particular emphasis should be placed on identification of sensitive neighborhood characteristics or cultural, historic, scenic

resources ***and areas where wildlife inhabit, need to move to and from, or would be attracted to.***

- Prepare a visual analysis of the project area. Take care to ensure that the analysis addresses specific issues related to neighborhood, cultural, historic, scenic resources, ***and wildlife*** that may be affected by project design.
- Provide the District Environmental Coordinator with description of constraints related to landscape and aesthetic resources**.**

Add at Chapter 3 *Project Development Process*, Section 3 *Environmental Design* under *Prepare Environmental Mitigation Plans (3390)* at page 3-22:

Landscape architects can be helpful in the preparation of environmental mitigation plans, particularly with respect to issues related to constructability and the preparation of PS&E. Types of mitigation projects where landscape architects can be of assistance are:

- earthwork modifications associated with aesthetics or wetland construction
- siting of structures and site development or reconstruction
- revegetation and reforestation for erosion control or environmental mitigation
- ***developing vegetation plans for wildlife access to crossing structures***
- water harvesting and retention
- special architectural detailing
- site planning and development for cultural and historic sites
- planning and mitigation actions needed to meet visual quality constrain**ts**

Add at Chapter 3 *Project Development Process*, Section 4 *PS&E Development* under *Prepare Culvert and Storm Drain Details (5570)* at page 3-30:

There are a number of structures involved in the final design of the drainage system. As appropriate, details of drainage structures should be developed to fit into the landscape and aesthetics scheme of the corridor, ***and when requested, for use as by wildlife of all kinds to use to cross under the road***. This includes elements such as head- and end-walls, steps, guardrails, pumping facilities, ***and vegetation at fences that encourage wildlife to move into a culvert and through bridges and at each end***. The primary goal is to ensure that the style, finishes, and materials are consistent with the LAMP.

6.2.8. Maintenance Management Manual

The Maintenance Management Manual provides guidance and information for maintenance management.

At Chapter 6 *Management Information Systems*, Section 2 *Maintenance Management System*, the text should be updated to include reference to a mobile application for accurate carcass removal counts, when this is completed by the FHWA and its consultant. The data from such an application will provide staff with real-time information on where wildlife-vehicle conflicts are occurring. Staff from the Environmental Affairs Division or TPWD can then recalculate wildlife population density and movement, and reassess hot spots as needed.

Add at Chapter 1 *Definitions and Planning*, Section 2 *Definitions of Maintenance* at the table titled "Roadside" under the column "Routine Maintenance" at page 1-4:

> All work to maintain the roadside including but not limited to: maintenance and operation of rest areas and picnic areas, litter removal, mowing, placing herbicides, tree and brush trimming and removal, repair and upgrading of guard rails and extruder terminals, repairing slides and side slopes, placing topsoil, sod, shrubs, etc. to reestablish proper grade and vegetative cover and landscaping, removal or treatment of roadside hazards, installation and maintenance of environmental protection devices ***(including repair of wildlife crossing structures, wildlife guards, fencing, and escape ramps),*** and mitigation of spills or hazardous materials.

The research team also recommends that at Chapter 3 *Level of Service*, Section 3 *Environmental Best Management* (which is currently reserved for a future section) the Environmental Affairs Division consider creating text regarding level of maintenance service for wildlife crossings. This service should be developed in conjunction with other divisions, and reflect the types of wildlife crossing structures that are developed within Texas.

6.2.9. Maintenance Operations Manual

The Maintenance Operations Manual provides guidance on routine and preventative maintenance of roadsides, bridges, pavement, traffic operations, emergency operations, and work for and by others.

At Chapter 2 *Roadside*, Section 2 *Litter*, the research team recommends the addition of carcass data collection metrics. Other states have developed mobile device applications that are used by maintenance crews to detail with a GPS marker the type of carcass removed. At the time of this writing, ENV staff were helping to develop a national mobile phone or electronic unit application. Once the app is finalized, ENV staff should develop language to be placed in this manual to instruct personnel how the carcass data should be collected and managed. This data can be used to accurately and consistently gather data to aid in future planning for AVC reductions by creating wildlife crossing structures or other mitigation strategies.

Add at Chapter 2 *Roadside*, Section 2 *Litter* under the *Animal Remains* final paragraph at page 2-3:

> ***Department maintenance personnel should report animal carcasses that are present on or removed from TxDOT road rights of way through the Roadkills of Texas project on iNaturalist. Contact ENV-NRM if you need assistance setting up the project on your smartphone or tablet. Simply take a picture using the iNaturalist app. If you know what the species is, then you can enter it or the app will make suggestions for you. If you can't identify the species, then leave it blank. Select Add to Project and select the Roadkills of Texas project. Fill out any information you have in the provided fields or leave blank. To finish just select the check mark in the project and the main observation page. The app will upload the information. so that the carcass will be properly geo-located and the District Environmental Coordinator can work with biologists in the Environmental Affairs Division to ensure proper identification of the species of the carcass.***

Add at Chapter 2 *Roadside,* Section 3 *Vegetation Management* under the *Vegetation Management* sub-heading, at page 2-5:

> The department will maintain highway right of way vegetation in an environmentally sensitive and uniform manner consistent with the special conditions presented by local climate, topography vegetation and level of urbanization.
>
> ***District staff should work with their District Environmental Coordinator to ensure that protected species are considered, and impacts are reduced to the extent necessitated by listing status for proposed roadside vegetation maintenance activities that could cause wildlife to move into the right of way.***

In Chapter 2 *Roadside*, Section 3 *Vegetation Management*, the research team recommends elaborating on the importance of creating or maintaining a line of sight. In an area known to have animal-vehicle conflicts, vegetation management can promote better visibility of vehicles for wild animals, and of wildlife for drivers. At Chapter 2 *Roadside*, Section 3 *Vegetation Management*, add a new paragraph between *Vegetation Management* and *Chemical Selection for Control of Pests* at page 2-5:

Line-of-sight Conditions

The department will also maintain line-of sight-conditions, with cleared vegetation allowing drivers better visibility of wildlife near the right of way in areas that have high incidences of animal-vehicle collisions or are close to wildlife crossing structures. A clear line of sight should be maintained to help reduce animal-vehicle conflict.

Add at Chapter 2 *Roadside*, Section 3 *Vegetation Management* under *Brush Control, Tree Removal and Tree Trimming* at page 2-6:

Timely tree and brush removal, tree trimming, and pruning is necessary for:

- maintaining required sight distance
- maintaining adequate clear zones on each side and above the roadway
- removing low branches or brush that may be hazardous to equipment operated on the right of way such as mowers
- aesthetics.

All tree trimming, tree removal and brush removal should follow the guideline provided in Chapter 5 of the Roadside Vegetation Management Manual, Pruning Guidelines.

- ***All brush and tree removal at and in the entrances of designated wildlife crossing structures should be coordinated with district environmental staff.***
- ***Brush and tree removal along and in wildlife exclusion fences for both large and small animals will need to be conducted on at least an annual basis in conjunction with district environmental staff.***

Add at Chapter 2 *Roadside*, Section 4 *Roadside Drainage*, under *Maintenance and Repair* at page 2-7:

Drainage appurtenances can be clogged by the following obstructions:

- silting
- erosion
- earth slides
- excessive brush and vegetation.

Obstructions should be removed as soon as practical when they create conditions that could restrict flow.

Maintenance personnel should coordinate with District Environmental Coordinator and staff to maintain, repair, and keep clear wildlife crossing structures so that silting, erosions, earth slides, and excessive brush and vegetation do not impede the movement of wild animals through the structure, or keep the approaches from being seen by wildlife.

6.2.10. Plans, Specifications and Estimate Development Manual

The Plans, Specifications and Estimate (PS&E) Development Manual reviews the clearances and approval processes, review of plan specifications, estimates of plan, and pre- and post-letting activities. In Chapter 1, Section 1, environmental requirements and studies are outlined. It assumes that all required environmental permits and schematic approvals have been obtained per the Project Development Process Manual. This project's findings indicate that this may be an ideal place to initiate discussions of wildlife crossing structures. It would allow designers and bridge staff at district and division levels to incorporate early design schematic reviews for such crossings.

Add at Chapter 1 *Pre-Assembly Activities*, Section 1 *Environmental, Design, Right-of-Way, and Utility: Requirements and Value Engineering Studies* under the *Design Schematic* paragraph on page 1-3:

As part of the environmental approval process and early project development, a preliminary and/or a geometric schematic may be prepared to describe the existing and proposed general geometric features, ***wildlife crossing structures***, and location requirements for a project. A geometric schematic is required for new location or added capacity projects and for projects requiring control of access or an Environmental Impact Statement. A list of schematic requirements can be found in the TxDOT Roadway Design Manual. The schematic should include basic design information, which is necessary for proper review and evaluation of the proposed improvements. For a more complete and detailed discussion of the preliminary schematic or the geometric schematic, refer to the Project Development Process Manual.

Add at Chapter 1 *Pre-Assembly Activities*, Section 1 *Environmental, Design, Right-of-Way, and Utility: Requirements and Value Engineering Studies* under *Design Conference* at page 1-3/4:

A design conference is an informal, working meeting to discuss, establish, determine, and finalize the following:

- Programming/funding/federal letter of authority for preliminary engineering
- Agreements

- Status of environmental approvals/public involvement process
- Geometric design elements
- Status of schematic completion
- Surveying elements/photogrammetric elements
- Right-of-way status
- Utility adjustments
- Design criteria
- Bridge data
- Hydraulic elements
- Pavement structures
- ***Wildlife crossing structures***
- Construction phasing/traffic handling
- Key Dates / Special Events when roadway closures are prohibited
- Value engineering study (for more information see the indicated subsection below).

Add at Chapter 1 *Pre-Assembly Activities,* Section 1 *Environmental, Design, Right-of-Way, and Utility: Requirements and Value Engineering Studies* under *Attendees* at page 1-4:

Attendees. The meeting is recommended for all projects and should be scheduled as soon as possible after authorization for PS&E has been secured. Scheduling and moderating should be accomplished by the Project Manager directly responsible for the design and development of the PS&E. Suggested attendees are as follows:.

- Staff from the Area Engineer's office who will have construction responsibilities
- Maintenance Supervisor who will be responsible for maintenance of the roadway
- ***District Environmental Coordinator, or ENV staff and specialists who will be responsible for environmental clearances and has data on area wildlife movements***
- Staff from offices having primary review responsibilities
- Staff from outside agencies directly involved with the project—i.e. funding responsibilities, review responsibilities, etc.
- Staff who will be directly involved in the development of PS&E for the project

Add at Chapter 2 *Plan Set Development*, Section 1 *Preliminary Review/Coordination* between the *Preliminary Storm Drain Layouts* and *Preliminary PS&E Design Reviews* paragraphs at page 2-4/5:

Preliminary Wildlife Crossing Structures

In cases where the districts need assistance, the preliminary wildlife crossing design schematic can be submitted to District Environmental Coordinator, ENV, BRG, and DES Divisions for preliminary review and approval.

Add at Section 3 *Plan Set Preparation under Plan Sheet Sequence* at pages 2-11 through 2-13:

V. Drainage Details

- Drainage Area Map Sheets
- Hydraulic Calculation Sheets
- Culvert Layouts

  Including culverts that are used for wildlife crossing that have ledges / steps.
- Drainage Plan and Profile Sheets
- Miscellaneous Details
- Standards.

X. Environmental Issues

- SW3P
- Wetland Mitigation Plan
- ***Wildlife Crossing Structure Details***
- Standards
- EPIC Sheet
- ***Migratory Bird Protection Exclusion Devices.***
- ***TPWD Sheets***

Add at Chapter 2 *Plan Set Development*, Section 3 *Plan Set Preparation* under *Culvert Cross Sections, Layout and Detail Sheets* at Page 2-30/31:

- North Arrow
- Skew Angle
- Centerline of Roadway
- Beginning and End of Structure (show begin and end stations and elevation for bridge class culverts)
- Roadway Width
- Centerline of Structure
- Direction of Flow
- Description of Existing Structure (should be included for documentation purposes)
- Roadway Cross Section
- Earthwork Slope(s)
- Flowline Elevations
- Slope of Culvert
- Wingwall Type
- Overall Length of Culvert
- ***Ledges and/or Steps in Culvert for Wildlife Crossing***
- Description for Proposed Culvert with Appropriate Standards
- Hydraulic Data (Headwater and Tailwater Elevations)
- Estimated Quantities shown in tabulated form
- Scale - (vertical and horizontal scales are relative to sheet size)
- Existing Ground Line
- Special Details (include details such as bill of reinforcing if the proposed work is not shown in a standard or provide location of such details elsewhere in the plans)
- Right-of-Way Lines and/or Easements.

At Chapter 2 *Plan Set Development*, Section 3 *Plan Set Preparation* under *Environmental Issues*, after the *Wetland Mitigation Plan* paragraph on page 2-39, add a new subsection titled "Wildlife Crossing Structure Plan" and the following text:

Wildlife Crossing Structure Plan

The wildlife crossing structure plan will consist of the detail design of each wildlife crossing, wildlife guard, fencing, exits/ramps, and gate requirements for the wildlife crossing structures on the proposed project. The plan should also be crosslinked to the EPIC sheet that lists all environmental commitments and other issues that may affect the contractor and their work on a specific project.

6.2.11. Procedure for Establishing Speed Zones

The purpose of this manual is to provide information and procedures necessary for establishing speed zones and advisory speed on the state highway system.

Add at Chapter 3 *Speed Zone Studies*, Section 4 *Speed Zone Design* under *Variation from the 85th Percentile*, in the second paragraph of the section titled *Crash Rate Greater than the Statewide Average Crash Rate for Similar Types of Roadways*:

After determination of the 85th percentile speed, the following factors should also be considered to determine the total speed reduction up to 12 mph:

- narrow roadway pavement
- horizontal and vertical curves
- high driveway density
- lack of striped, improved shoulders
- ***presence of wild animals that are involved in reported crashes***
- ***if landownership along the road is a federal or state park, refuge or monument, and if wildlife are protected and present***
- crash history within the speed zone.

Add at Chapter 3 *Speed Zone Studies,* Section 4 *Speed Zone Design* under *Variation from the 85th Percentile*, in the section titled *Additional Roadway Factors*:

The posted speed limit may be reduced by as much as 10 miles per hour (12 miles per hour for locations with crash rates higher than the statewide average) below the 85th percentile speed or trail-run speed (if 125 cars cannot be checked during the two- or four-hour 85th speed check), based on sound and generally accepted engineering judgement that includes consideration of the following factors:

- narrow roadway pavement widths (20 feet or less, for example)
- horizontal and vertical curves (possible limited sight distance)
- hidden driveways and other developments (possible limited sight distance)
- high driveway density (the higher the number of driveways, the higher potential for encountering entering and turning vehicles)
- crash history along the location
- rural residential or developed areas (higher potential for pedestrian and bicycle traffic)
- lack of striped, improved shoulders (constricted lateral movement)
- ***presence of wildlife that are known from crash and carcass data to be involved in vehicle collisions. It is also extremely important to reduce speeds in areas with federally and state-listed species of concern, such as ocelots.***

6.2.12. Project Development Process Manual

Add at Chapter 2 *Preliminary Design*, Section 2 *Data Collection/Preliminary Design Preparation* under *20200: Conduct early coordination with stakeholders* at page 2-8:

- Coordinate with District Environmental Coordinator and roadway design engineer.
- Identify resource and regulatory agencies and stakeholders.
- Identify environmental and design constraints.
- Identify possible construction methods.
- Explore project design modifications to avoid, minimize, or mitigate effects to natural resources, ***including wildlife crossing structures, fencing and associated infrastructure hardware and mitigation measures***.

Add to Chapter 2 *Preliminary Design*, Section 2 *Data Collection/Preliminary Design Preparation* under *20240: Obtain related data, plans, studies and reports* at page 2-13:

Helpful Suggestions

Related information typically available within TxDOT includes the following sources:

- “As-built” construction plans
- Right of way maps

- Bridge inventory data
- Traffic signal studies
- Pedestrian and bicycle plans
- Environmental studies and schematics for previous or adjacent projects, ***including wildlife crossings structures, wildlife guards, fencing, gates and jump out/exit designs***
- Texas Reference Markers, GIS data for railroads, city limits, and public roads, contact the Transportation Planning and Programming Division, Data Management office
- Traffic data, see Task 10430: Obtain Traffic Data
- Traffic accident data, see Task 20260: Obtain Traffic Crash Data
- Archived project history files
- Pavement Management Information System (PMIS) data
- Existing hydrologic/hydraulic reports
- Existing geotechnical reports
- Local agency comprehensive plans

Add at Chapter 2 *Preliminary Design*, Section 2 *Data Collection/Preliminary Design Preparation* under *20260: Obtain traffic crash data* at page 2-14:

Subtasks.

- If possible, obtain crash data for at least a three-year period.
- Obtain information about pertinent, physical features of the facility such as geometrics and traffic (i.e., average annual daily traffic).
- Observe traffic movements at the location during pertinent times (e.g., rush hour).
- Analyze the data. Identify factors contributing to crashes, look for similarities, patterns, or abrupt changes over time in the way crashes are happening. ***This should also include review of animal-vehicle conflicts, or changes in migratory or other patterns. This analysis should also look at time of day, as many such collisions occur at twilight and sunset, and if the area has any threatened or endangered species.***
- Consider design features that might reduce potential for crashes, reduce crash severity, or improve operations.

Helpful Suggestions.

- Through the district traffic operations section, contact Traffic Operation Division (TRF) to obtain access and training for the Crash Records Information System (CRIS).
- The Traffic Operations Division (TRF) can also assist in research, analyzing, and evaluating crash data.
- The district maintenance supervisor is a good source for traffic crash information.
- ***The district environmental coordinator may also be able to provide data on known animal-vehicle conflict areas and hot spot areas for crashes.***
- Local authorities may also assist in identifying or tracking problems as they develop.
- AASHTO Highway Safety Manual analysis can provide quantitative analysis and countermeasures to address safety.
- AASHTO Safety Analyst software can proactively predict safety improvements and optimize crash reduction as opposed to costly waiting for crashes to warrant an action.
- When data alone is insufficient, copies of a law enforcement officer's report may be obtained from CRIS.

Resource Material.

- AASHTO Highway Safety Manual, (HSM)
- Traffic Operations Division, Crash Data and Analysis Section
- Interactive Highway Safety Design Module (IHSDM), Six evaluation modules (Crash Prediction, Design Consistency, Intersection Review, Policy Review, Traffic Analysis, and Driver/ Vehicle)
- AASHTO Safety Analyst
- TxDOT Highway Safety Improvement Program Manual
- Texas Transportation Code Chapter 550

Add at Chapter 2 *Preliminary Design*, Section 2 *Data Collection/Preliminary Design Preparation* under *20290: Perform other surveys* at page 2-20:

ROW or property surveys: Task 40100: Perform preliminary right of way research

- Utility surveys: collect information on location and type of existing utilities. See Task 40110: Locate existing utilities.

- Cultural and historic: buildings, cemeteries, and other cultural resources
- Intersections: turning movements and through traffic
- Traffic generators: classification by Origin Destination
- Origin and destination
- Traffic: ADT
- Vehicle classification: percent truck traffic
- Environmental: type and location of environmental features
- ***Wildlife on property that may need to have wildlife crossing structures installed***

Add at Chapter 2 *Preliminary Design*, Section 4 *Preliminary Schematics* under *Geometrics* at page 2-25:

20400. Evaluate corridor alternatives

20410. Perform preliminary Level of Service analysis

20420. Evaluate route alternatives

20430. Initiate railroad coordination

20440. Identify requirements for crossing navigable waters

20450. Evaluate geometric alternatives

20460. Develop typical sections

20470. Prepare Landscape and Aesthetics Assessment

20480. Develop bicycle and pedestrian accommodation

20490. Update cost estimates
[NEW number] Develop wildlife crossing structure accommodation

For this new number add this new section after Prepare Landscape and Aesthetic Assessment at page 2-37/38:

[*New Number]: Develop wildlife crossing structure accommodation*

Description. Accommodations for wildlife crossing structures should be given full consideration on all highway projects and during construction, specifically on Federal-aid projects. Where animal-vehicle collision are expected, or where endangered or threatened

species are likely to be impacted these preliminary plans should be developed to include safe passes for wildlife to cross and for motorist safety.

Pertinent Project Types. All projects

Responsible Party. Roadway Design Engineer and District Environmental Coordinator

Subtasks.

- ***Decide what accommodation type can be reasonably provided.***
- ***If a bridge deck is being rehabilitated or replaced on a highway, consider developing a longer bridge span to provide wildlife crossing opportunities under the structure on the replaced or rehabilitated bridge.***

Helpful Suggestions.

- ***Refer to ENV Natural Resource Management Section and District Environmental Coordinators to gather information and instructions for conducting analysis and ensuring that threatened or endangered species are considered in the design process.***
- ***Coordinate with the District Environmental Coordinator during the planning stage.***
- ***Where new wildlife crossing structures are proposed, include sufficient information to explain the reasons for facility selection in the environmental effects statement.***

Critical Sequencing.

- ***Include provisions for wildlife crossing structures accommodations in the preliminary schematic.***

Resource Material

- ***TxDOT Environmental Affairs Division***
- ***TxDOT Bridge Project Development Manual***
- ***TxDOT Landscape and Aesthetics Design Manual,***
- ***NEPA***
- ***Endangered Species Act***

At Chapter 2 *Preliminary Design*, Section 5 *Geometric Schematics* add a new numbered subsection between subsections 20520 and 20525 at page 2-41:

***Add new number between* 20520. Consider impacts on historic structures *and* 20525. Perform detailed Level of Service analysis.**

The new numbered section's suggested title:

[*205XX]: Perform preliminary planning for wildlife crossings*

Description. An analysis of wildlife-vehicle conflicts is required to create preliminary plans and profiles of wildlife crossing structures. The purpose of this analysis is to determine approximate elevations and sizes of wildlife structures. The analysis should result in an estimate for the most efficient types of structures that can reduce wildlife vehicle conflicts for a safer road.

Pertinent Project Types. All projects.

Responsible Party. Roadway Design Engineer and District Environmental Coordinator

Helpful Suggestions.

- ***Refer to ENV Natural Resource Management Section and District Environmental Coordinators to gather examples of potential designs.***
- ***Refer to District Environmental Coordinator and to Environmental Affairs Division, who may have further schematics and designs already approved through TxDOT.***

Resource Material

- ***TxDOT Environmental Affairs Division***
- ***TxDOT Bridge Project Development Manual***
- ***TxDOT Landscape and Aesthetics Design Manual,***
- ***NEPA***
- ***Endangered Species Act***

Add at Chapter 3 *Environmental*, Section 1 *Preliminary Environmental Issues* under *30130: Collect environmental data* at page 3-6:

30130: Collect environmental data

Description. Environmental document research includes obtaining information from federal, state, and local agency databases, as well as on-the-ground surveys, ***and analysis of crash data.*** This data should be used to assess the existing baseline environmental conditions, identify "red flag" resources and areas requiring avoidance considerations, current transportation system, land use trends, local agency planning, and type of environmental document to be prepared.

Maintain an accurate project file. The file allows the project team quick access to important documents and reduces inefficiency and duplication. If a lawsuit is filed challenging the environmental decisions, the project file provides a starting point for the administrative record preparation.

Pertinent Project Types. All projects except preventive maintenance or restoration projects.

Responsible Party. Core team

Subtasks.

- Perform a site visit to identify and assess environmental constraints, potentially sensitive areas, historic structures, habitats, and landscapes.
- Gather information in addition to that gathered during detailed site visits performed earlier. See Task 10110: Perform site visit.
- Prepare a baseline environmental constraints map showing the location of sensitive environ-mental features. The roadway design engineer and District Environmental Coordinator use this map to determine potential environmental effects of proposed alignments, ***and places where wildlife crossings structures can be integrated***.

Helpful Suggestions.

- For complex projects or projects with more than one potential corridor, Geographic Information System (GIS) mapping data can be used to automatically calculate impacts.

Critical Sequencing.

- Preliminary environmental surveys, data collection, and coordination with local impacted agency goals/objectives should be started early during preliminary design.
- Develop the baseline environmental constraints map as soon as practical. It will be used for project decision making. It will serve as an important tool in communicating environmental constraints, and it is the first step in preparing the project's environmental document.

Resource Material.

- Inside TxDOT: Environmental Affairs Division, Best Practices for the Environmental Document Process
- AASHTO Practitioner's Handbook - Maintaining a Project File and Administrative Record for a NEPA Study, 2006
- TxDOT Resource for Linking Planning with Project Planning in support of NEPA, 0-6701-P1
- CDOT Planning and Environmental Linkages (PEL) Handbook, 2012
- Environmental Affairs Division: NEPA and Project Development Toolkit

Add at Chapter 3 *Environmental*, Section 3 *Environmental Documentation* under *30370: Prepare landscape recommendations* at page 3-29.

30370: Prepare landscape recommendations

Description. In the federal-aid highway program, highway aesthetics is a most important consideration. Highways must blend with our natural, cultural, and social environment and also provide pleasure and satisfaction in their use. Landscape development within the right of way shall be in conformity with accepted concepts and principles of highway landscaping and environmental design. Highway landscape design does not consist of seeding for erosion control or planting vegetation for screening purposes.

Federal cooperation with state and local agencies can provide opportunities for display of original works of art in the right of way. Designers should encourage the development of pollinator habitat, forage, and migratory way stations for monarch butterflies, honey bees, and other native pollinators by planting native forbs and grasses. Plant establishment durations should be sufficient for an expected survival in a highway environment. Consider a revegetation plan as an integral part of road construction and not an afterthought. ***In addition, landscaping can provide plant communities for use as habitat by birds, mammals, reptiles, or insects. Habitat creation involves providing one or all elements of cover, food, or water to a targeted species and requires detailed planning and development funding. Where general habitat for wildlife is a goal, the preservation of existing sites is preferable to the development of new habitat. Habitat plants can also be used with screening to direct animals to use wildlife crossings that have been installed.***

Pertinent Project Types. New construction, and major reconstruction, or rehabilitation projects
Responsible Party. Project manager

Authority.

- Landscape and Roadside Development: 23 CFR §752.1 et seq.
- Landscape and Scenic Enhancement: 23 USC §319
- Eligibility for Control of Noxious Weeds and Aquatic Noxious Weeds and Establishment of Native Species: 23 USC §329
- Green Ribbon Projects: 43 TAC §11.100 et seq.
- Transportation Enhancement Program: 43 TAC §11.200 et seq.

Subtasks.

- Planning and development of the project roadside should be concurrent with or closely follow the highway project.
- On new or major reconstructed highways, develop urban landscape appropriate to existing or planned environment.
- On new or major reconstructed highways, develop rural landscape appropriate to adjacent environment. Include an opportunity for regeneration and maintenance of native growth. Landscape planning shall incorporate planting native wildflower seeds or seedlings, unless a waiver is provided in accordance with 23 CFR 752.11(b).
- Request the landscape architect perform a visual inspection of the project area and identify visual and aesthetic resources that might be affected.

Helpful Suggestions.

- Integrate aesthetic elements in the design phase.
- Use native plants or xeriscaping.
- Enlist the support and advice of the landscape architect early in project development.
- Consider sight distance and maintenance requirements when developing the landscape plan.
- Coordinate planning with local officials to ensure compatibility with local aesthetic planning efforts.

Critical Sequencing.

- Aesthetic and landscape recommendations are usually developed only for the preferred alternative.

- Assemble a team that includes a revegetation specialist before soil and vegetation disturbances are planned.
- Understand that revegetation tasks begin 1 to 3 years before construction and continue after construction is complete.

Resource Material.

- TxDOT *Landscape and Aesthetics Design Manual*
- AASHTO A Guide for Highway Landscape and Environmental Design
- FHWA/USDOT, A Manager's Guide to Roadside Vegetation Using Native Plants, 2007

Add at Chapter 5 *PS&E Development*, Section 2 *Begin Detailed Design* under *50230: Design environmental mitigation details* at page 5-12:

Description. Mitigation for impacts due to highway improvements, should be defined in project environmental documents, permit conditions, or agreements with regulatory or resource agencies. Mitigation measures are typically defined, without much detail, during advance planning. Mitigation plans should have been prepared according to Tasks 20520: Consider impacts on historic structures and Task 30390: Prepare environmental mitigation plans. Mitigation details to be implemented during construction must be delineated in plans and specifications: and **Task *[New Number]*: *Perform preliminary planning for wildlife crossings* [which the research team recommended was placed between items 20520-20525 in Chapter 2 of this manual].**

Add at Chapter 5 *PS&E Development*, Section 3 *Final Alignments/Profiles* under *50300: Design final controlling conditions* at page 5-21, and the Resource Material subsection at page 5-23:

Description. Finalizing controlling conditions is a necessary first step in completing roadway design. Preliminary design development does not take into account as detailed analysis of conditions as is required for final design. Issues that may warrant modifications include final design of superelevation rates, stopping sight distances (SSD), intersection geometry, grades, access connections, traffic management during construction, major utility adjustments, ~~**or**~~ drainage facilities, ***and use of culverts / bridges for wildlife crossing structures***. Changes may also be required for minimizing impacts to Section 4(f) properties, wetlands, rights of way, and threatened or endangered species.

Resource Material.

- FHWA Revisions to the Controlling Criteria for Design and Documentation for Design Exceptions, Memorandum, May 5, 2016
- TxDOT Roadway Design Manual
- TxDOT Hydraulic Design Manual
- TxDOT Bridge Project Development Manual for information on bridge clearances and geometrics.

Add at Chapter 5 *PS&E Development*, Section 4 *Roadway Design Overview* at page 5-24:

This section discusses tasks necessary to finalize plan/profile and cross sections of the proposed facility and additional details related to roadway design. Note that final determination of right of way requirements and preparation of a remedial action plan for hazardous waste clean up are important, relative to the project schedule. These two items have the potential to affect project schedules and costs greatly if not given proper attention. This section includes the following tasks, which may be performed concurrently.

50400. Prepare cross sections and compute earthwork

50410. Review right of way requirements

50420. Design landscape/aesthetic plans

50430. Develop plan and profile sheets

50440. Design pedestrian walkways and bicycle transportation facilities

50450. Design miscellaneous details

[New number] Review and design wildlife crossing structure plan

50460. Review project for design exception/waivers

50470. Prepare hazardous material remediation plan

Add a new numbered task item at page 5-31 after *50450: Design miscellaneous details*[133]:

[New number] Review and design wildlife crossing structure plan

Description. Accommodations for wildlife crossing structures should be given full consideration on all highway projects and during construction. Where animal-vehicle

[133] Note: this could also be included in Task Item 50450 *Design miscellaneous details*.

conflicts are expected, or where endangered or threatened species are likely to be impacted, these preliminary plans should be developed to include safe passes for wildlife to cross and for motorist safety.

Pertinent Project Types. All rehabilitation projects and above would not be considered for seal coats and overlays.

Responsible Party. Roadway Design Engineer and District Environmental Coordinator

Subtasks.

- ***Determine funding available for wildlife crossing structures.***
- ***Write an assessment of wildlife crossing issues if necessary***
- ***If a bridge deck is being replaced on a highway, work to develop a longer bridge span to provide wildlife crossing opportunities under the structure on the replaced or rehabilitated bridge.***

Helpful Suggestions.

- ***Refer to ENV Natural Resource Management Section and District Environmental Coordinators to gather information and instructions for conducting.***
- ***A well written program can help to justify funds on wildlife crossings from a safety perspective and can be used in public outreach for decision-making purposes.***
- ***Coordinate with the District Environmental Coordinator.***

Critical Sequencing.

- ***Develop wildlife crossing structure plans before or concurrently with the roadway details.***

Resource Material

- ***TxDOT Environmental Affairs Division***
- ***TxDOT Bridge Project Development Manual***
- ***TxDOT Landscape and Aesthetics Design Manual***
- ***Endangered Species Act***

Add at Chapter 5 *PS&E Development*, Section 6 *Bridge Design* under *50620: Prepare bridge details* at page 4-49/50:

Subtasks.

- Update preliminary bridge layouts per Division and comments.
- Obtain the following from the roadway design engineer:
    - Current typical section
    - Alignments
- Superelevation and transition locations
- Pedestrian features
- ***Wildlife crossing structures***
- Required clearances
- Proposed utilities
- Roadway lighting
- Drainage conveyance method
- Construction staging
- Resource agency commitments
- Information regarding special issues such as noise wall on bridges and overhead fiber optic and power line restrictions
- Obtain current bridge hydraulics from the drainage engineer.

Resource Material.

- TxDOT Bridge Design Manual - LRFD
- TxDOT Bridge Detailing Manual
- TxDOT Hydraulic Design Manual
- TxDOT Geotechnical Manual
- TxDOT Landscape and Aesthetics Design Manual

Add at Chapter 5 *PS&7E Development*, Section 7 *Drainage Design* under *50700: Perform hydraulic design for culverts and storm drains* at page 5-23:

Description.

Roadway culvert and storm drain hydraulic design includes determining culvert and storm drain sizes and grades to handle design stormwater flows. The designer should evaluate the land use to determine the best structure for the location.

Culverts carry surface water across or from the highway right of way. They also must carry traffic and earth loads; therefore, culverts require both hydraulic and structural design. Structures measuring 20 ft. or more along the roadway centerline are classified as bridges***. In addition, culverts are often used by wildlife to safely cross under the road, and they are an easy and quick way to provide this type of connectivity while enhancing safety for motorists (due to reducing wildlife crossings on the highway right of way).***

Subtasks.

- Review preliminary engineering recommendations, as-built construction plans, drainage area maps, and hydrology reports.
- Obtain proposed typical sections, alignments, superelevation, geometric layouts, existing and proposed utilities, construction staging, natural resource agency commitments, and preliminary cross sections from the roadway design engineer ***that may also include the use of the culvert as a wildlife crossing structure with ledges and steps to access the ledges.***

Helpful Suggestions.

- Perform a site visit, preferably during a major rain event. Personally inspect items such as broken or damaged culverts, culvert end treatment type, localized flooding, sedimentation, and utilities. Taking these issues into account can be critical to the design of drainage facilities. Research commitments made to natural resource agencies.
- Drainage design should include consideration of pedestrian facilities, utility impacts, driveway grades, outfall and ditch erosion, wildlife habitat ***and wildlife crossings***, and retaining wall drainage.
- Placement of concrete traffic barrier should be evaluated for drainage impacts, ***and the potential to increase wildlife-vehicle conflicts.***

Resource Material

- FHWA Hydraulic Design of Highway Culverts, 3rd Edition

- Online TxDOT, Home, Business, Resources: Engineering Software for highway design such as, Bridge Geometry, Culvert Analysis, and Flow Manager
- Bridge Division, Scour Summary Sheet for Bridge Class Culverts, Form 2606
- AASHTO Highway Drainage Guidelines
- TxDOT *Hydraulic Design Manual*
- TxDOT *Roadway Design Manual*

At Chapter 5 *PS&E Development*, Section 7 *Drainage Details* under *50720: Prepare culvert and storm drain details* at page 5-55 add:

Description. The primary aim of an urban storm drain design is to limit the amount of water flowing along the gutters or ponding at low points to quantities which will not interfere with the passage of traffic or incur damage to the highway and local property. This is accomplished by placing appropriately sized inlets at the proper spacing. Culverts are used to carry water underneath a roadway (***and can include wildlife crossing structures***); storm drains typically drain sag areas. Culvert detail sheets typically include following elements:

6.2.13. Roadside Vegetation Management Manual

The Roadside Vegetation Management Manual contains guidelines for levels of vegetation management. The manual contains subsections that identify concerns about wildlife habitat and native plant conservation as well as endangered and threatened plants and animals. District Environmental Coordinators, vegetation management staff, and Environmental Affairs Division can all be consulted in these areas to encourage the protection of wildlife. Where a wildlife crossing structure is built, vegetation management can also provide clear opportunities to encourage wildlife to move to, and use, a wildlife crossing structure. Additionally, the manual calls for coordination to avoid damage to plant species that benefit the area and wildlife.

Add at Chapter 1 *Vegetation Management Guidelines*, Section 1 *Introduction* under *Purposes of Guidelines* at page 1-2:

The purposes of the vegetation management guidelines contained in this manual are to:

- enhance the safety of the traveling public
- enhance environmental protection
- promote and preserve native wildlife habitats and native flora throughout the state
- ***encourage wildlife to use wildlife crossing structures***

- mitigate erosion while providing adequate drainage
- promote coordination and efficiency in maintenance activities.

Add at Chapter 1 *Vegetation Management Guidelines*, Section 3 *Guidelines for Levels of Vegetation Management* under *Wildlife Habitat and Native Plant Conservation* at page 1-8:

Areas which receive frequent mowing seldom support the establishment of significant wildlife habitat or provide for the regeneration of native plants.

In those areas which may be designated as non-mow or natural areas, significant nesting cover for wildlife, ***opportunities to encourage wildlife to use a wildlife crossing structure,*** and strong regeneration and preservation of native plant species can be achieved.

Add at Chapter 4 *Pruning Guidelines*, Section 1 *Reasons for Pruning* under *Safety* at page 4-2:

Safety is always the first consideration in pruning and takes precedence over all other considerations. Pruning for safety includes:

- maintaining required sight distances
- maintaining adequate clear zones on either side of and above the roadway
- removing low branches that may be hazardous to equipment operated on the right of way, such as mowers.
- ***reducing food sources that encourage wildlife to cross a road to either get to food or leave food source (the figures below demonstrate the native plants at wildlife crossing structure entrance in the Pharr District)***

6.2.14. Roadway Design Manual

The Roadway Design Manual provides guidance in the geometric design of roadway facilities. While the document is a guide containing geometric design recommendations, it does not represent an absolute design requirement.

Add at Chapter 1 *Design General*, Section 3 *Schematic Layouts* under *Overview* at page 1-10:

- General project information including project limits, design speed, and functional classification.
- The location of interchanges, main lanes, grade separations, frontage roads, turnarounds, and ramps.
- Existing and proposed profiles and horizontal alignments of mainlanes, ramps, and crossroads at proposed interchanges or grade separations. Frontage road alignment data need not be shown on the schematic; however, it should be developed in sufficient detail to determine right of way needs.
- For freeways, the location and text of the proposed mainlane guide signs should be shown. Lane lines and/or arrows indicating the number of lanes should be shown.
- For freeway added capacity projects, a capacity analysis.
- An explanation of the sequence and methods of stage construction including initial and ultimate proposed treatment of crossovers and ramps.
- The tentative right of way limits.
- Bridges and bridge class culverts should be shown.
- The geometrics (pavement cross slope, superelevation, lane and shoulder widths, slope ratio for fills and cuts) of the typical sections of proposed highway mainlanes, ramps, frontage roads, and cross roads.
- Location of retaining walls and/or noise walls.
- ***Location of wildlife crossing structures***
- The existing and proposed traffic volumes and, as applicable, turning movement volumes.
- If applicable, the existing and proposed control of access lines.
- The direction of traffic flow on all roadways.
- If applicable, location and width of median openings.
- The geometrics of speed change and auxiliary lanes.
- Design speed.
- Existing roadways and structures to be closed or removed

At Chapter 1 *Design General*, Section 5 *Preliminary Design Submissions* at page 1-13, add a new final row to the "Preliminary Design Submission" table (underneath the "Hike/Bike facility schematic" row):

Item	Submission
Wildlife crossing structure (including fences, wildlife guards, other safety mitigation element) schematic	***Refer to ENV Natural Resource Management Section and District Environmental Coordinators, and submit to DES, Field Coordination prior to initiating detailed plan preparation***

Add at Chapter 3 *New Location and Reconstruction (4R) Design Criteria*, Section 5 *Multi-Lane Rural Highways* under *Converting Existing Two-Lane Roadways to Four-Lane Divided Facilities* at page 3-50:

> An accident analysis of the existing two-lane roadway should be conducted. Any specific areas involving high accident frequencies will be reviewed and corrective measures taken where appropriate. ***Where accident frequencies include a wildlife-vehicle collision as a contributing factor in the CRIS records, consult with the District Environmental Coordinator or with Environmental Affairs Division to determine if a wildlife crossing structure could improve safety at these hot spot areas. The ENV Natural Resource Management Section and District Environmental Coordinators can provides information to conduct hot spot analysis and details on types of crossings, including schematics used within TxDOT and other states.***

At Chapter 4 *Non-Freeway Rehabilitation (3R) Design Criteria*, Section 3 *Safety Enhancements*, there is opportunity to encourage changes to plans to help create more wildlife-friendly culverts, bridges, and approaches to those structures. Under *Safety Design*, add at page 4-8:

- At the beginning of 3R project design, highway designers should assess existing physical and operational conditions related to safety.
- Gather data to identify specific safety problems that might be corrected and compare this data with the system-wide performance of similar highways.
    - ***This could include conducting a hot spot analysis of crash data to find if safety problems arise as a consequence of an AVC.***
- Conduct a site inspection using experienced personnel to recognize the opportunities for safety improvements within the common operating conditions of that individual roadway.
    - ***This could include carcass data collection details (either within TxDOT or by a county/city) to determine if safety issues may be arising, as this is a natural pathway for wildlife movement.***

- Determine and verify existing geometry such as roadway widths, horizontal and vertical curvature, intersection layout, and other geometrics specific to the roadway section being examined.
- In addition to pavement repairs and geometric improvements, designers of 3R projects should consider incorporating other intersection, roadside, and traffic control improvements that may enhance safety, ***including wildlife crossing structures.***

Add at Chapter 4 *Non-Freeway Rehabilitation (3R) Design Criteria*, Section 3 *Safety Enhancements* at subsection *Other Safety Enhancements* at page 4-11:

Culverts. For culvert spans from 3 ft [0.9 m] to 5 ft [1.5 m] and heights up to 5 ft [1.5 m] that need to be safety treated, the pipe grated design is very effective from a safety standpoint and generally cost effective from an economic standpoint. If sloping or grated inlet designs are utilized for these low height and width culverts and their past performance has not been satisfactory, then inlet restrictions (entrance loss coefficients) should be evaluated as to their effects on hydraulics. If necessary, reference can be made to the Hydraulic Design Manual for entrance loss coefficients with various configurations as well as other hydraulic design information.

Culverts and drainage structures can also transport wildlife under roadways, railways, or embankments, and can improve safety for the motoring public. These types of wildlife crossing structures have been used by TxDOT and can be sized and located through coordination by the roadway designers with the District Environmental Coordinator and the Environmental Affairs Division. Details can be obtained from ENV Natural Resource Management Section and District Environmental Coordinators. When preparing structure plan sheets on cast-in-place or precast box culverts, designers should note that these can also have single or multiple openings allowing the passage of water, livestock, or wildlife under a roadway. In culverts that work in areas where drainage occurs on a regular basis, they can also have ledges and ramps for animal use that are elevated approximately 1 to 2 ‘ high and 1.5 to 2 ‘ wide.

The figure below demonstrates a box culvert structure used in Pharr District on SH 100.

Add two new paragraphs at Chapter 4 *Non-Freeway Rehabilitation (3R) Design Criteria*, Section 3 *Safety Enhancements* at subsection *Other Safety Enhancements* at page 4-11:

Wildlife Guards

Wildlife guards, with or without gates, may be used to (i) prevent livestock from entering into right of way and interfering with roadway traffic, (ii) maintain range control, and (iii) reduce animal-vehicle conflicts for wildlife. To prevent livestock and wildlife from entering the right of way, construction of wildlife guards, often accompanied by fencing at side roads and private entrances, can be a cost-effective way to improve safety on a roadway. When placed near traffic interchanges on a crossroad, wildlife guards without gates should be placed at or near the access control line to prevent livestock and wildlife entering a main roadway. The number of units will be determined by the width of the roadway, the number of private drives that need to access TxDOT right of way, and the types of wildlife or livestock that may enter the right of way. Pharr District has been developing new types of wildlife guards with different types of bars and checked grates to reduce wildlife egress from private driveways onto SH 100. Designers can work with their District Environmental Coordinators and the Environmental Affairs Division to determine the appropriate types of wildlife guards and fencing; see below for the Pharr District grated wildlife guard (top figure) and round bar wildlife guard (bottom figure).

6.2.15. Traffic Safety Program Manual

The Traffic Safety Program Manual establishes the fields of interest that are entered into the crash data software.

At Chapter 2 *Planning*, Section 3 *Problem Identification and Community Assessment*, there are no entries for the type of animal involved in a reported crash. Adding a field for the type of animal involved in a crash will allow wildlife-vehicle interactions to become a regular part of reporting procedures; districts or Environmental Affairs Division can then use this data to determine hot spots where vehicles and wildlife are interacting and creating safety hazards. Enhancing the crash reporting standards could also assist other political subdivisions and metropolitan planning organizations in using this data to consider wildlife vehicle interactions as part of their long- and short-range planning processes.

Add at Chapter 2 *Planning*, Section 3 *Problem Identification and Community Assessment* under *Crash Specific Data* at page 2-15:

Crash specific data may include any of the following:

- type and severity of crash (fatal, pedestrian, etc.)
- location
- roadway characteristics
- violations
- time of day
- day of week and month
- type of vehicle
- direction of travel
- driver's age
- driver's gender
- weather conditions
- vehicle maneuver
- occupant protection usage
- alcohol or other drug involvement
- ***wild or domestic animal involvement***
- emergency medical services (EMS) data
- investigating agency.

If either a national or Texas-specific app for collecting carcass data is developed, TxDOT should consider noting it within the manual.

Pending development of such an app, add at Chapter 2 *Planning*, Section 3 *Problem Identification and Community Assessment* under *Data Sources* at page 2-18:

Data sources may include any of the following:

- TxDOT Crash Records Information System (CRIS)
- local police department
- Department of State Health Services or regional or local health agencies
- EMS providers

- Evaluations
- Surveys
- national or statewide studies (such as Fatality Analysis Reporting System [FARS])
- local court system
- ***Roadkills of Texas project on iNaturalist***
- TxDOT district traffic engineering and roadway analyses
- other sources (interest groups, task forces, school districts, colleges, hospitals, universities, insurance companies, etc.).

At Chapter 2 *Planning*, Section 3 *Problem Identification and Community Assessment* under the subsections *Some Key Questions in Problem Identification* and *Problem Analysis*, the research team recommends that wording on wildlife causation of incidents is added into the examples and causal factors, as specified below.

Add at Chapter 2 *Planning*, Section 3 *Problem Identification and Community Assessment* under *Some Key Questions in Problem Identification* at page 2-19:

Question	Examples
Are high crash incidence locations identified?	Specific road sections, highways streets and intersections
What appears to be the major crash causation?	Alcohol, other drugs, speed, other traffic violation, weather, road condition, ***interaction with or avoidance of wild or domestic animal***
What characteristics are over-represented or occur more frequently than would be expected in the crash picture?	Number of crashes involving 16 to 19-year olds versus other age groups, or number of alcohol crashes occurring on a particular roadway segment compared to other segments, ***crashes reported to have an animal involved at a rate greater than 0.5 animal-related crashes per mile per year.***
Are there factors that increase crash severity which are or should be addressed?	Non-use of occupant protection devices (safety belts, motor-cycle helmets, etc.), ***and the species of animal involved, which relates to the size of animal hit and thus the safety issue to address.***

Add at Chapter 2 *Planning*, Section 3 *Problem Identification and Community Assessment* under *Problem Analysis* at page 2-19:

Causal Factors:	Crash Characteristics:	Factors Affecting Severity:
• Violation • Loss of control • Weather • Alcohol involvement • ***Wildlife or domestic animal involvement*** • Roadway design	• Time of day (light conditions • Day of week • Age of driver • Gender of driver	• Non-use of occupant protection • Position in vehicle • Roadway elements (marking, guard rail, shoulders, surface, etc.) • ***Animal characteristics (Size/type/speed)***

Add at Chapter 2 *Planning*, Section 3 *Problem Identification and Community Assessment* under *Impediments to Effective Problem Identification* at page 2-20:

Impediments to Effective Problem Identification

The following factors may impede effective problem identification:

- data access restrictions
- inability to link automated files
- lack of location-specific data
- poor data quality
- reporting threshold fluctuations (variations among jurisdictions in the minimum damage or crash severity they routinely report)
- insufficient data (property damage only, non-reportable crashes, near misses, bicycle crashes, etc.).
- ***lack of carcass data to identify hot spots***

Planners should be alert to these possible impediments and make appropriate adjustments when they appear.

6.2.16. Transportation Planning Manual

The Transportation Planning Manual contains the various types of plans, permitting processes, programs, and studies TxDOT must follow when developing a project. It is important to note the federal highway bills require protecting and enhancing the environment as a planning factor for Metropolitan Transportation Plans that fund projects with federal dollars.

Add at Chapter 1 *State Plans*, Section 3 *Strategic Planning Coordination* at the final paragraph on page 1-5:

> The Unified Transportation Program serves as TxDOT's internal mechanism for authorizing transportation project development. This program covers all transportation modes and all types of projects, from seal coats to new construction. It is a ten-year, fiscally constrained, annually updated plan with two classes of projects. Priority One projects are approved for construction within the next three years. Priority Two projects are those in the process of preliminary development/design, environmental clearance ***(which may identify where wildlife crossing structures could be included)*** major investment study, etc. Priority Two projects are slated for construction approval in Year 4 through Year 10 of the program.

The insertion of this language should alert a planner and designer of opportunities to design and include wildlife crossings at this stage of planning development.

At Chapter 3 *Regional Alliances and Studies*, Section 3 *Multi-state/Statewide Corridor/Feasibility Studies* under *TxDOT Studies*, add to the bulleted list under the second paragraph on page 3-4:

> - Study various alternatives
> - analyze current and future traffic
> - analyze potential environmental problems; ***for example, wildlife crossing points that may require wildlife crossing structure***
> - develop cost estimates
> - determine feasibility.

Add at Chapter 3 *Regional Alliances and Studies*, Section 4 *Long Range Project Planning* under *Programming Assessments* at page 3-5:

> - congruity with the Statewide Transportation Plan
> - congruity with the Metropolitan Transportation Plan

- major environmental issues
- level of community support
- cost effectiveness
- safety issues
- existing traffic/projected traffic
- other areas of interest; ***for example, environmental or safety issues caused by wildlife vehicle conflicts that may need mitigation through wildlife crossing structures***
- conclusion.

Add at Chapter 5 *Metropolitan Transportation Planning*, Section 9 *Major Investment Studies* under *Overview* at page 5-22:

The Major Investment Study (MIS) was envisioned as a tool for making better decisions at an earlier time than under previous methods, thus improving transportation planning in metropolitan areas. The MIS is an integral part of a metropolitan area's long-range planning process and is designed to provide decision makers with better and more complete information on the options available for addressing transportation problems before making investment decisions. The MIS provides a focused evaluation of needs and problems within a corridor or sub-region. The MIS may identify an appropriate set of multimodal investments and policy options to address needs and problems; develop measures of benefits, costs, and impacts ***including safety impacts that crash data analysis may provide***; and specify financial requirements. The MIS process leads to a decision on the design concept***, including any mitigation options highlighted by safety and crash data analysis*** and scope for a corridor/subarea's major investments.

6.2.17. Transportation Programming and Scheduling Manual

The Transportation Programming and Scheduling Manual outlines the scheduling process for TxDOT relating to prioritization, project development, and funding and implementation of work.

Add at Chapter 3 *Project Selection*, Section 3 *Project Responsibility and Authorization* under *Feasibility Studies* at page 3-7/8:

- The project is outside the MPO's jurisdiction.
- The project involves a major investment of funds.

- The solution is unknown.
- ***Animal-Vehicle Collision Crash data analysis shows hot spots for crashes***
- There are major environmental concerns.
- Consensus of the general public and property owners along the route has not been developed

Add at Chapter 5 *UTP Categories*, Section 9 *Category 4B STP: Transportation Enhancements* under *Restrictions* at page 5-18:

- provision of facilities for pedestrians and bicycles
- acquisition of scenic easements and scenic or historic sites
- scenic or historic highway programs (including the provision of tourist and welcome center facilities)
- landscaping and other scenic beautification
- historic preservation
- rehabilitation and operation of historic transportation buildings, structures, or facilities (including historic railroad facilities and canals)
- preservation of abandoned railway corridors (including the conversion and use thereof for pedestrian or bicycle trails)
- control and removal of outdoor advertising
- archaeological planning and research
- environmental mitigation to address water pollution due to highway runoff
- ***reduce animal-vehicle conflict, including animal-vehicle collisions*** while maintaining habitat connectivity
- provision of safety and educational activities for pedestrians and bicyclists
- establishment of transportation museums.

Add at Chapter 5 *UTP Categories*, Section 31 *Category 16 – Miscellaneous* at page 5-51:

- Travel Information Centers
- Construction Landscape Program

- Truck Weight Stations
- Rest Area Construction and Rehabilitation
- Railroad Grade Crossing Replanking Program
- Railroad Signal Maintenance Program
- Ferry Boat Discretionary - Federal Program
- Federal Lands Highways - Federal Program
- Indian Reservation Highways - Federal Program
- Forest Highways - Federal Program
- ***Reduction of animal-vehicle conflict, including animal-vehicle collision hot spots, through development of wildlife crossing structures***

6.2.18. Manual on Uniform Traffic Control Devices

The Texas-specific version of the MUTCD describes the general purpose, functions, and criteria for placement of traffic signs in the state. Section 2C.53 on the use of supplemental warning plaques could be amended to add:

A supplemental warning plaque (see Figure 2C-12) may be displayed with a warning or regulatory sign when engineering judgment **(*or, for example, analysis of crash data indicates a hot spot for animal-vehicle conflict)*** indicates that road users require additional warning information beyond that contained in the main message of the warning or regulatory sign.

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Appendix A. Final Value of Research (VoR) Estimate

A.1 Introduction

In accordance with the scope of TxDOT Project 0-6971, the Research Team prepared an estimate for the Value of Research (VoR) associated with the research products delivered by this project. The functional areas deemed relevant and identified in the project agreement for the purpose of establishing the VoR encompass both qualitative and economic areas. The six functional areas identified for this project are summarized in Table A.1.

Table A.1: Established Functional Areas for Project 0-6971

Benefit Area	Qual	Econ	Both	TxDOT	State	Both
Level of Knowledge	X			X		
Quality of Life	X			X		
Environmental Sustainability	X				X	
Reduced Construction, Operations and Maintenance Cost		X			X	
Engineering Design Improvement			X			X
Safety			X			X

A.2 Qualitative Benefits

Qualitative benefits attributed to the performance of this project were considered with respect to:

1. Level of knowledge gained and incorporated into TxDOT processes.
2. Engineering design improvements to implement wildlife crossing structures and fencing into TxDOT processes.
3. Reduced construction, operations and maintenance.
4. Impact on system safety as it relates to animal-vehicle conflicts (AVCs)
5. Quality-of-life effects from AVCs and potential mitigation impacts on environmental sustainability as it pertains to wildlife habitat permeability, allowing shifts in populations and migratory patterns.

Level of Knowledge

The qualitative assessment of information available from the state and national levels developed in this project can aid TxDOT personnel in making better-informed decisions pertaining to the design, construction, maintenance, and retrofitting of TxDOT roads with wildlife crossing structures. This improved level of knowledge shall provide a basis for incorporating wildlife crossing structure into the planning process.

Engineering Design Improvements

The review of TxDOT policy help identified potential changes to business processes that could better incorporate wildlife crossing structures and other mitigation along TxDOT roads. Improving the design process shall improve the performance of TxDOT roads relative to current conditions and AVC. In addition, integrating consideration of wildlife crossing structures into the planning process will reduce the probability that roads and structures may have to be retrofitted over time as wildlife-vehicle crashes (WVCs) occur. These improvements are expected to result in reduced costs to society over the lifetime of the road due to reduced AVC, and due to having to retrofit facilities.

Reduced Construction, Operations, and Maintenance

Integrating wildlife crossing structures into the planning process should reduce the amount and times that TxDOT has to retrofit roads when WVCs occur. Integrating wildlife crossing structures into the planning process will save on construction and design costs as opposed to having to retrofit structures as WVCs occur. Integrating structures into infrastructure development will also impact maintenance on two fronts: (i) reduce the number of carcasses that maintenance crews have to pick up and (ii) allow for structures to be designed with maintenance in mind—for example, pinpointing exact locations of structures that require maintenance to save maintenance staff having to 'find' structures.

Safety

AVCs negatively impact safety for road users in Texas. When wildlife crossing structures are utilized effectively, the likelihood of WVC is reduced. Such structures include driver warning and detection systems, variable message board signs, wildlife underpass bridges and culverts, and wildlife overpasses, all installed with wildlife exclusion fencing.

Quality of Life

WVCs negatively affect both road users and individual and total populations of wildlife. Fewer AVCs should reduce traffic delays for road users and increase quality of life for the driving public. An ancillary benefit is enhanced quality of life for wildlife populations, due to a reduction in interactions with vehicles.

Environmental Sustainability

Roads and vehicular traffic decrease permeability of the landscape for wildlife, cause mortality for individual animals, and can reduce the size of wildlife populations. This research used Geographic Information Systems (GIS) and data analyses to identify and assess locations of AVC hot spots, and how TxDOT can be proactive in creating mitigation measures to reduce collisions with wildlife while allowing wildlife populations to move beneath roadways.

A.3 Economic Benefits

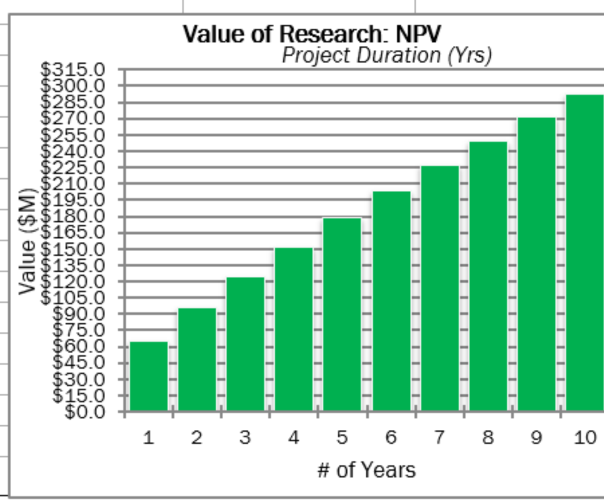
Economic analysis pertaining to three functional areas relevant to the performance of this project and identified in the project agreement was requested:

- Reduced Construction, Operations, and Maintenance Costs
- Engineering Design Improvements
- Safety

Analyzing the three functional areas, the research team generated Figure A.1. The research team used what they believe is an extremely conservative 5% reduction in AVC as the baseline for calculations. Assessing the benefits found an estimated total savings of $351,654,625, which equates to a net present value of $291,962,209. The payback period is 0.007 years and the cost benefit ratio is 1,074.

TEXAS DEPARTMENT OF TRANSPORTATION	**Project #**	0-6971			
	Project Name:	Incorporating Wildife Crossings into TxDOT's Project Development, Design and Operations Process			
	Agency:	CTR	**Project Budget**	$	271,914.68
	Project Duration (Yrs)	1.4	**Exp. Value (per Yr)**	$	34,412,657
Expected Value Duration (Yrs)		20	**Discount Rate**		5%
Economic Value					
Total Savings:	$ 343,854,655	**Net Present Value (NPV):**		$	257,387,992
Payback Period (Yrs):	0.007902	**Cost Benefit Ratio (CBR, $1 : $___):**		$	947

Years	Expected Value
0	$4,531,976
1	$34,412,657
2	$34,412,657
3	$34,412,657
4	$34,412,657
5	$34,412,657
6	$34,412,657
7	$34,412,657
8	$34,412,657
9	$34,412,657
10	$34,412,657



Variable Justification

Figure A.1: Summary of VoR Calculations for Project 0-6971

A.4 Explanation of VoR

To gain a current baseline of reported crashes within the state, the researchers used the total number of crashes reported with an animal (both domestic and wild) from seven years (2010-2017) of crash data reported to TxDOT. Average annual rates for each crash type are presented in Table A.2. Estimated costs for each crash type and U.S. mean values are taken from US Federal Highways' Director of Safety Integration revised 2017 data (Griffith, 2017). The US Crash Maximum costs were also taken from the updated FHWA data values Griffith, 2017).

Table A.2: Average Annual Costs for Animal-Vehicle Collisions in Texas

Types of crashes	Total # crashes over 7 years	Annual rate of crashes in Tx	Estimated costs (US mean)	Total costs for crashes in Tx (US mean)	Crash costs (US max)	Total costs for crashes in Tx (US max)
PDO	42,812	6,116	$11,100	$67,887,600	$42,298	$258,694,568
Type C Injury	3,084	440	$92,400	$40,656,000	$651,000	$286,440,000
Type B Injury	2,384	405	$181,900	$73,669,500	$651,000	$263,655,000
Type A Injury	750	107	$720,200	$77,061,400	$3,300,000	$353,100,000
Fatality - human	127	18.1	$3,936,100	$71,243,410	$9,600,000	$173,760,000
totals	49,157	7,089		$330,517,910		$1,335,649,568

Domestic and Wild Animals

Domestic Animals: Over the seven years of crash data, there were 28,293 domestic animal crashes, which were 26 to 34% of all animal crashes each year. Domestic animal crashes were, on average, 30% of total animal related crashes.

Wild Animals: over the seven years, there were 61,348 of crashes with wild animals. Wild animal crashes accounted for 60–69% of all animal crashes each year, and the seven-year average was 65% of all animal crashes.

The remaining crashes were with other types of animals not categorized either as domestic or wild.

Total Economic Value of Research

The total economic VoR for this project is based on the following assumptions and estimates (summarized in Table A.3):

- The VoR estimate was created with a set of extremely conservative calculations. The research team took this stance due to the lack of reliable data available on all AVCs that occur in Texas. Our assumptions were derived from TxDOT Crash Records Information

System (CRIS) data and in-house team knowledge of the range of AVCs that occur but are not reported, and lead to a CRIS data element. The research team has taken a baseline assumption that the project reduces AVCs by a modest 5%. If more accurate before and after data at Texas wildlife crossing structures are available, the VoR is anticipated to show even greater benefits due to incorporating wildlife crossings into its planning, design, construction, and maintenance processes.

- TxDOT has differentiated types of crashes based and assigned average costs associated with the different types. This project shows a 5% reduction in AVC for each type of crash. Fatalities and Type A, or disabling crashes are each valued at $3.3 million. On average there were 18.1 fatalities and 107 Type A crashes reported to TxDOT. Utilizing TxDOT estimates for costs associated with fatal and Type A crashes, the research team assumes annual savings of $20.6 million.

- Texas averages 405 Type B, or less severe, crashes annually. TxDOT estimates for these less severe, or non-incapacitating, crashes to cost $475,000. The research team estimated a reduction of 5% of these Type B crashes would be $9.6 million annually.

- On average there are 440 Type C crashes per year. Type C crashes are the least severe that may have resulted in injury. Currently, TxDOT values this type of crash at $86,000 per crash. A 5% reduction based on these averages yields an annual savings amount of $1.89 million.

- There are significantly higher crashes where property damage only (PDO) occurs in Texas. According to TxDOT CRIS data, 6,116 PDO crashes annually. The most recent Federal Highway Administration (FHWA) estimates for PDO costs average $11,100 per PDO crash. Assuming the 5% savings the research team estimates the project will may save $3.4 million annually for the Texas motorist.

- The research team estimated TxDOT maintenance staff monthly rates. This was based on an average monthly salary taken from TxDOT career job descriptions and salary ranges. The research team estimated there would be an average of two staff members per removal, an average time of removal to be 20 minutes, and assumed that maintenance staff operates two trucks during removal operations traveling approximately 150 miles per day (each) at $0.523 per mile vehicle cost. Given these rates a carcass removal costs TxDOT $14.79 per removal. This amount was then applied to the TxDOT 2016 CRIS data set to determine a value of $104,846 spent per year removing carcasses. The research team estimates a 5% decrease in time spent collecting carcasses as a result of this research, which adds a value of $5,242 yearly.

- Values per animal saved were estimated per species type. For the estimate of this VOR, white-tailed deer, mule deer and ocelots were used to determine benefit values. There are a number of species not listed that would also provide added value, but for the purpose of this initial estimate may be superfluous. Estimated restitution values of species were provided by Texas Parks and Wildlife Department (TPWD). White-tailed deer have a listed value of $273.50. This total could have been higher considering sex of the individual and trophy hunting payouts that can range from $1000 to $5000. The value of mule deer is listed at $881.50. Similar to white-tailed deer, the value of mule deer could have been considerably higher due to sex of deer and trophy hunting payouts. Texas leads the nation in AVC with more than 7,000 animal vehicle conflicts yearly. This number does not adequately represent the number of deer and other large wild animals affected by vehicle conflict as a result of unreported accidents. According to several studies (Olson 2013, Donaldson and Lafon 2008), the total number of large ungulates killed in collisions could be from 5.25 to 9 times higher.

- Even without taking these high numbers into account, the average annual costs for animal-vehicle collisions in Texas cost Texas from $330 million to $1.3 billion annually. The research team estimated this study could help reduce collisions with wildlife by a conservative reduction of 5% of all reported crashes. If this 5% equated to 25 fewer white-tailed deer and 25 fewer mule deer conflicts per year, the benefits of saved white-tailed deer and mule deer to residents of Texas would be $6,837.50 and $22,038 respectively, for an annual savings of $28,878 of the value of the 50 deer total not killed in collisions.

- TPWD estimates an ocelot's value of $11,907 per animal. The research team believes this is a gross underestimate of this endangered species and the implicit value of ocelots may be much higher. The research team estimated this study could help prevent the death by vehicle collision of one ocelot per year, thus this minimum value of $11,907 annually in prevented ocelot deaths is also part of the benefit of this research.

- In the future, costs will be incurred by TxDOT for the construction and maintenance of wildlife crossing structures. The research team estimates an annual cost of $20,000 for maintenance of future wildlife crossing structures and fences per wildlife crossing structure, but this is a rough estimate since little information is currently available on these costs. This research identified 59 locations that would have a benefit-cost ratio larger than 1.5 if a wildlife crossing structure is built (see Chapter 4 and Appendix F for more details). The research team assumes 59 wildlife crossing structures will be established, resulting in $1,180,000 annual maintenance costs.

- The research team assumes that on average, the construction or retrofitting costs of one wildlife crossing structure is $500,000. With the above assumption of 59 structures being built each year, the initial expenditures of building or retrofitting wildlife crossing structure is estimated to be $29,500,000.

Table A.3: Total Estimated Annual Savings and Costs from This Research Project

Area of Reduced Costs Each Year	Annual Cost/Savings
Initial construction costs	-$29,500,000
Value of 5% less Property Damage Only Crashes (FHWA estimates)	$3,394,380
Value of 50 deer not killed in collisions (25 White-tailed, 25 mule deer)	$28,878
Value of one ocelot not killed	$11,907
Value of 5% less human fatality crashes	$2,986,500
Value of 5% less severe injurious (Type A) crashes	$17,655,000
Value of 5% less severe (Type B) crashes	$9,618,750
Value of 5% least severe (Type C) crashes	$1,892,000
Value of 5% reduction Maintenance Personnel Time in picking up carcasses	$5,242
Initial Total Annual Cost Savings	$35,592,657
Annual Wildlife Crossing Device Maintenance Costs	-$1,180,000
Estimated Total Annual Cost Savings	$34,412,657

A.5 Discussion

This VoR estimate was developed by the research team based on an understanding of the VoR functional areas. This estimate likely includes incomplete information and a series of assumptions that generally do not have a strong basis. The research team believes this VoR estimate is extremely conservative, but chose to provide such a conservative estimate because data on AVCs from TxDOT's CRIS database only shows 'reported' crashes, and does not provide data on all AVC incidents in the state. The research team is aware that there are many more incidents that occur between the motoring public and wildlife where (i) a claim is not made, (ii) an incident report is not created, (iii) the wild animal is injured and runs away so no evidence of the incident is visible, or (iv) the animal is killed but the vehicle itself is not impacted. Consequently, the level of confidence that should be assigned to the initial VoR estimate is low.

Appendix B. Overview of Wildlife-Vehicle Conflict Literature

B.1 Outline

This review of U.S. state efforts to mitigate roads for wildlife is the result of our current and previous research, speaking and emailing with colleagues, attendance at workshops and national conferences, and literature searches. The investigation included a search of the Transportation Research Board's TRID (Transport Research International Documentation—a searchable database) for past papers and reports and ongoing studies from early 2017 back to the fall of 2014; attendance at the 2017 Transportation Research Board's annual meeting; meeting with western state colleagues specializing in transportation ecology at the 2017 national conference of The Wildlife Society; interviews with colleagues in Nevada, Utah, Colorado, Montana, California, Arizona, New Mexico, Georgia, and Florida; and internet searches of key words, such as "wildlife", "mitigation", "road ecology", "wildlife crossings", "carcass removal", "deer collision", "roadkill", and "wildlife fencing". Since this field has exponentially grown over the last decade, our research attempted to narrow the search to a ten-year time frame of 2007 to 2017; however, some studies from before that ten-year period have been reviewed for relevance.

Dr. Cramer learned of the priorities for the practice and research dealing with wildlife and roads while conducting the 2008 National Cooperative Highway Research Program (NCHRP) project 615, Evaluation of the Use and Effectiveness of Wildlife Crossings (Bissonette and Cramer 2008). Dr. Cramer interviewed over 400 professionals in the transportation and natural resources fields from 2004 to 2007 to learn of the mitigation measures created for wildlife in the U.S. and Canada and asked survey participants to rank the national priorities in the practice and research of wildlife mitigation for transportation.

The results of the NCHRP Report 615 telephone survey from 2004 through 2007 determined the participants' top priorities for the practice and research of restoring wildlife movement across roads in the U.S. and Canada. The priorities for each profession and geographic region were combined into the following top five recommendations:

1. Conduct early planning for wildlife mitigation needs.
2. Better understand the dynamics of animal use of wildlife mitigation structures, combine mitigation methods, and develop designs for the full suite of animals in an area.
3. Develop state-based conservation plans and connectivity analyses to inform transportation programming and planning.
4. Develop alternative cost-effective designs such as the retrofitting of existing infrastructure.
5. The engineers surveyed had an added top-five priority: develop guidelines to decide when wildlife mitigation is necessary both mandatory and voluntary.

These top priorities were the basis of the following categorization of the literature search:

1. Planning for wildlife mitigation.
2. Effectiveness of wildlife crossing structures and other mitigation.
3. State conservation plans and connectivity analyses.
4. Cost-effective designs and retrofits.
5. Guidelines to decide when to mitigate for wildlife.

References are presented according to the five topic areas listed above. The NCHRP final report for the project can be found here: http://www.trb.org/Publications/Blurbs/160108.aspx.

The top priorities from NCHRP 615 guided this literature review and how the literature was organized in this chapter.

In addition to gathering literature through Dr. Cramer's work on wildlife crossings, the research team conducted a series of literature reviews through CTR's library using a set of keywords for the past ten years. These keywords included wildlife crossing, wildlife mitigation, animal vehicle crash, and animal vehicle conflict. A set of searches was also conducted for key authors in this area, including Cramer, Bissonette, Huijser, Clevenger, and others. The search results were then collated and reviewed by the research team for usefulness and context from the Texas Department of Transportation's (TxDOT) perspective. The next section of this chapter provides references to relevant key works. The literature reviewed was then contextualized in Chapter 2 to synthesize all relevant information for TxDOT in a comprehensive and cogent way.

B.2 Planning for Wildlife Mitigation

Planning for wildlife mitigation involves both conducting data collection and integrating the results of the data analyses into transportation planning. This involves collecting crash and carcass data; mapping the crash and carcass data; and statewide projects that create prioritization methods to plan for wildlife mitigation. These tasks help identify both where wildlife are involved in wildlife-vehicle conflict, and where wildlife populations are most concentrated.

B.2.1 Reporting Wildlife-Vehicle Collision Carcasses with Apps and Websites

New technologies are advancing the way information is disseminated between government agencies, private sector businesses, and individuals. Prior to GPS and web-based applications, wildlife-vehicle collision (WVC) carcass data was often poorly and inaccurately reported; however, new modes of reporting are changing the way agencies are able to track this data. The following references deal with how GPS, apps, and websites have altered reporting mechanisms for government agencies for this field.

- Donaldson, B. and N. Lafon. 2008. Testing an integrated PDA-GPS system to collect standardized animal carcass removal data. Virginia Transportation Research Council. URL: http://www.virginiadot.org/vtrc/main/online_reports/pdf/08-cr10.pdf

- Jacobsen, M. 2014. Road-kill app paints clearer picture of WVC. *Desert News*. URL: http://www.deseretnews.com/article/865607995/Roadkill-app-paints-clearer-picture-of-wildlife-vehicle-collisions.html?pg=all

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- Tetra Tech EBA. 2016. Wildlife Watch App for improved road safety in Alberta. TAC Environmental Award submission, February 15, 2016.

- University of California Davis Road Ecology Center. 2017. California Roadkill Observation system (CROS), URL: URL:http://wildlifecrossing.net/california.

B.2.2 Mapping Wildlife-Vehicle Collisions

- Accurate mapping of WVCs provides better information for departments of transportation (DOTs) to utilize when implementing wildlife crossing structures in the planning process. The top six recent papers and websites on mapping WVC hotspots are listed below:

- Idaho Fish and Game. 2015. Roadkill/Salvage Wildlife Report Website. URL: https://idfg.idaho.gov/species/roadkill/add. Accessed May 9, 2016.

- Kociolek, A., L. Craighead, A. Craighead. 2016. Evaluating wildlife mortality hotspots, habitat connectivity, and potential mitigation in the Madison Valley. Final Report to Montana Department of Transportation. FHWA/MT-16-016/8217-001.

- McClure, M. and R. Ament. 2014. Where people and wildlife intersect: prioritizing mitigation of road impacts on wildlife connectivity. Center for Large Landscape Conservation. http://largelandscapes.org/media/publications/Where-People--Wildlife-Intersect-Prioritizing-Mitigation.pdf

- Shilling, F. D. Waetjen, and K. Harrold. 2017. Impact of wildlife-vehicle conflict on California Drivers and animals. Report released by the University of California at Davis Road Ecology Center. 20 pages. URL:

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B.2.3 Projects to Prioritize Wildlife-Vehicle Collision Areas Statewide

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B.2.4 Planning for Wildlife

Website and application usage has been shown to improve accuracy of data regarding WVCs. That information is then mapped and prioritized so DOTs have the ability to plan effectively for wildlife crossings. The following references provide information on how other states across the country have completed their planning process.

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B.3 Effectiveness of Wildlife Crossing Structures and Other Mitigation

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B.4 State Conservation Plans and Wildlife Connectivity Analyses

Several states have used conservation plans, guided by wildlife connectivity analyses, to better understand and implement wildlife mitigation practices. Wildlife connectivity analyses can be used to establish a trigger mechanism for when mitigation tools, such as wildlife structures, should be constructed in the planning process. The following references highlight the importance of ecology to develop a more robust process.

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B.5 Cost-Effective Designs and Retrofits

Cost-effective mitigation designs and retrofits are needed as funding is often limited. The references below discuss how state and federal agencies measure the cost and benefits of reducing WVCs and how retrofits to existing infrastructure may increase the benefit cost ratio.

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- Siemers, J. L., K. R. Wilson, and S. Baruch-Mordo. 2015. Monitoring wildlife-vehicle collisions: analysis and cost benefit of escape ramps for deer and elk on U.S. Highway 550. Report No. CDOT-2015-05, to Colorado Department of Transportation.

- U.S. Department of Transportation. 2013. Guidance on treatment of the economic value of a statistical life in U.S. Department of Transportation analyses. URL: https://www.transportation.gov/sites/dot.dev/files/docs/VSL%20Guidance%202013.pdf

B.5.2 Retrofits

- Kintsch, J., S. Jacobson, and P. Cramer. 2015. The wildlife crossing guilds decision framework: a behavior-based approach to designing effective wildlife crossing structures. Presented at the International Conference on Ecology and Transportation held in Raleigh, North Carolina. Center for Transportation and the Environment, North Carolina State University, Raleigh, NC.URL: http://www.icoet.net/ICOET_2015/program-proceedings.asp, Session 201.

- Kintsch, J. and P. C. Cramer. 2011. Permeability of existing structures for terrestrial wildlife: a passage assessment system. For Washington Department of Transportation, WA-RD 777.1. Olympia, Washington. 188 pages.URL: http://www.wsdot.wa.gov/research/reports/fullreports/777.1.pdf

- Smith, D.J., J. Kintsch, P. Cramer, S. L. Jacobson, and S. Tonjes. 2015 Modifying structures to enhance passage by wildlife on existing roads. In K.M. Andres, P. Nanjappa and S. P. Riely, (eds.) Roads and Ecological Infrastructure: Concepts and Applications for Small Animals. John Hopkins University Press, Baltimore, MD.

B.6 Guidelines to Decide When to Mitigate for Wildlife

DOTs should have clear guidelines in the planning process on when to use mitigation practices. Planning mitigation practices earlier in the project will aid in future construction of roadways. Below are several examples of best practices and guidelines from local, state, and federal agencies.

- Bissonette, J. A., P. C. Cramer. 2008. Evaluation of the use and effectiveness of wildlife crossings. Report 615 for National Academies', Transportation Research Board, National Cooperative Highway Research Program, Washington, D.C. URL: http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_615.pdf

- Chisholm, M., A. Bates, D. Vriend, and C. Cooper. 2010. Wildlife Passage Engineering Design Guidelines: City of Edmonton. Prepared by Stantec Consulting Ltd. 249 pages.

- Cramer, P. C., J. A. Bissonette, J. Anderson, and P. Jones. 2006. Wildlife and Roads: A resource to help mitigate roads for wildlife. Website initially developed for NCHRP 25-27, Evaluation of the use and effectiveness of wildlife crossings. URL: http://www.wildlifeandroads.org/

- Clevenger, A. P. and M. P. Huijser. 2011. Wildlife crossing structure handbook: design and evaluation in North America. Report # FHWA-CFL/TD-11-003. Federal Highway Administration. Washington, D.C.
- Leete, P. 2014. Best Practices for Meeting DNR General Public Waters Work Permit GP2004-0001. Minnesota Department of Natural Resources. URL: www.dnr.state.mn.us/waters/watermgmt_section/pwpermits?gp_2004_0001_manual.html.
- Meese, R.J., F.M. Shilling, and J.F. Quinn. 2009. Wildlife Crossings Guidance Manual. Manual prepared for Caltrans. https://roadecology.ucdavis.edu/files/content/projects/CA_Wildlife Crossings Guidance_Manual.pdf
- Shilling, F., P. Cramer, C. Reining, L. Farrell. 2012. Vermont's Best Management Practices for Highways and Wildlife Connectivity. Manual for Vermont Transportation Agency. http://roadecology.ucdavis.edu/files/content/projects/VTrans_BMP%20Manual_2012_Final.pdf
- US Fish and Wildlife Service, 2010. Innovative Approaches to Wildlife/Highway Interactions. Movie on wildlife mitigation. URL*:* https://training.fws.gov/NCTCWeb/catalog/CourseDetail.aspx?CourseCodeLong=FWS-CSP7089

Appendix C. Listing of Texas Mitigation Structures

Table C.1 Synthesis of Texas Wildlife Crossing Structures and Other Wildlife Mitigation

TxDOT District	Wildlife Crossing Structures and Other Mitigation Efforts within TxDOT District
Amarillo	State Loop (SL) 335 along West Amarillo Creek, a culvert was added with a wildlife ledge just north of the intersection with Ranch to Market (RM) 1061. This structure has 2’ of concrete walkway in a culvert with specs of 26” x 381” x 122.” The interviewee at this district noted that in 2005 there were three culverts (two on access roads and one under main road), with an upgrade from two to four lanes scheduled for the future (from a 2005 date).
Austin	In 1991, amphibian fencing added to existing culverts to funnel Houston Toads. However, this effort was ultimately of little value, in part because of extreme erosion that diminished the fencing’s utility.
Beaumont	The district has a bridge constructed in a manner to restrict turtle access to highway.
Corpus Christi	1. At FM 70, Petronilla Creek in Nueces County, TxDOT constructed a longer bridge structure to allow for any potential cats that use this riparian corridor. 2. Long Hollow Creek at US 281 (US 281 from George West to the Jim Wells County Line) was upgraded from a two-lane to a four-lane divided highway in 1996. Culverts were created for ocelot and bobcat populations. The specific dimensions of the four box culverts are given below (all in relation to Long Hollow Creek): o The first structure was left open in the median to allow for light into the box; its exact location is unknown (may be at Long Hollow Creek itself). o The second culvert is 5.1 miles south of Long Hollow Creek, 5’ x 3’ x 176’. o The third culvert is 5.66 miles south of Long Hollow Creek, 6’ x 5’ x 191’; this structure includes a concrete pedestal (18” wide by 12” high) in the culvert for a “catwalk” inside the box. o The fourth culvert is 2.6 miles north of Long Hollow Creek—in two sections, one a 5’ x 3’ x 52’ and a 5’ x 3’ x 107.2 ‘.
El Paso	FM 170 had a spring-fed ditch on the north side of the road and a wetland area on the south side; the Area Office designed French drains under the roadway so that the tadpoles could move from one side to the other when there was water.
Fort Worth	Parker County has four deer crossings.

TxDOT District	Wildlife Crossing Structures and Other Mitigation Efforts within TxDOT District
Laredo	This district has two structures. 1. Loop 20 has a box culvert that is 8’ wide, 4’ tall, and 135’ long. They planted mixed brush along all four sides/banks of the stream for a 30’ wide mixed brush corridor that is 300’ long on the south side and 150’ on north side. The wildlife crossing goes under the Loop 20 main lanes (which are the approaches to the Milo [IH 35] direct connectors and two Loop 20 access roads). 2. On the Camino Columbia Toll Road, a privately built road, an ocelot crossing 5’ x 5’ x 300’ long was constructed in 2000.
Lubbock	Los Lingos Creek Bridge on FM 689, north of Lubbock in Floyd County, was built in 2002. In building a new bridge over an ephemeral stream, which is an unnamed tributary to Los Lingos Creek, TxDOT accommodated wildlife passing under the bridge in the riparian area. With the original bridge, wildlife (deer and coyotes) walked on the bridge/road to cross the 15’ deep stream channel. A requirement for the new bridge was to do nothing to impede wildlife movement under the road along the stream channel. Wildlife use the bottom of the stream channel as a pathway. TxDOT made sure the opening was wide enough and high enough for such use, increasing the clearance in height and width. Thus, a large deer, for example, could continue to use the channel. The bridge height is 15’ over the channel bottom, and the length is 20’. The bridge is a class culvert, concrete span. The USFWS was involved.
Lufkin	This district generally designs their bridges to include longer spans, creating additional space beneath them along stream corridors in the hopes that wildlife moving adjacent to the stream will have plenty of room to safety pass beneath the bridge instead of coming up onto the roadway. This came about through discussions with their section personnel and the designers, partly based on previous conversations with TPWD. This district does not have any other specifically designed wildlife crossings.

TxDOT District	Wildlife Crossing Structures and Other Mitigation Efforts within TxDOT District
Pharr	1. SH 510 – small culvert 2. FM 509 – small bridge 3. FM 1419 – small culvert with fencing 4. US 83/I2 – Otha Holland culvert 5. SH 48 – Bridge for ocelots (CSJ: 0220-07-0510) -, created 2008, 5’ high, 45’ wide, 120’ long with fencing and associated vegetation. 6. US 281(military highway) east of FM 506 – One box culvert with step 7. SH 100 – constructed in 1990’s – 3 small RCB culverts, revised in 2016 with 2 large box culverts 10’ by 7’ with steps (2’ high 1.5’ wide), one 50’L, 7.4’ W, 6.5’ high bridge, and one 10’ x 5’ large box culvert at grade no steps with approximately 7 miles of fencing on both sides, and 18 wildlife guards, 9 grated and 9 piped. 8. FM 106 – General Brant, CSJ: 2243-01-009, 8 WCS installed from 2014 to 2018 consisted of 2 – 5’x 5’x 53’, 5’x 5’x 60’, 6’x 8’x 60’, 6’x 5’ x 60’, 2 – 8’x5’x100’, and 7’x 7’x 100’ with associated fencing at each WCS. 9. US 77 – three bridge WCS with associated fencing 10. US 83 – La Joya – one bridge WCS 11. FM 1847 –Proposed crossings: 5 new crossing structures, 2 – 7’ x 5’ x 69’ box culverts, , 7’x 4’x 80’, 7’x 5’x 60, and one bridge 48’ x 80’ long’ x17’ high with associated fencing, and modified piped wildlife guards – planned 12. US 281 – four bridge WCS with associated fencing planned

Appendix D. Survey Questions

Introduction to the Survey for All Participants

Thank you for participating on our survey. The Center for Transportation Research at the University of Texas at Austin is working with TxDOT to develop recommendations on how wildlife considerations are brought into transportation project development, design, and operations processes. The goal of this project is to reduce collisions with wildlife and facilitate wildlife connectivity beneath roads. We also welcome input on how to address livestock-vehicle collisions. We use the term animal-vehicle collision to include both wildlife and livestock collisions. Thank you.

Please select your title/position from the following list:

- TxDOT District Environmental Coordinator Staff
- TxDOT District Landscape Architects
- TxDOT District Area Engineers/District Engineers/District Directors of Planning and Development/Transportation Planning and Programming Division Director/Director of Project Planning and Development/Director of District Operations
- TxDOT District Director of Maintenance
- TxDOT Headquarters Bridge Division
- TxDOT Headquarters Traffic Operations Division
- TxDOT Headquarters Roadway Design Section, Design Division
- Texas Parks and Wildlife Department Agency Personnel

TxDOT District Environmental Coordinator Staff

1. Since 2007, has your district has constructed any types of mitigation for wildlife, wildlife fencing, or modified existing structures or projects to help prevent animal-vehicle collisions?

   ☐Yes ☐No

If so, could you enter information about these efforts in the table below? We will share this information in our report.

Type of Mitigation or Structure	Name of TxDOT Project	Location/ Highway	Mile Posts	Location/ City	Construction Completion Date	Target Species	Monitoring?	Comments

2. Do you have suggestions on how consideration of wildlife's needs to move across transportation corridors can be brought into the planning and daily operations processes?

3. Should considerations of wildlife crossings and other mitigation to facilitate wildlife connectivity and to reduce wildlife and livestock collisions, be placed in the NEPA process so TxDOT District ENV Section staff have a specific milestone in the process where they review data and consider these needs?

   ☐Yes ☐No

   Please enter your comments here:

4. Do you ever consult crash or carcass data to see if there are animal-vehicle conflict problems on upcoming projects?

   ☐Yes ☐No

5. Do you know if your district has entered into an agreement with Texas Parks and Wildlife (TPWD) or the US Fish and Wildlife Service (USFWS) to cooperatively work together to reduce wildlife-vehicle collisions and possibly provide for wildlife connectivity?

   ☐Yes ☐No

   If so, we will contact you to ask for a copy of the agreement and more details, to assist us in helping other TxDOT districts to create such agreements.

6. Are there any reports on areas of interest for wildlife movement and reduction of wildlife-vehicle conflict that you are aware of that pertain to your district?

   ☐Yes ☐No

If so, we will contact you to ask for more details, to assist us in helping other TxDOT districts to create such maps, mitigation, or reports.

7. Can you recommend best practices and strategies that your district may have adopted that could be used elsewhere in the state to help reduce animal-vehicle collisions and protect wildlife along roads?

8. Which TxDOT manuals and/or processes do you think should include information to guide TxDOT environmental, planning, design, construction and maintenance personnel to consider wildlife needs to move across transportation and the potential for animal-vehicle collisions in planning and daily operations?

Manuals: [Place check that all apply]

☐Roadway Design ☐Maintenance Operations

☐Maintenance Management ☐Highway Safety Improvement Program

☐Access Control Management-Design ☐Landscapes and Aesthetics Design

☐Bridge Project Development ☐Bridge Design

☐Construction Contract Administration

☐Design and Construction Information System (DCIS)

☐Procedures for Establishing Speed Zones

☐Project Development Process ☐Plans, Specifications and Estimate Development

☐Roadside Vegetation Management ☐Transportation Planning

☐Manual on Uniform Traffic Control Devices (UTCD)

Processes – please write in:

9. Do you have suggestions for methods to ensure coordination among multiple levels of TxDOT and the offices that use these various TxDOT manuals, that could help consider wildlife needs and the reduction of animal-vehicle collisions in planning and daily operations? Thank you.

TxDOT District Landscape Architects

1. Landscape design can encourage the use of an area by wildlife, thus helping to guide animals to wildlife crossing structures and encourage use of those structures. In the Landscape and Aesthetic Design Manual, section 'Restoration, Habitat Creation and Naturalization' (Chapter 2, Section 4), there are some guidelines for providing native vegetation and hydrologic function restoration. In your practice, do you restore native plants or improve habitat for wildlife of any kind?

   ☐Yes ☐No

2. Can you share some of your practices that could help wildlife move to and use wildlife crossing structures and existing culverts and bridges to safely move beneath the road? These ideas could be included in the future Landscape and Aesthetics Design Manual or our report. Thank you.

TxDOT District Area Engineers / District Engineers / District Directors of Planning and Development / Transportation Planning and Programming Division Director / Director of Project Planning and Development / Director of District Operations

1. At what point in the transportation planning process should TxDOT manuals instruct personnel to consider wildlife concerns? These include animal-vehicle reported crashes, and the presence of common and listed threatened and endangered species that may need to move to areas on both sides of roads.

2. Would planners and designers benefit from guidelines on when to place a wildlife crossing structures to reduce risks of wildlife collisions and provide connectivity for wildlife?

   ☐Yes ☐No

3. Please review the following potential guidelines for benchmarks on the need to install wildlife crossing structures, and rate each by clicking on the box of the statement that best pertains to your thoughts on the statement.

3a. Wildlife crossing structures are highly recommended if average number of reported animal-vehicle crashes are 3 or more crashes per mile per year.

☐Not Helpful or Pertinent

☐Too High

☐Yes, this is appropriate

☐Too Low

Comment:

3b. Wildlife crossing structures are highly recommended if there is 1 human fatality or more due to reported animal-vehicle crash that has occurred within the past 5 years in any mile of the segment of road under consideration.

☐Not Helpful or Pertinent

☐Too High

☐Yes, this is appropriate

☐Too Low

Comment:

3c. Wildlife crossing structures are highly recommended if there were 2 or more injury related reported animal-vehicle crashes per mile in the previous 3 years.

☐Not Helpful or Pertinent

☐Too High

☐Yes, this is appropriate

☐Too Low

Comment:

3d. Wildlife crossing structures are highly recommended if Texas Parks and Wildlife or the U.S. Fish and Wildlife Service have identified threatened and endangered listed species of wildlife near the road and their presence may delay or affect the transportation project.

☐Not Helpful or Pertinent

☐Yes, this is appropriate

Comment:

4. Are there other factors you think should be considered for placement of wildlife crossing structure?

5. Please rank the following potential methods that could improve the communication between headquarters and the TxDOT districts that in turn could help mitigate roads for wildlife.

5a. Training classes on animal-vehicle collisions, wildlife mitigation, planning for wildlife mitigation, resources and personnel who can help.

☐Useful

☐Not useful

☐Don’t know

5b. Training classes in conjunction with Texas Parks and Wildlife on protected species and how to account for these species in transportation planning and design.

☐Useful

☐Not useful

☐Don’t know

5c. Presentations on communication and coordination on wildlife mitigation, wildlife connectivity, and animal-vehicle collisions, presented at the annual meetings for Design, Construction, and Maintenance Divisions.

☐Useful

☐Not useful

☐Don’t know

5d. Presentations on animal-vehicle collisions, wildlife connectivity, and mitigation solutions to TxDOT Administration at either the TxDOT Short Course, or Center for Transportation Research (CTR) Annual Symposium.

☐Useful

☐Not useful

☐Don’t know

5e. Other suggestions on improving coordination and communication between districts and headquarters to improve the flow of information to help mitigate roads for wildlife, please write in. Thank you.

TxDOT District Director of Maintenance

1. Do your Maintenance District personnel collect carcass removal data?

☐Yes ☐No

If yes,

1a. Are the carcass data collected and reported:

☐For the majority of carcasses over most years

☐Most carcasses most years

☐Opportunistically, sporadic

1b. Is there a range of years when personnel in your district collected carcass data and reported it, if so, what are those years?

1c. Over your district, are carcass data collected in association with one or more of the following locations:

☐Collected on all TxDOT roads within a given maintenance section.

☐Collected on all TxDOT roads within a given county.

☐Collected along a specific route with wildlife signs.

☐Not collected according to any specific need or location, the data are used for every and anything, it's sporadic.

☐Or other method of identifying locations?

1d. How is the carcass data recorded and stored?

☐Hand written paper forms translated to Excel spreadsheets

☐Electronic data collection in Excel spreadsheet or other electronic application, or smart phone app

☐Other: please detail

1e. Who do you send carcass data to, and how often?

1f. Do you know how the carcass data are used by the District or Area office?

☐Yes ☐No

If yes, please explain:

1g. Would it be possible to obtain a copy of the past three years of carcass data or any carcass data? We are interested in seeing how it can inform planning and daily operations processes. If we can obtain data, we will contact you at a later date, but please give details below.

☐Yes ☐No

2. Could you give us your best estimate for the TxDOT Maintenance District cost for carcass removal on a lane-mile, monthly or annual basis?

3. What Area Office of your district has the highest costs for carcass removal?

4. Do you have any suggestions for future improvements to the carcass collection and data transfer process?

5. We will be making recommendations in the TxDOT maintenance manuals for mowing vegetation along wildlife exclusion fencing, right of way vegetation management, and culvert and fence upkeep. Can you suggest how to communicate to maintenance personnel the benefits of these actions in helping to reduce wildlife-vehicle collisions, reducing the number of carcasses along the road, and in helping wildlife from being killed? Thank you.

TxDOT Headquarters Bridge Division

1. Do you have any suggestions on the best way to insert specifications on wildlife crossing bridges into the Bridge Design Manual? These specifications could help with dimensions, materials, the slopes below the bridges so there is terrestrial passage by wild animals and humans.

2. Can changes be made to the Roadway Design Manual in the Non-Freeway Rehabilitation (3R) Design Criteria Chapter that would encourage small changes to plans to help create more wildlife friendly culverts, bridges, and approaches to those structures? Could you explain? Thank you.

TxDOT Headquarters Traffic Operations Division

1. In TxDOT crash data, if the First Harmful Event is an animal, or Vehicle Swerved or Veered from intended course was because of an animal, or Vehicle Slowing, Stopping or Stopped on Road was because of an animal, can the crash data software have a pull-down menu of about 14 species of animal the officers/sheriffs can choose from? This helps us identify the problem animals and the solutions.

2. In the TxDOT crash data, for the notation on the Object Struck, can there be an entry for an animal, and again, with a species pull down menu?

3. Do you have suggestions on how can we establish a regular analysis of crash data to evaluate the top animal-vehicle collision areas in the state and in each district? This would involve changes in planning, crash analyses, and also affect specific positions within TxDOT. Can you help give an overview of what that would take? Thank you.

TxDOT Headquarters Roadway Design Section, Design Division

1. In the TxDOT Access Management Manual, Section 4, in areas where TxDOT has constructed wildlife exclusion fencing, can TxDOT institute a rule that permits can be granted for driveways and roads only if they include a double cattle guard or other specified wildlife deterrent to prevent the animals from getting into the road? For example, In Nevada, Nevada DOT installed horse fencing to keep horses off a new highway, and to direct horses to use three equestrian underpasses. New businesses are applying for permits to install driveways, and NDOT is requiring the owners work with NDOT to keep the horse fencing up and for the permitees to install double cattle guards at drives. Thank you.

Texas Parks and Wildlife Department Agency Personnel

1. Have you ever worked with TxDOT on wildlife crossing structures or other mitigation that helped reduce wildlife-vehicle collisions or conflict?

   ☐Yes ☐No

   If so, what was the situation? Could you briefly describe why TxDOT and TXPWD worked together on this?

2. Do you have any recommendations on how TxDOT in planning and daily operations can be more proactive in identifying and addressing wildlife needs to move to different habitat on both sides of roads?

3. If we recommend the TxDOT district people contact TPWD, what positions at the local level of the TPWD offices would be the most helpful in assisting TxDOT concerning wildlife crossing structure needs along roads?

   3a. Do you have any recommendations on benchmarks for when TxDOT should consider placing a wildlife crossing structure on projects, such as presence of listed species, certain traffic thresholds, (number of animal vehicle collisions is presented below in 3b) or wetland presence?

   3b. Here we present a benchmark example. Please check the appropriate box that reflects your opinion on this statement: 'Wildlife crossing structures are highly recommended if average number of reported animal-vehicle crashes are at 3 or more crashes per mile per year.'

   ☐Not Helpful or Pertinent

   ☐Too High

   ☐Yes, this is appropriate

   ☐Too Low

Comments:

4. Do you know if your region has entered into an agreement with TxDOT to cooperatively work together to reduce wildlife-vehicle collisions?

☐Yes ☐No

If so, we will contact you to ask for a copy of the agreement and more details, to assist us in helping other TxDOT districts to create such agreements.

5. Are there any reports on areas of interest for wildlife movement and reduction of wildlife-vehicle conflict that you are aware of that pertain to your district?

☐Yes ☐No

If so, we will contact you to ask for more details, to assist us in helping other TxDOT districts to create such maps, mitigation, or reports.

6. We are collecting information on species' presence in Texas to help inform TxDOT personnel of where wildlife needs to move should be considered in planning and in daily operations. Could you direct us to any TPWD maps, reports, and websites that identify species locations that would be near roads, especially for larger and listed species? This information will possibly be added to recommendations for TxDOT in our final report. Thank you.

Appendix E. Review of Other State's Manuals

The research team reviewed materials from other state DOT manuals regarding wildlife crossing, or other mitigation or analysis components. Utah, Arizona, Montana, Idaho, Nevada, Washington, Florida, California, and North Carolina DOT manuals were reviewed. Although the manual titles may not exactly match the TxDOT manual nomenclature, the manuals reviewed are at least generally equivalent to TxDOT's: MUTCD, bridge design and construction, maintenance, environmental review, landscape design, traffic operations, transportation planning, and highway design. If a manual had any reference to wildlife-vehicle conflicts, or wildlife crossings (including for livestock), the section and page of the manual was notated.

In addition, the team reviewed manuals for states including Pennsylvania, Wisconsin, and Minnesota. Again keywords that were used to search through manuals included the following: wildlife, wildlife crossing, animal, animal-crossing, fencing, fish, amphibian, cattle guard, deer guard, eco passage, under crossings, and crash data analysis. No two states had the same materials, nor materials placed into similar manuals. California and Pennsylvania are the two states had specific Wildlife Crossing Manuals or substantial segments in other manuals providing guidance for different departments and divisions.

Links to the specific manuals that had wildlife crossing materials also provided in this appendix.

E.1 Arizona

2008 Standard Specifications for Road and Bridge Construction

https://www.azdot.gov/docs/business/2008-standards-specifications-for-road-and-bridge-construction.pdf?sfvrsn=0

Page 876 906-1 Cattle Guards

906-1 Description: The work under this section shall consist of furnishing all materials and constructing new cattle guards or reconstructing existing cattle guards at the locations shown on the project plans or designated by the Engineer, in accordance with the details shown on the plans and the requirements of these specifications.

906-2 Materials:

906-2.01 Concrete: Concrete shall conform to the requirements of Section 1006 for Class B concrete.

906-2.02 Steel: Reinforcing bars and structural steel shall conform to the requirements of Section 1003 and Section 1004, respectively. ASTM A 570, Grade 40 steel may be used as an alternate to ASTM A 36 for the fabrication of cattle guard grill rails.

906-2.03 Fencing: Fence posts and braces shall conform to the requirements of Sections 902 and 903.

906-2.04 Backfill: Backfill material shall conform to the requirements of Subsection 203-5.

906-2.05 Wood: Wooden shims shall conform to the requirements shown on the plans.

906-3 Construction Requirements: Excavation and backfill shall be in accordance with the requirements of Subsection 203-5. Completed cattle guards shall be well drained. Cattle guards shall be cast - in-place or, at the option of the contractor, may be precast units. A list of approved precast units may be found on the Department's Approved Products List (APL), available on the internet from the Arizona Transportation Research Center (ATRC), through its PRIDE program. The use of precast cattle guards shall be limited to roadway locations with maximum longitudinal grades of six percent. Precast units shall be installed to match the roadway centerline profile grade and the roadway cross-slope. Cattle guards shall be constructed in accordance with the details shown on the plans in reasonably close conformity to the lines and grades established or shown on the project plans. All fence and steel gates required shall be constructed as specified under Section 902 or 903, as applicable. Painting of structural steel shall be in accordance with the requirements of Section 610. Structural steel shall be painted with one coat of primer (Paint No. 1) in accordance with Section 1002. Painting of fence posts and gates shall be in accordance with the requirements of Section 902 or 903, as applicable.

Existing cattle guards designated on the project plans for reconstruct ion shall be dismantled to the extent required and in such a manner as to preserve all materials or port ions of the existing structure that are acceptable for use in the reconstructed structure. All removed concrete shall be disposed of in accordance with the requirements of Subsection 202-3.03(A).

Cattle guards to be reconstructed shall be constructed as specified herein, except that the materials required shall be salvaged to the extent possible from the existing cattle guards designated on the plans to be reconstructed or removed. Steel angles providing a bearing surface for each grille unit of a roadway cattle guard and wooden shims under railroad cattle guards shall be set to the required elevations with sufficient accuracy that no rocking under load of a grille unit or tread assembly can be observed and that no gap greater than 1/32 inch exists between any pair of bearing sur faces when the unit or assembly is not under load and is not spiked, welded or otherwise held in place.

The fabrication and connections of grille units, angle units, and other Either H-10 or H-20 loading will be designated on the project plans.

906-4 Method of Measurement: Cattle guard, and reconstruct cattle guard will be measured as a unit for each structure. Cattle guards consisting of a different number of grille units, different "H" loadings, different widths, or being new instead of reconstructed will be measured separately.

906-5 Basis of Payment: The accepted quantities of cattle guards and reconstruct cattle guards, measured as provided above, will be paid for at the contract unit price each, complete in place, including excavation, structure backfill, structural steel, reinforcing steel, grilles, concrete, painting, wood shims and concrete slabs where required. Payment for fence or gates will be made as specified under Section 902 or 903, except that posts and braces attached to the cattle guard shall be considered as included in the cost of the cattle guard.

Page 941 1001-8 Fences and Cattle Guards: Where the haul roads to material sources cross existing fence lines in areas where there is livestock of any kind, temporary cattle guards shall be installed by the contractor at each crossing. The livestock operator or owner shall be contacted prior to the beginning of any operations and effective measures shall be taken and means provided by the contractor to prevent livestock from straying. In operations where conditions will exist that are dangerous to livestock of any kind, temporary cattle guards and fence shall be installed around the pit area by the contractor to protect livestock. Temporary cattle guards and fence installed by the contractor shall be removed and existing fence disturbed shall be replaced or reconstructed and all fence shall be left in as good condition as it was prior to the beginning of work.

Roadway Design Guidelines

https://www.azdot.gov/docs/default-source/business/roadway-design-guidelines.pdf?sfvrsn=8

Page 163. 314 - Miscellaneous 314.1 - Cattle Guards

Cattle guards, with or without gates, may be required to prevent livestock from interfering with roadway traffic or to maintain range control. To prevent cattle from entering the right-of-way, the construction of cattle guards may be required at side roads and private entrances. When placed near traffic interchanges on a crossroad, cattle guards without gates should be placed at or near the access control line to prevent livestock entering the main roadway. Only under unusual circumstances will cattle guards be justified in urban areas. The number of units required should be determined by the width of the roadway. See Roadway Plans Details on the Roadway Design website for cattle guards.

Guidelines for Highways on Bureau of Land Management and U.S. Forest Service Lands.
https://www.azdot.gov/business/engineering-and-construction/roadway-engineering/roadway-design/standards-and-guidelines/guidelines-for-highways-on-bureau-of-land-management-and-us-forest-service-lands

Chapter 3 habitat connectivity, discussion on wildlife passages, overpasses and underpasses, including small culverts, fish passages and amphibian and reptile tunnels

https://www.azdot.gov/docs/default-source/business/habitat-connectivity.pdf?sfvrsn=20

Chapter 4 roadway design and construction

https://www.azdot.gov/docs/default-source/business/roadway-design-and-construction.pdf?sfvrsn=18

Chapter 5 major structure design and construction.

https://www.azdot.gov/docs/default-source/business/major-structure-design-and-construction.pdf?sfvrsn=18

E.2 California

Caltrans has a wildlife crossing manual in its own right. California also created a wildlife crossing mitigation credit system in April 2017 in coordination with California Fish and Wildlife. Caltrans also has a fish passage manual. These can be found at the following links.

- Caltrans Wildlife Crossings Guidance Manual.
- https://roadecology.ucdavis.edu/files/content/projects/CA_Wildlife%20Crossings%20Guidance_Manual.pdf
- State Agencies Pilot Wildlife Crossing Mitigation Credit System. Accessed at: http://www.dot.ca.gov/paffairs/pr/2017/prs/17pr039.html
- Fish Passage Design for Roadway Crossings. Accessed at: http://www.dot.ca.gov/design/manuals/fpm.html
- Caltrans, One Way Gates in Wildlife Fencing to Reduce Wildlife-Vehicle Collisions for Small and Medium Sized Animals. Accessed at:

http://www.dot.ca.gov/newtech/researchreports/preliminary_investigations/docs/wildlife_gates_preliminary_investigation.pdf

E.3 Florida

Design Manual

http://www.fdot.gov/roadway/FDM/

- Page 57 Initial Engineering Design 110.2 (5) Review Project Commitment Record (PCR) that was completed during PD&E and identify all prior PD&E commitments that will be addressed during design; e.g., the need to design and locate noise barriers (with insertion loss calculations), special pond site requirements, landscape or aesthetic considerations, pedestrian and bicycle commitments, access commitments, wildlife management commitments, wetland issues, transit issues.
- Page 60 110.5 Support Services Review information or support services that have been provided to determine the completeness and currency of data used in previous studies/reports. Technical data required for the design of a roadway project can be available from various sources, such as: (4) Environmental Documents (including Noise Study Report and wildlife connectivity recommendations).
- Page 65 110.5.4 Wildlife Connectivity
    - Wildlife connectivity features include new or modified structures; e.g. bridges, bridges with shelves, specially designed culverts, enlarged culverts, or drainage culverts. Exclusionary devices such as fencing, walls or other barriers may be included to funnel wildlife to a crossing. Disciplines that may be involved in this effort include Structures, Roadway, Drainage, Environmental Management, Permitting, Right of Way and Utilities. Wildlife connectivity needs are usually identified during the PD&E study. However, coordinate with the District Environmental Management Office and District Permit Office early in the design phase for determination of the type, size and other parameters for the wildlife crossing feature. For further guidance on wildlife connectivity refer to the FDOT Wildlife Crossing Guidelines, commitments section of the Environmental Document, and any other documentation regarding the wildlife connectivity related to the project.
    - In the event that wildlife connectivity needs are not identified until after the design process has begun, immediately start the coordination process with the District Environmental Management Office and District Permit Office.
- Page 142 Bridge Project Development §121.8.2 Contents
    - The bridge analysis provides conceptual guidance for the bridge design consultant. Conceptual guidance on how the bridge should fit into the uniqueness of the site should be provided. Bridge design and structure type should be left to the design team in the later phases of work. Include the following in the bridge analysis: Environmental and site considerations, including the need for wildlife connectivity (see FDM 110.5.4).
    - Page 144 121.9 Bridge Development Report/30% Structures Plans (2) Minor Grade Separations or Small Water Crossings: The BDR will be a thorough document that adequately addresses all viable structure types; however, the BDR will not usually be an extensive document since the viable types of superstructure and substructure are generally limited. The report is to consider scour, vessel collision, and wildlife

connectivity. (3) Major Bridges (including Movable) and Major Interchanges: The BDR will be an extensive and comprehensive document that thoroughly considers all viable structure types and considers all design parameters (such as scour, vessel collision and wildlife connectivity).

  - 121.9.1 Contents. Major items to be considered in the BDR are
    - (1) General: The bridge length, height and pier locations are subject to vertical and horizontal design clearance requirements such as those for clear zone, navigation, wildlife connectivity, and hydrology. After these considerations are met, span lengths are governed by economics and aesthetic considerations. Superstructure depths (grade separation structures in particular) are to be kept to the minimum that is consistent with good engineering practice. Recommended span/depth ratios for steel superstructures are shown in AASHTO. (b) environmental considerations including wildlife connectivity (see FDM 110.54)

- Page 155 121.10 Bridge Development Report (BDR) Submittal Checklist
  - (9) Wildlife Connectivity. Describe the decision to include or exclude wildlife connectivity features into the design. The discussion for excluding a wildlife connectivity feature should summarize coordination with the Environmental Management or Permit office (or may be an attached summary memo from one of these offices). The discussion for including wildlife connectivity should refer to the Wildlife Crossing Guidelines, commitments made during PD&E and any other documentation regarding the wildlife connectivity related to the bridge (or may be an attached summary memo from the Environmental Management or Permit office).
  - Page 521. 265 Reinforced Concrete Box and Three-Sided Culverts. 265.1 Three-sided concrete culverts on spread footings may be used for railroads, wildlife crossings, bicycle/pedestrian/equestrian/golf cart paths, and other uses that do not convey water or have scour vulnerability.
  - Page 530 Joint Waterproofing 265.9. Culverts will occasionally be used to allow the passage of things other than water, including but not limited to pedestrians, bicycles, trains, golf carts, wildlife, or farm animals. In cases where it is desirable to have a dry environment, a waterproof joint wrap should be used to cover the joints between precast culvert units or to cover the construction joints in cast-in-place culverts.

- Page 531 Design Requirements for Concrete Culverts. 265.12 Design Details.
  - Provide either a complete cast-in-place design or a conceptual precast barrel design with a complete foundation and wingwall design, in the contract plans when a three-sided concrete culvert is proposed for a site. The contractor is permitted to substitute precast three-sided culverts for cast-in-place three-sided culverts in accordance with Section 407 of the Standard Specifications. Design and fabrication details for precast three-sided culverts, including calculations, must be submitted to the Engineer of Record for approval. Do not place wildlife shelves in hydraulic structures.

Wildlife Crossing Guidelines – Issued March 2018

http://www.fdot.gov/environment/pubs/WildlifeCrossingGuidelines_2018revisions.pdf

Environmental Publications

http://www.fdot.gov/environment/publications.shtm

PDE Manual June 2017 edition

- Page 592 3.2.3.4.2 Existing Bridge Conditions
- FDOT's Bridge Maintenance Office maintains Bridge Inspection Reports for every public bridge in the State of Florida. The Project Manager must obtain the Bridge Inspection Report for each bridge on the existing corridor. Additionally, geotechnical and scour reports, environmental permits, and previous studies for existing bridges can be requested from the structures and environmental permits offices. If hydraulic analysis is anticipated, bridge information for each bridge upstream and downstream of the existing crossing can also be obtained.
- Evaluation of existing bridge conditions should include identification of wildlife crossing features. These features include bridges, bridges with shelves, specially identified culverts, enlarged culverts or drainage culverts, and/or exclusionary devices such as fencing, walls or other barriers, or some combination of these features. The Project Manager should confirm the location of a wildlife crossing feature based on coordination with the District Environmental Manager, District Permit Coordinator, and District Structures Design Engineer.
- Page 1035 16.3.1.2.1. ETDM process Contribution to PD&E. The Services or FWC comments should identify specific protected species or critical habitat that should be considered/analyzed during the PD&E Study. The Districts should use this list of species as a starting point for preparing the existing conditions for the NRE (see Section 16.3.2.1.2). Comments on the ETDM screening may also identify listed species habitats of concern or wildlife connectivity issues.
- Page 1038. Section 16.2.2.1. When wildlife crossing features are being considered, follow the FDOT Wildlife Crossing Guidelines, which were developed in coordination USFWS and FWC. Wildlife crossing feature locations should be identified as early as possible in the project planning and development processes, and prior to project design. The guidelines note that "wildlife crossing feature(s)" may include, but are not limited to new or modified structures, such as bridges, bridges with shelves, specially designed culverts, enlarged culverts or drainage culverts and/or exclusionary devices such as fencing, walls or other barriers, or some combination of these features. The guidelines were developed for use by FDOT to evaluate the appropriateness of including wildlife crossings (upland or wetland) and associated features for proposed projects on the SHS and establish criteria to be considered during design. In cases where a FDOT District has an off-SHS project, the District will coordinate with the OEM regarding possible inclusion of any wildlife crossing features.
- Page 1038. 16.3.2.3 Conduct Protected Species and Habitat Analysis Impact Assessment. The impact assessment includes comparing the species and habitat mapping data and field survey results (Section 16.3.2.1), with the proposed project footprint from the plan sheets (if available) to evaluate direct, indirect, and in some instances cumulative effects to listed species and habitats (see Section 16.1.2for definitions). It is also important to consider potential project impacts related to habitat connectivity for all wildlife, not just protected species, as habitat fragmentation can directly or indirectly impact multiple species. Although there are no federal or state requirements to avoid habitat fragmentation for unlisted species, this can be considered in coordination with the Services and/or FWC. If wildlife crossings are considered they must follow the FDOT Wildlife Crossing Guidelines.
- Page 1049. 16.3.3.3 Design Considerations. Project commitments may include construction conditions for protected species, specific design specifications (e.g., the construction of wildlife crossings, or wildlife crossing features that can minimize take) or other project specific treatments (e.g., exclusionary fencing, curb heights, etc.). In some cases, special provisions or modified special provisions may need to be considered. Plan notes are only used when absolutely necessary

and must be project-specific and cannot repeat specifications, permit conditions and/or design standards.

- Page 1052. 16.3.3.7 Maintenance Activities. Maintenance activities such as roadside mowing, culvert repair/replacement, herbicide/fertilizer application, tree/shrub trimming, guardrail repair, and bridge maintenance and repair typically are undertaken without impacting protected species or wildlife habitat. District Environmental Office staff should assist the Office of Maintenance when protected species issues arise (Section 16.3.3.5) or maintenance activities that may affect protected species or wildlife habitats are planned. Examples include: 1.Culvert repair/replacement in areas known to be inhabited by the Panama City Crawfish; 2. Mowing and or herbicide/fertilizer application on roadsides inhabited by listed plant species; 3.Bridge repair/maintenance in bridges that may be roosting sites for protected bat species; 4.Bridge repair/maintenance requiring in water work; and, 5.Tree/shrub trimming in mangrove areas

Plans prep manual design criteria and process 2017

http://www.fdot.gov/roadway/PPMManual/2017/Volume1/2017Volume1.pdf

http://www.fdot.gov/roadway/PPMManual/2017PPM.shtm

- Noted in 26.8.2 bridge analysis section under contents (page 746). Section 26.9.1.2 & 3
- Minor Grade Separations or Small Water Crossings: The BDR will be a thorough document that adequately addresses all viable structure types; however, the BDR will not usually be an extensive document since the viable types of superstructure and substructure are generally limited. The report is to consider scour, vessel collision, and wildlife connectivity.
  Major Bridges (including Movable) and Major Interchanges: The BDR will be an extensive and comprehensive document that thoroughly considers all viable structure types and considers all design parameters (such as scour, vessel collision and wildlife connectivity).

26.9 Bridge Feasibility Assessment/Structures Concept Plans

At the discretion of the Department, a Bridge Feasibility Assessment may be necessary during the RFP development phase for the purpose of developing the structures concept plans. When required, the assessment must target specific critical bridge components to ensure that the preliminary information presented in the concept plans can meet all of the project constraints depicted in the RFP.

For aesthetic and wildlife connectivity requirements, see RFP.

- Chapter 13 initial engineering design process section 13.5.4 – wildlife connectivity
- Wildlife connectivity features include new or modified structures; e.g. bridges, bridges with shelves, specially designed culverts, enlarged culverts or drainage culverts. Exclusionary devices such as fencing, walls or other barriers may be included to funnel wildlife to a crossing. Disciplines that may be involved in this effort include Structures, Roadway, Drainage, Environmental Management, Permitting, Right of Way and Utilities.
- Wildlife connectivity needs are usually identified during the PD&E study. However, coordinate with the District Environmental Management Office and District Permit Office early in the design phase for determination of the type, size and other parameters for the wildlife crossing feature. For further guidance on wildlife connectivity refer to the ***FDOT Wildlife Crossing Guidelines***,

commitments section of the Environmental Document, and any other documentation regarding the wildlife connectivity related to the project. In the event that wildlife connectivity needs are not identified until after the design process has begun, immediately start the coordination process with the District Environmental Management Office and District Permit Office.

26.10 bridge development report submittal checklist item (9) Wildlife Connectivity:

Describe the decision to include or exclude wildlife connectivity features into the design. The discussion for excluding a wildlife connectivity feature should summarize coordination with the Environmental Management or Permit office (or may be an attached summary memo from one of these offices). The discussion for including wildlife connectivity should refer to the ***FDOT Wildlife Crossing Guidelines***, commitments made during PD&E and any other documentation regarding the wildlife connectivity related to the bridge (or may be an attached summary memo from the Environmental Management or Permit office). Page 760

2016 manual: http://www.fdot.gov/roadway/PPMManual/2016/Volume1/2016Volume1.pdf

E.4 Michigan

The research team could not find relevant text in any Michigan DOT manuals.

http://www.michigan.gov/mdot/0,4616,7-151--425471--,00.html

E.5 Idaho

http://apps.itd.idaho.gov/apps/manuals/manualsonline.html

Roadway Design Manual

http://apps.itd.idaho.gov/apps/manuals/RoadwayDesign/Roadwaydesignprintable.htm

- Page 420 of PDF: Drainage improvements when required should be landscaped and constructed in a manner that replicates a natural waterway. Where bridged crossings are required, the design should consider clearances that allow wildlife to cross the road at a grade separation.

Design Build Manual

- Page 24 of pdf. When planning how environmental requirements will be carried out and achieved, the Department should consider implementing the following items. Contractual items must be included in the RFP. Attachments to be included in the RFP or as reference documents include:
  - Approved environmental document, including technical reports
  - *Mitigation requirements (including avoidance, minimization and conservation measures, BMP's, and compensatory mitigation*)
  - A list of all required permits, including any permits already acquired, with details on who will prepare, submit and review the permit application, and anticipated timeframes for the

expected application process. For a 404 permit, attach description of impacted wetlands by type, function, value and acreage.

- Require the design-build firm to provide minimum qualifications for the design-build firm's environmental staff when appropriate
- Comply with all mitigation requirements of the environmental decision document
- Develop, implement, maintain, and document Best Management Practices for the project design and per permit application requirements
- Identify, develop, implement and maintain mitigation measures resultant from their final design to gain regulatory approval
- Hold scheduled coordination meetings with regulatory agencies when appropriate/applicable

Operations Manual

http://apps.itd.idaho.gov/apps/manuals/OperationsManual/OperationsManual.html

Pg 58 Operations Manual Section: Roadsides

- In cooperation with the Idaho Department of Fish & Game (IDFG), and to address highway safety concerns related to animal/vehicle collisions, recording and reporting of dead animals (carcass) which have been killed upon the Rights-of-Way shall be accomplished by Department personnel. The Department's Transportation Asset Management System (TAMS) has been configured to allow for the easy input of carcass information. Department personnel shall record all animal carcasses that are removed in TAMS. If an animal has been salvaged in accordance with the Idaho Salvage Law, it will be recorded in the IDFG database as part of the salvage permit process and does not need to be entered into TAMS as a carcass record

Traffic Manual

This manual contained no relevant material other than wildlife signs.

Environmental Process Manual

The link to this manual on the website did not work.

E.6 Minnesota

They have a traffic information sheet on deer crossing signs.

http://www.dot.state.mn.us/trafficeng/signing/doc/deer-crossing-signs-informational-sheet.pdf

Also available is a sheet on the passage bench crossing, which includes drawings.

https://www.dot.state.mn.us/d7/projects/hwy22mapleton/passage-bench.pdf

Minnesota Department of Natural Resources has a short guide on roadways and turtles with links to design specs in other manuals hey have.

https://files.dnr.state.mn.us/assistance/nrplanning/community/roadsidesforwildlife/road-turtles.pdf

E.7 Montana

Bridge Structures Manual part 1

http://www.mdt.mt.gov/other/webdata/external/bridge/structures-manual/part_I/volume-1.pdf

- Chpt 3 section 1 subsection 2: A Section 4(f) approval is required if a project will impact publicly owned land (e.g., public park, recreational area, wildlife and waterfowl refuges). An approval will be granted only if there is no feasible and prudent alternative. Where a Section 4(f) approval is required, the Bridge Area Engineer will provide the necessary project information to the Environmental Bureau, who will then secure the approval.

Geotechnical Manual

Chapter 17 Earth Retaining Systems
http://www.mdt.mt.gov/other/webdata/external/materials/geotech_manual/chapter17.pdf

- 17.1.2.4 Calls for the environmental bureau to be brought into the planning process when environmentally sensitive areas are present.

Hydraulics Manual

Chapter 9 Culverts

http://www.mdt.mt.gov/other/webdata/external/hydraulics/manuals/chapter_9_culverts.pdf

- 9.2.2 The cost savings of multiple uses (utilities, stock and wildlife passage, land access, and fish passage) shall be weighed against the advantages of separate facilities.

Roadway Design Manual

http://www.mdt.mt.gov/other/webdata/external/cadd/RDM/50-RDM-COMPLETE.pdf

This manual contained no relevant material

Traffic Engineering Manual

(All chapters are separate links)

This manual contained no relevant material

Maintenance Manual

http://www.mdt.mt.gov/publications/manuals/maint_manual.shtml

- Section C, Chapter 6 removal of carcass: review MDT environmental practices (Section D, Chpt 3)

http://www.mdt.mt.gov/publications/docs/manuals/mmanual/chapt3d.pdf

- Large game animals – (Black bears, Elk, Moose, Bighorn sheep, etc.) A MFWP warden should be notified for disposal instructions.

E.8 Nevada

Structures Manual

https://www.nevadadot.com/doing-business/about-ndot/ndot-divisions/engineering/structures/structures-manual

Similar to Montana. Environmental Division is used in environmentally sensitive areas. Nothing else related to wildlife crossings

Strategic Highway Safety Plan

https://www.nevadadot.com/home/showdocument?id=4728

A PowerPoint show of overall strategy. Discussed how Nevada has been compliant with FHWA safety plans from https://safety.fhwa.dot.gov/hsip/hrrr/manual/sec44.cfm#s44c

Road Design Guide

http://www.nevadadot.com/home/showdocument?id=1535

- Section 3.15 **Tortoise fencing.** Upon evaluation from Environmental Services, tortoise fencing may be required to be installed within the project limits and proposed NDOT material site. These projects are typically in Clark County.

E.9 New Mexico

Found references to wildlife crossing studies and development, however no relevant material in their manuals

US 70 Wildlife Crossing Study CN-3964

The New Mexico Department of Transportation is conducting a Wildlife Crossing Feasibility Study for eight miles of US Highway 70 (US 70) in the San Augustine Pass area from milepost (MP) 162 to MP 170. The purpose of the study is to gain an understanding of wildlife movement through the study area, and to develop ways to facilitate wildlife movement while reducing the potential for animal-vehicle collisions.

US 70 Wildlife Study Questionnaire - PDF
Overall Study Area - PDF
Study Area 1 - PDF
Study Area 2 - PDF
Study Area 3 - PDF
Study Area 4 - PDF

Map
US-70/N. Main St. Phase I

NM 41 US 285 –http://dot.state.nm.us/content/dam/nmdot/D5/NM41_Phase_A.pdf

Study of vehicle crashes showed animals struck; however, this reporting was very minimal and did not indicate an imminent concern.

Wildlife Vehicle Collision Mitigation in NM – Jim Hirsch ENV section in NMDOT.

https://nhnm.unm.edu/sites/default/files/nonsensitive/news-files/Hirsch%20NMDOT%20Wildlife%20collision%20mitigation%20presentation%20Dec%205.pdf

Tijeras Canyon Safe Passage Project 2008= 3 drainage crossings and 2 at grade crossings.

Game fencing projects in 2010 on I-40.

House Joint Memorial 10 created in 2011 between DOT, NMDFG and NM State Police.

House Memorial 1 and Senate Memorial 11 in 2013 directed NMDOT and NMDGF to host workshop to identify priority road segments for future wildlife-vehicle collision mitigation measures, one highway safety program was required to be submitted in 2014. Two were submitted. The PowerPoint shows areas identified.

E.10 North Carolina

Standard Specifications Manual

https://connect.ncdot.gov/resources/Specifications/Pages/2012StandSpecsMan.aspx?Order=SM-00-000

- Pg 114- Describes process by which environmental consultants should be hired to review vegetation in construction period to evaluate wetlands and endangered species effects

https://connect.ncdot.gov/projects/Roadway/Pages/Roadway-Design-Manual.aspx

Mountain Stream Relocation Guidelines

https://connect.ncdot.gov/projects/Roadway/RoadwayDesignAdministrativeDocuments/Guideline%20for%20Mountain%20Stream%20Relocations.pdf

Not sure if this would be included or not but put it in here anyway.

- Provides schematics and guidelines on how to relocate streams during road planning process

Construction Manual

https://connect.ncdot.gov/projects/construction/Pages/ConstMan.aspx?Order=CM-00-000

Division 16, Section 1606

- Special sediment control fence is generally used in conjunction with silt fence to provide outlets for water that can be trapped by silt fence. It is also useful in area near flowing water to permit tides and surges to cross the fence without knocking it down.
- Section 1667: Specialized hand mowing is utilized around signs and guardrail and can be performed with a variety of powered equipment. The equipment must be capable of working

timely and efficiently. Payment is made by the man hour for each worker who is working efficiently.

  - For our purposes could be applied to mowing around wildlife fencing?

NES Procedures Manual

https://connect.ncdot.gov/resources/Environmental/Pages/NES-Procedures-Manual.aspx

- Section 3-On-site mitigation planning: The Natural Environment Engineering Group (NEEG) is a multi-discipline group of engineers that are involved in the planning, design, construction, monitoring, and remediation of on-site and/or adjacent wetland, buffer, stream, and conservation mitigation sites, statewide. These mitigation efforts are a result of unavoidable environmental impacts associated with roadway construction projects. The projects are used for compensatory mitigation to offset unavoidable environmental impacts pursuant with State and Federal Environmental Law and Guidelines. The mitigation projects are closely coordinated with several different internal Department Units, as well as State and Federal Environmental Regulatory Agencies, adjacent property owners, and the local citizens.

Crash Data and Maps

https://connect.ncdot.gov/resources/safety/Pages/Crash-Data.aspx

- Included just as a reference. Only data in this set, but it does show NC has been tracking deer related crashes, time of day, by county, and by month

E.11 Pennsylvania

Design Manual, Part 2, Highway Design, March 2015 Edition.

http://www.dot.state.pa.us/public/pubsforms/Publications/PUB%2013M.pdf

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13.1 Considerations relevant to construction – in chapter 13 erosion and sediment pollution control.

Water Management Act shall be designed and constructed in accordance with the standards of the individual watershed stormwater management plans. In some special cases, a multipurpose detention basin may be installed to provide water quality and wildlife habitat enhancements. Permanent erosion and sediment pollution control BMPs shall have a plan of maintenance. Temporary erosion and sediment pollution control BMPs shall be cleaned and maintained to assure proper functioning for the expected period of use. Some basins or ponds, because of size or location, may require protective fencing to limit unauthorized access.

Chapter 13 is literally littered with references to different plant types and their efficacy for wildlife as either cover or as food.

13.-3

A. Standard Highway Seeding Mixtures. Publication 408, *Specifications,* Section 804 lists several standard seeding mixture formulas which should be used on typical construction slopes for highway construction projects. A general description and guideline for their use is as follows:

6. Formula W. This is a rough textured blend of tall fescue and birdsfoot trefoil (leguminous plant) with a nurse crop of redtop. This formula can be used on a wide assortment of conditions ranging from fairly dry to fairly wet soils where non-mow conditions are desired such as wetland replacement areas or wildlife habitat areas. This formula will eventually allow the desired invasion and succession of adjacent native plant material.

Other seeding formulas for various specialty areas such as wetland replacements, wildlife habitat areas, wildflower establishment or other soil conservation areas can be developed on a project by project basis.

11. Big Bluestem (Andropogan gerardi)

a. Tall growing, perennial, deep rooted, vigorous bunch grass, sod forming. More drought tolerant than other "warm season" grasses. Grows 1 to 2 m (3 to 6 ft) tall. **b.** Grows well on most soil types but can be used on excessively drained soil with low water holding capacity. Good tolerance to low pH and low fertility. Can be used on coal waste areas or strip-mined soils. **c.** Generally takes 2 years to reach its maximum growth potential because of slow germination and seedling growth. **d.** Seed is chaffy and will not flow well unless debearded. Specify 'Debearded' seed only. (Note: There are several specially designed seedbox seeders that will accommodate 'fluffy' seed.) **e.** Important forage grass in the Midwest prairie states. **f.** Wildlife use by songbirds and white-tailed deer for food and for nesting and escape cover.

Chapter 20 Wildlife Crossings

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E.12 Utah

2017 Standard Specifications for Road and Bridge Construction

https://www.udot.utah.gov/main/uconowner.gf?n=31730316757114651

- Page 137 §3.7 environmental clearance by contractor, subsection A.2 perform a wildlife survey for threatened, endangered or other sensitive species are affected by activity
- Page 539 – §02821 wire mesh fence – they have a specification for a wildlife fence.
- Page 546 – §02825 – cattle guard specifications
- Page 548 §02827 – entire section on wildlife escape ramps – three types of ramps combination, corner and standard. Refers to sections on topsoil, hydraulic erosion control products and seed turf, and turf sod.
- Page235 Section 02221 remove structure and obstruction, at part 3.21 on removing cattle guard.

Manual of Instruction for Right of Way Design

https://www.udot.utah.gov/main/uconowner.gf?n=9286109459519309

- §5.22 on page 190 requires in total track map to show all boxes larger than 5 feet that could provide access for animals.
- §10.02 roadside facilities which is in chapter 10 on roadside development and erosion shows that these features can include animal control

Signalized Intersection Design Guidelines 2017

https://www.udot.utah.gov/main/uconowner.gf?n=13679121470326565

We found nothing here for animal or wildlife.

For crash data – in section 7 on advanced warning signal systems notes that warranting for AWS systems is done through central traffic and safety, and has a chart that looks at history of severe crashes.

Structures Design and Manual

https://www.udot.utah.gov/main/f?p=100:pg:0:::1:T,V:4358,

https://drive.google.com/file/d/0B8QRVMpaE6oYa0htTkhobEtDWDg/view

- Chapter 19 expansion joints mentions at §19.1.1 (1) notes that bearing seats can collect debris and lead to animal habitation.
- At section 10.10 in chapter 10 (page 220) for abutments the manual notes that "Spill through abutments with 2H:1V fill slopes are often preferred for wildlife undercrossings because the slope provides a more natural setting"
- Chapter 10 on culverts notes under §10.12.1 on cast in place or precast box culvers that these can have single or multiple openings allowing the passage of water, livestock, or wildlife under a roadway. This section notes a disadvantage of confining feel for wildlife or difficulty adapting to complex geometry. Section 10.12.2.1 notes that precast three sided culvert structures are viable solution for stream crossings where scour is not a concern and for wildlife undercrossings.
- Chapter 18 substructurees under 18.1 abutments at .Section 18.1.1.1.5 notes for slope protection that:
  - Use slope protection on all slopes steeper than 2H:1V when the slope is located under the bridge. When transitioning from 1½H:1V to 2H:1V in the slope, terminate the protection when the slope reaches 1¾H:1V and the 1¾H:1V slope is not under the bridge. Do not use slope protection, and use slopes 2H:1V or flatter, when the area under the bridge is primarily a wildlife crossing.
- Chapter 22 miscellaneous structures (page 541) at Section 22.1 on culverts and draining structures notes that: Culverts are buried structures that transport water or traffic (pedestrian, wildlife or vehicle) under roadways, railways or embankments. It also notes that:
  - Wildlife crossings are sized and located by the Environmental Division. Coordinate with the Environmental Division and roadway designers when preparing structures plan sheets.
  - Show bedding and backfill requirements in the plans of all buried structures.
- Chapter 21, at section 21.4.2.8 on parapet retrofit or replacement refers to examine the following when evaluating an existing bridge parapet. Review the crash history.

Bridge Management Manual – chp1 and 2

https://www.udot.utah.gov/main/uconowner.gf?n=35942524323318753

- Within entire bridge manual in chapter 3 on inspection, it has §3.1.3.9 nonhighway traffic bridges. Section 3.1.6.3 under safety training, training should include risks that include wildlife.

Pavement and Pavement Design Manual

https://www.udot.utah.gov/main/uconowner.gf?n=10118516350311477

- This manual contained no relevant material Some references to accidents but no mention of type of accident

Sign Manual

https://www.udot.utah.gov/main/uconowner.gf?n=3000306255336296

Supplemental manual

https://www.udot.utah.gov/main/uconowner.gf?n=13202015905895727

- Frequent wildlife crossing next whole miles (freeway/expressway) page 561
- Frequent wildlife crossing sign page 562
- Frequent wildlife migration area page (freeway/expressway563
- Frequent wildlife migration area page 564r

UDOT Project Delivery Guide (this document contains links to other manuals as well)

https://www.udot.utah.gov/main/uconowner.gf?n=13674306628756252

This manual contained no relevant material

UDOT Project Management Manual

https://www.udot.utah.gov/main/uconowner.gf?n=4293905911234615

This manual contained no relevant material

Advanced Traffic Signal Management Manual

https://www.udot.utah.gov/main/uconowner.gf?n=38640805599768082

This manual contained no relevant material

Stormwater Management Manual

https://www.udot.utah.gov/main/uconowner.gf?n=39517213266675103

This manual contained no relevant material

UDOT Wildlife and Domestic Animal Accident Toolkit

https://www.udot.utah.gov/main/uconowner.gf?n=9770519209812457

Wildlife and domestic animal vehicle collisions

https://www.udot.utah.gov/main/uconowner.gf?n=7842322577586730

http://insights.wsp-pb.com/articles/transportation/designing-a-safe-wildlife-crossing-in-utah

E.13 Washington

Design Manual

https://www.wsdot.wa.gov/publications/manuals/fulltext/M22-01/design.pdf

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510.02 Special Features

510.02(2) Cattle Passes

The desirability of or need fora cattle pass will be considered during the appraisal or negotiation process. A cattle pass will be approved only after complete studies of location, utilization, cost, and safety elements have proved its necessity. Upon approval, such an improvement and appurtenant rights will be established. Future right of access for maintenance is negotiated during acquisition. On limited access highways, approval by the Director & State Design Engineer, Development Division, and the addition of a traffic movement note on the right of way and limited access plan (see the *Plans reparation Manual*) are required.

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560.03(3) Other Considerations Extremely tall fences (7 to 10 feet high) may be used in areas where there are exceptional conditions such as large concentrations of deer or elk. (See the region Environmental Services Office and the Roadside Manual concerning wildlife management.) Metal fencing can interfere with airport traffic control radar. When locating fencing in the vicinity of an airport, contact the Federal Aviation Administration to determine whether metal fence will create radar interference at the airport. If so, use nonmetallic fencing. Do not straddle or obstruct surveying monuments with any type of fencing.

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800.03 Hydraulic Considerations

(2) Stream Crossings

When rivers, streams, or surface waters (wetland) are crossed with bridges or culverts (including open-bottom arches and three-sided box culverts), consider:

• Locating the crossing where the stream is most stable.

• Effectively conveying the design flow(s) at the crossing.

• Providing for passage of material transported by the stream.

• The effects of backwater on adjacent property.

• Avoiding large skews at the crossing.

• The effects on the channel and embankment stability upstream and downstream from the crossing

• Location of confluences with other streams or rivers.

• Fish and wildlife migration.

• Minimizing disturbance to the original streambed.

• Minimizing wetland impact.

For further design details, see the Hydraulics Manual.

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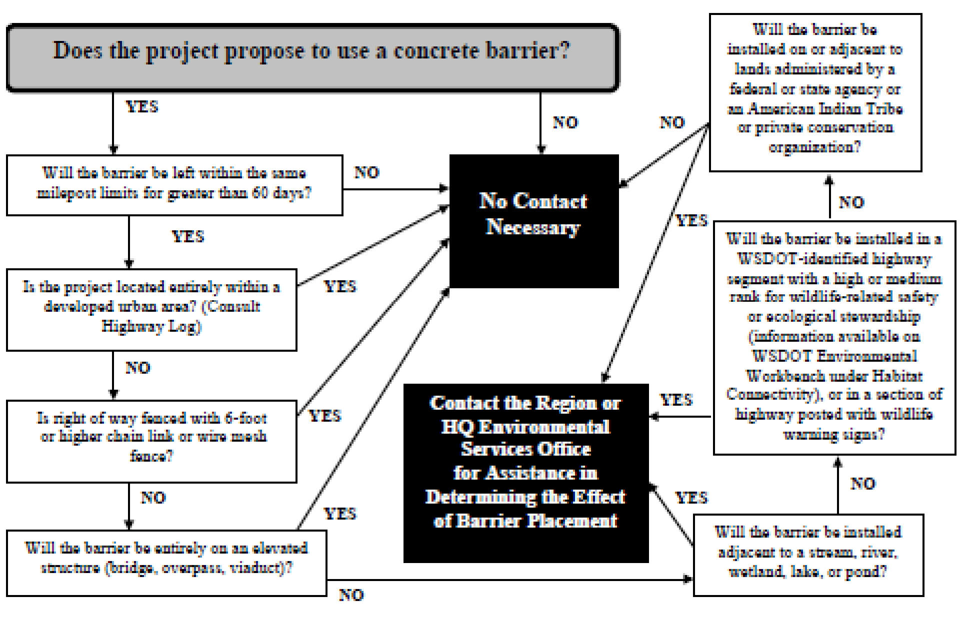
1610.02(2) Assessing Impacts to Wildlife The placement of concrete barriers in locations where wildlife frequently cross the highway can influence wildlife-vehicle crash potential. When wildlife encounters physical barriers that are difficult to see beyond or cross, such as concrete barriers, they often stop or move parallel to those barriers, increasing their time on the highway and their exposure. Traffic-related wildlife mortality may play a role in the decline of some species listed under the Endangered Species Act. To address wildlife concerns, see Exhibit 1610-1 to assess whether barrier placement needs to have an evaluation by the HQ Environmental Services Office to determine its effect on wildlife. Conduct this evaluation early in the project development process to allow adequate time for discussion of options.

Exhibit 1610-1 Concrete Barrier Placement Guidance: Assessing Impacts to Wildlife



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1610.06 Concrete Barrier

Concrete barriers are identified as either rigid, rigid anchored, or unrestrained rigid systems. They are commonly used in medians and as shoulder barriers. These systems are stiffer than beam guardrail or cable barrier, and impacts with these barriers tend to be more severe. Consider the following when installing concrete barriers:

For slopes 10H:1V or flatter, concrete barrier can be used anywhere outside of the shoulder.

Do not use concrete barrier at locations where the foreslope into the face of the barrier is steeper than 10H:1V.

Light standards mounted on top of precast concrete median barrier must not have breakaway features. (See the concrete barrier light standard section in the

Standard Plans.)

When considering concrete barrier use in areas where drainage and environmental issues (such as stormwater, wildlife, or endangered species) might be adversely impacted, contact the HQ Hydraulics Office and/or the appropriate environmental offices for guidance. Also, refer to 1610.02

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1710.05

Location, Access, and Site Design

(15) Vegetation

Vegetation enhances the physical environment by providing shade, shelter from wind, visual screening, wildlife habitat, and other benefits. Landscape Architects engaged in the project employ designs that emphasize low-maintenance practices and obstacle-free lawns, and minimize water usage for irrigation and impacts to existing native vegetation where practicable.

Construction Manual

https://www.wsdot.wa.gov/publications/manuals/fulltext/M41-01/Construction.pdf

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1-05 Control of Work

SS 1-05.1 Authority of the Engineer

The Revised Code of Washington (RCW 47.01.300 and 47.85.030) requires that projects with environmental considerations be reviewed during the preconstruction meetings held with the contractor. The *Memorandum of Agreement Concerning Implementation of Fish and Wildlife Hydraulic Code for Transportation Activities* requires WSDOT to invite the Area Habitat Biologist for the Washington State Department of Fish and Wildlife to all environmental preconstruction meetings. More information about discussing environmental topics at the preconstruction meeting is found in the Chapter 610 of the *Environmental Manual*. A procedure is available (PRO610-b) to help the Project Engineer prepare environmental topics to discuss at the preconstruction meeting. Verification of the Contractor's Certified Erosion and Sediment Control Lead (CESCL) is required when the project has obtained a NPDES Construction Stormwater General Permit. A procedure is available (PRO610-c) that allows the Project Engineer to verify the Contractor's CESCL credentials are valid.

All information exchanged should be documented in the project records, by formal meeting minutes, by file copies of letters, or by diary entries.

The nature, amounts, and methods of communication with the Contractor are left to the Project Engineer.

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9-4.90 Miscellaneous Steel Structures (Cattle Guards, Handrail, Retrofit Guardrail Posts With Welded Base Plate, Seismic Retrofit Earthquake Restrainers, Column Jackets)

1. **Approval of Material** – Approval of the Fabricator is required prior to the start of fabrication. The Fabricator will be approved by the *Qualified Products List* or Request for Approval of Material DOT Form 350-071. Be certain to verify that the product is in fact qualified for its intended use and the product is listed under the appropriate specification. Materials used within the fabricated item do not require approval through the Project Engineer office. Provide the WSDOT Materials Fabrication Inspection Office with a copy of the Qualified Products Page or Request for Approval of Material listing the Fabricator. Review of the Contract Special Provisions is necessary to determine if special qualifications or testing is required for approval of the fabricator.

2. **Preliminary Samples** – A preliminary sample of the material will be required only if coded on the Request for Approval of Material DOT Form 350-071.

3. **Acceptance** – Acceptance is based on "APPROVED FOR SHIPMENT" Stamp and/ or Tag (Figure 9-4 or 9-5). An "F" or "D" will be stamped to indicate the steel or iron is of foreign or domestic origin.

4. **Field Inspection** – Field verify per Section 9-1.5. Check for "APPROVED FOR SHIPMENT" Stamp and/or Tag (Figure 9-4 or 9-5) and the "F" or "D" Stamp for foreign or domestic steel and document it. Check for damage caused by shipping and handling.

5. **Specification Requirements** – See *Standard Specifications* Section 6-03. Review contract documents to determine if supplemental specifications apply.

6. **Other Requirements** – Certification of Material Origin will be the responsibility of the Materials Fabrication Inspector as defined in Section 9-2.1A.

For projects with the Buy America provision refer to Section 9-1.2E to determine if Certification of Materials Origin is required. If the Buy America requirement applies, the Contractor is required to submit to the Project Engineer a Certification of Materials Origin all foreign steel or iron materials. The Project Engineer will track the quantity of the materials and retain these documents in the project records.

Bridge Architect

Fish Passage Aesthetics Guidance

http://www.wsdot.wa.gov/publications/fulltext/Bridge/Fish_Passage.pdf

Found a passage enhancement toolbox for improvement permeability of existing structures for terrestrial wildlife.

http://www.wsdot.wa.gov/NR/rdonlyres/AECC63E5-76FA-411B-9B28-15E1FB9388EF/0/PassageEnhanceToolbox.pdf

Wildlife Management – under maintenance

RRMP endangered species guidelines

http://www.wsdot.wa.gov/Maintenance/Roadside/Esa.htm

WSDOT Best Management Practices Field Guide for ESA § 4 (d) Habitat Protection (pdf 368 kb)

- This guide is intended for WSDOT maintenance crews and regional maintenance environmental coordinators who work within sensitive priority areas (red). The guide was developed to train and alert staff as to when and where to apply and report implementation of the Regional Road Maintenance Endangered Species Act (ESA) Program Guidelines (RRMP) Best Management Practices.

Wildlife migration across highways

The link to this manual is dead.

Fish passage

http://www.wsdot.wa.gov/Projects/FishPassage/default.htm

E.14 Wisconsin

Highway Maintenance Manual, Chapter 07 Roadside Management, Section 15 Wildlife, Section 05 wildlife crossings and barriers.

http://wisconsindot.gov/Documents/doing-bus/local-gov/hwy-mnt/mntc-manual/chapter07/07-15-05.pdf

http://wisconsindot.gov/Pages/doing-bus/local-gov/hwy-mnt/mntc-manual/chapter07.aspx

Section 01 carcass removal.

Section 05 wildlife crossings and barriers

Section 10 Karner blue butterfly accommodations

Section 15 animal and inspect pest control.

Facilities Development Manual, Chapter 24 land and water reduces impacts

Section 15 wildlife.

http://wisconsindot.gov/rdwy/fdm/fd-24-15.pdf

Develop an asset management tool for collecting and tracking commitments on selected environmental mitigation features, September 2009.

http://wisconsindot.gov/documents2/research/08-25assetmgmtenvmitigation-f.pdf

Appendix F. Motorcycle-Animal Collision Hot Spots

Given that motorcyclists make up over half of deaths due to AVCs each year in Texas, researchers further investigated occurrences involving motorcyclists. The results of that investigation are displayed in Figures F.1 through F.4 to indicate problem areas for those drivers who are most at risk for fatal and severely injurious collisions.

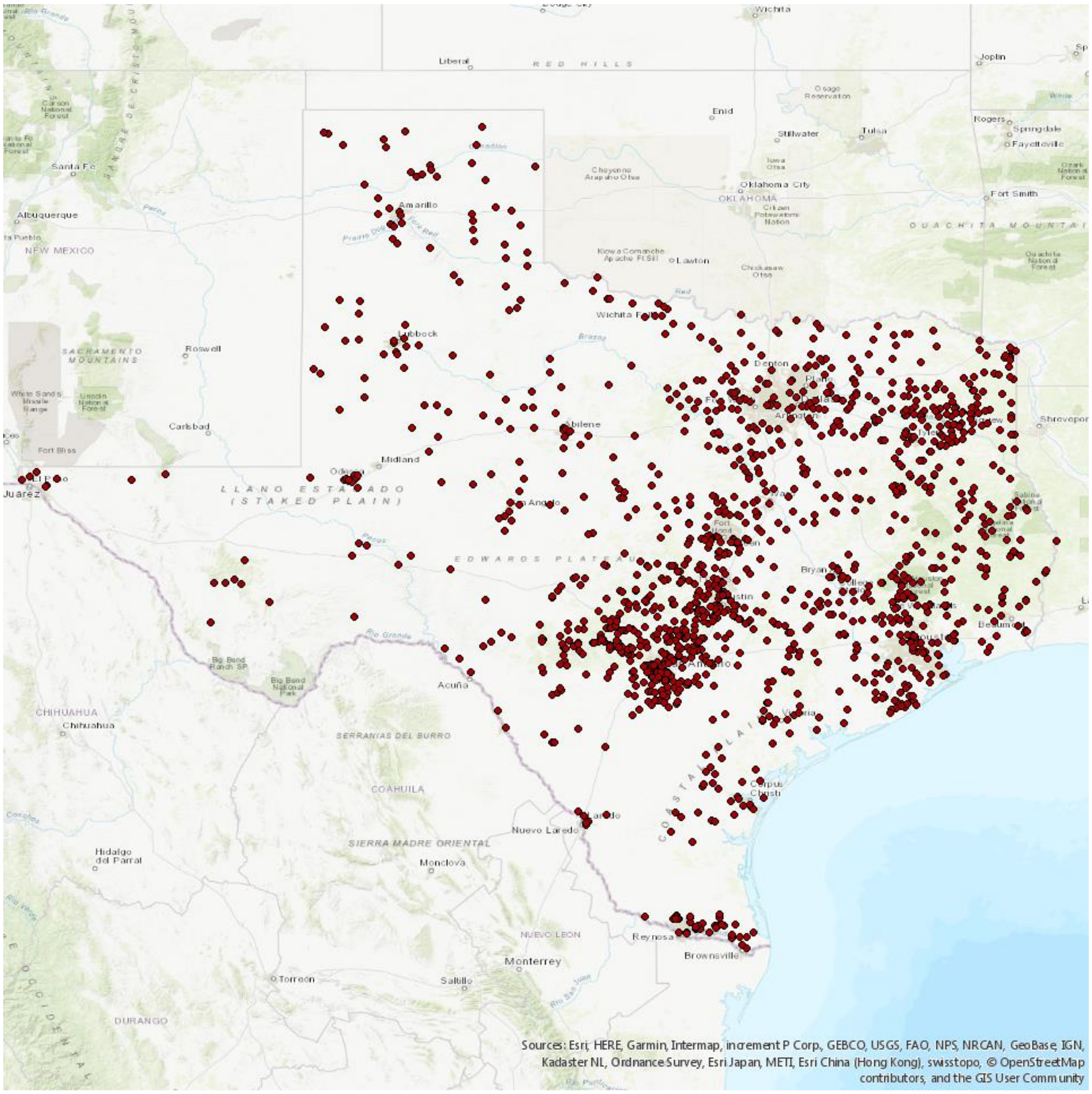

Figure F.1: All CRIS AVCs Involving Motorcycles 2010–2016 (n=1399 AVCs[1])

[1] Note: n=113 CRIS AVCs with motorcyclists do not specify animal type (wild or domestic), but they are shown here.

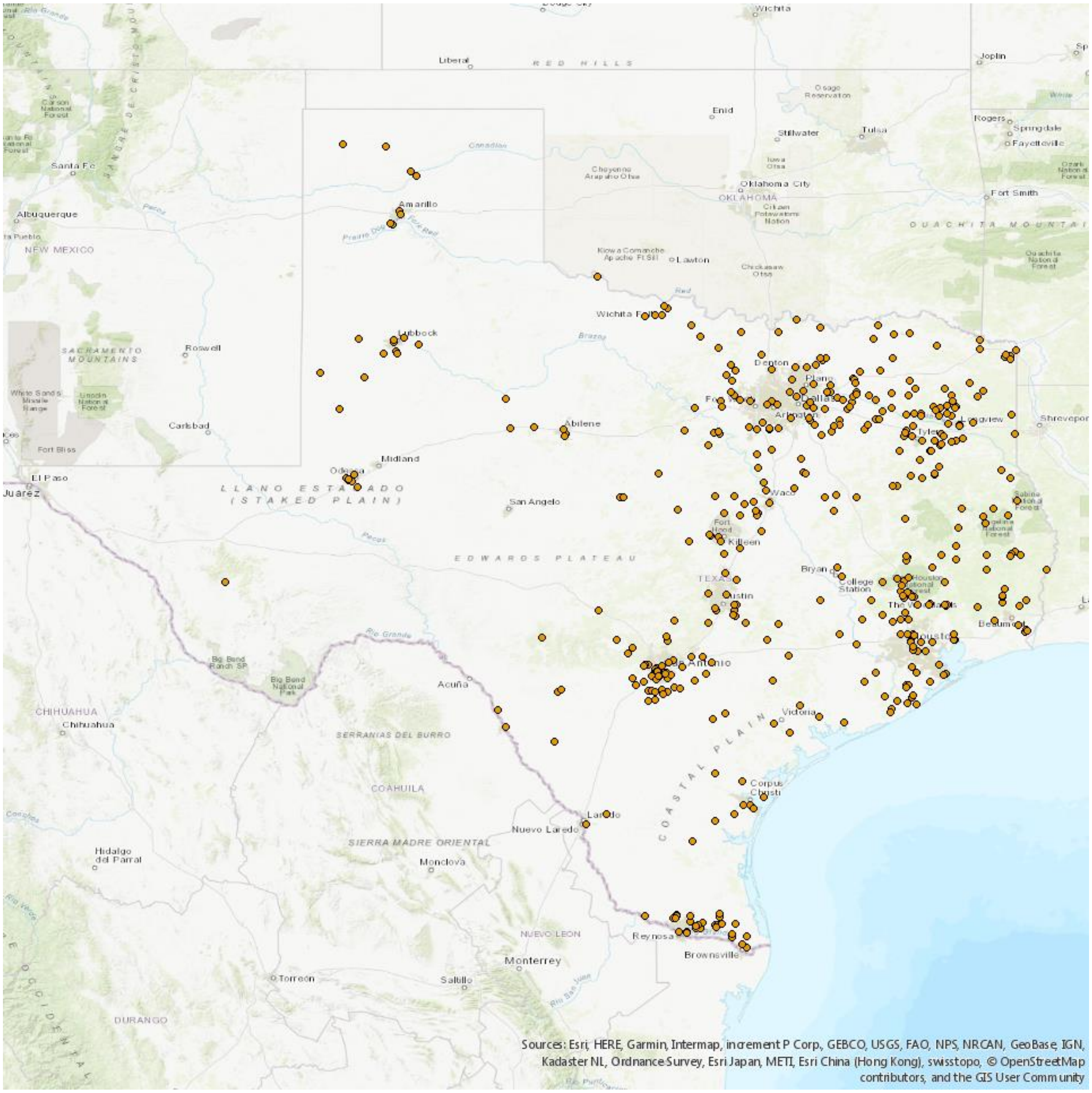

Figure F.2: All CRIS-reported Collisions of Motorcycles with Domestic Animals 2010–2016 (n=444 AVCs)

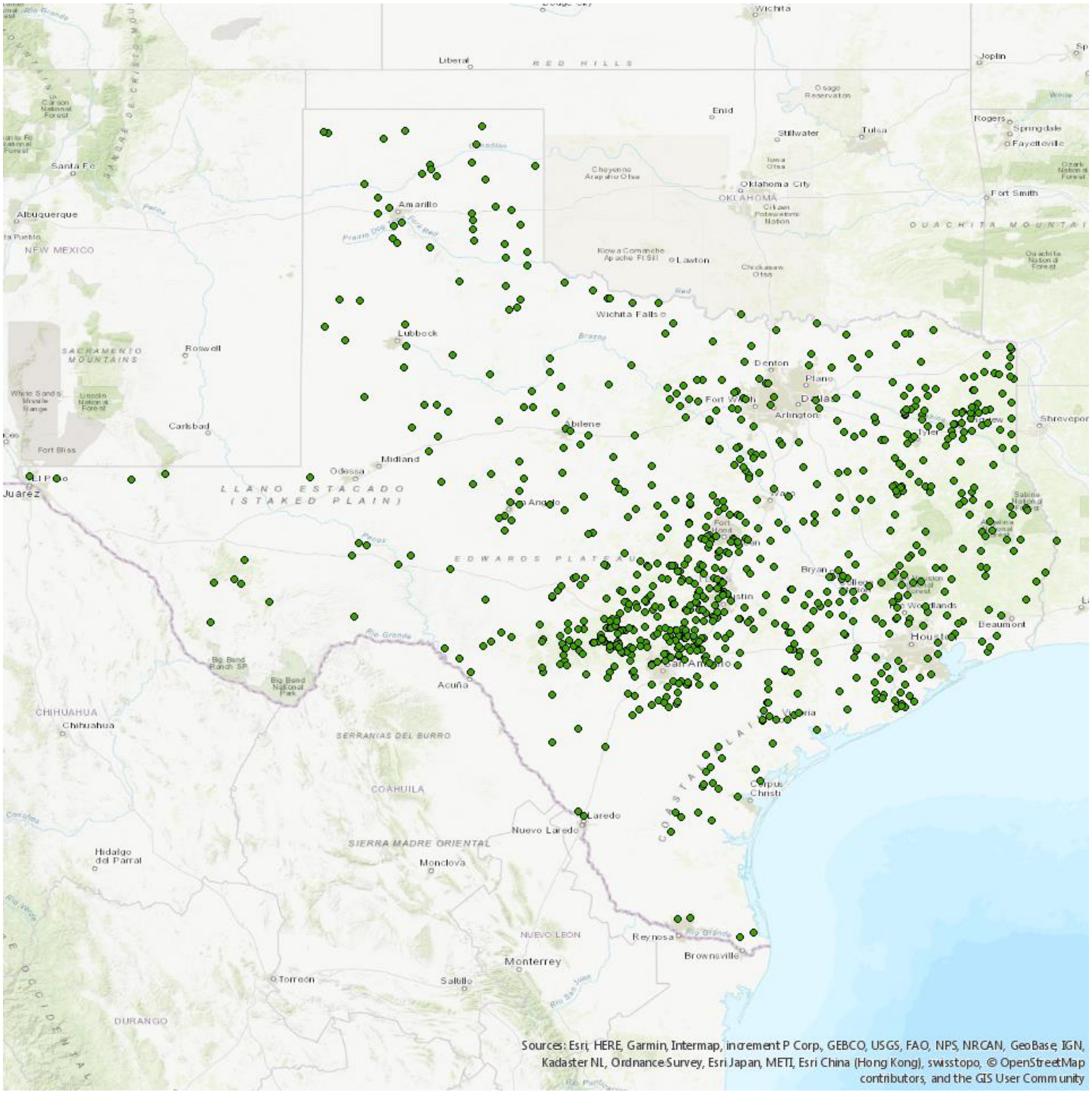

Figure F.3: All CRIS-reported Collisions of Motorcycles with Wild Animals 2010–2016 (n=842 AVCs)

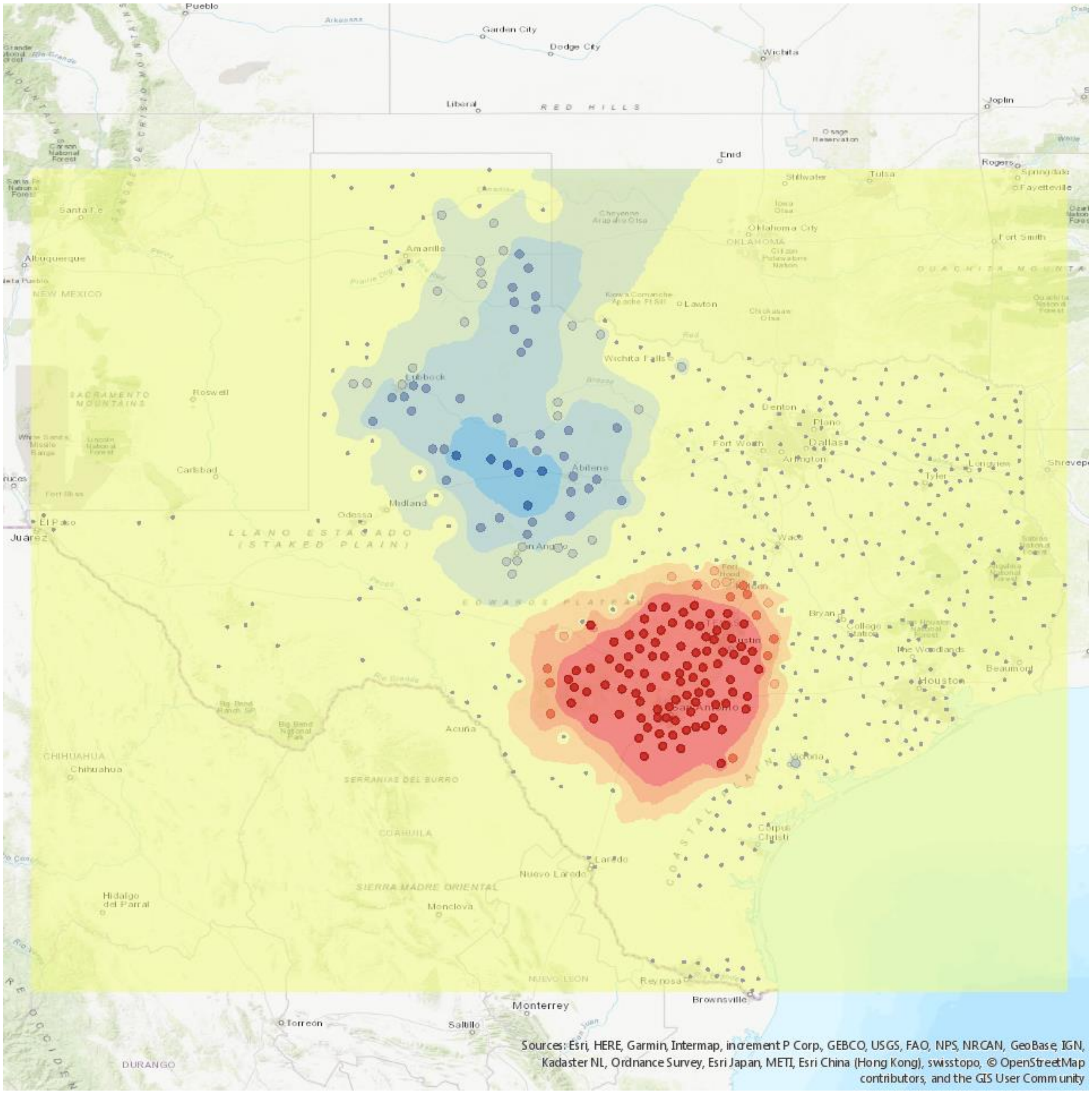

Figure F.4: All CRIS-reported Collisions of Motorcycles with Animals 2010–2016 (optimized hot-spot map)

Appendix G. Benefit-Cost Analysis Results

Table G.1 Network Segments with Highest Benefit-Cost Ratios for Wildlife Fencing + Overpass Structures[2]

LINK_ID	HWY System	From Reference Marker #	To Reference Marker #	Length of Section	K crash	A crash	B crash	C crash	O crash	Total crash	BCR
58552*	**SH**	**544**	**546**	**1.392**	**1**	**1**	**1**	**0**	**3**	**6**	**2.829719**
60344*	SH	548	548	0.73	0	2	0	0	1	3	2.596011
15242	FM	510	510	0.314	1	1	0	0	0	2	2.555084
14122	FM	530	534	2.037	0	2	0	0	1	3	2.548857
33238	FM	668	670	2.006	0	1	0	3	9	13	1.960563
69130	SH	656	658	1.759	0	1	1	0	6	8	1.674958
61292	SH	672	674	1.629	0	1	1	0	5	7	1.634031
38663	FM	708	708	1.475	0	1	1	0	4	6	1.593104
68923*	SH	194	194	1.227	1	0	1	0	4	6	1.593104
82065	SL	516	516	1.457	0	1	0	0	7	8	1.564029
80978	SH	336	338	1.429	0	1	1	0	3	5	1.552177
84552	US	648	650	1.85	0	1	0	1	4	6	1.548103
46263	FM	484	486	1.278	0	1	0	0	6	7	1.523103
68820	SH	774	776	1.772	0	1	0	0	6	7	1.523103
100785	US	176	178	1.767	0	1	0	0	6	7	1.523103
34645*	FM	390	390	0.82	0	1	1	0	2	4	1.51125
57511*	SH	552	554	0.616	0	1	1	0	2	4	1.51125
62599	SH	550	550	1.857	0	1	0	0	5	6	1.482176

[2] Links with * are roadway segments that appear in the top 100 BCR counts for all mitigation strategies.

LINK_ID	HWY System	From Reference Marker #	To Reference Marker #	Length of Section	K crash	A crash	B crash	C crash	O crash	Total crash	BCR
64817*	SH	758	760	0.952	0	1	0	0	5	6	1.482176
66068	SH	640	644	1.848	0	1	0	0	5	6	1.482176
24941	FM	512	516	2.618	0	1	2	1	6	10	1.477209
12478	FM	200	202	1.926	0	1	1	0	1	3	1.470324
17668	FM	520	524	3.841	0	2	1	1	0	4	1.465136
59211	SH	724	724	1.153	0	1	1	0	0	3	1.455632
10126*	FM	544	546	0.555	0	1	0	0	4	5	1.441249
34947*	FM	674	674	0.832	0	1	0	0	4	5	1.441249
325782	FC	0	0	1.774	0	1	0	0	4	5	1.441249
54033	PR	472	474	1.988	0	1	1	0	0	2	1.429397
55539*	RM	464	464	0.318	1	0	1	0	0	2	1.429397
59258	SH	218	220	1.644	0	1	1	0	0	2	1.429397
72830*	SH	350	350	0.518	0	1	1	0	0	2	1.429397
29115*	FM	472	474	0.941	0	1	0	1	1	3	1.425323
64402*	SH	438	438	0.931	0	1	0	1	1	3	1.425323
102039	US	566	568	1.872	0	1	0	1	1	3	1.425323
23690	FM	592	594	1.675	1	0	0	0	3	4	1.400322
49327*	IH	289	290	1.052	0	1	0	0	3	4	1.400322
65419*	SH	282	282	1.022	0	1	0	0	3	4	1.400322
86968	US	660	660	0.679	0	1	0	0	3	4	1.400322
316409	FC	0	0	1.152	0	1	0	0	3	4	1.400322
20492	FM	446	448	2.05	0	1	0	1	1	3	1.390559
63497	SH	472	474	1.535	0	1	0	1	0	2	1.384396

LINK_ID	HWY System	From Reference Marker #	To Reference Marker #	Length of Section	K crash	A crash	B crash	C crash	O crash	Total crash	BCR
60037	SH	534	536	2.29	0	1	1	1	1	4	1.377448
7508	FM	478	480	1.822	0	1	0	0	2	3	1.359395
40595	FM	260	262	1.262	0	1	0	0	2	3	1.359395
46328*	FM	476	478	0.885	0	1	0	0	2	3	1.359395
56805*	SH	364	366	0.705	1	0	0	0	2	3	1.359395
62563*	SH	508	508	0.76	1	0	0	0	2	3	1.359395
67747	SH	446	446	1.546	0	1	0	0	2	3	1.359395
74560*	SH	68	68	0.186	1	0	0	0	2	3	1.359395
74606*	SH	62	64	1.063	0	1	0	0	2	3	1.359395
74843	SH	310	310	1.952	1	0	0	0	2	3	1.359395
77079*	SL	548	548	0.654	0	1	0	0	2	3	1.359395
80523*	SH	386	386	1.059	0	1	0	0	2	3	1.359395
81377*	SH	632	632	0.466	0	1	0	0	2	3	1.359395
82401	SL	728	730	1.263	0	1	0	0	2	3	1.359395
90100	US	280	280	1.479	0	1	0	0	2	3	1.359395
91313*	US	752	752	0.74	0	1	0	0	2	3	1.359395
91393	US	348	350	1.766	0	1	0	0	2	3	1.359395
92115*	US	772	772	0.638	0	1	0	0	2	3	1.359395
94957	US	580	582	1.976	0	1	0	0	2	3	1.359395
102817*	US	396	398	1.033	0	1	0	0	2	3	1.359395
83441	SL	436	438	2.428	0	1	1	0	5	7	1.345989
88724	US	412	414	1.875	1	0	0	0	1	3	1.344704
9496	FM	166	168	1.098	0	1	0	0	1	2	1.318469

LINK_ID	HWY System	From Reference Marker #	To Reference Marker #	Length of Section	K crash	A crash	B crash	C crash	O crash	Total crash	BCR
9697	FM	340	342	1.069	0	1	0	0	1	2	1.318469
11820*	FM	738	740	0.673	0	1	0	0	1	2	1.318469
12377	FM	500	502	1.31	0	1	0	0	1	2	1.318469
15688	FM	390	392	1.723	0	1	0	0	1	2	1.318469
17646	FM	520	522	1.195	0	1	0	0	1	2	1.318469
21174*	FM	584	584	0.428	0	1	0	0	1	2	1.318469
22164	FM	512	512	1.838	0	1	0	0	1	2	1.318469
27706	FM	160	164	1.692	0	1	0	0	1	2	1.318469
28330	FM	226	230	1.992	1	0	0	0	1	2	1.318469
30033	FM	416	418	1.468	0	1	0	0	1	2	1.318469
32329	FM	418	420	1.642	1	0	0	0	1	2	1.318469
32682*	FM	644	644	0.062	0	1	0	0	1	2	1.318469
32958*	FM	556	556	0.513	0	1	0	0	1	2	1.318469
37696	FM	692	692	1.614	0	1	0	0	1	2	1.318469
45403	FM	268	270	1.359	0	1	0	0	1	2	1.318469
47174*	FM	224	224	1.017	0	1	0	0	1	2	1.318469
51922*	IH	324	324	0.101	0	1	0	0	1	2	1.318469
56158	RM	494	494	1.387	0	1	0	0	1	2	1.318469
57111*	SH	204	204	0.55	0	1	0	0	1	2	1.318469
57196	SH	262	266	1.241	0	1	0	0	1	2	1.318469
57633*	SH	562	562	0.592	0	1	0	0	1	2	1.318469
60099*	SH	608	608	0.529	0	1	0	0	1	2	1.318469
63571*	SH	470	470	0.729	0	1	0	0	1	2	1.318469

LINK_ID	HWY System	From Reference Marker #	To Reference Marker #	Length of Section	K crash	A crash	B crash	C crash	O crash	Total crash	BCR
63880*	SH	316	316	0.638	0	1	0	0	1	2	1.318469
64389*	SH	596	598	0.487	1	0	0	0	1	2	1.318469
64666*	SH	502	502	0.183	0	1	0	0	1	2	1.318469
69230	SH	684	686	1.112	0	1	0	0	1	2	1.318469
69495	SH	734	736	1.473	0	1	0	0	1	2	1.318469
72540*	SH	320	334	0.817	0	1	0	0	1	2	1.318469
73866	SH	372	372	1.571	0	1	0	0	1	2	1.318469
74481	SH	148	150	1.609	0	1	0	0	1	2	1.318469
75435*	SH	550	550	0.351	0	1	0	0	1	2	1.318469
75654*	SH	660	660	0.272	0	1	0	0	1	2	1.318469
89857	US	578	580	1.367	0	1	0	0	1	2	1.318469
91619	US	516	518	1.913	0	1	0	0	1	2	1.318469
92539	US	550	550	0.38	0	1	0	0	1	2	1.318469

Table G.2 Network Segments with Highest Benefit-Cost Ratios for Wildlife Fencing + Underpass Structures

LINK_ID	HWY System	From Reference Marker #	To Reference Marker #	Segment Length	K crash	A crash	B crash	C crash	O crash	Total Crashes	BCR
60344	SH	548	548	0.73	0	2	0	0	1	3	2.97197
15242	FM	510	510	0.314	1	1	0	0	0	2	2.925116
58552	SH	544	546	1.392	1	1	1	0	3	6	2.327245
34645	FM	390	390	0.82	0	1	1	0	2	4	1.730113
57511	SH	552	554	0.616	0	1	1	0	2	4	1.730113
64817	SH	758	760	0.952	0	1	0	0	5	6	1.696827
10126	FM	544	546	0.555	0	1	0	0	4	5	1.649974
34947	FM	674	674	0.832	0	1	0	0	4	5	1.649974
55539	RM	464	464	0.318	1	0	1	0	0	2	1.636405
72830	SH	350	350	0.518	0	1	1	0	0	2	1.636405
29115	FM	472	474	0.941	0	1	0	1	1	3	1.631741
64402	SH	438	438	0.931	0	1	0	1	1	3	1.631741
86968	US	660	660	0.679	0	1	0	0	3	4	1.60312
65419	SH	282	282	1.022	0	1	0	0	3	4	1.56861
46328	FM	476	478	0.885	0	1	0	0	2	3	1.556266
56805	SH	364	366	0.705	1	0	0	0	2	3	1.556266
62563	SH	508	508	0.76	1	0	0	0	2	3	1.556266
74560	SH	68	68	0.186	1	0	0	0	2	3	1.556266
77079	SL	548	548	0.654	0	1	0	0	2	3	1.556266
81377	SH	632	632	0.466	0	1	0	0	2	3	1.556266
91313	US	752	752	0.74	0	1	0	0	2	3	1.556266
92115	US	772	772	0.638	0	1	0	0	2	3	1.556266

LINK_ID	HWY System	From Reference Marker #	To Reference Marker #	Segment Length	K crash	A crash	B crash	C crash	O crash	Total Crashes	BCR
49327	IH	289	290	1.052	0	1	0	0	3	4	1.523878
11820	FM	738	740	0.673	0	1	0	0	1	2	1.509412
21174	FM	584	584	0.428	0	1	0	0	1	2	1.509412
32682	FM	644	644	0.062	0	1	0	0	1	2	1.509412
32958	FM	556	556	0.513	0	1	0	0	1	2	1.509412
51922	IH	324	324	0.101	0	1	0	0	1	2	1.509412
57111	SH	204	204	0.55	0	1	0	0	1	2	1.509412
57633	SH	562	562	0.592	0	1	0	0	1	2	1.509412
60099	SH	608	608	0.529	0	1	0	0	1	2	1.509412
63571	SH	470	470	0.729	0	1	0	0	1	2	1.509412
63880	SH	316	316	0.638	0	1	0	0	1	2	1.509412
64389	SH	596	598	0.487	1	0	0	0	1	2	1.509412
64666	SH	502	502	0.183	0	1	0	0	1	2	1.509412
72540	SH	320	334	0.817	0	1	0	0	1	2	1.509412
75435	SH	550	550	0.351	0	1	0	0	1	2	1.509412
75654	SH	660	660	0.272	0	1	0	0	1	2	1.509412
92539	US	550	550	0.38	0	1	0	0	1	2	1.509412
102851	US	660	660	0.242	1	0	0	0	1	2	1.509412
103838	US	396	396	0.488	0	1	0	0	1	2	1.509412
102817	US	396	398	1.033	0	1	0	0	2	3	1.50655
68923	SH	194	194	1.227	1	0	1	0	4	6	1.486406
47174	FM	224	224	1.017	0	1	0	0	1	2	1.484181
80523	SH	386	386	1.059	0	1	0	0	2	3	1.469562

LINK_ID	HWY System	From Reference Marker #	To Reference Marker #	Segment Length	K crash	A crash	B crash	C crash	O crash	Total Crashes	BCR
74606	SH	62	64	1.063	0	1	0	0	2	3	1.464032
6411	BU	424	424	0.77	1	0	0	0	0	1	1.462558
10451	FM	596	596	0.441	1	0	0	0	0	1	1.462558
11990	FM	250	250	0.752	0	1	0	0	0	1	1.462558
12047	FM	604	604	0.614	0	1	0	0	0	1	1.462558
12388	FM	686	686	0.882	0	1	0	0	0	1	1.462558
14789	FM	400	400	0.048	0	1	0	0	0	1	1.462558
18362	FM	188	188	0.522	0	1	0	0	0	1	1.462558
18475	FM	538	540	0.351	0	1	0	0	0	1	1.462558
19865	FM	584	584	0.472	0	1	0	0	0	1	1.462558
20474	FM	542	542	0.47	1	0	0	0	0	1	1.462558
23578	FM	720	720	0.437	0	1	0	0	0	1	1.462558
26084	FM	226	226	0.576	0	1	0	0	0	1	1.462558
26399	FM	716	716	0.29	0	1	0	0	0	1	1.462558
26522	FM	544	544	0.08	0	1	0	0	0	1	1.462558
28626	FM	660	660	0.677	0	1	0	0	0	1	1.462558
29475	FM	384	384	0.224	1	0	0	0	0	1	1.462558
30686	FM	568	568	0.341	0	1	0	0	0	1	1.462558
31235	FM	372	374	0.299	1	0	0	0	0	1	1.462558
31340	FM	492	492	0.183	0	1	0	0	0	1	1.462558
31569	FM	654	654	0.853	0	1	0	0	0	1	1.462558
31807	FM	406	406	0.92	0	1	0	0	0	1	1.462558
33008	FM	454	454	0.135	0	1	0	0	0	1	1.462558

LINK_ID	HWY System	From Reference Marker #	To Reference Marker #	Segment Length	K crash	A crash	B crash	C crash	O crash	Total Crashes	BCR
38984	FM	378	380	0.724	1	0	0	0	0	1	1.462558
39031	FM	266	266	0.724	0	1	0	0	0	1	1.462558
39394	FM	272	272	0.355	0	1	0	0	0	1	1.462558
39725	FM	722	724	0.777	0	1	0	0	0	1	1.462558
40550	FM	684	686	0.467	0	1	0	0	0	1	1.462558
40773	FM	700	700	0.612	0	1	0	0	0	1	1.462558
40779	FM	290	292	0.901	0	1	0	0	0	1	1.462558
42924	FM	636	636	0.341	1	0	0	0	0	1	1.462558
44515	FM	384	384	0.229	0	1	0	0	0	1	1.462558
45537	FM	386	386	0.849	0	1	0	0	0	1	1.462558
47973	IH	291	292	0.978	0	1	0	0	0	1	1.462558
48108	IH	7	7	0.088	0	1	0	0	0	1	1.462558
49009	IH	531	531	0.581	0	1	0	0	0	1	1.462558
53904	RM	420	420	0.113	0	1	0	0	0	1	1.462558
54237	RM	464	464	0.11	0	1	0	0	0	1	1.462558
55601	RM	70	70	0.21	0	1	0	0	0	1	1.462558
56496	SH	434	434	0.04	0	1	0	0	0	1	1.462558
61300	SH	524	526	0.786	1	0	0	0	0	1	1.462558
61620	SH	634	634	0.385	0	1	0	0	0	1	1.462558
62151	SH	296	296	0.783	0	1	0	0	0	1	1.462558
62974	SH	446	446	0.437	0	1	0	0	0	1	1.462558
63114	SH	472	472	0.082	0	1	0	0	0	1	1.462558
63525	SH	470	472	0.43	1	0	0	0	0	1	1.462558

LINK_ID	HWY System	From Reference Marker #	To Reference Marker #	Segment Length	K crash	A crash	B crash	C crash	O crash	Total Crashes	BCR
63895	SH	458	458	0.269	0	1	0	0	0	1	1.462558
64042	SH	42	42	0.022	0	1	0	0	0	1	1.462558
65974	SH	796	799	0.917	1	0	0	0	0	1	1.462558
65980	SH	206	206	0.793	0	1	0	0	0	1	1.462558
72541	SH	462	462	0.925	0	1	0	0	0	1	1.462558
74596	SH	566	566	0.36	1	0	0	0	0	1	1.462558
76162	SH	286	288	0.658	0	1	0	0	0	1	1.462558
78390	SH	386	386	0.223	1	0	0	0	0	1	1.462558
80419	SH	386	386	0.317	0	1	0	0	0	1	1.462558

Appendix H. Field Trip to Pharr District

The research team members visited Pharr District Office on July 10, 2018, to learn more about their experience building wildlife crossing structures. The research team met with Robin Gelston, Environmental Supervisor; Romualdo Mena, Transportation Engineering Supervisor; and Homer Bazan, Jr., Director of Transportation Planning and Development from the Pharr District.

H.1 Notes from the Field Trip

There is one bridge crossing on SH 48 that the USFWS has determined to be successful, used by over 200 bobcats. However, no ocelots have been documented. Figures H.1 through H.3 provide site photos.

Figure H.1: Photo from on Top of the Bridge Crossing on SH 48, Looking Southwest

Figure H.2: Photo Taken by P. Cramer under US 48 of the Ocelot Crossing Bridge Structure.

Figure H.3: Photo Taken under SH48 by USFWS Cameras on 4/21/2013 of a Bobcat, Using the SH48 Crossing

While on the field trip on SH 100 we saw that five different species of animals had used the wildlife crossing early that day. Figure H.4 shows the tracks, highlighted with blue arrows. Figures H.5 and H.6 show the tracks closer up.

Figure H.4: Animals Using SH100 Crossing; Photo Taken by L. Loftus-Otway


Figure H.5: Animals Using SH100 Crossing; Photo Taken by L. Loftus-Otway

Figure H.6: Animals Using SH100 Crossing; Photo Taken by L. Loftus-Otway

The research team asked about the maintenance of vegetation at the structure entrances. TxDOT is responsible for vegetation control and fence maintenance. TxDOT developed a re-vegetation plan in 2011 with the support of USFWS to regrade the wildlife crossing and replant native plants near the entrance. In 2011, with the assistance of USFWS and the Gorgas Science Society from UTB, 250 native plants (9 different species) were planted.

Box culverts with ledges (TxDOT calls these *steps*), box culverts typically range from 3 by 4 feet to 8 by 5 feet with steps are approximately 1 to 2 feet in height and approximately 1.5 to 2 feet wide. Box culverts get a big as 10 ft by 10 ft; however, at that size they typically do not have steps.

These box culvert work in areas where drainage occurs on a regular basis. This allows water flow through the main channel, and these steps allow wildlife movement through the structures during those times.

On FM 106 from FM 1847 to FM 510, eight box culvert crossings are being constructed. Construction should be completed by December 2018. Dimensions of these wildlife crossing vary, from 8 ft by 5 ft to 5 ft x 5 ft. There are five different design sizes. Figures H.7 through H.11 provide site photos.

Figure H.7: Crossing on FM 106 at Ted Hunt Drainage Ditch

Figure H.8: Photo of FM100 Wildlife Crossing Box Culvert (with Ledges Increasing Access for Animals to Structure)

Figure H.9: FM106 Second Structure with Slightly Different Ramp Design (Note: small alligator was seen here.)

Figure H.10: Terrestrial Box Culvert for Ocelot and Other Species, SH100

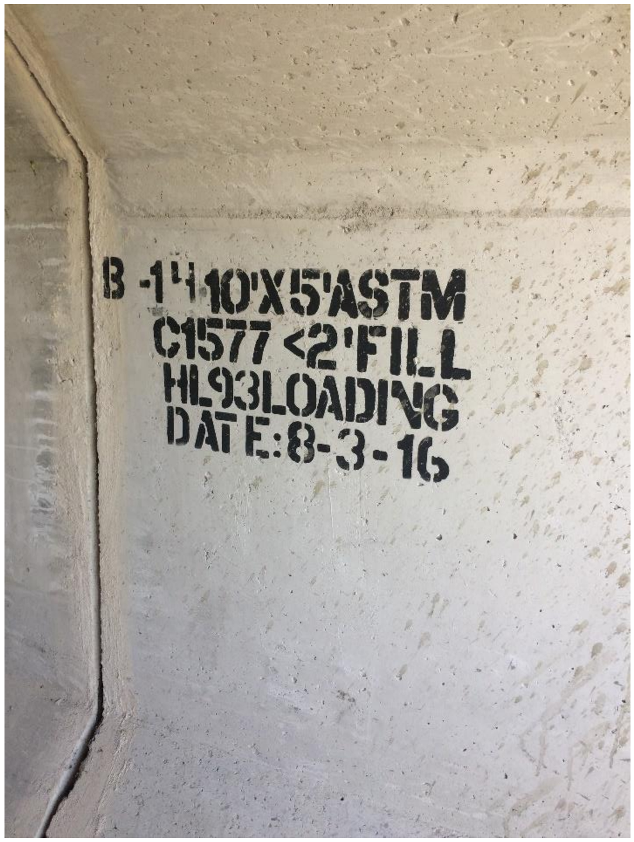

Figure H.11: Original Measurements of 10'x5' box culvert

On SH 100 three crossing structures were installed in the early 1990s—mostly reinforced concert pipe (RCP) culverts. USFWS said these did not work. These have been replaced by 10 x 10 box culverts with specially designed steps and walkways. Two culverts are on drainage ditches. These are natural travel corridors. Two ocelots were killed at one of the drainage ditches previously.

One wildlife crossing structure is on USFWS refuge land. It is a 6 ft high bridge, and 3 feet of this is below the natural surface grade, which means material was excavated to ensure the bridge height of 6 feet (Robin Gelston colloquially calls this a *half bridge*). Figure H.12 provides the bridge schematic and Figures H.13 through H.15 provide additional photos. Articulated mats were placed as the abutment instead of concrete riprap in order to place a 3-foot-wide step halfway the embankment. The contractors indicated they like working with this material.

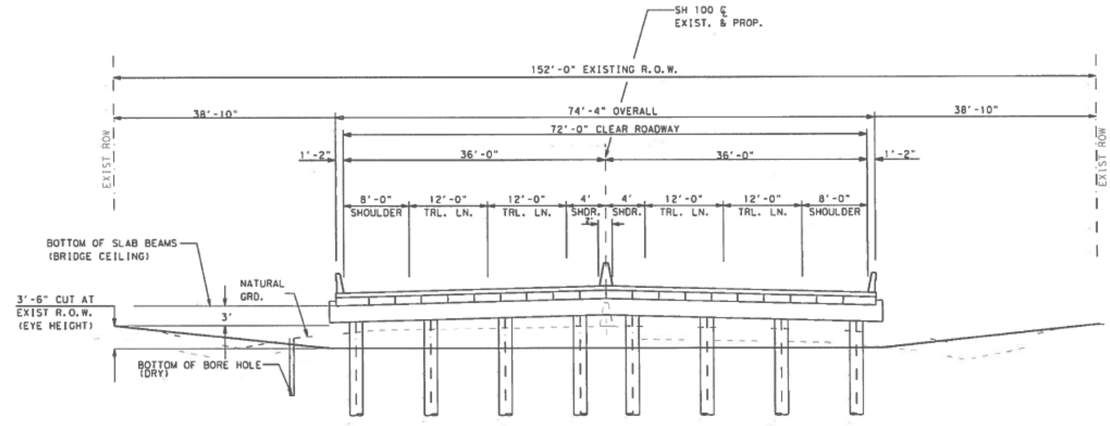

Figure H.12: Schematic of Crossing

Figure H.13: Wildlife Crossing #3 "Half Bridge" Under Construction

Figure H.14: Half Bridge with the Articulated Mat being placed on SH 100.

Figure H.15: SH100 Bridge for Wildlife, with Students Checking Cameras on Opposite Side, after a flood event

Box culverts with steps are customized designs and require special specifications. This design process is required every time and is undertaken by the Design Division; this process does add extra time (a few months) to the construction timeline.

Research Team Suggestion: Formalize the design for the box culverts with steps used for the Pharr District by using the design as an example in the TxDOT manuals. Standardize them so that such structures will not require the special specification process each time.

Figure H.16 provides a photo of the culver while Figure H.17 relays the diagram (not to size).

Figure H.16: Wildlife Crossing #2 on SH 100 with Step and Ramp and vegetation planted on the banks

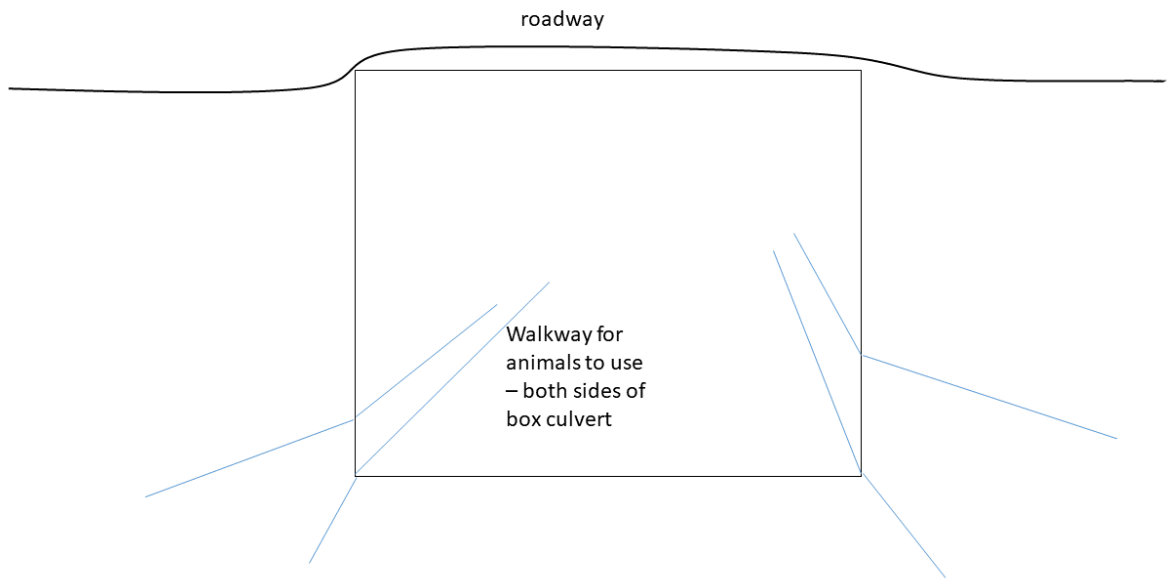

Figure H.17: Drawing of Culvert (not to scale)

Sizes of box culverts with step/ledge

8 x 5	5 x 5	6 x 8	6 x 5
7 x 7	10 x 10	10 x 7	10 x 5

One issue that Pharr had to contend was the elevation of the road, as the area is generally very flat, and the drivers expect that the roadway will be flat also, with a smooth surface. The greater the elevation of the box, the greater the cost of the project. This is just one factor to consider during the design process.

Box culverts at grade or below grade need a ramp to allow wildlife to get to and from the step/ledge. Pharr District has done this. Originally, these were done under change orders in the field. The step/ledge is now a standard practice for them as they have specifications for this. The step/ledge is 1.5 to 2 ft wide.

Research Team Suggestion: Make this part of specification so you don't have to do a change order. Pharr can supply these specifications to any other districts.

The SH 48 bridge crossing as well as the wildlife crossing structures on SH 106 are fenced (Figure H.18). USFWS requested an additional 500 ft of fencing along the north side of SH 48 and additional vegetation. TxDOT entered into an agreement to purchase the fencing and the vegetation as long as USFWS would be responsible for the planting of the vegetation. TxDOT designed the vegetation plan and there are over 250 plants consisting of 9 different native species in front of this crossing. SH 48 was deemed successful by USFW in 2012. However, for a rare species it is extremely difficult to determine if the crossing is successful from a performance measure standard.

Figure H.18: SH 48 Ocelot Crossing Structure with Chain Link Fence and Guard Rail

The FM 106 crossings begin at CR 1847. Wildlife crossings structures at Unit 1 and 2 are both 8 ft high but due to the proximity to each other, fill was placed between the two crossings so there would not be a significant dip (roller coaster effect) in the roadway.

H.2 Major Takeaways from Interviews with Pharr District Staff

The research team discussed with Robin Gelston, Romualdo Mena, and Homer Bazan, Jr., how wildlife crossing structures are planned, designed, and constructed in the Pharr District; what lessons the staff have learned, and what experience they can share with others. The major takeaways from this meeting are summarized here.

1. Collaboration is essential.

To build wildlife crossing structures and make them successful, internal collaboration among different sections within the TxDOT Districts and external collaboration with other agencies (such as USFWS and regional drainage/irrigation districts) are essential. For example, while the TxDOT environmental staff determines the type of species to target and the location, size, and configuration of the wildlife crossing structure, designers need to look at topography, access, and driveway issues to ensure grades and sight distances meet safety and roadway standards. Sometime the size and the location of the wildlife crossing structure must be changed to meet roadway and safety standards. Thus, having staff from other sections understand the importance of these structures and support the implementation of these mitigation strategies is crucial.

2. Good public relations and education create public support.

According to the experience from the Pharr District, even the engineer and planner have had doubts about building/retrofitting structures for animals. However, once they started implementing these specialized structures and saw the glowing news reports, they felt proud. Because of the good press and heightened education on these issues, public acceptance of constructed wildlife crossings has increased. Those structures have grown in popularity as the tangible benefits have swayed public perception. Promoting wildlife preservation as an eco-tourism element can also help improve public acceptance, as tourism activities support local economies. Social media should be used to showcase the successful results.

3. Incorporating some of the designs into manuals can expedite the whole process.

Integrating wildlife crossing considerations into the designing process can be a time-consuming and lengthy procedure, as the structures and associated elements have to be approved as special specifications. For example, the migratory bird exclusion devices for bridges had to be approved by the Environmental Affairs, Design, and Construction divisions and by the FHWA. Approval can take up to 12 months. If these mitigation designs are made part of design standards, obviating the request for special specifications, the whole process can be expedited significantly.

4. Dedicated funding sources are needed to monitor the performance of the structures.

Pre- and post-construction monitoring of animal crossings are critical to the success of the structures. Necessary adjustment can be made to increase the success rate of certain structures. This monitoring is also required by the USFWS. However, currently, the funding for those monitoring cameras comes out of district discretionary funds—ideally; those costs would be covered by a division budget (most likely ENV).

5. Dedicated funds for environmental mitigation issues can be helpful.

Currently, wildlife crossing structure funds come out of construction budget after the petition for that funding is granted by the Transportation Commission. Transportation projects typically originate during the planning process at the MPOs, which typically consider only added capacity or safety roadway projects; there is no dedicated fund for environmental mitigation issues. An extra category under Category 8 funding for safety that is separated from the MPO process would be ideal to fund these structures. It might be even more effective if wildlife crossings were in the planning and design manual and a separate funding source was available to help retrofit existing roadways that pose a wildlife connectivity issue. The special fund could also be used for other type of mitigation issues such as wetlands (which cannot be done under the construction project) or extended monitoring period.

6. The need of and details on planning for, building, and maintaining wildlife crossing structures can be imbedded into multiple stages to smooth the entire process.

Wildlife mitigation considerations should be incorporated into following stages/processes/manuals:

- Roadway Design Manual
- Bridge Design Manual
- Project development – start early in the process
- Design summary report
- Identification of hot spots on travel corridors for crossings