Pima County RTA
Wildlife Connectivity Proposal

# KITT PEAK LINKAGE
# WILDLIFE CONNECTIVITY:
# WILDLIFE OVERPASSES AND FENCING
# State Route 86

Submitted by the:

Tohono O'odham Nation
Department of Natural Resources
Wildlife and Vegetation Management Program

In partnership with the:

ADOT Tucson District
ADOT Urban Project Management
ADOT Environmental Services

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## INTRODUCTION

Highways constitute one of the most significant forces altering natural ecosystems in North America (Forman and Alexander 1998, Trombulak and Frissell 2000, Farrell et al. 2002, Forman et al. 2003). Direct mortality from wildlife-vehicle collisions (WVC) has been recognized as a serious and growing threat to wildlife populations as well as contributing to human injuries, deaths, and property loss (Schwabe and Schuhmann 2002, Bissonette and Cramer 2008). However, the most pervasive highway impact on many species is barrier and fragmentation effects resulting in diminished habitat connectivity and permeability (Forman 2000, Forman et al. 2003, Bissonette and Adair 2008). Highways constitute barriers to wildlife movement that fragment populations and habitats, and limit juvenile dispersal (Beier 1995), genetic interchange (Epps et al. 2005) and even population viability.

The integration of structures designed to promote wildlife passage across highways in transportation projects has increased in the past decade (Bissonette and Cramer 2008). Passage structures have shown benefit in promoting passage for a variety of species (Farrell et al. 2002, Clevenger and Waltho 2003, Dodd et al. 2007*a*, 2012), and in conjunction with fencing have dramatically reduced the incidence of ungulate-vehicle collisions (Clevenger et al. 2001, Dodd et al. 2007*b*, McCollister and van Manen 2010) and promoted permeability (Dodd et al. 2007*b*, Dodd and Gagnon 2011). In Arizona, elk highway permeability across State Route 260 increased 58% after underpasses were constructed and ungulate-proof fencing was erected (Dodd et al. 2007*a*), and white-tailed deer permeability was 433% higher on reconstructed sections with underpasses compared to controls (Dodd and Gagnon 2011). Critical to the success of underpasses was the fact that traffic levels did not influence passage rates during below-grade underpass crossings for elk (Gagnon et al. 2007) or white-tailed deer (Dodd and Gagnon 2011).

Over the past decade, Arizona, the Arizona Department of Transportation (ADOT), and its many paretners have become recognized national leaders in addressing wildlife connectivity in transportation projects, with comprehensive measures integrated along State Route (SR) 260 with 11 wildlife underpasses, US Highway 93 with three bighorn sheep overpasses, and SR 68 with three bighorn sheep underpasses. Where available, existing drainage structures have been retrofitted to serve as wildlife passage structures with the erection of fencing to limit at-grade crossings and funnel animals to structures (Gordon and Anderson 2003, Ng et al. 2004). In Arizona, such retrofitting has considerable promise as a cost-effective approach to minimizing WVC and promoting permeability (Gagnon et al. 2010), particularly compared to costly highway reconstruction that may not occur on some highways for decades. Along SR 260 and Interstate 17, retrofit wildlife fencing projects were pursued to limit WVC and funnel animals to existing suitable bridges and have dramatically reduced the incidence of WVC involving elk by 97 and 100%, respectively (Gagnon et al. 2010). However, where no major reconstruction is programmed in the future nor do enough suitable structures to accommodate wildlife passage exist, projects involving the installation of new wildlife passage structures are now being pursued as part of relatively minor widening projects. Along SR 77, construction of a new wildlife overpass and underpass north of Tucson will be linked with wildlife fence and integrated with three existing large bridges to create a comprehensive connectivity strategy as part of a highway widening project to be implemented beginning in early 2014.

In 2006, ADOT and its partners completed the landmark *Arizona's Wildlife Linkages Assessment* (Arizona Wildlife Linkages Workgroup 2006). This comprehensive statewide effort identified 152 important linkage zones needed to maintain and promote wildlife connectivity across the state from a transportation/highway perspective (Figure 1). This assessment was intended to serve as a planning tool for the identification of both conflicts and opportunities to be addressed in ADOT's short- (e.g., 5-year) and long-range statewide transportation improvement plans (STIP). The assessment also prioritized linkages for action by ADOT and identified 28 of the 152 linkages as "highest priority" reflective of both their biological value and threat/opportunity value, including their status in ADOT's short-term STIP. Subsequent to the statewide assessment, county-level wildlife connectivity assessments were begun with a goal of refining the identification of wildlife linkages. The county-level assessments assembled current knowledge of linkages and barriers to wildlife movement while helping build collaborative partnerships with local jurisdictions for implementation efforts. Each county assessment report and its associated GIS data is intended to identify wildlife linkages at a finer scale or that may have been overlooked in the statewide assessment and that will be useful for regional and local planning efforts. A county-level assessment for Pima County was completed in 2012; it includes several refined and expanded linkage delineations (Arizona Game and Fish Department 2012).

**State Route 86 Background**

SR 86 is the highway linking Tucson to the Tohono O'odham Nation (TON) and its Tribal seat of government, Sells. SR 86 continues west, linking to SR 85, Ajo, Mexico, Gila Bend, and I-8. Most of the existing highway is a 2-lane roadway. ADOT has embarked on an improvement program of widening the existing narrow 2-lane roadway with limited shoulders to include paved 8-foot shoulders and graded 30-foot vehicle recovery zones to improve motorist safety. The improvement projects have also involved extending existing drainage culverts to 88 feet in length to accommodate the vehicle recovery zones. West of Robles Junction, ADOT has completed the improvement of two highway segments on the TON, and construction is now underway along the Kitt Peak (MP 132.8−137.1; TRACS No. H8010) and Santa Rosa (MP 128.5−132.8; H8011) segments. Design and environmental clearances are currently ongoing for the next project, the San Isidro Segment (MP 123.9−128.8; H8469 & H8348).

The *Arizona's Wildlife Linkages Assessment* identified the stretch of SR 86 between approximately MP 130 and 138 as the "Kitt Peak Linkage" (Figure 1); it also identified the Kitt Peak Linkage as one of the 28 "highest priority" linkages reflective of its biological value and status in ADOT's short-term STIP. The linkage's biological value stems from its habitat value for mule deer, javelina, and a multitude of reptile species including desert tortoise, as well as from a landscape perspective for far-ranging species such as mountain lion, bighorn sheep, and jaguar due to its strategic location within a north-south running string of "sky islands" stretching along the Baboquivari Mountain Range west of the Altar Valley from Mexico to I-8 and beyond. The TON raised the issue of addressing wildlife connectivity needs as part of the ongoing planning for the Kitt Peak and Santa Rosa segments roadway widening projects, and recognized that widening and improvement of these segments represented a critical "project of opportunity" to address wildlife connectivity, as future reconstruction likely will not occur for decades. At the same time, the TON expressed the desire to see wildlife connectivity along the northwestern extent of the Baboquivari Mountain Range addressed as part of the San Isidro Segment project.

The refined *Pima County Wildlife Connectivity Assessment* expanded the size of the Kitt Peak Linkage, especially to the west into the Baboquivari Valley to encompass the entire northern extent of the Baboquivari Mountain Range (Figure 2). This extension includes the stretch of SR 86 where the TON had previously recommended a wildlife passage structure along the San Isidro Segment, primarily to accommodate desert bighorn sheep passage across SR 86.

To address wildlife connectivity and an identified WVC "hotspot" along SR 86 within the Kitt Peak Linkage, the TON submitted a proposal and request for funding to the Pima County Regional Transportation Authority (RTA) in 2011. The TON, with assistance from ADOT, evaluated six potential sites for drop-in underpasses and overpasses along the combined 8.6-mile Kitt Peak and Santa Rosa widening project limits, and recommended that new structures be built at three sites, spaced approximately 1.8 miles apart on average, with fencing and escape ramps (Figure 3). The RTA approved two precast arch underpasses which are now under construction (Figure 4), at MP 131.2 and 134.9 with the cost for the underpasses ($746,280) provided as part of ADOT's highway widening that has been ongoing since June 2013. RTA also committed to the future deferred funding ($1,444,729) of a wildlife overpass at MP 133.5 (Appendix A) as well as fencing and escape ramps, to be done as a separate project outside the widening project. This staged strategy provided RTA needed funding flexibility, as it is concurrently fulfilling other funding obligations such as the costlier connectivity project along SR 77 (>$13 million).

The TON proposal to the RTA also identified the need to conduct monitoring of the effectiveness of the underpasses, overpass, and other measures in promoting highway permeability and reducing the incidence of WVC, which was not requested nor funded by the RTA; the TON committed to securing monitoring funds. Also, under the staged approach to project implementation and separation of the underpass from the overpass implementation, insufficient funds were approved by RTA to fully conduct engineering design, geotechnical survey, or environmental and cultural clearances for the overpass. To partly address these needs, the TON submitted a Tribal Wildlife Grant (TWG) application to the U.S. Fish and Wildlife Service in September 2013 for $200,000, intended to fund overpass engineering design and post-construction monitoring of the underpasses; it is expected that a decision on this grant award will be made in early 2014. It is intended that this proposal will now provide an opportunity to fully fund both the already-RTA approved overpass and a second one on the San Isidro Segment. The TWG funds, if awarded could be used for other aspects of the project, including long-term monitoring.

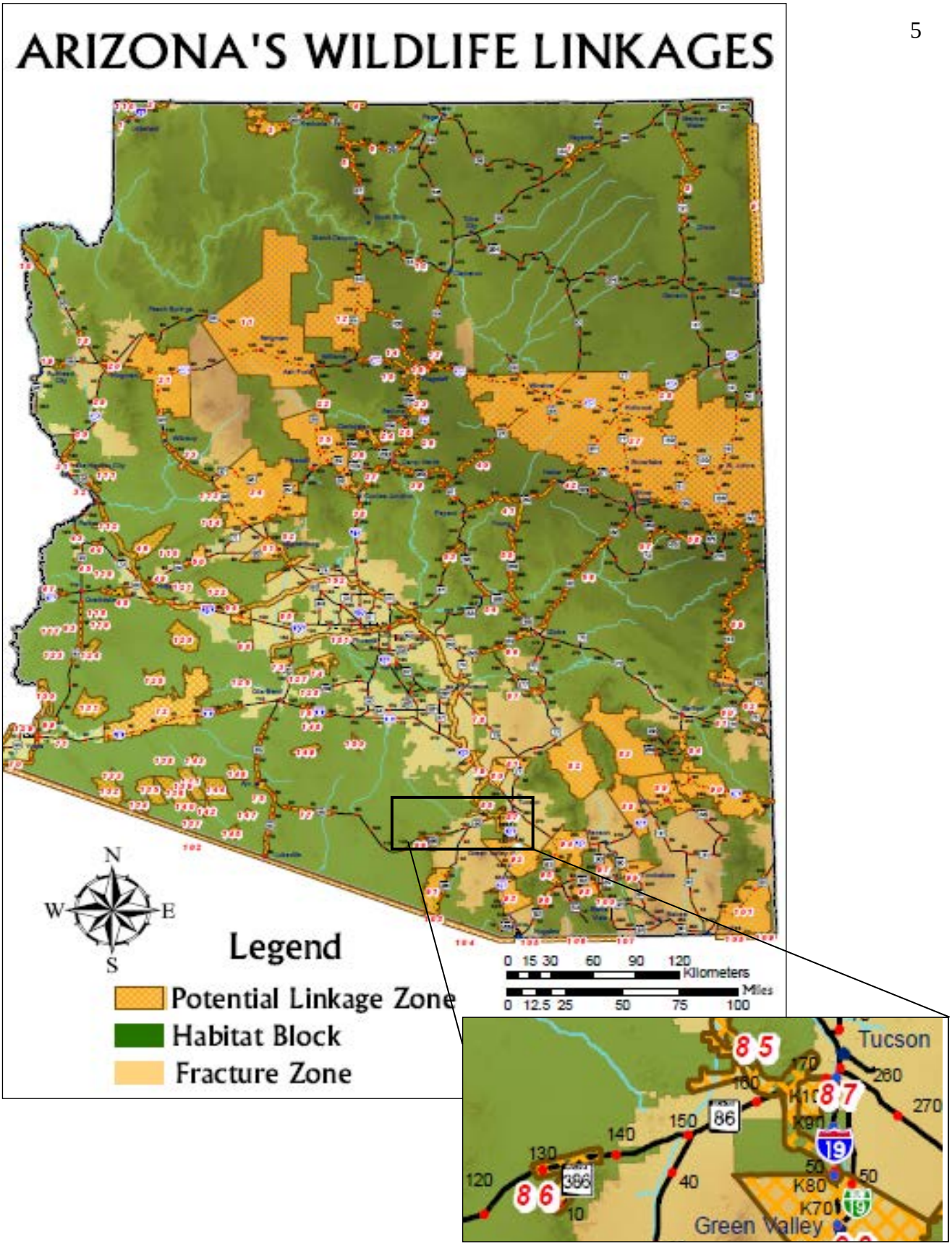


*Figure 1*. Statewide map of 152 linkages identified in the *Arizona's Wildlife Linkages Assessment* (top) and the location of the Kitt Peak Linkage (#86) along SR 86 (bottom).

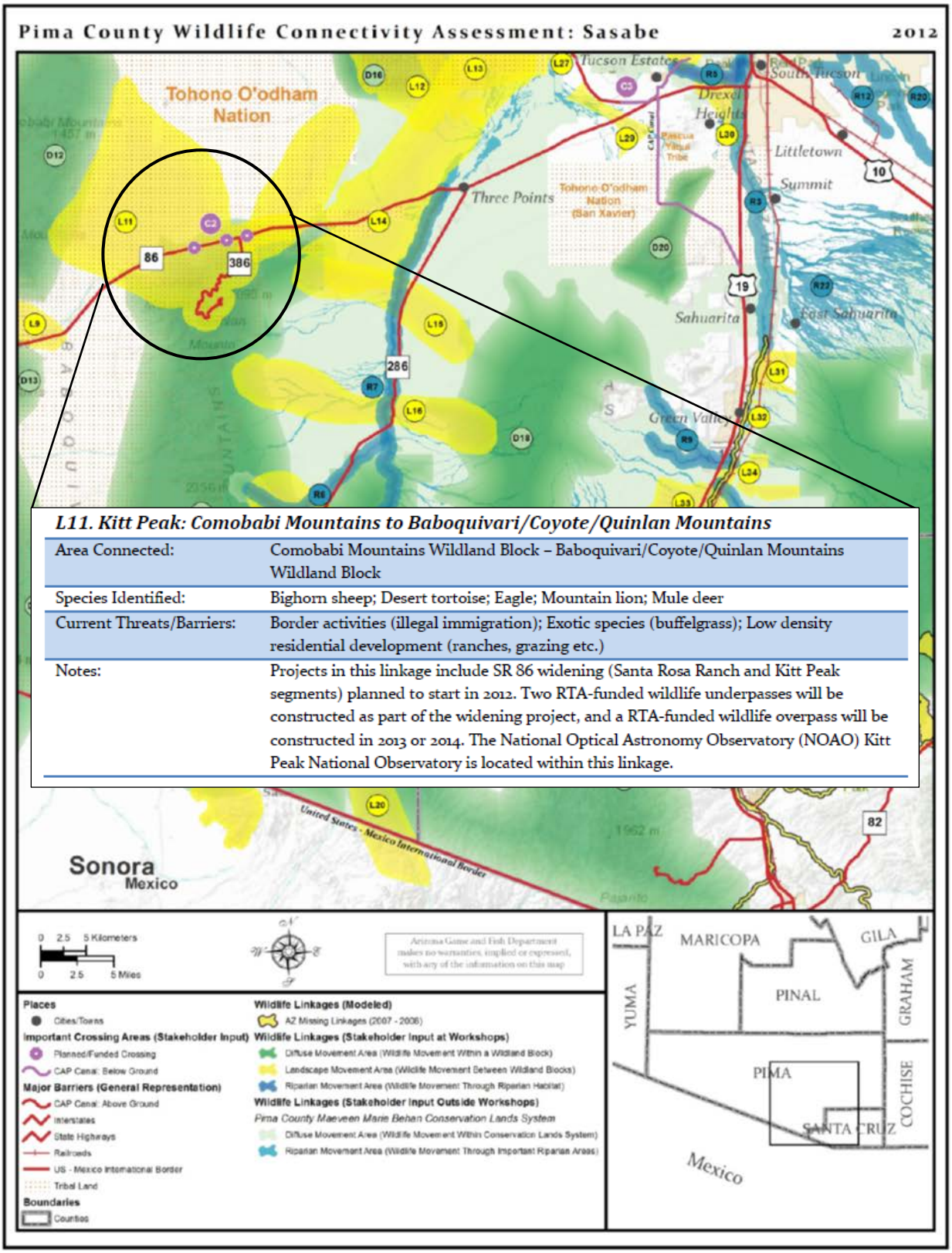


*Figure 2.* Wildlife linkages (yellow) in the *Pima County Wildlife Connectivity Assessment* including the expanded Kitt Peak Linkage (L11; circled) and its report summary (inset).

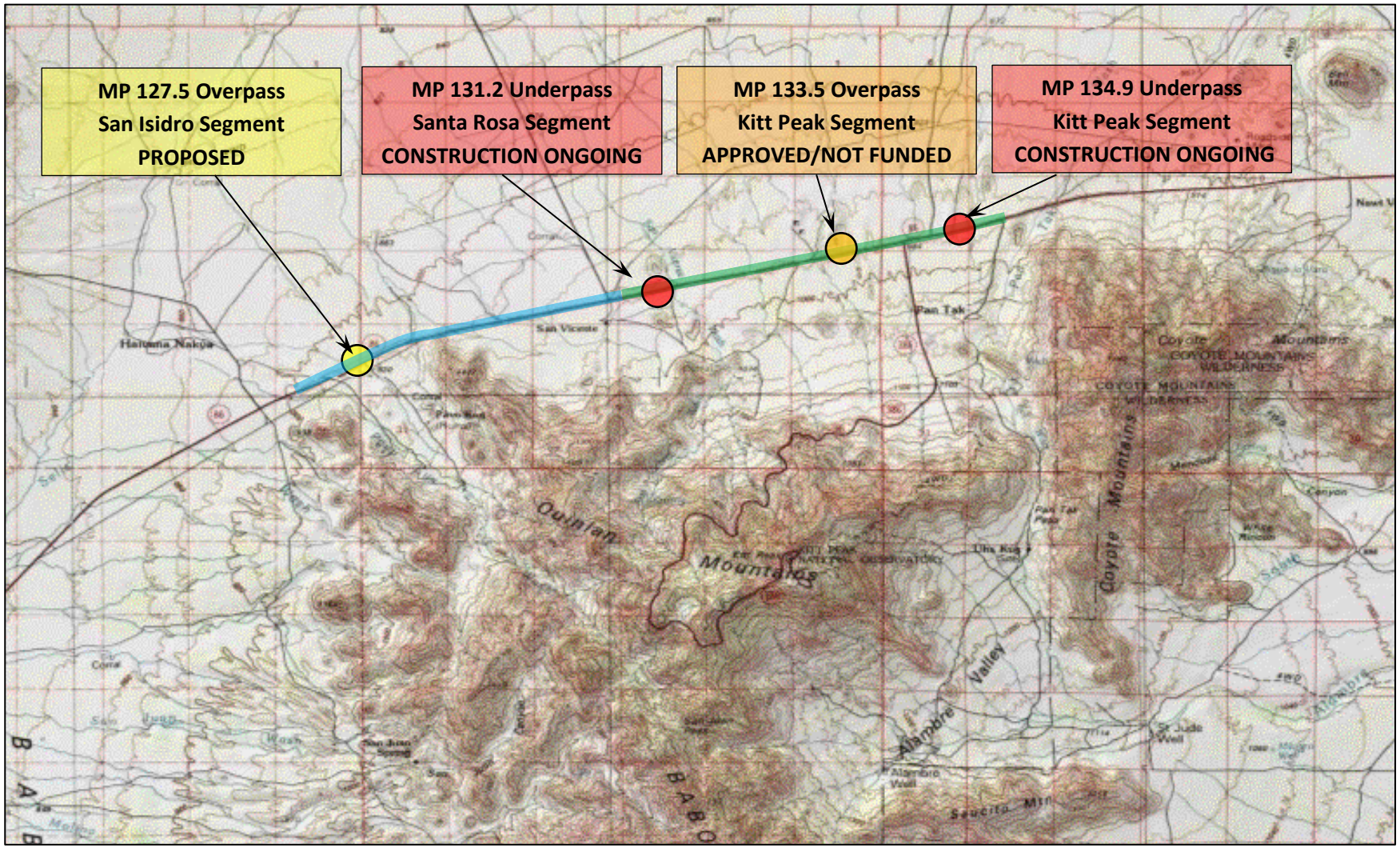


*Figure 3*. The SR 86 wildlife connectivity strategy for the Kitt Peak Linkage at the northern extent of the Baboquivari Mountain Range, including two RTA-funded wildlife underpasses currently under construction as part of the Kitt Peak and Santa Rosa segments widening project (red dots), a wildlife overpass (orange dot) approved for later implementation along with wildlife fencing (green line), and another proposed wildlife overpass (yellow dot) and wildlife fencing (blue line).

## PROJECT JUSTIFICATION AND OBJECTIVES

Under the previously RTA-approved Kitt Peak Linkage wildlife connectivity strategy, measures to promote highway permeability and connectivity across the SR 86 San Isidro Segment on the western half of the Kitt Peak Linkage (Figure 2) were not addressed (Figure 3). This proposal builds upon and expands the RTA-approved connectivity strategy. It would add a second wildlife overpass at MP 127.5 and 4.3 miles of associated wildlife fencing to the previously approved strategy. With this additional overpass and wildlife fencing, wildlife permeability across SR 86 along the entire northern tier of the Baboquivari Mountain Range and across the expanded Kitt Peak Linkage will be fully accommodated to address the various target species, including desert bighorn sheep (Figure 3). This proposal includes both overpasses and all other measures including fencing, escape ramps, and lateral access road measures to limit wildlife encroachment (cattle guards) needed to fully implement an integrated connectivity strategy.

*Figure 4*. Initial constuction of the Kitt Peak (top left; 7 of 15 arch panels installed) and Santa Rosa (bottom left; 10 of 15 arch panels installed) segments pre-cast arch willdife underpasses during Novemeber 2013. The remainder of the arches were installed in late-February 2014.

In addition to fully addressing the wildlife connectivity needs at the northern end of the Baboquivaris, implementation of this proposal would help more comprehensively address highway safety considerations associated with vehicular crashes involving wildlife. Along the three SR 86 widening projects between MP 123.9 and 137.1 (Figure 5), the stretch on the Kitt Peak and Santa Rosa segments accounting for 51.5% of all accidents involving wildlife (2000-2013) will be fenced under the approved RTA connectivity project. The San Isidro Segment accounts for another 42.4% of the collisions involving wildlife over the same timeframe, presenting further opportunity to address the incidence of wildlife-vehicle collisions and promote highway safety (Figure 5).

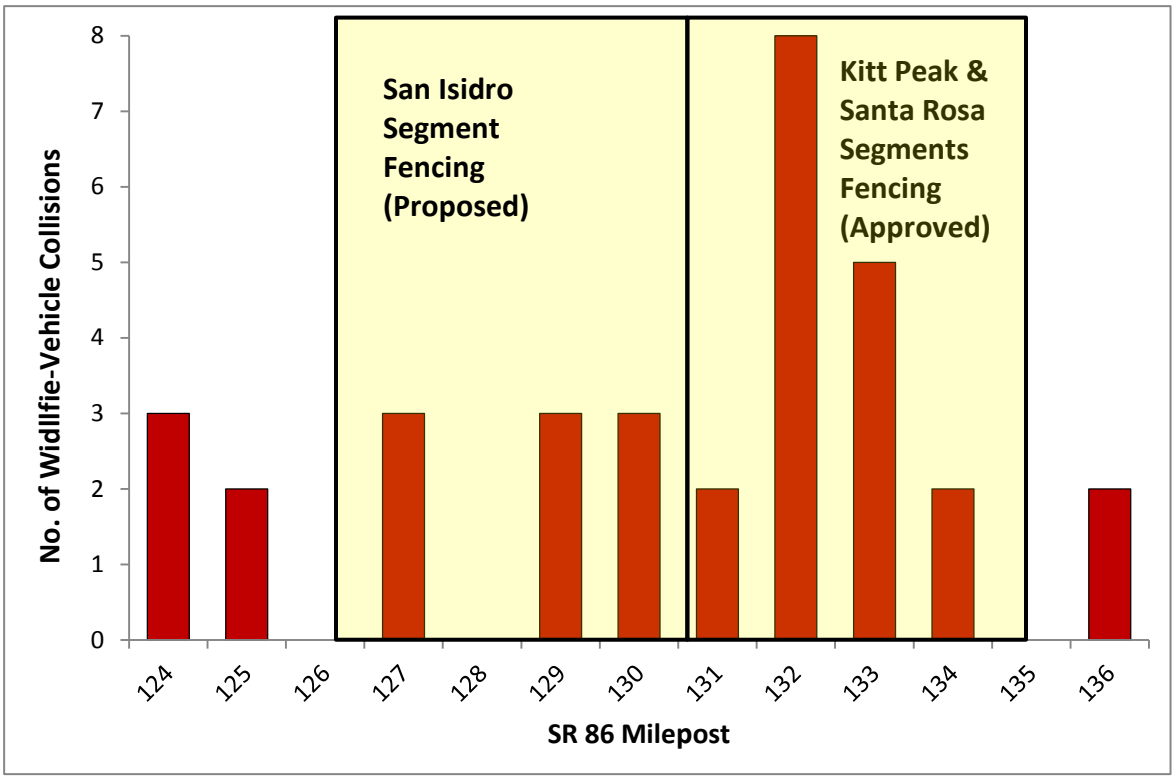


*Figure 5.* Incidence of accidents involving wildlife between SR 86 MP 124 and MP137 86 from 2000−2013, with the stretches of highway fenced under the RTA-approved Kitt Peak/Santa Rosa and proposed San Isidro segments wildlife connectivity projects.

**Project Objectives**

The objectives of this proposed Kitt Peak Linkage Wildlife Connectivity project are to:

1) Fully address and integrate all wildlife connectivity needs on the Kitt Peak, Santa Rosa, and San Isidro segment portions of the Kitt Peak Linkage,

2) Implement additional effective wildlife passage structures (overpasses) along the Kitt Peak and San Isidro segments to promote wildlife passage and landscape connectivity,

3) Erect wildlife fencing and associated escape and access control measures to funnel wildlife to and through passage structures to promote connectivity and reduce WVC,

4) Take advantage of the previously RTA-approved wildlife overpass and wildlife fencing to achieve cost efficiency in addressing wildlife connectivity and reduced incidence of WVC on the San Isidro Segment of SR 86, and

5) Ensure that sufficient funding is budgeted and approved by RTA to fully design and implement both SR 86 wildlife overpasses, wildlife fencing, and associated measures.

## PROJECT APPROACH AND PROPOSAL

The approach taken to develop strategies to promote wildlife connectivity along the San Isidro Segment included conducting field review to identify potentially suitable existing structures that could accommodate wildlife passage as well as sites suitable for new "drop-in" structures. We also compiled available WVC data and evaluated various options to meet the project objectives while balancing motorist safety, proposed structure effectiveness, and project cost.

### Wildlife Passage Structure Sites

Unlike the Kitt Peak and Santa Rosa segments, we found very limited opportunities for both retrofitting of existing structures suitable for wildlife passage and sites where new "drop-in" structures could be built on the San Isidro Segment; much of the eastern portion was very flat terrain no highly suited for passage structures. In fact, along the entire San Isidro Segment, only one site that could potentially accommodate a new wildlife passage structure was identified; a stretch of cut slope suitable for construction of a wildlife overpass at approximately MP 127.5 (Figures 3 and 6). This site would accommodate a 144-foot overpass similar to that already approved and awaiting final funding by the RTA at MP 133.5 on the Kitt Peak Segment (Appendix A). The San Isidro Segment site possesses good approaches, particularly on the south side of SR 86, which will minimize the amount of fill material needed to create gently- sloping approaches for wildlife overpass crossings, often a major cost associated with such structures.

*Figure 6*. The proposed SR 86 San Isidro Segment overpass site at MP 127.5, looking south toward the Baboquivari Mountains (left) and northwest toward the Comobabi Mountains (right).

**Wildlife Structure Spacing**

With only a single site for an effective wildlife passage structure site identified on the San Isidro Segment, passage structure spacing on the segment is not ideal. With a single structure integrated with approximately 4.3 miles of fenced highway (see fencing section) and 3.7 miles to the next passage structure to the east (wildlife underpass at MP 131.2), this spacing exceeds Bissonette and Adair's (2008) recommendation for spacing to facilitate deer and other ungulate passage. There are three existing concrete box culverts (CBC) between the proposed overpass and the end of the stretch previously approved for fencing (MP 131.0) on the Kitt Peak and Santa Rosa segments, located at MP 127.7, 128.5, 129.0; these CBC will accommodate passage for smaller, less mobile species. Further, the 2-mile stretch between MP 129.0 and 131.0 of the segment is flat and devoid of washes and ridges along which larger animals often travel; while originally considering leaving it unfenced, this 2-mile stretch does account for 18.2% of the WVC along the entire 13-mile San Isidro to Kitt Peak stretch (Figure 5).

When considered within the context of the entire Kitt Peak Linkage wildlife connectivity strategy (Figure 3), the spacing between all four structures averages a more acceptable 2.5 miles (Table 1); again, numerous smaller CBC exist along the Kitt Peak and Santa Rosa segments that will also accommodate passage for smaller, less mobile species.

*Table 1*. Summary of the SR 86 wildlife passage measures approved (orange) for the Kitt Peak and Santa Rosa segments and proposed for the San Isidro Segment, including wildlife underpasses, overpasses and extent of wildlife fencing.

| **Wildlife Passage Measure** | **State Route 86 Mileposts by Construction Project Segment** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **San Isidro Segment** | | | | **Santa Rosa Segment** | | | | **Kitt Peak Segment** | | | |
| | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 |
| Underpass | | | | | | | MP 131.2 | | | MP 134.9 | | |
| Overpass | | | MP 127.5 | | | | | | MP 133.5 | | | |
| Wildlife Fencing | | MP 126.7 – 131.0 (4.3 miles) | | | | | MP 131.0 – 135.2 (4.2 miles) | | | | | |

**Wildlife (Ungulate) Fencing**

A growing body of evidence points to the integral role that 6.5−8 foot wildlife (ungulate) fencing plays in achieving highway reconstruction objectives for minimizing WVC and promoting highway safety, as well as promoting wildlife permeability (Dodd et al. 2007*b*, 2012). This vital role of fencing integrated with passage structures has been stressed by Romin and Bissonette

(1996), Forman et al. (2003), and others, and the empirical basis for fencing in reducing WVC has continued to grow, with reductions in WVC from 80% (Clevenger et al. 2001) to over 90% (Ward 1982, Woods 1990, Gagnon et al. 2010). Fencing is costly and requires substantial maintenance (Forman et al. 2003), often making it difficult for transportation officials to justify fencing long stretches of highways. However, failure to erect adequate fencing in association with passage structures, even when adequately spaced, was found to substantially mitigate their effectiveness in reducing WVC and promoting permeability (Dodd et al. 2007*b*, 2009).

As part of the approved connectivity project for the Kitt Peak and Santa Rosa Segments, the RTA approved 44,677 lineal feet (lf; 4.2 miles) of wildlife fence, half to be erected along each side of SR 86 (Figure 3). While approved, the implementation of this fence has been deferred until construction of the wildlife overpass on the Kitt Peak Segment and all or portion of this fence could potentially be erected before June 2014 by ADOT. On the San Isidro Segment, proposed wildlife fencing will terminate on the west at the large 4-barrel CBC at MP 126.7 and extend eastward. One option considered was to extend fencing only to the CBC at MP 129.0 (2.3 miles), as the 2-mile stretch east of MP 129.0 is very flat. However, the WVC data for the 2-mile stretch suggests that it should be fenced to address the incidence of WVC here, as it accounts for a disproportionate percentage of all Kitt peak Linkage accidents (18.2%; Figure 5). Thus it is recommended that wildlife fence be extended to the western terminus of the previously approved fence extent at MP 131.0 for a total of 4.3 miles of fenced highway corridor. This brings the total fenced corridor along all three highway widening segments to 8.5 miles, or a total of 89,777 lf (both sides of SR 86).

On other Arizona wildlife connectivity projects (e.g., SR 260), ADOT's 8-foot wildlife fence standard has been applied, particularly in those instances where elk and potential for ponderosa pine forest deadfall exist. However, on US Highway 93, a lower 5-foot fence standard has been applied along much of the 17-mile fenced corridor as part of a wildlife connectivity project focusing on desert bighorn sheep (Figure 7; Appendix B). This fence appears to be functioning well in preventing sheep encroachment into the fenced corridor in a desert environment without tree deadfall. Further, this fence design is less visually obtrusive than 8-foot fence. This fence could likely be erected as an upgraded retrofit application along the existing right-of-way fence.

*Figure 7.* Five-foot high wildlife fence erected along US Highway 93 to prevent desert bighorn sheep passage onto the highway, recommended for consideration along SR 86.

Maintenance of the wildlife fence is a significant issue, particularly with the high incidence of undocumented alien traffic through the area and potential for damage to the fences to occur. Cooperative approaches to achieving long-term fence maintenance need to be pursued between the ADOT Tucson District, Tohono O'odham Nation which has expressed a willingness to assist with maintenance, and ADOT Environmental Services which is also addressing wildlife asset maintenance strategies across the state.

When highway corridors are fenced, provision must be made to allow animals that breach the corridor to escape. Fencing can be tied into each of the underpass abutments such that escape jumps can be created at minimal cost, and standalone escape ramps will be constructed along the fence between the underpasses no further than one mile apart. Eight cost-effective rock gabion basket escape ramps (Figure 8; Appendix C) were already approved for the Kitt Peak and Santa Rosa segments, and another eight are recommended for the San Isidro Segment fencing.

*Figure 8*. Rock gabion basket wildlife escape ramp constructed along US Highway 93 recommended for application along SR 86.

Another consideration when erecting wildlife fence along highways is addressing lateral access control on roads that emanate from the highway; without proper treatment, animals may breach the fenced corridor at these access points. Single-wide cattle guards have exhibited mixed results in preventing deer from beaching fenced corridors, and bighorn sheep have regularly jumped and otherwise negotiated single-wide cattle guards along US Highway 93 (Jeff Gagnon, Arizona Game & Fish Department; personal communication). In most instances where elk, deer and bighorn sheep are present, double-wide (or side-by-side) cattle guard applications have been employed (e.g., SR 260, US Highway 93; Figure 9; Appendix D). Though quite expensive, this approach is the most prudent course of action to take to prevent potential wildlife encroachment via access points, especially since bighorn sheep are a focal species with their proven propensity to breach single-wide cattle guards.

Along SR 86, as part of this proposal, double-wide cattle guards (or single cattle guards installed next to existing cattle guards) would be needed at three access roads along the length of the Kitt Peak Linkage wildlife connectivity project area:

- SR 386 (Kitt Peak Segment; not previously addressed; MP 134.3) – 6 or 7 unit cattle guard
- BIA Road 035 (Santa Rosa Segment; MP 130.9) – 5 or 6 unit cattle guard
- Upgraded San Isidro Road (San Isidro Segment; MP 127.5) – 4 or 5 unit cattle guard

*Figure 9*. Double-wide cattle guard application along SR 260 to prevent wildlife encroachment into the fenced corridor.

**Relationship to Wildlife-Vehicle Collisions**

The incidence of WVC along the Kitt Peak Linkage stretch of SR 86 has been raised as a concern by the TON; WVC with large mammals have involved mule deer, mountain lion, javelina, bobcat, coyote, and grey fox. Several species of reptiles are affected by WVC, most notably the desert tortoise. ADOT's standardized statewide crash database was queried for SR 86 accidents between MP 125 and 136, for the period 2000−2013 (through April 2013). A total of 33 crashes involving wildlife were recorded, with a peak in WVC incidence on the Kitt Peak Segment between MP 132 and 133 (Figure 5). WVC involving deer, javelina and other mammals are typically underreported compared to larger ungulates like elk that result in more property damage and human injuries (Dodd et al. 2012).

Along the Kitt Peak and Santa Rosa segments (MP 131–136), fencing is approved and planned along the stretch of SR 86 accounting for 89.5% of WVC, while proposed fencing on the San Isidro Segment (MP 124–130) corresponds to the stretch accounting for 64.3% of WVC (Figure 5). Combined, wildlife fencing will limit wildlife from making at-grade crossings along the stretch of SR 86 accounting for a total of 78.8% of all WVC associated with all three widening project segments along the Kitt Peak Linkage. This is anticipated to contribute to improved motorist safety.

### Achieving Project Implementation Cost Efficiency

The RTA has already approved the deferred funding of an overpass and associated wildlife fencing for the Kitt Peak and Santa Rosa segments. The addition of another overpass and additional fencing for the San Isidro Segment would likely result in some project cost efficiency if these elements and all deferred project elements are accomplished under a single construction project, especially the associated fencing. There would be some cost savings associated with project costs like mobilization, design, traffic control, etc. for the construction of two overpasses versus one, as well as the construction of 8.5 versus 4.3 miles of wildlife fence. The cost efficiency realized by combining all future project elements separate from the two wildlife underpasses, for which construction is now ongoing, should help ensure that adequate funding is programmed for all aspects of project planning and implementation. As such, this proposal addresses the concurrent implementation of both wildlife overpasses and all other associated measures.

### Construction Approach

Whereas the two Kitt Peak and Santa Rosa segments precast arch wildlife overpasses are now being implemented as part of the planned ADOT widening/safety enhancement project for these segments (TRACS No. H8010 and H8011), all other proposed connectivity elements including overpasses, wildlife fencing, escape ramps and lateral access control measures will be conducted as an ADOT permitted project to a separate entity such as the Pima County RTA, including the project design, administration and all construction activities. ADOT will provide project oversight and periodic permit reviews during the design and project management phases. An agreement will need to be developed for the maintenance of project elements beyond structures (overpasses).

## ESTIMATED PROJECT COSTS

Preliminary cost estimates for the project are provided below and summarized in Table 2. These estimates may be refined and modified by ADOT engineers. The cost estimates are considered somewhat conservative to ensure that sufficient funding is requested and hopefully obtained to adequately and fully implement the project.

### Overpass Structures

The 2011 cost for the Kitt Peak wildlife overpass approved for MP 133.5 utilized an estimate of $140/square foot of bridge deck. The recent cost estimate developed for the planned SR 77 wildlife overpass which will employ a similar AASHTO I-beam girder design utilized a cost of $200/square foot, though this higher estimate reflects the construction of median piers to span the highway. For the approved Kitt Peak overpass (MP 133.5) and the newly proposed San Isidro Segment overpass at MP 127.5 (both with 144’ lengths to accommodate future addition of 2 travel lanes; original Kitt Peak overpass was a 120’ structure; Appendix A), we used an intermediate cost, $170/square foot. This yielded an estimated cost for each overpass (40’ × 144’) of **$979,200**. In addition to the structure cost, the overpass estimates includes retaining

walls (1,500 square foot) previously estimated at $50/square foot, totaling **$75,000**, and earth work involving backfilling and grading the overpass, estimated to involve up to 2,000 cubic yards (CY) of soil moving at $55/CY, or a total of **$110,000** for each overpass site. Overpass structure heights will need to be in excess of 20 feet above the roadway to accommodate potential oversize loads. All totaled the overpass costs are estimated at **$2,328,400**.

**Wildlife Fence and Associated Measures**

In the Kitt Peak and Santa Rosa segments proposal (43,360 LF) estimate for wildlife fence of $9/LF was used, based on the same 5 to 6-foot standard discussed in this proposal; it was assumed that the wildlife fence would be a retrofit application to new right-of-way fence thus reducing cost. For the San Isidro Segment fencing entailing a total of 45,417 LF, the cost is estimated at $545,000. The total fence cost for all three segments (89,777 LF) is **$807,993**. Escape ramps were estimated at $6,000 per unit, and with sixteen total needed along the length of wildlife fence on all three segments, their cost totals **$96,000**. Lateral access control cattle guards range in price from $22,000 for a 5-unit cattle guard (e.g., San Isidro Road) to $33,000 for a 7-unit cattle guard (e.g., SR 386); the estimated cost totals **$82,000**, bringing the total fencing and associated measures estimated cost to **$985,993**.

**Engineering/Design**

A variety of engineering and design costs are associated with the implementation of all elements of the proposed San Isidro Segment wildlife connectivity project. Geotechnical investigation and testing, critical to the wildlife overpass design is estimated at **$100,000**. Environmental clearances, surveys and NEPA compliance is estimated a**t $50,000** (NOTE: fence alignments have been cleared as part of the widening projects), archaeological survey and recovery **$150,000**, right-of-way survey and temporary construction easements **$150,000,** while engineering design and development of final plans, cost estimates, and bid materials was estimated at 20% of total construction costs, or **$565,328**.

**Mobilization and Administration Costs**

Contractor mobilization and traffic control were both estimated at 15% of the construction costs (**$497,159**), construction contingencies at 25% (**$828,598**), and RTA (10%; **$331,439**) and ADOT (5%; **$165,720**) construction administration, for a total of **$2,320,075**.

**Total Estimated Cost**

The total estimated cost for this wildlife connectivity proposal is **$6,649,796** (Table 2).

*Table 2*. Estimated costs for the San Isidro Segment wildlife connectivity proposal project elements.

| PROJECT ELEMENTS | DESCRIPTION | UNITS | COST | TOTAL COST |
|---|---|---|---|---|
| **Construction** | | | | |
| Overpass 1 (40’ × 144’) Kitt Peak (MP 133.5) | Bridge structure | 5,760 sq ft | $170/sq ft | $979,200 |
| | Retaining walls | 1,500 sq ft | $50/sq ft | $75,000 |
| | Backfilling/grading | 2000 CY | $55/CY | $110,000 |
| Overpass 2 (40’ × 144’) San Isidro (MP 127.5) | Bridge structure | 5,760 sq ft | $170/sq ft | $979,200 |
| | Retaining walls | 1,500 sq ft | $50/sq ft | $75,000 |
| | Backfilling/grading | 2000 CY | $55/CY | $110,000 |
| Wildlife fence | 6-ft fence | 89,777 LF | $9/LF | $807,993 |
| Escape measures | Wildlife escape ramps | 16 | $6,000 ea | $96,000 |
| Access controls | Cattle Guard (7 unit) | 1 ea | $33,000 ea | $33,000 |
| | Cattle Guard (6 unit) | 1 ea | $27,000 ea | $27,000 |
| | Cattle Guard (5 unit) | 1 ea | $22,000 ea | $22,000 |
| | | | **Construction Subtotal** | **$3,314,393** |
| **Engineering/Design** | | | | |
| Investigation/testing | Geotechnical | 2 ea | $50,000 | $100,000 |
| Environmental clearing | Surveys and NEPA | 1 ea | $50,000 | $50,000 |
| Right-of-Way | Survey and TCE | 1 ea | $150,000 | $150,000 |
| Final design | Final plans, costs, etc. | 20% of construction cost | | $565,328 |
| Archaeological | Survey and recovery | 1 ea | $150,000 | $150,000 |
| | | | **Engineering/Design Subtotal** | **$1,015,328** |
| **Mobilization/Administration** | | | | |
| Mobilization | | 15% of construction cost | | $497,159 |
| Traffic control | | 15% of construction cost | | $497,159 |
| Contingencies | | 25% of construction cost | | $828,598 |
| Construction administration (RTA) | | 10% of construction cost | | $331,439 |
| Construction/permit administration (ADOT) | | 5% of construction cost | | $165,720 |
| | | | **Mobilization/Administration Subtotal** | **$2,320,075** |
| **GRAND TOTAL** | | | | **$6,649,796** |

**Total RTA Funding Commitment to SR 86**

Along with the $746,280 already committed by the RTA to the construction of the two SR 86 underpasses (Figure 4), for which ADOT assumed all indirect costs ranging from design to traffic control/detours, the requested amount in this proposal would bring the total RTA commitment to the Kitt Peak Linkage to **$7,396,076**. However, this substantial commitment for a priority statewide linkage (and certainly a county-wide linkage as well) to construct two underpasses, two overpasses, 17 miles of wildlife fence and associated measures is comparably cost effective at **$435,063/project mile**. This is particularly the case when SR 86 is compared to RTA's other major wildlife connectivity commitment to date, along SR 77. Here, a single large overpass and underpass (spanning six versus two lanes), wildlife fence and associated measures will be implemented soon; the cost (including one mile of highway where only fencing will be done) will approach **$2,166,667/project mile**, or nearly five times the cost/mile for SR 86.

## MONITORING

Given a project of this size and scope, as well as its status as being part of one of the first comprehensive efforts to promote wildlife connectivity within the Sonoran Desert, monitoring of wildlife passage structure effectiveness and wildlife use is a priority. The TON is committed to monitoring the effectiveness of all the passage structures and associated measures. The TON recently submitted a Tribal Wildlife Grant application to conduct monitoring of the two underpasses under construction on the Kitt Peak and Santa Rosa segments, and will be pursuing longer-term funding for also monitoring the effectiveness of the overpass(es) and fencing. Effectiveness monitoring will be conducted by the TON Department of Natural Resources Wildlife and Vegetation Management Program in cooperation with ADIOT Environmental Services. Monitoring activities will include camera and prepared track bed documentation of wildlife use of passage structures, and tracking of WVC incidence in cooperation with ADOT. The TON will seek other funding sources to cover expenses for monitoring activities, including from ADOT's Research Center.

## JURISDICTIONAL SPONSOR AND PARTNERS

The sponsor and key partners for this RTA wildlife connectivity grant application include:

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## APPENDIX A

Engineer's planning level opinion of reasonable cost estimate and task details and plans for the 120' long wildlife overpass structure approved for MP 133.40 on the Kitt Peak Segment of SR 86; costs for underpass and overpass options at this site and plans were developed by Kitt Peak engineering design contractor Kimley-Horn and Associates.

## SR 86 Kitt Peak

**ENGINEER'S PLANNING LEVEL OPINION OF PROBABLE COST**

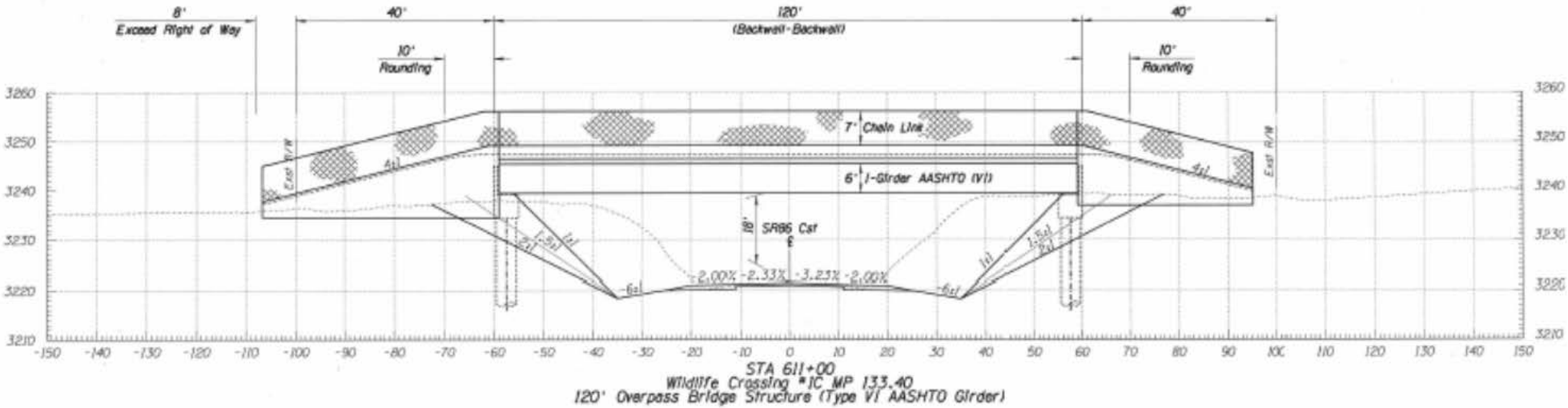
**WILDLIFE CROSSING #1**

**MP 133.40**

prepared by
ARH
5/6/2011

| TASK | Approx. Quantity | Unit Price | Unit | Total |
|---|---|---|---|---|
| ***Wildlife Crossing #1A MP 133.40 - 48' Underpass Conspan Structure*** | | | | |
| 32' span X 9' high X 48' long Conspan Structure | 48 | $1,600 | LF | $76,800 |
| Headwalls & Wingwalls | 2 | $33,000 | EACH | $66,000 |
| Concrete Foundations | 1 | $21,420 | LSUM | $21,420 |
| Installation of Prefabricated Overpass System | 1 | $35,700 | LSUM | $35,700 |
| Backfill of Conspan System | 50 | $70 | CY | $3,500 |
| End Terminal | 4 | $3,000 | EACH | $12,000 |
| Thrie Beam Transition | 4 | $2,000 | EACH | $8,000 |
| Concrete Barrier | 815 | $100 | LF | $81,500 |
| Removal of Structural Concrete | 115 | $525 | CY | $60,375 |
| Maintenance and Protection of Traffic/Detour | 1 | $82,500 | LSUM | $82,500 |
| Traffic Control | 1 | $35,500 | LSUM | $35,500 |
| Contingency | 1 | $53,000 | FA | $53,000 |
| **TOTAL INSTALLED COST OF WILDLIFE STRUCTURE #1A** | | | | **$536,295** |
| | | | | |
| ***Wildlife Crossing #1B MP 133.40 - 88' Underpass Conspan Structure*** | | | | |
| 32' span X 9' high X 88' long Conspan Structure | 88 | $1,600 | LF | $140,800 |
| Headwalls & Wingwalls | 2 | $33,000 | EACH | $66,000 |
| Concrete Foundations | 1 | $31,020 | LSUM | $31,020 |
| Installation of Prefabricated Overpass System | 1 | $51,700 | LSUM | $51,700 |
| Backfill of Conspan System | 100 | $70 | CY | $7,000 |
| Removal of Structural Concrete | 115.00 | $525 | CY | $60,375 |
| Maintenance and Protection of Traffic/Detour | 1 | $97,500 | LSUM | $97,500 |
| Traffic Control | 1 | $42,500 | LSUM | $42,500 |
| Contingency | 1 | $53,000 | FA | $53,000 |
| **TOTAL INSTALLED COST OF WILDLIFE STRUCTURE #1B** | | | | **$549,895** |
| | | | | |
| ***Wildlife Crossing #1C MP 133.40 - 120' Overpass Bridge Structure (Type VI AASHTO Girder)*** | | | | |
| 120' long X 40' wide Bridge | 4800 | $140 | SF | $672,000 |
| Backfill and grading of Overpass System | 1616 | $55 | CY | $88,856 |
| Chain Link Fencing | 408 | $10 | LF | $4,080 |
| Retaining walls | 1454 | $50 | SF | $72,700 |
| Maintenance and Protection of Traffic | 1 | $51,000 | LSUM | $51,000 |
| Traffic Control | 1 | $24,000 | LSUM | $24,000 |
| Contingency | 1 | $100,000 | FA | $100,000 |
| **TOTAL INSTALLED COST OF WILDLIFE STRUCTURE #1C** | | | | **$1,012,636** |

DRAFT

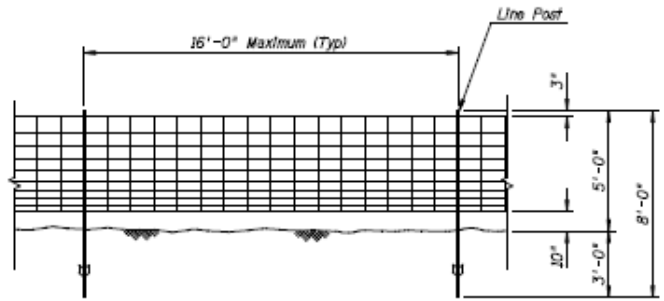



Kimley-Horn and Associates, Inc.

## APPENDIX B

Standard detail sheet for 5’ wildlife used along US 93 (MP 1-17).

| REVISION | STATE | PROJECT NO. | SHEET NO. | TOTAL SHEETS | AS BUILT |
|---|---|---|---|---|---|
| 9 | ARIZ. | 093-A(200) | 57 | 902 | |
| | | 093 MO 002 | | | |




TYPE 4 WOVEN WIRE (WW) (MODIFIED AS SHOWN)

NOTE:
See Std C-12.10 for typical Installation, notes and dimensions not shown.

# DETAIL F3

5' WILDLIFE FENCE

| | NAME | DATE |
|---|---|---|
| DESIGN | A. CRISTOFH | 04/08 |
| DRAWN | S. TAYLOR | 04/08 |
| CHECKED | H. HYLAND | 04/08 |

amec

ARIZONA DEPARTMENT OF TRANSPORTATION
INTERMODAL TRANSPORTATION DIVISION
ROADWAY DESIGN SERVICES

DETAIL SHEET
DETAIL F3

PRELIMINARY
PRE-FINAL
100% Review
NOT FOR CONSTRUCTION OR RECORDING

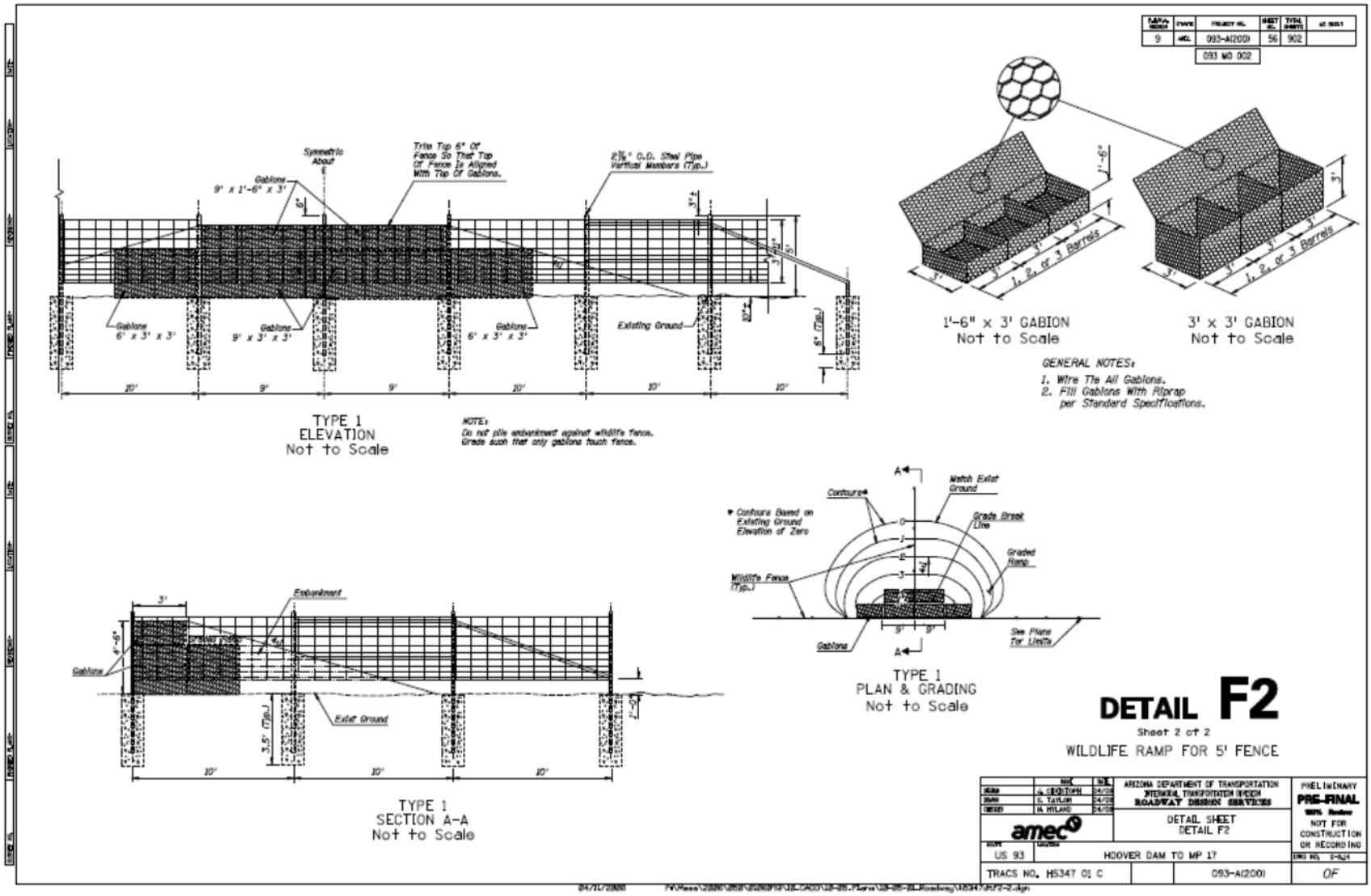
ROUTE: US 93
LOCATION: HOOVER DAM TO MP 17

TRACS NO. H5347 01 C | 093-A(200) | OF

04/21/2008 P:\Mesa\2006\058\2006058\3D_CADD\3D-25-Plans\3D-25-3D_Roadway\H5347dt72.dgn

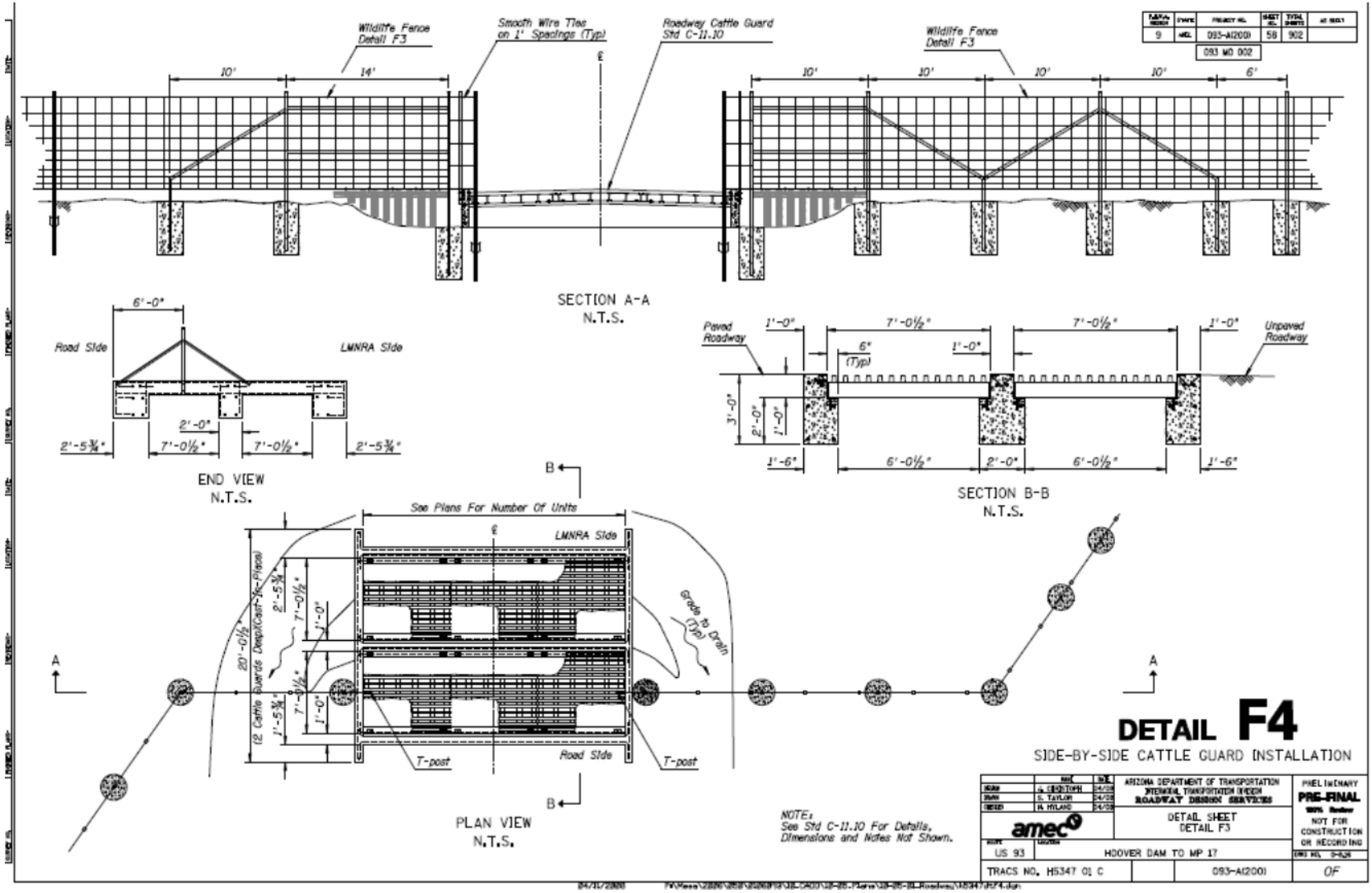
# APPENDIX C

Standard detail sheet for rock gabion basket escape ramp used along US 93, I-17 and SR 260.


TYPE 1
ELEVATION
Not to Scale
NOTE:
Do not pile embankment against wildlife fence.
Grade such that only gabions touch fence.
1'-6" x 3' GABION
Not to Scale
3' x 3' GABION
Not to Scale
GENERAL NOTES:
1. Wire Tie All Gabions.
2. Fill Gabions With Riprap per Standard Specifications.
TYPE 1
PLAN & GRADING
Not to Scale
TYPE 1
SECTION A-A
Not to Scale
DETAIL F2
Sheet 2 of 2
WILDLIFE RAMP FOR 5' FENCE
ARIZONA DEPARTMENT OF TRANSPORTATION
INTERMODAL TRANSPORTATION DIVISION
ROADWAY DESIGN SERVICES
DETAIL SHEET
DETAIL F2
PRELIMINARY
PRE-FINAL
NOT FOR CONSTRUCTION OR RECORDING
US 93
HOOVER DAM TO MP 17
TRACS NO. H5347 01 C
093-A(200)
OF

## APPENDIX D

Standard detail for double-wide or side-by-side cattle guard used along SR 260 and US 93 in conjunction with wildlife fence.


Wildlife Fence Detail F3
Smooth Wire Ties on 1' Spacings (Typ)
Roadway Cattle Guard Std C-11.10
Wildlife Fence Detail F3
SECTION A-A
N.T.S.
Road Side
LMNRA Side
END VIEW
N.T.S.
Paved Roadway
Unpaved Roadway
SECTION B-B
N.T.S.
See Plans For Number Of Units
LMNRA Side
Grade to Drain (Typ)
12 Cattle Guards Deep(Cast-In-Place)
T-post
Road Side
T-post
PLAN VIEW
N.T.S.
NOTE:
See Std C-11.10 For Details, Dimensions and Notes Not Shown.
DETAIL F4
SIDE-BY-SIDE CATTLE GUARD INSTALLATION
ARIZONA DEPARTMENT OF TRANSPORTATION
INTERMODAL TRANSPORTATION DIVISION
ROADWAY DESIGN SERVICES
DETAIL SHEET
DETAIL F3
HOOVER DAM TO MP 17
US 93
TRACS NO. H5347 01 C
093-A(200)
PRELIMINARY
PRE-FINAL
NOT FOR CONSTRUCTION OR RECORDING