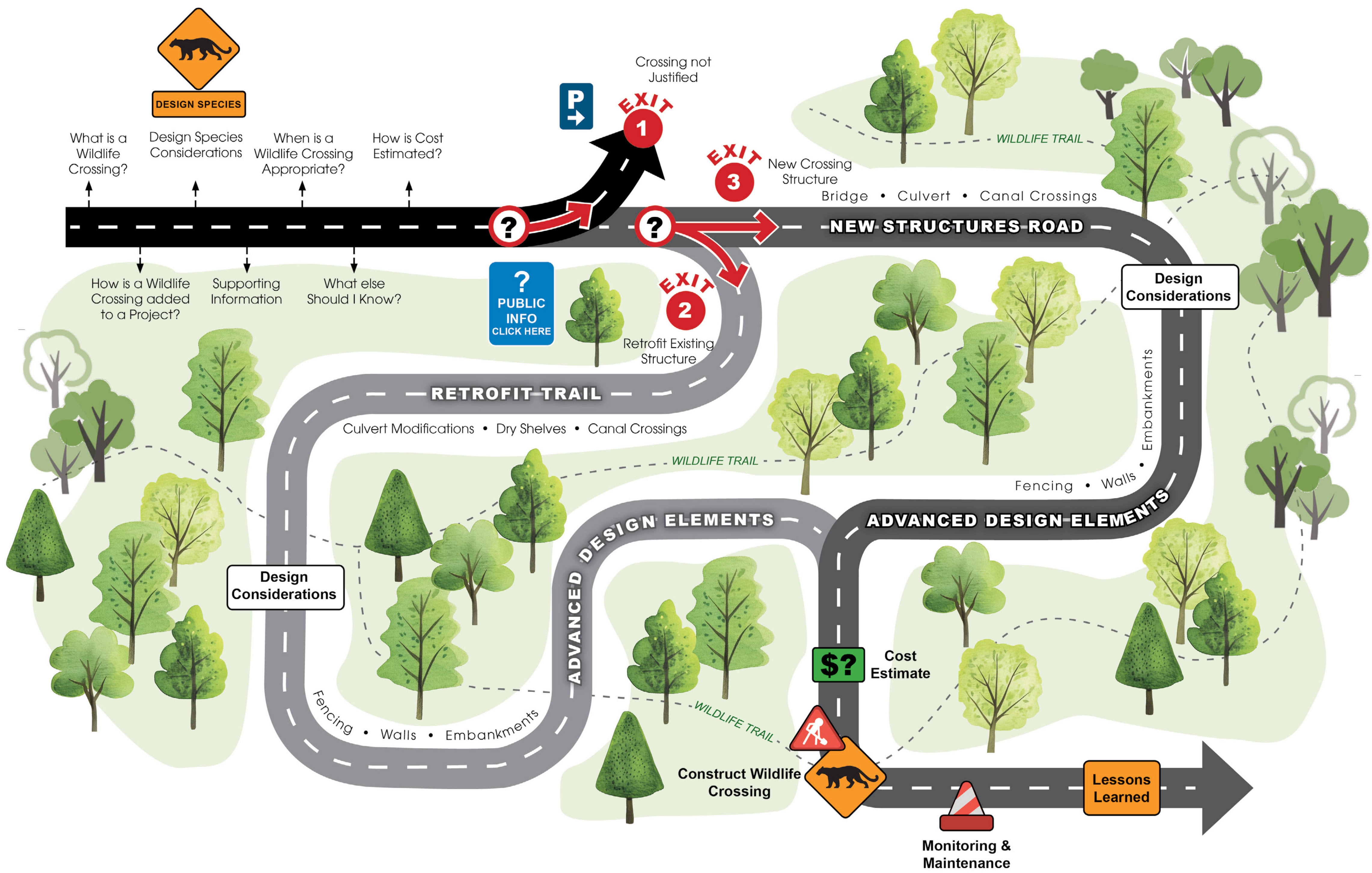
A ROAD MAP TO WILDLIFE CROSSING DEVELOPMENT



What is a Wildlife Crossing?

BACK TO ROADMAP

A wildlife crossing represents a combined transportation/landscape design element that connects two or more wildlife habitat corridors. The crossing functions as a conduit for wildlife to pass beneath or over roads, waters, and other barriers to their movement. Crossing designs protect Florida panthers and other critical wildlife habitat corridor connections, reduce motor vehicle collisions with wildlife, reduce the likelihood of injuries and mortalities to humans and wildlife from such collisions, and reduce subsequent damage to motor vehicles from such collisions.

Wildlife crossing designs account for site-specific requirements and limitations, and they usually feature one or more of the following construction elements:

- New or modified structures (e.g. bridges, bridges with shelves, or wildlife overpasses)
- Specially designed culverts (may be dry, wet (aquatic), or a combination of wet/dry)
- Directional or barrier fencing (with jump outs if appropriate), walls or embankments

Other design elements may also be incorporated into wildlife crossing locations such as:

- Canal crossings
- Approach aprons and/or trails
- Species crossing signs
- Reduced nighttime speed limits
- Roadside animal detection

Guidelines have been developed for use by the Florida Department of Transportation (FDOT), to evaluate the appropriateness of including wildlife crossings and associated design elements for proposed projects on the State Highway System (SHS) or as possible stand-alone retrofit projects on the SHS, when warranted. The guidelines were developed in coordination with the USFWS and FWC.

Wildlife crossings are often designed for mammals such as the Florida panther and Florida black bear; however the term “wildlife”, as used here, has the same meaning as in Article II of the Wildlife Violator Compact Act, s. 379.2255 which reads in part: “…all species of animals, including, but not limited to, mammals, birds, fish, reptiles, amphibians, mollusks, and crustaceans, which are defined as “wildlife,” and are protected or otherwise regulated by statute, law, regulation, ordinance, or administrative rule refers to listed, protected or otherwise regulated species under the jurisdiction of United States Fish and Wildlife Service (USFWS) and Florida Fish and Wildlife Conservation Commission (FWC).

How is a Wildlife Crossing Added to a Project?

BACK TO ROADMAP

The FDOT evaluates the appropriateness of including a wildlife crossing (upland or wetland) for proposed projects on the State Highway System (SHS) or as possible stand-alone retrofit projects on the SHS. Criteria have been established that must be considered during the justification and design of wildlife crossings.

During project development the FDOT District offices, in coordination with USFWS and/or FWC, will determine if a wildlife crossing is appropriate. The FDOT also considers input from other stakeholders, including local government, non-governmental organizations, and the public. Although opportunities for input exist throughout the process, the FDOT process offers two phases when early coordination and input are most effective in addressing wildlife connectivity: the Planning phase and the Project Development and Environment (PD&E) phase. The processes used for review and input during these phases include:

1. During the Planning phase, the Efficient Transportation Decision Making (ETDM) is the process used to screen qualifying projects during which wildlife agencies, land acquisition and management agencies and other stakeholder input is solicited to provide early scoping information regarding potential effects and resources of concern in the project area. During a screening event, FDOT uses the Environmental Screening Tool (EST) and assesses available habitat, land use and wildlife information-including running the Habitat and Wildlife Connectivity Report which uses the Wildlife Crossing Considerations data layers among others to identify initial wildlife crossing opportunities. The FDOT District can also use other methods and information, such as field reviews and local knowledge to supplement GIS information. Resource agencies and stakeholders are requested to review and comment on wildlife crossing opportunities or other wildlife impact minimization measures and potential mitigation strategies as well as identify opportunity areas or gaps in conservation lands where land acquisition may be needed to support wildlife crossings.

2. During the PD&E phase, FDOT develops the project alternative(s) and analyzes project impacts according to a specific federal or state environmental study process. Resource agencies and stakeholders are critically involved during this phase, since a PD&E Study provides the platform where preliminary design, constructability, financial needs, and resource agency/stakeholder considerations are balanced to develop the preferred alternative and a conceptual design. During this phase it is critical for FDOT to properly time when resource agencies can address opportunity areas or gaps in conservation lands needed to support wildlife crossings. This is also the phase when project commitments are initially developed.

3. For projects that do not have a PD&E phase, wildlife crossings can still be considered especially those in more rural areas of the state. Running a Habitat and Wildlife Connectivity Report during Work Program cycle updates is encouraged to best plan for any additional funding that might need to be requested, but the report can also be run during project scoping. While it may be more difficult for these types of projects to accommodate more traditional wildlife crossing structures, other options may be able to support enhanced connectivity while being cost

effective. These would include features such as signage (e.g. bear crossing signs, nighttime reduced speed limits), modifying bridge embankment for a "shelf," adding culverts for small animals, installing directional or barrier fencing, or adding natural cover materials or screening.

Commitments to construct wildlife crossings often result from a PD&E Study and should be entered into the Project Commitment Record (PCR). PD&E Study recommendations, conclusions, and commitments will be incorporated into the design scope. The process leads to the New Design Parkway route on the Roadmap graphic.

During design phase, the final plans for the wildlife crossing are then developed in parallel with the transportation infrastructure design. The overall project is permitted (as necessary) and can advance to the construction phase. FDOT continues coordinating with wildlife agencies throughout final design, which may include reviews and comments on feasibility studies, identified crossing locations, and conceptual design plans, plus progress updates throughout the design process.

Should wildlife connectivity needs arise that were either 1) not identified in a PD&E Study; or 2) identified after the design process has begun, then FDOT should immediately initiate coordination with the District Environmental Management Office and District Permit Office. In these (and other) circumstances, wildlife crossings may follow the Retrofit Trail on the graphic or may go to **EXIT 1** Parking Lot.

Maintenance-led contracts may occasionally be an option to implement smaller, retrofit concepts. FDOT's Roadway Maintenance and Bridge Maintenance are separate but related programs dedicated to maintaining FDOT roadway assets. Operational budgets are established for each program. Cost estimates for a retrofit project would require coordination with the District Maintenance Office. Funding the retrofit would require securing the necessary funds which may be allocated from one of the maintenance budgets, or the project could be implemented by District Maintenance crews but funded from other resources.

If a retrofit project is requested by outside agencies, FDOT Districts may require those organizations to provide scientifically based documentation or studies which substantiate their requests. Funding for justified requests could result from financial partnerships with requesting entities. In support of these efforts, requesting entities can work with other stakeholders to facilitate funding, to meet coordination requirements with property owners and other stakeholders, and to identify right-of-way and maintenance requirements. Retrofit projects may require the requesting entity to agree to maintain and/or fund the maintenance of the wildlife crossing. It is also important to advise the requesting entity that appropriate agreements would need to be executed in a manner consistent with FDOT requirements, with the related approvals necessary to design and construct a retrofit project.

For off-state highway system projects, FDOT Districts will coordinate with the Office of Environmental Management regarding possible inclusion of any wildlife crossings.

Design Species

BACK TO ROADMAP

Designing wildlife crossings requires both the consideration of the types or sizes of animals that would use the crossing (design species) and landscape-level information. Florida is home to the endangered Florida panther (*Puma concolor coryi*) and Florida black bear (*Ursus americanus floridanus*)—wide ranging species whose survival depends on the ability to traverse roadways safety as they move across the landscape. Smaller mammals and herpetofauna (reptiles and amphibians) also benefit from wildlife crossings that reconnect habitats and reduce wildlife vehicle collisions (WVCs).

At times, a design species is known such as when a project occurs in a "hot spot" for Florida panthers. Hot spots are documented areas of WVCs. In the absence of hot spot data, it may be more appropriate to begin the analysis by considering the design species as a category based on size or habitat requirements, such as large mammals or small mammals; or aquatic or terrestrial. If a design species or group of species is not known, the geographic area of the proposed project is defined, and a review of existing wildlife data is performed with resources from wildlife agencies like the Florida Natural Areas Inventory's (FNAI) habitat suitability and biodiversity database, Florida Fish and Wildlife Conservation Commission's (FWC) Imperiled Species Management Plan and the US Fish and Wildlife Service (USFWS) Information for Planning and Consultation (IPaC) lists. After combining these lists, habitat mapping and field surveys of the project area will aid biologists to filter the list to determine species that are reasonably expected to be present.

The design species list is based on conservation status or ecological importance of wildlife species. For example, deer and hogs would be considered due to the role these play as prey species for the Florida panther. Other criteria in determining ecological benefits of a crossing include the evaluation of road mortality risks, habitat fragmentation sensitivity, and feasibility of movement of the design species. Data such as wildlife movement including GPS or telemetry data, wildlife corridors, WVCs and habitat models also play a role in identifying which species to specifically design a wildlife crossing for because these resources can assist in predicting movement of species.

With the design species in mind, the design elements for the crossing, fencing or jump outs can become more definitive. Large mammals like panthers and bears prefer wide, dry crossings with natural substrate, minimal human disturbance, and vegetated approaches to encourage use. For smaller species such as small mammals and herpetofauna, culverts may be more appropriate or elements of a wider or larger structure that provides cover. The size and placement of crossings will take into consideration the design species' preferences such as upland or aquatic habitat and maintain the natural hydrology throughout the year.

Species-specific wildlife fencing will help to guide animals to the crossing approaches and prevent entry into the roadway. Jump outs are an escape route to safe habitat if an animal is caught on the roadway side of a wildlife fence.

An assessment of the region and project specific landscape will result in potential locations for the wildlife crossing. This assessment includes synthesizing the existing movement data (such as WVC hot spots and GPS tracking) with an analysis of physical landscape features, right-of-way constraints, and engineering feasibility to maximize the crossing's long-term effectiveness. The Wildlife and Habitat layers of the Environmental Screening Tool (EST) on the Efficient Transportation Decision Making

(ETDM) website provides GIS data layers essential for assessing potential locations of a wildlife crossing within the landscape. Reviewing existing regional wildlife connectivity maps, models and preservation areas will identify wildlife corridors, greenways and conservation lands that provide regional travel routes between important habitats. Other EST layers provide geographic ranges for species, locations of known habitat and occurrence data. Regulatory and special project areas are identified such as federal species consultation areas, essential fish habitats, and major regional restoration projects. These layers are available on the public facing side of the EST. Inside users can establish an Area of Interest (AOI) and select the option for EST to scan the data layers and develop a report called a Wildlife Crossings Potential Report. Manually reviewing the data or generating a Wildlife Crossing Potential Report includes reviewing wildlife connectivity, wildlife-vehicle collision data, habitat, and crossing opportunities and conflicts, all of which are considered in the process to identify crossing locations.

Use of EST Wildlife and Habitat layers or the Wildlife Crossings Potential Report will assist in selecting the best potential ecological locations within the landscape, while coordination with the design team will help to identify the constructible sites. The engineering site selection criteria will evaluate right-of-way or other property constraints, utility conflicts, roadway profile, drainage, geotechnical, maintenance of traffic, and construction techniques or possible challenges. The combined efforts of the biological and engineering teams will produce a wildlife crossing that provides long-term ecological benefit for the design species.

What Types of Information will Support a Wildlife Crossing?

BACK TO ROADMAP

Before committing to the design and location, the ecological necessity of a wildlife crossing must be established through the review of both biological and spatial information. Information that supports a wildlife crossing is driven by three core data sets: documenting the presence and movement patterns of design species, verifying the suitability and continuity of available habitat, and analyzing current and future land use to ensure the crossing yields maximum long-term ecological and conservation returns. Therefore, specific data sets such as those below will help to document the need for wildlife enhancements:

1. Presence of species (including WVCs),
2. Presence of habitat, and
3. Analysis of land use.

The FDOT Office of Environmental Management (OEM) (in collaboration with the US Fish and Wildlife Service (USFWS), Florida Fish and Wildlife Conservation Commission (FWC), University of Central Florida (UCF), the Panther Recovery Implementation Team (PRIT) Transportation Sub-team, and other non-governmental organization (NGO) partners), has developed several GIS data layers that support wildlife crossing analyses and justification decisions during transportation project development. Wildlife Crossing Considerations and other habitat/landscape layers are housed in the FDOT Environmental Screening Tool (EST), an internet application used to support environmental reviews under the Efficient Transportation Decision Making (ETDM) process.

The EST consists of hundreds of data layers to assist in identifying environmental, cultural, physical and community resources. Selecting the Natural category provides access to a subset of GIS data called Wildlife and Habitat. These layers include topics such as species occurrence information, existing managed lands and priority conservation lands. Any of these data layers may be used when considering the need for wildlife crossings, but a few specific layers may be helpful to review in conjunction with the Wildlife Crossing Consideration and Florida Wildlife Corridor layers. These are:

- Florida Ecological Greenways
- Florida Wildlife Corridor (further described below)
- Florida Forever Acquisitions
- Florida Forever BOT Projects
- FNAI Florida Managed Areas (FLMA)
- Rural and Family Lands Protection Program
- Future Land Use

These layers are available on the public facing side for review and evaluation of a project area. Inside users may establish an Area of Interest (AOI) and select the option for EST to scan the applicable data layers and develop a report called a Wildlife Crossings Potential Report. This document summarizes the analysis of applicable data layers and organizes the information in four "tiers" of relevant decision-making factors. The tiers are 1) Wildlife Connectivity; 2) Wildlife-Vehicle Collision/Hot Spots; 3) Habitat, Wetlands, and Species Occurrence; and 4) Crossing Opportunities and Conflicts (from highest to lowest tier). Although each tier is important, some factors provide more relevant guidance when reviewed in their entirety.

In addition to GIS data layers, the 2021 Florida Wildlife Corridor Act (259.1055, Florida Statutes) established a multi-faceted purpose that includes: “providing for wildlife crossings for the protection and safety of wildlife and the traveling public.” The Act defines the Florida Wildlife Corridor as “the conserved lands and opportunity areas defined by the department (Florida Department of Environmental Protection/FDEP) as priority one, two, and three categories of the Florida Ecological Greenways Network (FEGN).”

When is a Wildlife Crossing Appropriate?

BACK TO ROADMAP

The following list can be used to determine whether a wildlife crossing is appropriate. The list is not exhaustive and other factors may apply:

- Is there a documented or science-based need for a wildlife crossing that is supported by USFWS and/or FWC and other resource agencies (as applicable) such as:
  - Are endangered, protected, or other meaningful wildlife species documented within the project area?
  - Are there documented road kills of wildlife with high conservation value? If not, this should not be construed as a requirement for FDOT to conduct a survey.
  - Is there camera data to support the continued presence of the species?
  - Does wildlife traversing the roadway create a potential hazard to motorists and/or wildlife?
  - Does the project lie within the documented range of Florida panther and/or Florida black bear?
- Does the project cross or cause fragmentation to designated critical habitat or a documented landscape-level habitat linkage, ecological greenway (such as the Florida Wildlife Corridor), or a Florida Forever project area?
- Does the project involve locations of critical conservation need as determined by USFWS or FWC?
- Are conservation lands necessary to achieve successful use of a wildlife crossing?
  - If so, are conserved lands present in sufficient size on both sides of the road (adjoining and contiguous), where a wildlife crossing may be located, including the ability to provide adequate fencing (where appropriate) to guide wildlife for a sufficient distance to achieve successful use of the crossing?

Generally, these questions apply to larger new or retrofit wildlife crossings designed for wildlife with a large home range, as compared to smaller wildlife crossings where perhaps a wildlife shelf is being added to an existing structure. These questions should be discussed and needs agreed upon with USFWS or FWC during the ETDM Screening and/or the PD&E Study (or early in the Design phase if the project doesn’t have a PD&E phase).

If one of the conditions required to achieve successful use of the crossing does not exist prior to the design phase but is reasonably certain to occur no later than the beginning of the 60% project design phase (when environmental permit applications are typically submitted), then the wildlife crossing can still be considered. Should the conditions agreed upon by the FDOT and resource agencies not exist at the beginning of the 60% design phase, the FDOT may decide not to move forward with the inclusion of the wildlife crossing in the project. In cases where a project achieves 60% design yet is not funded for right-of-way acquisition or construction, the FDOT may consider adding a wildlife crossing to the design, subject to project budget and schedule.

What Else Should I Know?

BACK TO ROADMAP

A wildlife crossing design must take the following criteria into consideration:

- The wildlife crossing cannot compromise any state or federal highway safety criteria.

- The wildlife crossing cannot compromise FDOT design requirements. Should roadway or bridge design variations or exceptions be needed for the proposed wildlife crossing, then proper and timely review by the Districts and Central Office (as applicable) would be required. If not approved, the wildlife crossing would require redesign and further coordination with agencies prior to determining feasibility.

- The wildlife crossing (and fencing) cannot block an adjacent property owner's only practicable route of ingress or egress to their property. Coordination with adjacent property owners may be needed for addressing access-related issues. Results of this coordination may affect structure locations and/or fencing lengths.

- The wildlife crossing cannot negatively impact adjacent properties (e.g., provide access for people and/or wildlife species to private properties where none presently exist).

- The wildlife crossing cannot negatively impact existing drainage patterns or create conditions that flood off-site properties.

- The placement of the wildlife crossing is usually associated with wildlife mortality hotspots; however, the ultimate placement may be based on the most cost efficient and ecologically effective design in coordination with USFWS and/or FWC and regulatory agencies as appropriate.

- Upland and wetland habitat impacts should be avoided and minimized to the extent practicable by proper design.

- Lighting at wildlife crossings should be minimized to the greatest extent practical. Refer to Section 231.2.1 Environmental Lighting in the FDOT Design Manual.

- The wildlife crossing must be accessible for proper maintenance to ensure the structure remains viable. Considerations should include maintenance of fence and gates, vegetation management, "skylight" or other small features supporting the crossing, and sediment or erosion issues.

- Long-term performance of wildlife crossings will be enhanced by maintenance, particularly for vegetation management and fencing. Maintenance needs, cost ranges, scheduling and responsibility for the maintenance should be considered early in the PD&E or design phases.

What Else Should I Know?

BACK TO ROADMAP

- When various types of wildlife crossings could be applied to a location, a cost-benefit analysis should be considered. The costs of each wildlife crossing should be compared to the anticipated benefit of reduced risks of collisions for both motorists and wildlife. Costs for the wildlife crossing should include design, permitting, right-of-way, construction and long-term maintenance (e.g., fencing, gates and maintaining wildlife access to the wildlife crossing when applicable). Costs for collision reductions should be coordinated with the Traffic Operations Office and be based on the anticipated number of reduced collisions using the data supporting the need for the wildlife crossing. The Wildlife Crossing Calculator developed by UC Davis may be used to develop this cost benefit analysis. Contact OEM for access and support.

- Should post-construction monitoring be requested by a regulatory agency, USFWS and/or FWC should have an active role in the review and development of the monitoring plan. Any post-construction monitoring should be for data collection and information only and will typically be conducted for a limited period of time. FDOT may also implement long-term monitoring at broad intervals (e.g., semiannually, bi-annually) to look for any maintenance issues that may need to be addressed.

- Post-construction monitoring can provide a source of data to evaluate successful use or hesitation at the crossing. Adaptive maintenance techniques or future design modifications related to the structure type, walking surface, fences, gates and surrounding vegetation may be developed based on both types of wildlife behavior.

Cost Estimating

BACK TO ROADMAP

Estimating the cost of a wildlife crossing is a process involving multiple components associated with roadway construction and long-term maintenance. This overview highlights primary factors that influence the final cost using typical categories as a framework for the analysis. Common roadway elements involved in developing a cost estimate include:

- Construction
- Utilities Coordination
- Right-of-Way
- Mitigation for Impacts
- Maintenance and Life Cycle Cost
- Post Construction Monitoring

Figure 1 below shows an example of a wildlife underpass culvert on a four-lane roadway. Specific construction cost components are called out. Figure 2 provides a profile view demonstrating the need to elevate the roadway to accommodate the new culvert.

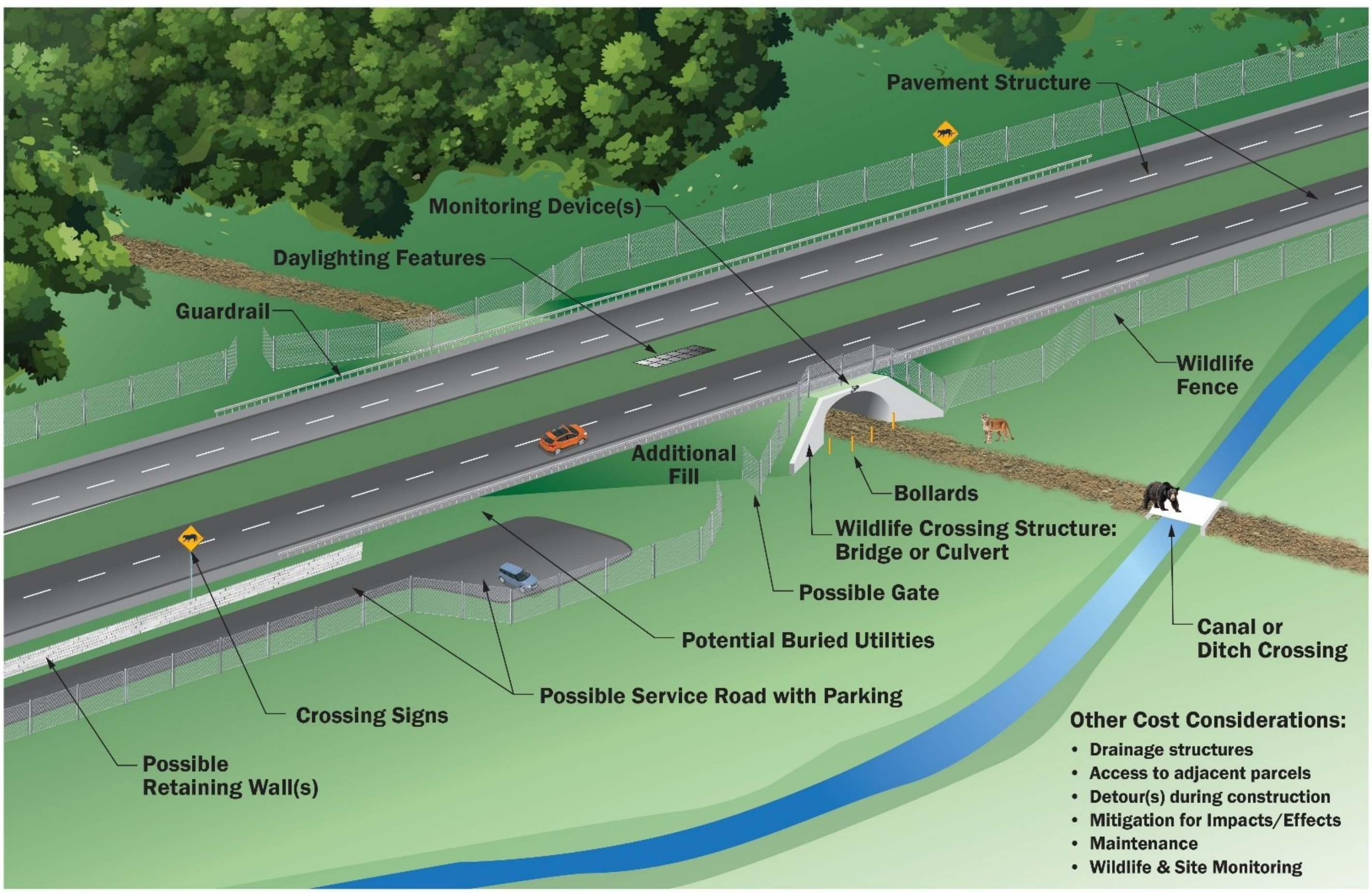


Figure 1 Typical Cost Components for a Wildlife Crossing

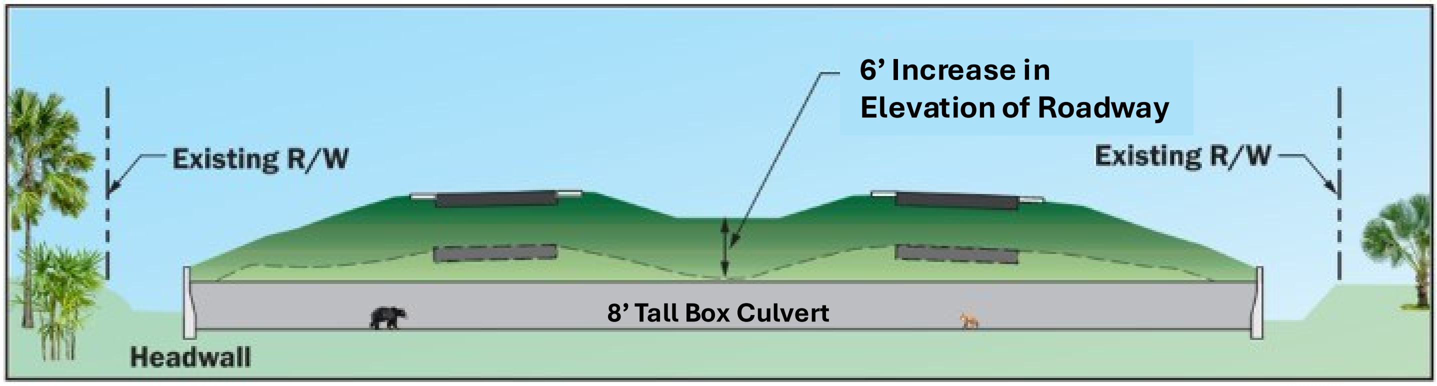


Figure 2 Cross section of a wildlife crossing underneath a roadway.

Investigating the components of typical construction components in Figures 1 and 2 results in the first steps of developing an overall cost estimate. The specific wildlife crossing project will be assessed for all elements that would add cost to the construction of the project. These elements would be quantified for the specific project and then costs are applied to arrive at final cost estimates. Initially the following items would be reviewed and quantified:

- Wildlife crossing structure itself; a culvert as shown in the example depicted in Figure 1.
- Additional fill material, pavement, drainage modifications, and guardrail.
- Retrofits to any driveways, intersections, ditches, or other infrastructure.
- Gates or access points to parking areas, service roads, and access roads to parcels affected by wildlife fencing.
- Retaining walls for the highway; wingwalls or abutment/embankment walls for the structure.
- Utilities that may require relocation.
- Daylighting features (for longer culverts).
- Wildlife shelves/ledges and transition paths.
- Signage.

While direct construction accounts for a large portion of the total project budget, it is not the only cost factor. A critical component that must be assessed is the cost associated with acquiring additional right-of-way. Although projects aim to be contained within existing roadway corridors, certain designs may require a larger footprint, requiring the purchase of right-of-way to accommodate the crossing or associated roadway modifications.

To install a culvert as shown in Figure 1, the roadway itself would need to be elevated as shown in Figure 2 and reconstructed for a distance leading up to and away from the culvert. For example, consider a rural, two-lane roadway as shown in Figure 3 below.

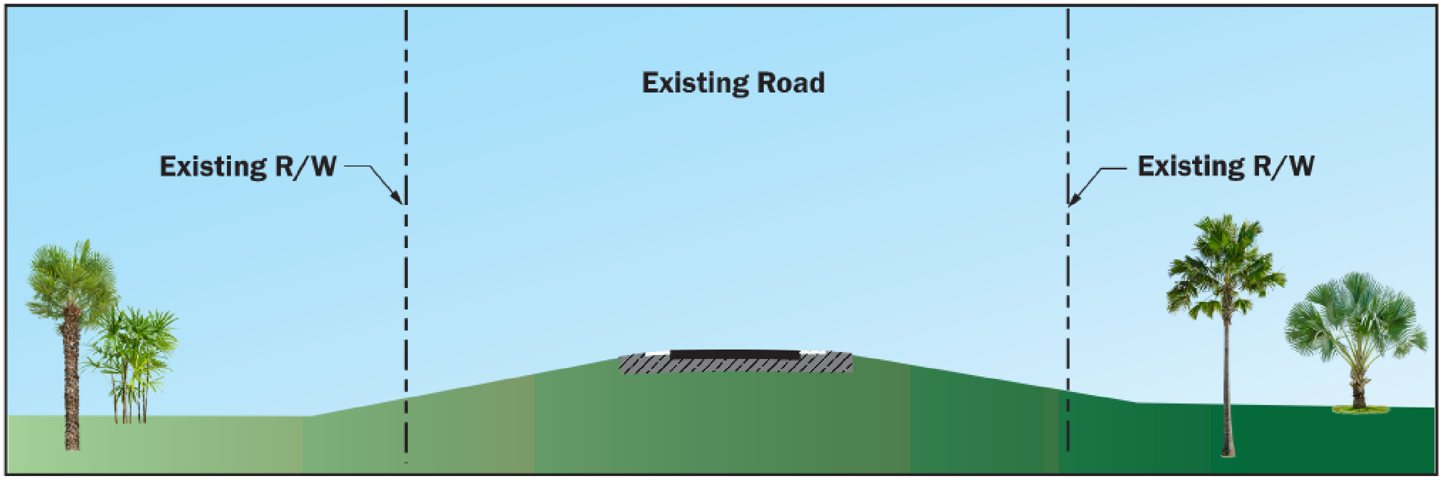


Figure 3 Typical cross section of a two-lane roadway.

For rural roadways in Florida, the general topography is often relatively flat. To add a dry box culvert, the existing roadway must be elevated by adding fill and then reconstructing pavement at the new, higher elevation above the box culvert. Raising the highway also projects the side slopes outward, which potentially requires more right-of-way.

Figure 4 depicts this scenario, whereby adding fill extends the side slopes beyond existing right-of-way. Acquiring right-of-way is an option; however, the addition of highway retaining walls and guardrail may also be considered. Either option adds cost.

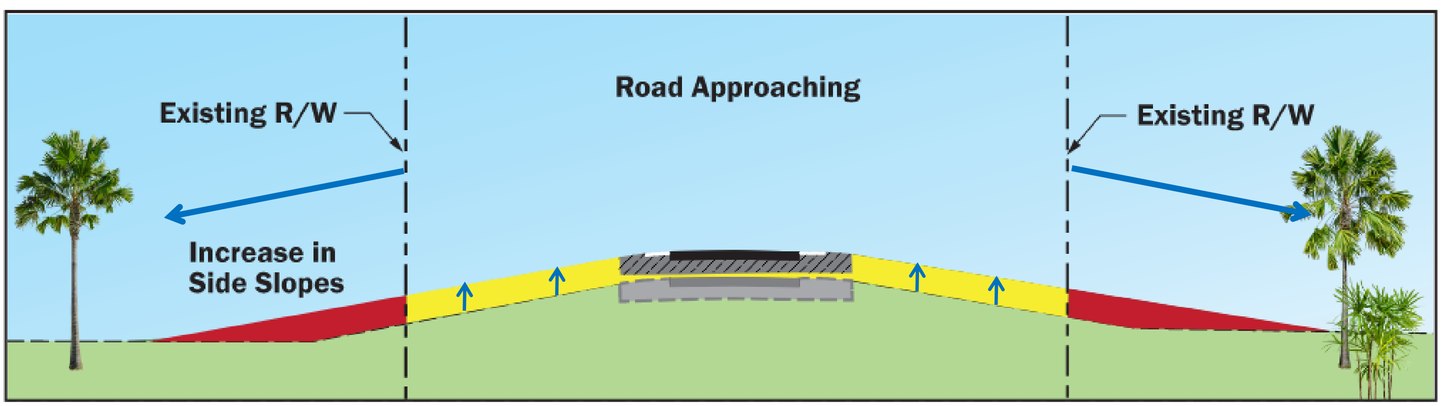


Figure 4 Cross section showing the change in the footprint of the road as the grade is raised.

In this example, the finished grade of the new travel lanes are about six feet above their previous elevation (see Figure 2). Although a six-foot change in elevation seems nominal, it is important to recognize that Figure 2 only depicts the effects of the wildlife crossing directly at the culvert station/location. To achieve acceptable highway grades and smoothly transitioning vertical curvature, the additional fill material and pavement reconstruction must gradually taper back to meet the existing highway, often at a considerable distance from the crossing itself.

As the grade of the roadway is slowly elevated to the maximum grade at the culvert, its interaction with all existing features must be considered and accommodated in the reconstruction design – which may include driveways, intersections, utilities, existing drainage features, and the impacts of a widened highway footprint. Depending on site conditions, guardrail may be needed on both sides leading up to the culvert.

New wildlife crossings on new road alignments do not usually require temporary traffic accommodation; yet retrofits on existing roads require this temporary measure. To install a new box culvert like the one shown in Figure 1 or Figure 2, a detour plan and traffic control plan would be developed. The plan may recommend a temporary, on-site detour or Florida Department of Transportation (FDOT) may consider a temporary route closure that uses a nearby detour route. Once traffic is re-routed, the existing pavement is removed, and the box culvert is installed. The new, elevated travel lanes are then constructed with additional fill, new pavement, and new drainage components.

Estimating Methods

In general, Districts utilize one of two estimating methods for a wildlife crossing – long range or pay item estimates. The Long Range Estimate (LRE) is a computer application used early in project development prior to determining detailed quantities and pay items. The LRE produces conceptual construction cost estimates for roadway and bridge projects. This method of cost estimating is based on the conceptual design which uses modeling tools, typical characteristics, and historical costs. The LRE application contains the pre-design project scope and cost estimates covering the proposed work. The estimate is then used to program future design projects. An LRE estimate example is provided in Figure 5 below to demonstrate the elements of roadway construction required for the addition of one dry box culvert for a four-lane roadway as a wildlife crossing for large mammals.

The second, more detailed, estimating method and more typical of costs produced in the design phase calculates various material and component quantities. It then converts these to pay items which may include the "installed cost." Various other costs and multipliers may then apply, such as inflation and contractor mobilization and staging.

Box Culvert			
Pay Item #	Description	Unit	Quantity
104-10-3	SEDIMENT BARRIER	LF	7580
104-15	SOIL TRACKING PREVENTION DEVICE	EA	2
107-1	LITTER REMOVAL	AC	17.58
107-2	MOWING	AC	17.58
110-3	REMOVAL OF EXISTING STRUCTURES/BRIDGES (See Notes Below for Details)	SF	5,000
110-1-1	CLEARING & GRUBBING	AC	10.45
120-1	REGULAR EXCAVATION	CY	4,621
120-6	EMBANKMENT	CY	20,992
125-3	SELECT BEDDING MATERIAL	CY	348.44
160-4	TYPE B STABILIZATION	SY	13,224
285-701	OPTIONAL BASE, BASE GROUP 01	SY	389
285-709	OPTIONAL BASE, BASE GROUP 09	SY	1,868
327-70-2	MILLING EXISTING ASPHALT PAVEMENT, 3 1/2" AVG DEPTH	SY	4,123
334-1-55	SUPERPAVE ASPHALTIC CONCRETE, TRAFFIC E, PG76-22	TN	1,120
337-7-25	ASPHALT CONCRETE FRICTION COURSE, INC BIT, FC-5, PG 76-22	TN	618
339-1	MISCELLANEOUS ASPHALT PAVEMENT	TN	25
400-2-1	CONCRETE CLASS II, CULVERTS	CY	-
400-2-5	CONCRETE CLASS II, BRIDGE SUBSTRUCTURE	CY	5
415-1-6	REINFORCING STEEL- MISCELLANEOUS	LB	-
425-1701	INLETS, GUTTER, TYPE S, <10'	EA	4
430-17-5118	PIPE CULVERT,OPTIONAL MATERIAL,ROUND, 18"S/CD	LF	112
430-98-4125	MITERED END SECTION, OPTIONAL ROUND, 18" SD	EA	4
455-34-1	PRESTRESSED CONCRETE PILING, 12" SQ.	LF	75
520-6	SHOULDER GUTTER- CONCRETE	LF	771
521-5-4	CONCRETE TRAFFIC RAILING- BRIDGE, 32" VERTICAL FACE	LF	68
536-1-1	GUARDRAIL -ROADWAY, GENERAL TL-3	LF	703
536-8-112	GUARDRAIL TRANSITION CONNECTION TO RIGID BARRIER, F&I- INDEX 536-001, APPROACH TL-3	EA	2
536-8-113	GUARDRAIL TRANSITION CONNECTION TO RIGID BARRIER, F&I- INDEX 536-001, TRAILING	EA	2
536-73	GUARDRAIL REMOVAL	LF	0
536-85-20	GUARDRAIL END TREATMENT- TRAILING ANCHORAGE	EA	2
536-85-24	GUARDRAIL END TREATMENT- PARALLEL APPROACH TERMINAL	EA	2
546-72-1	GROUND-IN RUMBLE STRIPS, 16"	GM	1.81
550-10-251	FENCING, TYPE B, 8.1-10.0', WITH BARBED WIRE ATTMT	LF	4,648
550-60-211	FENCE GATE, TYPE B, SINGLE, 0- 6.0' OPENING	EA	2
570-1-2	PERFORMANCE TURF, SOD	SY	22,540
706-1-3	RAISED PAVEMENT MARKER, TYPE B	EA	120
711-15-101	THERMOPLASTIC, STANDARD-OPEN GRADED ASPHALT SURFACES WHITE, SOLID, 6"	GM	0.91
711-15-131	THERMOPLASTIC, STANDARD-OPEN GRADED ASPHALT SURFACES, WHITE, SKIP, 6",10-30 SKIP	GM	0.91
711-15-201	THERMOPLASTIC, STANDARD-OPEN GRADED ASPHALT SURFACES, YELLOW, SOLID, 6"	GM	0.91
713-103-201	PERMANENT TAPE, YELLOW, SOLID, 6" FOR CONCRETE BRIDGES	GM	0.00
713-103-101	PERMANENT TAPE, WHITE, SOLID, 6" FOR CONCRETE BRIDGES	GM	0.00
713-103-131	PERMANENT TAPE, WHITE, SKIP/DOTTED, 6" FOR CONCRETE SURFACES	GM	0.04

Figure 5 Example of a list of pay items for a dry box culvert in a Long Range Estimate (LRE).

Mitigation Costs for Impacts

Although a wildlife crossing is intended to be a beneficial project, its construction may cause impacts to the surrounding right-of-way or adjacent lands and protected resources. FDOT's Environmental/PD&E (Project Development & Environment) staff can assist with identifying these potential impacts. Affecting certain protected resources may require additional study and potential mitigation. While this list is not all-inclusive, the following resources require special attention during the planning, funding, and permitting stages of a crossing:

- Wetlands and Waters of the United States
- Endangered species or habitat
- Cultural Resources protected by Section 106 of the National Historic Preservation Act of 1966
- Resources protected under Section 4(f) of the Department of Transportation Act of 1966
- Land purchased under Section 6(f) of the Land and Water Conservation Act
- Federal and State-owned or managed lands
- Railroad or utility right-of-way or easements
- Conservation/Preservation Easements

Roadway projects, including the construction of wildlife crossings, require a comprehensive analysis of their potential impact on the natural and physical environment. This process involves identifying and addressing both positive and negative effects. Negative impacts can result from a change in the road's footprint and may involve resources that require permitting or mitigation, such as impacts to wetlands or habitat for various species.

Any proposed project must evaluate its effects on listed or protected species and their habitats. The costs associated with surveys, permitting, and mitigation for these environmental impacts must be factored into the overall project design and budget.

Maintenance, Lifecycle, and Monitoring Costs

Although the maintenance costs for most wildlife crossings are minimal, maintenance to fences, gates, and vegetation will be perpetual. Structure engineers can assist with long-term maintenance cost-estimating as well as a Life-Cycle Cost analysis.

Wildlife crossings often have pre- and post-construction monitoring programs to record wildlife use. Costs are associated with adding new cameras, maintenance or replacement costs, and staffing to collect and process the monitoring data.

At some sites, continuity of Public Access becomes a design requirement. In these scenarios: Safe service roads, parking, and self-closing gates may be employed – which also implies frequent site monitoring for gate closure, infrastructure condition, trash, and other considerations.

Cost-Benefit Considerations

When various types of wildlife crossing could be applied to a location, a cost-benefit analysis may prove helpful with decision-making. The estimated cost of each wildlife crossing can be compared to the anticipated benefit of reduced risks of collisions for both motorists and wildlife. Costs for the wildlife crossing should include design, permitting, right-of-way, construction and long-term maintenance (e.g., fencing, gates and maintaining wildlife access to the wildlife crossing when applicable).

Parking Lot

BACK TO ROADMAP

There are circumstances where a proposed location may show conceptual potential for a wildlife crossing, retrofit, or other connectivity enhancement; however, the information needed to support its inclusion is not yet available. In these cases, factors such as project type, budgets, limited biological or spatial data, uncertain land-use conditions, or the absence of agency-supported justification may preclude advancing the concept at this time.

A lack of current justification does not mean the idea is dismissed permanently. These concepts remain “parked” for future consideration and may be re-evaluated if new data become available, conservation conditions change, or if subsequent phases of project development create new opportunities. By documenting these ideas now, FDOT and partner agencies can quickly revisit and reassess them when conditions are more favorable.

Retrofit Trail

BACK TO ROADMAP

Should wildlife connectivity needs arise that were either 1) not identified in a PD&E Study; or 2) identified after the design process has begun, then FDOT should immediately initiate coordination with the District Environmental Management Office and District Permit Office. In these (and other) circumstances, wildlife crossings may follow **EXIT 2** Retrofit Trail. Click any of these elements on the road map to jump to more information, graphics and photos of wildlife crossing retrofits such as culvert modification, dry shelves and canal crossings. Non-structural elements like wildlife fences, jump outs, and advanced design elements (e.g. dynamic messages) also may fall under a retrofit category.

New Structures Road: What Project Types are Appropriate?

BACK TO ROADMAP

Wildlife crossings are typically considered when the transportation project recommends a new alignment, capacity improvement, roadway reconstruction, or a bridge replacement. In these cases, **EXIT 3** New Structures Road provides a route to develop a wildlife crossing on these project types. For new transportation facilities, New Structures Road provides several options, as appropriate to the project site which may include bridges, culverts or canal crossings. Click any of these elements to jump to more information, graphics and photos of completed projects.

Bridges: New or Modified Structures

BACK TO ROADMAP

Structures such as bridges that provide specifically designed wildlife crossings serve a primary function of providing wildlife connectivity with the potential to provide additional functions for drainage, a wildlife trail crossings or a feature to accommodate aquatic animal movement. Structure designs discussed here include:

- Wildlife Underpasses
- Wildlife Overpasses
- Wildlife Underpasses with Shelves
- Retrofitted bridges with shelves

Design Species

Bridged wildlife crossings can facilitate movement of wide-ranging, large-bodied species such as the Florida panther and Florida black bear, while also accommodating smaller mammals, reptiles, and, in some cases, amphibians and aquatic taxa. Incorporating species-specific design elements—such as appropriate span width, substrate continuity, vegetative cover, and hydrologic connectivity—can enhance functional effectiveness and maximize habitat connectivity across a broad suite of species.

Bridges as a Wildlife Crossing Structure – Pros and Cons

PROS:

- Bridges effectively pass wildlife underneath - or over - various transportation modes
- Longer spans provide wider, daylit, and more spacious wildlife passage
- Adaptable to designs for dry, aquatic, or combination wet/dry crossings
- Easier maintenance access
- Slightly more difficult for predatory species to ambush prey; therefore, smaller species are more likely to use
- Crossings can accommodate or restrict human or vehicle passage, if desired

CONS:

- Most expensive to build
- Most expensive to maintain
- Designers may want to consider restrictions for unauthorized use or access by humans

Wildlife Bridge Structure Functions

Bridged wildlife crossings are designed either as dry, aquatic, or a combination to accommodate both terrestrial and aquatic species.

- Dry crossings serve as a passage for terrestrial wildlife.
- Aquatic crossings are designed to primarily convey water beneath the bridge and generally lack dedicated features for terrestrial wildlife. Under normal flow conditions, aquatic and amphibian species may use these features, and some mammals or reptilian species may also utilize them if willing to swim.

Combination wet/dry crossings intend to serve a dual role by conveying water or providing an aquatic crossing while also providing a terrestrial wildlife passage. A typical design might include a linear water body with wildlife shelves on one or both sides of the channel bank. The shelves may be specifically designed and constructed or consist of naturally occurring floodplain or uplands along the top of bank.

Canal crossings are a type of bridge structure. Click **Canal Crossings** on the **Roadmap to Wildlife Connectivity** graphic to access information on structures that serve solely as means for wildlife connectivity across linear water bodies.

Structure Types, Concepts and Photographs

Wildlife Underpasses

Underpasses feature a highway bridge or bridge-sized culvert that spans the wildlife pathway. FDOT defines "bridge-size culvert" as any structure, whether of single-span or multiple span construction, with an interior width greater than or equal to 20 feet. Often these structures serve a primary purpose of spanning a river or stream, and the wildlife pathway is then designed as an additional feature. In the case of water crossings, the bridge location is determined by the water feature.

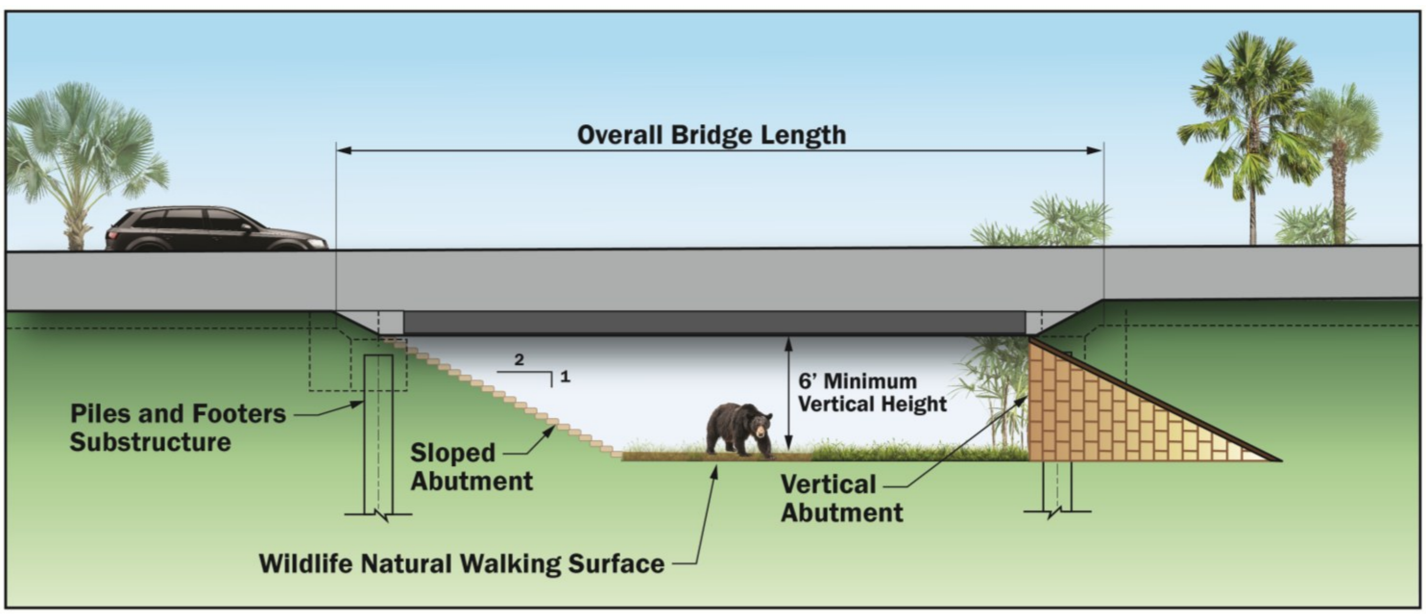


Figure 6 Wildlife Underpass with a dry crossing underneath the highway bridge. Two potential bridge abutment designs are depicted above: a sloped bridge abutment (left) and a vertical abutment (right).

Figure 7 Bridge for dry crossing under I-4 in Volusia County, D5 (FPID 408464-1).

Figure 8   Dry crossing for Key deer on US 1, Big Pine Key, East Crossing, Monroe County, D6.

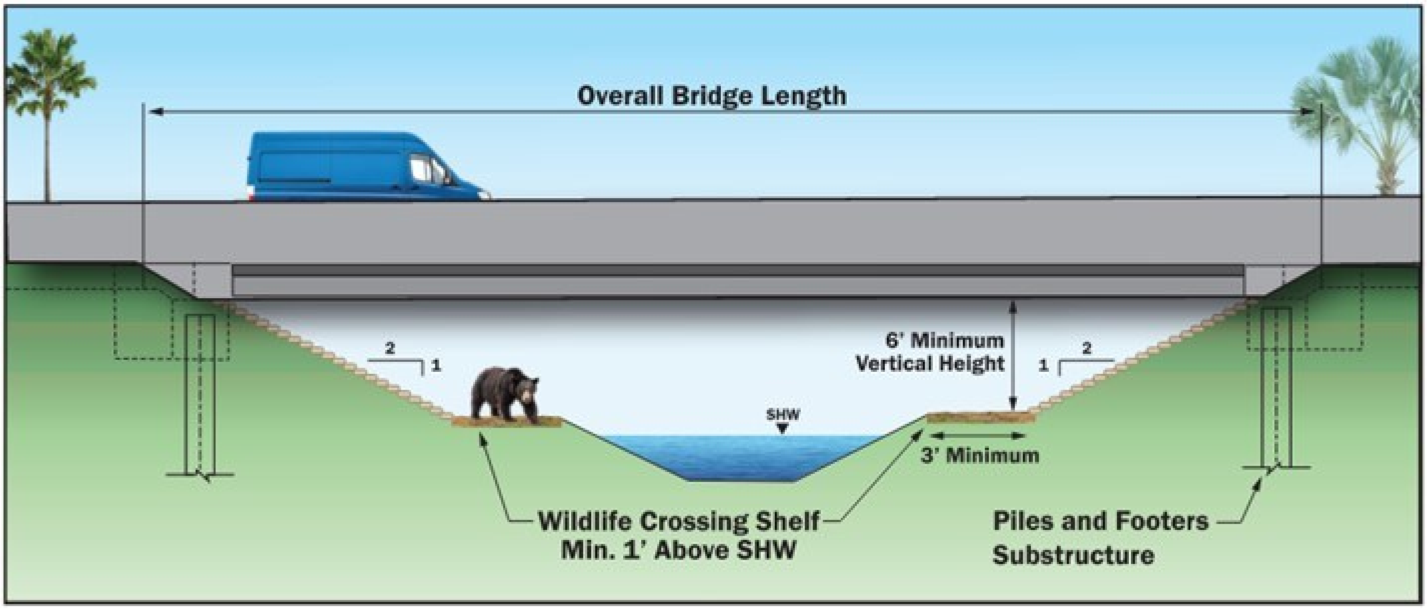


Figure 9 New bridge structure with dry shelves and an aquatic feature (a wet/dry crossing).

*Figure 10 A wildlife crossing under I-4 east of SR 557 interchange, Polk County, D1 (FPID 201215-3).
Dry crossing is provided along both sides with an aquatic feature in the center for wetland-dependent species.*

Wildlife Overpasses

Overpasses feature a bridge which carries a wildlife pathway above the roadway. This design often works well when the roadway lies lower than adjacent topography, or if other factors may preclude raising the highway grade to bridge an underpass crossing.

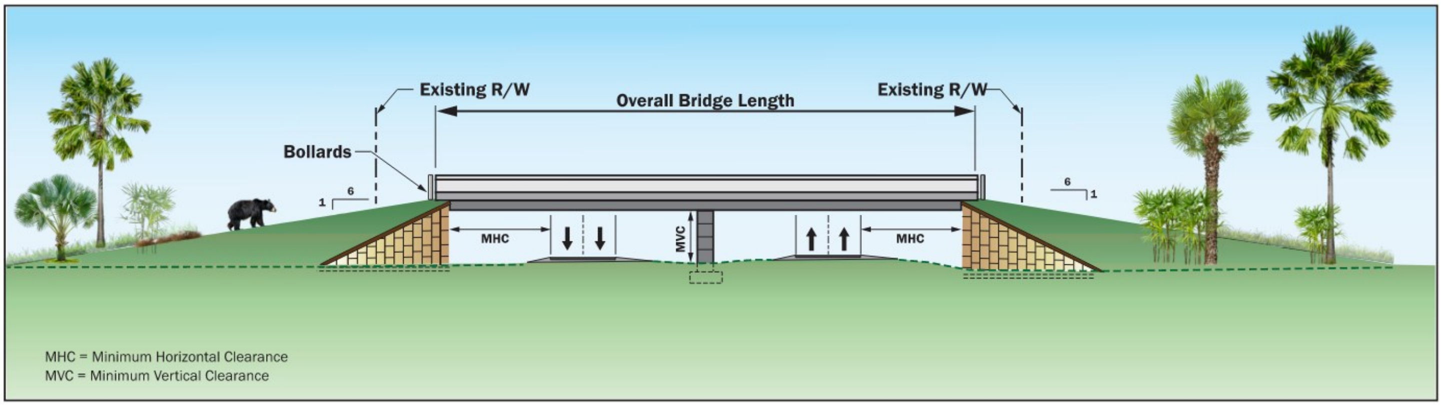


Figure 11 Wildlife Overpass, carrying wildlife over the roadway.

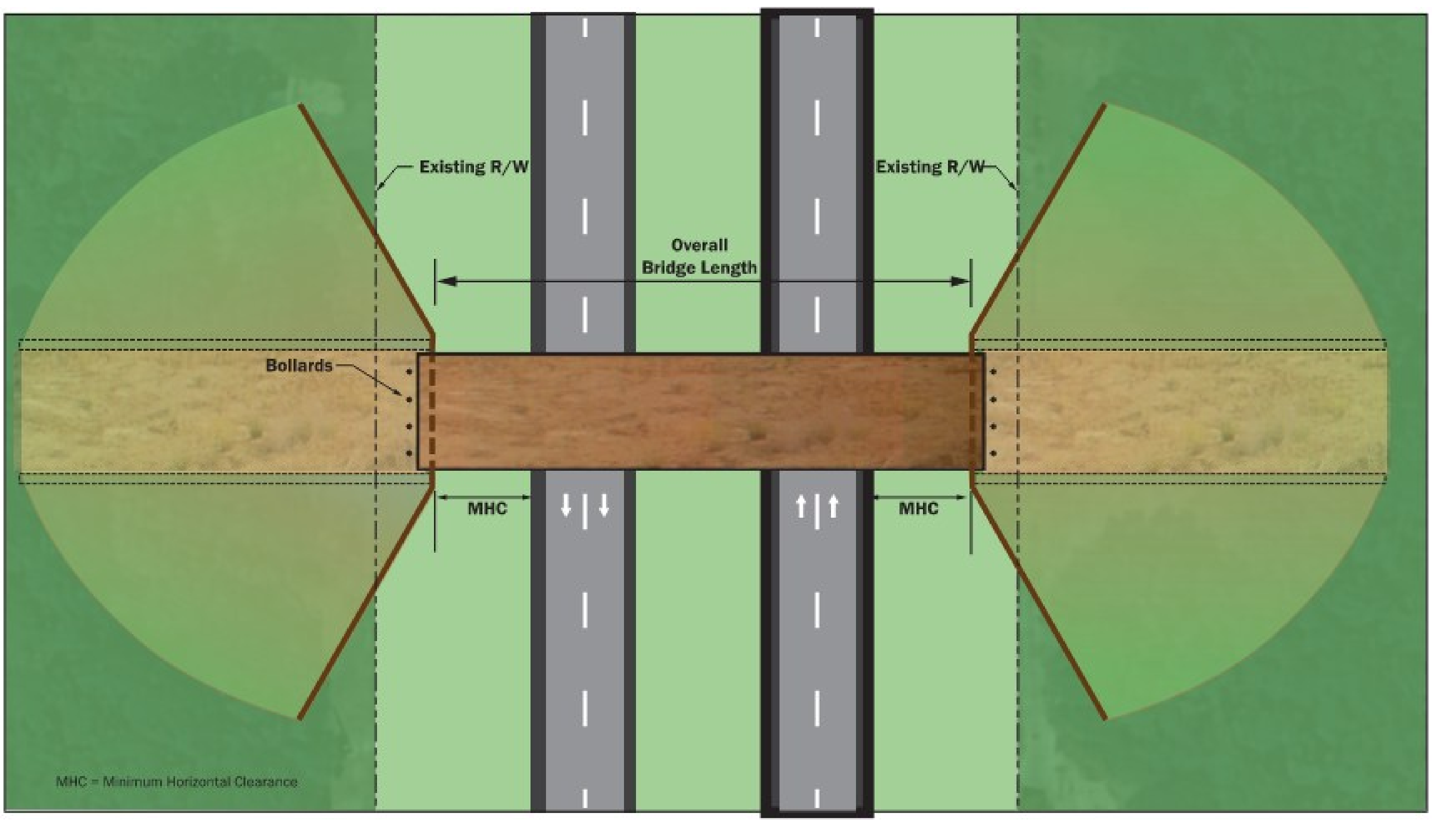


Figure 12 Wildlife overpass plan view.

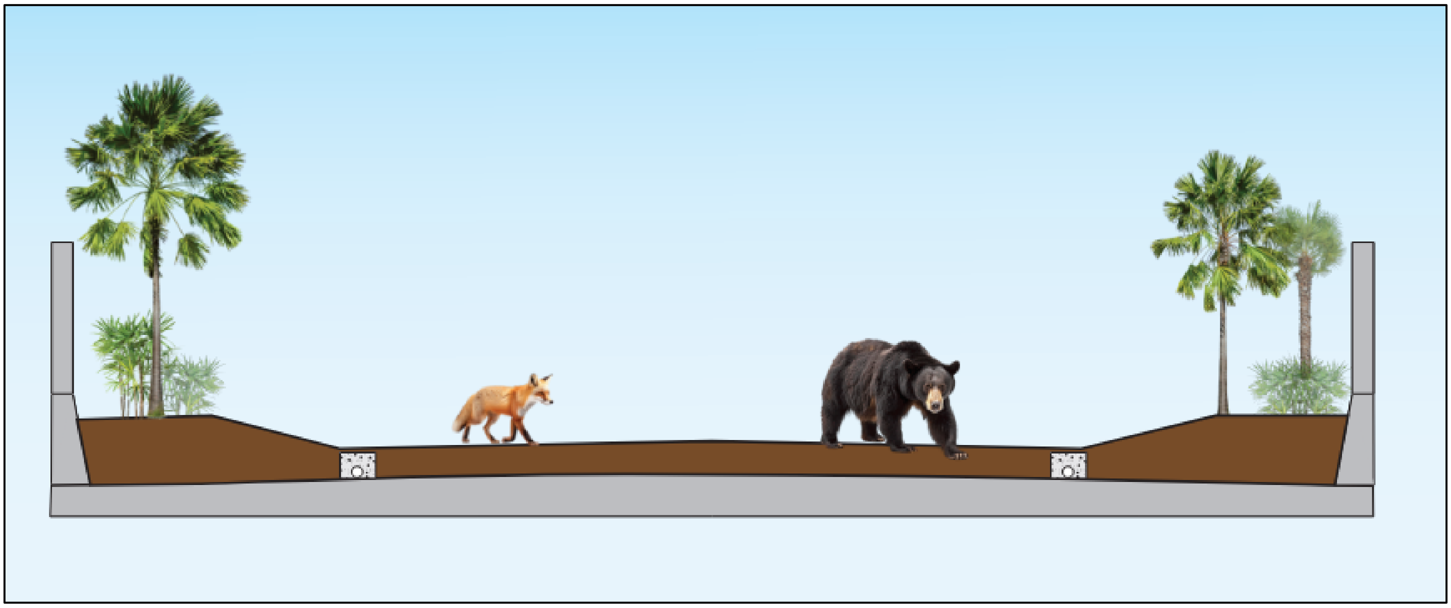


Figure 13 Example of a wildlife overpass showing walking surface substrate. This example includes noise barrier walls and traffic separator barriers. Drainage is provided for the walking surface by an embedded underdrain in this example.

Bridge Retrofits for Wildlife Crossings

Existing bridges may be retrofitted rather than replaced. A bridge retrofit project provides an opportunity to evaluate the incorporation of a **dry shelf** on one or both sides of an existing drainage channel by altering the embankment. On a site-specific basis, the existing abutment may be altered to provide a narrow shelf with enough vertical clearance for animals to use as an underpass.

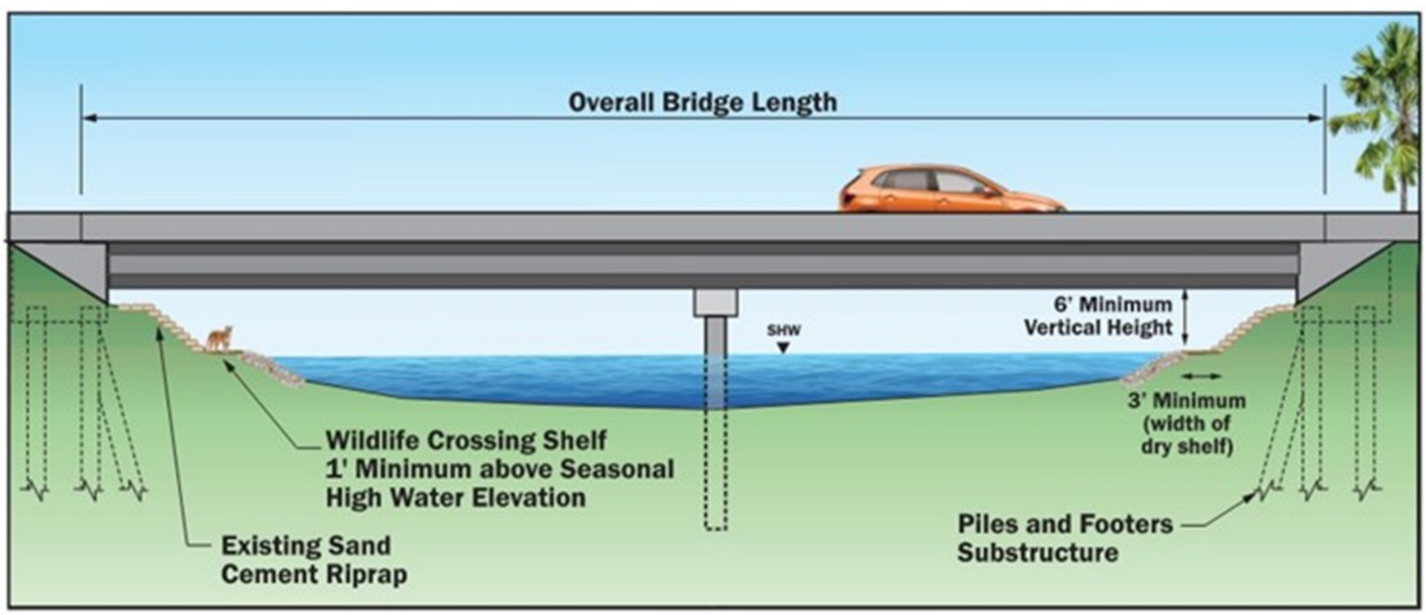


Figure 14 Retrofitted bridge to add dry shelves.

Figure 15 Dry shelf retrofit of a crossing at Harold Strand, I-75 Alligator Alley, Collier County, D1 (FPID 444008-2). The concrete retaining edges retain the natural walking surface.

Designs

Bridged wildlife crossing projects typically occur as a result of these design opportunities:

- New bridge designs
- Wildlife crossing retrofits that modify existing bridges

New Bridge Designs

These projects offer the greatest design flexibility, since designers can determine span length, number of piers/bents, girder heights, and whether the bridge abutment is a vertical wall or sloped. If no hydraulic conveyance is necessary, then a Dry Wildlife Crossing is designed by including the walkway elevation and minimum horizontal passage width in the structure design considerations. If a hydraulic conveyance or an aquatic crossing element applies, the project team will include the wildlife crossing details with the bridge's hydrology design.

Dimensions of the Wildlife Passage Zone

- Vertical Clearance - The minimum clearance from the walking surface to the low member of the superstructure should be six feet. The perception of an "open" passage is important to attract wildlife use. Decisions on the vertical clearance will also be influenced by the characteristics of the surrounding landscape and the width of the existing road.
- Width - The minimum width for dry shelves is three feet. For dry crossings, the widest width possible given the specific conditions is usually better to promote an open-air feeling.

Lighting

Natural light under the structure is necessary to encourage wildlife to pass through. On roadways that are four-lanes or wider, there may be two separate structures that allow for natural light in the center (median). If the structure consists of one span, a feature that allows natural daylight in the center of the crossing should be included to avoid a tunnel effect or closed environment feeling. A modified grate that serves as a skylight in the center has been used in long culvert designs. Click Culverts on the Roadmap to Wildlife Connectivity to access information on skylight designs. A skylight feature could be incorporated in the superstructure design to provide natural light in a bridge structure

Walking Surface

The seasonal high water (SHW) elevation is an important design consideration. The crossing profile depends on the SHW elevation, which drives many aspects of the overall design.

If water overtops the walking surface, the wildlife crossing may not be used year-round by all wildlife and result in more seasonal use only. Repeated inundation and drying can also lead to increased maintenance needs as soil is washed away and concrete walking surfaces are exposed.

When the bridge also serves to span a surface water or wetland, the seasonal high water elevation and the limits of any floodplains should be used to establish the walking surface elevation. Wildlife shelf elevations are ideally three (3) feet wide and located at least be one foot above the seasonal high water (SHW) elevation to be dry throughout the year. Depending on the species, one-half foot above SHW may be acceptable when vertical constraints are present.

Walking Surface Composition

The walking surface is an important consideration to encourage the use of many types of animals. Bears, panthers, and bobcats have padded feet and are more likely to adapt to different surfaces. Deer and other hooved animals may avoid hard surfaces like concrete. Providing a minimum of six inches of natural substrate, typically a layer of soil, over the concrete structure will accommodate the widest range of terrestrial species. The substrate depth on overpasses will be deeper to accommodate vegetation. Drainage features can be incorporated into these small-scale retaining walls.

With the interest of attracting passage, wildlife walking surfaces ideally consist of softer, natural substrates and low grasses or cover for the walking surface as opposed to rough or irregular surfaces such as gravel or riprap. Using substrates and soil types that mimic the surrounding natural landscape helps create a sense of continuity across the crossing.

Transition from Walking Surface to Natural Ground

While the walking surface under the bridge itself is a primary design focus, the transition from the shelf to the natural ground is equally critical to the success of the design. Riprap at the bridge abutments or wetlands at the toe of slope may be barriers between the end of the walking surface and adjacent habitat. Site specific conditions will dictate the overall design, however often a pathway between the end of the dry walking surface and adjacent habitat may be needed to encourage wildlife towards the crossing.

Figure 16 Example of a Crossing Retrofit: A dry shelf with a pathway to transition between end of dry shelf and natural ground at Harold Strand, I-75 Alligator Alley, Collier County, D1 (FPID 444008-2). PVC pipe in right foreground is a drainage feature for the walking surface.

FDOT Project Examples

Bridge Type	Design Species	Project Information	District
Retrofitted Dry Shelf	Panther, Florida black bear	I-75 Alligator Alley FPID 444008-2	District 1
Wildlife Overpass Bridge	Large mammals	I-4 at SR 33 FPID 430185-7	District 1
Wildlife Underpass Bridge	Large mammals	I-4 at CR 577 FPID 201215-3	District 1
Wildlife Underpass Bridge	Florida black bear	I-4 Volusia County FPID 408464-1	District 5
Wildlife Underpass Bridge	Key deer	US 1 Monroe County 434684-1, 443897-1, and 250564-2	District 6

Culverts

BACK TO ROADMAP

A culvert is a metal, concrete, or plastic structure that conveys surface water underneath a road, railroad, driveway, or any other obstruction to the natural flow of water. Common types of culverts include box culverts, three-sided culverts, bridge-size culverts, round pipes, elliptical pipes, and pipe arches - which may include multiple culverts or a combination of different sizes, types, and elevations at the same location. Culverts can be designed for site-specific use – meeting both needs of hydraulic conveyance and accommodation of design wildlife species. Culvert designs discussed here include:

- Dry culverts
- Wet/aquatic culverts
- Wet/dry culverts
    - Bottomless pipe or three-sided culverts
    - Shelves/Ledges

Design Species

For large terrestrial wildlife the typical culvert is a box-shaped concrete structure, or possibly three-sided to provide adequate vertical height and a natural substrate and flat walking surface. Figure 1 is a depiction of a dry box culvert for large animals.

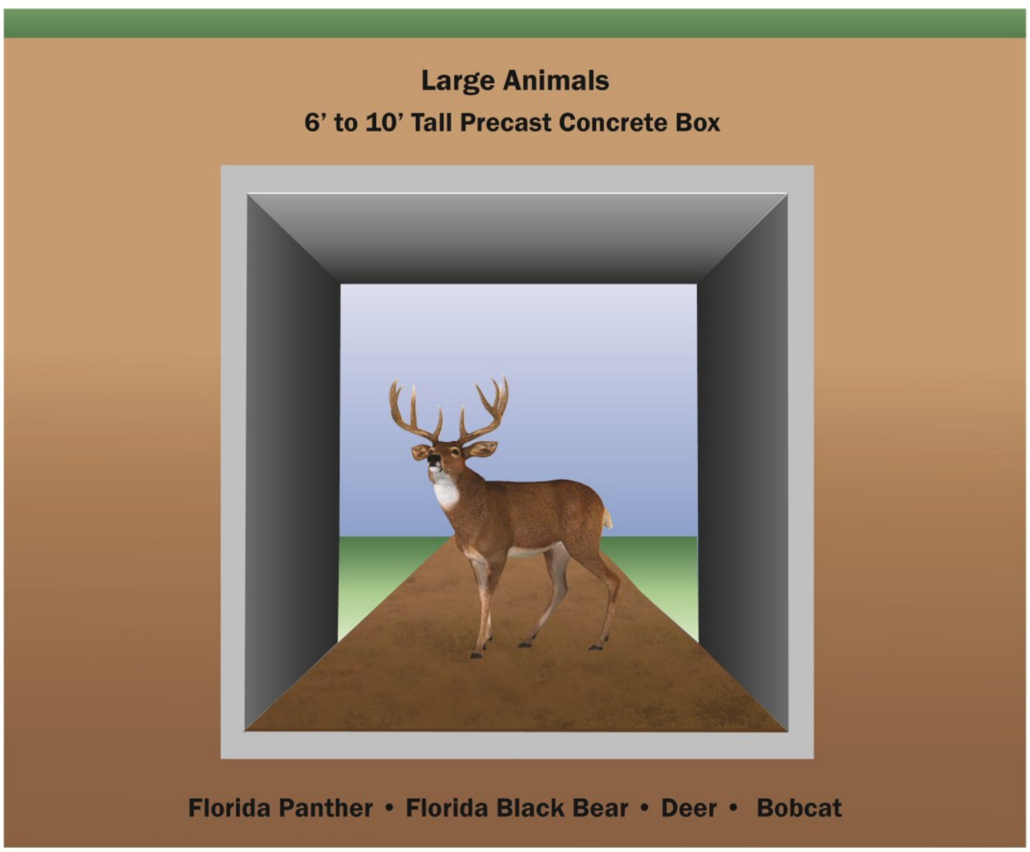


Figure 17 Culverts for large mammals

Culverts

Small terrestrial wildlife are typically accommodated with smaller box culverts, round pipes or elliptical-shaped pipes, or with arch-pipes if a walking surface is desired. Inside the pipes, a natural walking surface may be created by applying natural substrate.

Culverts designs for herpetofauna (reptiles and amphibians) and other aquatic species typically involve small boxes, larger boxes with "keyed" inverts, and round or elliptical pipes - depending on hydraulic conditions and design species needs. Figure 2 depicts some culvert options for smaller animals.

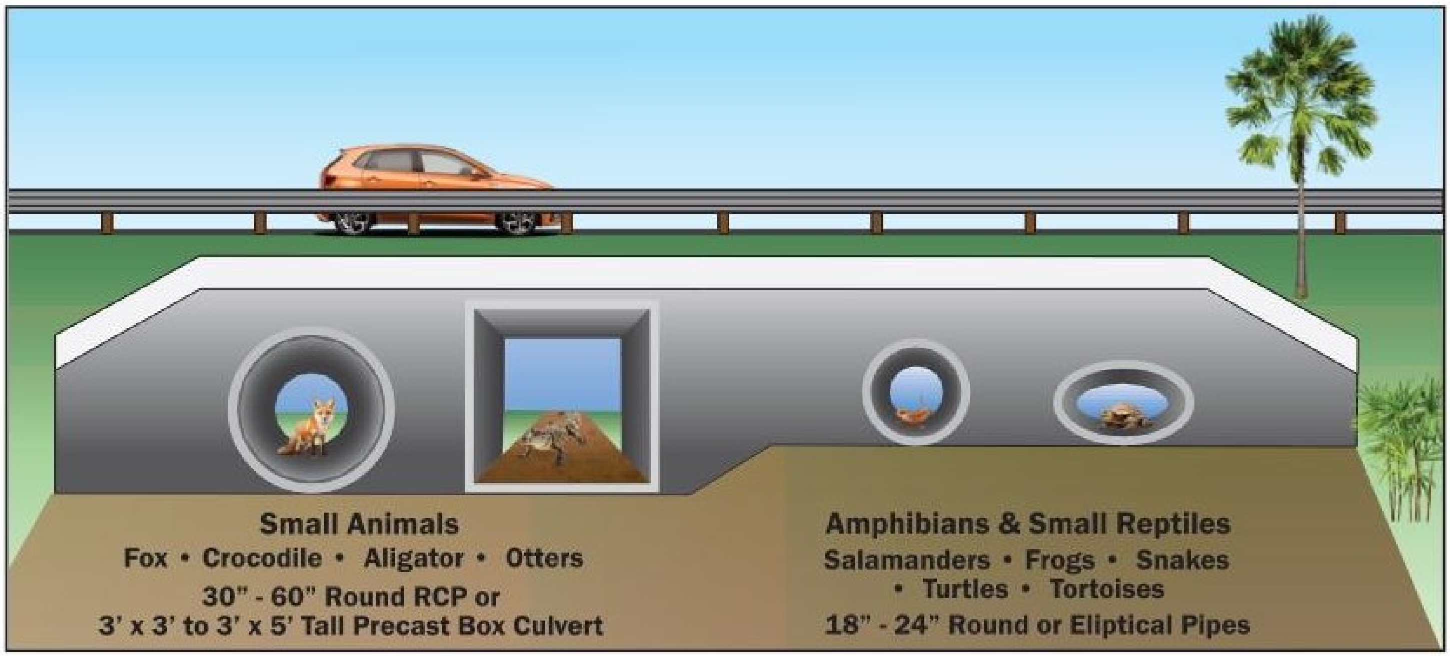


Figure 18 Culverts for smaller animals

Culverts as a Wildlife Crossing Structure – Pros and Cons

PROS:

- Cost effective solutions for small animal crossings
- Less complex constructability than a bridge structure
- Good option for aquatic species

CONS:

- Size of culvert limits the size of wildlife use
- Unnatural walking surface
- Accommodations for natural light are typically needed

Wildlife Culvert Functions

Wildlife culverts are designed either as dry, wet, or a combination to accommodate both terrestrial and aquatic species. For all adaptations, a wildlife crossing culvert provides an underpass for species and the opening is sized specifically to accommodate small to large wildlife. The invert elevation is designed to serve the function of the culvert.

- Dry culverts serve as a passage for terrestrial wildlife. The desired invert (i.e., bottom of channel) should be elevated one foot above the seasonal high-water elevation to ensure dry crossing year-round
- Wet/aquatic culverts convey water under the roadway with no accommodation for terrestrial species. Aquatic and amphibian species readily pass under normal circumstances. Certain mammals or reptilian species may elect to swim. The invert elevation is typically established based on hydraulic conveyance needs.
- Wet/dry crossings serve a multi-function role by conveying water, providing an aquatic crossing, and providing a terrestrial passage.
- A typical design might include a box culvert to convey water with an interior dry ledge or shelf on one side of the culvert. The culvert invert must meet hydraulic conveyance needs, while considering the use of shelves or ledges to pass wildlife above normal water levels.

Culvert designs intended to support terrestrial, aquatic, and amphibious species result in a wide range of possible pipe sizes and configurations. Each design must typically balance multiple objectives, with protected wildlife passage and water conveyance representing primary considerations. Additional key factors commonly include construction cost, service life, and maintenance requirements.

Culvert Types, Concepts and Photographs

Dry Box Culverts

These are precast or cast-in-place concrete, or aluminum, or steel, typically presenting a square or rectangular-shaped opening. Culvert dimensions are described in terms of width x height of inside dimensions. For example, a 10' x 8' box culvert is 10 feet wide and 8 feet high from inside wall to inside wall.

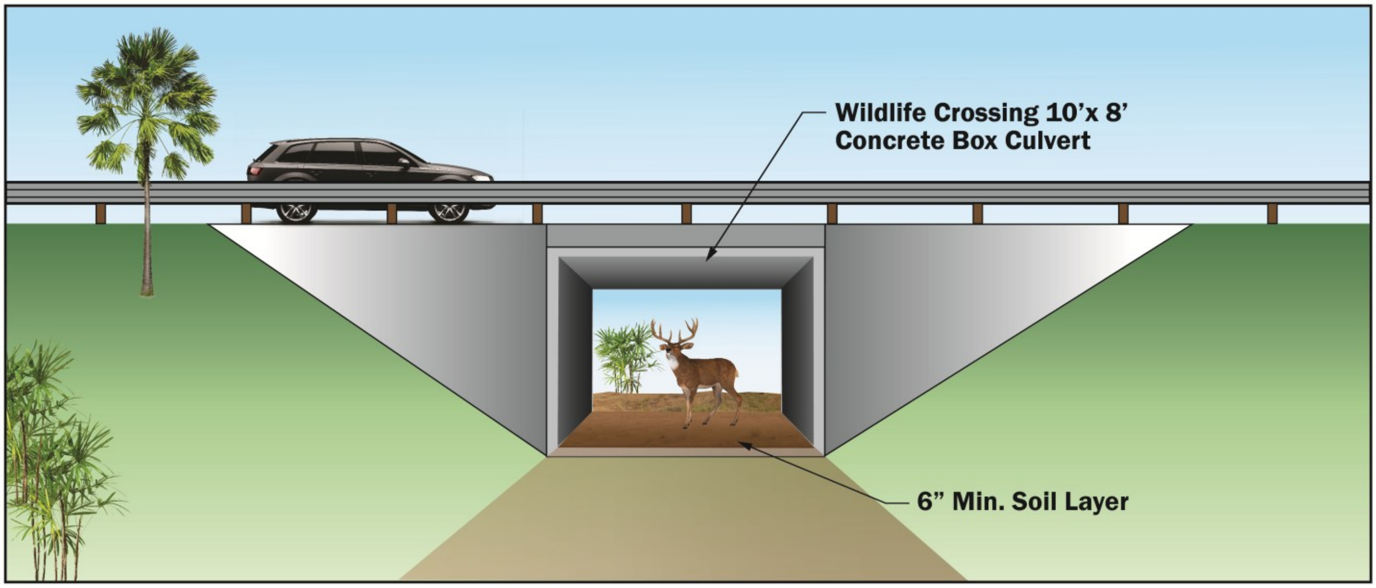


Figure 19 Dry box culvert.

Figure 20 Dry box culvert under SR 55, Polk County, D1 (FPID 201215-3).

Figure 21 Dry box culvert under SR 52, Pasco County, D7 (FPID 256323-1).

Figure 22 The above photo is an example of an aquatic crossing (culvert visible on the right side within the headwall) with a monitoring camera. The photo on the right is documented use of the culvert by an American crocodile based on camera data; US 1, Monroe County, FPID 446005-1.

Wet and Dry Box Culverts

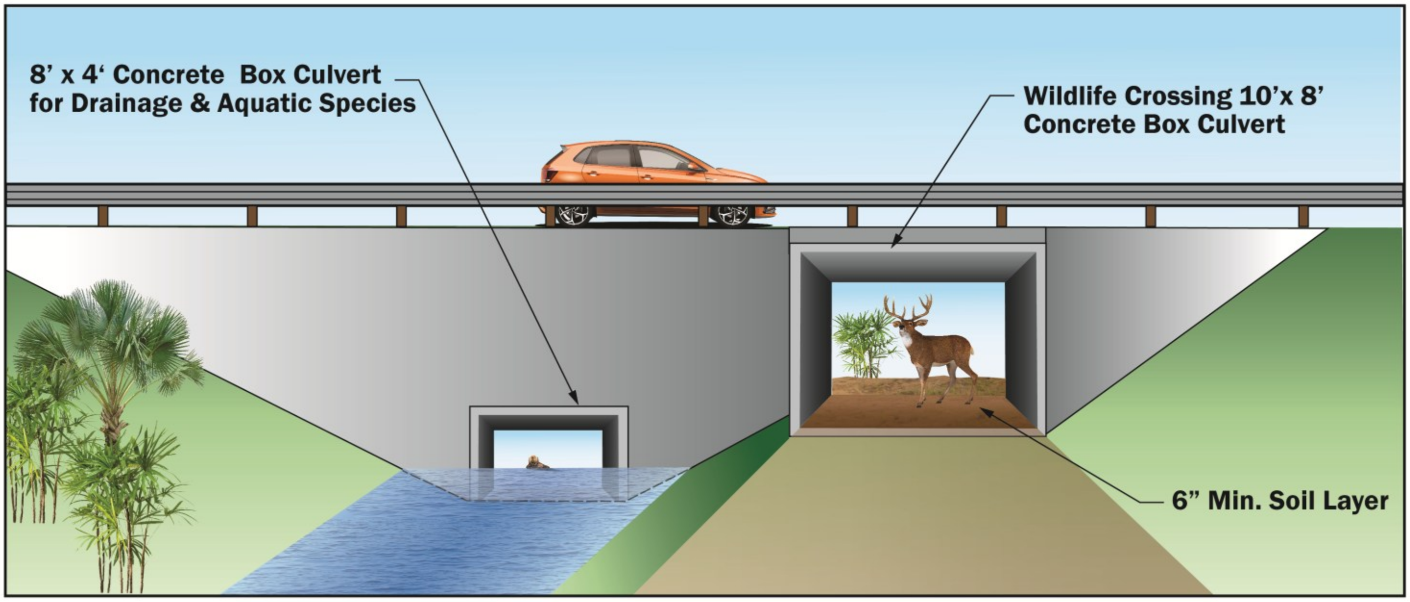


Figure 23 Example concept of a dry box and aquatic feature.

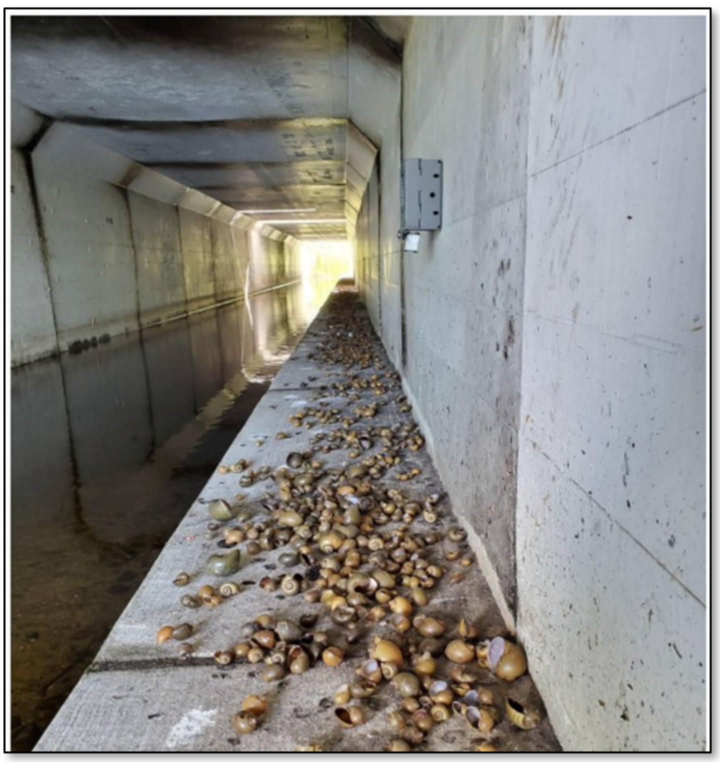


Figure 24 Aquatic box culvert with a dry ledge under SR 710, Martin County, D4 (FPID 432705-1).

Three-sided Concrete Culverts

This culvert type is defined by FDOT as a culvert that may be rectangular in shape or a frame with varying wall and/or slab thickness or an arched or arch-topped structure. These structures have separate foundations with spread footings supported by earth, rock or piles. The largest culverts are typically not boxes; rather they are frames or arches. Use of three-sided concrete culverts where rock is not at or near the streambed requires pile support for the footings or some other form of positive scour protection. 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.

Figure 25 Rectangular three-sided concrete culvert.

Bridge-sized Culverts

As a subset of three-sided culverts, FDOT defines “bridge-size culverts” as any structure, whether of single-span or multiple span construction, with an interior width greater than or equal to 20 feet.

Figure 26 Bridge-sized three-sided concrete culvert.

Pipe Culverts

This structure is a tunnel-like structure constructed under roadways to provide cross drainage of water typically. Pipe shapes can be round, elliptical, or arch shaped. Common materials are manufactured concrete, aluminum, and steel.

Figure 27 Aluminum Arch-Pipe Culverts

Figure 28 Corrugated steel pipe culvert.

Bottomless Pipes and Culverts

In a bottomless culvert the bottom of conveyance area is typically comprised of natural substrate and rock. Round and pipe arch designs are more common; however, box designs are possible. Pre-cast spans (bridging members) are also a possibility, sitting on foundation walls that parallel the conveyance channel.

Figure 29 Bottomless corrugated steel pipe.

Figure 30 Bottomless Concrete Arch-pipe

Figure 31 Arch culvert.

Designs

The culvert is often box-shaped or three-sided box to provide a flat walking surface particularly for large terrestrial wildlife while small terrestrial wildlife may use round or elliptical-shaped culverts. The walking surface may be augmented with soil to provide natural substrate. Culverts designed for aquatic species may be flat, round, or elliptical depending on the hydric conditions and design species needs. The material may be concrete, polyvinyl or corrugated metal.

Dimensions of the Culvert

For dry culverts:

- The maximum height of the culverts often considered for Florida species ranges from a maximum of 12 feet to 10 feet for large mammals. The vertical clearance is measured from the walking surface. If soil is added to the walking surface, the vertical clearance is measured from the top of the soil layer.
- The minimum height of Florida dry underpasses is often set at six feet to accommodate deer which is a common prey species. Panthers and deer may use culverts five feet high; however, at minimum of six feet is more likely to encourage use by deer.
- The width proposed for dry culverts may range from 16 feet for box designs to 24 feet for arch designs.
- An eight-foot wide by 6-foot-high concrete box culvert is typically the minimum desirable dimensions if deer, panthers and bears are the design species.

For wet/aquatic culverts, the dimensional guidelines are similar to dry culverts; however, the water depths required by the design species will be as important as the dimensions of the culvert. Seasonal variations in water elevations may result in seasonal use by species. Ledges in culverts are more specialized, but the dimensional guidelines are similar.

Wet/dry culvert dimensions and shelf/ledge designs require site-specific judgements to accommodate the multiple needs for hydraulic conveyance and the design-species' wildlife passage in normal flow conditions.

Elevation of Walking Surfaces

The seasonal high water (SHW) elevation is an important design consideration. The crossing profile depends on the SHW elevation, which drives many aspects of the overall design. If water overtops the walking surface, the wildlife crossing may not be used year-round by all wildlife and result in more seasonal use only.

A dry wildlife walking surface is ideally located at least be one foot above the seasonal high water (SHW) elevation to be dry throughout the year. Depending on the species, one-half foot above SHW may be acceptable when vertical constraints are present.

Natural Lighting

Natural light within the culvert is necessary to encourage wildlife to pass through. If the culvert is long and narrow, a feature that allows natural daylight in the center of the crossing should be included in the design. A modified grate that serves as a skylight in the center has been used in long culvert designs.

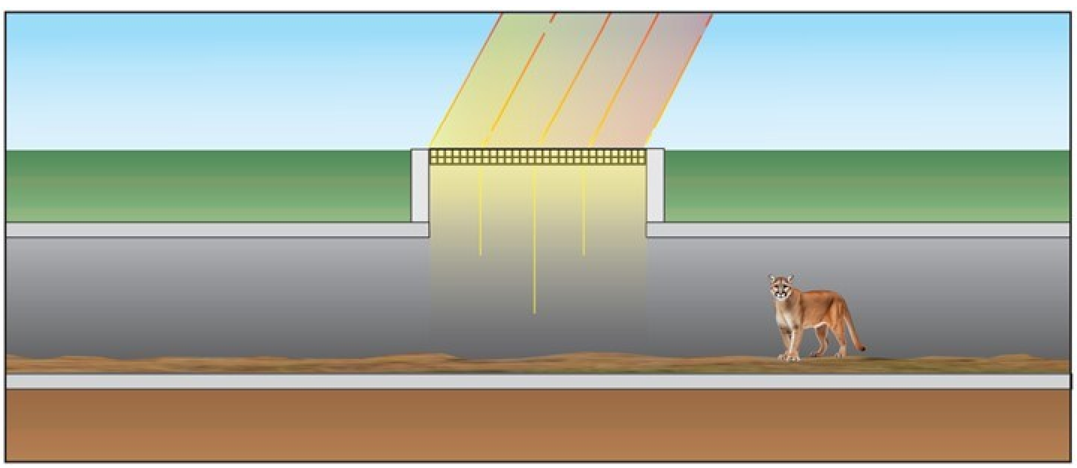


Figure 32 Cross section of a culvert with a modified grate for interior light.

Sills and Baffles

Sills and baffles introduce vertical projections attached to the culvert bottom, which assist in retaining native material within the culvert. Sills are found at the inlet and outlet of the culvert while baffles are found along the interior of the culvert. Sills and baffles can be concrete or metal that may vary in size and shape.

Figure 33 Culverts with baffles.

Walking Surfaces

Walking surfaces can determine whether wildlife will use a crossing and should always be considered. Softer surfaces are normally included in the design for dry culverts and may be considered for wet/dry applications – depending on susceptibility of substrate wash-out.

The walking surface is usually a soil layer (minimum 6 inches) that is overlaid on the concrete, steel, or aluminum structure. Yet, the surface should also resist any anticipated erosion. The material used and the site conditions should be considered along with the ultimate functions of the dry culvert to avoid a design that results in a high-maintenance requirements.

Transition from Walking Surface to Natural Ground

While the elevation of the walking surface of the culvert itself is a primary design focus, the transition from the end of the culvert to natural ground is equally critical to the success of the design. Riprap on the slopes or ditches near the end of the culvert may be barriers between the end of the culvert and adjacent habitat. Site specific conditions will dictate the overall design, however often a pathway between the culvert leading to adjacent habitat may be needed to encourage wildlife towards the crossing.

FDOT Project Examples

Culvert Type	Design Species	Project Information	District
Dry Box Culvert	Large mammals	I-4 at SR 557 Interchange Improvements FPID 201215-3	District 1
Drainage Box Culvert with Dry Ledge	Aquatic species and small mammals	SR 710/SW Warfield Blvd from E of SR 70 to Palm Beach/Martin CL FPID 432705-1	District 4
Dry Box Culvert	Large mammals	SR 52 Widening from Suncoast Parkway to East of US 41 FPID 256323-1	District 7
Aquatic Crossing	Aquatic species	US 1/Overseas Highway/Monroe County FPID 446005-1	District 4

Canal Crossings

BACK TO ROADMAP

Canal crossings are structures intended to improve or provide access between habitats by spanning a linear surface water like a canal that would otherwise be a barrier to connectivity. Canal crossing designs may use one of several common structure alternatives:

- Concrete slabs or beams
- Prestressed concrete pile used horizontally
- Timber utility poles
- Covered box culverts or pipes

The width of the canal to be spanned will help determine the superstructure and substructure design, with wider canals requiring increased attention.

Design Species

Terrestrial mammals, reptiles and amphibian species can benefit from a canal crossing.

Canal Crossings – Pros and Cons

PROS:

- It can be a simple and inexpensive method to reduce the barrier effects of a deep canal.
- Narrow canals (40' to 75') can be spanned without placing piles in the canal.
- Because these crossings are not designed for human use, the design may proceed as a non-typical bridge design since no ADA requirements are needed and lower loads expected.
- Historically it does not require a Bridge Design Report.
- Typically, easy to construct and heavy equipment can be minimized.

CONS:

- Although a BDR may not be required, analysis for the design load, vertical loads, lateral loads and changes in temperature are still required.
- May become an element that collects trash and debris in the waterway.
- Could provide an unauthorized access point to offsite habitat for pedestrians or small vehicles like ATVs.
- The materials used have a direct correlation to the walking surface. Analysis between the design species' preferred walking surface is needed when selecting materials.
- Timber poles have been used, but the round and naturally tapered characteristics of the poles when laid side-by-side can be an unattractive walking surface to hooved animals.

Structure Types, Concepts and Photographs

A canal crossing is a wildlife overpass that is a simplified bridge structure. Designs used have included superstructures made from wood or concrete. The substructure can consist of traditional pile-supported footers or more simple concrete end blocks at the top of bank on either side of the canal with the superstructure embedded in the end block. The end block design can eliminate the need for piles.

Canal Crossings

Concrete Slab or Beams

Concrete slabs and Florida I-Beam (aka FIB) superstructures have been used to provide canal crossings. Both structures can be designed to span the entire width of the canal which eliminates the need to install substructure elements such as piers or piles within the canal which may impede flow and have adverse hydraulic impacts.

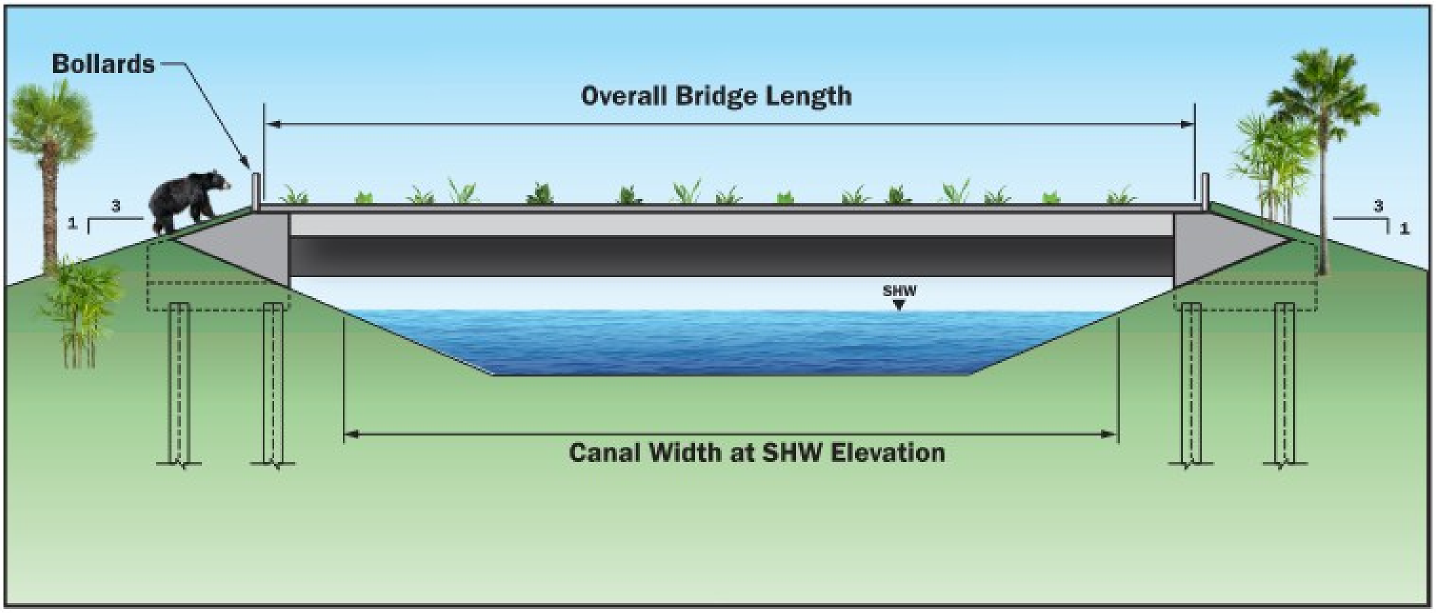


Figure 34 Profile view of a canal crossing with a concrete Florida I-Beam (FIB) design, pile supported substructure and parapets to retain a layer of soil for a natural walking surface.

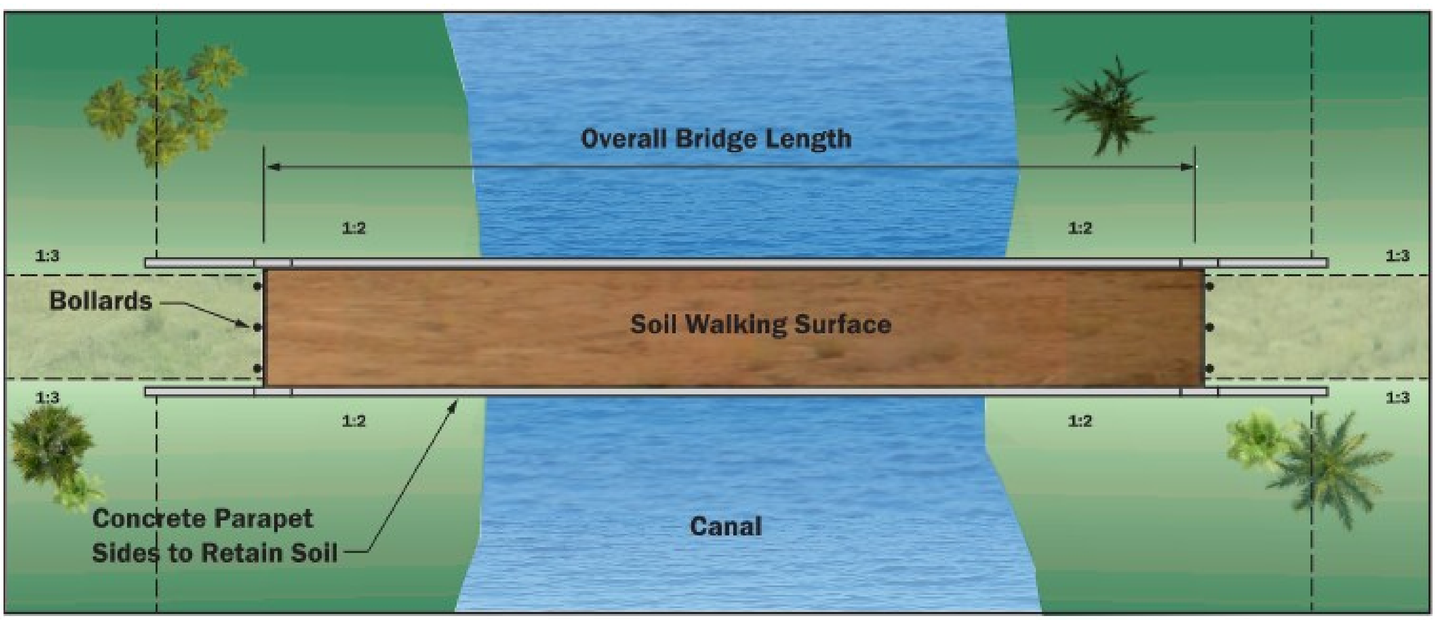


Figure 35 Plan view of a FIB design canal crossing with natural walking surface.

Figure 36 Concrete FIB structure with natural walking surface and bollards, SR 29, Collier County, D1 (FPID 407940-1).

Figure 37 Concrete FIB structure with natural walking surface, SR 29, Collier County, D1 (FPID 407940-1).

Prestressed Concrete Piles

Precast, prestressed concrete piles are normally used as bridge piles. However, 30-inch square concrete piles have been used in designs to provide canal crossings. The piles are placed side-by-side horizontally to create a five-foot walking surface to cross the canal. The use of concrete end blocks is employed at the ends of the piles with slope protection to prevent any future bank erosion at the structure location.

The type of piles used are prestressed square concrete piles from FDOT Standard Plan Index #455-031. The advantages of choosing this alternative would be to provide a flat walkway, having materials that are readily available, and they are suitable for wider canals (greater than 50 feet).

Canal Crossings

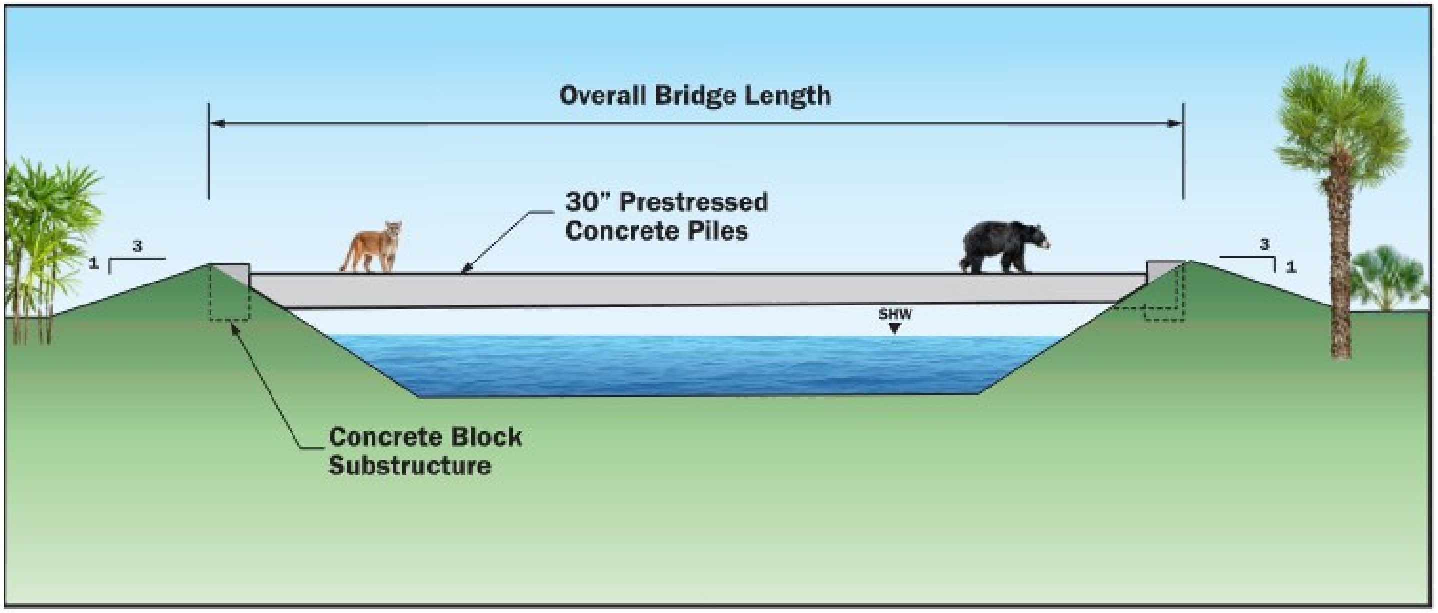


Figure 38 Concrete pile bridge canal crossing with end blocks for substructure.

Figure 39 Concrete pile bridge, I-75 Alligator Alley, Collier County, D1 (FPID 444008-3).

Timber Utility Poles

Timber utility poles can provide a low-cost option for short spans and are better suited for more narrow canals (canals 50 feet wide or less). The light weight of the timber poles simplifies construction and requires smaller equipment to install. Class 2 utility poles have been specified in the past. If larger, Class 1 poles are used, then the concrete foundation and end block sizes must be increased to maintain cover.

Timber poles are round and tapered, and naturally uneven when laid side by side so the walking surface is not flat and smooth. To provide a more uniform surface and width, the timber poles can be laid in an alternating pattern so that the top of pole 1 lies adjacent to the bottom of pole 2, etc. The pole ends can be affixed and banded - or otherwise are secured in concrete end blocks situated at the top of the canal banks.

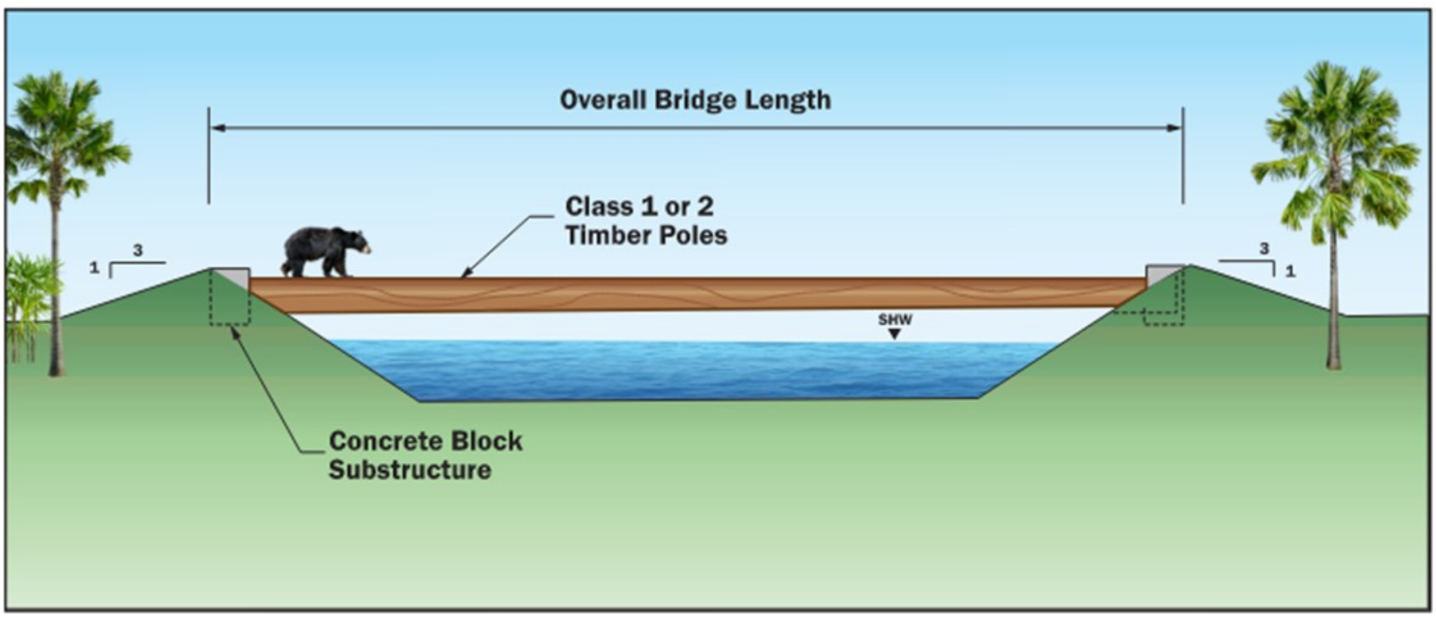


Figure 40 Concept of a timber pile bridge canal crossing with end blocks for substructure.

Figure 41 Timber pile bridge, I-75 Alligator Alley, Collier County, D1 (FPID 444008-3).

Covered Box Culverts or Pipes

In smaller canal or large-ditch locations a suitably-sized, precast box culvert or large pipe can simply be placed into the canal - then covered with soil and seeded. Limited embankment protection is a good idea, using materials such as riprap. This strategy can work well in low flow conditions with stable soils at the channel bottom. An additional benefit of this method is the possibility of installing tidal “flap-gates” on the structure - which allow one-way water flow. The main detriment of flap-gates is the impeded movement of aquatic and amphibian species along the channel.

Walking Surface

The walking surface will depend entirely on the type of canal crossing being designed. The timber pole option has limitations where wildlife with padded feet may not be affected; yet hoofed species may be deterred from using an uneven, rounded walking surface. Longitudinal gaps between the poles will be present due to the timber poles being both a natural material and tapered. Camera data has demonstrated that panthers and Florida black bears in D1 will use the timber pole bridges while no records of deer have been obtained to date. Adaptations to timber pole bridges to encourage hooved animals to use the structure would likely be necessary, possibly flattening the top plane to provide a smoother surface, or pursuing a method to fill the longitudinal gaps.

Canal Crossings

Concrete slab and FIB structures can be designed to include side walls or concrete parapets. Previous designs have used a 27-inch-tall concrete parapet that serves as side walls to retain a layer of soil substrate that provides a natural ground cover.

Square concrete pile bridges provide a flat surface for walking; however natural soil cover on the walking surface are less feasible with this alternative. Modifications to add soil-retaining side walls could be pursued. Hooved species may also be deterred from using a purely concrete walking surface.

Transition from Walking Surface to Natural Ground

The difference in elevation between the natural ground to the walking surface may need a small earthen ramp. While large and medium-size mammals will likely step up, a ramp would accommodate smaller mammals and small reptiles. The design should consider long-term stability of the soil and site-specific conditions to avoid recurring maintenance for the ramp.

Project Examples

Type	Design Species	Project Information	District
Timber Pole	Florida Panther, Florida Black Bear	I-75 Alligator Alley from Broward County Line to Naples Toll Booth FPID 444008-2, 444008-3, and 444008-4	District 1
Concrete Pile	Florida Panther, Florida Black Bear	I-75 Alligator Alley from Broward County Line to Naples Toll Booth FPID 444008-2, 444008-3, 444008-4	District 1
Concrete Florida I-Beam with Natural Walking Surface	Florida Panther, Florida Black Bear, Prey species	SR 29 Wildlife Crossings, 407940-1	District 1

Design Considerations

This section provides additional planning and design considerations for a wildlife crossing. The considerations include:

- Wildlife Corridor Connectivity
- Approach Zones
- Roadway Lighting
- Roles of Disciplines in Wildlife Crossing Teams
- Utilities – New and Relocated
- Construction Considerations
- Environmental Documentation
- Other Environmental Laws
- Signage
- Maintenance

Wildlife Corridor Connectivity

Wildlife crossings intend to connect existing (or proposed) wildlife corridors; therefore, the selection of crossing locations places a major emphasis on the corridor's long-term viability. Public lands which are conserved for this purpose provide an optimum candidate – as can conservation easements or FDOT right-of-way.

Approach Zones

The approach zones to a wildlife crossing are critical to successful use by the design species. It must be inviting, easily accessible, and considered during design so that no unintentional barriers result from implementation of the design. Approach zones for terrestrial animals should provide a continuous pathway from the off-site natural environment to the man-made elements of the wildlife crossing. As an example, rubble riprap is commonly used at bridge abutments, but this substrate is also difficult for animals to traverse. The overall design may need to include an accommodation for a pathway leading to the crossing. Other potential barriers may be deep roadside ditches or canals.

Developing a plan for approach zones may include the use of substrate to form pathways, native vegetation plantings, or other features that enhance a continuous, uninterrupted corridor similar to the natural surrounding landscape. The use of natural ground material, minimal human disturbance, and a design that reduces light and noise from the road all contribute to a natural approach zone for wildlife entering the crossing.

Roadway Lighting

Wildlife strikes tend to increase at night. Certain species more actively forage at night – plus wildlife are far less visible to drivers. In this regard, crossing locations may install improved roadway lighting, but not at the crossing itself. Rather, lighting may benefit wildlife where the fencing terminates on either end of the highway approach. In the case of some species, nighttime lighting at the crossing may – or may not be – preferred.

Roles of Disciplines in Wildlife Crossing Team

The design for a crossing for wildlife typically involves a multi-disciplined team. Crossing designs must typically serve a combination of needs; therefore, coordination with appropriate professionals is essential for success:

- Biological staff can establish various species' needs, consider location and quality of wildlife corridors, help to select potential crossing locations, and then establish crossing parameters.
- Roadway Design engineers can help to design horizontal and vertical crossing dimensions and then provide iterative alternative options that might consider varying highway grade elevation.
- Drainage/Hydraulic engineers can help to provide both opportunities and constraints regarding the location and elevation of new culverts.
- Structures engineers are responsible for the structural design and details of larger wildlife crossings including footings, walls, beams, decks, and any load-carrying elements.
- Construction engineers may review plans and provide a constructability review that includes feasibility considerations and input on construction costs.
- Right-of-Way staff may offer guidance regarding fence designs and components, access management and gate locations.
- Environmental (NEPA) staff can determine the most efficient environmental documentation and work with biological staff to broach any necessary permits.
- District maintenance can evaluate the maintainability of proposed designs.

Coordination with wildlife resource agencies is essential when determining location and design of a wildlife crossing. The U.S. Fish and Wildlife Service (USFWS) and the Florida Fish and Wildlife and Conservation Commission (FWC) would be involved for terrestrial crossings. Aquatic crossings may involve the National Marine Fisheries Service (NMFS).

Utilities – New and Relocated

New or retrofitted highway improvements – such as wildlife crossings – may require the modification of existing utilities or require consideration for future accommodation. Most utilities run parallel with a highway; yet perpendicular utility crossings are common as well.

Wildlife crossings provide an outstanding opportunity to pre-plan and accommodate existing and future utility needs that perpendicularly cross a highway. Sometimes design enhancements may emerge which serve both functions.

For example: Suppose the utility engineer identifies a future across-the-highway utility need. If a concrete encasement or "u-duct" were constructed off to one side, then this pre-positioned utility vault can provide for the future need - or even act as a drain, if desired. Yet, if the u-duct's elevated surface and cover plate are constructed at the right elevation – the vault can also act as a raised Wildlife Pathway Shelf (see Figure 3).

Figure 42 Concrete Vaults that carry Utilities.

Utility placement should be coordinated during the design phase to avoid post-construction retrofits that could compromise the function of the wildlife crossing. For example, as shown in Figure 4, a pipe installed under a bridged crossing is acceptable if it is included in the original design and vertical clearance accounted for; however, retrofitting a pipe after construction could reduce the crossing's vertical clearance and impair its effectiveness.

Figure 43 Under-bridge Pipe Addition.

Construction Considerations

The design of a wildlife crossing may also need to consider several during-construction aspects which directly affect the access, construction duration, and overall cost of a proposed crossing.

Construction Access and Staging

Contractors and construction equipment need access to the site – as well as a staging area to store materials and park/move equipment. Certain construction activities (such as crane use) may also require platforms to work from – with appropriate setback based on boom lengths and other equipment features. A safe construction access driveway and possibly a short access road may be required – accompanied by MUTCD components to warn and slow drivers. Adequately sized staging area(s) and construction platforms should also be considered and included in any permitting efforts.

Traffic Control and Construction Phasing

Construction phasing plans and traffic control plans will be developed when the wildlife crossing is proposed on an existing highway. Temporary detour routes may be needed. The construction phasing plan will identify specific sequences for construction activities; each of these sequences, or phases, may need a different traffic control plan depending on where the activities occur.

Seasonal Construction Restrictions

Some sites require the consideration of seasonal construction restrictions. The presence of habitat for listed or protected species may have an impact on construction schedules. Examples include the presence of roosting bats, nesting seasons for bald eagles and Florida sandhill cranes or the presence of flightless chicks near or within construction areas.

Environmental Documentation

As with other highway improvements, a new or retrofitted wildlife crossing may create an impact footprint. In this regard, the wildlife crossing's production schedule should provide adequate time for the appropriate environmental study. Coordinating with the Environmental Management Office (EMO) is essential for determining the correct National Environmental Policy Act (NEPA) documentation route. This coordination is critical because FDOT has assumed the federal government's responsibilities for NEPA review and will assist in determining the most appropriate level of review required for the project.

Other Environmental Laws

Positive or negative impacts from a wildlife crossing may affect certain protected resources, which subjects the proposed project to legal or regulatory requirements. As appropriate, environmental studies may need to consider, coordinate and study parameters such as:

- Section 7 or 10 of the Endangered Species Act
- Section 4(f) of the US Department of Transportation Act of 1966
- Section 106 of the Historic Preservation Act of 1966
- Lands owned and/or managed by Federal, State and Local Governments
- Impact on adjacent properties
- Impact on conservation easements

Signage

Advance warning signage about the potential presence of wildlife attempts to modify driver behavior by alerting drivers. The practice is based on both ecological and traffic engineering principles. Specialized roadway signs may range from permanent, static signs featuring specific wildlife icons to dynamic message signs.

Signs serve as components of a proactive traffic control strategy designed to alert drivers to the potential presence of wildlife near roadways to reduce wildlife vehicle collisions. Advancements in promoting safety through wildlife crossing zones have resulted in the development of new signage which is covered in greater detail under the **Advanced Design Elements** hyperlink on the Roadmap to Wildlife Connectivity. Other sign examples are provided below.

- Vehicular notification signs on the highway
- Pedestrian warning or “use” signs, such as: “Designated Wildlife Crossing,” “No Trespassing,” “Restricted Area,” “Please Close and Lock Gate.”
- Reduced nighttime speed limit signs

Reduced nighttime speed limit signs are a form of static signage used as a tool to reduce wildlife vehicle collisions. Many species are most active at dusk, dawn and nighttime—when drivers have the least visibility. These signs are strategically placed in important habitats or known travel corridors and work in conjunction with daytime speed limits to create a variable speed zone for specific times when animals are the most active.

Maintenance

As with other highway improvements, wildlife crossings need to be maintained. There may be many components to wildlife crossings that would require maintenance activities following construction; these may include bridge substructure and superstructure, culverts, fences, gates, wildlife pathways, canal or water crossings, and road or parking access accommodations. The **Monitoring and Maintenance** section provides greater detail on maintenance needs specific to types of wildlife crossings or enhancements.

Maintenance needs will vary according to specific features or type of crossing. Future maintenance needs are an important component of the design considerations in developing the plans. The maintenance activities themselves should be identified during design and appropriate access points to conduct any maintenance will need to be included in the construction plans.

Wildlife overpasses and some box culverts will enter the FDOT’s bridge inventory for the Bridge and Other Structures Inspection Program. Structures with spans less than 20 feet in length are typically inspected as part of the FDOT’s area maintenance center. The bridge components for wildlife overpasses will be inspected through the Bridge Inspection Program, however criteria for maintenance of the walking surfaces will need to be established.

Some issues could affect all crossings, such as extreme overgrowth of vegetation or exotic or nuisance species that impede approaches to or use of the crossing should be maintained as needed. Damage to wildlife fences, gates, locks or latches could allow wildlife to enter the roadway if not routinely inspected, reported and maintained. Post-construction drainage patterns that differ from anticipated conditions, or repeated human access also may affect the functionality and require adaptive management. The condition of the walking surface should be inspected for erosion and maintained to restore the effectiveness and suitability of the crossing.

Advanced Design Elements

This section will provide examples of advanced design elements consisting of devices and techniques that have been used throughout Florida to alert drivers about the potential for wildlife entering roadways. These include:

- Signs
- Pavement Markings
- Advanced Wildlife Warning Systems

Types, Concepts and Photographs

Signs

Warning signs to alert drivers of the potential to encounter wildlife on or near roadways are often used in areas where wildlife is known to frequently cross roads or have a high potential to be present. These may be used to provide a wildlife crossing warning near conservation lands or used to indicate entry into habitat. Warning signs may be accompanied by signs notifying drivers to reduce nighttime speed limits. Locations of signs specifically warning drivers for the potential of Florida panthers and Florida black bears have been developed into GIS layers and are available for viewing in the Environmental Screening Tool (EST) of the Efficient Transportation Decision Making (ETDM) website.

Figure 44 Warning sign for Key deer in D6.

Figure 45 Warning sign for the Florida panther and a night time speed limit sign in D1.

Pavement Markings

Pavement markings are used to convey messages to roadway users and are painted on the roadway in advance of a feature. An example of using pavement markings for wildlife is shown in Figure 2 specific to the Key deer. The pavement markings notify drivers of possible deer crossing the roadway ahead in combination with a wildlife warning sign and flashing yellow beacon. The beacon flashes at a constant interval both day and night.

Figure 46 Key Deer Crossing pavement marking with wildlife warning sign in D6.

Advanced Wildlife Warning Systems

Alternatives to static road signs may have a better result of slowing down traffic in wildlife-heavy areas. Advance warning systems seek to change driving behavior based on messages sent to drivers. Real-time information can be provided to drivers via flashing or dynamic message signs when used in combination with systems to detect wildlife entering or near the road. However, the system to detect wildlife must be a system that will provide highly accurate results with a goal of being more than 90 percent accurate. Too many false-positive signals will have the effect of drivers assuming the system is inaccurate and driving habitats will not change.

An advanced wildlife warning system was developed as a pilot project to install radar and three types of cameras (pan-tilt-zoom or PTZ, fixed thermal, and stationary) in 1.6-mile segment of SR 29 that was selected due to a high number of panther-vehicle collisions. The thermal camera is the primary tool for observing wildlife, while the fixed camera is trained on the same view to provide visual confirmation. The PTZ camera allows an operator to zoom into specific areas of interest without affecting the fixed camera view. The radar detector provides a 360-degree sweep that will aid in detecting animals within the detection zone, particularly at or past the limits of the thermal camera.

The radar detector and cameras would be mounted on an ITS pole located in the mid-point of the project corridor to detect wildlife movement. Once wildlife is detected, signals are sent to advisory signs at the beginning and end points of the project corridor. The advisory signs consisted of a yellow flashing beacon with a wildlife warning sign panel as shown in Figure 3.

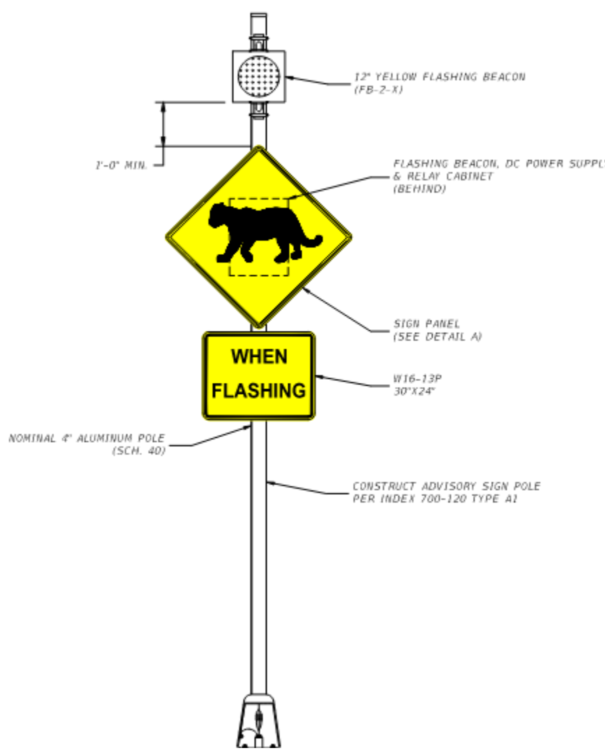


Figure 47 Advanced wildlife warning signal pole.

Advanced Design Elements

BACK TO ROADMAP

In District 5, an advanced wildlife warning system has been proposed which will utilize dynamic message signs (DMS), dual-sided LED highlighted “WILDLIFE XING” sign assemblies, and sensor systems called Wildlife Collision-Avoidance Systems (WCAS). These would be placed in locations along a 30-mile segment of SR 40 to detect and monitor wildlife movement and provide real-time information to motorists. The Florida black bear is the target species, although other wildlife would trigger the warning system. The proposed system will use pole-mounted cameras or sensors to detect wildlife movement and send a signal to the dynamic signs.

Figure 48 Example of a static sign used in combination with dynamic message signs (DMS) triggered by signals from a wildlife collision-avoidance system (WCAS).

Currently, the project is being organized in two phases, the detection system and the infrastructure. The detection system consists of cameras, sensors, conduit, communication, electrical and power components. Infrastructure components consist of flashing beacons and signs. Power sources will include solar panels.

To develop the detection system, D5 has installed a utility pole and is working with various vendors to temporarily install and test a combination of camera types and sensors to achieve a highly accurate system. Technologies that will be tested include cameras, thermal detection and radar. Cameras can detect movement during daylight hours. Radar can sense motion and can determine if the source is behaving like wildlife or moving like a human. Thermal devices are useful in low-light conditions. It is expected that a mix of different devices will be used once the test period is completed. The optimal combination of cameras and sensors is expected to be up scaled and used for the length of the project corridor.

Design

The Manual on Uniform Traffic Control Devices (MUTCD) developed by the Federal Highway Administration (FHWA) guides the development of wildlife warning signs. Advanced warning systems may use Intelligent Transportation Systems (ITS) components, particularly for wildlife sensors and transmission of information to dynamic or flashing signs.

FDOT Project Examples

Type	Design Species	Project Information	District
Advanced Wildlife Warning System	Large mammals	Advanced Wildlife Warning System FPID 448693-1	District 1
Pavement Markings and Statics Signs with Flashing Beacons	Key Deer	Push Button Contracts FPID 434684-1, 443897-1, 250564-1	District 6
Wildlife Collision-Avoidance Systems (WCAS)	Florida Black Bear	ITS Safety Deployment FPID 451415-1	District 5

Fencing, Walls and Embankments

BACK TO ROADMAP

Combinations of elements like fencing, walls and embankment can be used to deter wildlife from entering a roadway, or for directing animals to a wildlife crossing or a jump out. An analysis of wildlife movement, side streets, driveways and land use along the fence limits is necessary to determine the needs of adjacent landowners and access points, while balancing an ecologically beneficial placement of fence. Site specifics and the design species will drive the design.

Types, Concepts and Photographs

Wildlife Fencing

Wildlife fences often extend up to ten feet above the surface of the ground for large, agile wildlife, but may be lower if the design species are smaller. The wire arm attachment at the top of the fence is an option that may be included depending on the design species. The fence material can be chain link fabric or woven wire.

The FDOT Standard Plans Index (550) defines the standardized fences used in design plans. Normal right-of-way fences in rural areas are usually woven wire fence with posts made from timber, steel, recycled plastic or concrete, and barbed wire strands are added at the top and bottom of the woven wire fence. This form of fence is usually about five feet tall. While this type of fence can be a barrier for some species, it is not normally specified as a wildlife fence.

Specifically designed wildlife fences are often designated in plans as a fence either eight or ten feet tall, with barbed wire along the top. With the Fiscal Year (FY) 2026-27 Standard Plans, the FDOT has added wildlife fence details to Index 550-001 (Fence Type A). This standardized plan specifies a ten-foot-tall fence consisting of woven wire with three strands of barbed wire at the top and one at the bottom.

While Index 550-001 provides a standard, other fence materials such as chain link have been used for wildlife fencing. The characteristics of a wildlife fence should consider the size and strength of the design species as well as jumping, climbing, and digging tendencies of the species that would benefit from the fence. For example, Florida black bears have been known to climb chain link fences and the 2-inch by 4-inch game fence shown in Figure 1 has been used when bears are the design species. Smaller gauge fence material such as 0.25-inch by 0.25-inch mesh can be installed over larger gauge fence material at the ground line to discourage small mammals, some reptiles and amphibians (herpetofauna) from permeating a game fence.

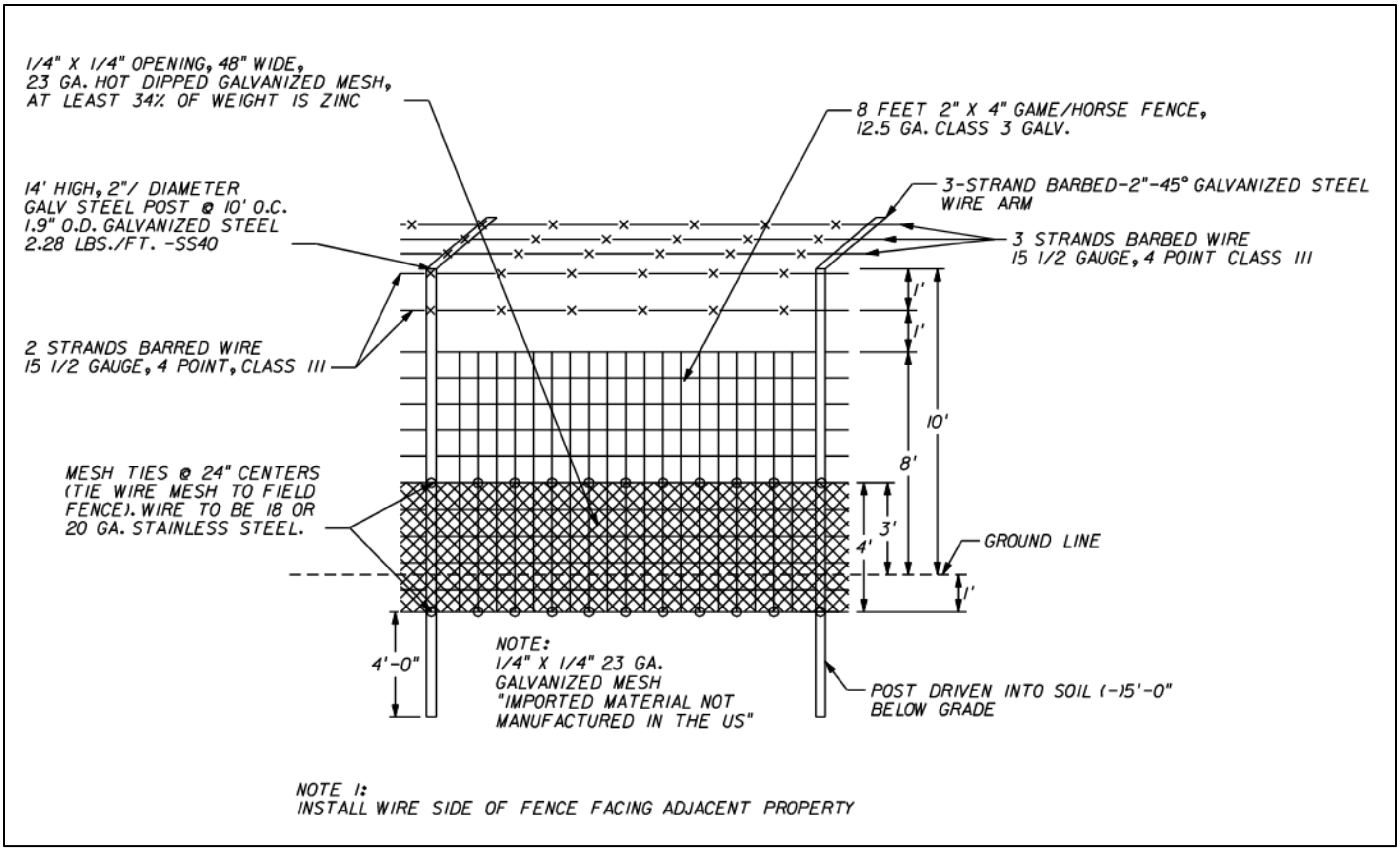


Figure 49 Typical detail for a special wildlife fence.

The fence placement should guide animals to and from the crossing yet not prohibit access to important habitats and resources necessary for survival. The wildlife crossing or associated fencing cannot impede an adjacent property owner's only practicable route of ingress or egress to their property. Similarly, the placement of the fence should consider off-site features that may require maintenance such as utility cabinets or poles.

The length of fence that can be provided on either side of the wildlife crossing is another important consideration during site selection phase, however the specific length is variable due to site conditions and design species. A minimum of 1,000 feet of fencing on each side of the crossing is a practical starting point; factors to consider when determining the final length include:

- Sufficient length to guide animals to the crossing feature,
- Fence is implemented on both sides of the road,
- Fence extends beyond known wildlife movement zones or hot spots,
- The termination points provide enough buffer zone to minimize entry to the roadway, and
- Fence ends are aligned opposite each other.

Determining the endpoints of a wildlife fence requires balancing ecological, engineering, and safety considerations. Aligning fence ends opposite each other and considering landscape features can further enhance the effectiveness of wildlife fencing. Fences should tie into natural barriers or features that animals are unlikely to cross, while also extending beyond known wildlife movement hotspots to guide animals safely toward the intended wildlife crossing. Termination points must consider roadway intersections, drainage, utilities, and driveways, while minimizing the “end effect” where animals attempt to cross at the fence’s end. Ultimately, the goal is to provide continuous guidance for wildlife while ensuring the fence is practical to build, maintain, and effectively reduce vehicle collisions.

Interstates and limited access roadways may be suited to “fence only projects” because they are designed to control the entry and exit points for vehicles. Long stretches of fence are not interrupted by driveways or intersections with other roads. In areas of prime habitat, projects to install only wildlife fences may be implemented along roadways to reduce the chance of wildlife vehicle collisions. An example of this is along I-75 (Alligator Alley) in Collier County where ten-foot-high wildlife fence was installed in 2015 along a nine-mile stretch of interstate that had seen a high number of vehicle collisions with Florida panthers. The result was successful in reducing the number of collisions and assisted in directing wildlife to existing crossings further to the east. In the years that followed, wildlife connectivity was enhanced in this nine-mile segment through later retrofit projects to promote wildlife passage under I-75.

Figure 50 Wildlife fence with woven wire and barbed wire (Type A) on I-4, Volusia County, D5 (FPID 408464-1).

Figure 51 Wildlife fence specifically for key deer on US 1, Monroe County, D6 (FPID 434684-1, 443897-1, and 250564-2).

Figure 52 Herpetofauna fence attached to woven wire fence, I-4, Volusia County, D5 (FPID 408464-1).

Figure 53 View within the median of a ten-foot chain link wildlife fence attached to a bridge on I-75 Alligator Alley, Collier County, D1 (FPID 405882-3).

Gates

Gates are used to provide human access points within the limits of the wildlife fence. The gates are sized for the purpose, for example, three-foot swing gates for personnel, or wider for vehicle access. Tight connections to crossings or gates are needed to avoid weak spots or gaps in the fence.

Gates are normally chain-link swing gates when used within the limits of a wildlife fence. Sliding gates or special gates may be called out in the plans. Figure 2 is a detail of a double 10-foot swing gate designed for a landowner. Bears particularly can damage swing gates due to their heavy weight. For this application, a bear crossing adaptation was included consisting of the installation of wood slats parallel to the ground on one side of the swing gates. The wooden slats are intended to encourage bears to use the slats like a ladder instead of using the swing gate as a way over the fence.

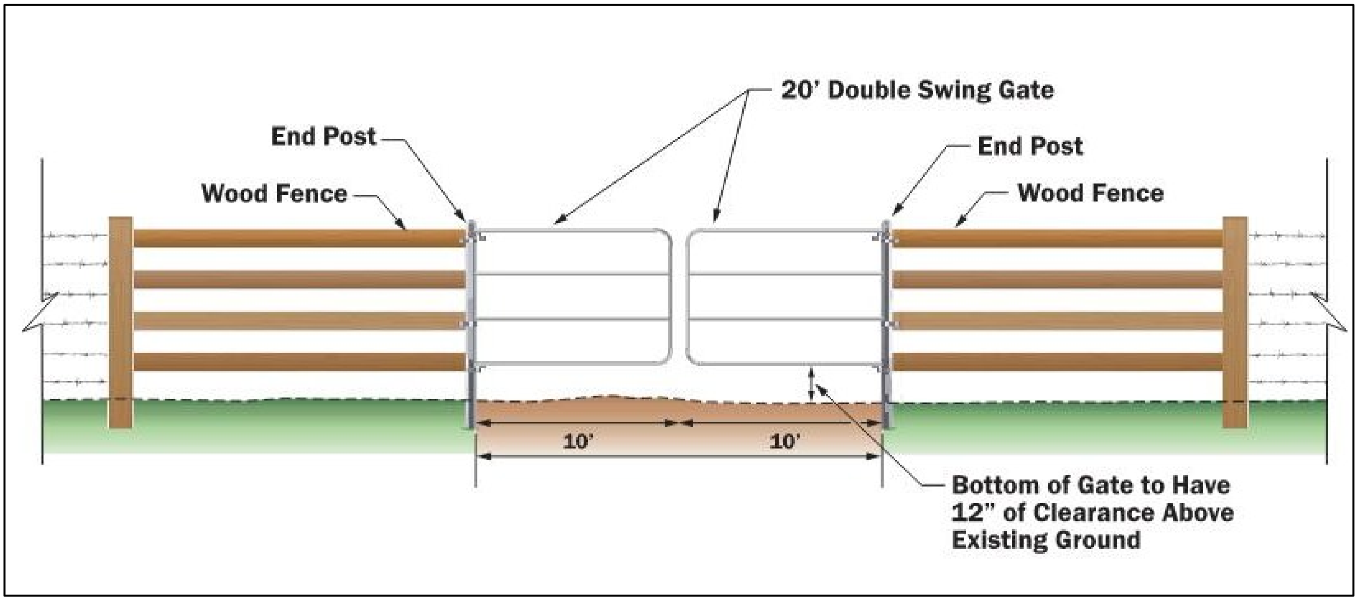


Figure 54 Typical offsite gate detail with wooden slats on left side for bear crossing.

Figure 55 Example of public awareness sign on an access gate within a segment of wildlife fence, SR 29, Collier County, D1 (FPID 407940-1).

Figure 56 Access gate and swing gate for maintenance within a segment of wildlife fence on SR 29, Collier County, D1 (FPID 407940-1).

Figure 57 Three-foot-wide swing gate for maintenance and monitoring, I-75 Alligator Alley, Collier County D1 (FPID 405882-3).

Jump Outs

Wildlife jump outs are intended to be a one-way escape route for animals that find a way into and become trapped on the inside - or roadside - of wildlife fences. On the roadside, the jump out appears to be a gap in the upper portion of a wildlife fence at the top of an embankment. The embankment gently slopes up to the gap. The off-site side of the jump out consists of a retaining wall to support the embankment. The height of the wall is designed to discourage wildlife from jumping back into the right-of-way. The height of the retaining wall can be up to eight feet depending on the design species.

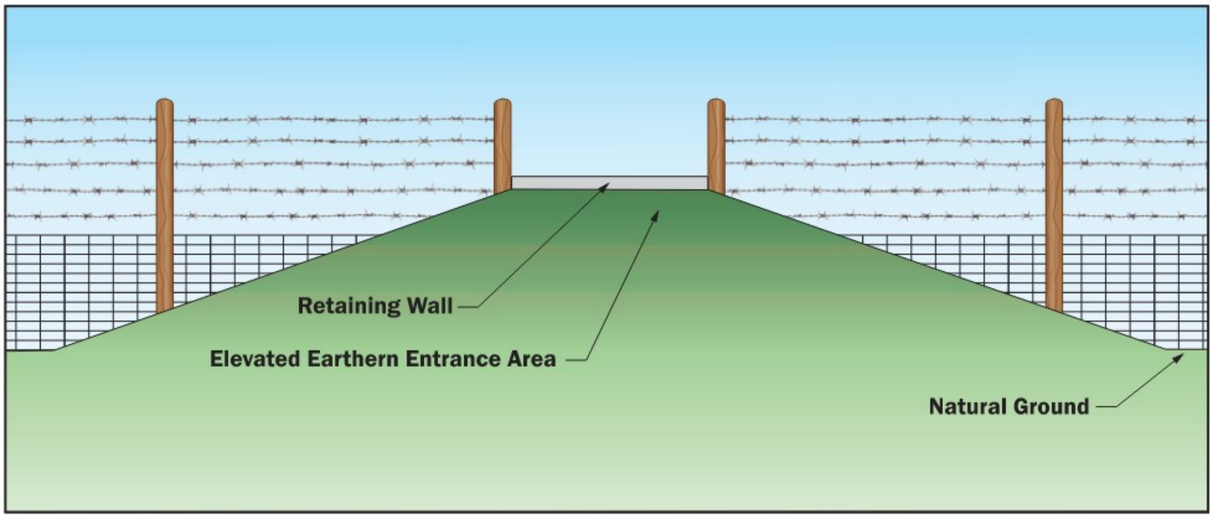


Figure 58 Jump Out view from Roadway (Inside the Fence)

Figure 59 Roadside view of a Jump Out on I-4, volusion County, D5 (408464-1)

Figure 60 Concrete barrier wall and wildlife fence for a jump out, I-4, Volusia County, D5 (FPID 408464-1).

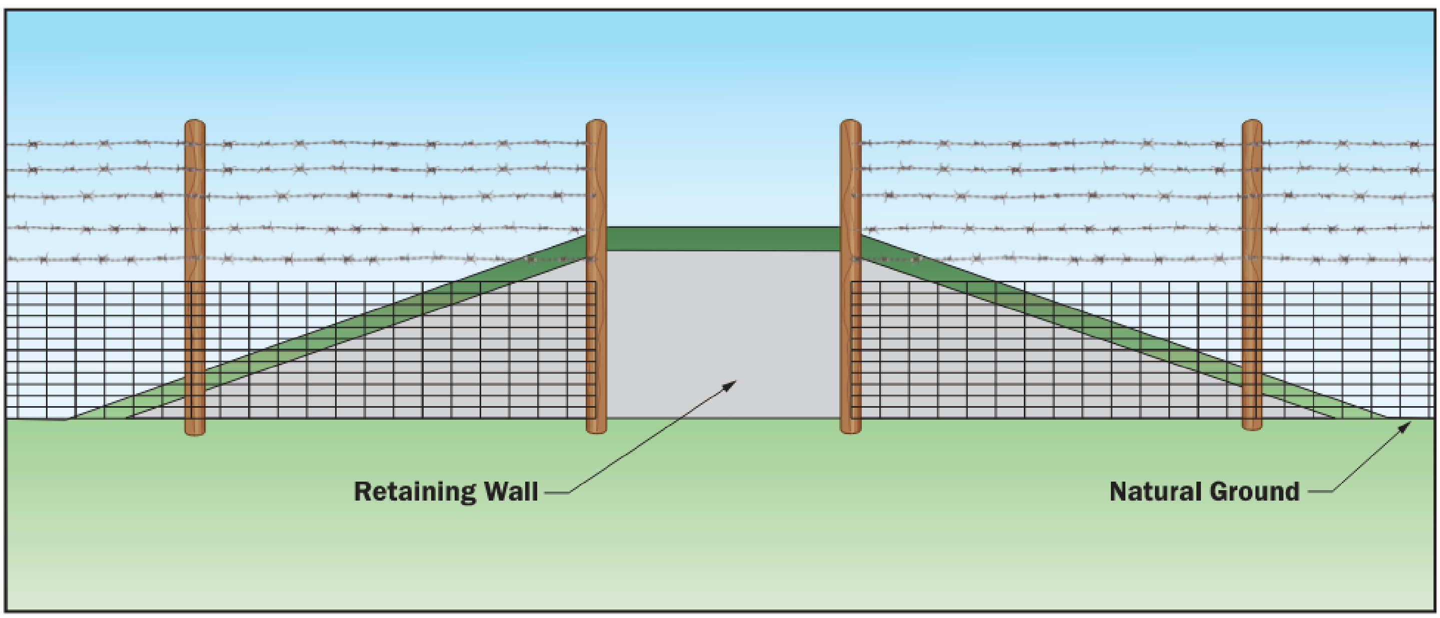


Figure 61 Jump-out view from off-site. The retaining wall supports the embankment on the roadside.

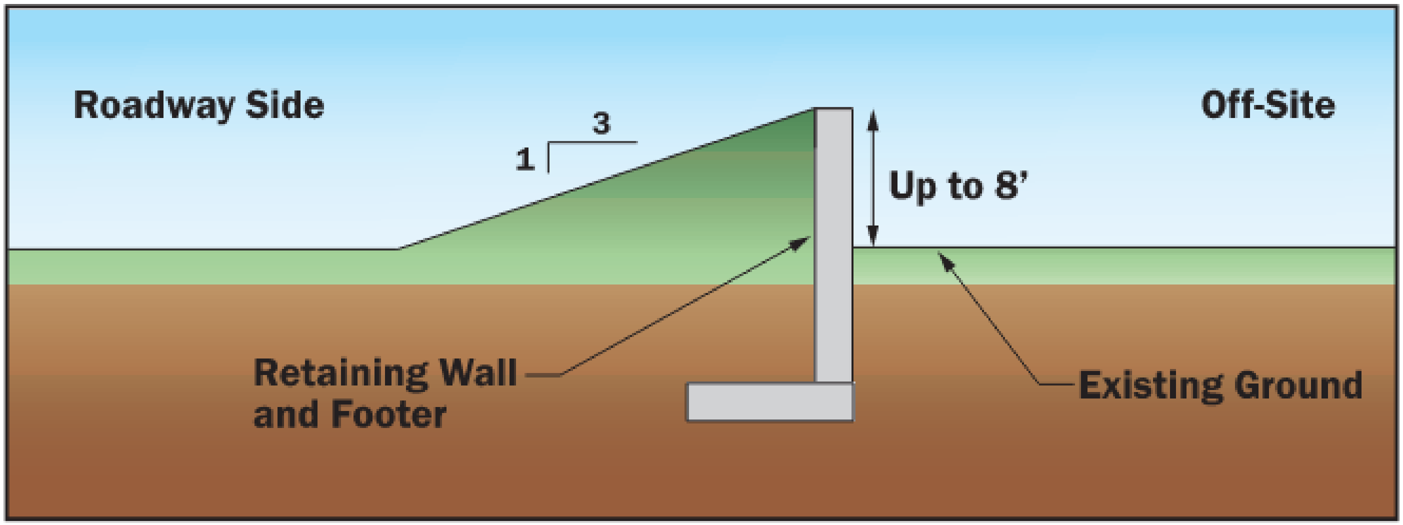


Figure 62 Cross section of a jump-out with embankment on the roadway side.

Figure 63 View of the landing area behind concrete barrier wall and wildlife fence for a jump out, I-4, Volusia County, D5 (FPID 408464-1). In this photograph, the roadway side is on the right and the off-site side is on the left.

Designs

Jump outs should lead to flat and clear landing areas. The fence opening needs to be clear of branches and vegetation. The earthen ramp should have a gradual slope up to the jump out. The height of the barrier wall for Florida species is a minimum of five feet and up to eight feet has been used.

Jump out designs are provided in plans as special details. While concrete retaining walls have been used in Florida (see Figures 10-15), notes in literature indicate retaining wall materials may consist of wooden planks, gabion baskets or stacked and interlocking concrete blocks. Spread footers are necessary to support the concrete retaining wall. Earth embankments provide a gentle slope up to the edge of the jump out.

Walking Surfaces

Walking surfaces for the jump outs should be natural, earthen berms with a slope as gentle as practicable, such as a 1:3 slope. The landing surface behind the retaining wall should be natural upland and provide a safe zone for wildlife to jump down.

Project Examples

Type	Design Species	Project Information	District
Wildlife Fence (Directional Barrier)	Key Deer	US 1 Monroe County 434684-1, 443897-1, and 250564-2	D6
Wildlife Fence (Directional Barrier) Jump Out	Florida Black Bear, amphibians and reptiles	I-4 FPID 408464-1	D5
Wildlife Fence (Directional Barrier)	Florida Panther	I-75 Alligator Alley FPID 405882-3	D1
Gates for Maintenance and Monitoring	Personnel	I-75 Alligator Alley FPID 405882-3	D1
Access Gates and Public Awareness Sign	Personnel, Public Access Points	SR 29 New Bridge Structures/Wildlife Crossings FPID 407940-1	D1

Monitoring and Maintenance

BACK TO ROADMAP

Once a crossing feature or enhancement has been completed there may be associated monitoring or maintenance. Wildlife crossings often have pre- and post-construction monitoring programs to record wildlife use, described below. As with other highway improvements, wildlife crossings need to be maintained. Various components such as bridge substructure and superstructure, culverts, fences, gates, wildlife shelves, canal or water crossings require maintenance. This section summarizes some of the various maintenance considerations for wildlife crossings and other enhancements.

Monitoring

Pre-construction monitoring is often related to collecting camera data via a digital trail camera to support the presence of species. This type of monitoring is normally short-term and undertaken at specific locations to aid in the development of design species, the most appropriate crossing type and to finalize a crossing location.

Should post-construction monitoring be requested by a regulatory agency, the USFWS and/or FWC should have an active role in the review and development of the monitoring plan. Any post-construction monitoring should be for data collection and information only and will typically be conducted for a limited period of time.

FDOT may also implement long-term monitoring at broad intervals (e.g., semiannually, bi-annually) to look for any maintenance issues (e.g., vegetation removal, erosion issues, fence repairs) that may need to be addressed. Costs are associated with adding new cameras, maintenance or replacement costs, and staffing to collect and process the monitoring data.

Post-construction monitoring can provide a source of data to evaluate successful use or hesitation at the crossing. Adaptive maintenance techniques or future design modifications related to the structure type, walking surface, fences, gates and surrounding vegetation may be developed based on both types of wildlife behavior.

FDOT hosts an interactive **Statewide Wildlife Crossing Map** featuring photo galleries at crossings equipped with wildlife-monitoring cameras. While the map does not constitute a formal monitoring program, it represents a collaborative effort between FDOT and partner organizations to gather, manage, and publicly share images captured at these crossings.

Maintenance

Maintenance needs will vary according to the specific features or type of crossing, however some issues could affect all crossings, such as extreme overgrowth of vegetation or exotic or nuisance species that impede use should be noted at the approaches and maintained as needed. Damage to wildlife fences, gates, locks or latches could allow wildlife to enter the roadway if not maintained. Post-construction drainage patterns that differ from anticipated conditions, or repeated human access also may affect the functionality and require adaptive management. The condition of the walking surface should be inspected for erosion and maintained to restore the crossing effectiveness.

Potential maintenance activities specific to bridge, culverted, and canal crossings are provided below. Additionally, different types of maintenance activities will be required for fencing, walls and embankments as well as specialized maintenance for advanced design elements, as described in the following sections.

Bridge Crossing Maintenance

Wildlife overpasses and some box culverts will enter the FDOT's bridge inventory for the Bridge and Other Structures Inspection Program. Structures with spans less than 20 feet in length are typically inspected as part of the FDOT's area maintenance center. The bridge components for wildlife overpasses will be inspected through the Bridge Inspection Program, however criteria for maintenance of the walking surfaces will need to be established. The soil layer for a dry walking surface could be affected by vegetation or erosion. Periodic checks will confirm there are no obstructions or overgrown vegetation that would affect use by wildlife.

Culvert Maintenance

Structures with spans less than 20 feet in length are typically inspected as part of the FDOT's area maintenance center. Box culverts greater than 20 feet in length will enter the FDOT's bridge inventory for the Bridge and Other Structures Inspection Program. Box culverts are likely to have little to no maintenance needs for the structure itself, although periodic reviews to assess the conditions of the approaches to the crossing may be needed. The soil layer for a dry walking surface could be affected by vegetation or erosion. Periodic checks will confirm there are no obstructions or overgrown vegetation that would affect use by wildlife.

Canal Crossing Maintenance

Canal crossings require low maintenance. Unless pedestrian traffic uses the facility, no biannual inspections are expected or required to be done. If natural surfaces or transitional ramps from the ground to superstructure are provided, the canal crossing can be checked to ensure the soil is retained in place and vegetation maintenance, if any, is addressed.

Fencing, Walls and Embankments Maintenance

Fences can be damaged by vehicle collisions, hurricanes, and tree fall to name a few. Gaps at the ground level from erosion can occur. Wildlife fences require routine monitoring and maintenance to retain its functionality. Guidelines for the maintenance of wildlife fences may include:

- Regular inspections for vegetation overgrowth, erosion or fence damage.
- Vegetation management to prevent vegetation from compromising fence integrity or providing pathways for wildlife to bypass the fence.
- Structural repairs to address damaged or leaning posts, torn mesh and sagging wires.
- Gate and access point checks to ensure gates close property, and there are no gaps at the ground level that could allow wildlife to pass through.

Advanced Design Elements Maintenance

Maintenance on advanced detection systems includes vegetation maintenance and system maintenance. Calibration of the systems is needed occasionally and may be required after a hurricane or a storm with high winds. Any obstructions to the camera view will need to be removed quickly to not impede the accuracy of the warning system.

Monitoring and Maintenance

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Maintenance agreements should be considered carefully because of the limited number of vendors currently offering detection systems. Vendors who are located out of state may have a longer response time for maintenance or recalibration. Options may include requiring the detection vendors to provide training to ITS management vendors to avoid a delayed response to maintenance. Other maintenance items include repair or replacement due to lighting, vandalism or theft.

All signs would enter the inspection cycle to inspect elements including the physical integrity, legibility, and retro-reflectivity of static signs among other criteria. Given that wildlife warning signs normally are placed in rural, poorly lit areas, the visibility and functionality of these signs are paramount for species protection.

Over the past several decades, Florida has implemented a wide range of wildlife-crossing designs—including culvert and canal crossings, wildlife bridge underpasses, exclusionary fencing, and more advanced design elements—to improve habitat connectivity and reduce wildlife–vehicle conflicts. As these projects have been planned, constructed, and their performance has been reviewed, valuable lessons have emerged regarding design performance, maintenance needs, and species use. The following section summarizes key lessons learned from these projects to inform future crossing planning and design.

Culverts Lessons Learned

Installing taller dry culverts often requires raising the roadway profile, and the need for guardrails to address clear-zone safety must also be considered. Construction typically involves dewatering, formwork, rebar installation, and concrete placement. Excavation for box culverts—particularly at greater depths—may require temporary sheet piling to stabilize the surrounding soil during wing wall construction, with cranes needed to install and remove the sheets. Depending on culvert dimensions, either truck-mounted or crawler cranes may be required for placement. In some cases, alternative design options may also necessitate foundation installation.

Canal Crossings Lessons Learned

Geotechnical analysis may be required to evaluate soil stability near the top of canal banks and to determine appropriate foundation depths for the selected crossing type. Depending on site conditions, embankment protection—such as shore-rubble riprap—may be necessary at the ends of the structure to reduce erosion along the canal bank. Temporary and permanent impacts to the canal banks should be assessed, and any associated surface-water impacts may trigger environmental permitting requirements. To prevent vehicle intrusion onto the structure, bollards can be installed at each end of the crossing.

Designs that fully span the canal help avoid the need for in-canal piers. If piers are used, construction becomes more complex and requires specialized equipment such as large cranes or pile-driving systems. Span length also influences the depth and weight of the superstructure: wider spans generally require deeper beams or slabs, which can decrease freeboard between the lowest structural member and the canal surface. Increased structural depth may, in turn, require raising the crossing elevation, which conflicts with the goal of maintaining the structure close to natural ground elevation at the top of bank.

Compared to timber-pole and pile-supported bridges, slab bridges and Florida I-Beam (FIB) structures require more substantial substructures. Depending on geotechnical conditions, foundations may need deeper footings or piles, which increases cost and requires additional constructability analysis. In contrast, concrete end blocks—commonly used with timber-pole systems—are simpler to construct. However, these blocks must be designed to safely resist dead loads as well as lateral forces from water flow, wind, and thermal expansion or contraction.

The use of surplus utility poles may offer cost savings, but availability at the time of construction can be unpredictable, posing potential delay risks. Longer poles, necessary for wider canal crossings, may be particularly limited or require longer lead times. Additionally, variations in pole diameters—larger at the base and smaller at the top—can create uneven walking surfaces. Plans should specify alternating pole orientation (top-end adjacent to bottom-end) to reduce surface variation and require poles to be temporarily bound together to prevent shifting during concrete end-block placement.

For crossings supported by prestressed piles, the Standard Index 455-031 for 30-inch square piles specifies a one-inch vent hole through the side of the pile to vent the internal void. Installation plans should specify that piles be set with the vent hole facing downward.

Fencing, Walls and Embankment Lessons Learned

Proper placement of wildlife fencing must ensure that access to private property and utility assets is not restricted. Altering or blocking landowner access can trigger the need for full right-of-way acquisition or the construction of access service roads, both of which are significant costs that should be avoided when possible. Early coordination with affected property owners may be required to determine feasible driveway relocations and to evaluate whether access gates within the fenced segment will function effectively. In addition, access points through the fence will be needed for maintenance and for any monitoring of the wildlife crossing.

When designing a property access gate, consider the types of vehicles that will use the entry, including trucks with trailers, and provide adequate turning space for vehicles pulling off the roadway. Public-facing signage or educational messaging may also be appropriate to clarify the purpose of the gate and reduce misuse or confusion.

Advanced Design Elements Lessons Learned

Signs, pavement markings and advanced warning systems are typically low impact activities. Some sign poles or utility poles may need foundations, and ITS components need a power source. While solar panels may be used, trenching or boring may be required for conventionally powered sign assemblies that would require conduit for electrical wiring.

Roadway geometry will dictate some elements of an advanced warning system. For example, horizontal curves require multiple cameras to obtain views necessary to accurately detect movement. Under this condition, radar sensors may be better but are more costly. Radar sensors have been used to detect human movement as a building security measure for example and are currently being tested to determine their accuracy in identifying wildlife movement. Vegetation cover can impact the field of view for cameras. In some cases, using taller poles may help increase the lines of sight around vegetation or vertical curves. Thermal cameras are being tested to determine the effects of vegetation on the quality of thermal images captured. High accuracy detection is required to affect driver behavior.

Currently there are a limited number of vendors with expertise involving wildlife detection systems. Developing a system may involve vendors that are not within Florida.

Wildlife agencies and FDOT may work together closely to determine the placement for wildlife warning signs. At times, FDOT Districts will coordinate with agencies for input on where to put signs. In several instances, wildlife agencies have asked FDOT to install specific signs—like new deer or bear crossing warnings—when a need is perceived. These requests can occur independently of a road construction project, allowing for quick response times in high-priority areas.

Other stakeholders may include local citizen groups who have an interest in species protection, as was the case with the key deer in D6 (FPID 434684-1, 443897-1, 250564-1). The D5 ITS Safety Deployment project (FPID 451415-1) involved coordinating with National Parks Service staff to develop a camera design that was in balance with the aesthetic of a national forest.

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