PIMA COUNTY ROADWAY DESIGN MANUAL

Fourth Edition
2013

TABLE OF CONTENTS

Page

1.0 INTRODUCTION 1-1

1.1 Purpose 1-1

1.2 Use 1-2

1.3 Contents 1-2

1.4 Referenced Standards and Publications 1-2

1.5 Updates 1-3

2.0 ELEMENTS OF DESIGN 2-1

2.1 Introduction 2-1

2.2 Horizontal Alignment 2-2
Design Speed 2-2
Stopping Sight Distance on Horizontal Curves 2-2
Horizontal Curves 2-2

2.3 Roadway Sections 2-5
Lane and Shoulder Width 2-5
Clear Zone and Cross Slope 2-5
Side Slope 2-5
Medians 2-5
Pedestrian Walkways 2-6
Roadside Barriers 2-6
Utilities 2-6

2.4 Vertical Alignment (Profile) 2-8
Grades 2-8
Vertical Curves 2-8
Stopping Sight Distance 2-9
Passing Sight Distance 2-10
Coordination of Vertical and Horizontal Alignments 2-10

2.5 Intersections 2-11
Design Elements 2-11
Roadway/Driveway Location and Configuration 2-12
Sight Distance 2-13
Exclusive Turn Lanes 2-14
Curb Radii 2-15
Median Openings 2-15

Driveways 2-15
Lane Tapers 2-16

2.6 Bicycle and Pedestrian Facilities 2-17
Bicycle Lanes and Paths 2-17
Pedestrian Sidewalks 2-17
Multiuse Paths 2-18
Trails 2-18
Transit Facilities 2-18

2.7 Traffic Signals and Roadway Lighting 2-19
Warrants for Traffic Signals 2-19
Traffic Signal Design Criteria 2-19
Roadway Lighting Design Criteria 2-19
Other Traffic Control Devices 2-19

2.8 Traffic Signs and Pavement Markings 2-20
Traffic Sign Design Criteria 2-20
Pavement Marking Design Criteria 2-20
Roadway Naming 2-20

2.9 Railroad Geometry 2-21

2.10 Drainage 2-22
Hydrology 2-22
Hydraulics 2-23
Bridges 2-26
Pavement Drainage 2-27
Pavement Surface Flow 2-29
Storm Drain 2-29
Drainage Structure Materials and Joint Connections 2-31

3.0 DESIGN PROCESS 3-1

3.1 Introduction 3-1
Chapter Format 3-1
Phases, Tasks, Submittals, Reviews, and Approvals 3-1
Project Website 3-3

3.2 Quality Control 3-5
Purpose 3-5
Process 3-5
QC Plan Content 3-5

3.3 Utility Coordination and Design 3-6
Purpose 3-6
Process 3-6
Utility Services 3-8
Tucson Water Desing – Scoping Memorandum 3-8

Utility Design – Memorandum of Agreement 3-8
Prior Right Claim 3-10

3.4 Public Participation 3-11
Purpose 3-11
Process 3-11
Tasks and Documentation 3-11
Exemptions 3-12

3.5 Federal, State, and Local Coordination 3-13
Purpose 3-13
Process 3-13
Documentation 3-13

3.6 Public Art 3-14
Purpose 3-14
Process 3-14

3.7 Data Gathering 3-15
Purpose 3-15
Process 3-15
Information to be Acquired 3-15

3.8 Environmental Screening 3-17
Purpose 3-17
Process and Documentation 3-17

3.9 Location Study 3-20
Purpose 3-20
Process 3-20
Report Content 3-20

3.10 Surveys and Mapping 3-22
Purpose 3-22
Coordination Meeting 3-22
Research 3-22
Datum and Basis of Bearing 3-23
Stationing 3-23
Horizontal Control Network 3-23
Vertical Control and Benchmarks 3-24
Topographic Mapping and Surveys 3-24
Cross Sections 3-25
Utility Coordination 3-26
Culture Surveys 3-26
Background Culture 3-26
Mapping for Location Study 3-27
Right-of-Way Surveys 3-27
Title Reports 3-28
Orthophotos 3-28
Protection of Vegetation 3-28

Protection of Archaeological and Historical Sites 3-28
Survey Report 3-28
Results of Survey Drawing 3-29
Summary of Survey and Mapping Deliverables 3-29

3.11 Drainage Report 3-31
Purpose 3-31
Process and Documentation 3-31

3.12 Geotechnical Investigation 3-37
Purpose 3-37
Process 3-37
Trench Backfill Investigation 3-37
Report Content 3-39

3.13 Pavement Design 3-41
Methodology 3-41
Design Approach 3-41
Special Considerations for Pima County Projects 3-41
Pavement Design Report 3-44

3.14 Bridge Structure Selection Study/Report 3-46
Purpose 3-46
Process 3-46
Report Content 3-46

3.15 Traffic Engineering Study 3-50
Purpose 3-50
Process 3-50
Report Content 3-50

3.16 Arterial Street Lighting Design 3-54
Purpose 3-54
Report Content 3-54

3.17 Design Concept Report 3-55
Purpose 3-55
Pima County Ordinances 3-55
Environmentally Sensitive Roadways 3-56
Report Format 3-56
Report Content 3-56

3.18 Environmental Assessment and Mitigation Report 3-65
Purpose 3-65
Environmentally Sensitive Roadways 3-65
Scoping Confirmation 3-66
Funding Options 3-66
Report Format 3-66
Report Content 3-66

Special Provisions 3-70

3.19 Right-of-Way 3-71
Introduction 3-71
Standard of Accuracy 3-71
Right-of-Way Plan Functions 3-71
Right-of-Way Plan Format and Content 3-71
Legal Descriptions 3-74
Individual Parcel Maps 3-75
Orthophotography 3-75
Field Staking 3-75
Finalized Plans 3-76
Checklists 3-77

3.20 Construction Plan Documents 3-78
Purpose 3-78
Construction Plans 3-78
Plan Phases 3-79
Special Provisions 3-80
Bid Item, Cost Estimate, and Quantities Report 3-80
Construction Document Submittal to Procurement 3-81
As-Built Plans 3-83
Post Design Services 3-83

3.21 Project Review and Approval Processes 3-84
Purpose 3-84
Report and Plan Review 3-84
Value Engineering Review 3-85
Constructability Review 3-86
Project Management Exit Gate Process 3-86

4.0 ENVIRONMENTALLY SENSITIVE ROADWAY ROADWAY DESIGN GUIDELINES 4-1

4.1 Introduction 4-1

4.2 Environmentally Sensitive Lands and Roadway Designation 4-2

4.3 Environmental Resource Mitigation Process 4-3

4.4 Biological Resource Process 4-6
Steps in the Process 4-6
Key Definitions 4-8

4.5 Cultural Resource Process 4-9
Key Terms 4-9
National Register of Historic Places 4-10
Steps in the Process 4-11

Conclusion 4-13

4.6 Visual and Aesthetic Resource Process 4-16
Key References 4-16
Steps in the Process 4-16

4.7 Mitigation Tools 4-21
Environmentally Sensitive Roadway Design Guidelines 4-21
Biological Resource Conservation Treatment/Mitigation Options 4-23
Cultural Resource Treatment Options 4-27
Visual and Aesthetic Resource Treatment/Mitigation Options 4-30

4.8 Post-Construction Assessment 4-34

APPENDICES

(Note: Appendices are presented at the end of the chapter in which they are referenced for the first time. Appendices at the end of Chapter 1 include those appendices generally applicable to the entire manual.)

Chapter 1

Appendix 1-A	Pima County Community Participation and Mitigation Ordinance
Appendix 1-B	Pima County Roadway Design Process Flowchart

Chapter 2

Appendix 2-A	Chapter 2 References
Appendix 2-B	Roadway Figures
Appendix 2-C	Required Intersection Sight Distance Calculation Procedure
Appendix 2-D	Design Guide for Constructing and Relocating Utilities within Public Right-of-Way

Chapter 3

Appendix 3-A	Chapter 3 References
Appendix 3-B	Quality Control Plan *(Sample)*
Appendix 3-C	Preliminary Design Notification *(Sample)*
Appendix 3-Da	Public Involvement Plan Guidance
Appendix 3-Db	Public Involvement Plan Checklist
Appendix 3-Dc	Public Involvement Summary *(Sample)*
Appendix 3-E	Pima County Public Art Program (BOS Policy C3.3)
Appendix 3-Fa	Environmental Screening: Questionnaire for Establishing Potential Areas of Impact
Appendix 3-Fb	Environmental Screening: Summary Impact Matrix
Appendix 3-Fc	Environmental Screening: Results Memorandum
Appendix 3-G	Matrix for Comparison of Alternatives *(Sample)*
Appendix 3-H	Location Map *(Sample)*
Appendix 3-I	Design Concept Report Table of Contents
Appendix 3-J	Items for Cost Estimate
Appendix 3-K	Environmental Mitigation and Assessment Report - Table of Contents
Appendix 3-L	Environmental Assessment and Mitigation Report - Executive Summary Outline
Appendix 3-M	Environmental Assessment and Mitigation Report - Impact and Mitigation Summary *(Sample)*
Appendix 3-N	Environmental Categories and Assessment Guidance for Environmental Assessment and Mitigation Report
Appendix 3-O	Environmental Assessment and Mitigation Report - Hearing Notice and Approval Process
Appendix 3-P	Right-of-Way Plans, Parcel Maps, and Legal Descriptions
Appendix 3-Q	Final Design Phase Construction Plan Checklist
Appendix 3-R	Initial PS&E Phase Construction Plan Checklist
Appendix 3-S	Final PS&E Construction Plan Checklist
Appendix 3-T	Storm Drain Inlet Design Data
Appendix 3-U	Special Provisions Guidelines
Appendix 3-V	Sample Utility Memorandum of Agreement

Chapter 4

Appendix 4-A	Chapter 4 References
Appendix 4-B	Websites
Appendix 4-C	ESR Project Maps *(Sample)*
Appendix 4-D	Vegetation Measurement
Appendix 4-E	Pima County Approved Plant Species for Environmentally Sensitive Roadways
Appendix 4-F	Landscaping Guidelines
Appendix 4-G	Visual and Aesthetic Resource Evaluation Process

LIST OF FIGURES

Figure 2-1 Typical Section for 3-Lane Road (Urban) 2-B-1
Figure 2-2 Typical Section for 5-Lane Road (Urban) 2-B-2
Figure 2-3 Typical Section for 4-Lane Divided Road (Urban) 2-B-3
Figure 2-4 Typical Section for 6-Lane Divided Road (Urban) 2-B-4
Figure 2-5 Typical Section for 2-Lane Road (Rural) 2-B-5
Figure 2-6 Typical Section for 3-Lane Road (Rural) 2-B-6
Figure 2-7 Typical Section for 5-Lane Road (Rural) 2-B-7
Figure 2-8 Pavement Drainage (4-Lane Roadway) 2-B-8
Figure 2-9 Pavement Drainage (6-Lane Roadway) 2-B-9
Figure 2-10 Catch Basin Typical Locations 2-B-10
Figure 2-11 Utility Corridor (90’ or Greater R/W) 2-B-11
Figure 2-12 Utility Impact Zone 2-B-12
Figure 2-13 Intersection/Median Opening Paving Layout 2-B-14
Figure 4-1 Environmental Resource Mitigation Process Flow Chart* 4-5
Figure 4-2 Archaeological Resource (Example) 4-8
Figure 4-3 Historic Resource (Example) 4-9
Figure 4-4 A Historic Road Feature (Example) 4-9
Figure 4-5 Place of Traditional Cultural Value (Example) 4-9
Figure 4-6 Visual Resource Study Process 4-16
Figure 4-7 Large Wildlife Crossing (Example) 4-23
Figure 4-8 Herp Wall Along a Roadway 4-23
Figure 4-9 Examples Of Bridges Designed To Span Drainages. 4-24

LIST OF TABLES

Table 2-1 Lane Width Standards - Pima County Design 2-7
Table 2-2 Cross Section Standards - Pima County Design 2-7
Table 2-3 Stopping Sight Distance - Pima County Design 2-10
Table 2-4 Minimum Spacing between Consecutive Roadways & A Roadway and Driveway 2-13
Table 2-5 Minimum Spacing between Consecutive Driveways 2-13
Table 2-6 Driveway Widths 2-16
Table 2-7 Design Threasholds for At-Grade Crossings 2-25
Table 2-8 Spread Criteria 2-27
Table 2-9 Capture Ratios for Inlets 2-28
Table 2-10 Frequency of Coincidental Occurrence 2-30
Table 3-1 Design Process Tasks and Submittals 3-4
Table 3-2 Survey and Mapping Deliverables and Schedule 3-30
Table 3-3 Suggested Drainage Report Table of Contents 3-36
Table 3-4 Project Contingencies 3-63
Table 4-1 Cultural Resources Review Process 4-13
Table 4-2 Examples of Treatment Options by Cultural Resource Type 4-14
Table 4-3 Archaeological Resources: Sites, Objects, Districts/Complexes 4-27
Table 4-4 Historic Resources: Buildings, Structures, Objects, Districts, Landscapes 4-28
Table 4-5 Historic Roads - Aesthetic, Engineered, and Cultural 4-28
Table 4-6 Traditional Cultural Places - Shrines, Burials, Rock Art, Gathering Places, Natural Features, Springs/Drainages, Landscapes 4-29

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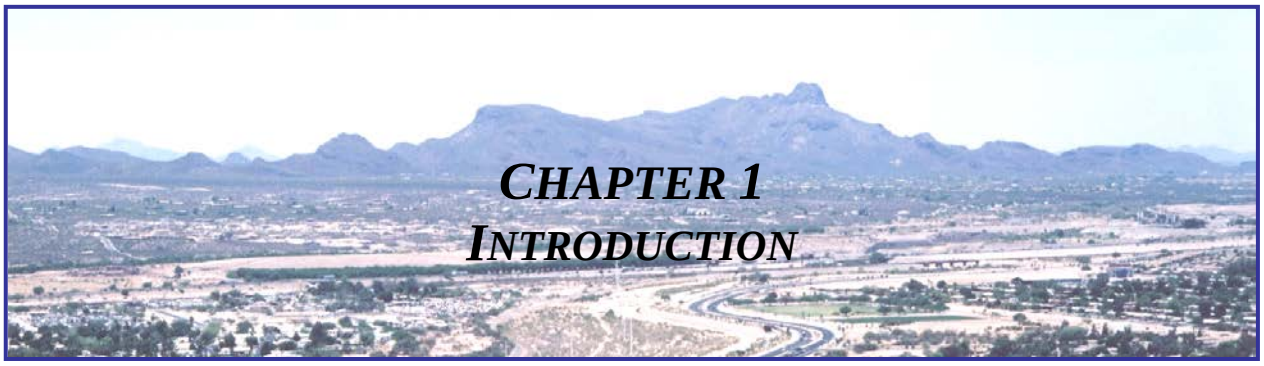
ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
AB	Aggregate Base
AC	Asphaltic Concrete
ACOE	U.S. Army Corps of Engineers
ACS	Arizona Coordinate System
ADA	Americans with Disabilities Act
ADOT	Arizona Department of Transportation
ADT	Average Daily Traffic
AGF	Above Ground Utility Facilities
AGFD	Arizona Department of Game and Fish
ARAC	Asphalt Rubber Asphaltic Concrete
ARS	Arizona Revised Statues
BMS	Bid Management System
CAC	Community Advisory Committee
CRHPO	Cultural Resources and Historic Preservation Office
County	Pima County
DCR	Design Concept Report
DTM	Digital Terrain Model
EAMR	Environmental Assessment and Mitigation Report
ESAL	Equivalent Single Axel Loads
ESL	Environmentally Sensitive Lands
ESR	Environmentally Sensitive Roadway
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FHWA	Federal Highway Administration
HCM	Highway Capacity Manual
HEC	Hydraulic Engineering Circular
KOPs	Key Observation Points
MUTCD	Manual on Uniform Traffic Control Devices
NAD or NAVD	North American Vertical Datum
NPPO	County Native Plant Preservation Ordinance
PAG	Pima Association of Governments
PI	Plasticity Index
PISA	Preliminary Initial Survey Assessment
PS&E	Plans, Specifications, and Estimates
PSI	Present Serviceability Index
QC	Quality Control
RDM	Roadway Design Manual
RLA	Registered Landscape Architect
RMS	Root Mean Square
SDCP	Sonoran Desert Conservation Plan
SHPO	State Historic Preservation Officer
SN	Structural Number
TCE	Temporary Construction Easements
TS	Tractor Semi-Trailer
TST	Tractor Semi-Trailer Trailer
TT	Tractor Trailer
USFWS	U.S. Fish and Wildlife Service



CHAPTER 1
INTRODUCTION

1.1 PURPOSE

The fourth edition of the *Pima County Roadway Design Manual* (RDM) was prepared by the Pima County Department of Transportation (DOT). The revisions to the manual, as reflected in this edition, are based on the additional experience of County and consultant designers who used the previous editions of the manual; changes in applicable standards and publications; and evolving policies and practices regarding the County's transportation infrastructure. The RDM is intended to serve both private developers constructing off-site improvements within a public right-of-way (Chapter 2); designers charged with developing roadway plans for the Department of Transportation; and those charged with reviewing the plans, specifications, and reports.

The primary purpose of the manual is to standardize the County roadway elements by ensuring that they meet both state and nationally accepted design criteria, as well as supplemental County criteria. The manual establishes the steps to be followed in the design process, including report and plan submittal requirements, to help further the consistency and efficiency of roadway implementation. All guidelines included in the manual are consistent with the Pima County *Community Participation and Mitigation Ordinance*, which is included at the end of this chapter as Appendix 1–A.

While the manual provides design guidance, it is not a substitute for professional judgment and close coordination with the County Project Manager during plan preparation.

1.2 USE

The focus of the RDM is on urban and rural roadway design. Pima County Project Managers and consultant firms shall use the manual to develop the scope of work for each individual roadway project – including the sequence of steps, the schedule, and the specific report and plan submittals required, to complete the work. Appendix 1-B provides a flow chart that identifies project components and processes associated with the roadway design process, and illustrates how they relate to each other.

A project designated as an "environmentally sensitive roadway" by Pima County, or that meets the criteria of an environmentally sensitive roadway, must generally follow the process described in this manual as modified by specific assessment and mitigation techniques for biological

resources, cultural resources, and visual and aesthetic qualities provided in Chapter 4, "Environmentally Sensitive Roadway Design Guidelines," of this manual.

The RDM is not meant to serve as a substitute for professional judgment, nor minimize/eliminate close coordination with the project team members, partners, and stakeholders. At the onset, and throughout the project, the project team may identify the need to deviate from standard, codes, requirements, policies, or other formalized guidance and direction. In such cases, the project team shall review with and receive the approval of Pima County before using any alternative standard. Pima County will consider such requests and may, at its discretion, accept or reject them. Some of the more frequently used deviations/exceptions/exemptions include:

1. Elements of the Community, Participation and Mitigation Ordinance – Pima County Code, Chapter 10.56 (Refer to Section 3.4).
2. Public Art – The Board of Supervisors retains final authority to grant exemptions to the policy and procedures on a case-by-case basis (Refer to Section 3.6).
3. Design Features – Various design features and elements contained in this manual (Refer to Section 3.17).

The project team shall be responsible for identifying the requirement/standard that is normally followed and being proposed as a deviation, exception, or exemption. The project team shall also identify the deviation/exception/exemptions and complete the appropriate research to identify the requirements for obtaining said deviation/exception/exemption. This information shall then be reviewed with Pima County. If said deviation/exception/exemption is approved, the supporting documentation (e.g. – Backup materials, reference information, concurrence by other partners and stakeholders) shall then be retained within the project files, with the key elements of said deviation/exception/exemption captured within the DCR/EAMR.

1.3 CONTENTS

Chapter 2 of this manual presents the elements of design. Chapter 3 describes the process for developing plans, specifications, and estimates (PS&E) for new or improved County roadways. As noted in the previous section, Chapter 4 presents the methods and techniques to be used in assessing the effects of environmentally sensitive roadway projects on biological resources, cultural resources, and visual and aesthetic qualities.

The RDM chapters are comprised of multiple sections that address standards to be followed, methods for conducting technical analyses, and submittals for review and approval by the County. Each chapter is followed by the appendices that are cited in the chapter, with the exception of repeated appendices, which are included at the end of the chapter in which they are first cited.

The fourth edition of this manual provides detailed specifications regarding report formatting in an effort to ensure more consistency across reports and to facilitate more efficient reviews, along with details regarding the overall Project Management Process and when Value Engineering and Constructability Reviews should be completed; and expands on Chapter 3.3 Utility Construction and Design Requirements.

1.4 REFERENCED STANDARDS AND PUBLICATIONS

The manual is supported by state and nationally accepted documents on design standards and practices, including the most current edition of the American Association of State Highway and Transportation Officials (AASHTO), *A Policy on Geometric Design of Highways and Streets*. These documents are referenced as appropriate throughout this manual.

1.5 UPDATES

Updates of this fourth edition of the RDM will be made available through the:

- Pima County Website
  http://dot.pima.gov/

- Pima County Department of Transportation
  Engineering Information Management Section
  201 North Stone Avenue, 5th Floor
  Tucson, Arizona 85701
  (520) 724-6332

APPENDIX 1-A

Pima County initially adopted a Community Participation and Mitigation Ordinance (1992-69) and has provided updates to the original adoption (Ordinance 2006-31). The results are reflected in Pima County Code, Sections 10.56.010 thru 10.56.300 and reflected below

PIMA COUNTY CODE - CHAPTER 10.56

COMMUNITY PARTICIPATION AND MITIGATION

Sections:

10.56.010 Purpose.
10.56.020 Applicability.
10.56.030 General considerations.
10.56.040 Project initiation.
10.56.050 Reserved.
10.56.060 Location report.
10.56.065 Design concept report.
10.56.070 Environmental assessment and mitigation report.
10.56.080 Construction documents.
10.56.090 Public participation.
10.56.100 Project mailing list.
10.56.110 Establishment of community advisory committees.
10.56.120 Public meetings.
10.56.130 Public opinion questionnaire.
10.56.140 Project status reports.
10.56.150 Report and executive summary for board of supervisors hearing.
10.56.160 Board of supervisors hearing notification.
10.56.170 Community advisory committee.
10.56.180 Community advisory committee-Membership.
10.56.190 Community advisory committee-Formation.
10.56.200 Community advisory committee-Functions and duties.
10.56.210 Community advisory committee-Permitted scope of review.
10.56.220 Community advisory committee-Matters not to be reviewed for change.
10.56.230 Community advisory committee-Meeting schedule.
10.56.240 Mitigation measures.
10.56.250 Reserved.
10.56.260 Roadway design criteria.
10.56.270 Advance right-of-way acquisition.
10.56.280 Operation and maintenance.
10.56.290 Exemptions and variances.
10.56.300 Annual report.

10.56.010 - Purpose.

The purpose of this chapter is to ensure that, with respect to proposed major roadway improvement projects:

A. Adequate consideration is given to possible social, economic, environmental and transportation effects;
B. Appropriate consideration is given to reasonable alternatives;
C. Interested parties are afforded an opportunity to express their views early enough in the study process to influence the course of studies as well as the action taken; and
D. Decisions on projects are made in the overall public interest.

(Ord. 1992-69 § 1, 1992)

10.56.020 - Applicability.

A. Major projects. This chapter shall apply to proposed major roadway projects, including environmentally sensitive roadway projects, constructed by Pima County. This chapter shall be a policy statement and guide for proposed major roadway improvement projects and environmentally sensitive roadway projects constructed jointly by Pima County and other agencies or jurisdictions. For purposes of this chapter, the term "major roadway" means a roadway depicted on the Pima County Major Streets and Scenic Routes Plan and which is classified and functions as an arterial roadway. The term "environmentally sensitive roadway" refers to a transportation project within or crossing environmentally sensitive lands as determined by certain Sonoran Desert Conservation Plan conservation land system categories and/or designation as a Scenic and/or Historic Route, and/or location within or crossing a High or Moderate Archaeological Sensitivity Zone or a Priority Cultural Resource, as described in the *Pima County Roadway Design Manual*.

B. Minor projects. All minor projects shall include a minimum level of public notification and information. The Department of Transportation shall be responsible for determining the appropriate level of public outreach, participation and notification on a project by project basis. The following projects may be considered minor projects:
   1. Overlay or maintenance of an existing roadway;
   2. Addition of paved shoulder, bike lanes, or multi-use lanes to an existing roadway;
   3. Pavement widening of an existing roadway which does not increase the number of through traffic lanes;
   4. Traffic control or warning device installation projects;
   5. Changes or improvements to the right-of-way area outside the shoulder of an existing roadway;
   6. Drainage improvements; and
   7. Safety improvements.

   (Ord. 2006-31 § 1 (part), 2006; Ord. 1992-69 § 2, 1992)

10.56.030 - General considerations.

To promote compatibility between proposed major roadway projects and surrounding properties, the following shall be considered for each proposed project:

A. Environmental Effects. Effects of the proposed project on the environment, including but not limited to noise, air quality and wildlife.
B. Neighborhood Impacts. Protection of existing neighborhoods and minimizing negative impacts from a proposed project.
C. Business Impacts. Protection of existing businesses and minimizing negative impacts from a proposed project.

D. Alternative Transportation Modes. Features for alternative modes of transportation as a part of the proposed project.
E. Cost. Cost and budget limitations incorporated throughout the design and construction of a project.
(Ord. 2006-31 § 1 (part), 2006; Ord. 1992-69 § 3, 1992)

10.56.040 - Project initiation.
A project may be initiated after the desirability and necessity for the project is established by action of the Board of Supervisors or by inclusion of the improvement in the regional transportation plan adopted by the Pima Association of Governments. After corridor planning has occurred, the project design process shall begin with an environmental screening and inventory. If previous corridor planning has determined an analysis of alignment alternatives is required, this analysis shall be performed and documented in a location report. The location report shall be approved by the Board of Supervisors. An analysis of design alternatives and design criteria shall then be documented in a design concept report. In conjunction with the preparation of the design concept report, the appropriate measures to mitigate the impacts identified during the environmental screening shall be identified. These mitigation measures, as well as the environmental screening and inventory, shall be documented in an environmental assessment and mitigation report. Upon approval of the design concept report by the Director, and the environmental assessment and mitigation report by the Board of Supervisors, preparation of project plans beyond the design concept stage and specifications shall begin.
(Ord. 2006-31 § 1 (part), 2006; Ord. 1992-69 § 4.1, 1992)

10.56.050 - Reserved.

10.56.060 - Location report.
A. If previous corridor planning has determined that a location report is required, the criteria of Section 10.56.060 shall apply. If a location report is not required, project design shall proceed with a design concept report as outlined in Section 10.56.065 and environmental assessment and mitigation report as outlined in Section 10.56.070.
B. A location report is a recommended final right-of-way alignment based on a comparative study of all reasonable alternative right-of-way alignments. The location report shall include a general overview of anticipated environmental impacts for each alignment. The location report shall contain the information specified in the *Pima County Roadway Design Manual*.
C. A location report is appropriate where (1) the proposed project is a new roadway on a new alignment, (2) the proposed roadway has virtually no existing right-of-way, or (3) there are significant alignment choices to be made between the identified project termination points. A location report is not appropriate where (1) the established or existing right-of-way is not of adequate width in accordance with the Major Streets and Scenic Routes Plan, (2) the alignment variations are contiguous with the existing road right-of-way and location, (3) additional right-of-way is needed only to accommodate minor alignment alterations or intersection widening.
D. After the location report is completed, the Board of Supervisors shall hold a public hearing to determine the final right-of-way alignment. At the conclusion of the hearing, the Board of Supervisors may approve any of the alternative alignments studied in the location report, may

order the preparation of a new location report, or may order that the project be terminated or delayed.
(Ord. 2006-31 § 1 (part), 2006; Ord. 1992-69 § 4.3, 1992)

10.56.065 - Design concept report.
The design concept report shall identify the processes undertaken in developing a design concept for a roadway project, including the issues identified, design criteria employed, optional approaches considered, public input, and the recommended concept for design. The design concept report shall contain the information specified in the *Pima County Roadway Design Manual*. (Ord. 2006-31 § 1 (part), 2006)

10.56.070 - Environmental assessment and mitigation report.
A. An environmental assessment and mitigation report shall be prepared in conjunction with the design concept report.
B. The environmental assessment and mitigation report shall identify adverse impacts of the proposed project and shall provide recommendations for mitigation measures which may be undertaken to minimize the adverse impacts. The environmental assessment and mitigation report shall contain the information specified in the *Pima County Roadway Design Manual*.
C. After the environmental assessment and mitigation report is completed, the Board of Supervisors shall hold a public hearing to determine the mitigation components to be incorporated into the project. At the conclusion of the hearing, the Board of Supervisors may approve any of the mitigation measures considered in the environmental assessment and mitigation report, may order the preparation of a new environmental assessment and mitigation report, or may order that the project be terminated or delayed. Approval of mitigation components after the Board of Supervisors hearing on the environmental assessment and mitigation report shall constitute authorization to prepare construction documents and to acquire right-of-way for the project.
(Ord. 2006-31 § 1 (part), 2006; Ord. 1992-69 § 4.4, 1992)

10.56.080 - Construction documents.
Construction documents shall be prepared in conformance with the action taken by the Board of Supervisors on the environmental assessment and mitigation report and the Transportation Director on the design concept report. Any deviations from the Board's or Director's actions shall be identified in a project summary report, which shall be sent to the Board with the request for permission to advertise for bids for the project.
(Ord. 2006-31 § 1 (part), 2006; Ord. 1992-69 § 4.5, 1992)

10.56.090 - Public participation.
It is the policy of Pima County to promote public involvement and comment throughout the roadway development process, including during preparation of any location report, design concept report, or environmental assessment and mitigation report for major roadway projects constructed by Pima County. For minor projects, the Department of Transportation will evaluate the need for public involvement and notification on a project by project basis. Minimum levels of public notification shall be required for all projects.
(Ord. 2006-31 § 1 (part), 2006; Ord. 1992-69 § 5, 1992)

10.56.100 - Project mailing list.
The Pima County Department of Transportation shall maintain a project mailing list for each project subject to this chapter. The mailing list shall be used for all notifications required to be made under this chapter. The project mailing list shall consist of all owners of properties located within at least a one-half mile wide corridor along the alignment of the proposed project, based on the latest available records of the Pima County Assessor's Office. In addition, the list shall contain the names of all business property owners and tenants and the president or secretary of each homeowner and business association officially registered with Pima County adjacent to the project corridor. Throughout the project implementation process, this mailing list shall be expanded to include any additional resident and business who requests to be included in the mailings. (Ord. 2006-31 § 1 (part), 2006; Ord. 1992-69 § 5.1, 1992)

10.56.110 - Establishment of community advisory committees.
For each project subject to this chapter, a community advisory committee shall be established by the Department of Transportation to provide input and feedback to the Department of Transportation concerning any proposed location report, design concept report, or environmental assessment and mitigation report relating to the project. The community advisory committee shall function as set forth in Section 10.56.170.
(Ord. 2006-31 § 1 (part), 2006; Ord. 1992-69 § 5.2, 1992)

10.56.120 - Public meetings.
A. A public meeting shall be held at least once during each of the following steps in project development:
   1. During the process of preparing a location report, if applicable;
   2. During the process of preparing a design concept report, and;
   3. During the process of preparing an environmental assessment and mitigation report.

   A general public invitation to each public meeting shall be posted on the Pima County Department of Transportation website and shall be given in a display ad published in at least one daily newspaper of general circulation in Pima County not less than fifteen and not more than thirty calendar days before the meeting. The website posting and display ad shall include a project location map and a description of the prominent features of the proposed project. Invitations to each public meeting shall be sent by mail to each person on the mailing list (see Section 10.56.100).
B. Public meetings shall be held in reasonable proximity to the proposed project site. Illustrations to assist the public to visualize the proposed project shall be available for public viewing at each public meeting, and Pima County staff and consultants shall be available to answer questions about the proposed project. The public shall have access to the illustrations, staff, and consultants for each public meeting. Following the public meeting, project illustrations may be posted on the Pima County Department of Transportation website in addition to being available upon request.
   (Ord. 2006-31 § 1 (part), 2006; Ord. 1992-69 § 5.3, 1992)

10.56.130 - Public opinion questionnaire.
After each public meeting, a public opinion questionnaire shall be sent by mail to each person on the mailing list (see Section 10.56.100), soliciting public opinion concerning key design, environmental impact and mitigation issues. The questionnaire results shall be reported, along

with the number of questionnaires sent and the percentage of responses obtained, to the Board of Supervisors at or before the hearing on the location report or environmental assessment and mitigation report. (Ord. 2006-31 § 1 (part), 2006; Ord. 1992-69 § 5.4, 1992)

10.56.140 - Project status reports.
After appointment of a community advisory committee for a project, the Department of Transportation shall prepare and submit project status reports to the community advisory committee whenever there is a substantial change in the project status.
(Ord. 2006-31 § 1 (part), 2006; Ord. 1992-69 § 5.5, 1992)

10.56.150 - Report and executive summary for Board of Supervisors hearing.
A location report or environmental assessment and mitigation report shall be delivered to the Board of Supervisors at least thirty days before the public hearing, along with an executive summary of the report prepared by or for the Pima County Department of Transportation. The executive summary shall explain whether and to what extent the opinions, requests and suggestions of the community advisory committee were incorporated in the location report or the environmental assessment and mitigation report.
(Ord. 2006-31 § 1 (part), 2006; Ord. 1992-69 § 5.6, 1992)

10.56.160 - Board of Supervisors hearing notification.
Notice of Board of Supervisors public hearings shall be published in at least one daily newspaper of general circulation in Pima County not less than thirty and not more than forty-five calendar days before any Board of Supervisors public hearing required by this chapter. Notice of the public hearing shall also be sent to each person on the mailing list (see Section 10.56.100). The location report or environmental assessment and mitigation report to be considered at the hearing shall be available for public review at the time the hearing notice is published.
(Ord. 2006-31 § 1 (part), 2006; Ord. 1992-69 § 5.7, 1992)

10.56.170 - Community advisory committee.
The function of each project's community advisory committee is to provide input and feedback to the Pima County Department of Transportation during the preparation of any location report, design concept report, or environmental assessment and mitigation report for the project, so that ample consideration is given to the concerns of those who are most directly affected by a project.
(Ord. 2006-31 § 1 (part), 2006; Ord. 1992-69 § 6, 1992)

10.56.180 - Community advisory committee-Membership.
Each community advisory committee shall consist of between five and fifteen members. Two to eight members shall own property or reside immediately adjacent to the proposed improvement. One to six members may own property or reside within an approximate one-half mile corridor but not immediately adjacent to the proposed improvement. Up to four members may own property or reside outside of the one-half mile corridor. Preference will be given to property owners, business owners, and representatives of homeowners' and merchants' associations.
(Ord. 2006-31 § 1 (part), 2006; Ord. 1992-69 § 6.1, 1992)

10.56.190 - Community advisory committee-Formation.

To solicit volunteers for membership on a project's community advisory committee, notices shall be mailed to all whose names appear on the project mailing list (see Section 10.56.100), and an advertisement shall be posted on the Pima County Department of Transportation website and shall be published at least once in a newspaper of general circulation in Pima County not less than fifteen days before appointment of members. The notice shall contain a brief description of the proposed improvements and information on obtaining an application for membership on the community advisory committee. The notice shall specify the maximum number and composition of the community advisory committee, along with a deadline for receiving applications. The Director of the Department of Transportation shall appoint each community advisory committee. (Ord. 2006-31 § 1 (part), 2006; Ord. 1992-69 § 6.2, 1992)

10.56.200 - Community advisory committee -Functions and duties.

A. Community advisory committee members shall attend meetings as called by either the Department of Transportation or the chair, generally at regular intervals during project development through the end of construction.
B. The Department of Transportation shall provide community advisory committee members with training materials, reports, construction documents, and copies of this chapter, and shall explain operating procedures, duties and responsibilities of membership.
C. The community advisory committee shall elect a chairperson, who shall conduct meetings and supervise the preparation of the community advisory committee's written comments.
D. The community advisory committee shall review the location report, the design concept report, the environmental assessment and mitigation report, and the construction documents, based on the meeting schedule set forth in Section 10.56.230. The community advisory committee shall prepare written comments containing the committee's recommendations concerning the location report, the design concept report, the environmental assessment and mitigation report, project summary report and any other matter listed in Section 10.56.210. The community advisory committee's written comments may suggest a priority for elements of the proposed improvements, including the committee's priorities for allocation of mitigation resources available to the project.
E. The community advisory committee's written comments shall be presented to the Department of Transportation at least forty-five days before the Board of Supervisors public hearing on the location report or environmental assessment and mitigation report. A copy of the community advisory committee's written comments shall be presented to each member of the Board of Supervisors with the location report or environmental assessment and mitigation report (see Section 10.56.150).
F. After construction, the community advisory committee shall provide a written post-construction evaluation of the project. The evaluation shall analyze whether the construction has achieved the mitigation goals identified in the environmental assessment and mitigation report.

(Ord. 2006-31 § 1 (part), 2006; Ord. 1992-69 § 6.3, 1992)

10.56.210 - Community advisory committee -Permitted scope of review.

The community advisory committee may review any aspect of the following items, including mitigation methods, except as limited by Section 10.56.220:

A. The location report, which identifies the roadway location within a roadway corridor;

B. The design concept report, which documents the analysis of design alternatives;
C. The environmental assessment and mitigation report, including but not limited to:
   1. Environmental factors, such as:
      a. View shed treatments;
      b. Landscaping theme;
      c. Wildlife crossings;
      d. Ecological resources; and
      e. Cultural and historic resources,
   2. Neighborhood factors, such as:
      a. Noise abatement methods;
      b. Streetscape themes, including public art;
      c. Architectural treatments;
      d. Street lighting;
      e. Access control and mitigation; and
      f. Other neighborhood impacts,
   3. Business factors, such as:
      a. Access control and mitigation;
      b. Signage;
      c. Visibility; and
      d. Construction impacts,
   4. Alternative modes considerations, such as:
      a. Pedestrian facilities, including sidewalks, trails and paths;
      b. Equestrian crossings; and
      c. Alternative travel modes (for example, public bus and bicycle facilities),
   5. Cost considerations.

   (Ord. 2006-31 § 1 (part), 2006; Ord. 1992-69 § 6.4, 1992)

10.56.220 - Community advisory committee -Matters not to be reviewed for change.

The community advisory committee may request information regarding the following, but shall not alter these requirements or their applicability:

A. Pima County ordinances;
B. Pima County Department of Transportation engineering design standards and procedures;
C. Federal Highway Administration, Arizona Department of Transportation Standards, American Association of State Highway Transportation Officials, and the Institute of Traffic Engineers design criteria, and other generally accepted engineering and safety principles and standards;
D. Pima County regional long range transportation plan roadway designations;
E. Pima County Department of Transportation adopted typical roadway cross sections;
F. Pima County Department of Transportation design and posted speed limit standards and procedures;
G. Pima Association of Governments traffic projection modeling;
H. Pima County capital improvements program funding allocation;
I. Federal and state historic, cultural, and archaeological site protection requirements;
J. Federal and state endangered species protection requirements;
K. Federal and state wildlife habitat protection requirements;
L. The Americans With Disabilities Act.

(Ord. 2006-31 § 1 (part), 2006; Ord. 1992-69 § 6.5, 1992)

10.56.230 - Community advisory committee -Meeting schedule.
The following meeting schedule is recommended for each community advisory committee. Progress drafts of the report or documents under consideration shall be available prior to each respective meeting:

Items Under Consideration	Suggested Number of Meetings	Community Advisory Committee Meeting Schedule
Location report (if applicable)	3	A meeting when the draft report is initiated, one when it is completed, and one when the final report is approved.
Design concept report	2	A meeting when the draft report is initiated, and one when the final report is completed.
Environmental assessment and mitigation report	3	A meeting when the draft report is initiated, one when it is completed, and one when the final report is approved.
Construction documents	Optional	As the construction documents are being prepared, the project team shall provide the community advisory committee with reports identifying deviations from the approved environmental assessment and mitigation report. The committee may meet as it deems necessary to review the construction documents based upon this report.
Post-construction	1	Upon completion of the project

(Ord. 2006-31 § 1 (part), 2006; Ord. 1992-69 § 6.6, 1992)

10.56.240 - Mitigation measures.
General and specific impact mitigation measures as approved by the Board of Supervisors as a result of the public hearing on the environmental assessment and mitigation report shall be utilized to mitigate adverse impacts of each major roadway project. Mitigation includes measures to (1) avoid the impact altogether by not taking a certain action or selected elements of a proposed action, (2) minimize impacts by limiting the degree or magnitude of the action and its implementation, (3) rectify the impact by repairing, rehabilitating or restoring the affected environment, (4) reduce or eliminate the impact over time by preservation and maintenance activities during the life of the action, or (5) compensate for the impact by replacing or providing substitute resources or environments. The following mitigation measures shall be implemented for each major roadway project covered by this chapter:

A. Environmental.
   1. Preservation of Environmentally or Ecologically Sensitive Areas. Where possible, the location of major roadway projects shall avoid areas of significant environmental and ecological sensitivity. Where major roadway projects are adjacent to areas of unique environmental or ecological sensitivity, acquisition in fee simple, acquisition of

development rights, or conservation easements may be proposed by the appropriate environmental assessment and mitigation report (see Item 5 below for additional requirements).

2. Landscaping. All medians and right-of-way areas on major roadway projects shall be landscaped with drought-resistant, low pollinating, preferably native plants. Plant species shall be listed as permissible pursuant to the landscaping requirements of the Pima County zoning code. The landscaping theme of each major roadway project shall be compatible with the native landscape through which the roadway passes. Installation of landscaping shall begin not later than six months after the formal completion date of the roadway project.
3. Dust Abatement. Curbs or paved roadway shoulders shall be provided adjacent to through traffic lanes to minimize air borne dust generated by vehicular traffic.
4. Scenic Route Designations. A visual impact analysis shall be included in any environmental assessment and mitigation report prepared for improvements on major roadway projects designated as scenic routes.
5. Environmentally Sensitive Roadways. Roadways are defined as Environmentally Sensitive Roadways (ESR) if they are located within or cross (a) unique ecologically or culturally sensitive lands as determined by the Sonoran Desert Conservation Plan, (b) High or Moderate Archaeological Sensitivity Zones or Priority Cultural Resources, or (c) if the roadways are identified as Historic or Scenic Routes. Projects that are defined as ESR shall be designed and constructed to minimize disturbance to the area resources. Additional environmental resource assessment and mitigation procedures are required as defined in the *Pima County Roadway Design Manual*.

B. Neighborhood.

1. Area Adjoining Roadway. The primary purpose of the area between the roadway improvements and the right-of-way line shall be to mitigate adverse effects of highway development on adjacent land uses and provide an aesthetically pleasing environment. Therefore, the following uses are permitted: installation of noise walls, screens or berms; landscaping; public art; facilities for public bus, pedestrian, equestrian and/or bicycle use; underground utilities; drainage system components, safety appurtenances and environmental mitigation measures. Overhead utilities are permitted only when the cost of placing the utilities underground causes the project budget to be exceeded or when the voltage exceeds fourteen thousand volts. Where native vegetation exists, a design goal shall be to conserve and incorporate this vegetation within the project landscaping plan.
2. Neighborhood Traffic Intrusion. Major roadway projects shall be designed to minimize neighborhood traffic intrusion. Where local street connections offer a bypass or shortcut between major roadway projects which in the opinion of the Board of Supervisors has a substantial adverse impact on neighborhood traffic, such streets shall be closed to through traffic or otherwise modified to minimize traffic intrusion.
3. Noise Abatement. Noise abatement shall be incorporated into the project design to protect inhabited residential or other sensitive land uses from roadway traffic noise. Noise abatement measures shall be considered for these land uses when existing or design year projections of exterior traffic noise measurements exceed an hourly A-weighted sound level of sixty-seven dBA or when there is an increase in noise measurements of fifteen dBA or greater. The preferred method of noise abatement shall be the construction of noise barrier walls. Other methods such as rubberized asphalt,

berms, and/or landscaping may be utilized if the cost to Pima County does not exceed the cost of noise barrier walls.

C. Businesses.
   1. Business Assistance Program. Pima County shall develop a Business Assistance Program to assist businesses throughout the design and construction phases of roadway projects. The goals of this program are to help businesses maintain profitability throughout roadway projects, improve communication between businesses and Pima County Department of Transportation, and to minimize and mitigate the impacts associated with roadway projects.
   2. Information Program. Pima County shall implement an information program to provide project information to business owners and tenants throughout the design and construction phases of roadway projects.
   3. Access Control. Major roadways shall be designed and constructed to maintain and control safe and convenient access to businesses and parking. During construction, at least one access driveway shall be maintained at all times.
   4. Signage and Visibility. Major roadways shall be designed to maintain business visibility and signage, including careful placement of street trees, vegetation, utility and other structures that could impact visibility. During construction, additional business signage shall be provided to improve visibility.

D. Alternative Modes.
   1. Bicycle and Pedestrian Considerations. The outside lane width for any urban (curbed) and rural (noncurbed) major roadway project shall be per the standards specified in the *Pima County Roadway Design Manual* to accommodate bicycles and other uses. Physically separated bicycle paths shall be examined as a design alternative where right-of-way widths are two hundred feet or greater and side street and driveway connections are limited. Sidewalks shall be provided where warranted by pedestrian travel, and special consideration shall be given to pedestrian or bicycle crossings with major routes. Pedestrian overpasses/underpasses shall be considered for school crosswalks or school zones for existing public or private schools adjacent to any major route.
   2. Transit Vehicles. The project design shall consider mass transit vehicle pullouts if bus or other mass transit services are available or planned along the proposed improvement.
   3. Park and Ride Facilities. To facilitate carpooling, ridesharing and mass public transportation ridership, additional right-of-way shall be considered in the vicinity of major intersections of major roadway projects for the development of future park and ride facilities. Park and ride facilities shall be convenient and screened with landscaping. (Ord. 2006-31 § 1 (part), 2006; Ord. 1992-69 § 7.1, 1992)

10.56.250 - Reserved.

10.56.260 - Roadway design criteria.

The roadway design criteria for any major roadway project covered by this chapter shall be specified in the current *Pima County Roadway Design Manual*.
(Ord. 2006-31 § 1 (part), 2006; Ord. 1992-69 § 7.2, 1992)

10.56.270 - Advance right-of-way acquisition.
To minimize displacement, disruption and right-of-way acquisition costs, and to maximize the effectiveness of mitigation measures, advance right-of-way acquisition may be proposed in the environmental assessment and mitigation report, per the current procedures used by Real Property Services. Where funding is available, priority for consideration of advance acquisition shall be given to single-family residences with sole, direct access to major roadway projects for hardship and protective reasons, and to real property for which the inevitability of acquisition affects its marketability. (Ord. 2006-31 § 1 (part), 2006; Ord. 1992-69 § 8, 1992)

10.56.280 - Operation and maintenance.
Except as otherwise agreed to in a maintenance agreement duly authorized by the Board of Supervisors, all major roadway project improvements including noise walls, public art, landscape medians, and other similar features shall be maintained as part of Pima County's normal maintenance process. (Ord. 2006-31 § 1 (part), 2006; Ord. 1992-69 § 9, 1992)

10.56.290 - Exemptions and variances.
A. At any time before or during consideration of a proposed improvement, the Board of Supervisors may exempt the project or any portion of it from any or all procedural or substantive requirements of this chapter. The Board of Supervisors may grant a variance from the specific application of any substantive requirement of this chapter where the application of the provision will impose an unnecessary hardship on a property owner or on the general public.
B. An exemption or variance may be granted by the Board of Supervisors as part of the approval of the final road alignment (see Section 10.56.060) or the mitigation components to be incorporated into the project (see Section 10.56.070). In that case, the public hearing notice required for consideration of the location report or the environmental assessment and mitigation report shall identify each recommended alterative which constitutes an exemption or waiver from the requirements of this chapter. No further notice shall be required.
C. If not granted as part of the approval of the final road alignment or the mitigation components to be incorporated into the project, an exemption or variance may be granted after a public hearing by the Board of Supervisors, at least one notice of which shall be published no less than fifteen days before the hearing in a newspaper of general circulation in Pima County.
(Ord. 1992-69 § 10, 1992)

10.56.300 - Annual report.
Each year the Director of the Department of Transportation shall prepare a report to the Board of Supervisors regarding the application, use and effectiveness of this chapter. The annual report shall contain a list of the projects to which this chapter was applied in the past year, the status of each project, estimated costs of each project, and any suggested modifications to the procedures and processes of project implementation which would improve the effectiveness of this chapter. (Ord. 2006-31 § 1 (part), 2006; Ord. 1992-69 § 11, 1992)

APPENDIX 1-A
EXHIBITS

1. Location Report Contents
2. Environmental Assessment and Mitigation Report Contents

Exhibit 1

LOCATION REPORT

Table of Contents

I. Introduction
  A. Description of Proposed Roadway Corridor
II. Identification of Alternative Locations
  A. Description of Roadway Alternatives
III. Comparative Impact Assessment and Analysis
  A. Preliminary inventory of existing data
  B. Comparative impact assessment
  C. Evaluation of comparative impact assessment
  D. Conclusions
IV. Recommendation
  A. Proposed Action
  B. Identification of potential impacts of preferred alignment requiring further analysis in the Environmental Assessment and Mitigation Report
    1. Environmental
    2. Neighborhood
    3. Alternative Modes
    4. Cost
V. Exhibits
  A. Roadway Alternatives
  B. Graphic illustrations

* An Executive Summary will be prepared which can be inserted at the beginning of this report.

Exhibit 2

ENVIRONMENTAL ASSESSMENT AND MITIGATION REPORT

Contents

Executive Summary

Table of Contents (Chapters, Sections, List of Exhibits, Appendices)

Abbreviations

1.0 Background

1.1 Project Cost and Funding

1.2 Direction by Board of Supervisors

1.3 Project Design Process

2.0 Project Purpose And Need

3.0 Project Setting

4.0 Proposed Project

5.0 Environmental Screening

6.0 Environmental Assessment And Mitigation

6.1 Natural/Physical Environment

6.1.1 Biological Resources*

6.1.2 Drainage/Section 401/404

6.1.3 Floodplain

6.1.4 Air Quality

6.1.5 Noise

6.1.6 Utilities

6.1.7 Hazardous Materials

6.1.8 Construction

6.1.9 Historic/Cultural Resources*

6.1.10 Visual Resources*

6.2 Neighborhood/Social Environment

6.2.1 Right-of-Way Acquisition and Displacement

6.2.2 Temporary and Permanent Access and Parking Impacts

6.2.3 Neighborhood Disruption

6.2.4 Parks and Recreational Areas

6.2.5 Consistency with Other Plans

7.0 Agency Coordination

8.0 Public Participation

- 8.1 Public Participation Plan
- 8.2 Community Advisory Committee
- 8.3 Public Meetings
- 8.4 Community Concerns

9.0 Conclusion and Recommendations

10.0 References

Tables

Figures

Project Documents

Exhibits (as applicable)

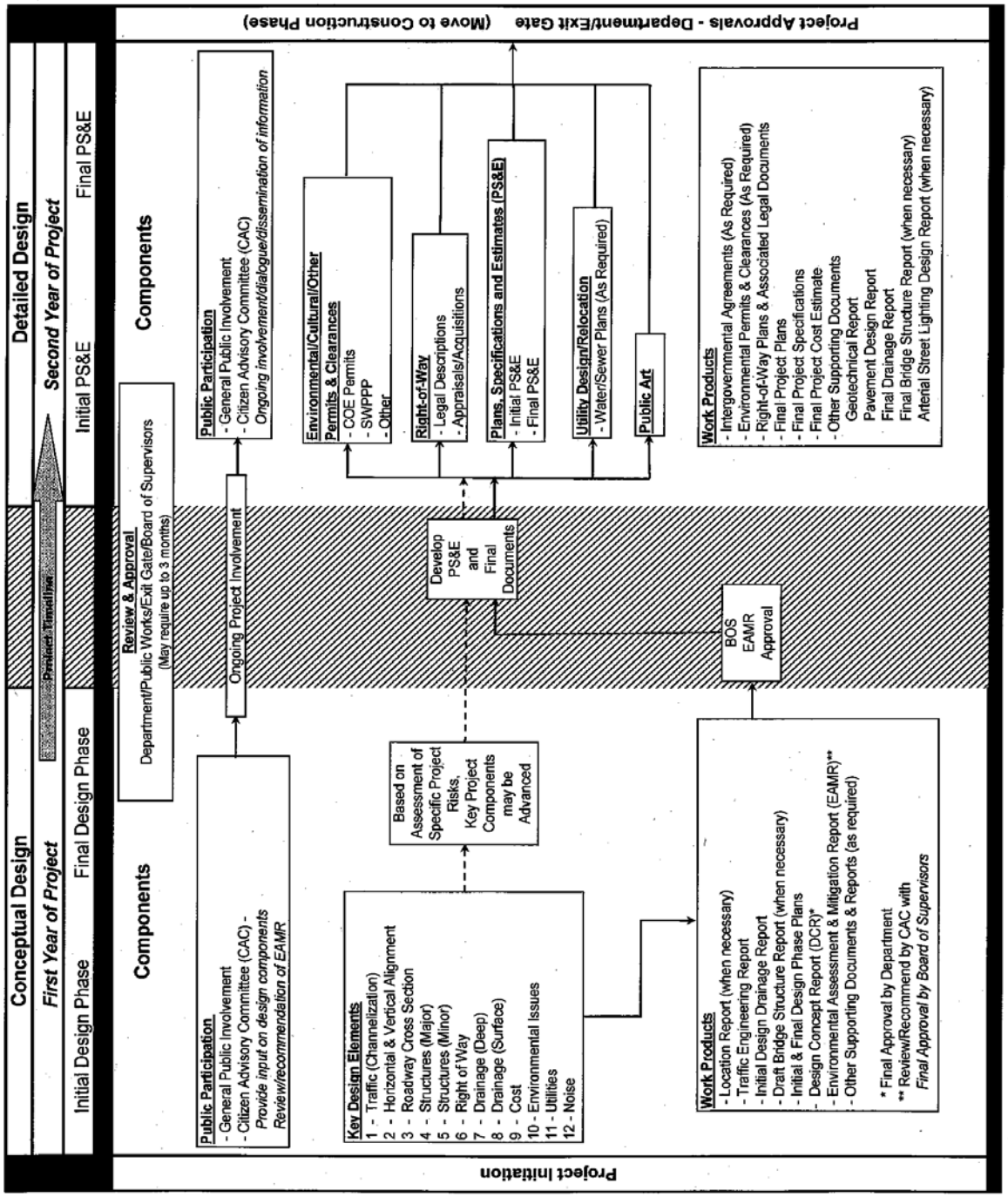
- Location Map
- Aerial Photo (project limits and prominent physical features)
- Existing Conditions Photos (captioned)
- Noise Measurement Location Map
- View Analysis Location Map and Photos of Analysis Locations
- Existing Land Use Map
- Alternative Transportation Routes Map (e.g., bus routes, sidewalks, and designated trails)
- Park and Recreational Facilities Map
- *Optional:* Photo simulations of the proposed project
- *Other as appropriate*

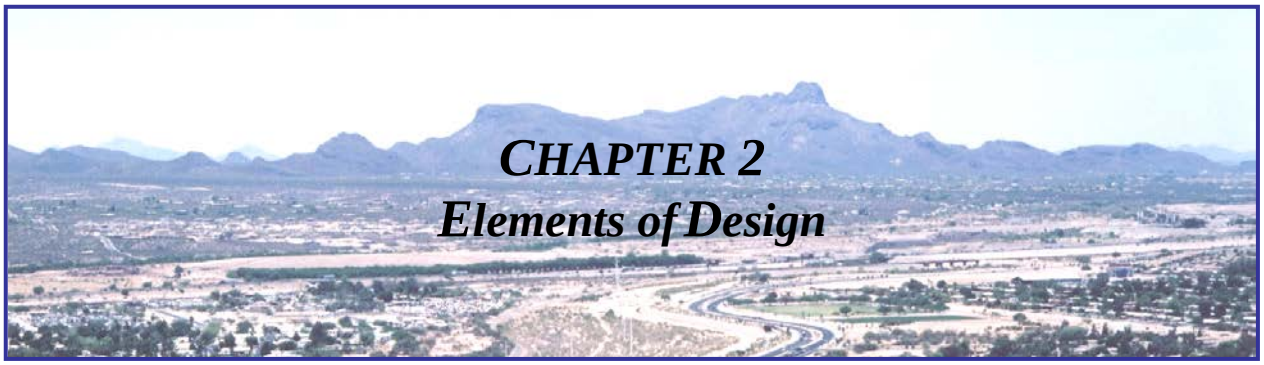
Appendices (as applicable)

* If project is designated as an Environmentally Sensitive Roadway, see Chapter 4 for information on conducting this assessment.

APPENDIX 1-B

PIMA COUNTY DESIGN PROCESS FLOWCHART





CHAPTER 2
Elements of Design

2.1 INTRODUCTION

This chapter highlights the important considerations and requirements in designing and reviewing plans for new and improved Pima County roadways. The chapter sections present the elements of roadway design and include references to other documents for additional guidelines and specifications. These latter documents are also listed in the Appendices of this chapter.

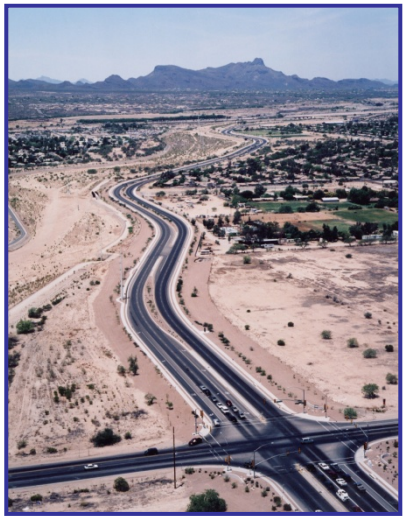
In addition, this chapter is based on the principles of "Complete Streets" which looks to incorporate use by all existing and future users, and not be limited to just motor vehicles. This expansion of thought associated with the roadway design, includes a responsibility to the public health, safety and welfare in order to design, operate, and maintain the right of way in a manner that enables safe and efficient access for drivers, transit users, vehicles, pedestrians, and bicycles; along with children, the elderly and those with disabilities. It is essential to recognize that all modes of travel need to be analyzed, evaluated and accommodated to the maximum degree practicable.

Note that these documents are revised periodically; therefore users should double check that they have either the specific version of the document specified in this chapter, or, that they have the most recent version if the reference is updated.

Pima County recognizes that each roadway project is likely to have some conditions that require special and/or unique treatment. This chapter, therefore, is not intended as a "cookbook." That is, this chapter is not a substitute for experience, professional judgment, and ongoing communication between the designers and reviewers. In those cases, however, where the application of a particular standard **is required**, the words "must" or "shall" have been used. In other cases, "may" or "should" are used to imply some flexibility at the discretion of Pima County. Figures referenced within this chapter are included consecutively at the end of the chapter, but preceding the chapter's appendices. Tables are presented near their point of reference within the text.

Finally, if a project is designated an "environmentally sensitive roadway" by Pima County or meets the criteria of such a roadway, designers and reviewers must also take into account the County document entitled *Environmentally Sensitive Roadway Design Guidelines*, which is included as Chapter 4 of this manual.

2.2 HORIZONTAL ALIGNMENT



The horizontal alignment of a roadway is comprised of horizontal curves and tangent sections. Superelevation is introduced into the alignment to provide appropriate balance between centrifugal forces and side friction on the tires of the vehicle moving through the curved section.

Two primary factors that provide the framework for horizontal alignment are design speed and stopping sight distance. The design must also consider the functional classification, topography, vertical alignment, environmental factors, right-of-way width, access locations and project costs, etc. Sight distance must be considered concurrently with topography since it will often require a greater curve radius than what is required solely by design speed.

Design Speed

The design speed is based on the physical features and functional classification of the roadway. Horizontal and vertical alignment, sight distance and superelevation are features directly related to the selected design speed. Pima County will specify a design speed for each project, with the maximum design speed being 60 miles per hour (mph).

Stopping Sight Distance on Horizontal Curves

The sight distance available to drivers across the inside of horizontal curves is an important element in the design and review of horizontal alignment. When sight obstructions such as walls, outside curbline barriers, cut slopes, buildings, and continuous median barriers exist on the inside of curves, the distance to the obstruction from the center of the nearest travel lane must be checked. This distance, M, is termed the middle ordinate of the curve. Guidelines for the middle ordinate are given in the latest edition of the *American Association of State Highway and Transportation Officials, A Policy on Geometric Design of Highways and Streets* (*AASHTO Policy)*, based on the stopping sight distances that should be provided.

Horizontal Curves

Values for design elements, including minimum curve radii, design speed, and superelevation, are found in the *AASHTO Policy*. When designing the horizontal alignment of new or improved roadways, the following factors should be considered:

- The design of horizontal and vertical alignments should be well coordinated in order to avoid undesirable driver reactions. For more information on this topic, refer to the latest edition of the *AASHTO Policy*.
- Differences in design speed between successive horizontal curves should be avoided.

- For small deflection angles, horizontal curves should be sufficiently long to avoid the appearance of a kink. Curves should be at least 500 feet for a central angle of 5 degrees, and the minimum length should be increased 100 feet for each 1-degree decrease in the central angle (*AASHTO Policy*).
- An angle point is acceptable for breaks in tangent alignments of less than 1°08'.
- Horizontal curves, meeting minimum radii as defined by the latest edition of the *AASHTO Policy*, should be avoided at points where driver expectation is low, such as at the ends of long horizontal and vertical tangent sections.
- Median openings along horizontal curves are generally discouraged.
- Broken-back curves (i.e., two horizontal curves in the same direction separated by short tangent sections) should be avoided.

Superelevation

Superelevation refers to cross slope introduced into the cross section of a roadway in order to compensate for the centrifugal forces created by horizontal curves. In Pima County, 0.06 ft/ft and 0.04 ft/ft are the maximum rates for rural and urban/suburban roadways, respectively.

Examples of design superelevation rates based on the design speed, the radius of curve, and the superelevation rate can be found in *AASHTO Policy*.

Typical superelevation sections are presented in Appendix 2-B (Figures 2-8 and 2-9), at the end of this chapter.

Axis of Rotation

When superelevation is introduced to account for horizontal curvature and to provide a stable turning motion for vehicles traveling at or below the design speed, the rotation of the pavement section must be designed along a given axis. The location of this axis of rotation has impacts on the length required to transition from a normal crown section to a superelevated section. The location can also impact drainage patterns, driver perception of the transition area, and aesthetics. Within a given project, the axis of rotation should remain constant for all horizontal curves and for a given type of cross section.

Regardless of the location of the axis of rotation, "flat" areas shall be avoided and the change in cross slope between the roadway and its intersecting driveways and cross streets shall be carefully reviewed. Designing narrow medians is particularly challenging since the cross section slope across the width of the median (from outer curb face to outer curb face) should be flatter than 10:1. Median openings should conform to a maximum grade differential of 5%.

Superelevation Transitions

Superelevation transitions refer to the lengths of highway that are used to bring a normal crown section up to the superelevation rate that is being designed. Transitions are also used to bring a superelevated section back to the normal crown section. There are two components that make up

the total transition for a superelevated section. The first component is the tangent runout, which denotes the length of highway needed to bring a normal crown section to a section with an adverse crown removed (zero cross slope), or vice versa. The second component is superelevation runoff, which denotes the length of highway needed to bring a section with the adverse crown removed (zero cross slope) up to a fully superelevated section, or vice versa. Guidelines for the minimum length of superelevation runoff and tangent runout for a variety of design speeds and superelevation rates are given in *AASHTO Policy*.

Refer to the latest edition of the *AASHTO Policy* for a complete discussion of superelevation transitions, including proportion of runoff length on the tangent, the use of spiral transition curves, and maximum relative gradients.

Spiral Curves

Spiral curves are used in Pima County projects only when required to coordinate and be compatible with roads designed by other agencies, particularly the Arizona Department of Transportation (ADOT).

Compound and Reverse Curves

The use of compound circular curves should be avoided. In special cases, where topography or right-of-way constraints require the use of compound curves, the radius of the flatter curve should not exceed 1.5 times the radius of the sharper curve.

Where topographic or right-of-way constraints require the use of reverse simple curves, a minimum tangent separation between the curves equal to at least 4/3 of the longer of the two superelevation runoff lengths shall be used. Special attention to roadway drainage requirements must be given when using reverse curves.

Broken back curves, which consist of two curves in the same direction connected by a short tangent section, should be avoided in the design of horizontal alignment. Pima County will review requests for permission to use this type of curve.

For curvature and superelevation transitions near bridges, the beginning and end of horizontal curves should occur sufficiently beyond the bridge limits so that the superelevation transition sections do not fall on the bridge or its approach slabs.

2.3 ROADWAY SECTIONS

The typical cross sections for Pima County roadways are shown in Appendix 2-B (Figures 2-1 through 2-7), at the end of this chapter. For roadways that may be annexed in the near future by a city or town, Pima County may elect to incorporate none, some, or all of the city's or town's standards into the design.

Lane and Shoulder Width

The preferred lane widths to be used for Pima County roadway design are presented in Table 2-1 at the end of this section. Proposed lane widths that will exceed the preferred lane width shall be reviewed to determined if a wider lane is justified based on roadway geometry, traffic conditions, volume, vehicle mix (percentage of trucks), bicycle use, driver age/demographics for the location, along with design and posted speed limits.

Clear Zone and Cross Slope

Standards for other cross section features are presented in Table 2-2 at the end of this section. Drainage structures should extend beyond the clear zone limits. Noise walls and retaining structures should be installed beyond the clear zone limits. However, there may be circumstances which require the location of these types of features within the clear zone due to functionality or for other reasons/requirements (e.g. – available right-of-way, constraints associated with project construction, impact on other roadway features/components, costs, etc.). Therefore, when these types of features are constructed within the clear zone, a further review for appropriate clear zone mitigation shall occur.

Refer to the latest edition of the *AASHTO Roadside Design Guide* for further discussion on clear zone, crash attenuation, traversable and recovery slopes, and barriers.

Side Slope

Figures 2-1 through 2-7 illustrate required side slopes, both in cut and fill sections. The Pima County standard for cut and fill sections is a 4:1 slope on urban roadways, and a 6:1 foreslope and 4:1 backslope on rural roadways. Embankments and excavations steeper than 4:1 and heights greater than 10 feet must be in compliance with the Pima County Hillside Development Overlay Zone.

Medians

The standard median width for Pima County designed projects is 22 feet. The minimum median width is 20 feet. A maximum median width of 24 feet may be included as part of the design, subject to a review of documentation and justification for the increased width, and with approval of Pima County prior to it being included as part of the design.

Pedestrian Walkways

Pedestrian walkways (sidewalks and paths) should be incorporated in a roadway cross-section design based on a review and analysis of existing and projected pedestrian use, unless otherwise directed by Pima County. The standard width for sidewalks is 5 feet unless the sidewalk is placed abutting the back of curb; then the standard width is 6 feet. Pedestrian facilities are furhter discussed in Section 2.6. Sidewalks, paths, and all ramp connections shall be designed and installed to be compliant with the Americans with Disabilities Act.

Roadside Barriers

Roadside barriers are systems used to shield motorists from natural or man-made obstacles located along the traveled way and may be used to protect pedestrians and bicyclists from vehicles under special conditions. The primary purpose of all roadside barriers is to prevent an errant vehicle from striking a fixed object or terrain feature that is less forgiving than striking the barrier itself. Roadside obstacles and embankments within the clear zone may warrant shielding by a roadside barrier and require evaluation in accordance with the barrier warranting process identified in the latest edition of the *AASHTO Roadside Design Guide*. Roadside obstacles and embankments located outside the clear zone should be reviewed for potential barriers based on engineering judgment relative to the risk and severity of an incident.

Barrier warrant analysis documentation shall be included in the project files and submitted to the department for review and approval. Documentation shall include the location and description of the obstacle, evaluation, and final approved disposition of all existing and proposed improvements and obstacles.

Regardless of the location of the obstacle, the preferred placement for barrier and/or guardrail treatment should be at the face of the curb for curbed roadways and back of shoulder for uncurbbed roadways. The length shall meet the reocmmendations presented in the latest edition of the *AASHTO Roadside Design Guide.* The guiding principal in barrier selection is its' funcitonality and proven performance. The barrier chosen shall have been crash tested and approved byFHWA, with its' use compatible with the testing performed.

Utilities

The formally adopted Pima County *Design Guide for Constructing and Relocating Utilities within Public Right-of-Way* is provided in Appendix 2-D of this chapter. The guideline requires that all new overhead and above-ground utilities be constructed outside of the roadway clear zone. Also, underground utilities should be placed outside the paved areas of the roadway section. See Figure 2-11 in Appendix 2-B for standard locations of overhead and underground utilities.

Table 2-1 Lane Width Standards – Pima County Design

Lane Type	Preferred Width (Ft)
Travel	11
Travel (inside), with median curb	12[1]
Right-turn	13[2]
Left-turn, with median curb	13[1]
Left-turn, no curb	12
Two-way, left-turn lane	12
Paved Shoulder (urban)	6
Shoulder (2 lane rural), paved + unpaved	10

Notes: Widths measured from center of stripe to center of stripe unless otherwise noted.

1. Width is inclusive of the median yellow edgeline offset of one foot

2. Width is inclusive of the edge of pavement white edgeline/curb offset of one foot.

See Typical Section figures 2-1 through 2-9

Table 2-2 Cross Section Standards – Pima County Design

Element	Standard	Minimum
Median width	22 feet	20 feet
Cross slope (travel lanes)	2%	2%
Cross slope (paved shoulder)	2%	2%
Cross slope (turn lanes)	2%	1%
Cross slope (pedestrian walkway)	2% (toward road)	1% (toward road)
Cross slope (graded shoulder)	2%	2%
Cut slope	4:1	3:1
Fill slope	4:1	3:1
Clear zone	6:1	4:1

Note: See the latest edition of the AASHTO Roadside Design Guide, for clear zone values.

2.4 VERTICAL ALIGNMENT (PROFILE)

The vertical profile gradeline is the reference line by which the elevation of the pavement and other roadway features are established. The profile gradeline of a roadway is defined by a series of tangent grades and vertical curves. The vertical curve used for roadway design is a parabola. Consistency of the vertical alignment is important in order to provide safe stopping sight distance at all points along the roadway. Also, the vertical alignment must be coordinated with the horizontal alignment during the design effort.

Grades

Pima County guidelines for maximum and minimum profile grades are:

- 3% maximum grade in flat terrain
- 7% maximum grade in foothill or mountainous areas
- 0.5% minimum grade in all areas
- 4% maximum grade break at side-street intersections
- 8% maximum grade break at driveways without using vertical curves
- A minimum 18 foot level landing should be placed at driveways and side streets

Vertical Curves

Pima County uses vertical curves based on the simple parabola and with the vertical axis centered on the point of intersection. Vertical curves generally should be made as long as possible to provide greater stopping sight distance and more pleasing aesthetics. In some cases, however, a minimum length vertical curve may be required to reduce the amount of excavation in rolling or hilly terrain.

The formulas used to establish the length of a vertical curve for crest situations are:

for $S < L$ $\quad L = AS^2/2158$

for $S > L$ $\quad L = 2S - 2158/A$

where

L = length of crest vertical curve (ft)

S = sight distance (ft)

A = algebraic difference in grades (percent)

Pima County's design control criterion for both crest and sag vertical curves is the provision of adequate safe stopping sight distance (refer to the next section for a discussion on stopping sight distance). A minimum length of vertical curve of three times the project design speed is desirable for Pima County roadways. Most project designs should use a longer than minimum vertical curve length. Specific values for crest vertical curves, both tabular and graphical, can be found in the latest edition of the *AASHTO Policy*.

The following equations apply for the design of sag vertical curves:

for $S < L$ $\quad L = AS^2/400+3.5S$
for $S > L$ $\quad L = 2S - (400+3.5S)/A$

where

L = length of sag vertical curve (ft)
S = sight distance (ft)
A = algebraic difference in grades (percent)

In Pima County, the sight distance value for designing sag vertical curves is taken as the minimum safe stopping sight distance. The design will approximate the condition of headlight distance on the pavement at nighttime by using the stopping sight distance. The assumption for the design of sag vertical curves is that no continuous street lighting will exist, and that headlight distance will govern. For design values for sag vertical curves for Pima County projects, see the latest edition of the *AASHTO Policy*.

Some of the important design considerations for both crest and sag vertical curves are:

- A smooth grade line with longer tangent grades and fewer vertical curves should be a design objective.
- Grade breaks in the profile of 0.5% or less do not require a vertical curve.
- Broken-back grade lines (i.e., two vertical curves in the same direction separated by short sections of tangent grade) should be avoided.
- For long upgrades, it is preferable to place the steepest grade at the bottom and reduce the grades at the top. Roller coaster and hidden dip profiles should be avoided.
- Drainage and flow patterns at the top of the crest and at the bottom of sag curves.

Stopping Sight Distance

The principal design control for both crest and sag vertical curves is the provision of adequate stopping sight distance along the entire length of the curve. All portions of the profile gradeline shall meet sight distance requirements for the design speed of the roadway. In computing and measuring stopping sight distance, the height of the driver's eye is estimated to be 3.5 feet and the height of the object to be seen by the driver is 2.0 feet. The equation used to calculate stopping sight distance (SD) is:

$$SD = 1.47\ Vt + 1.075\ V^2/a$$

where

SD = stopping sight distance (ft)
V = design speed (mph)
t = brake reaction time, 2.5 sec
a = deceleration rate, ft/sec^2 (use 11.2 ft/sec^2)

Refer to the latest edition of the *AASHTO Policy* for information about the effects of grade on stopping sight distance.

Values for stopping sight distance for Pima County roadway design are given in Table 2-3. These values assume wet pavement and a 2.5 second brake reaction time.

Table 2-3
Stopping Sight Distance – Pima County Design

Design Speed (mph)	SD (ft)
30	200
40	305
45	360
50	425
55	495
60	570

Source: AASHTO 2011 Policy, Chapter 3
Note: Verify with the latest edition of the AASHTO Policy. Use the more restrictive length

Passing Sight Distance

On two-lane highways, provision of passing sight distance can be an important consideration. Generally, for crest vertical curves, the passing sight distance is substantially longer than the stopping sight distance, and the latter is used as the design control. Appropriate no-passing zones and markings must be in place in order to enforce the no passing criterion. For multilane highways, the stopping sight distance is again used as the design control for vertical alignment. Refer to the latest edition of the *AASHTO Policy* for a discussion of passing sight distances for various design speeds. Note that the AASHTO standard is based on a driver's eye height of 3.5 feet and an object height of 3.5 feet (passing) or 2.0 feet (stopping).

Coordination of Vertical and Horizontal Alignments

The combined effect of vertical and horizontal alignments along a given section of roadway is an important factor to consider. Although there are no specific design values or specific criteria, the following considerations should be addressed:

- A design that balances horizontal and vertical alignments in the middle range of values is preferable to allowing either the horizontal or vertical alignment to become extreme in order to optimize the other.
- Crest vertical curves should not be coincident with or immediately precede sharp horizontal curves.
- Sharp horizontal curvature near the low point of a sag vertical curve should be avoided.
- Horizontal curvature and vertical profiles should be as flat as possible at intersections, where vehicles have to decelerate, stop or accelerate. Refer to the latest edition of the *AASHTO Policy*.

2.5 INTERSECTIONS

The goal of intersection design should be to provide layouts that allow for safe and efficient crossing, merging, and diverging of conflicting vehicle streams. These conflicts can be significantly reduced through the provision of adequate sight distances and efficient traffic control devices. Providing safe sight distances and effective control will depend on human factors related to the drivers, bicyclists, and pedestrians; the traffic volumes to be accommodated; and the geometric and topographical characteristics of the intersection itself.

Design Elements

Human Factors

Two of the most important human factors that impact the design of intersections are the perception reaction time of drivers and the walking speed of pedestrians. The perception reaction time affects required intersection sight distances and also affects traffic signal timing. Pedestrian walking speed affects traffic signal timing, as well as placement of channelization and islands. The values appropriate for Pima County design are a driver perception reaction time of 2.5 seconds and a pedestrian walking speed of 3.5 feet per second. In areas where the proportion of older drivers or pedestrians is greater than average, these human factor values should be reviewed and may be revised upward in the case of the perception reaction time, and downward in the case of pedestrian walking speed. For projects in the Green Valley area of Pima County, a slower pedestrian walking speed of 3.0 feet per second should be used.

Traffic Demand

There are two key items relative to traffic demand that must be identified early in the design process. First, a design hour volume must be established. In Pima County, typical practice is to use the 20-year traffic forecasts prepared by the Pima Association of Governments (PAG). These forecasts provide average daily traffic (ADT) over a 24-hour period on the major roadway system in the County. Pima County may also provide a set of recent traffic volume and turning volume counts at major intersections. Using the 20-year forecasts and existing data, a set of volumes for both through and turning traffic is established for the design. All of this material is reported in the Traffic Engineering Report required by the Pima County design process (see Chapter 3, Section 3.15). See below for a general indication of the ranges of values that are often encountered for intersection design. Note, however, that for each design effort, the specific values documented in the Traffic Engineering Report may vary from these ranges significantly.

- K-factor - 0.08 to 0.10 (Ratio of the design hour traffic volume to the average daily traffic volume)
- D-factor - 55/45 to 65/35 (Directional distribution of peak hour traffic)

- Peak-hour factor - 0.80 to 0.90 (Ratio of the peak hour volume to four times the highest 15-minute volume during the peak hour)
- Heavy vehicles - 2% to 6% of total volume (Percent of heavy vehicles in the design traffic volume)

Design Vehicles

Design vehicle selection is an important geometric design component for roadway projects. The design vehicle should be selected based upon the roadway functional classification and the existing and anticipated vehicle type and volume. The standard design vehicle to be used for Pima County projects is the large semi-trailer denoted as WB-62. Dual left and right turn lanes should be designed for the SU-30 in the inside lane and the WB-62 in the outside lane. The standard bus vehicle may also be considered in areas with school bus activity.

The dimensions and turning templates for design vehicles may be found in the latest edition of the *AASHTO Policy*. All turning movements shall be contained within the pavement for the design vehicle, and shall not cross into the opposing lane of travel. Consideration must be given to accommodate the largest vehicle that may use the intersection/segment. Turning template diagrams shall be made available upon request by Pima County.

Traffic Control

The requirements for two-way stop control, all-way stop control, or traffic signal control will be analyzed in the Traffic Engineering Report for the project. Selection of a specific form of control will have significant impact on design elements, such as length of storage for exclusive turn lanes, warning and regulatory signs, sight distance, and the need for acceleration and deceleration lanes. Also, the type of control to be implemented will affect how pedestrians and bicycles are managed and controlled at the intersection.

Roadway/Driveway Location and Configuration

The establishment of locations for cross street intersection locations is often constrained by existing street patterns. Intersections shall be created or revised according to the following general guidelines:

- 90-degree intersections are almost always preferable to skewed intersections
- Skews greater than 20 degrees are to be avoided
- Intersections should be located along tangent sections of the roadway
- A minimum of 200 feet of tangent is recommended for the approach and departure into each intersecting roadway
- Signalized intersections should be spaced no closer than 0.5 miles
- Intersections with more than four entering approaches should not be used.

Roadway and driveway tie-ins, on the same or opposite sides of the street, shall be spaced at the minimums shown in Tables 2-4 and 2-5, and shall not be located within the functional limits of an intersection, unless otherwise approved by Pima County. Functional limits are defined as the

beginning and ending of tapers for right- and left-turn lanes and acceleration and deceleration lanes, the redirection tapers for through lanes, or from the near curb line of an intersection street to the end of such tapers. New construction that encompasses existing roadways/driveways that do not meet the minimum spacing requirements are subject to Pima County approval. A variance to these minimum requirements shall be requested in writing from the Department.

Table 2-4: Minimum Spacing between Consecutive Roadways
&
A Roadway and Driveway

Posted Speed on Adjacent Street (MPH)	Minimum Corner Clearance (FT)
≤35	150
40	185
45	230
50	275

The minimum corner clearance denoted in Table 2-4 shall be measured from the nearest pavement edge of the roadway/driveway to the curbline of the nearest intersecting roadway/driveway. Pima County may request increased spacing in rural areas, or when warranted by field conditions such as significant weaving or insufficient left turn peak period queue storage.

Table 2-5: Minimum Spacing between Consecutive Driveways

Posted Speed on Adjacent Street (MPH)	Minimum Driveway Spacing (FT)
25	105
30	125
35	150
40	185
45	230
50	275

The minimum driveway spacing denoted in Table 2-5 shall be measured from driveway centerline to driveway centerline. Pima County may request increased spacing in rural areas, or when warranted by field conditions such as significant weaving or insufficient left turn peak period queue storage. Driveways near median openings should be centered with the center of the median opening or should be a minimum of 100 feet from the center of the median opening. If return radii are used for the driveway, the returns shall be located within the extension of the property line, to ensure that they do not interfere with the adjacent property.

Sight Distance

In the design of street, driveway and access point intersections, three types of sight distance shall be considered: (1) stopping sight distance, (2) intersection sight distance, and (3) as needed, decision sight distance.

Stopping Sight Distance

Stopping sight distance shall be provided at all intersections and driveways. The standard values are given in Section 2.4, Table 2-3, of this chapter.

Intersection Sight Distance

Adequate intersection sight distance and traffic controls significantly reduce potential vehicle conflicts at intersections. An unobstructed and continuous view of both the intersection and the intersecting roadway help drivers to avoid conflicts. Pima County has developed a procedure to calculate the required intersection sight distance for unsignalized intersections (not for multiple residential roadways). The required intersection sight distance shall be calculated in accordance with Appendix 2-C. For the required intersection sight distance at signalized intersection, refer to the latest edition of the *AASHTO Policy*.

The sight triangle at each intersection quadrant should provide a continuous and unobstructed view for the major and minor road vehicle at the eye/object height denoted in the latest edition of the *AASHTO Policy*. The sight triangle must be clear of any visual obstructions including structures, cut slopes, vegetation, and mounds of natural earth or rock. Intersection sight distance triangles are required to be shown on the design plans. Also, obstructions in both the horizontal plane and the vertical plane must be reviewed when designing the intersection. *The Pima County Department of Transportation Landscape and Irrigation Guidelines* (http://dot.pima.gov/transeng/landscape/) contain additional information regarding sight triangle planting configurations.

Decision Sight Distance

Decision sight distance is defined as the distance required for a driver to detect an unexpected or difficult to perceive source of information in a complex roadway environment such as found along urban and suburban roadways. If such a combination of characteristics exists, refer to the latest edition of the *AASHTO Policy*. Decision sight distances can be significantly greater than intersection sight distance. It is important, therefore, to review the overall design to determine if the application of decision sight distance at critical points is appropriate.

Exclusive Turn Lanes

Exclusive left-turn lanes shall be provided on all Pima County roadways classified as arterials or collectors. Design values for the length of the left-turn tapers and storage are provide in the latest edition of the Pima County Department of Transportation and City of Tucson Department of Transportation *Pavement Marking Design Manual.*

The provision of exclusive right-turn lanes and the associated additional right-of-way should be considered at major intersections and at locations where safety is significantly improved by providing a deceleration area for vehicles moving from the major roadway and turning right into a cross street or driveway. Exclusive right-turn lanes generally improve both safety and efficiency of operation at both signalized and un-signalized intersections. Where a right-turn slip-lane (with a separation island) is being considered, the latest edition of the FHWA

PEDSAFE: Pedestrian Safety Guide and Countermeasure Selection System should also be reviewed to assure pedestrian needs are appropriately addressed.

Curb Radii

A standard curb radius of 35 feet should be used for arterial/arterial intersections, 30 feet for arterial/collector intersections, and 25 feet for intersections with residential streets. The design radii can be modified as necessary for special conditions, such as large volumes of truck traffic and/or skewed intersection angles. Consideration must be given to accommodate the design vehicle and the largest vehicle that may use the intersection/segment. Three center curves should be considered to accommodate the need for a larger radius. The minimum turning radius for the design vehicles is shown in the latest edition of the *AASHTO Policy*. Variations to curb radii proposed shall be reviewed and approved by Pima County prior to being included as part of the design.

Median Openings

Median openings along Pima County arterials and collectors should be spaced one-quarter mile apart, but generally no closer than 660 feet to other median openings and major intersections. Median openings shall not be allowed within the functional limits of an intersection without prior Pima County approval. Functional limits are defined as the beginning and ending of tapers for right- and left-turn lanes and acceleration and deceleration lanes or of redirection tapers for through lanes, or from the near curb line of an intersection street to the end of such tapers.

Driveways

Residential Driveways

Driveways providing access to residential properties shall comply with the following standards unless otherwise approved by Pima County:

- Access to residential property that has frontage along a major arterial and a collector/local road should access off of the collector/local road.
- Access onto major arterial roadways should be limited to one driveway.
- Driveway entrances should be constructed perpendicular to the roadway.
- Driveways should provide sufficient maneuvering area within the property to allow a vehicle to exit the property in a forward direction.
- Paved driveways on rural uncurbed roadways should consist of a minimum 25 foot radius fitted with a 6-inch by 12-inch concrete header.
- On curbed roadways, a driveway apron with curb cuts is preferred to return radii. See Section 8.1.2 of the Pima County Subdivision and Development Street Standards for more information and exception criteria and can be found at the following location:

  http://dsd.pima.gov/Dev_Review/PDFs/SubDevStreetStandards.pdf

- Maintenance and repair of driveways shall be the responsibility of the property owner. Pima County will reconstruct existing driveways located within the right-of-way with standard construction material applicable to the project.
- Driveway widths should be placed in accordance with the following Table:

Table 2-6 Driveway Widths

Single residential	14 ft
Joint Use Residential (Maximum 4 joint use properties)	20 ft
Commercial & Industrial (See Pima County Subdivision and Development Street Standards)	24 ft to 30 ft

Commercial and Industrial Driveways

Except as provided for herein, Commercial and Industrial driveways shall be placed in accordance with the requirements of the Pima County Subdivision and Development Street Standards, Section 8.1.2, Driveway Aprons and Return Radii, and can be found at the following location: http://dsd.pima.gov/Dev_Review/PDFs/SubDevStreetStandards.pdf.

It should be noted that driveways that have one entry and one exit lane shall be a maximum of 30 feet in width. Driveways having three or more lanes should follow the design standards for street intersections. Where more than two lanes are provided, a raised median island with a width between 6 and 16 feet shall be installed and each side of the median divided driveway shall be a minimum of 16 feet.

On curbed roadways, driveways should be depressed curb driveways unless turning movement requirements dictate the use of return radii as prescribed in section 8.1.2 of the Pima County Subdivision and Development Street Standards.

Refer to the Roadway/Driveway Location and Configuration section for further driveway information.

Lane Tapers

Lane tapers are used along roadways for two purposes. First, a lane taper is used when the number of lanes is going to be reduced in a given direction of travel. A lane width reduction taper can also be used to reduce the widths of travel lanes. Second, when the number of lanes or the width of the existing lanes is going to be increased, a lane addition taper is appropriate. Lane taper standards can be found in the Pima County and City of Tucson *Pavement Marking Design Manual* identified in Section 2.8.

Pavement Type

The installation of ARAC as the final pavement lift shall be avoided within intersections and median openings due to higher volumes of turning movements. Regular AC shall instead be placed as the final lift. Examples of typical configurations can be found in Figure 2-13 Intersection/Median Opening Pavement Layout.

2.6 BICYCLE, PEDESTRIAN AND TRANSIT FACILITIES

Bicycle Lanes and Paths

Bicycle facilities and activities within Pima County are an important part of the overall transportation and a key component for a complete street type of system. The Pima County *Community Participation and Mitigation Ordinance* (Appendix 1-A Pima County Code - 10.56.240 D.1.) sets forth the requirements to include bicycle lanes and paths. On curbed roadways, 6 feet are to be added to the typical width of outside travel lanes to accommodate bicycles. This 6-foot width is designated as a paved shoulder. For roadways considered rural and uncurbed, the typical width of outside travel lanes shall also be increased by 6 feet for the same purpose. Refer to the AASHTO *Guide for the Development of Bicycle Facilities*, and to the latest Federal Highway Administration (FHWA) *Manual on Uniform Traffic Control Devices*, Part IX, for further direction regarding design of bicycle features.

Other design features that shall be considered when major roadways are being planned and designed, including:

- Appropriate striping and signing along roadway sections and at intersections to identify proper bicycle/vehicle interactions, including the potential to use pavement coloring (green) in special situations.
- Location of pushbuttons and vehicle detectors at signalized intersections to accommodate bicycle and pedestrian activity.
- Design of curb inlets, catch basins, drainage grates, and locations of manhole covers such that they do not impede bicycle activity.

When a paved shoulder is being added to an existing roadway (typically for bike lane purposes), considerations to be used in determining an appropriate pavement section shall include a review of the intersecting cross streets/driveways to assess any special or unusual turning movements, the existing pavement section, and the potential for other shoulder crossing uses (e.g. – parking associated with adjacent parcels). Should this review not identify the need for an enhanced structural section, then an analysis of the condition and makeup of the subgrade adjacent to the roadway shall be made. If the evaluation determines that the sub-grade is suitable (e.g. - uniformly graded gravel/sand with no predominant layers of silt or clay), then the pavement design will consist of 2½" AC placed directly on subgrade (compacted to 100%). If the evaluation determines that the sub-grade contains unsuitable material, then the unsuitable materials will be over excavated and replaced with 4" of compacted AB.

Pedestrian Sidewalks

Based on the *Community Participation and Mitigation Ordinance (*Appendix 1-A 10.56.240 D. 1.), and the incorporation of a complete street system, pedestrian sidewalks shall be provided along major roadways where warranted by pedestrian travel. Determination of pedestrian travel shall be based on a visual inspection that notes an absence of sidewalks and evidence of

pedestrian traffic, as well as an assessment of pedestrian demand/travel generators. Additional guidelines regarding pedestrian facilities can be found in the AASHTO *Guide for the Planning, Design, and Operation of Pedestrian Facilities* and the FHWA *PEDSAFE: Pedestrian Safety Guide and Countermeasure Selection System.*

The standard sidewalk width is 5 feet, but may be increased to accommodate special conditions taking into account the characteristics i.e. age, mobility, etc. of the primary users. When the sidewalk is designed to be flush with the back of the raised curb, the standard width is 6 feet. Pedestrian considerations shall also include pedestrian crosswalks, mid-block crossings, accessible median openings, overpasses, underpasses, and school zones. Additionally, the design shall meet appropriate American with Disabilities Act (ADA) requirements. Useful web sites include www.ada.gov and www.access-board.gov. The report published by the Public Rights-of-Way Access Advisory Committee (PROWAAC), entitled *Special Report: Accessible Public Rights-of-Way: Planning and Designing for Alterations*, also discusses possible ADA solutions to pedestrian mobility. This report can be accessed at the following site:

http://access-board.devis.com/guidelines-and-standards/streets-sidewalks/public-rights-of-way/guidance-and-research

Multiuse Paths

Multiuse Paths are another component of a complete streets system and shall be considered based on a review of pedestrian traffic/activities. These facilities shall be designed to meet all applicable codes and other requirements. Asphalt should be considered as the primary material for these types facilities due to its longevity and maintainability, with other materials being considered as conditions warrant.

Trails

Trails shall be considered based on a review of the *Eastern Pima County Trail System Master Plan* (http://www.pima.gov/nrpr/geninfo/masterplan.htm), a review of pedestrian traffic, equestrian traffic, and other activities. These facilities shall be designed to meet all applicable codes and other requirements.

Transit Facilities

Transit facilities within Pima County are another important part of the overall complete streets transportation system. The Pima County *Community Participation and Mitigation Ordinance* (Appendix 1-A Pima County Code - 10.56.240 D.2 & D. 3.) sets forth the requirements to consider and include facilities for transit vehicle pullouts if service is available or planned along the proposed improvement. In addition, should the proposed improvement project be located in the vicinity of major intersections, consideration should also be made regarding the potential for the development of park and ride facilities. Additional guidelines for Transit Facilities are found in the Pima County Department of Transportation *Transit Guidelines for Roadway Design and Construction*. The link is as follows:

http://dot.pima.gov/transeng/transitguidelines/PCDOT_BusStopTransitGuidelines.pdf

2.7 TRAFFIC SIGNALS AND ROADWAY LIGHTING

Roadway and intersection design plans for Pima County projects include plan sheets for traffic signal installations or upgrades and for roadway and intersection lighting. The County follows specific standards for the equipment to be used and for installation details.

Warrants for Traffic Signals

A Traffic Engineering Report will be prepared for new signal installation based on the warrants presented in the most current *MUTCD*. There are eight warrants that relate to the volume, delay, and accident experience of the intersection. Satisfying one or more of these warrants may be an indication that installation of signals is appropriate.

Traffic Signal Design Criteria

Refer to the Pima County Department of Transportation *Traffic Signal Design Manual* for specific design direction. This manual can be found at the Traffic Engineering website: http://dot.pima.gov/trafeng/

Roadway Lighting Design Criteria

Refer to the Pima County Department of Transportation *Street Lighting and ITS Conduit Design Manual* for specific design direction. This manual can be found at the Traffic Engineering website listed above.

Other Traffic Control Devices

Emergency Vehicle Access - Roadways which connect and provide access to facilities which house emergency response vehicles (e.g. fire stations) shall be identified, with a review being made in accordance with Traffic Engineering Division Procedure 15.1 which identifies the process to be followed to determine if additional traffic control devices should be incorporated into the project.

Photo Enforcement Camera (PEC) Installations - Pima County Department of Transportation Traffic Engineering Division shall be consulted regarding efforts associated with the inclusion of PEC installations into the project.

2.8 TRAFFIC SIGNS AND PAVEMENT MARKINGS

Roadway and intersection design plans for Pima County projects include separate plan sheets for traffic sign installations, upgrades or modifications (Signing Plans), and for roadway and intersection marking (Pavement Marking Plans). The County has developed specific standards for the material to be used and for installation details associated with signing and pavement marking, along with a standard roadway naming process.

Traffic Sign Design Criteria

Refer to the latest edition of the Pima County/City of Tucson Department of Transportation *Traffic Design Signing Manual* for specific design direction. This manual can be found at the Traffic Engineering website: http://dot.pima.gov/trafeng/

Pavement Marking Design Criteria

Refer to the latest edition of the Pima County Department of Transportation and City of Tucson Department of Transportation *Pavement Marking Design Manual* for specific design direction. This manual can be found at the Traffic Engineering website listed above.

Roadway Naming

Pima County Development Services shall be contacted and coordinated with, should a section of roadway require naming (e.g. – newly created roadway segment, segment not previously named or renaming of an existing roadway). The links to initiate these efforts are as follows:

http://www.pimaxpress.com/Addressing/PDFs/Naming%20A%20Street.pdf

http://www.pimaxpress.com/Addressing/PDFs/Changing%20A%20Street%20Name.pdf

2.9 RAILROAD GEOMETRY

The most important document for railroad design standards is the American Railway Engineering and Maintenance-of-Way Association (AREMA) *Manual for Railway Engineering*, which is updated and published on an annual basis in April of each year. Section 5 of the manual focuses on the design of horizontal and vertical aspects of the rail line.

2.10 DRAINAGE

Drainage is a complex subject and no one set of guidelines can address every circumstance. Drainage design should be integrated fully into roadway design at the earliest stages of planning. The guiding principle of roadway drainage design is to maintain existing flood plain limits, depths, and velocities; and manage stormwater in a safe and responsible manner. An important part of roadway drainage are the stormwater management facilities that perform the vital functions of conveying, diverting, and removing stormwater from the roadway surface. Once removed from the roadway surface, directing stormwater to non-paved and vegetated areas where it is able to infiltrate, is a recommended strategy for the purpose of reducing pollutants and peak flow rates, and to promote the use of natural systems of infilitration and evapotranspiration. The design of stormwater facilities are based on criteria and guidelines that are generally defined in this section and illustrated in Figures 2-8 through 2-10. When the designer encounters design issues that are not clearly described by these guidelines, consultation with Pima County is necessary.

Drainage structures such as bridges, box culverts, other large drainage structures and headwalls shall be structurally designed using the load and resistance factor design (LRFD) methodology. Bridge designers should reference the latest version of AASHTO bridge specifications.

Drainage design requires application of the principles of hydrology and hydraulics. In Pima County, hydrology for roadway design generally involves surface water rather than groundwater. The design of roadway drainage will require the determination of the quantity and frequency of surface water runoff impacting the roadway project, and the design of stormwater management facilities to intercept, divert, or convey stormwater runoff along, under, or over the roadway within drainage structures such as culverts, bridges, channels, ditches, and storm drains. Using sustainable stormwater management principles that allow for stormwater to infiltrate into non-paved right-of-way areas should be encouraged when possible.

Hydrology

<u>Offsite</u>

Offsite hydrology pertains to stormwater runoff from upstream tributary areas that discharge across, under, or over the roadway by way of culverts and at-grade and weir crossings. Offsite design discharges shall be based and calculated for the 100-year storm frequency unless the County Engineer has provided prior approval for a design using a lesser storm frequency.

Pima County Regional Flood Control District's Technical Policy, TECH-015 *Acceptable Methods for Determining Peak Discharges* shall be used as the basis for determining peak discharges.

Onsite

Onsite hydrology addresses stormwater runoff from watersheds within the road right of way that discharge to stormwater control facilities such as storm drains, roadside ditches, culverts, and spillways.

Onsite discharge design shall be determined using the Rational Method. A maximum 5 minute time of concentration shall be used. When both on and offsite flow are directed to a stormwater control facility, the design discharge shall be calculated using PC-Hydro with the offsite flow added to the pavement drainage values.

Hydraulics

Open Channel

Pima County Regional Flood Control District's Technical Policy, TECH-016 *Acceptable Mthods for Floodplain Delineation* shall be used to determine open channel flow in engineered channels and floodplain flow in natural washes. At the direction of RFCD, two-dimensional modeling may be required in distributary flow areas. When open channels are proposed to intercept flows approaching the right-of-way, open channel flow modeling is also necessary

Computations for channel design elements, such as bank protection and channel alignment, and for outlet protection shall be in accordance with the Pima County *Drainage and Channel Design Standards for Local Drainage, 1984*, the *Standards Manual for Drainage Design and Floodplain Management in Tucson, Arizona, 1989, revised 1998,* and the Pima County *Floodplain and Erosion Hazard Management Ordinance*.

Flood limits, depths and velocities shall be kept unchanged unless mitigation options such as the following are exercised: (1) Drainage improvements are provided to prevent flood damage (2) Flood limits are contained within the road right-of-way and the structural roadway components are not subject to infiltration and (3) Drainage easements are acquired to encompass the increased flood limit when outside the road right-of-way. In no case shall a habitable structure be subjected to increased flood limits due to improvements. Computations and exhibits shall be provided to the extent that pre-developed and post-developed flood limits, depths and velocities are equal

The potential for erosion or sedimentation occurring in the channel should be considered. The design shall be in accordance with the *Pima County Floodplain and Erosion Hazard Management Ordinance*. Energy dissipators for channel outlets should be designed in accordance with FHWA, *Hydraulic Design of Energy Dissipators for Culverts and Channels - Third Edition (2006),* HEC-14, or other applicable methodology approved by the Pima County.

Cross Drainage

When cross-drainage structures are located within natural washes or major watercourses, open channel hydraulic modeling is required to evaluate the pre-developed and post-developed floodplain and flow characteristics of the natural wash.

Every effort shall be made to design drainage crossings and associated channels to convey the 100-year storm under the roadway unless the County Engineer approves a design to convey a lesser storm event under the roadway. The depth of flow crossing the roadway in the 100-year storm shall not exceed one foot in depth at any point within the paved section regardless of the design discharge under the roadway. In addition, the 100-year storm must not be allowed to overflow to adjacent drainage basins.

Flood limits, depths and velocities shall be kept unchanged unless mitigation options such as the following are exercised: (1) Drainage improvements are provided to prevent flood damage (2) Flood limits are contained within the road right-of-way and the structural roadway components are not subject to infiltration and (3) Drainage easements are acquired to encompass the increased flood limit when outside the road right-of-way. In no case shall a habitable structure be subjected to increased flood limits due to improvements. Computations and exhibits shall be provided to the extent that pre-developed and post-developed flood limits, depths and velocities are equal.

Hydraulic calculations for pipe and box culvert flow shall be in accordance with methodologies contained in the latest edition of the *Federal Highway Administration Hydraulic Design Series Number 5 Hydraulic Design of Highway Culverts,* or other programs or methodologies accepted by RFCD and Pima County.

End sections or headwalls shall be provided on all pipe culverts. For pipe diameters 30 inch or greater or for multiple pipes, the end treatment shall be headwalls with wingwalls. Straight headwalls without wingwallls are discouraged. The use of traversable designs for culvert end sections, such as ADOT Safety End Sections, is encouraged whenever feasible.

Where an inlet headwall and/or wingwall are proposed, the top of the inlet headwall and/or wingwall shall, at a minimum, be placed above the design headwater elevation. Where no headwall and/or wingwall is proposed or flows from drainage crossings and associated channels occur adjacent to embankments, an impervious treatment shall be placed at or above the design headwater elevation. Erosion protection shall be provided at the top of and around headwalls, wingwalls, retaining walls and other similar drainage structures.

Storm drains and open channels discharging into or adjacent to culverts or bridges shall be designed to prevent harmful erosion or damage to the structure. Where possible, storm drain outlets should be located on the downstream side of the roadway through the outlet wingwalls.

An evaluation of the outlet scour potential shall be made at all culverts. While the outlet velocity is the predominant factor in determining the potential need for and type of outlet protection, the ratio of the outlet velocity to the natural stream velocity can be used as a guide in determining the actual need for protection. Outlet protection shall be in accordance with the Pima County *Drainage and Channel Design Standards for Local Drainage, 1984*, the *Standards Manual for Drainage Design and Floodplain Management in Tucson, Arizona, 1989, revised 1998,* and the Pima County *Floodplain and Erosion Hazard Management Ordinance.*

Energy dissipators for culvert outlets, when required, shall be designed in accordance with HEC-14, *Pima County Drainage and Channel Design Standards for Local Drainage, 1984*, the *Standards Manual for Drainage Design and Floodplain Management in Tucson, Arizona, 1989,*

revised 1998, and the Pima County *Floodplain and Erosion Hazard Management Ordinance,* or other applicable methodology approved by RFCD and Pima County.

The potential for sedimentation within the culvert or at the inlet or outlet~~s~~ shall be considered.

Culverts must be suitably protected with traffic and pedestrian barriers. Adequate distance should be provided for pedestrian access within the roadway Typical Section. (See Section 2.3 of the *Pima County RDM*, Roadway Sections - Clear Zone and Cross Slope, for further information.) Refer to the latest edition of the *AASHTO Roadside Design Guide* for further discussion on clear zone, crash attenuation, traversable and recoverable slope and barriers.

At-Grade Crossings

At-grade crossings are acceptable in rural typical sections due to low frequency of stream flow, provided that the 100-year flow traversing the roadway is less than 500 cfs and all-weather criteria are met.

At-grade crossings in which the transverse flow during the 100-year event is less than or equal to 50 cfs, shall at a minimum be fitted with 6-inch by 12-inch concrete headers.

If the 100-year flow ranges from 50 to 500 cfs, concrete ford walls (cut-off walls) shall be installed to maintain the integrity of the roadway pavement. Ford walls shall be designed 1 foot deeper than the scour, as determined by use of approved general and local scour equations, with sliding and overturning moments also requiring analysis for at-grade crossings protected by walls deeper than 6 feet. The roadway pavement width shall be increase at the locations of the ford walls such that the total pavement width is 4' wider, both upstream and downstream, than the typical roadway section. Concrete walls and headers shall extend to the developed 100-year flow width.

If the flow rate of the 100-year event exceeds 500 cfs, or the 100-year event will cross the road at a depth greater than one foot, a culvert or a culvert dip section combination shall be used to assure drainage over the roadway meets all-weather access criteria. These design thresholds are illustrated in the following Table 2-7:

Table 2-7 Design Thresholds for At-Grade crossings

100-year peak flow	**Minimum Treatment**
≤ 50 cfs	Concrete headers
50-500 cfs	Concrete ford walls (Cut-off walls)
≥ 500 cfs	Culvert or Culvert plus at-grade crossing

In order to improve safety and to reduce maintenance, all at-grade crossings shall be designed to be self-cleaning by providing an appropriately designed superelevated section at the at-grade crossing, installing a sediment trap, or by other means. The method shall be approved by RFCD and Pima County.

Erosion protection must be provided at the culvert outlets of at-grade crossings and shall be in accordance with Pima County *Drainage and Channel Design Standards for Local Drainage, 1984*, the *Standards Manual for Drainage Design and Floodplain Management in Tucson, Arizona, 1989, revised 1998,* and the Pima County *Floodplain and Erosion Hazard Management Ordinance.*

Bridges

Bridge Hydraulic Design

HEC-RAS shall be used to analyze the hydraulic conditions at bridges. Transitions and friction head losses as well as pier head losses should be considered.

The bridge waterway opening shall be designed to meet the 100-year design storm frequency with the extreme storm event as the check storm criteria. The extreme event is defined as the flood resulting from a storm having a flow rate in excess of the design flood, but in no case a flood with a recurrence interval exceeding 500 years. The waterway opening should be sized and situated such that:

- Backwater is limited, as noted below;
- Erosion of banks is limited;
- Progressive sedimentation is not encouraged;
- General and local scour are minimized; and
- Minimal bank protection is needed.

Backwater computations for a bridge shall be based upon approved methodology and on the design conditions which result in the highest value of backwater. Backwater shall be computed with no allowance for scour (i.e. with rigid channel boundaries).

Bridge piers and abutments should be located to provide the following benefits:

- Minimize hindrance to the passage of water and debris;
- Be compatible with the location of piers and abutments of adjacent structures;
- Minimize the depth of local scour; and
- Minimize upstream and downstream bank erosion.

Bridge piers should be round or have the upstream end rounded. Solid wall piers should only be used where the direction of flow is well controlled and will remain so in the future. Piers should not be used to align the flow.

Bridge Deck Drainage

Bridge deck drainage systems shall not allow surface drainage to encroach into any traffic lane(s) on the bridge deck, and must be free of ponding or flowing water in each direction of travel during the 10-year storm event. Drainage that collects in pools or sheet flow across the travel

lane can slow traffic, plug deck drains, cause hydroplaning, and may form ice, making the roadway slick and dangerous to motorists.

Deck drainage on railroad overpasses should be conveyed in a piping system from deck drain inlets to a properly designed drainage outfall system. The use of piping systems on other bridges or overpasses may also be required, depending upon project requirements. Design methods provided in the latest edition of HEC-21, *Design of Bridge Deck Drainage*, or other alternate methodology approved by Pima County shall be used in determining the size and location of bridge deck drainage openings and details. At a minimum, deck drainage must be provided at the quarter points of all spans using standard ADOT deck drains or other approved methods or details. Particular care must be taken regarding bridge deck drainage at the beginning and end of the bridge deck in order to prevent erosion of the approach roadway embankment.

Bridge Scour and Freeboard

Bridge scour and freeboard shall conform to the guidelines presented in the latest edition of the Pima County Department of Transportation and Pima County RFCD *Guidelines for Establishing Scour and Freeboard for Bridges in Pima County*.

Pavement Drainage

Storm Frequency

Storm drains shall be designed to convey intercepted offsite and onsite flows. Design storm frequencies for pavement drainage and storm drain systems are as follows:

- 10-year for pavement drainage.
- 100-year for depressed roadway with a sag vertical curve such as an underpass.

Spread Criteria

In a 10-year storm, the following spread criteria shall be met:

Table 2-8 Spread Criteria

Number of Lanes	Number of lane equivalent width pavement to be left clear of flowing or ponded water in each direction of travel *
2 to 5	One-lane equivalent
6	Two-lane equivalent

***** Clear lanes shall be kept within normal thru travel lanes but may cross between lanes through superelevated transitions. Turn lanes shall not be used as clear lanes.

For urban sections with curbing, the following criteria shall be utilized in order to limit the spread of flow and prevent runoff from crossing travel lanes:

- On superelevated roadways, drainage interception structures, such as catch basins and scuppers, etc., shall be installed at the approximate locations, as shown in Figure 2-8, and on the upstream side of intersections, driveways and median openings

- Storm water should be intercepted at side curbs in order to prevent curb flow and side street flow from crossing travel lanes
- Drainage inlets are not permitted within crosswalks or within 10 feet of a curb access ramp.

Sizing of Inlets

The safety factors presented in Table 2-9 below shall be used for sizing inlets.

Table 2-9 Capture Ratios for Inlets

	On Grade	**In Sump**
Standard Inlets		
– Grate	0.50	0.50
– Curb Inlet	0.80	0.80
Combined Curb and Grate		
– Grate	0.50	0.50
– Curb Inlet	0.80	0.80
Combined Slotted Drain and Grate		
– Grate	0.50	0.50
– Slotted Drain	0.67	0.50

Source: ADOT Roadway Design Guidelines. May 2012, Table 606.2

All storm drain grates shall be ADA compliant and bicycle safe on roadways with a pedestrian access route.

Calculation of Spread and Inlet Capacity

Methods presented in the latest edition of *HEC-22, Design of Urban Highway Drainage, Federal Highway Administration* or other methodology approved by Pima County shall be used to calculate the capacity of inlets and pavement spread.

100-year Check Storm Pavement Drainage Evaluation

A check storm evaluation of the pavement drainage and storm drain system shall be provided using the 100-year design discharge. Flowing or ponded water shall not exceed one foot in depth within the pavement and the 100-year storm shall not overflow to adjacent drainage basins or increase the floodplain limit in any area.

Flood limits, depths and velocities shall be kept unchanged unless mitigation options such as the following are exercised: (1) Drainage improvements are provided to prevent flood damage (2) Flood limits are contained within the road right-of-way and the structural roadway components are not subject to infiltration and (3) Drainage Easements are acquired to encompass the increased flood limit when outside the road right-of-way. In no case shall a habitable structure be subjected to increased flood limits due to improvements. Computations and exhibits shall be provided to the extent that pre-developed and post-developed flood limits, depths and velocities are equal.

Pavement Surface Flow

Non-curbed Sections

The pavement surface should have a cross slope that directs flow away from the roadway. A minimum 2% cross-slope is recommended. The shoulder cross slope should match the pavement cross-slope. See Typical Sections Figures 2-5 through 2-8. Roadways with steep longitudinal slopes may require steeper cross-slopes, since drainage will tend to flow along the longitudinal pavement surface. When sidewalks are located adjacent to and along the outside edge of the shoulder, the shoulder cross-slope should be continued through the sidewalk.

Shoulders should direct water flow to roadside ditches. Roadside ditches should be designed with a minimum longitudinal slope of 1%. Steep longitudinal slopes may require erosion protection. Side slopes of 4:1 are desirable. Roadside designs that are traversable and recoverable are preferred. Steeper side slopes shall be evaluated for erosion protection requirements and for barrier warrants. See the latest edition of the *AASHTO Roadside Design Guide* for guidance and additional information.

Curbed Sections

Pavement drainage within a curbed roadway shall be directed to drainage structures by way of curb or curb and gutter as approved by the County Engineer. Most major roadway designs will include a storm drain system to accept flow from the pavement; however, in some cases, flow may be directed off the pavement through a curb opening structure into an open natural or engineered channel adjacent to the roadway. These structures shall be located and spaced in a manner to ensure that the spread criterion is met and that design considerations shown in Figure 2-8 thru 2-10 are followed.

Storm Drain

Design

The latest edition of FHWA, *Urban Drainage Design Manual*, HEC-22 shall be a reference document for pressure and non-pressure flow designs. The recommendations shall be considered in the design within Pima County roadway systems. Non-pressure flow design may only be used with the prior approval of the County Engineer.

When off-site flows along curbed roadways are directed into and through the pavement drainage system, that length of the pavement drainage system (point of introduction of off-site flow until point of discharge) should be designed to accommodate the 100-year storm frequency. However, when this is being considered as the proposed design, it shall be reviewed and discussed with Pima County prior to being finalized, as it may be impacted by other considerations.

Pressure flow design shall include the following design criteria:

- Storm drain mainlines shall be routed through catch basins rather than manholes. When manholes cannot be avoided, they shall be kept outside the pavement either behind curb or within the median, unless otherwise approved by the County Engineer.

- Calculation of the hydraulic grade lines, including the water surface elevation, from junction to junction. The hydraulic grade line shall be a minimum of 1 foot below curb inlets, grates, slotted drains, area inlets, manhole rims, or other free-surface openings in the pavement drainage system, unless otherwise approved by the County Engineer.
- Standard calculations for pipe losses due to friction and "minor" losses at manholes, junctions, bends, transitions, and entrances.
- A normal full-flow velocity of at least 3.0 feet per second for storm drains. It is generally desirable to maintain a minimum slope of at least 0.3 % unless precluded by utility conflicts or other constraints. The minimum allowable slope is 0.1 %.
- A check of discharge velocities to determine if outlet protection and/or energy dissipation is required.
- Presentation of all storm drainage system elements on the final project plan and profile sheets, including proposed culvert type, stationing, size, discharge value, hydraulic grade line, pipe slope from junction to junction, proposed finished grade at the pipeline center line, and all catch basins, manholes, junction structures, bends, transition structures, connectors, inlets and outlets, and inverts.
- Calculations of head losses through junctions, bends, manholes, and catch basins, using the procedures of HEC-22 or other reference(s) approved by the County Engineer. Junction losses do not need to be considered when the incoming lateral flow is less than 10% of the combined mainline outflow.
- Soffits of adjoining pipes in a transition or junction structure shall be placed at the same elevation, unless other constraints such as utility conflicts exist and are approved by the County Engineer.

Where storm drains discharge into an open channel, the frequency of storm for determining tail water depth in the channel is not necessarily that for which the storm drain is being designed. Rather, it should be based on the comparative size of the tributary areas of the channel and the storm drain as indicated in Table 2-10 as follows:

Table 2-10 Frequency of Coincidental Occurrence

Area Ratio	**10-Year Design**		**100-Year Design**	
	Main Stream	**Tributary**	**Main Stream**	**Tributary**
10,000 to 1	1 10	10 1	2 100	100 2
1,000 to 1	2 10	10 2	10 100	100 10
100 to 1	5 10	10 5	25 100	100 25
10 to 1	10 10	10 10	50 100	100 50
1 to 1	10 10	10 10	100 100	100 100

Source: HEC-22, Table 7-3, pp. 7-9 This table may also be used for channel design.

Pipe size

The minimum pipe size for storm drain mains is 24 inches and 18 inches for laterals. Slotted drains shall be a minimum of 18 inches in diameter and sized using the same hydraulic procedures as for normal storm drains.

Manhole placement

Manhole placement within the pavement is not allowed unless otherwise approved by the County Engineer. Storm drains shall be routed through catch basins rather than manholes wherever possible. Catch basin geometry may require adjustment in order to accommodate a varying number and size of storm drains. Manholes shall be spaced according to the following parameters:

300 feet for pipe diameters $\leq$ 30 inches
400 feet for pipe diameters > 30 inches to 42 inches
500 feet for pipe diameters > 42 inches

Note: Catch basins with frame and covers and accessible grates are considered manholes for manhole spacing requirements.

Drainage Structure Materials and Joint Connections

Drainage structures such as bridges, box culverts, other large drainage structures and headwalls shall be structurally designed using the load and resistance factor design (LRFD) methodology. Bridge designers should reference the latest version of AASHTO bridge specifications.

Storm Drains

Reinforced concrete pipe shall be used for storm drain systems under public roadways, unless an alternative material is approved by the County Engineer.

Cross Culverts

Reinforced concrete pipe or box culverts shall be used for cross drainage under public roadways, unless an alternative material is approved by the County Engineer. Box Culverts should have a minimum height of 5 feet and a minimum width of 6 feet. Pipe culverts should have a minimum diameter of 24 inches. Alternative sizes will be considered on a case-by-case basis.

Cross Culverts under driveways

The material for cross-drainage pipe under driveways shall be approved by the Pima County.

Alternative Pipe Materials

The County Engineer may allow alternative storm drain and cross culvert materials and will consider alternatives on a case-by-case basis. The following items shall be considered in evaluating the use of storm drain and cross culvert materials:

- The Arizona Department of Transportation (ADOT) Pipe Selection Guidelines and Procedures manual and related guidelines shall be used as a guide in determining the product type and thickness/gauge for the service life desired. The County Engineer shall approve the final pipe selection.
- The use of alternative pipe, such as plastic pipe and steel pipe, may be allowed within enclosed storm drain systems, except where storm drains will convey runoff from tank farms, sites that are at risk for spills (such as gas stations, refueling locations, certain warehouse or manufacturing facilities), and locations where hazardous or flammable liquids can flow into the system.
- The use of alternative materials outside the roadway prism is more likely to be accepted.
- A 36 inch diameter pipe will generally be considered the maximum diameter alternative storm drain or cross culvert pipe.
- All evaluations shall include a flammability risk assessment.
- All evaluations shall show that the alternative material is equivalent to reinforced concrete pipe or reinforced concrete box culverts in terms of loading, performance and service life.

Joint Connection

Water tight joints are recommended for storm drains and cross culverts under the roadway prism. Water resistant joints are recommended for storm drains and cross culverts outside of the roadway prism. Testing procedures shall conform to the most current ADOT and PAG specifications.

APPENDIX 2-A
Chapter 2 References

Note: These documents, including standards, regulations, and guidelines, are revised periodically. Users, therefore, should double check that they have the specific version of the document specified in this chapter, or, if the reference is undated, that they have the most recent version.

- American Association of State Highway Transportation Officials. 2004. *Guide for the Planning, Design, and Operation of Pedestrian Facilities.* 1st ed.
- ———. 2011. *Policy on Geometric Design of Highways and Streets*. 4th ed.
- ———. 2011. *Roadside Design Guide.* 4th ed.
- ———. 2012. *Guide for the Development of Bicycle Facilities.* 4th ed.
- American Railway Engineering Association. *Manual for Railway Engineering*.
- Pima County. 1984. *Drainage and Channel Design Standards for Local Drainage*.
- ———. 1992. *Community Participation and Mitigation Ordinance*.
- ———. 2011. *Procedures & Checklist for Landscape & Irrigation Plans*
- ———. *Eastern Pima County Trail System Master Plan*
- ———. *Floodplain and Erosion Hazard Management Ordinance* 2010-FC5 (Title 16)
- Pima County Department of Transportation/City of Tucson Department of Transportation.
- ———. *Guidelines for Establishing Scour & Freeboard of Bridges in Pima County*.
- ———. *Pavement Marking Design Manual*.
- ———. *Street Lighting and ITS Conduit Design Manual.*
- ———. *Traffic Signal Design Manual.*
- ———. *Traffic Signing Design Manual.*
- U.S. Army Corps of Engineers. *HEC-1/HEC-HMS*.
- ———. *HEC-2/HEC-RAS.*
- U.S., Department of Justice. 2010. *ADA Standards for Accessible Design*
- ———. 2011. *Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right of Way*
- U.S., Department of Transportation. Federal Highway Administration. 1993. *Design of Bridge Deck Drainage.* HEC 21.
- ———. 2006. *Hydraulic Design of Energy Dissipators for Culverts and Channels.* HEC-14
- ———. 2009. *Manual on Uniform Traffic Control Devices*
- ———. 2009. *Urban Drainage Design Manual*. HEC – 22. 3rd ed.
- ———. 2012. *Evaluating Scour at Bridges.* HEC 18. 5rd ed.
- ———. 2012. *Hydraulic Design of Highway Culverts.* HDS No. 5. 3rd ed.
- ———. 2012. *Hydraulic Design of Safe Bridges.* HDS No. 7.

APPENDIX 2-B
Typical Sections

Figure 2–1 Typical Section for 3 Lane Road (Urban)

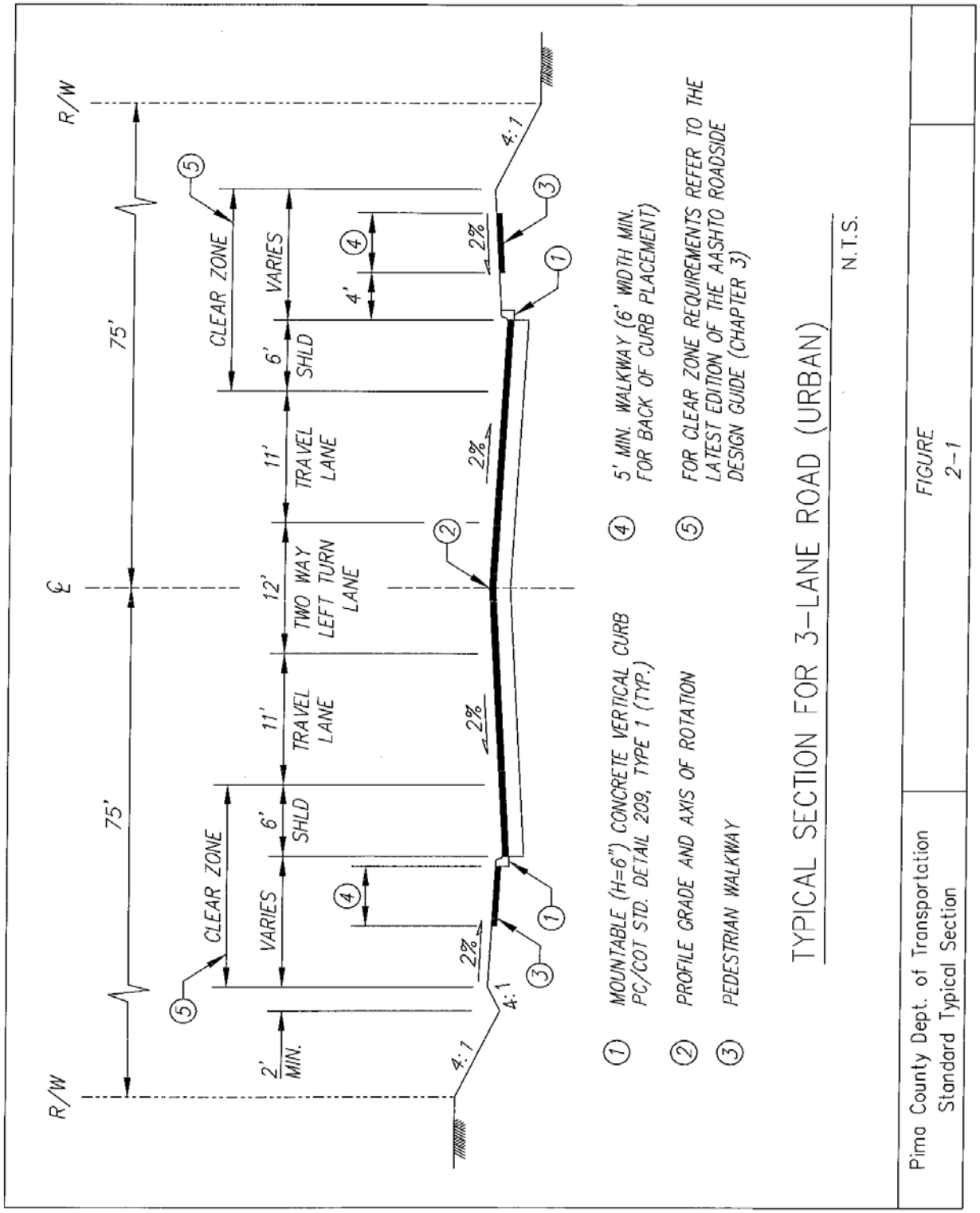


Figure 2–2 Typical Section for 5 Lane Road (Urban)

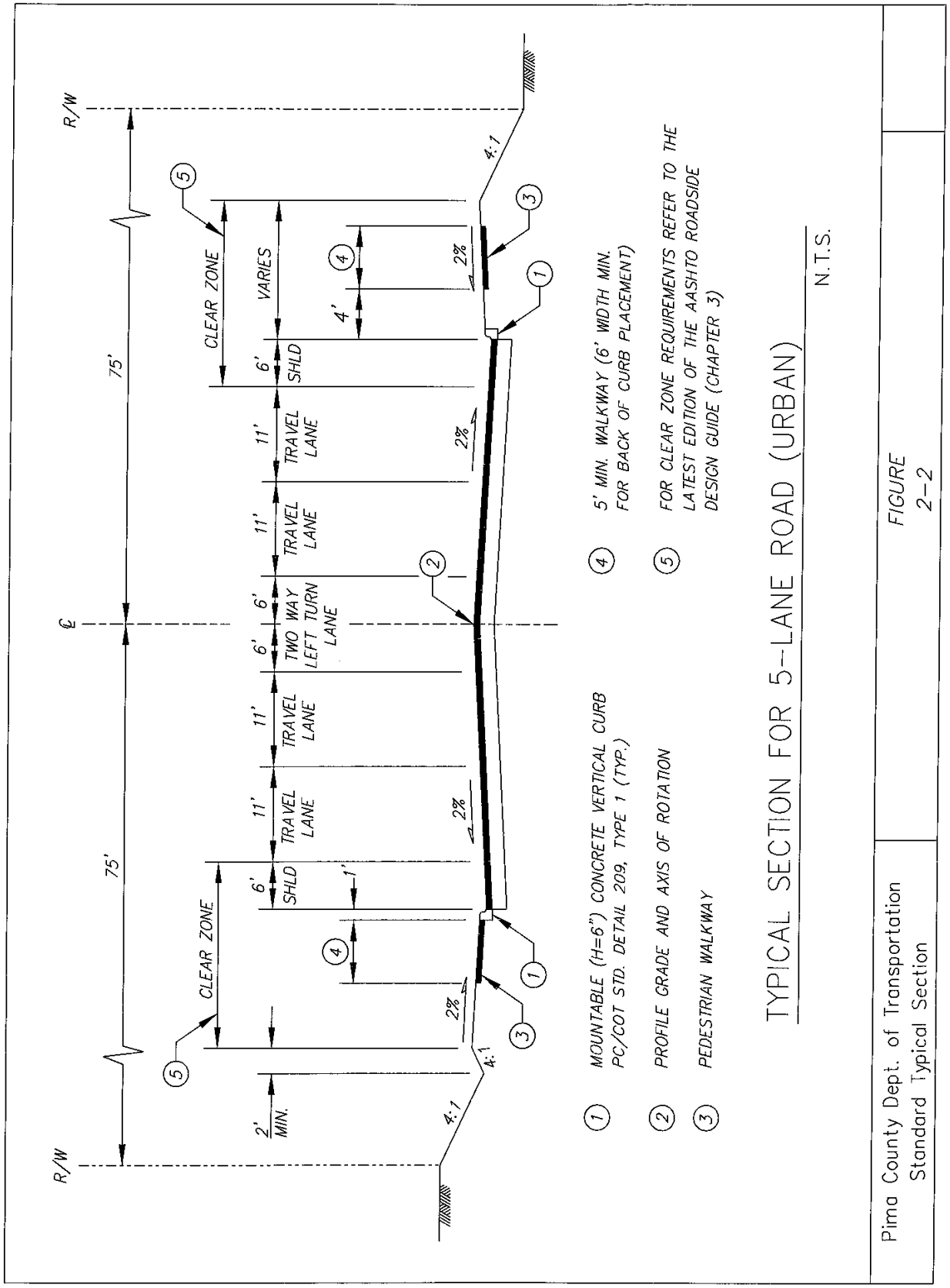


Figure 2-3 Typical Section for 4 Lane Divided Road (Urban)

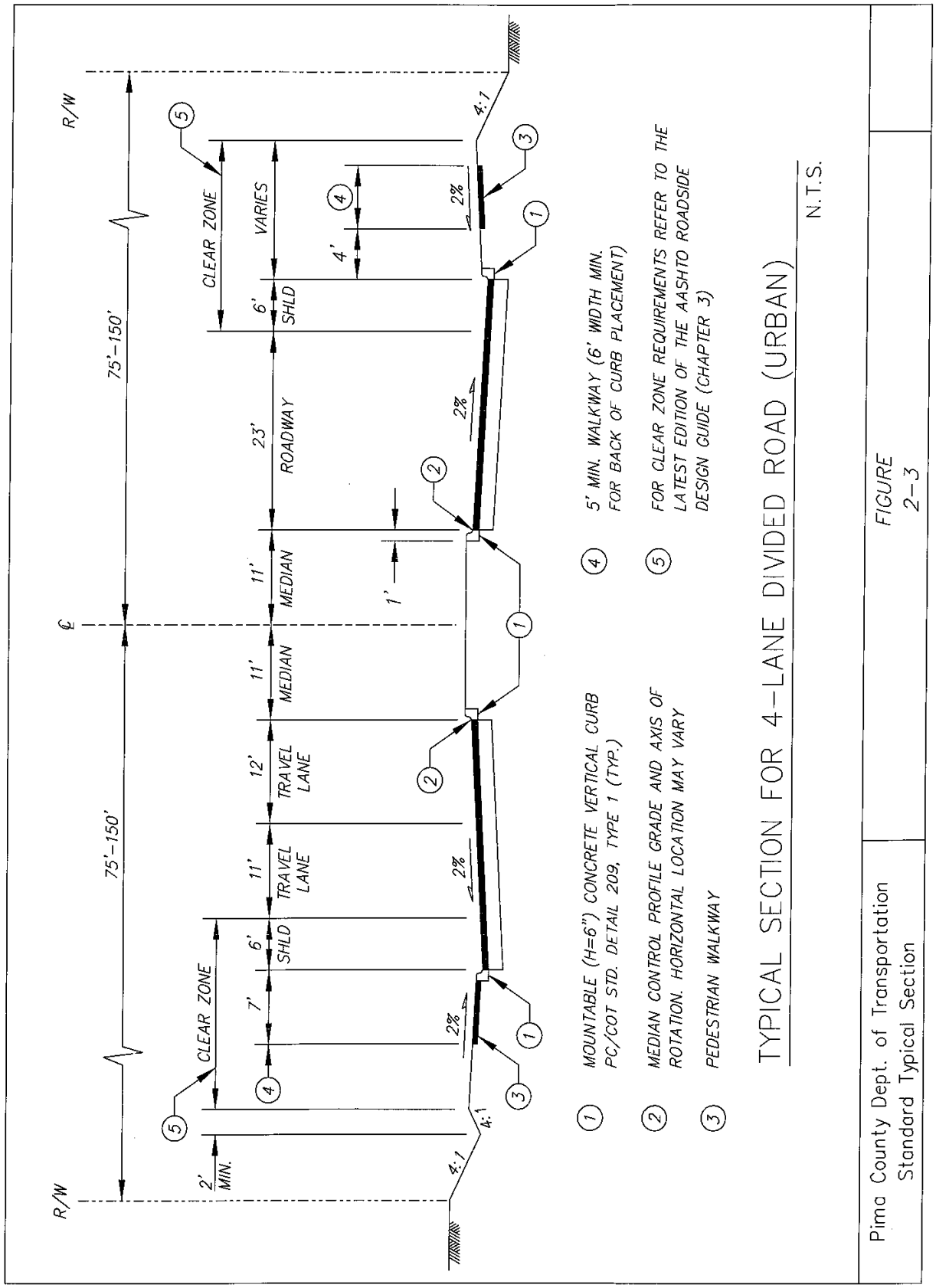


Figure 2–4 Typical Section for 6 Lane Divided Road (Urban)

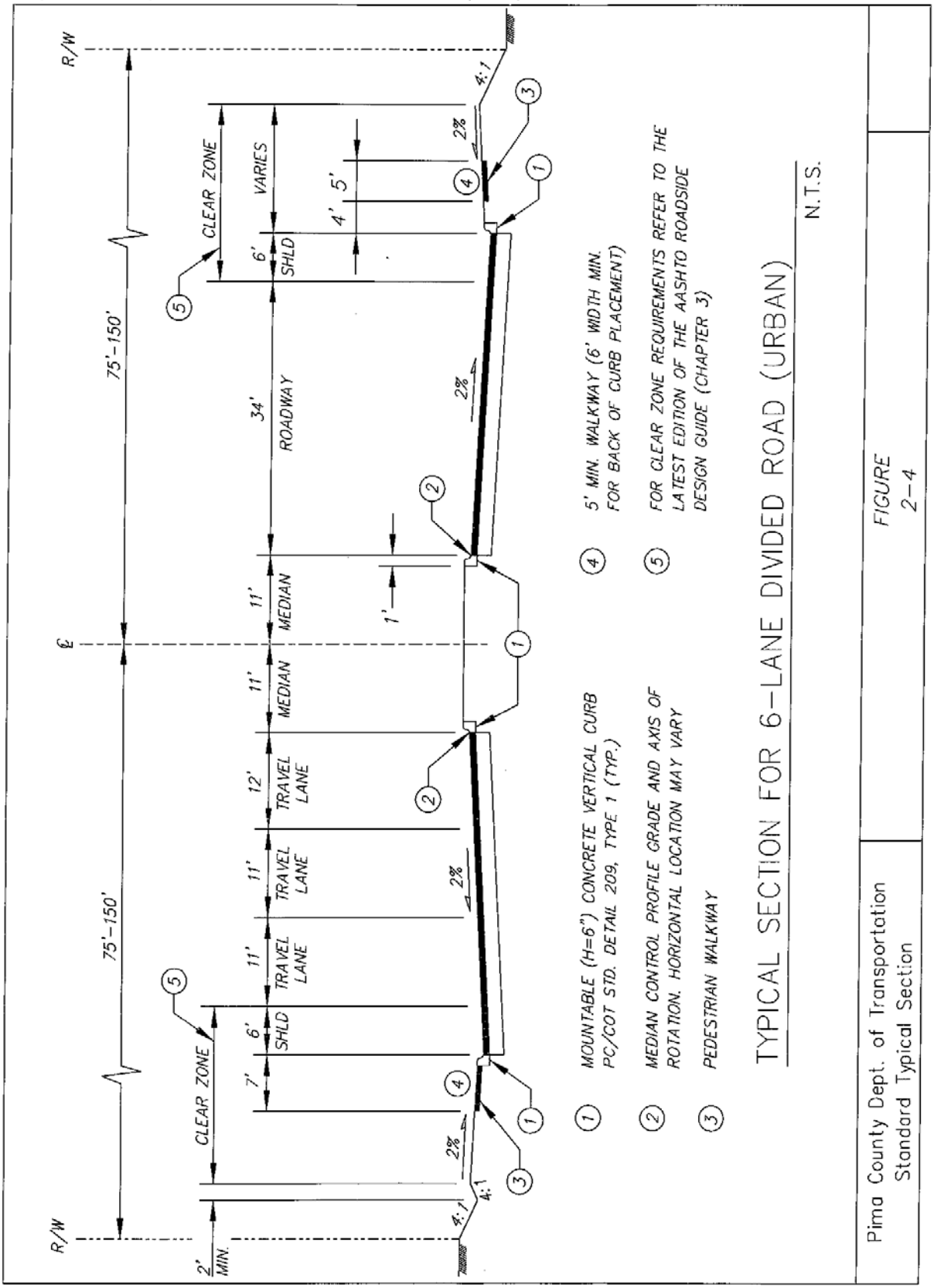


Figure 2-5 Typical Section for 2 Lane Road (Rural)

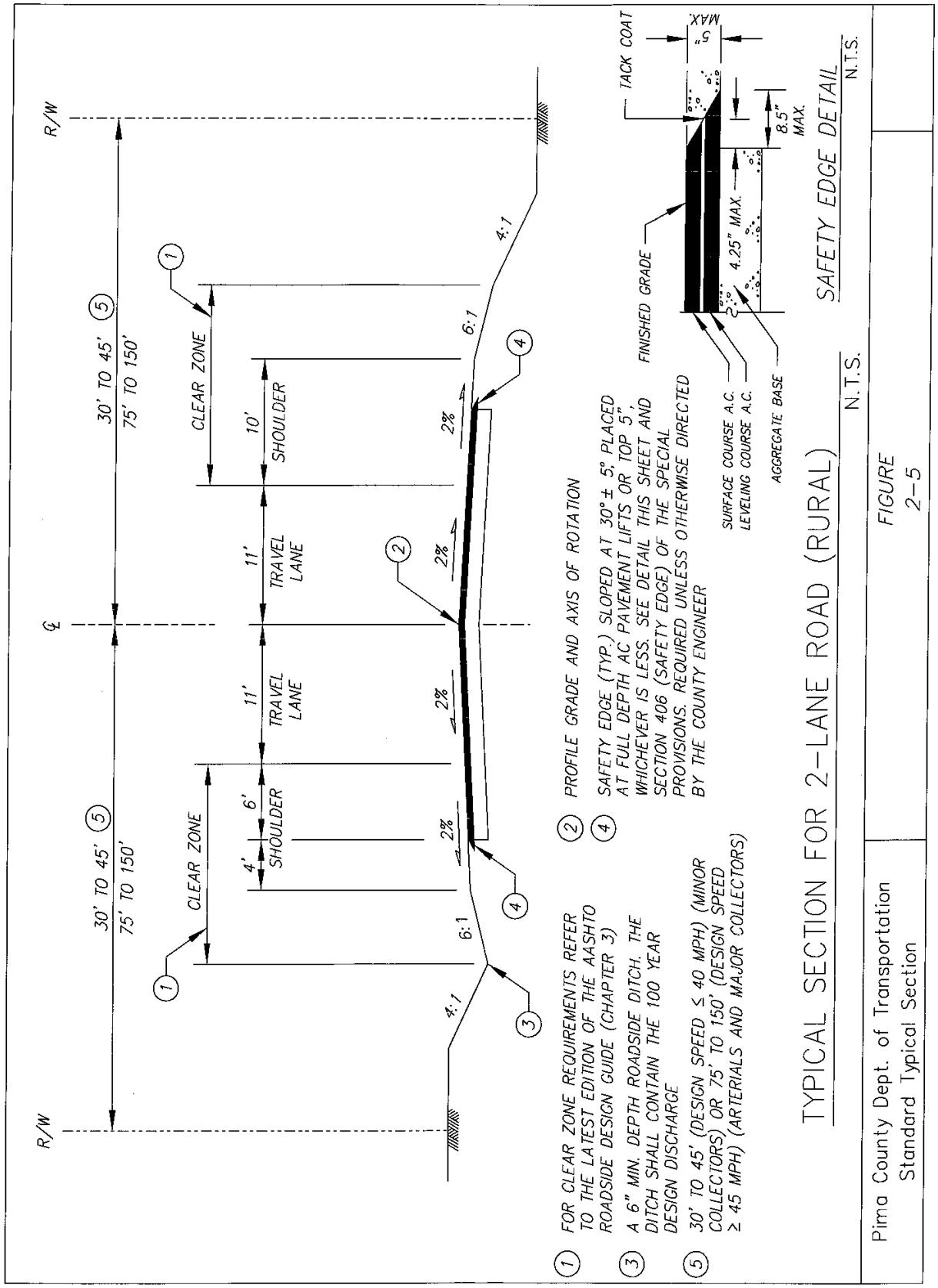


Figure 2–6 Typical Section for 3 Lane Road (Rural)

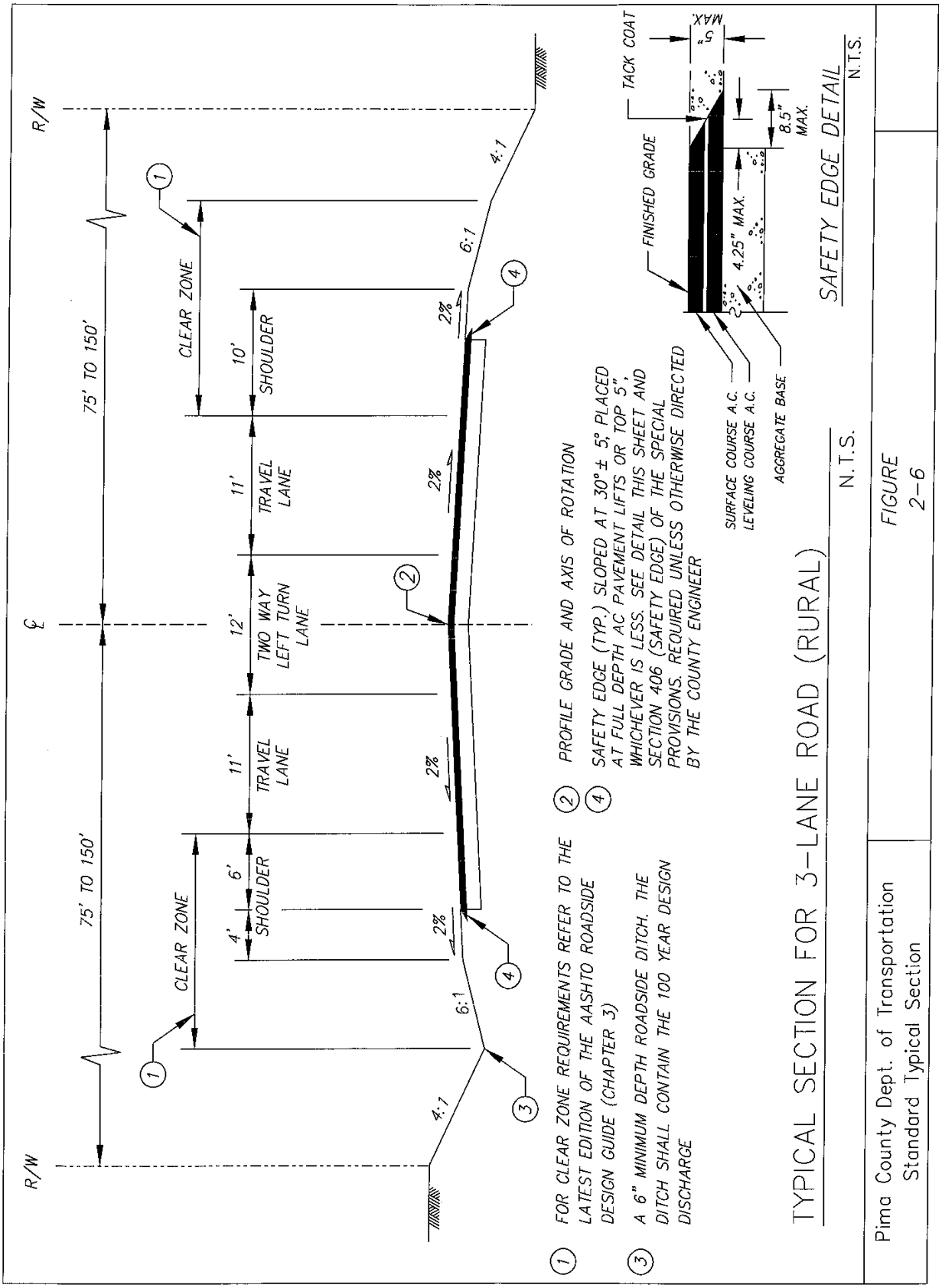


Figure 2–7 Typical Section for 5 Lane Road (Rural)

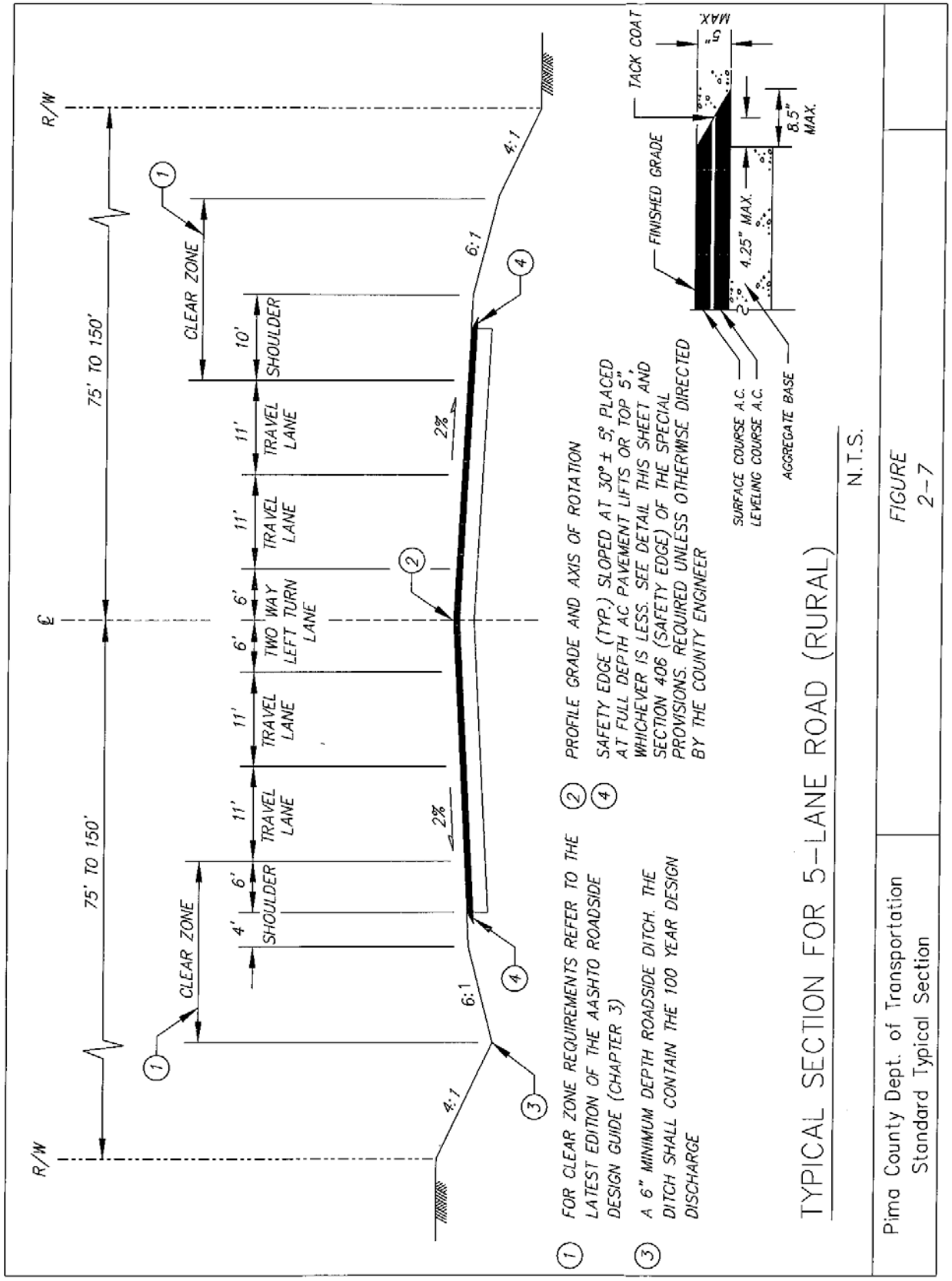
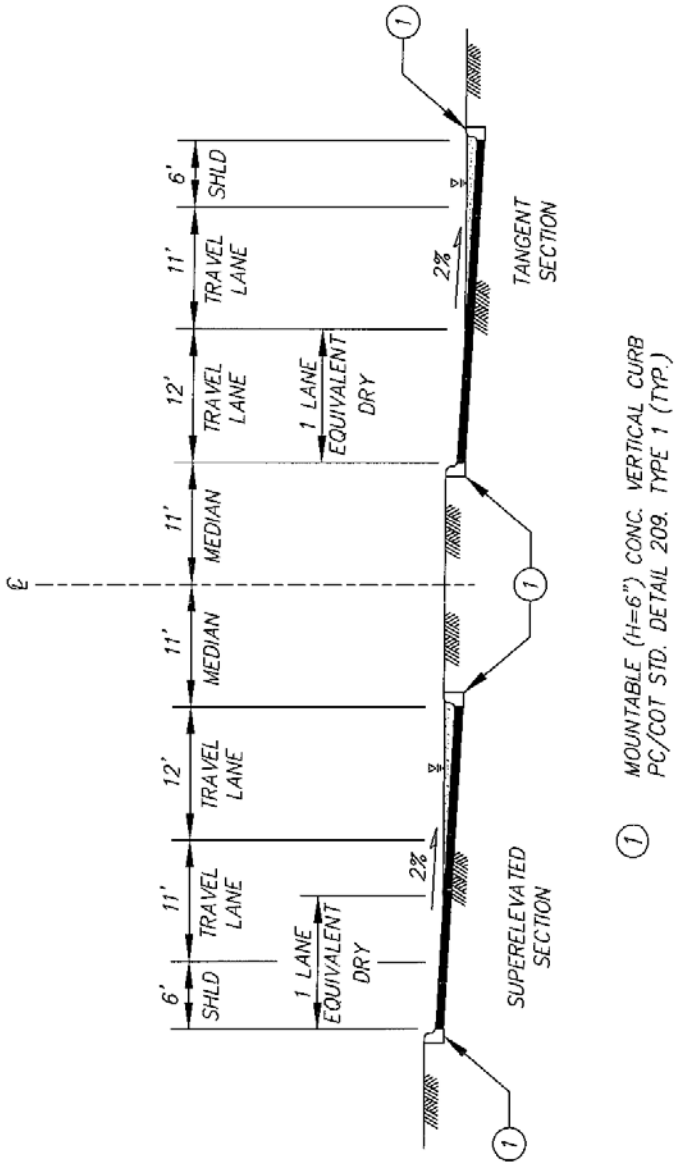


Figure 2–8 Pavement Drainage – Typical Superelevated Section on a 4 Lane Roadway



1 MOUNTABLE (H=6") CONC. VERTICAL CURB PC/COT STD. DETAIL 209. TYPE 1 (TYP.)

PAVEMENT DRAINAGE

(Typ. Superelevated or Tangent Section on a 4–Lane Roadway)

N.T.S.

FIGURE 2–8

Pima Co. Dept. of Transportation Standard Typical Section

Figure 2–9 Pavement Drainage – Typical Superelevated or Tangent Section on a 6 Lane Roadway

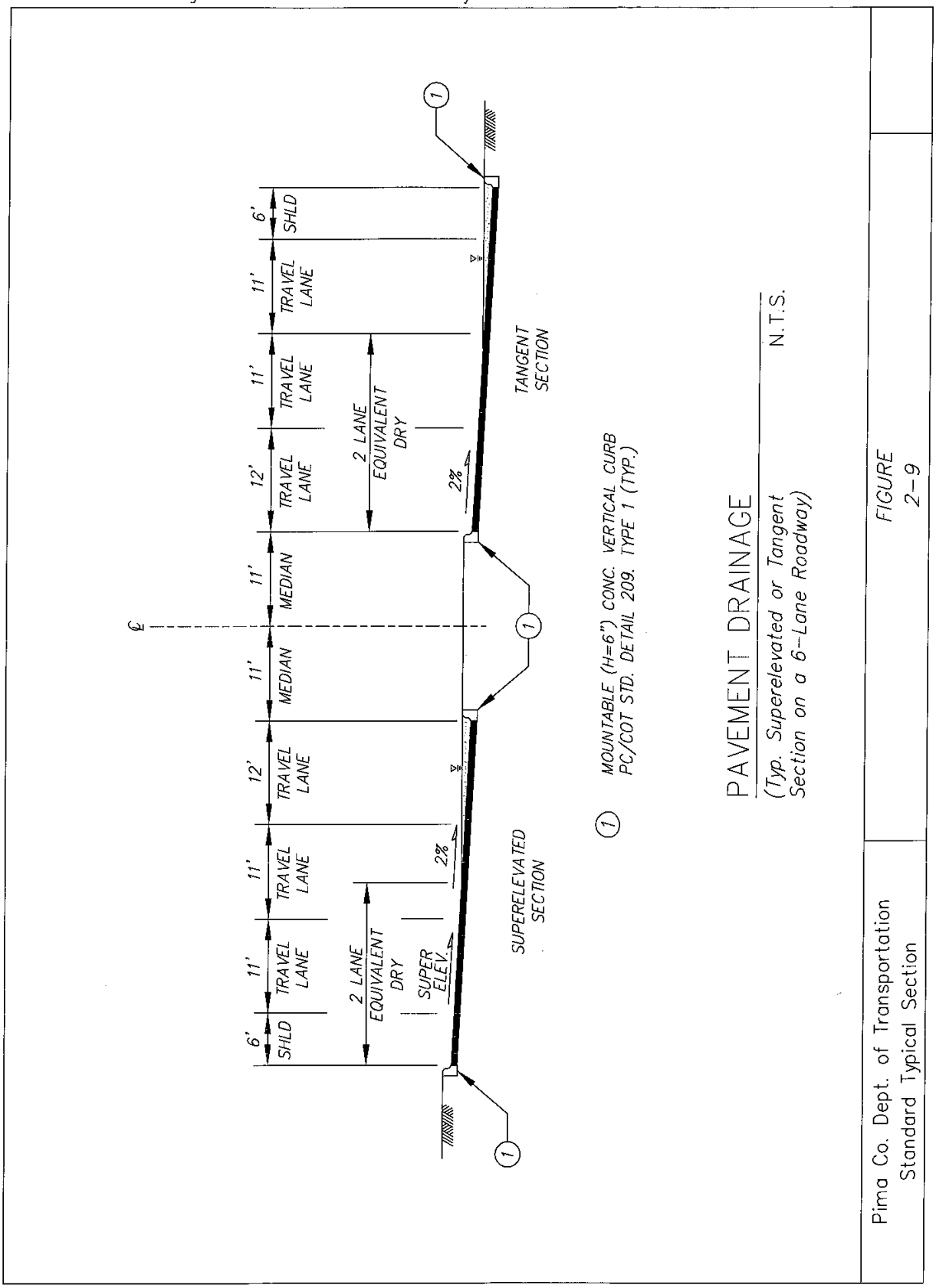


Figure 2–10 Catch basin Typical Locations

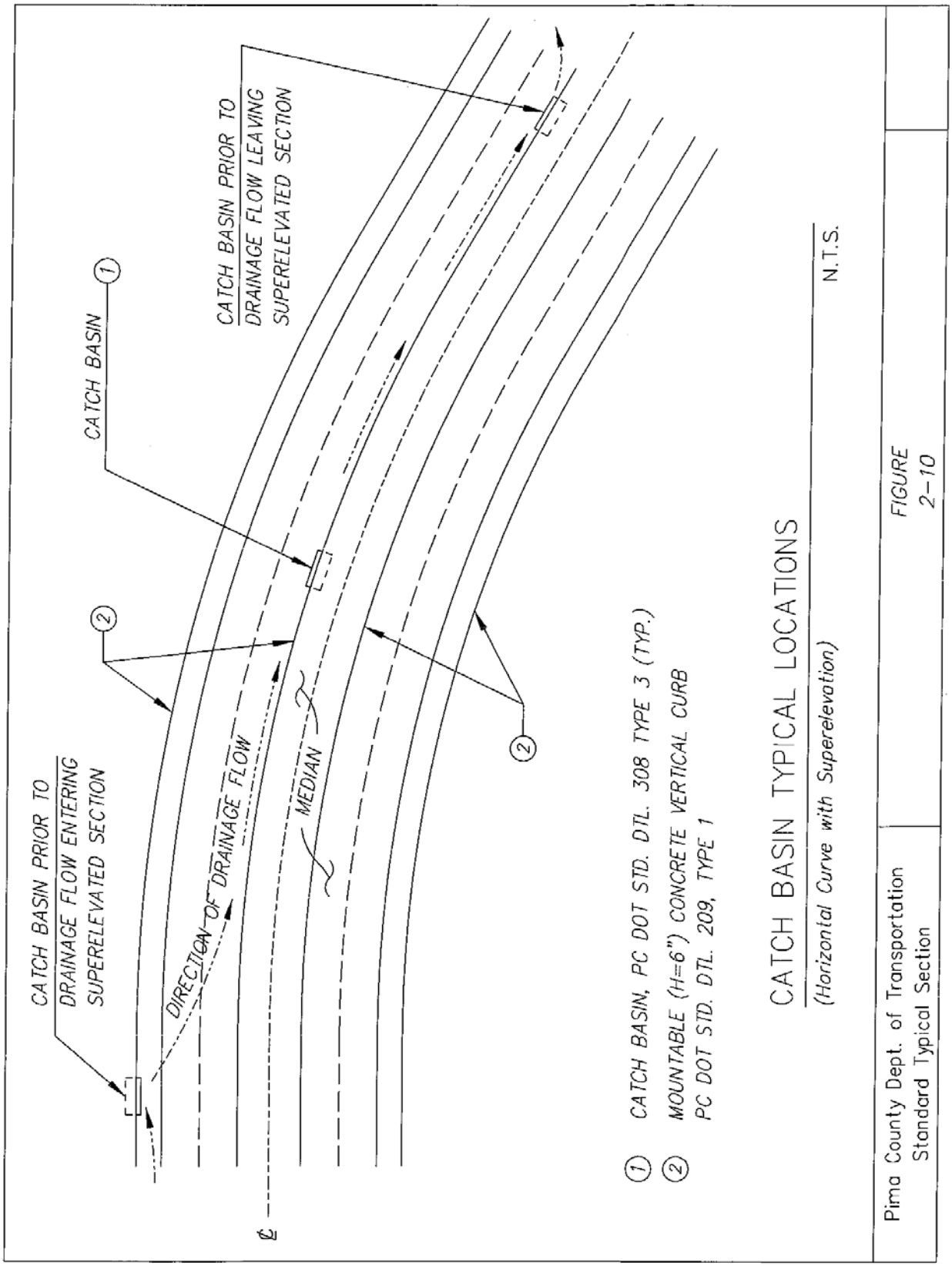


Figure 2–11 Typical Section for Divided Roadway (Urban)(Utility Corridor)

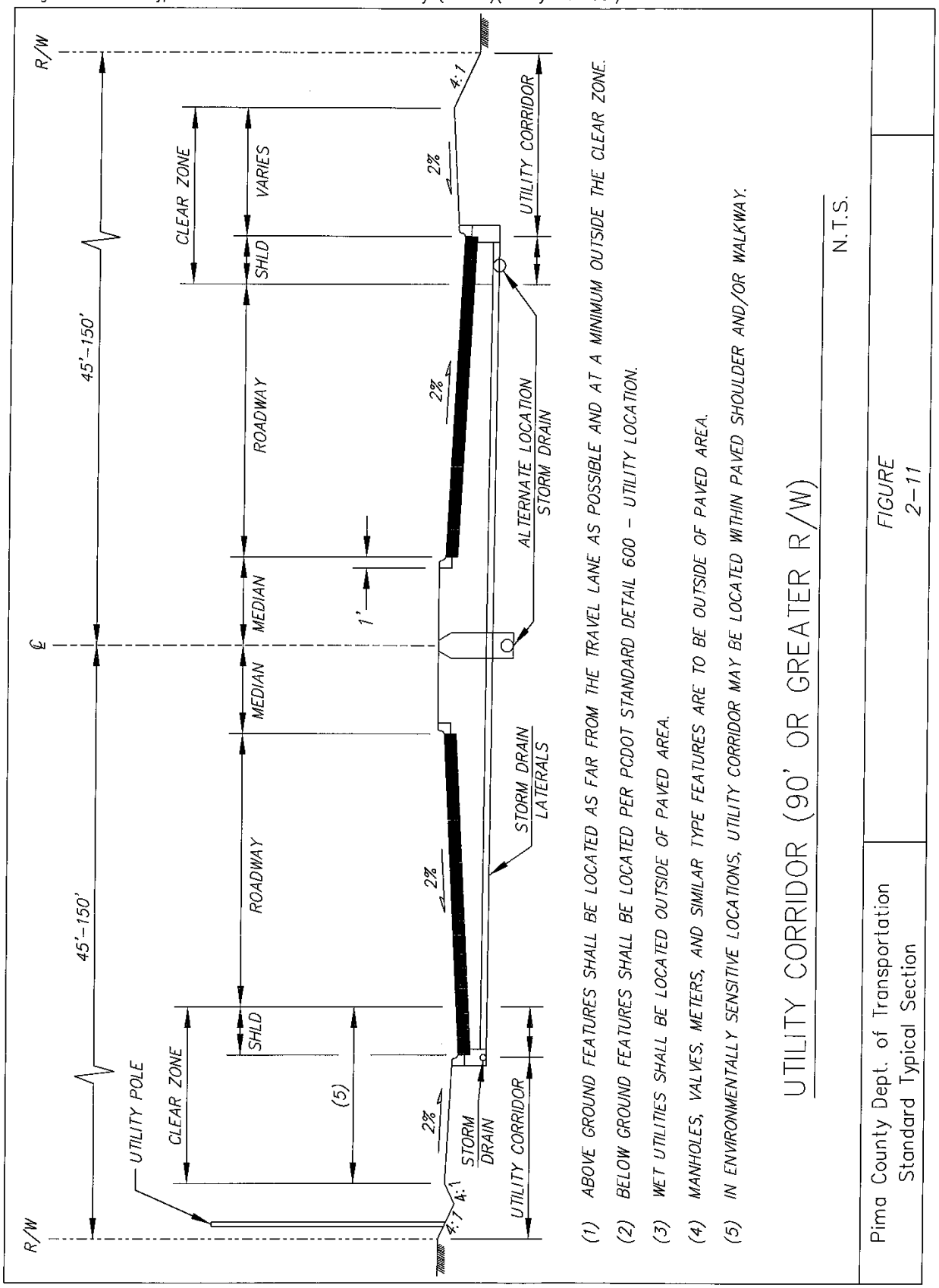


Figure 2–12 Utility Impact Zone

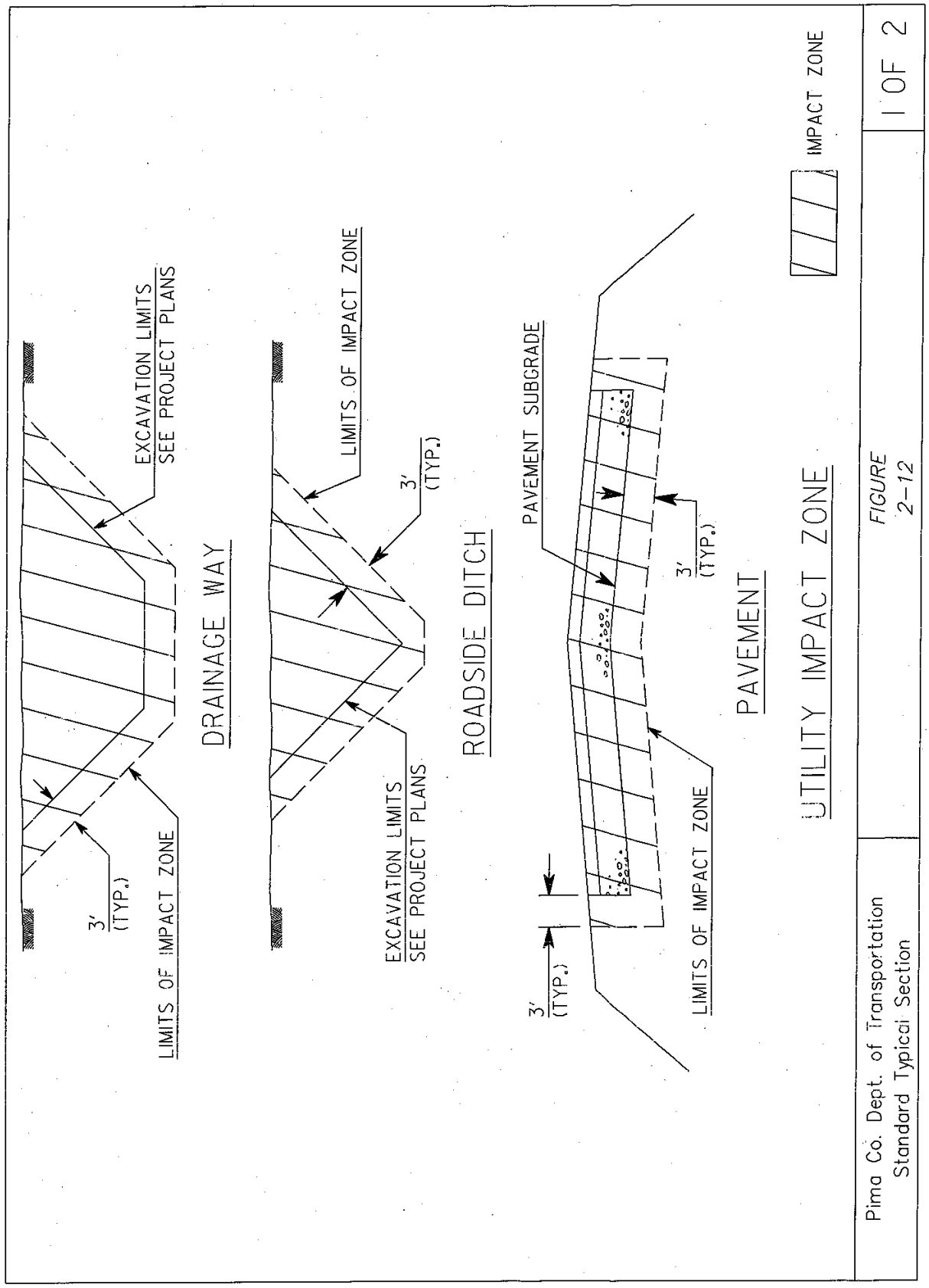


Figure 2–12 Utility Impact Zone

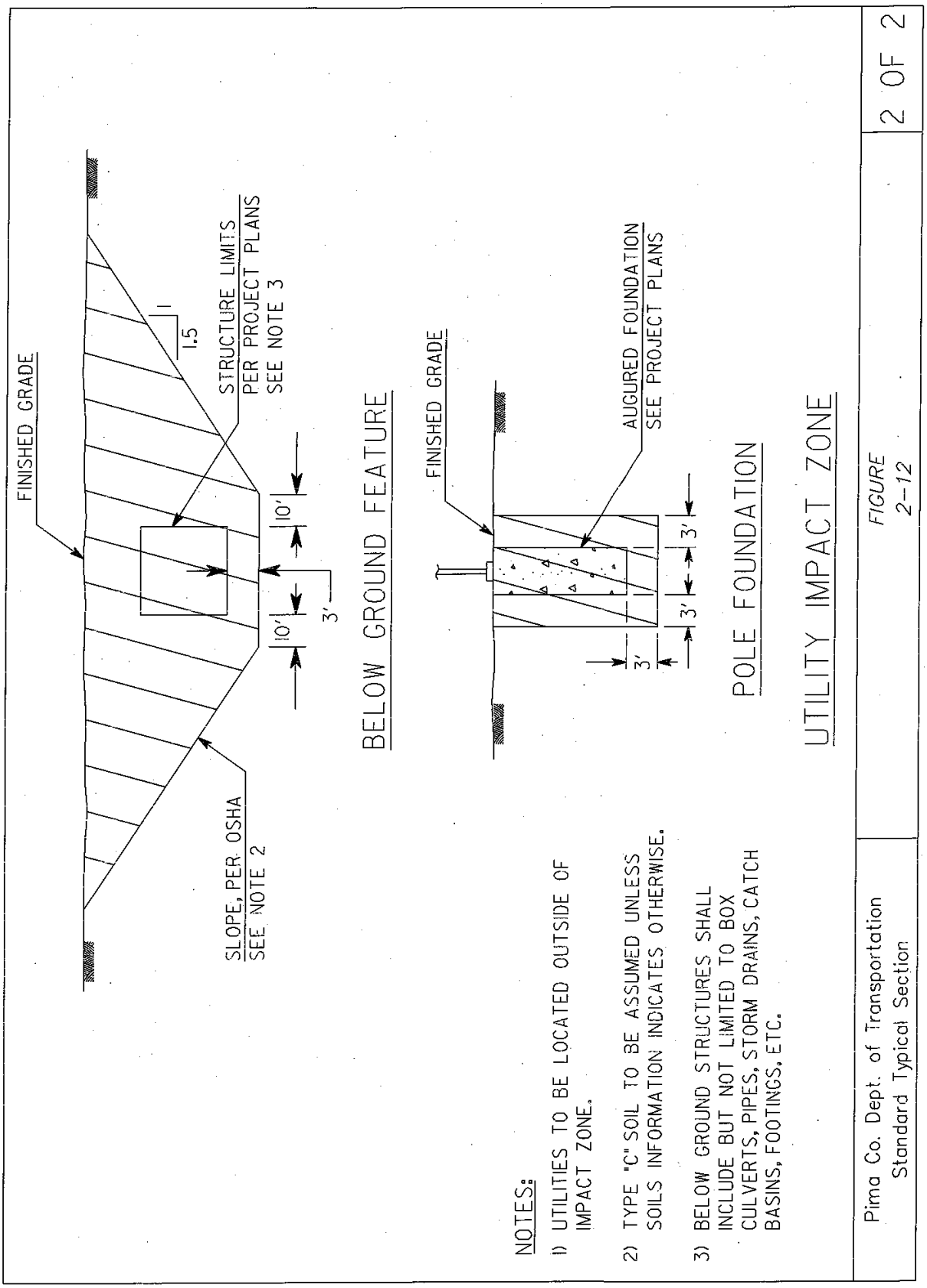
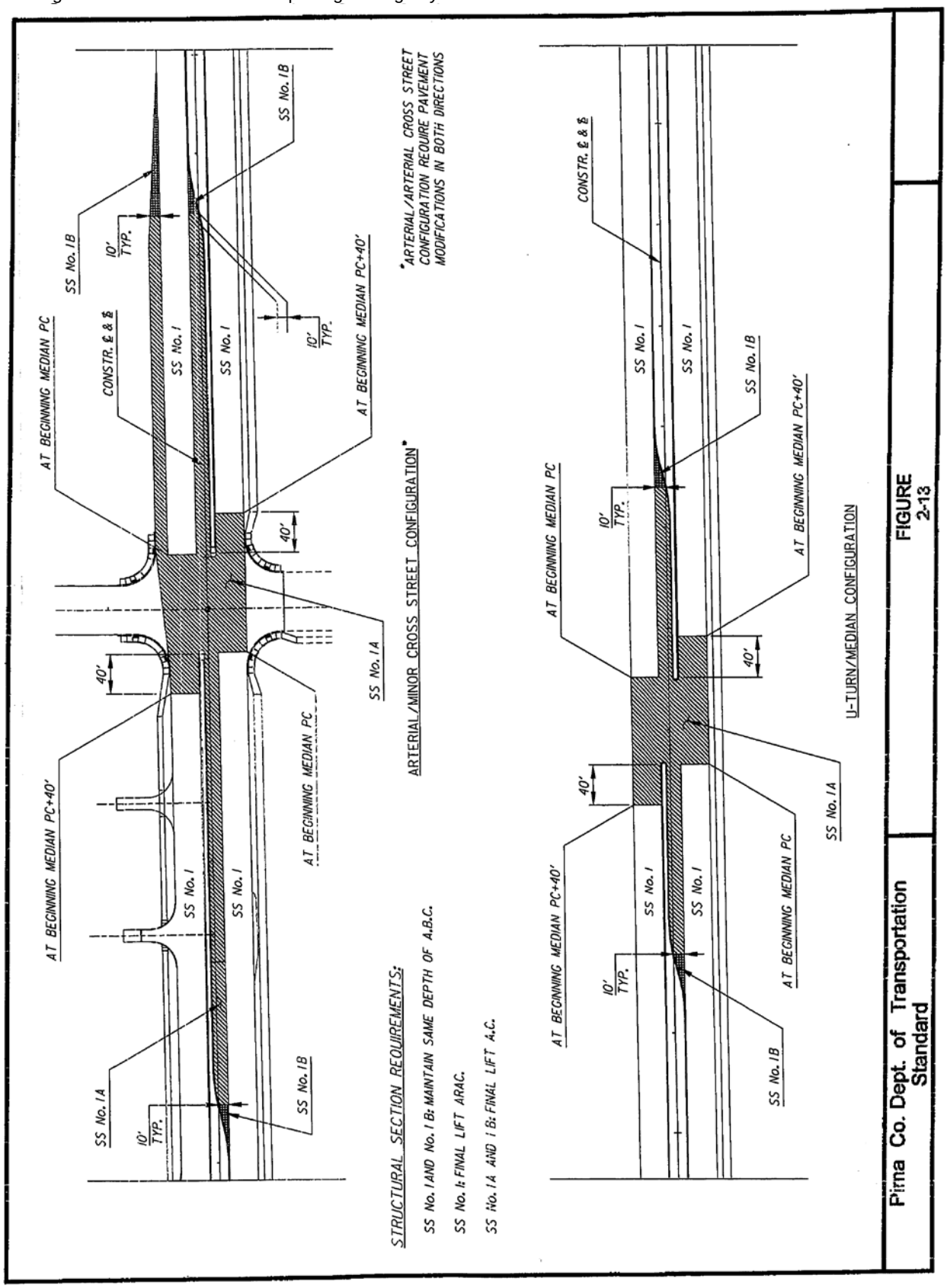
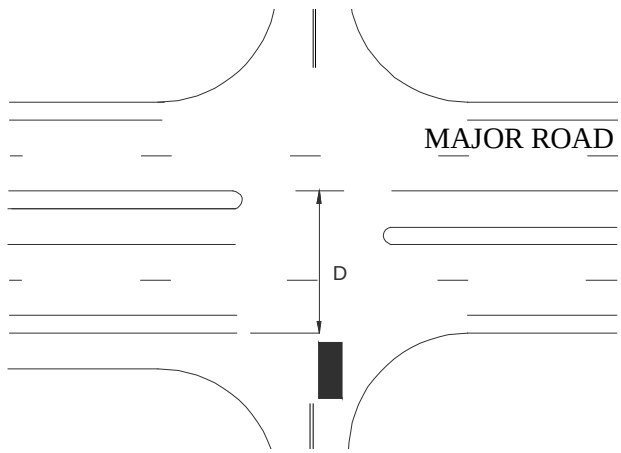


Fig 2-13 Intersection/Median Opening Paving Layout

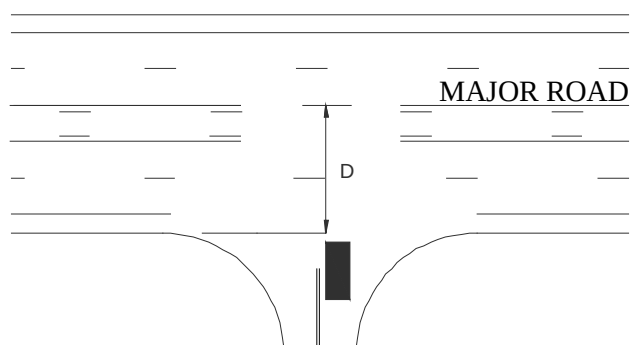


APPENDIX 2-C
Required Intersection Sight Distance Calculation Procedure

Measure the distance on the major road from the edge of pavement to the first lane the vehicle can turn into for a left-turn. If a right-turn lane (on the major road to turn onto the minor road being studied) is present, the width of the right-turn lane is not included in the distance measurement. This distance is indicated as "D," with examples given below.



Distance "D" Example 1:
Four Lane Divided Roadway with Left-Turn Lanes, a Right-Turn Lane and
Bike Lanes/Paved Shoulders/Multi-Use Lanes



Distance "D" Example 2:
Five Lane Roadway with Bike Lanes/Paved Shoulders/Multi-Use Lanes

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Utilize the following equation to calculate the ISD required for each approach to the minor road:

$$ISD = 1.47 V_{major}\, t_g$$

Equation 1: Intersection Sight Distance (ISD) Calculation

ISD = intersection sight distance required for a left-turn from stop (ft)

V_{major} = posted speed limit on the major road (if new construction use the design speed) (mph)

t_g = time gap for the minor road vehicle to enter the major road and make a left-turn (s)

If $D \leq 12\,feet$, then $t_g = 7.5$. If $D > 12\,feet$, use Equation 1 below.

$$t_g = 7.5 + \left(\frac{D}{24} - 0.5 \right)$$

Equation 2: Time Gap (t_g) *Calculation for* $D > 12\,feet$

$D =$ distance on the major road from the edge of pavement to the first lane the vehicle can turn into for a left-turn. If a right-turn lane (on the major road to turn onto the minor road being studied) is present, the width of the right-turn lane is not included in the distance measurement.

Equation 1 above is based on *AASHTO Policy* Case B1 and should be utilized to determine the time gap for each approach on the major road. For cases other than Case B1, (ex: Crossing Maneuver from the Minor Road, Right-Turn From Stop), if grades are involved, and if a design vehicle other than a passenger car is to be studied, utilize the same methods indicated above, along with the time gap value adjustments provided in the *AASHTO Policy*. For the required intersection sight distance at signalized intersection, refer to the *AASHTO Policy*.

ISD Triangles should be created from the information calculated above, and are required to be depicted on the design plans. The major and minor road vehicles should have an unobstructed and continuous view within these sight triangles at the eye/object height denoted in the latest edition of the *AASHTO Policy*.

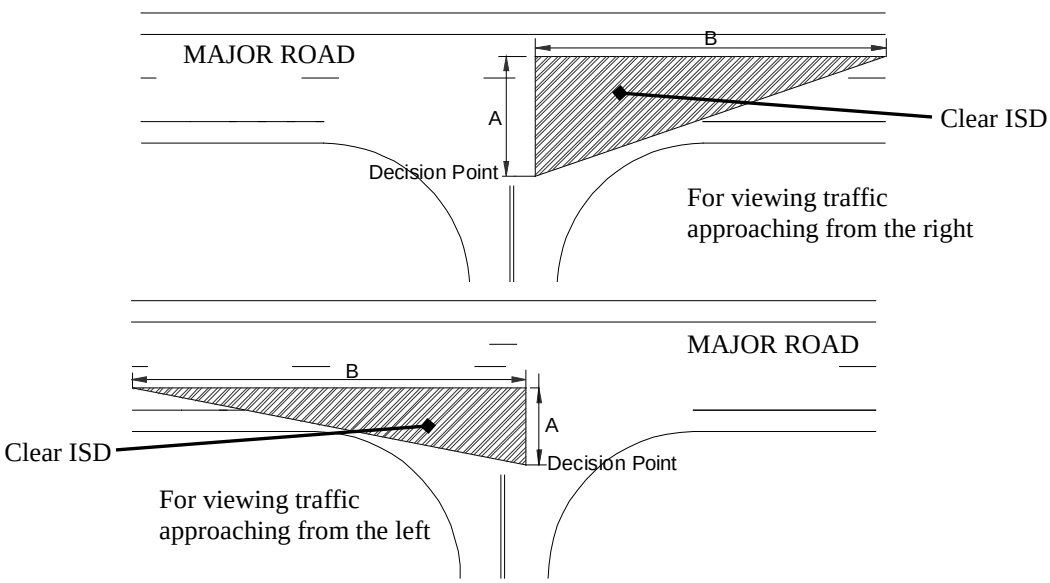


Figure 2: Intersection Sight Distance Triangle Examples

Decision Point = driver's eye offset (15 feet from the edgeline or edge of pavement in absence of an edgeline) at the center of the exiting minor road lane

A = The distance from the Decision Point to the center of the closest approach lane to the minor road from the left or right (per Figure 2 examples)

B = Intersection Sight Distance along the major road (per Equation 1)

Appendix 2-D
Design Guide for Constructing and Relocating Utilities within Public Right-of-Way

Introduction

Pima County Department of Transportation is mandated by Arizona Revised Statutes to construct and maintain roads and streets for safe and efficient transportation of people and goods. It is, therefore, the intent of the department to strive to provide safety and convenience to the motoring public by eliminating and minimizing driving hazards on arterial and major collector roadways.

This guide applies to all public and private utilities including but not limited to communication, electric power, gas, water, sewer, cable television, telephone, fiber optics, irrigation, and similar facilities that are located on, over, and under arterial roads and major collectors within Pima County public right-of-way.

Statement of Guidelines

All overhead utility lines, utility poles, and other above ground utility structures shall be constructed outside the clear zone in accordance with the latest edition of the AASHTO *Roadside Design Guide* and as specified by the Pima County *Roadway Design Manual*. Pole guys are not permitted within the functional limits of an intersection and discouraged within road right-of-way, especially when adjacent to sidewalks, equestrian paths, and along property frontage where existing and future access may be affected. The use of guys should be brought to the attention of the department's utility coordinator for review. Overhead lines are not permitted within the operational limits (i.e. fifteen feet vertically and horizontally) of overhead traffic signals, lighting, signing, and other similar type features.

All underground utility lines, manholes, valves, risers, and other appurtenant structures should be located outside of the through travel lanes of the roadway section, and preferably outside of pavement, sidewalks, and paths between the existing right-of-way line and the outer travel lane edge. Specific locations of each utility within the corridor will be determined by overall project design criteria, including environmental considerations; and be coordinated with the respective utility provider. Service meters, backflow preventers, private service lines and all features identified by a utility as private, shall be placed outside of public right-of-way.

Additionally, all above ground utility facilities (AGF) such as, but not limited to, transformers, splice cabinets, and pressure relief valves shall be placed away from roadways, driveways, alleys, and sidewalks/pedestrian facilities. AGF shall not block safe cross corner sight distance, impede or hinder pedestrian access, or block viewsheds, existing signage, businesses, or homes. Whenever possible, aesthetic as well as practical considerations shall be studied prior to locating AGF. Air pressure relief valves, natural gas regulators, water backflow prevention assemblies, and other similar facilities should be placed subsurface.

Where it is necessary for underground utility lines to cross a roadway, the trench for such utility lines shall be constructed per specifications for utility trench construction approved by the Pima County Department of Transportation.

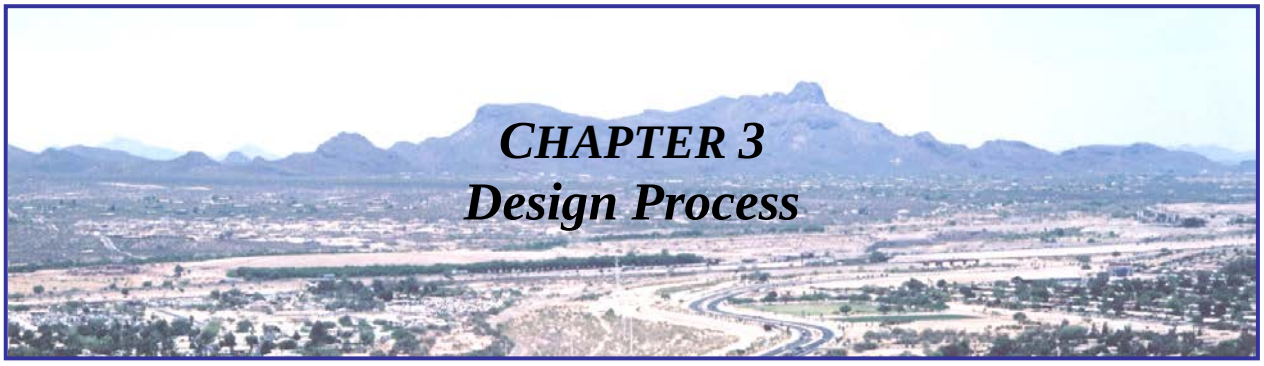
Final disposition of utility facilities shall be coordinated with the Department's utility coordinateor for conformance with latest department directives, regulations, and requirements. The designer is directed to the Department of Transportation's website for the latest directives and policies related to utility occupany within public right-of-way.

All existing utilities that do not adversely affect the safety, design, or construction of proposed roadway improvements and are not identified by the County as in need of relocation may remain. Abandon utilities are to be remvoed from public right-of-way per County Ordiance 10.50.150 Abandonment of Facilities.

Location Details and Construction

Utility corridors along roadways shall be adjacent and parallel to the outer right-of-way limits of the roadway. Appendix 2-B, Figure 2-11 of the Pima County *Roadway Design Manual*, while reflecting a typical section for a divided roadway, also identifies the locations for these types of corridors and also provides suggested locations of overhead utilities relative to the clear zone of the roadway. Figure 2-12 delineates the underground utility impact zone for minimum utiliity clearances for typical roadway improvements.

These design guidelines are intended to supplement existing nationally accepted design criteria. Professional Engineering judgment is expected to be exercised in generating the design of major arterial and collector roadways. If, in the course of preparing the design, it is necessary to deviate from these guidelines, approval from the Pima County Department of Transportation must be obtained.



3.1 INTRODUCTION

This chapter of the *Roadway Design Manual* (RDM) provides guidelines for undertaking the design process and preparing the documents required to complete a Pima County roadway project. These guidelines are for use by those involved in roadway design for specific projects and in reviewing the adequacy of the documents produced. The term "designer" has been used to denote whoever undertakes roadway design for a specific project, including either Pima County in-house staff or a consultant under contract to Pima County.

As stated in Chapter 1, in the course of scoping a design project and/or carrying it out, the designer may determine that it is desirable to use methodologies and/or standards other than those presented and/or referenced in this manual. In such cases, the designer must request Pima County's permission to use the alternative methodologies or standards. Pima County will consider all such requests and may, at its discretion, accept or reject them.

Additionally, due to the numerous stakeholders involved with the development of a Pima County roadway project, it is recommended that a Project Web Site be established for use by the Project Team to for the collation of data and information associated with the project.

Chapter Format

Each section begins with an explanation of the purpose of the task described, followed with a discussion of the process to complete the task, and, generally, concludes with guidance on the content of required reports or other documentation. Additionally, some sections include references to appendices that provide further guidance in the form of sample tables of content, checklists of key plan components, and other relevant material. All appendices are consolidated at the end of the chapter. The first appendix, Appendix 3-A, provides a list of references for Chapter 3.

Phases, Tasks, Submittals, Reviews and Approvals

The plan development process is divided into four phases. These phases (milestones) are described briefly below, and in detail in Section 3.20 of this chapter. Additionally, projects are typically reviewed and approved for advancement at key junctures of their development. These efforts include a review of various project documents, performance of a Value Engineering review(s) when applicable, completion of a Constructability Review, and following a specific

Project Management Gate process (detailed in Section 3.21) to assure agreement and approval of the project's scope, schedule and budget prior to it moving forward to its next phase.

- *Initial Design Phase*
- *Final Design Phase*
- *Initial PS&E Phase*
- *Final PS&E Phase*

Table 3-1 summarizes key design process tasks and related plan and report reviews/submittals required to complete Pima County's Roadway Design Process. The *Roadway Design Process Component Chart*, included in Chapter 1 as Appendix 1-B, provides a listing of the components to be addressed and developed within the Conceptual and Detailed Design efforts associated with the project.

The initiation, review, and approval for all project reports and plans shall conform to the following steps:

Step 1: Report and Plan Initiation

Development of a listing of the appropriate reports and plans for each Phase of the project, a timeline for said efforts, establishment a Quality Control Plan (refer to 3.2), and identification of an issues resolution methodology to be followed for the project.

Step 2: Report and Plan Development

Development of reports and plans identified for the project along with ongoing review/comment by appropriate Pima County Staff and other appropriate stakeholders during regularly scheduled working sessions (e.g. - weekly, bi-weekly, etc.). Attendees to these working meetings should include representatives from the appropriate disciplines (traffic, flood control, operations, engineering, right-of-way, cultural, transit, utility, etc.) and others whom may be impacted/involved with the project or deal with specific areas being discussed and reviewed.

Step 3: Report and Plan Review

Workshop reviews shall consist of the designer and other appropriate parties providing an update of the Reports and Plans associated with the particular "Phase" of the project. Comments made during the workshop review sessions should be based on the current Phase of the project's development. However, other comments about potential future issues (refined design) may be made and noted by the project team for consideration as the project is further developed. Once consensus is reached regarding the associated Reports and/or Plans, the project moves forward to its next Phase of development, which may include key milestone approvals (Step 4) or advancement to the next Phase of development. Additional details regarding Project Review and Approval Processes are found in Section 3.21

Step 4: Report and Plan Approval.

Location Report - Reviewed and recommended for approval by Staff and submitted for approval by the Director of the Department of Transportation (Director).

Design Concept Report (DCR) - Reviewed and recommended for approval by Staff and submitted for approval by the Director.

Environmental Assessment and Mitigation Report (EAMR) - Reviewed and recommended for approval by Department (Staff and Director). Reviewed and commented on by the Citizens Advisory Committee (CAC), with a formal submittal of comments to the Pima County Board of Supervisors. Reviewed and Approved by the Pima County Board of Supervisors. This process is further discussed in Section 3.4 and documented in Pima County's *Community Participation and Mitigation Ordinance (Code Chapter 10.56).*

Note: The purpose of Pima County's *Community Participation and Mitigation Ordinance* is to ensure that proposed major roadway improvement projects address the overall public interest through:

- Adequate consideration of possible social, economic, environmental, and transportation effects
- Appropriate consideration of reasonable alternatives
- Interested parties are afforded an opportunity to express their views early enough in the study process to influence the course of studies as well as the action taken
- Decisions on projects are made in the overall public interest.

Project Website

In order to assist with access by team members for various project reviews, it is recommended that a Project Website, accessible by the Project Team be established where various project documents can be posted, maintained and updated as the project advances.

Table 3-1 Design Process Tasks and Submittals

Task	Task Description	☐ Key Submittals
3.1	Introduction to process	NA
3.2	Quality control throughout process	☐ Quality Control Plan
3.3	Utility coordination	☐ Preliminary Design Notification ☐ Water, Reclaimed Water, and Sanitary Sewer Design Scoping Memorandum (as appropriate) ☐ Plans for Utility Companies
3.4	Public participation starting early in the process	☐ Public Participation Plan ☐ Documentation of Public Comments and County Responses
3.5	Coordination with government agencies	☐ Record of Communication (e.g., correspondence, etc.)
3.6	Integration of public art as applicable	☐ Public Art Plans
3.7	Gathering of relevant data	NA
3.8	Environmental impact screening prior to design	☐ Completed Questionnaire for Establishing Potential Areas of Impact ☐ Summary Matrix ☐ Results Memorandum
3.9	Study of alternative locations if needed	☐ Location Report
3.10	Surveying and mapping	☐ Summary of Coordination Meeting ☐ Digital Files of the Topographic Mapping and DTM ☐ Survey Report ☐ Plots of Results of Culture and Utility Surveys ☐ Results of Survey Drawing Showing Right-of-Way Data
3.11	Design of drainage facilities	☐ Initial Design Drainage Report ☐ Final Design Drainage Report ☐ Final PS&E Drainage Report
3.12	Investigation of geotechnical issues	☐ Geotechnical Report
3.13	Design of pavement related to project	☐ Pavement Design Report
3.14	Selection of bridge structure if needed	☐ Draft Bridge Structure Selection Report ☐ Final Bridge Selection Report
3.15	Traffic Engineering	☐ Initial Traffic Engineering Report ☐ Final Traffic Engineering Report
3.16	Design of arterial lighting	☐ Arterial Street Lighting Design Report
3.17	Study of design concept alternatives and selection of preferred concept	☐ Draft Design Concept Report ☐ Final Design Concept Report
3.18	Environmental assessment needed beyond that done for screening (3.8) and development of mitigation as needed	☐ Draft Environmental Assessment & Mitigation Report ☐ Final Environmental Assessment and Mitigation Report
3.19	Documentation for acquiring right-of-way	☐ Right-of-Way Plans
3.20	Preparation of construction documents	☐ Initial Design Phase ☐ Final Design Phase ☐ Initial PS&E Phase ☐ Final PS&E Phase
3.21	Project Review and Approval Documents	☐ Value Engineering Review ☐ Constructability Review ☐ Exit Gate Review/Approval

Note: Appendix 1-B identifies key components associated with Pima County Roadway Design Process.

3.2 QUALITY CONTROL

Purpose

Pima County expects designers to undertake Quality Control (QC) throughout the design process to ensure the production of well-executed plans. The QC Plan provides the basis for performing the QC review of the various documents that the designer shall submit to Pima County. The purpose of this review is to ensure that the documents are prepared in accordance with the proper standards, formats, and requirements of Pima County, that all mathematical calculations are performed correctly, and that all comments and concerns raised by the County at each phase of the document review are addressed.

Process

At the beginning of the project, the designer shall prepare a QC Plan that documents the procedures to be used to ensure the accuracy and completeness of all project plans, reports, and related materials. The designer shall submit the QC Plan to Pima County for review and approval early in the project.

The QC Plan establishes the process by which the qualified individual designated by the designer fully checks plans, reports, and other documents prior to their submittal to Pima County. The individual assigned to conduct the QC review shall possess the qualifications required to perform the original work. Every project document shall be clearly marked with the name of the individual who checked the document.

Non-compliance with the QC Plan shall be sufficient cause for Pima County to reject a submittal. Pima County may perform periodic quality assurance audits.

QC Plan Content

The QC Plan shall address the staff assignments, technical review procedures, checking process, and quality control monitoring approach. The Sample QC Plan presented in Appendix 3-B illustrates the items that the designer shall cover at a minimum in the QC Plan.

3.3 UTILITY COORDINATION AND DESIGN

Purpose

The purpose of the Utility Coordination and Design task is to ensure the timely and accurate identification of the location of surface, underground, and overhead utilities; and if necessary, their effective and efficient relocation, such that the utilities do not impact, conflict with, or interfere with the project's construction activities.

Process

Working with Pima County's Utility Coordinator (PCUC), the designer shall complete a Preliminary Design Notification for the Utility Coordinator's signature. Pima County will distribute the notification to all the utility companies on file with the County, such that utilities that are within the project's limits are identified, and information regarding their facility location, long-range planing, and prior rights documentation is obtained. Refer to Appendix 3-C for the Preliminary Design Notification Form.

Subsequent to the Preliminary Design Notification, the designer shall schedule a coordination meeting with those entities that have active and abandoned facilities within the project limits. The purpose of the meeting will be to further review the project and discuss how the project may affect existing and future utilities in the area. During this meeting, the PCUC shall describe the requirements associated with Pima County Code, Section 1, Title 10, Chapter 10.50, Regulations for the Use of the Public Right-of-Way, which details efforts to be undertaken by utility companies that have facilities within Pima County right-of-way.

As the roadway design efforts advance, the designer shall provide the County with progress drawings for distribution to the utilities. The designer and PCUC shall schedule and hold additional utility coordination meetings as necessary to support the overall roadway design process. The PCUC and all potentially affected utilities shall be invited to these meetings to continue discussion of the identified and potential utility conflicts, focusing on approaches to resolving said conflicts, and working towards agreement on the next steps to be taken by the participants.

Utilities with facilities within the project's limits are required to provide the designer with facility horizontal survey data for incorporation into the project plans. Upon completion of "Background Culture" of the Surveys and Mapping task, Section 3.10, the designer shall dstribute the results of the mapping and culture survey drawings to utility companies and request written confirmation that the depiciton of their facilities, both active and abandon is compete an accurate to the best of their knowledge. A copy of the drawings shall also be sent to the PCUC for review.

The designer shall work with each utility company to identify facility locations that could impact, conflict, or otherwise interfere with the project, creating a listing of potential project/utility facility conflicts by facility type, station, and offset. Overhead facilities, (including down-guys) shall be investigated for aerial separation from improvements and possible impacts on roadway constructability. Each utility company with facilities listed will be required by a specified date to provide elevations of the facility (aerial and subsurface) at the

listed location. Subsurface facilities shall be potholed and exposed to accurately establish the facility's elevation. In the event this data is not provided to the project designer by the date specified, the design team will take appropriate steps necessary to obtain said data. Costs associated with this effort shall be tracked and provided to the PCUC for billing of the non-responsive utility in accordance with Pima County Code, Section 1, Title 10, Chapter 10.50.

The designer shall incorporate the vertical survey data into the project plans to refine the locations of project/utility facility conflicts. Based on this updated listing by facility, station, offset, and vertical location, the designer shall work with the impacted utilities to identify a proposed course of action/mitigation strategy. The proposed course of action shall be reviewed with, and approved by the PCUC prior to it becoming an approved mitigation strategy. The designer shall maintain an ongoing list of project/utility facility conflicts and related correspondence during the project.

As the roadway design efforts advance, the designer shall provide the County with progress drawings for distribution to the utilities. The designer and PCUC shall schedule and hold additional utility coordination meetings as necessary to support the overall roadway design process. The PCUC and all potentially affected utilities shall be invited to these meetings to continue discussion of the identified and potential utility conflicts, focusing on approaches to resolving said conflicts, and working towards agreement on the next steps to be taken by the participants.

Due to the variable nature of roadway design elements, the County and designer will assess the extent of project completeness, utility relocation timeframes, and project's bid advertisement date to determine when the Utility Clearance Letter request and project plans stamped *Final Plans for Public Utilities Only* will be distributed to utilities.

Upon distribution of the *Final Plans for Public Utilities Only* plans and request for a clearance letter, a meeting with each utility shall be arranged to establish a utility mitigation design schedule and milestones. The designer will be responsible for obtaining utility mitigation progress drawings from each utility at the identified milestones. The designer shall also consult with the PCUC on all plan changes subsequent to the distribution of *Final Plans for Public Utilities Only* for the purpose of identifying possible impacts to on-going utility mitigation design efforts. Should plan changes impact a utility's mitigation design, the designer shall arrange a meeting with the appropriate utility to determine what design modifications are required.

Throughout the project's design, the designer shall continue coordinating with the utility companies to monitor ongoing efforts and to resolve any other outstanding utility issues that may arise. The designer shall keep PCUC informed of any discussions conducted with and/or information provided to the utilities outside of the previously identified meetings.

The designer is directed to visit the Department's website for updates in guidelines, directives, policies, and procedures related to utility coordination and design.

Utility Services

Utility services to each property that abut the project shall be researched for type and location (i.e. gas, water, electric, cable, phone, septic, and sewer). The designer shall develop a list of addresses of all properties abutting the project's right-of-way for distribution to utilities requesting information on whether service to the property is being provided.

Based on the information received, culture survey data, and field inspection of each property, a spreadsheet listing each property's address or tax code (if appropriate) (row) and utility servicing the area (column) shall be developed. The spreadsheet should clearly indicate which utilities are servicing the property. The location of each property service within road right-of-way shall be identified on the project plans and reviewed for impacts with the roadway improvements.

Tucson Water Design – Scoping Memorandum

The designer may be requested by the County to prepare utility design drawings for the alteration of Tucson Water facilities. When this is the situation, the designer shall prepare a scoping memorandum that describes apparent potable, reclaimed water conflicts, and includes a scope that details the work required to design necessary modifications of those facilities. The designer shall provide the scoping memorandum to Pima County at the time the Final Design Phase is initiated.

Upon approval of the scoping memorandum by Pima County and Tucson Water, the designer shall submit a fee proposal to Pima County for the authorized design work. Following authorization of the additional services, the designer shall prepare water modification plans in accordance with the standards dictated by Tucson Water. These plans once completed and approved by Tucson Water, will be distributed to the other utilities as needed.

Utility Design – Memorandum of Agreement

Utility work (design and/or construction) other than for Tucson Water to be performed by the County at the request of a utility company, shall be memorialized in a Memorandum of Agreement (MOA) signed by the County and utility. The purpose of the MOA is to have a written understanding of the agreement between the County and utility. No work shall commence until the MOA has been executed. Refer to Appendix 3-V, Sample Utility Memorandum of Agreement.

The MOA shall include the following sections and language:

1. GENERAL

   {Insert language that provides the necessary background information addressing the reason for the MOA; agreement participates; county project name, location, and number; and other pertinent information.}

2. PURPOSE

   {Insert language describing the intent and purpose of the parties to the agreement.}

3. DESCRIPTION OF WORK

   {Insert description of work including design and/or construction standards and specifications, if applicable.}

4. ROLES AND RESPONSIBILITIES

   Pima County Department of Transportation

   {Insert language that describes the departments role and responsibilities including, but not limited to, specific work activities, processes to follow, deliverables, permitting requirements, deadlines, assistance to be provided, inspections, commitments, acceptance of work, etc.}

   {Insert Name of Utility}

   {Insert language that describes the departments role and responsibilities including, but not limited to, specific work activities, processes to follow, deliverables, permitting requirements, deadlines, assistance to be provided, inspections, commitments, acceptance of work, etc.}

5. COMPENSATION AND BILLING

   {Insert a detailed breakdown of all costs to be paid by each party. Cost should include, either on a percentage of total cost basis or actual invoice amount, administration, inspection, mobilization, profit, overhead, traffic control and other similar type charges, if applicable. Method of payment, payment due date, and consequences for nonpayment or past due payment should be included. An estimate of costs may be used if exact costs are not known at the time of execution of the agreement. Billings will be based on actual costs incurred. }

6. MODIFICATION AND TERMINATION

   This Agreement may be modified or terminated at any time only by the mutual written consent of *{insert name of utility}* and Pima County Department of Transportation.

7. ENTIRE AGREEMENT

   This Agreement constitutes the entire agreement hereto and supersedes any prior understanding or written or oral communication between *{insert name of utility}* and Pima County Department of Transportation respecting the subject matter hereof.

8. EFFECTIVE DATE, TERM, AND SIGNATURE

   This Agreement shall be effective on the date on which both parties sign hereto, whichever date is later, and end *{insert date},* or until the Agreement is terminated pursuant to the terms contained herein, whichever event occurs first.

Authorized signatures and dates

_____	_____
{Insert name and title of authorized person for Party 1}	Date
_____	_____
{Insert name and title of authorized person for Party 2}	Date

Prior Right Claim

A claim of a prior right shall be brought to the attention of the Pima County Utility Coordinator for processing. The utility alleging a claim of prior right shall submit the following information:

- Property or easement documentation
- Acquisition date of the property or easement
- Documentation identifying when the effected facility physically occupied the property or easement.

The Pima County Utility Coordinator shall submit the information to the Pima County Engineering Information Management Mapping and Records Section for validation of the claim.

3.4 PUBLIC PARTICIPATION

Purpose

The purpose of Public Participation is to inform citizens about projects and solicit their input during project development. In recent years, members of the public have made it clear that they want roadways that are functionally compatible with their neighborhoods, constructed in a manner that is sensitive to the surrounding environment, and aesthetically pleasing. The public participation process provides the opportunity for understanding what is important to the public at an early stage and for seeking ways to respond to citizen issues as an integral part of the design process.

Key goals of Pima County's public participation process are to:

- Educate the public about the project's purpose and need
- Solicit the public's comments on the roadway project
- Review public comments and adjust the roadway design to address public concerns to the greatest extent possible and within the constraints of safety and cost

Process

The Public Participation process shall be in accordance with the latest version of Pima County's *Community Participation and Mitigation Ordinance* (see Chapter 1, Appendix 1-A). Key elements of the Public Participation process are summarized below.

Pima County will establish and select the members of the required Community Advisory Committee (CAC). Pima County will arrange for a regular meeting place, and will develop and mail all meeting notices. Meetings shall be held as often as necessary for the committee to provide input to the development of all reports and plans identified in this chapter. Typically, the CAC meetings are used to introduce the public participation process and project basics to the Committee members, provide preliminary design information, obtain input relative to the project's design, and follow-up on the comments/suggestions made by the CAC, ultimately working towards a final project design concept based on these interactions.

Public open house meetings shall also be held, as necessary, for Pima County to disseminate information and for the public to provide input. Pima County will arrange the site for all public open house meetings, develop the mailing list, develop open house meeting notices and mail all notices. Pima County will develop and distribute all questionnaires and public opinion surveys used at the public open house meetings.

Tasks and Documentation

The designer shall assist Pima County with the following public participation as appropriate:

- Develop a Public Participation Plan in coordination with the Pima County Project Manager and Pima County Community Relations office. The plan shall begin with the requirements of the Pima County *Community Participation and Mitigation Ordinance* and then be

expanded as appropriate to reflect the scale of the project, probable controversy, and level of potential impacts on the physical, social, and economic environment. Checklists of tasks required to implement the plan activities, events, and/or mailings and those responsible for each task shall be developed along with the plan. Items for consideration in developing a Public Involvement Plan are presented in Appendix 4-Da.

- Provide sufficient representation at all CAC meetings, public open house meetings, and public hearings
- Provide necessary background information, reports, plans and displays for all CAC meetings and open houses
- Provide meeting summaries for all CAC meetings
- Develop questionnaires and public opinion surveys
- Summarize the results of all questionnaires and public opinion surveys
- Assist the County in the documentation of responses to public comments

Summarize the implementation of the Public Involvement Plan (see Appendix 3-B). Include the summary to date in the project documents that discuss public involvement, including the DCR (Section 3.17) and the EAMR (Section 3.18). Include complete documentation of the public involvement effort in the appendix to the EAMR including the Public Participation Plan; copies of all mailings, surveys, questionnaires, advertisements, meeting and event announcements, handouts, and displays; copies of all mailing lists; copies of all meeting and event sign-in sheets; copies of all written comments and all written responses; photographs of meetings and events, if available; and any other relevant material.

Pima County shall also establish and maintain a project web site where project materials and information will be uploaded for access and review by the public.

Exemptions

While all projects must follow the use of design guidelines and standards, including potential environmental and cultural resource evaluations to ensure compliance with State or Federal Regulations, the Department may use its discretion in determining the appropriate level of documentation and/or public involvement required to facilitate the decision making efforts for minor projects. "Minor projects" which are exempt from the Community Participation Ordinance, but shall require approval by the Director of the process to be utilized include the following:

- Overlay or maintenance of an existing roadway
- Addition of paved shoulder, bike lanes, or multi-use lanes to an existing roadway
- Pavement widening of an existing roadway which does not increase the number of through traffic lanes
- Changes or improvements to the right-of-way area outside the shoulder of an existing roadway
- Drainage improvements
- Safety improvements identified as contained in Traffic Engineering's Safety Management System (SMS)

3.5 FEDERAL, STATE, AND LOCAL COORDINATION

Purpose

The purpose of federal, state, and local coordination is to make sure that all other governmental agencies and jurisdictions (hereafter referred to as agencies) that have an interest in the project area are informed of the project and provided an opportunity to comment on the project and, as appropriate, participate in the project development process.

Process

Agencies with a potential interest in the project shall be identified by the Pima County Project Manager and the designer and confirmed with other members of the Design Team at an early project Coordination Meeting. Agencies with an interest would normally be those agencies with property adjacent to the project site or with regulatory responsibilities within the project area. Examples of such entities might be the Tohono O'Odham, Pascua Yaqui, U.S. Department of the Interior - Bureau of Land Management, U. S. Forest Service, U.S. Fish and Wildlife Service, Arizona Game and Fish Department, Arizona State Land Department, U.S. Army Corps of Engineers (ACOE), Town of Marana, Town of Oro Valley, Town of Sahuarita, City of South Tucson, City of Tucson, and others.

Once potentially interested agencies are identified, Pima County, or the designer if so instructed by Pima County, shall contact those agencies by letter or phone to determine their level of interest in the project. This agency coordination should be undertaken to satisfy any agency coordination that may be needed in conjunction with undertaking the Environmental Screening (Section 3.8) and the EAMR (Section 3.18).

If there are particular agencies with whom intergovernmental agreements (IGAs) or mitigation measures must be established, the Pima County Project Manager will be responsible for setting up meetings, conference calls, or whatever form of communication is most appropriate for addressing and resolving any issues directly relevant to the design of the project.

If the design of a project changes substantially after consultation with an agency is completed, the agency shall be informed of the change and provided another opportunity to comment.

Documentation

Coordination with other agencies shall be documented in a Record of Communications that includes letters, e-mails, faxes, and summaries of phone calls, and meetings.

3.6 PUBLIC ART

Purpose

The purpose of the Public Art Program is to comply with Pima County's Public Art Program Policy as found in Board of Supervisor's Policy C 3.3, which requires that 1% of the planning, design, and construction cost of each roadway project be used for public art. Works of art may include the integration of artistic elements into bridges, noise walls, railings, benches and sidewalk surface treatments, as well as stand-alone sculptures placed within public right-of-way. A copy of the Board's Policy is found in Appendix 3-E.

Process

The Public Art Program for a project shall be in accordance with the Pima County Board of Supervisors Policy on Public Art. The program is implemented pursuant to Administrative Procedure 3-16. The process includes project scoping, artist solicitation and selection, project design and construction.

Pima County contracts with the Tucson-Pima Arts Council (TPAC) to coordinate artist solicitation and selection, and to assist during project design and construction. The Arts Council is responsible for development of the Call to Artists; assembling the artist selection panel (a professional artist, two representatives of the affected neighborhood with one being appointed by the Board member within whose district the public art project will be located, two artists appointed by the Public Art Coordinator based on input from the Public Art and Community Design Committee, one designee from the department funding the project – typically the project manager, and one project professional – e.g. design principal, landscape architect, project contractor); and completing a final inspection of the artwork, certifying to Pima County that the artwork is complete.

The selection process is an open and competitive process, with the panel reviewing all applicants and selecting an artist based upon their qualifications. After the artist is selected by the panel, the selection shall be approved by County Administration. The artist will then contract with Pima County (DOT) and become a member of the project design team. When the project design is initiated, the project team (including the artist) shall schedule a Community Advisory Committee (CAC) meeting to discuss the public art for the project and solicit community input. As the artwork is developed, additional CAC involvement may be required. Designs for the artwork are to be included in the project design plans, specifications and construction documents. Additionally, the project artist and PCDOT shall be responsible for assuring the artwork is designed and constructed within the scope, schedule and budget established for this component of the project.

Due to the time that is necessary to complete the efforts associated with an artist's selection, approval, and contracting (typically 4 – 6 months); it is imperative that the artist selection activities are scheduled and occur sufficiently early enough within the project to assure the Public Art component is appropriately addressed and included as part of the project. The Department has designated a specific position (Public Art Coordinator) within the Transportation Planning Division whom shall be contacted to provide guidance and assistance with these efforts.

3.7 DATA GATHERING

Purpose

The purpose of Data Gathering is to obtain all available pertinent information required to complete the project. This information shall be used throughout the design process to develop reports and plans.

Process

The designer shall collect and assemble the required data from Pima County and other sources.

Information to be Acquired

The designer shall acquire, at a minimum, the following project area information as is relevant and available:

- Record of Survey Maps, Subdivision Plats (including original subdivision plat information if a replat of subdivision), and Development Plans
- Assessor maps
- Zoning maps
- Aerial photography and topography with support data
- Improvement plans
- Hydrology/hydraulic reports
- Geotechnical reports
- Property ownership from assessor's records
- Right-of-way ownership records (deeds, easements, leases, patents)
- Existing and proposed development plans
- Proposed rezoning cases
- Ordinances and statutes
- Homeowner associations
- Permitting requirements
- Planning reports/studies
- Traffic studies/reports
- City limit maps (annexation maps)
- Applicable design standards
- Floodplain map (by Federal Emergency Management Agency [FEMA])
- Road maps
- As-built plans

- Blue Stake information
- Utility plans and easements

3.8 ENVIRONMENTAL SCREENING

Purpose

The Environmental Screening provides an initial indication of potential environmental impacts to the surrounding physical, social, and economic environment that may result from construction and operation of the project. The screening results should inform the design process, allowing early and careful consideration of possible design modifications and/or alternatives that would help avoid or minimize adverse impacts. The screening is also the first step in the preparation of the EAMR, which is discussed in detail in Section 3.18.

Process and Documentation

The Environmental Screening process includes the following three documents:

- Questionnaire for Establishing Potential Areas of Impact (Questionnaire)
- Summary Impact Matrix (Matrix)
- Results Memorandum (Memorandum)

Sample forms for the Questionnaire and Matrix, as well as a suggested outline for the Memorandum, are included as Appendices 3-Fa, 3-Fb, and 3-Fc, respectively. Together these documents provide the tools for the systematic identification of potential areas of concern in the surrounding natural, physical, and social environment; of project elements and construction and operational activities; and of the potential impact of the project elements and activities on the potential areas of concern.

The Environmental Screening process shall take place early within the Initial Design Phase and prior to development of the initial draft DCR submittal (see Chapter 1, Appendix 1-B).

Step 1: Environmental Coordination Meeting

The designer shall arrange an Environmental Coordination Meeting with the full Design Team, including any environmental specialists working on the team, and the Pima County Project Manager. The focus of the meeting shall be to raise any questions about the project that would assist in completing the Questionnaire, and, most importantly, to go through the Matrix to identify the project elements and construction and operational activities that are applicable to the project and could potentially cause impacts to the surrounding natural, physical, and social environment. A copy of the Matrix shall be revised to reflect the outcome of the discussion.

A field visit to observe and photograph the site is strongly recommended prior to the Environmental Coordination Meeting. (Some photographs may be appropriate for use in the Results Memorandum and later in the DCR and EAMR.)

Step 2: Completing the Questionnaire (Appendix 3-Fa)

The purpose of the Questionnaire is to systematically identify areas of the physical, natural, and social environment that might be affected by the project. The Design Team member charged with overseeing the environmental impact assessment for the project shall be responsible for making sure that the Questionnaire is completed. However, questions related to specific technical disciplines shall be answered by or in collaboration with a member of the Design Team trained in the discipline. Information sources shall be cited in the space allotted on the Questionnaire form, (e.g., maps, species lists, conversations, documents, field visits, written communication).

Step 3: Completing the Matrix (Appendix 3-Fb)

The chief purpose of the Matrix is to provide a "snapshot" of potential adverse environmental impacts so that they may be addressed in the design, or if that is not feasible, analyzed further and mitigated to the extent possible. The Design Team member charged with overseeing the environmental impact evaluation for the project shall be responsible for making sure that the Matrix is completed.

The level of research and/or assessment undertaken in preparation for filling out the Matrix will vary from project to project. It is assumed, however, that most roadway projects that would be subject to the *Roadway Design Manual* would have either in-house or contracted environmental specialists on the Design Team. These specialists may want to proceed with literature reviews at the screening stage. This reconnaissance work should provide information useful to identifying potential project issues and concerns.

Step 4: Preparing the Memorandum (Appendix 3-Fc)

The team member charged with overseeing the environmental impact assessment for the project shall be responsible for preparing the Memorandum, which should include the following:

- Summary of the screening process
- Discussion of environmental issues revealed through completion of the Questionnaire and Matrix
- Suggestions/recommendations on how environmental issues might be addressed through the design process
- Identification of technical issues that many need analysis above and beyond those included in the original scope of work for the project's environmental assessment

The Memorandum shall serve as the basis for the text on environmental considerations included in the DCR (see Section 3.17). Additionally, the completed Questionnaire, Matrix(cies) (see Step 6 below), and Memorandum shall be included in the DCR Appendices.

Step 5: Team Review of Screening Results

The results of the screening process shall be reviewed and discussed with the full Design Team to ensure that members representing different disciplines are aware of the potential environmental concerns as early as possible in the project, so that these concerns can be actively taken into account during the development of the design concept.

Step 6: Project Modifications/Alternatives

If project modifications are made to address potential environmental issues or for some other reason, or project alternatives are considered, additional Matrices may be prepared to show how the "snapshot" evaluations of the modified project and/or alternatives differ from the original "snapshot" evaluation.

3.9 LOCATION STUDY

Purpose

A Location Study is undertaken for a new roadway project or for a major improvement project for which there are several possible alternative roadway alignments that are worthy of examination. The purpose of the Location Study is to develop reasonable corridor alignments and compare them based on costs, impacts to the area, and construction requirements.

Process

The designer shall conduct the study of possible locations using data gathered and environmental issues identified during the Data Gathering and Environmental Screening Tasks (see Sections 3.7 and 3.8). The designer shall document the results of the study and the recommended roadway alignment in a Location Report.

Report Content

Items that shall be addressed in the Location Report include:

Introduction

Summarize the reasons that a Location Report was determined necessary.

Mapping

See Section 3.10, Mapping, for Location Study.

Identification of Alternative Locations

Briefly describe both the horizontal and vertical geometry for each location.

Comparative Impact Assessment and Analysis

Determine potential impacts of the project on the existing conditions and the conceptual construction cost of each roadway location. Present a qualitative and quantitative (when possible) comparison of the impacts and construction costs of the alternative roadway locations. Summarize the results of the comparison of alternative roadway locations. (The forms provided for the Environmental Screening [see Section 3.8 and Appendices 3-Fa, 3-Fb, and 3-fc] may be helpful in evaluating the location alternatives.)

Conclusions and Recommendations

Identify the recommended roadway location. Summarize the potential impacts of the recommended location on the environment, neighborhoods, and alternative modes. Identify which of these impacts should be further analyzed in conjunction with preparation of the EAMR (see Section 3.18).

Report Exhibits

- An aerial photo showing the alternative locations with significant features such as major streets and washes, as well as features evaluated in the alternative comparison such as residential areas, businesses, historic sites, and habitat.
- A matrix comparing impacts of the alternative roadway locations studied. An example is provided in Appendix 3-G.

3.10 SURVEYS AND MAPPING

Purpose

The purpose of Surveys and Mapping is to provide the field data needed to perform the planning, design, and right-of-way tasks for the project. This typically includes record research, control surveys, right-of-way surveys, photogrammetric mapping, and engineering surveys.

Coordination Meeting

The designer shall arrange to have a Survey Coordination Meeting with the Pima County Project Manager and a representative of the Pima County Survey Section to determine project-specific survey approaches and details. This meeting shall be held during contract negotiation to further define the scope of work. Items to be resolved include the following:

- Basis of horizontal and vertical control – use of Arizona Coordinate System, 1983 (ACS 83), and North American Vertical Datum, 1988 (NAVD88), and availability of acceptable control points
- Availability of as-built plans, right-of-way plans, and other research materials
- Basis of stationing
- Contour interval and scale of topographic mapping if required
- Scale and extent of Location Study mapping if required
- Timing of survey tasks, including arrangement by Pima County for utility Blue Staking for design
- Format and information to be included in survey report
- Format of other survey-related deliverables to be provided by the designer, including the line type and weight, symbols, and layering scheme for digital submittals

The designer shall prepare a written summary of the meeting documenting any instructions given and choices made. This summary and any clarification shall be completed in a manner compatible with the contract negotiation.

Research

The designer shall:

- Obtain as-built plans, right-of-way plans, and deeds of acquisition from the Pima County Engineering Information Management Section
- Obtain copies of encroachment licenses from Pima County Real Property and review licensed improvements within the road right-of-way, creating a listing of impacted improvements
- Check other sources of information, including recorded plats and recorded surveys

- Make inquiries with the Pima County Developmenet Services Department for proposed development that is adjacent to the project. These developments may impact the project and require coordiantion with Pima County.
- Make inquiries at municipal offices, utility company offices, and other agencies for documentation that may impact the project
- Obtain applicable Public Land Survey System plats and notes from the Bureau of Land Managemen office
- Seek information from local surveyors known to have worked in the area as appropriate

Datum and Basis of Bearing

Horizontal control shall be referenced to the ACS 83 utilizing the latest published adjustments of the North American Datum, 1983 control network. (international foot, as specified in the Arizona Revised Statute (ARS) §33-132).

The basis of bearing shall be established on a well-defined line, between two existig found monuments, within the project limits and shall be referenced to ACS 83 grid north.

The vertical datum shall be NAVD88 utilizing the most recently published orthometric heights.

Stationing

Stationing shall be south to north and west to east for roadway improvements, and in the upstream direction for drainage improvements. The initial station shall be set large enough to preclude the possibility of negative stations should the project limits be expanded. Stationing shall be established in the Survey Coordination Meeting.

Pima County will not accept horizontal survey equations on design plans unless prior written approval has been obtained. Vertical survey equations will not be accepted under any circumstances.

Horizontal Control Network

A horizontal control network shall be established encompassing the project. Pima County will provide the existing control points on which the project horizontal control network is to be based at the Survey Coordination Meeting.

Horizontal control points shall be recovered or established at each end of the project, at major intersections, and at the ends of intersecting streets where the proposed work extends more than one-quarter mile.

Section corners, quarter corners, sixteenth corners, and other monuments that define existing alignments and rights-of-way and/or lie within the project limits shall be incorporated into the horizontal control network. Obliterated aliquot corners shall be identified and re-monumented as specified in the Arizona Revised Statutes (ARS) §33-103. Corners deemed lost shall be re-established and monumented as specified in the ARS §33-103.

The horizontal control network shall meet a 2 cm local accuracy standard (minimally constrained least squares adjustment) and 4 cm network accuracy standard (fully constrained least squares adjustment) with a 95% level of confidence.

The ACS 83 coordinates and the surface coordinates of each horizontal control network point shall be determined. A single mean combined grid-to-surface factor shall be computed and used to transform the horizontal control network to the surface. Surface values shall be used for all other survey and design work.

Horizontal centerline (not including property centerline, etc.) control points shall be referenced with swing ties to at least two durable points, which are to be tagged or marked "Ref." Reference points shall be located at the edge of right-of-way or in other locations where they are unlikely to be disturbed during construction. At least two reference points shall be provided to each section corner, quarter corner, and centerline monument.

Vertical Control and Benchmarks

Vertical control shall be tied to at least two known benchmarks provided by Pima County at the Survey Coordination Meeting identified previously. Benchmark level lines shall, at a minimum, originate on one existing benchmark agreeing within the limits of these specifications and terminate on one existing benchmark agreeing within the limits of these specifications. The originating and the terminal benchmarks must be recognized as Third Order or better by the NGS or Pima County DOT Survey Section. The following equations will be used to compute the maximum elevation closure.

Third Order – maximum elevation closure (in feet) = $0.05 * \sqrt{M}$, where M equals the distance between checks (in miles)

All supplemental vertical control surveys necessary for establishing vertical positions or vertical control points, shall be performed by medthod of differential levels inititated and terminated on a benchmark, double run, or looped, and a turn may be made on the point. Vertical Control points shall be established, at a minimum interval of 500 feet, on alternating sides of the project centerline control and shall be located at the edge of the right-of-way, or in other locations where they are unlikely to be disturbed during construction.

Missed closure for benchmark leveling shall be prorated throughout the marks, in proportion to the distance between them. Missed closure for supplemental vertical control leveling shall be uniformly distributed throught the turns in the run or loop.

The survey notes for the bench circuit, including benchmarks set for te project, shall be included in the survey report.

Topographic Mapping and Surveys

Terrestrial and/or photogrammetric topographic surveys shall be performed to determine contours, spot elevations, ridges, drainage patterns, and other elevation-related information needed for project studies and design. For Field Surveys (i.e. topographic & photogrammetric

surveys) existing NGS control points will be used to establish Third Order Control on projects as defined in Part 4 of the latest edition of *Standards for Architecture, Engineeering, Construction and Field Mamgement of the Federal Geographic Data committee Standars manual (i.e. FGDC-STD-007.4-2002).*

Topographic information normally obtained for a project includes (1) digital files of the terrestrial and/or photogrammetric contour mapping in the drawing file format to be used for design, (2) a hardcopy plot of the topographic mapping, and (3) a digital terrain model (DTM) in a format that can be used with roadway design software such as InRoads.

Topographic mapping, photogrammeterically derived, shall conform to the accuracy standards approved by the American Society for Photogrammetry and Remote Sensing Professional Practicing Division, March 1990, Class 1. The term "error" is used here to signify the discrepancy between the locations of a particular point as shown in the mapping and as determined by a field survey. The accuracy of the mapping is indicated by the root mean square (rms) of the error existing at a finite number of well-defined points. The rms is computed as

$$\text{rms} = (D^2 / n)^{1/2}$$

where

$$D^2 = (d_1^2 + d_2^2 + \ldots + d_i^2 \ldots + d_n^2)$$

N = number of points

d_i = error at a particular point

This is typically applied separately in the x and y components of horizontal location. It is also used as a measure of vertical error, though a different standard applies. The unit of rms is measured in distance (feet in most cases). RMS error analyusis applies to x, y, and z equally. Horizontal points must be well defined in the mapping in order to be located in the field. Vertical checks are random and computed against the DTM surface. Units must match the project datum definition.

The horizontal standard of accuracy of rms is one hundredth of the map scale. For 1" = 40' mapping, for example, the separately calculated rms_x and rms_y should both be less than 0.4'.

The vertical standard of accuracy of rms for contours is 1/3 the contour interval and for spot elevations, 1/6 the contour interval.

Note: The topographic mapping and DTM within the right-of-way shall be sufficiently accurate (within 0.1') to allow for the determination of pay quantities associated with the project earthwork (e.g. – roadway excavation, drainage excavation, embankment demand, and borrow).

Cross Sections

Cross sections of the existing corridor shall be provided. These may be determined by manual field surveys or created from the DTM with special software such as InRoads. Cross sections shall be taken at 50-foot intervals along roadways and minor drainage ways, and at 100-foot intervals along major drainage ways. Cross sections shall also be taken at grade breaks, drainage crossings, and other significant terrain features. All cross section points must meet the topographic mapping accuracy requirements stated above.

Additional cross sections, data collection of both horizonatal and vertical information, shall be made at any and all designated "tie-in/match existing" locations identified within the project limits (including but not limited to begin/end of project, side streets and driveways) to verify the existing conditions. These additional cross sections shall be field surveyed by conventional survey methods utilizing trig leveling for vertical data. GPS RTK data or computer generated vertical datum derived from aerial topigraphic DTM will not be acceptable for vertical data on thes additional cross sections.

Utility Coordination

Pima County will provide utility coordination and arrange for Blue Stake for design prior to the culture survey. Note: Right-of-way and/or construction limits may need to be marked prior to Blue Staking.

Culture Surveys

The purpose of culture surveys is to locate existing improvements and other features within the project limits that are potentially relevant to the studies and design of the project. Culture items typically located, include but are not be limited to:

- Existing paving, sidewalks, and curbs
- Utilities and appurtenances, including underground facilities located by Blue Stake and the utility owner
- Structures
- Mailboxes, walls, and fences*
- Driveways
- Signage (e.g. – subdivision or business)*
- Significant landscaping*
- Major vegetation
- Washes/drainage ways
- Geotechnical features visible on the surface, such as boring locations and landfill limits that have been marked on the ground by others

* Note: When signage or other improvements/facilities are found within the public right-of-way, additional investigation shall occur (e.g. - review with Pima County Real Property) to determine if the facility is licensed to be within the public right-of-way.

Background Culture

The results of the mapping and other culture surveys shall be compiled in a form suitable for depicting existing conditions in the plan views for roadway, drainage, right-of-way, and other plans as needed. Background culture shall be a separate design file with differing types of features on separate layers that can be turned on or off, depending on the type of plan. The background culture also serves to document existing conditions along the length of the project,

including natural topography and features, and existing improvements with utilities. Section lines, centerlines, existing right-of-way lines, and property lines are shown for reference but are not dimensioned. The culture information would typically be derived from the photogrammetry, supplemented with field surveys as necessary.

The background culture shall include the following items:

- Pertinent natural features such as washes and mature vegetation
- Existing improvements shown in the photogrammetry or located by field surveys. This would include pavement, curbs, sidewalks, culverts, buildings, and similar enhancements
- Existing traffic control facilities such as signs, signals, and striping
- Utility surface features such as poles, pedestals, vaults, manholes, and transformers, including the locations of any Blue Staking. Use utility base maps, as-built plans, and field and photogrammetric survey information to show the location of underground utilities as reasonably as possible.
- Underground utilities which have the potential to impact the design of the project's features shall be horizontally located by the Utility Company in accordance with terms and conditions of Pima County Code, Section 1, Title 10, Chapter 10.50
- Topographic information consisting of contours at one-foot intervals and spot elevations determined either photogrammetrically or by field measurement
- Existing centerlines correctly plotted and labeled; section, quarter section, and sixteenth section lines within the project limits shown; existing right-of-way lines and approximate location of property lines defining the frontage of parcels adjacent to the project plotted
- Centerlines and right-of-way lines of intersecting streets along with street names shown

Unless requested separately by Pima County, this information shall be initially submitted in the form of culture background for the DCR plan. All information, including contours and spot elevations, shall be included with that submittal. Non-critical background information such as contours and spot elevations, after conversation with the Project Manager, may be eliminated from subsequent submittals if necessary to reduce clutter.

Mapping for Location Study

If a Location Study (Section 3.9) is to be conducted, preliminary mapping of the study area at a larger (less detailed) scale than used for design may be appropriate. Pima Association of Governments (PAG) orthophotos and digital terrain modeling may be sufficient for this purpose and shall be considered. Scale, contour interval, and extent of any mapping to be obtained for a Location Study shall be discussed during contract negotiation and approved by Pima County. Once an alignment is selected, more detailed mapping is required.

Right-of-Way Surveys

Right-of-way surveys are essentially boundary surveys of the project right-of-way and adjacent properties. Right-of-way surveys shall be extended to the limits necessary to recover the data needed to support the right-of-way documentation requirements of the project. Section corners,

quarter corners, sixteenth corners, centerline markers, property corners, and other monumentation defining existing right-of-way shall be incorporated in the horizontal control network as described above. If record monuments, other than section corners, quarter corners, and sixteenth corners, are not found during the field survey search, they shall be noted as "not found" on the Record of Survey drawing described below.

Survey work done in support of documenting existing rights-of-way, and/or in support of acquiring new rights-of-way shall conform to the procedures and standards set forth in the current version of *Minimum Standards for Arizona Land Boundary Surveys* as adopted by the State Board of Technical Registration.

Title Reports

Status-of-Title reports with a 30-year chain of title are required at the start for all parcels from which all types of easements are to be acquired. Updates to the title reports shall be required at approximately the time of the Initial PS&E Phase submittal (see Chapter 1, Appendix 1-B), and again at the time of actual acquisition. The responsibility of obtaining title reports shall be determined during the contract negotiation.

Orthophotos

Pima County may request that digital orthophotos be provided to assist with the design and right-of-way acquisition process. The need for this task will be identified during contract negotiation. Scale, accuracy, resolution, and extent of coverage shall be determined at that time. Orthophotos will be registered to the project control. The orthophotos are primarily for use in the right-of-way acquisition process. See Section 3.19, Right-of-way Acquisition Support, for more discussion on scale, extent of coverage, and resolution.

Protection of Vegetation

No vegetation shall be disturbed, harmed, or damaged during survey work without the prior written approval of the property owner. Pima County will approach the property owners for this permission when needed.

Protection of Archaeological and Historical Sites

No artifacts from any historic or prehistoric ruin or archaeological site located within the project limits and corridor shall be disturbed, excavated, or collected. The discovery of any archaeological or historical site or object during the course of survey, excavation, or construction shall be reported to Pima County. All reasonable steps shall be taken to secure the preservation of those sites or objects.

Survey Report

All survey work shall be documented in such a manner that copies or original notes can be provided to Pima County. This shall be done in the format of a Survey Report, which documents research, control work, calculations, and other related items of importance.

Document control network points and their references in the survey report. Provide a sketch of the control network. Include a point description list describing what was set and found. Provide both legal and physical descriptions of the points. Provide the ACS 83 and surface coordinates of the network points. Certify the accuracy of the control network.

The Survey Report shall be submitted no later than the Final Design Phase of the process (see Chapter 1, Appendix 1-B), and may be requested to be submitted as part of the Initial Design Phase efforts. Suggested note keeping techniques are available in the Survey Section of the Field Engineering Division of Pima County. If the fieldwork is done using electronic data collection hardware and software, computer printouts and plots of the raw and adjusted data may be provided in lieu of field books. The exact format for submitting this data shall be determined at the Survey Coordination Meeting. Pima County may request that measurements, calculations, and drawings be submitted in electronic form on magnetic media or CD-ROM as well.

Results of Survey Drawing

A "Results of Survey" drawing shall be submitted in conjunction with the Survey Report. This drawing or series of drawings is intended to document both existing survey conditions and the project control, and shall include the following:

- Existing survey control information such as section lines, existing centerline, existing section corners, quarter corners, sixteenth corners and other applicable monuments. Include coordinates of key points. Show basis of bearing and relation to the ACS 83. Provide the grid to surface factor and surface coordinates for a central point.
- Project horizontal and vertical control, including project coordinates and elevations as applicable. Include at least two existing benchmarks to which the project vertical control is referenced.
- Existing right-of-way definition, including existing right-of-way lines, street names, and recording information and year for instruments establishing the existing rights-of-way. Show description and locations of found monuments along the project centerline and intersecting streets.
- Adjacent property definition, including existing right-of-way lines, property lines, and pertinent easements. Provide description and locations of found property pins. Show name of owner, tax identification number, and parcel recording information for adjacent parcels.

The Results of Survey drawing must be sealed by a registered Arizona Professional Land Surveyor and be suitable for recording as a Record of Survey.

Summary of Survey and Mapping Deliverables

Table 3-2 provides a summary of survey and mapping deliverables and the schedule for submittal to Pima County.

Table 3-2
Survey and Mapping Deliverables and Schedule

Deliverable	Submittal Schedule
☐ Summary of Coordination Meeting	Within one week of meeting date
☐ Digital files of the topographic mapping and DTM	When obtained
☐ Plots of culture and utility survey results, including Blue Staking, if possible, and existing center, section, and right-of-way lines accurately plotted and labeled, but not dimensioned	With Initial Design Phase submittal
☐ Survey Report, including Results of Survey drawings	With Final Design Phase submittal
☐ Results of Survey drawing showing right-of-way data	With Preliminary Right-of-Way Plan submittal

3.11 DRAINAGE REPORT

Purpose

The purpose of the Drainage Report is to document the proposed drainage design and the considerations and calculations on which the design is based. The report shall present a description of the existing drainage conditions and any impacts the proposed improvement may have. The drainage analysis and design should generally be accomplished in accordance with the guidelines, procedures, and references discussed in Section 2.10. Deviation from Section 2.10, if necessary, shall be discussed first with Pima County.

Process and Documentation

The drainage report at various stages of completion is included with the Initial Design Phase, Final Design Phase, and Final PS&E Phase Reviews/Submittals (see Chapter 1, Appendix 1-B, and Section 3.20). The following text describes the various elements of the drainage report expected with each.

Initial Design Phase Review/Submittal

At the time of the Initial Design Phase Review/Submittal, the preliminary drainage concept that has been developed should be described and documented. In particular, the following report sections and material to be included are as follows:

1.0 Introduction

1.1 *Project Description:* Provide an overview of the project, including a description of the proposed roadway improvements, project limits, and vicinity and location maps.

1.2 *Major Drainage Features:* Identify major washes, channels, storm drains, or other significant existing drainage features in the project vicinity and generally how they will be treated.

1.3 *Proposed Improvements:* Provide a narrative overview of the drainage system that is proposed to deal with the drainage issues facing the project.

1.4 *Design Criteria:* State the design criteria to be used for the various components of the drainage design, such as return frequency, allowable spread of flow, placement of catch basins upstream of intersections, and so forth. These criteria are generally those stated in Chapter 2 of this manual, but shall be spelled out specifically for the project under design. Any criteria not covered in Chapter 2 but needed for the project shall be stated here as well.

2.0 Existing Conditions

2.1 *Overview:* Provide an overview of the drainage patterns and features that currently exist along the project limits. Describe generally the topography of the area, existing and projected land use, vegetative and soil characteristics, and other factors affecting drainage impacting or being impacted by the project.

2.2 *Existing Conditions Hydrology:* Determine peak discharges and other hydrologic information needed to establish existing conditions. Provide a drainage map showing

points of concentration for which information is needed, tributary areas and flow paths of offsite drainages, and existing drainage features affecting the project such as culverts, washes, and channels. Breakouts upstream that materially affect the location or amount of flow reaching the project should be accounted for.

State the hydrologic methodology used. Provide in tabular form the results of the hydrologic analysis. Include key information such as precipitation, subbasin area, runoff coefficients, times of concentration, rainfall intensity, and peak discharges for return frequencies needed. Discuss any results of particular interest or importance. Provide calculation sheets for each point of concentration, along with electronic modeling files as an appendix.

2.3 *Existing Conditions Hydraulics:* Determine the depth and velocity of flows crossing or adjacent to the project. Account for the capacity of existing culverts, flow overtopping the roadway, and flow breaking out along the roadway into adjacent drainage basins.

Identify the methodologies used for the existing conditions hydraulics determination. Discuss and summarize in tabular form roughness coefficients, expansion and contraction factors, culvert geometrics, and other parameters used in the calculations.

Summarize the results of the hydraulics analysis, identifying areas of flooding, flow breakout, and other key results. Present in tabular form depth and velocity of flow at key points. Provide a drainage map showing the 100-year floodplain limits and a plan and profile of floodplains if appropriate. Provide electronic modeling files as an appendix.

2.4 *Summary of Existing Conditions:* Provide a short narrative summary of key results and observations arising from the existing conditions analysis that should be considered during the project design.

3.0 Proposed Cross Drainage Improvements

3.1 *Offsite Drainage Approach:* Discuss the approaches proposed for dealing with the various offsite drainages impacting the project. Such approaches might include new or modified culvert installations; downstream channelization; drop inlets; and taking offsite drainage into the storm drain system. Include diagrams as report figures or appendices as needed to illustrate the discussion.

3.2 *Proposed Conditions Hydrology:* Provide any additional hydrologic calculations needed to reflect drainage basins altered or newly created by the proposed design. Such basins may include portions of the new roadway being drained by the same storm drain mains and laterals used for offsite drainage. Provide a “Proposed Conditions” drainage map, unless noted otherwise. Summarize these results in tabular form, comparing pre- and post-construction conditions where appropriate. Discuss in the narrative any results or changes from existing conditions of note. Provide electronic modeling files as an appendix.

3.3 *Proposed Conditions Hydraulics:* Provide hydraulic calculations used to determine the sizing and other aspects of culverts, inlet and outlet treatments, channelization, erosion protections, and other elements of the offsite drainage. Include diagrams and sketches depicting the proposed drainage system as report figures or appendices. Provide a storm drain delineation map demonstrating consistency with the drainage basins that provides the basis for the design. The delinieation map will include, but not be limited to the deisgn-year flood plain limits and the design-year discharge values. Summarize in tabular

form key results, including comparison of proposed and existing water surface elevations where appropriate. Explain in the narrative any results or issues of particular concern. Include supporting calculations and electronic modeling files as an appendix.

3.3x *Preliminary Storm Drain (Initial Design Phase submittal only):* Discuss in general the storm drain system being proposed to provide pavement drainage for this project. Note any segment of storm drain main that will also be used for offsite drainage and any special requirements that will result, such as over-sizing for a larger design storm. Provide sketches or diagrams showing the preliminary location and size of storm drain mains, including the potential for use of prefabricated structures.

At this stage, storm drain sizing may be approximated by assuming normal flow of the conduit flowing full with appropriate allowance for minor losses. Alternatively, standard hydraulic grade calculations may be used. Summarize the results of the sizing calculations with appropriate narrative discussion and tables. Provide the preliminary sizing calculations and electronic modeling files as an appendix.

Note: This subsection for preliminary storm drain design is provided with the Initial Design Phase submittal only. Storm drain design in subsequent submittals is addressed separately (see Section 5.0 below).

3.4 *Sedimentation:* Note any special consideration of sedimentation needed in the design of culverts or channels. Do not place culvert inlets below the invert elevation of the approaching drainage way without accounting for the capacity and sedimentation implications. Maintain suitable velocity of approaching flow and flow through the barrel to carry incoming sediment, accounting for downstream backwater effects if present.

3.5 *Channelization:* In cases where it is necessary to channelize upstream or downstream of the culvert, follow the procedures outlined in Pima County *Drainage and Channel Design Standards for Local Drainage,* 1984.

3.6 *Outlet Protection:* Determine if the discharge velocity warrants outlet protection downstream culvert, storm drain, and channel discharge points. Procedures for addressing culvert outlets are provided in Pima County *Drainage and Channel Design Standards for Local Drainage,* 1984 and the U.S., Department of Transportation - Federal Highway Administration, *Hydraulic Design of Energy Dissipators for Culverts and Channels - HEC-14*, 1983.

3.7 *Right-of-Way Requirements:* Identify any special acquisitions of right-of-way or drainage easements required to accommodate the proposed drainage improvements.

3.8 *Mitigation Measures:* Discuss the environmental impact of the proposed improvements. Identify proposed measures for mitigating loss of vegetation and other impacts associated with channelization and other drainage improvements.

3.9 *Permitting Requirements:* Identify whether an ACOE 404 permit or other permits and/or approvals are required.

<u>Final Design Phase Review/Submittal</u>

A draft final drainage report is to be included with the Final Design Phase Review/Submittal. Comments from the initial review/submittal shall be addressed and additional information supplied, as appropriate, to reflect design revisions. Revisions shall be submitted for review and

approval by both Pima County and RFCD prior to being included in the final drainage report and project plans. Provide calculations and electronic modeling files as an appendix.

Additionally, the sections discussed below shall be included.

4.0 Storm Drain Inlet Design

4.1 *Inlet Configuration:* Discuss generally the types and locations of catch basin inlets being proposed for the pavement drainage system and for capturing offsite drainage where applicable. Provide a diagram showing proposed inlet locations and types as a report figure or an appendix. Note that catch basins shall be used in-lieu of manholes for access to the storm drain system and for cleaning purposes when possible.

4.2 *Inlet Design:* Determine inlet location and sizing utilizing the methods outlined in HEC-22 or other approved software or references. Provide a tabulated summary of results as a report figure, including spread data. Summarize the inlet design data on a form such as the one found in Appendix 3-T. Place the detailed intle design calculations and the electronic modeling files as an appendix.

5.0 Storm Drain Design

5.1 *Storm Drain Configuration:* Revise the preliminary storm drain design as needed to serve the proposed catch basin layout, avoid major utilities, minimize the installation of storm drains under pavement, minimize manholes within pavement, and meet other constraints that have emerged in the project design. Update report diagrams as needed.

5.2 *Hydraulic Grade Line Calculation:* Update the storm drain hydrology and preliminary pipe sizing developed in Section 3.3x to reflect any changes in design that have occurred since the initial submittal. Calculate the hydraulic grade line through the proposed storm drain system. Revise the pipe sizing, junction structures and other system components if necessary to meet project design criteria. Provide the hydraulic grade line calculations as an appendix, and provide a plot or table summarizing results as a report figure. Provide diagrams of the proposed storm drain configuration, a storm drain plan and profile plan, appropriate design-year hydraulics grade line, discharge values and sketches of unusual junction structures and other special components.

6.0 Bridge Analysis

This section is included if a bridge over drainage is included in the project design, or, alternatively, a separate report may be provided. Pima County shall be consulted during the project scoping to determine the form for the documentation of the bridge analysis.

The Initial Design Phase drainage report should include sufficient hydrologic and hydraulic information for the Draft Bridge Structure Selection Report to be prepared. Subsequent submittals should reflect finalized bridge geometrics, channel improvements, and other relevant design features.

6.1 *Overview:* Describe the nature of the drainage to be crossed by the bridge. Note the character of the surrounding area (e.g., is it natural, developed, are existing structures threatened by flooding or erosion, and other pertinent information). Note any special environmental conditions that may apply, such as the presence of riparian habitat, wildlife crossing patterns, or the need to span the entire floodplain.

6.2 *Design Criteria:* State the hydrologic, hydraulic, and scour criteria being applied to the design of this structure. Typically, bridges in Pima County are designed for a 100-year storm. In special cases, such as environmentally sensitive areas or roadways with low traffic volumes, other standards may apply. Pima County shall be consulted to develop the design criteria to be used for special cases.

6.3 *Hydraulic Modeling:* Use HEC-2, HEC-RAS, or equivalent flow-profile analysis methodology to evaluate existing conditions and to develop bridge and improved channel geometrics that meet the design criteria.

6.4 *Scour Analysis:* Perform appropriate scour analyses to determine the depth of bridge abutments and piers using the *Guidelines for Establishing Scour and Freeboard for Bridges in Pima County*. If soil cement or other bank protection exists along the channel to be spanned by the bridge, evaluate its long-term viability. If it appears that the bank protection is questionable, not sound or could be breached, the abutments shall be designed as piers, or appropriate remedial action shall be taken to upgrade the bank protection.

Final PS&E Phase Review/Submittal

Final revisions to the Drainage Report shall address Pima County's Final Design Phase Submittal comments as well as revisions to the final project design. Final PS&E Phase plan documents shall not be submitted until the Drainage Report is accepted by Pima County and RFCD.

Suggested Drainage Report Table of Contents and Study References

Table 3-3, which follows, summarizes the content for the drainage report submittals. Appendix 3-A presents a list of Chapter 3 references including those relevant to conducting and documenting drainage studies.

Table 3-3
Suggested Drainage Report Table of Contents

Section			Initial Design Phase Submittal	Final Design Phase Submittal	Final PS&E Submittal
1.0	Introduction				
	1.1	Project Description	X	X	X
	1.2	Major Drainage Features	X	X	X
	1.3	Proposed Improvements	X	X	X
	1.4	Design Criteria	X	X	X
2.0	Existing Conditions				
	2.1	Overview	X	X	X
	2.2	Existing Conditions Hydrology	X	X	X
	2.3	Existing Conditions Hydraulics	X	X	X
	2.4	Summary of Existing Conditions	X	X	X
3.0	Proposed Cross Drainage Improvements				
	3.1	Offsite Drainage Approach	X	X	X
	3.2	Proposed Conditions Hydrology	X	X	X
	3.3	Proposed Conditions Hydraulics	X	X	X
	3.3 x	Preliminary Storm Drain (Initial Design Phase)	X	–	–
	3.4	Sedimentation	X	X	X
	3.5	Channelization	X	X	X
	3.6	Outlet Protection	X	X	X
	3.7	Right-of-Way Requirements	X	X	X
	3.8	Mitigation Measures	X	X	X
	3.9	Permitting Requirements	X	X	X
4.0	Storm Drain Inlet Design				
	4.1	Inlet Configuration	–	X	X
	4.2	Inlet Design	–	X	X
5.0	Storm Drain Design				
	5.1	Storm Drain Configuration	–	X	X
	5.2	Hydraulic Grade Line Calculation	–	X	X
6.0	Bridge Analysis				
	6.1	Overview	X	X	X
	6.2	Design Criteria	X	X	X
	6.3	Hydraulic Modeling	X	X	X
	6.4	Scour Analysis	X	X	X

3.12 GEOTECHNICAL INVESTIGATION

Purpose

The purpose of the geotechnical investigation is to determine the pavement structure, trench backfill requirements, foundation designs, and other geotechnical information needed for design of the various elements of the roadway project.

Process

The designer shall undertake the investigations described below as appropriate for the particular project. The designer shall arrange to have a geotechnical investigation coordination meeting with the County to discuss proposed test boring locations and geotechnical issues related to the project. Prior to beginning any investigations, testing or sampling, the designer shall develop plans outlining proposed test boring and sampling locations, and shall request Blue Stake to locate utilities.

Upon completion of the geotechnical investigations, the report will be submitted to Pima County for review. The Materials Section will evaluate the appropriateness of the existing soils for the trench backfill. This information will be provided to the designer for inclusion in the final Geotechnical Report and preparation of the project's Special Provisions.

Roadway Soil Investigation

The roadway soil investigation shall be performed in accordance with the recommended requirements found in the current edition of the Arizona Department of Transportation (ADOT) *Materials Preliminary Engineering and Design Manual*.

Trench Backfill Investigation

The trench backfill soil investigation shall be conducted at the plan development stage when the storm drain system and cross drainage structures are fairly well defined. Sampling locations and test bores shall be taken at enough locations to be considered representative of the materials in the area. The sampling depth shall be to the pipe or cross drainage structure invert elevation, plus the thickness of the structure, plus 6 inches. Test boring locations shall be marked and numbered consecutively on 11"x17" project plan sheets and included in the appendix of the Geotechnical Report.

Soils shall be classified in accordance with ASTM D3282.

Channel Soil Investigation

For channel improvements, the wash bottom and banks shall be sampled a minimum of every 500 feet. At least one test boring shall be taken at each proposed grade-control structure location. These borings shall extend a minimum of 25 feet below the existing flow line unless an impenetrable substratum is encountered. For bank protection design, tests shall be conducted a minimum of every 500 feet along both sides of the proposed bank protection alignment. Testing

alternate sides of the channel is permissible if the results demonstrate uniformity between the sides.

The investigation may need to provide structural information necessary to design rigid lining, soil cement mix design if in situ material is to be used, and depth of scour. Borings to determine toe down stability analysis shall extend a minimum of 5 feet below the proposed bottoms of the toe downs.

Bridge Soil Investigation

The bridge soil investigation shall be performed in conjunction with the Bridge Structure Selection Report (see Section 3.14). Adequate exploration, testing, and analysis shall be performed to determine the bridge foundation and abutment designs.

If the bridge is a river crossing, sufficient geotechnical information for determining depth of scour must also be obtained. A minimum of one test boring at each proposed bridge pier and abutment location is required. These test borings shall extend a minimum depth of 70 feet unless an impenetrable substratum is encountered. Test borings must also extend at least 20 feet below the ultimate bottom of each pier and abutment.

Protection of Vegetation

Vegetation may not be disturbed or damaged during the geotechnical investigation without the prior written approval of the property owner. Pima County will approach the property owner for such permission subsequent to the designer demonstrating the need for vegetative disturbance.

Protection of Archaeological and Historical Sites

A geotechnical-boring plan showing any existing roadways and proposed boring locations shall be provided to the Pima County Project Manager in advance of fieldwork. The Project Manager will forward the plan to the Pima County Office of Cultural Resource and Historic Preservation (OCRHP), which will determine if the proposed field work is located in an area of know artifacts. If sufficient concern exists, the OCRHP will provide an archaeologist to observe the boring as it is being conducted.

Note: The discovery of archaeological or historical sites or objects shall be immediately reported to Pima County, and all reasonable steps taken to secure its preservation. Artifacts from historic or prehistoric ruins or archaeological sites may not be disturbed, excavated, or collected.

Restoration of Test Sites

Test sites must be restored to their prior condition unless written permission to leave the site disturbed has been obtained from the affected property owner. Pima County will contact the affected property owner for this permission upon demonstration of the need by the designer.

Report Content

The designer shall document the procedures, findings, and resulting design recommendations in a Geotechnical Report. Normally, this report should contain the following:

Introduction

Describe the location and limits of the project, and the proposed improvements with emphasis on those elements requiring geotechnical consideration.

Site Exploration

Discuss the number and location of borings, boring procedures, and laboratory testing methodology and procedures.

Subsurface Conditions

Describe the types of materials, the depth of impermeable substratum (if encountered) and the general subsurface conditions. Summarize the results of the analyses needed for the particular project. These may include the following:

Pavement Design:

- Sieve Analysis
- Plasticity Index (PI)
- R-values
- pH and Resistivity
- Resilient Modules

Trench Backfill:

- *Gradation*
- *Liquid Limit*
- *Plastic Limit*
- *Plasticity Index (PI)*

Retaining Wall, Spread Footing, Drilled Shafts and Other Structures:

- Unit weight of soil
- Allowable bearing pressure
- Active and passive friction coefficients
- Active and passive lateral pressure
- Shear Strength (C)

- Settlement
- Internal friction angle (Ø)
- Swell
- Other specific information such as spring constants of soil-structure interaction analysis

The designer shall consult with the pavement design engineer and/or structural engineer to confirm the specific information needed for the project.

Conclusions and Recommendations

Recommendations, which shall also include the information needed for the particular project, typically address the following:

- Maximum cut and fill slopes
- Special treatment of subgrade
- Treatment of embankment materials
- Collapse and differential settlement
- Swell potential
- Compaction
- Bridge foundation design parameters for drilled shafts, spread footings, and abutment walls
- Retaining wall design parameters
- Need to replace in situ material with engineered backfill
- Possible slope stabilization techniques
- Other geotechnical information needed for the particular project

3.13 PAVEMENT DESIGN

Methodology

Generally, ADOT methodology is used for pavement structure design in Pima County. This process is outlined in the latest edition of ADOT's *Materials Preliminary Engineering and Design Manual*. For simplicity, that document is referred to in this section as "the reference." An overview of the process for flexible pavement design is provided here along with parameters appropriate for Pima County. The reference shall be consulted for guidance in the design of rigid pavement structures.

Design Approach

Flexible pavement structure design follows four general steps.

Step One

Determine the geotechnical properties of the in-place or borrow material that will make up the subgrade on which the pavement structure is to be placed. The geotechnical characteristic that reflects the strength of subgrade is the Resilient Modulus (M_R), which is derived from R-Values (R_T) based on actual R-Value tests and from correlated R-Values (R_C) estimated from less costly measurements of PI and percent of soil by weight passing a #200 sieve.

Step Two

Estimate the traffic loading to which the pavement will be subjected during its design life. This is expressed as the number of equivalent 18-kip single axle loads (SAL) and is typically based on the current and projected design year average daily traffic (ADT) and the current mix of vehicle classifications.

Step Three

Combine the geotechnical and traffic information into a quantifiable measure reflecting the strength of the pavement structure needed. That measure is the Structural Number (SN) from which the thickness of various paving courses can be determined.

Step Four

Apply ADOT methodology to determine a pavement structure that provides the necessary SN. Typically, several possible structures are developed with the final selection being based on cost and constructibility.

Special Considerations for Pima County Projects

The following list presents choices of parameters and other considerations – consistent with ADOT methodology – that are normally appropriate for Pima County projects.

- For determining Equivalent SAL, the following single vehicle values shall be used for the indicated vehicle classifications:

Cars	0.0008
Bus	0.2500
LT (Light Truck)	0.0100
MT (Medium Truck)	0.4000
TS (Tractor Semi-Trailer)	2.0668
TT (Tractor Trailer)	2.0227
TST (Tractor Semi-Trailer Trailer)	3.1506

The above shows that a tractor semi-trailer is nearly 4,000 times as destructive to the roadway surface as a passenger car. The values for heavier trucks increase with time in accordance with the following equations:

TS	-0.98126 + 0.02771 * Yr
TT	-0.22238 + 0.02041 * Yr
TST	-1.44956 + 0.04182 * Yr

where Yr = the median year of the design period - 1900

The above are regression equations developed by the Federal Highway Administration (FHWA) based on annual measurements taken throughout the U.S. The values shown above for Tucson, TT and TST are based on the year 2010.

- The percentage of total traffic assumed in the design lane for various roadway widths is:

Two-lane roadway	50% *[50% each direction x 100% in the design lane]*
Four-lane roadway	45% *[50% each direction x 90% in the design lane]*
Six-lane roadway	40% *[50% each direction x 80% in the design lane]*

- The Seasonal Variation Factor appropriate for the Tucson area is 1.7. Figure 202.02-1 and Table 202.02-4 of the reference shall be consulted for areas outside Tucson.
- The maximum M_R value of 26,000 allowed by ADOT shall be observed for major highways and arterials. For collectors and local streets, the possibility of a higher maximum shall be explored with Pima County. In such cases, the impact of using the actual M_R on pavement structure thickness and cost shall be explored to determine if any meaningful savings would be realized.
- Statistical concepts are incorporated into the pavement design process to account for variability of traffic prediction, materials analysis, and construction processes. Two statistical parameters used for this are Level of Reliability and Combined Standard Error (So). Associated with the Level of Reliability is the standard normal random variable Z_R. Values of these variables appropriate for various roadway classifications are as follows:

FunctionalLevel of Classification	*Corresponding Reliability*	*Z_R Value*	*So*
Arterials	95%	-1.645	0.35
Collectors	90%	-1.282	0.35
Local Streets	80%	-0.841	0.35

- The combined standard error of traffic and performance prediction "So" has been established by the American Association of Transportation Officials (AASHTO) and ADOT as 0.35.
- Present Serviceability Index (PSI) is the performance criterion for flexible pavement design. It ranges from 5 for a perfect roadway to 0 for an impossible roadway. The change in serviceability index (△PSI) is the difference in initial and terminal serviceability index (Po - Pt) and is a measure of pavement deterioration considered to constitute failure. These values are also a function of roadway functional classification as follows:

Functional Classification	*Po*	*Pt*	*△PSI*
Arterials	4.2	2.8	1.4
Collectors	4.1	2.6	1.5
Local Streets	4.0	2.4	1.6

- The structural number required for a given roadway is a complex function of geotechnical, traffic loading, and reliability factors. This function is presented in the reference and cannot be solved directly. It is necessary to find SN by trial-and-error, a task that can be readily accomplished using a spreadsheet application. The spreadsheet also allows the effects of alternative parameters and pavement structures to be easily investigated.
- The structural coefficients to be used for various pavement structure courses are as follows:

Asphalt Rubber Asphaltic Concrete (ARAC)	0.55
Asphaltic Concrete (AC)	0.44
Cement or Bituminous Treated Base	0.28
Cement or Bituminous Subgrade	0.23
Aggregate Base (AB)	0.12

Note the following with respect to these coefficients:

1. The value for AB shall be adjusted by a drainage coefficient of 0.92 for projects in the Tucson area. This effectively results in a value of 0.11. Table 202.02-7 (p. 102 of the reference) shall be consulted for projects in other areas.
2. Only 2 inches of ARAC may be assumed at the coefficient of 0.55. The coefficient for thickness in excess of 2 inches shall be considered to be 0.44.

- The minimum thickness of paving courses for various roadway classifications and pavement types is as follows:

Arterial, Using Standard AC	
Top Lift (AC)	2.5"
Bottom Lift (AC)	2.5"
AB	4.0"
Minimum SN	2.64

Arterial, ARAC Surface Course	
Top Lift (ARAC)	2.0"
Bottom Lift (AC)	2.5"
AB	4.0"
Minimum SN	2.64

Major Collector (2,500 to 10,000 ADT)	
Single Lift AC	3.0"
AB	6.0"
Minimum SN	1.98

Collector (1,000 to 2,500 ADT)	
Single Lift AC	3.0"
AB	4.0"
Minimum SN	1.75

Local Street (Less than 1,000 ADT)	
Single Lift AC	2.5"
AB	4.0"
Minimum SN	1.49

- For arterial roadways, the minimum total AC thickness shall be 5 inches, placed as one 2.5 inch lift of Mix #1 on the aggregate base and one 2.5-inch lift of Mix #2 as the surface course. For a discussion of AC mixes, see the latest edition of Standard Specifications for Public Improvements applicable to Pima County.
- If ARAC is used for the surface course, its thickness can be reduced to 2 inches and the total thickness of AC to 4 1/2 inches.
- Driveways shall be 2.5 inches AC on a minimum of 4 inches AB, subject to local conditions.
- Cement or bituminous treatment of the subgrade can be considered in lieu of removing and replacing poor native soil. The minimum thickness of these courses is 6 inches. Lime stabilization and the use of geotechnical membranes may also be considered in lieu of removing and replacing poor native soil.
- The ratio of AB to AC generally shall be between 1:1 and 1.75:1. It may be necessary to proportionately adjust the thickness of AC and AB courses to achieve this ratio.
- If minimum thickness of the AC and AB courses together does not provide the necessary SN, increasing the thickness of AC is preferable to specifying deeper sections of AB. This is particularly true if utilities are impacted and driveways must be maintained to adjacent properties during construction.
- Cost and constructibility of alternative pavement structures shall be considered. Comparing structures that reflect minimizing the thickness of asphaltic concrete versus the thickness of the aggregate base should provide sufficient information for making a knowledgeable selection. Generally minimizing the base course thickness is preferable from a constructibility perspective.

Pavement Design Report

The data, procedures, and design recommendations shall be documented in a pavement design report, which would typically contain the following:

Introduction

Describe the location and limits of the project, and the proposed improvements with emphasis on the pavement design aspects.

Geotechnical Data

Summarize the general geotechnical characteristics of the soils on which the roadway will be constructed. Provide in tabular form the geotechnical data used in designing the pavement structure. Note the Seasonal Variation Factor used.

Traffic Data

State the traffic data used in developing the pavement structure such as current and design year traffic volumes, percentage of vehicle types, percentage of total traffic in the design lane, reliability factors, and so forth.

Pavement Structure Design

Discuss the procedures and results of the pavement structure design. Provide in tabular or other appropriate form the calculations used to determine the structure number for the various portions of the project. Present the data used and the calculations made in a manner that is straight forward and easily repeated for checking.

Recommendations

Discuss the recommended structural sections, including sub-base and subgrade treatment, and any alternatives that were considered. Include cost, construction, and other factors taken into account in developing the recommendations.

3.14 BRIDGE STRUCTURE SELECTION STUDY/REPORT

Purpose

The purpose of the Bridge Structure Selection Study effort is to evaluate various materials and approaches to determine the most suitable for the particular bridge structure, which result in the development and documentation of findings in a Bridge Structure Selection Report.

Process

The Draft Bridge Selection Report is included with the Initial Design Phase Submittals. The Final Bridge Selection Report is provided with the Final Design Phase Submittals. The final report shall reflect any comments on the draft report provided by Pima County, as well as any design modifications.

Report Content

The content and procedures of the Bridge Structure Selection Report shall conform to the current version of the ADOT *Bridge Design Guidelines*. An outline for use in the preparation of the report and guidance on the content are presented below. Deviations from this process or changes in assumed values (e.g. – modifications of concrete strength values or allowing of continuity of pre-stressed girder design), shall be reviewed and approved by Pima County DOT prior to initiating said changes/modifications.

<u>Executive Summary</u>

Prepare a two-page (maximum) executive summary that presents the key features of the report.

<u>Introduction</u>

Describe the location and site conditions of the structure and the roadway. Mention any previous or existing structures at or near the site. State the purpose of the bridge, and note if it will serve a flood control function.

<u>Geometrics</u>

Discuss the following items providing diagrams and figures as appropriate:

- Roadway alignment, profile, cross section, typical bridge cross section, longitudinal bridge section
- Identify an open or closed bridge median and provide appropriate justification
- Location with respect to right-of-way
- Provisions for structure access and maintenance
- Provisions for future widening or lengthening – provide justification if not providing for future widening

- Skew angle of substructure units
- Headroom clearances, walkways (pedestrian/equestrian/bicycle), barriers, handrail placement, parapet design, lighting (natural & artificial) requirements, and public art/aesthetics
- Wildlife crossing provisions, when appropriate

Drainage Summary

Provide key hydraulic information affecting the bridge. Cite the source of the information (i.e., the project Drainage Report).

- *Hydrology:* Cite the return frequency and discharge amount for which the bridge is being designed, and state the information source. Provide discharges for other return frequencies for which hydraulic analyses have been done.
- *Hydraulics:* Describe the results of the hydraulic analyses on which the bridge design is based. Include design flow and hydraulic properties of the bridge such as channel cross section, bridge length, number and type of piers, and abutment type. Tabulate water surface elevations under existing and proposed conditions. Provide plotted profiles of the water surface elevation for existing and proposed conditions, channel invert, top-of-bank, and the transverse section of the proposed bridge superstructure. State the recommended freeboard (based on review with PCDOT & PCRFCD), minimum soffit elevation, and recommended foundation depth. For hydraulic analysis purposes, assume two feet on each side of the pier to account for debris.
- *Scour:* Summarize the results of the scour used to determine scour depth, including long-term degradation. Identify the source of information used in determining long-term degradation.
- *Channel Improvements:* Discuss any channel improvements to be made in conjunction with the bridge construction, including channel alignment, cross section and bank protection design. Provide the results of the scour analysis for existing or proposed bank protection upstream and downstream of the bridge and describe any modifications or improvements being proposed.
- *Surface Drainage:* Address roadway surface drainage on bridge deck and approaches.

Geotechnical Summary (Final Report Only)

Provide results of the geotechnical report applicable to the bridge design, such as recommended bearing pressures, allowable bearing pressures, soil friction coefficients, active and passive lateral pressure, etc. with the Final Bridge Structure Selection Report. Special information may be requested by the designer such as spring constants and modulus of subgrade reaction for soil-structure interaction analysis

Bridge Substructure (Final Report Only)

Describe the process on which the pier, abutment, and foundation types have been based.

- *Piers:* Describe the pier types considered and the economic, hydraulic, and other considerations leading to the selected type.
- *Abutments:* Describe the considerations made in developing the proposed abutment design, including compatibility with the proposed superstructure, the use of expansion type versus integral, wing-wall skew, and proposed abutment protection.
- *Foundations:* Describe the issues leading to the proposed foundation design, including cost, soil characteristics, and ground water effects. Generally, pile, drilled shaft, and spread footings are given consideration. Summarize the capacities needed and the dimensions and/or depths of the recommended footings.

Bridge Superstructure

Describe the considerations leading to the recommended superstructure type including the following alternatives:

- Cast-in-place Portland cement concrete slabs or girders
- Precast Portland cement concrete girders
- Steel girders

Discuss the corresponding decks, pedestrian rails/barriers, traffic barriers and foundation, pier, and abutment type.

Utilities

Discuss existing utilities and indicate any utility relocation requirements associated with the proposed alternative designs. Discuss any additional accommodation or prohibition for utilities on structure. Identify need for future lighting.

Architectural Treatments

Discuss and illustrate possible architectural designs and treatments for exposed concrete surfaces to improve the aesthetics of the various alternatives. Recommendations by a registered architect are required for urban structures and structures located in highly scenic areas or protected areas (e.g., national, state or local parks, nature preserves).

Construction Procedure

Discuss any proposed phased construction or provisions for future expansion. Discuss issues associated with maintenance of traffic, detours, potential need for road closures (Note: Requires Department and BOS Authorization) and estimated construction times for the proposed alternatives.

Cost Comparison

Compare and discuss the costs of the alternatives considered. Express the costs as dollars per square foot.

Summary

Summarize the report findings and recommendations.

Appendices

Provide the following appendices:

- Preliminary design calculations
- Cost estimates for alternatives considered
- Plan and elevation sketches for various alternatives

3.15 TRAFFIC ENGINEERING STUDY

Purpose

The purpose of the Traffic Engineering Study is to document existing traffic conditions, evaluate the impacts of future traffic volumes, and present design recommendations. The recommendations shall address such issues as the number of through traffic lanes, the need for auxiliary lanes, the need for signalization improvements, the need for raised medians, the location of median openings, and alternative mode improvements (sidewalks, multiuse paths/trails, bicycle lanes/paths, equestrian trails, and transit facilities). The recommendations shall guide the design of the proposed roadway and intersections, as well as the specific design of the traffic engineering features.

Process

The study process and findings shall be documented in the Traffic Engineering Report. The Traffic Engineering Report shall be submitted, reviewed, and approved prior to the completion of the Design Concept Report. The report should also be shared with the public as part of the overall project outreach process. (See Chapter 1, Appendix 1-B and Section 3.20 for information on the County development process phases.)

Report Content

The following paragraphs detail the activities and information to prepare the Traffic Engineering Report.

Executive Summary

Prepare a two-page (maximum) executive summary that presents the key features of the report. This executive summary can also be used as an informational hand out at project open houses.

Introduction

Provide a project description, a location map, a vicinity map, and an aerial photo (1” = 400’) of the project.

Existing Conditions

Provide an inventory of existing features and conditions for all roadways, intersecting roadways, and intersections to be improved. The traffic data collection schedule shall be coordinated with and approved by the County. This inventory shall include the following:

- Geometrics and roadway cross section.
- Auxiliary (turning) lanes.
- Turning movement traffic counts for critical intersections (a.m. and p.m. peak hours). Critical intersections shall be determined during the project scoping process. New data shall be collected if the existing data is more than one year old.
- Hourly approach traffic volume counts for one full 24-hour period at critical intersections. New data shall be collected if the existing data is more than one year old.
- Directional ADT and hourly volumes on major arterials at the approximate midpoint between existing signalized intersections.
- Directional ADT on all side streets except for minor cul-de-sacs.
- Capacity and level of service analyses for existing conditions along the segments and at critical intersections (a.m. and p.m. peak hours).
- Accident data (Pima County supplied data) and accident/crash rates based on the most recent edition of the County *Accident/Crash Statistics Report*.
- Traffic control devices.
- Posted speed limits.
- K (proportion of the ADT occurring in the peak hour) and D (proportion of the peak hour traffic in the peak direction) factors.
- Peak hour factor by movement at critical intersections.
- Heavy vehicle percentage based on a manual classification study (8:00 a.m. to 11:00 a.m.).
- Alternative transportation modes (bus routes; pedestrian, bicycle and equestrian usage; transit, bicycle, pedestrian and equestrian facilities).
- Intersection and roadway lighting.
- Intelligent transportation systems (based on County data).
- Traffic signal warrant analyses at critical intersections defined in the project scoping process. Traffic signal warrant analyses shall be conducted in accordance with the latest County policy associated with the application of the latest FHWA, *Manual on Uniform Traffic Control Devices* warrants.

Future Conditions

Determine the a.m. and p.m. peak hour volumes for all roadways, intersecting roadways, and intersections to be improved. These shall be determined for the opening year and the design year (typically 20 years into the future). The volumes shall be based on the existing traffic volumes obtained in the previous section, on traffic projections prepared by PAG or by the designer guided by County staff, a review of the zoning, and existing and future development proposed in the area. Private driveways with significant traffic volumes shall be evaluated in a similar manner. Perform traffic signal warrant analyses for the project-opening year at those intersections identified in the scope of work.

Proposed Improvements

Document the required traffic-related improvements, including alternative transportation modes, for all roadways, intersecting roadways, and intersections to be improved. The improvements shall be those needed to maintain level of service D or better for the a.m. and p.m. peak hours in the design year. Determine the number of traffic lanes required using the most recent version of the Transportation Research Board *Highway Capacity Manual* (HCM) or a software package that reflects the HCM and is approved for use by Pima County. Include the output generated by this software in the appendix of the Traffic Engineering Report.

Present the proposed improvements for all roadways, intersecting roadways, and intersections to be improved. The proposed improvements shall be for the project opening year and the design year. It is recognized that not all of the required improvements for the design year may be provided as a part of the project under consideration (e.g., grade separations). All initial improvements shall be compatible with the design year improvements. Identify the following for all proposed improvements:

- Posted speed limits
- Alternative transportation modes (bus routes; pedestrian, bicycle and equestrian usage; transit, bicycle, pedestrian and equestrian facilities)
- Design parameters (design speeds, sight distances, shoulders, access, clear zones)
- Raised median justification if applicable
- Median opening locations (preliminary locations provided in the Initial Traffic Engineering Report are subject to change prior to submittal of the approved Final Traffic Engineering Report.)
- Roadway cross section
- Need for auxiliary (turning) lanes and frontage roads
- Storage lengths per Pima County approved methods for the design year or other year specified by Pima County
- Traffic control devices for critical intersections
- Peak hour volumes (a.m. and p.m.) for critical intersections
- K (proportion of the ADT occurring in the peak hour) and D (proportion of the peak hour traffic in the peak direction) factors for arterial segments
- Peak hour factors (a.m. and p.m. peak hours) for critical intersections
- Heavy vehicle percentages for arterial segments and critical intersections
- Need for intersection and arterial roadway street lighting
- Impact on adjacent neighborhoods (both during and after reconstruction) and the potential need for traffic calming measures within the subdivisions and arterial access issues

- Intelligent transportation systems (including, but not limited to, fiber optics communications and conduit, pan-tilt-zoom cameras, traffic and speed counting stations, video detection, traffic signal coordination, emergency vehicle pre-empt systems, and dynamic message signs)

Conclusions and Recommendations

The final section of the report shall summarize:

- Conclusions of the report
- Recommended improvements for the project-opening year
- Recommended improvements for the design year

3.16 ARTERIAL STREET LIGHTING DESIGN

Purpose

The purpose of the Arterial Street Lighting Design Report is to present and document all calculations that define the levels of illumination, lighting layout and configuration of poles, luminaries, power source(s) and the electrical operation of arterial street lighting system(s). If a unique street lighting system is required for the project, the report shall discuss the justification for the unique system and parameters used to define, design, operate and maintain said system. Note: An Arterial Street Lighting Report shall not be required for projects that do not include such systems.

Report Content

For further detail on the contents of the Arterial Street Lighting Report, the designer shall refer to the most current version of the Pima County *Street Lighting and ITS Conduit Design Manual* for specific design direction. The link is as follows:

http://dot.pima.gov/trafeng/DesignManual/SLManual2011.pdf

3.17 DESIGN CONCEPT REPORT

Purpose

The DCR documents the processes undertaken in developing a design concept for a roadway project, including the issues identified, design criteria employed, optional approaches considered, public input, and the recommended concept for design. The report will be approved by the Pima County Director of Transportation and a signature block for that purpose shall be provided on the title page.

An important function of the DCR is to document the tradeoffs made between the various, sometimes disparate, elements in developing a viable overall project design. For example, designing the roadway geometry to balance earthwork may increase the time and cost to relocate utilities beyond that of importing or exporting material. Raising the profile of the roadway across a drainage feature may increase the need for sound walls and visual mitigation, but could reduce cost and environmental impact of downstream channelization. A successful design considers the project as a whole, finding an appropriate balance between conflicting design issues. The DCR brings together the results of the various studies and reports, and documents the process by which the recommended concept was developed.

It should be noted that while there will be the potential to analyze several alternatives in an attempt to obtain the "optimal" design concept for the roadway, it is important to maintain an equilibrium between the amount of effort focused on investigating these alternatives, versus the potential improvement that would occur from their inclusion/addition into the recommended roadway design concept. Components such as roadway lane configuration and drainage, while impacting the overall roadway design concept, have limited flexibility due to traffic volumes and the drainage within the area being impacted

The draft DCR and associated plans may be processed thru a Value Engineering (VE) Review for the purposes of identifying opportunities to enhance the project. Determination of which projects that will have a VE Review and the appropriate time for this review within the overall project development schedule, will be determined on a individual project basis. Typically, projects that are over $10 million or have several significant and/or complicating components will be reviewed. Note: VE reviews usually occur during an early phase of the project.

The DCR is provided to Pima County staff for review and comment and may be distributed to other interested agencies to provide them with information about the proposed project. Ultimately, the report serves as the guide for the project design phase.

Pima County Ordinances

All applicable Pima County ordinances must be met. Any conflicts found between operative ordinances and this manual shall be brought to the attention of Pima County as soon as possible for resolution.

Environmentally Sensitive Roadways

If the project has been designated as an Environmentally Sensitive Roadway (ESR), it is subject to additional requirements and procedures. See, the Pima County *Environmentally Sensitive Roadway Guidelines*, which are included in this manual as Chapter 4.

Report Format

The DCR is prepared first as a draft for review by Pima County staff. The Design Team then revises the draft report based on Pima County's comments and resubmits it for review as a final report. The DCR is typically reviewed and recommended for approval by Staff and submitted for approval to the Director. Note: The DCR should be as brief as possible while containing enough information to clearly explain the basis for the selection of the key project elements and their proposed implementation.

Report Content

A typical table of contents for the DCR is included as Appendix 3-I. The remainder of this section discusses the various items that shall be included in the DCR

Executive Summary

Provide a brief description of the project location and scope, design year, estimated cost, funding source, project purpose and need, alternatives considered, comparative findings, and recommended alternative. Include a Location Map as described previously under "Format." This Executive Summary shall be of limited length and shall be comprehensible to non-technical readers.

Project Overview

Introduce the project by noting the Pima County assigned project number, name, location, project budget, funding sources, and construction fiscal year. Briefly discuss previous work and actions leading up to the DCR, including reference to the Location Report if one was required for the project. Describe the project location and limits and provide a Location Map as discussed previously under "Report Format." Discuss the project need and objectives.

Project Description

Describe the scope of the project and note key features and approaches being proposed, including the following (as applicable):

- Type of project (e.g., widening, overlay)
- Project termini and length (in miles)
- Design and posted speeds
- Nominal right-of-way width

- Roadway section including number and type of travel lanes, medians, bikeways, sidewalks, and Americans with Disabilities Act (ADA) features
- Drainage improvements, including pavement and cross drainage
- Utility, railroad, or irrigation impacts and relocation
- Access control, if any
- Proposed striping, marking, and signing
- Signalization and lighting
- Landscape
- Public art
- Intersection improvements
- Safety upgrades such as culvert extensions and guardrail
- Other key features or approaches that define the construction process or project as it will be ultimately completed

Project Area Characteristics (Existing Conditions)

Address the existing conditions of the project site, including as applicable:

- Surrounding topography and terrain
- Existing roadway, including horizontal and vertical alignment, width of pavement, type and width of existing lanes, surface type, and posted speed limit
- Roadway geometric deficiencies
- Other existing roadway features, such as curb and gutter, bikeways, sidewalks, and ADA features
- Width of existing rights-of-way
- Drainage characteristics likely to affect the project, such as watersheds and drainages
- Drainage structures such as culverts, storm drains, and bridges
- Known drainage problems and recurring drainage complaints
- Signalization and lighting
- Existing utilities
- Existing vegetation and landscaping
- Biological resources
- Archaeological and historic resources
- Visual resources
- Existing land use
- Future land use

- Current zoning
- Proposed developments and other significant traffic generators
- Potentially affected community facilities such as schools, hospitals, parks, and recreational and historic facilities
- Public lands within or adjacent to the project area, either under the jurisdiction of Pima County or of any other public agency (e.g., City of Tucson)
- Tribal lands
- Applicable known intergovernmental agreements that are in place or under discussion

Traffic and Accident Data

Provide current and projected design year ADT volumes. Summarize results of the traffic operational analysis. Provide traffic turning movements at interchanges and intersections. Address parking and pedestrian and bicycle movements where applicable. Present historical accident data and locations, indicating the beginning and end dates of the accident sample. Reference the Traffic Engineering Report (see Section 3.15).

Design Standards and Criteria

List the design standards and criteria used in developing the project as discussed below. For projects that have been or may be designated Environmentally Sensitive Roadways, see also design standards and criteria provided in the Pima County *Environmentally Sensitive Roadway Guidelines,* which are included in this manual as Chapter 4. Consult Pima County's website, for a regularly updated bibliography of standard references used for roadway design.

- *Geometric Standards:* Note the reference(s) for the geometric design of the project. In most cases the reference will be this manual. Other possible sources include the latest version of AASHTO's *Policy on Geometric Design of Highways and Street* and AASHTO's *Roadside Design Guide*.
- *Design Standards:* State the design standards used for the project. In most cases the standards will also be from this manual and the most current joint Pima County/City of Tucson *Standard Details for Public Improvements*.
- *Slope Standards:* Note the cut and fill slopes to be used. If they differ from those presented in this manual, state the reason and reference the geotechnical report where the technical aspects are addressed.
- *Pavement Structure:* Describe the methodology used to develop the pavement structure design. (See Section 3.13.)
- *Design Speed:* State the design speed used for the project design.
- *Drainage Design:* State the design return frequency for cross-drainage and pavement drainage systems. Indicate if cross-drainage is to be taken into the pavement drainage system and, if so, any design implications.
- *Access Control:* Note any portions of the project that will be access controlled. Typically, access would be controlled in the vicinity of intersections.

- *Cross Section Elements:* State the number, type, and width of travel lanes, turning lanes, medians, shoulders, and special use lanes, if any. Generally, these elements shall conform to the guidelines presented in this manual. Provide a diagram of the typical section.
- *Roadway Geometrics:* Describe key alignment characteristics such as minimum radius and maximum profile gradient.
- *Right-of-Way Width:* State the proposed right-of-way width.

Major Design Features

Discuss each of the major design features listed below as it applies to the proposed project. Identify any situations or locations where design exceptions are needed and the reasons why.

- *Horizontal and Vertical Alignment:* Include a general description of the geometry with emphasis on major considerations that influenced the recommended alignment and profile. Provide Initial Design Plans consisting of typical section and plan/profile sheets as an appendix to document proposed geometrics.
- *Right-of-Way:* Provide estimated quantity (in acres) of right-of-way to be acquired. Identify private or public entities that control the property needed. Identify any special right-of-way impacts (e.g., relocations, effect on the operation of businesses, and other environmental issues associated with acquisitions, including habitat impacts). Provide Right-of-Way Requirements Plans as an appendix showing existing right-of-way, existing parcels with owner's names and addresses, and anticipated acquisition of right-of-way, drainage easements, slope easements, and temporary construction easements to the extent known at the time. Include in the drawings existing driveway locations and access for vacant land. Note if no new right-of-way is required for the project.
- *Drainage:* Describe the general direction and slope of the drainage. State the storm return frequency to be used in the hydrologic and hydraulic calculations. Reference the drainage report, and summarize overall drainage features and any drainage changes that would be created as a result of the project. Indicate the type, size, and condition of existing structures and identify the type, size, and location of proposed drainage structures; including options for precast vs. cast-in-place structures. Describe any proposed alterations to existing drainage ways and structures, along with any additional features (e.g. - drop inlets, walls, bank protection, etc.) which may be required. Note whether the project encroaches on regulated floodplains and if a LOMR or CLOMR is required in the case of Federal Emergency Management Act (FEMA) floodplains. Describe the proposed surface (pavement, surrounding terrain, channel, etc.) drainage approach and whether a storm drain system or open ditch drainage is recommended. Note any special permits that may be required at the federal, state, or County levels, (e.g. 404 permit).
- *Earthwork Considerations:* Note if waste or borrow is anticipated, or if the earthwork is to be balanced. Note if unusually large cuts or fills are anticipated and options for dealing with them.
- *Structures:* Describe any new major types of structures or structure upgrades that are proposed (e.g. - bridges or widened bridges). Describe any minor types of structures that are being upgraded or added (e.g. – retaining walls). Note the type, size, and location for structures.

- *Roadway Cross Section & Pavement Design:* Describe and illustrate the typical roadway cross section, including side-slopes and identification of clear zone. Additionally, identify the pavement structure being proposed, along with any alternatives that were considered and the rationale for the selected choice. Reference the Pavement Design Report (see Section 3.13).
- *Traffic:* Describe whether the project will be access controlled or whether access to adjacent properties will be permitted subject to applicable agency standards. Include the Access Management Plan in the Traffic Report (see Section 3.15). Discuss traffic channelization, number of lanes, configuration, special turning lanes, shoulders, bicycle, pedestrian and auxiliary facilities (e.g. – bus pull-outs, mass transit ride share lots, etc.). Identify the location and design features of major intersections (including specific lane configurations). Describe signalization and lighting facilities to be provided with the project, including conduits for future signal, lighting, and Intelligent Transportation System (ITS) installations. Note: Should a unique street lighting system be required for the project, discuss the justification for the unique system and parameters used to define, design, operate and maintain said system.
- *Utilities:* Describe utilities and railroads located in the vicinity of the project. Discuss impacts of the project on these facilities and how the impacts will be addressed (including approximate quantities of utility relocation/reconstruction work). Identify utilities that are proposing to upgrade or add to their existing infrastructure. Also note utilities and railroads known to have, or represented having prior rights. Discuss the possibility of a joint trench and of installing overhead power lines underground. Identify any utility relocations subject to construction time restrictions.
- *Construction Issues*: Describe key components to be considered as part of the construction sequencing and traffic control plan for the project. Address such issues as whether the traffic flow should be maintained during construction, or if closures and detours might be required and where the detours will be located. Discuss how access can be maintained to adjacent residences and businesses. Identify any construction timing constraints imposed by environmental or utility relocation considerations.
- *Design Exceptions*: Note any exceptions from the design criteria established for the project and why such exceptions are necessary.

<u>Social, Economic, and Environmental Considerations</u>

Summarize the results of the environmental screening process (see Section 3.8). Include the environmental impact screening matrix in the DCR as an exhibit or appendix. Provide a written overview of the screening results with particular attention to impacts requiring treatments or mitigation. Briefly address each of the following areas:

- *Air Quality:* State the potential impact of the project on air quality.
- *Biological Resources*: Identify any threatened, endangered, proposed, and/or candidate species likely to be impacted by the project, and any mitigation measures under consideration. Identify protected native plants likely to be impacted and mitigation measures under consideration. Identify invasive species likely to be encountered and measures that will be employed to reduce the likelihood of further propagation.

- *Community Resource Impact:* Identify potential impacts on schools, parks, churches, recreational facilities, and other community facilities.
- *Hazardous Materials:* Summarize the results of the Preliminary Initial Survey Assessment (PISA), including any special measures that may be required to address identified hazardous materials issues.
- *Historic/Cultural Resources*: Summarize the results of the Cultural Resource survey, including any protected resources identified and any special mitigation measures under consideration. This effort shall be coordinated with the Pima County OCRHP in accordance with Board of Supervisor's Policy C 3.17 - *Protection of Cultural Resources*
- *Neighborhood Impact:* Summarize potential impacts the completed project will have on nearby neighborhoods, such as the continuity of circulation and access, and intrusion of traffic. Identify impacts that construction activities may have on nearby neighborhoods and any special measures under consideration.
- *Noise:* Identify noise impacts from the project, any sensitive noise receptors in the area, and mitigation measures recommended in conformance with the Pima County Department of Transportation - Traffic Noise and Mitigation Guidance for Major Road Projects, Procedure 03-5.
- *Visual/Aesthetic Resources:* Discuss important views and other aesthetic resources affected by the project and any special measures under consideration.

Public Involvement

Summarize the public participation plan developed for this project and implementation to date (e.g., meetings and open houses, mailings, informational materials, notices). Include as an appendix documentation of comments that have been received from the public and responses provided. Identify any outstanding issues and how they are being addressed. Provide the proposed schedule for implementing any remaining public involvement steps (see Section 3.4).

Agency Coordination

Describe agency coordination undertaken for environmental review, intergovernmental agreements, etc. Summarize how the coordination was conducted (e.g., written correspondence, phone calls, meetings), issues raised regarding the project, agreed upon resolution, and any ongoing consultation (see Section 3.5).

Alternatives

Each project will have several possible alternatives that should be considered in developing the design which may have not been documented elsewhere in the design process. Examples of alternative studies that should be documented in the DCR include:

- Typical section considerations such as the use of a four-lane divided versus a five-lane section
- Use of retaining walls versus slope easements in areas of large cuts or fills

- Shifting the alignment to minimize impacts to adjacent property or the environment
- Use of special non-standard lanes

Examples of alternative studies that would be documented elsewhere include:

- Choice of culvert sizing and pipe materials (precast vs. cast-in-place), which would be documented in the Drainage Report (see Section 3.11)
- Choice of pavement structure, which would be documented in the Pavement Design Report (see Section 3.13)

If a Value Engineering Review was performed, briefly recap the process and results, and reference the Value Engineering Report (see Section 3.21)

If a Location Study was performed, briefly recap the process and results, and reference the Location Report (see Section 3.9).

Following is a suggested procedure for documenting the evaluation of alternatives:

- First, identify the needs/deficiencies of the existing roadway features and elements.
- Second, identify any constraints that will impact the various solution alternatives which need to be considered in the overall decision making/evaluation process.
- Third, summarize the alternatives that were initially considered infeasible and discounted without detailed analysis. State the basis for rejection.
- Fourth, discuss the detailed analysis of the concepts retained for further study. Compare the costs and other impacts of each alternative, including the following as appropriate:
  - Effectiveness in meeting the project purpose and need
  - Potential effect on future land use
  - Impact on the environment
  - Impact on neighborhoods
  - Impact on traffic operations
  - Traffic control
  - Drainage
  - Utilities
  - Constructibility
  - Cost
  - Design exceptions

The use of comparative matrices such as the sample provided in Appendix 3-G is encouraged.

Cost Estimate

Provide an initial cost estimate of the project as proposed. Identify the recommended alternatives on which the estimate is based. Provide as an appendix the quantities and item or unit costs used to arrive at the project cost estimate. Include the cost of design, right-of-way acquisition, and utility relocation to be borne by Pima County, mobilization, construction, and construction administration. An example of items that should be included in the cost estimate along with some potential percentage ranges are provided as Appendix 3-J. An appropriate level of contingency funding should be included based on the level, and detail of information available for the project. Projects which do not have significant unknowns should have a smaller contingency percentage and associated amount than those with more significant unknown/unresolved issues. As the project moves forward and more becomes known and/or defined, the percentage and amount being held as a contingency should be reduced. PCDOT's practice, as reflected in the table below is to maintain a 10% contingency for unforeseen construction issues at the Final PS&E Phase of project development.

Examples of project contingencies associated with project development are as follows:

Table 3-4 Project Contingencies

Phase	Percent Contingency
Initial Design	35% - 40%
Final Design	25%
Initial PS&E	10 - 15%
Final PS&E	10%

Budget Considerations

Identify if the budgeted amount is sufficient to construct the project as currently planned. In the event that it is not, identify viable options for reducing construction costs such as shortening the project, eliminating medians, and making other project modifications. If there is still insufficient funding available, identify potential project phasing that could be used to address the most critical needs first.

Delivery Method

Historically, project delivery has been completed thru the Design-Bid-Build process. However, it is appropriate to assess and identify if the project should be delivered in this manner, or if there are circumstances/issues associated with the project that could be improved upon/enhanced using an alternative delivery method (e.g. – Construction Manager at Risk, Job Order Contract, Design/Build). This review and assessment should include an evaluation of the specific circumstances, issues, risks, benefits, and opportunities associated with the project; the recommended delivery method, and how conducive said delivery method is towards meeting the needs of the project.

Conclusions and Recommendations

Identify the recommended set of alternatives/project characteristics and explain the reasons for their selection. Discuss the interaction of various design elements and the trade-offs that constitute the recommended course of action, along with recapping the overall benefits of the project.

3.18 ENVIRONMENTAL ASSESSMENT AND MITIGATION REPORT

In order to be consistent in the development of the two primary project documents, the DCR and EAMR shall be developed jointly, or concurrently such that the elements and features that are contained within these documents are described and addressed consistently

Purpose

The purpose of the EAMR is to document the results of the assessment undertaken to identify unavoidable adverse impacts of the recommended alternative on the physical, social, and economic environment located within the vicinity of the project, and to recommend measures to mitigate those adverse effects. Mitigation measures are separate from features of the proposed action that avoid or substantially reduce the environmental consequences of the proposed action. Mitigation includes measures that:

- Compensate for impacts by replacing or providing substitute resources or environments
- Rectify impacts by repairing, rehabilitating, or restoring the affected environment
- Minimize impacts by limiting the degree or magnitude of the action and its implementation
- Avoid certain impacts altogether by <u>not</u> taking a certain action or by <u>not</u> incorporating selected elements of a proposed action

The environmental screening process conducted early in the project planning (see Section 3.8) and summarized in the DCR shall serve as the starting point for this final assessment. The results of any assessment conducted in conjunction with the environmental impact screening, as well as additional assessments undertaken, shall be documented in the EAMR to provide a comprehensive environmental report for review by the Pima County Board of Supervisors and the public.

The EAMR is provided initially to Pima County staff for review and comment and then revised as appropriate and submitted to the Pima County Board of Supervisors for review and approval following a public hearing. The EAMR is also made available to the CAC for its comments (see Section 3.4) and is available to the general public for review at the Pima County Department of Transportation prior to the public hearing.

Environmentally Sensitive Roadways

An EAMR that follows the general process described in this section must also be prepared for projects that are designated as Environmentally Sensitive Roadways as defined in the Pima County *Environmentally Sensitive Roadway Guidelines*, which is included in this manual as Chapter 4. Environmentally sensitive roadway projects are also subject to the assessment process and mitigation tools for biological resources, cultural resources, and visual and aesthetic resources as described in the aforementioned guidelines.

Scoping Confirmation

In conjunction with the development of the scope for development of the DCR, the Pima County Project Manager and appropriate Design Team members shall meet to confirm the scope of work required for the EAMR. This meeting shall consist of reviewing the evaluation completed in conjunction with the screening process undertaken prior to the DCR (see Section 3.8), reviewing the preferred alternative and project limits as identified in the DCR, and identifying any assessments needed above and beyond that undertaken for the environmental impact screening.

Funding Options

These EAMR guidelines have been developed with the knowledge that projects sometimes acquire federal funding during their planning. The approach and methodologies described below should provide the majority of information needed to complete the necessary federal-level environmental documentation, should it become necessary.

Report Format

The EAMR is prepared first as a draft for review by Pima County staff, along with any technical assessment reports prepared. The Draft EAMR is then revised based on comments received and resubmitted as a Final EAMR for review and approval by Staff and submitted for approval to the Director. Upon approval by the Director, the EAMR is forwarded for review and approval by the Pima County Board of Supervisors (Appendix 3-O provides additional background relative to requirements/scheduling of EAMR for Public Hearing/Board Action). The EAMR shall briefly discuss any technical evaluations and surveys that were conducted in conjunction with the early environmental impact screening, as well as additional technical work undertaken for the EAMR. The discussion shall include a brief description of methodologies used and the results. Any technical documentation referred to in the EAMR shall include the title, author, and date. Technical environmental documentation prepared in conjunction with the project and referred to in preparing the EAMR shall be posted on the project's web site.

The EAMR is the major and final document approved by the Pima County Board of Supervisors for a project. It is important to understand that the report must serve as a "stand alone" document, which can be read and understood independent of other documents prepared for the project.

Note: It is acceptable to summarize or repeat relevant information from other project documents, with those documents being referenced within the document and posted on the project web site should the reader wish to investigate a specific area further. It is not acceptable to simply refer the reader to another document to obtain information necessary to understanding the EAMR.

Report Content

A typical EAMR Table of Contents is included as Appendix 3-K. The remainder of this section provides additional detail on what shall be covered in the major sections of the EAMR.

Executive Summary

Prepare an Executive Summary that provides a project overview, including project name, number, location, limits and Location Map, estimated cost, funding sources, and construction year; an explanation of the project purpose and need; a brief description of the project; a summary of the unavoidable adverse impacts identified, the recommended measures for mitigating the impacts, any agency coordination and consultation conducted, and parties responsible for the implementation of the mitigation; and finally a summary of the public involvement activities conducted for the projects, the comments received from the public, and Pima County's responses. Appendix 3-L provides an outline for the Executive Summary, while Appendix 3-M offers a sample table for summarizing impacts, recommended mitigation, agency coordination and consultation, and responsible parties, and Appendix 3-Db presents a sample table for summarizing public participation activities.

The Executive Summary shall be of limited length and shall be comprehensible to non-technical readers. The summary shall be prepared as a document that can be both bound into the EAMR and distributed and understood independent of the full EAMR.

Abbreviations

Provide an alphabetized listing of the abbreviations used in the document.

Background

Begin the report with the following information:

- Pima County assigned project name and number
- Project location and limits (including construction easements)
- Estimated cost, funding sources, and construction fiscal year
- Listing of the steps completed in the design process to date (see Table 3.1 and Chapter 1, Appendix 1-B)

Exhibit: Provide a copy of the Location Map specified for the DCR (see Appendix 3-H).

Project Purpose and Need

Develop a purpose and need statement that describes the overall objective of the project – that is, why the agency is undertaking the project, and what objectives are to be achieved by the project. The statement shall explain why the proposed action, with its inherent costs and potential adverse environmental impacts, is being pursued.

The distinction between the "purpose" and the "need" might be described as follows:

- *Purpose* is the specific objective(s) of the project (e.g., to widen the road)
- *Need* is the problem(s) that is (are) being addressed or the opportunity(ies) being pursued (e.g., to address congestion problems)

Project Setting

Provide an overview description of the environment in which the project will be located. Include both physical and socioeconomic aspects of the setting, such as the configuration of the existing roadway (if the project is an upgrade or improvement project), general characteristics of the vegetation, the level and type of development, etc. Include any unusual or important elements or features of the existing setting.

Base the description on information completed in the Questionnaire for Establishing Areas of Impact (see Section 3.8 and Appendix 3-Fa) and on the "Project Area Characteristics" prepared for the DCR (see Section 3.17).

Exhibits: Include an aerial photo with project limits and prominent physical features identified (e.g., major streets, washes, and recreational areas). Provide captioned photographs to illustrate key features.

Proposed Project

Drawing on the Environmental Screening Summary Impact Matrix (see Section 3.8 and Appendix 3-Fb) and the project description presented in the DCR (see Section 3.17), describe the proposed project. Include the following items:

- Key features of the facility's design and operation (e.g., number of lanes, bicycle, pedestrian, and transit facilities, traffic signals, ADA facilities, medians, drainage facilities, proposed speed limit, etc.)
- Construction activity (e.g., utility involvement, etc.)
- Features incorporated into the proposed action's design to avoid or reduce adverse environmental impacts

Environmental Screening

Describe how the environmental screening process (see Section 3.8) was used in the development of the design to respond to potential impacts and reduce the need for mitigation measures by avoiding or minimizing potential impacts. Identify the adverse impacts that could not be avoided, and note additional technical analyses that were done above and beyond that done for the environmental screening to identify impacts.

Environmental Assessment and Mitigation

Appendix 3-N presents the Natural/Physical and Neighborhood/Social environmental categories that shall be considered when undertaking a roadway project design. The table also includes guidance on evaluating potential project impacts for each category. The EAMR shall address each environmental category separately, providing information on each of the topics listed below. If the project will not affect an environmental category, note the category and provide a one or two sentence explanation as to why the category is not applicable.

- *Existing Conditions:* Describe the existing conditions related to the environmental category of interest in the vicinity of the project area. *(Note: The area of concern for different categories varies.)*
- *Potential Impacts:* Identify findings of the assessment for the environmental category, clearly calling out the potential impacts that were unable to be avoided or minimized in the development of the design concept.
- *Mitigation Measures:* Describe the recommended measures to mitigate the potential impacts, and any effects that the measures may have on other environmental categories.
- *Permits:* Identify any permits associated with the environmental category that are likely to be needed, and briefly describe any mitigation measures that are likely to be needed to obtain permit approval.

Agency Coordination

Identify any coordination and consultation conducted with the following:

Local Jurisdictions and Tribal Nations: Document any coordination undertaken with other local jurisdictions and/or with tribal nations that is relevant to the environmental issues addressed in this EAMR. Reference correspondence, meetings, Intergovernmental Agreements, etc. Include any coordination letters sent and responses received in the EAMR appendices.

State and Federal Agencies: Describe any coordination and/or consultation with state and federal agencies that occurred during the evolution of the project and that was associated with addressing environmental issues. Provide dates and topics of correspondence, meetings, phone calls, and other relevant communication. Include any coordination/consultation letters sent and responses received in the EAMR appendices.

Public Participation

Describe the public participation process undertaken in accordance with the Pima County *Community Participation and Mitigation Ordinance* (see Appendix 1-A) and the Public Participation Plan prepared for the project (see Section 3.4). Discuss the formation of the CAC and its make-up. Summarize the public activities undertaken, as well as the comments received from the public and the County's responses to those comments.

Characterize the key issues raised by the CAC and/or the general public, how the issues were addressed, and whether the CAC has any remaining key issues of concern. Discuss comments raised by members of the general public through written correspondence, public open houses, phone calls, the Pima County Website, or other means. Describe how the comments were taken into consideration in the project planning and the means of response to the public.

Describe the CAC's ongoing role in the project. Describe whether any other public meetings or activities regarding this project are planned for the general public in the future.

Include in the EAMR appendices, the names and affiliations of the CAC members and copies of materials handed out at the CAC meetings, materials mailed or distributed to the public, the

public open house sign-in sheets, CAC and public open house meeting announcements and notifications, and written comments received from members of the public.

Conclusions and Recommendations

Provide a table summarizing the results of the EAMR, including the following: (a) potential adverse impacts; (b) measures recommended to mitigate the possible impacts; and (c) the party(ies) responsible for implementing the mitigation measures. A sample summary table is presented in Appendix 3-L. *(Note: This table is to be included in the EAMR Executive Summary also.)* If a potential adverse impact cannot be mitigated, explain why. Provide the estimated total cost of the recommended mitigation measures.

References

Provide a listing of the information necessary for the reader to locate and retrieve any of the sources that were cited in the document. Each source cited shall appear in the reference listing and should also be cited within the document itself.

Tables

Provide a listing of the Tables contained within the document.

Figures

Provide a listing of the Figures contained within the document.

Project Documents

Provide a listing of Project Documents used to in the development of the EAMR and website linkage information.

Special Provisions

Upon approval of the EAMR and specified mitigation measures, the measures must be incorporated into the Special Provisions for the project.

3.19 RIGHT-OF-WAY

Introduction

This section describes the preparation of right-of-way documents associated with roadway improvements, including those required for acquisition and disposal of real property. Right-of-way documents include right-of-way plans, legal descriptions, title reports, individual parcel maps, and orthophotos. Field staking of acquisitions may be required as well. This section also details the function of each type of right-of-way document and outlines the content expected with each.

For the purposes of this section, “a parcel” is considered to be a tract of land that has unity of title, unity of use, and physical contiguity. The term "affected parcels” refers to those parcels for which right-of-way or easements will be acquired, or which will be economically impacted by the roadway project in some other way.

Real property, rights-of-way, and easements acquired as part of the project shall be designated as “new” if recordation of the instrument by which they were established occurs prior to finalization and acceptance of the project plans by the County. If not, a designation of “proposed” shall be used.

Ownership of real property and property rights (i.e. land, right-of-way, easements) necessary for construction of a roadway project shall be acquired and recorded with the Pima County Recorder prior to submitting the construction documents to the Pima County Procurement Department unless directed otherwise by the County.

Standard of Accuracy

Fieldwork shall be performed in accordance with the procedures and accuracy standards described in Section 3.10, Surveys and Mapping. Boundaries of proposed acquisitions must close mathematically.

Right-of-Way Plan Functions

Right-of-way plans serve several functions.

- Define existing right-of-way, including relevant drainage and utility easements. Other types of easements, such as private ingress/egress easements, are shown if they affect the design and operation of the improvements.
- Show proposed and new fee right-of-way and easement acquisition with sufficient dimensions and ties to existing monumentation to define them for the purpose of preparing legal descriptions and locating them in the field.
- Provide supplemental information such as areas of acquisition needed for appraisal and other acquisition activities.

Right-of-Way Plan Format and Content

The following paragraphs provide guidance that shall be followed in preparing project right-of-way plans.

General

Right-of-way plans shall stand alone in terms of defining existing, new, and proposed right-of-way with respect to existing monumentation and to the construction control line. Sufficient ties, dimensions, stationing, and other information necessary to accomplish this shall be provided.

Right-of-Way Plan Sheets

Plan sheets shall adhere to the following format and content guidelines:

- Prepare right-of-way plans as 22” x 34” sheets and normally at a scale of 1” = 40'. It may be necessary to provide details at larger or smaller scales to show large parcels in their entirety or if an unusual amount of detail is necessary.
- Orient north to the top or right of the sheet.
- Show major street intersections in their entirety on a single sheet, even if this results in the incomplete use of the sheet.
- Label all streets.
- Show and label the right-of-way and construction control line and stationing.
- Provide a table of curve data for each sheet, listing the delta, radius, and arc length for each curve shown on that sheet for which dimensions are required. Curves shall be designated with consecutive numbers enclosed in ellipses placed as near as possible to the pertinent curve. Arrows and leaders may be employed if necessary for clarity. Data for curves that extend from one sheet to another shall be shown in the tables on each sheet.
- Show and label major topographic features such as rivers, washes, and railroads.
- Show and label jurisdictional limits such as city limits, Indian reservations, national forest boundaries, State land, and similar jurisdictional limits.
- Show recorded subdivisions adjacent to the project including the subdivision name, book and page, block and lot numbers, along with year of recording in parenthesis. Original lot and block lines that are no longer current property lines shall be shown as dashed and without dimensions.
- For adjacent lots that are subdivided, show the subdivision lot number, assessors parcel number, name of owner, and address of parcel. For adjacent parcels that are not subdivided, provide the same information except replace lot number with the word “UNSUBDIVIDED.”

Monumentation and Control

- Show the monumentation from which existing and proposed rights-of-way are established. Provide legal and physical descriptions for each monument.
- Show and label section, quarter section, and sixteenth section lines (aliquot lines) applicable to the existing or proposed rights-of-way. Show the existing right-of-way control line if

other than an aliquot line.

Existing Rights-of-Way and Easements

- Show existing rights-of-way and easements, referencing the instruments by which they were established, along with the date of establishment (e.g., map and plat, County road map, and recorded deed/easement). Include the recorded book and page of each document, along with year of recordation in parenthesis. Show these references on the project side of the right-of-way lines. It should be clear how the exisiting right-of-way originated at any location on the plan. Utility blanket easements shall be clearly identified.
- Show any vacated rights-of-way and easements. Reference the instruments by which they were vacated, and show these in parentheses. Show vacated rights-of-way with dashed lines and without dimensions or ties. In many cases, rights-of-way abandoned or vacated for roadway purposes continue to serve as public utility easements.
- In cases where rights-of-way originally created by a subdivision plat have been widened by a subsequently recorded document, show the original line as dashed. Clearly show the amount of widening.

Access Control

- Show any existing and proposed access control lines.

New and Proposed Right-of-Way and Easements

- Show new and proposed rights-of-way, and permanent and temporary easements. Label these and show the dimensional information needed to prepare legal descriptions. For New rights-of-way, reference the instrument by which it was acquired alon with the date of establishment. Show these references in parentheses on the project side of the right-of-way lines. It should be clear how the existing right-of-way originated at any location on the plan.
- Shade or crosshatch new and proposed right-of-way and easements to be distinctive. Provide any necessary labeling or notes.
- New and proposed rights-of-way shall be brought to the attention of PCDOT – Engineering Information Management (EIM) Mapping and Records to determine if a new roadway or modification of an existing roadway establishment is required. PCDOT – EIM Mapping and Records Section will coordinate said establishment and/or modification.

Affected Parcels

- Show affected parcels in their entirety with record or calculated dimensions. Use broken lines, details, or insets at different scales if necessary to show very large or very small parcels.
- Assign each affected parcel an identifier consisting of the sheet number on which the parcel first appears and a consecutive letter unique to the particular sheet. Enclose this identifier in a hexagon to make it visually distinctive.
- Show record distance, bearing, and curve data of property line of affected parcels. Provide

radial or tangent bearings if necessary to fully define curves that are not tangential to adjoining curves or line segments. The portion to be acquired shall be tied to permanent control and sufficiently dimensioned that this portion can be unambiguously described and the area of take calculated.

- As appropriate, show physical features that may impact the acquisition of affected parcels such as:
  - Permanent improvements and structures within 50 feet of the proposed right-of-way line. Label the type of improvement, such as house, barn, garage, and shed.
  - Points of ingress and egress such as driveways, access easements, and private roads.
  - Fences, sidewalks, patio walls, major landscaping, signs, utility service lines and meters, and other structures.
  - Evidence of unwritten or unrecorded easements, such as visible utilities that may indicate unrecorded utility easements.
- Indicate the disposition of any improvements located within proposed acquisitions (demolition or relocation).
- For each affected parcel provide a table or tables containing the parcel identifier, the Pima County Tax ID number, docket and page of the parcel deed, the parcel owner, gross area of the parcel per assessor records, the type of acquisition, the size of the area to be acquired, and the net area of the remainder. Include areas for permanent and temporary construction easements (TCE). Areas shall be rounded to the nearest square foot or the nearest one thousandth of an acre.
- Provide a table of coordinates of found monuments, new right-of-way points, and other key points. Use the project specific surface coordinate system established per Section 3.10. Note the basis of bearing and project grid to surface factor established per Section 3.10.

Legal Descriptions

Legal descriptions shall be prepared for each right-of-way and easement acquisition required for the project. Preparation of legal descriptions will require the data outlined in Sections 3.7 and 3.10. Additional data gathering may be necessary such as updates of the data gathered earlier, status of title and/or chain of title reports for adjoining parcels, and copies of documents referenced in the other documents.

The legal description is the primary component of the conveyance package and must unambiguously define the area being acquired. If a legal description includes by reference other recorded instruments, those instruments shall be submitted to Pima County with the legal description. Include on the legal description, as a foot note, the project name, number and parcel identification letter shown on the right-of-way plans, The acquisition area (square feet or acres) shall not be included in the legal description. Each legal description shall be sealed by an Arizona Registered Land Surveyor and shall state the type of acquisition such as “Fee Road Right-of-Way”, "Drainage Easement”, “Temporary Construction Easement”, or “Slope Easement”.

Individual Parcel Maps

An individual parcel map shall accompany each legal description. This map is a diagram of the legal description and shall include a reference location map, the existing parcel, and the acquisition area clearly shown and labeled. The parcel map is attached to and recorded with the legal description and shall have no text less than 11 points in size for legibility. When an entire parcel is acquired, and only a portion of the property taken is for road right-of-way, said portion shall be labeled as "Road Right-of-Way", with the remaining portion(s) of the property labeled according to the type of acquistion.

Individual parcel maps shall be prepared on 8 1/2" x 11" paper at a scale sufficient to depict pertinent information. Each parcel map shall include the consulting firm's name, type of acquisition, assessor number, date written and dates of any revisions, property owner's name, parcel address, and sufficient dimensional information to illustrate the derivation of the legal description.

For areas less than 1,000 square feet, provide the area to the nearest square foot; for areas between 1,000 square feet and 1/4 acre inclusive, give area to the nearest 1/10,000 of an acre; and for areas greater than 1/4 acre give the area to the nearest 1/1,000 of an acre.

Orthophotography

Provide orthophotographs of the project site. These photos shall be at the same scale as the right-of-way plan and at a resolution of 0.25 feet per pixel. Aerial coverage shall extend at least 200 feet each side of the proposed centerline for the full length of project. Each photo shall be on a 22" x 34" mylar with the date of the photo placed in the lower right-hand corner of each sheet. Show the following on these photos:

- Existing rights-of-way and easements
- New and proposed rights-of-way and easements
- New curb lines and sidewalks
- New curb cuts and driveway openings
- New median cuts and turn bays
- New travel lanes (vehicular and multi-purpose)

The orthophotos are submitted with the right-of-way plans, but not considered a part of the record documents.

Field Staking

Field staking of new and proposed right-of-way acquisition may be necessary in special cases. If so, that work shall:

- Mark existing, new and proposed right-of-way lines with a sufficient number of nails with flagging to clearly define existing right-of-way and proposed acquisitions on the ground. Provide nails at key points such as angle points, intersections of existing property lines with

the proposed right-of-way, corners of easements, and so forth. Provide lath labeling key points.

- Coordinate parcel staking with Pima County Real Property Services. Notify Real Property Services as parcels are completed to allow them to photograph the results.
- Tie all staking to the project construction control line via station and offset. Provide stations and offsets on lath labeling key points, as well as type of right-of-way identified (e.g., existing, new TCE, drainage easement, slope easement).
- At completion of approved right-of-way plans, provide field staking services to permanently monument the new and existing right-of-way line. Place 1/2-inch pins or other suitable markers at angle points, beginning of curves, and end of curves on existing and new right-of-way line. Place monuments at the intersection of right-of-way with public land survey lines.
- Do not disturb, excavate, or collect artifacts from any historic or prehistoric ruin or archaeological site located within the project limits and corridor. The discovery of any archaeological or historical site or object during the course of survey, excavation, or construction shall be reported to the Pima County Department of Transportation, which will notify the Pima County CRHPO. All reasonable steps shall be taken to secure any archaeological or historical resources.
- Do not disturb, harm, or damage any vegetation during survey work without the prior written approval of the property owner. Pima County staff shall approach the property owner(s) for this permission once the need has been demonstrated by the designer.

Finalized Plans

Once construction is completed, the right-of-way plans shall be updated to reflect any changes in the actual acquisitions. An as-built record of survey of the finalized right-of-way shall be performed to be recorded with the Pima County Recorder and filed with the Pima County Engineering Information Management (EIM) Mapping and Records Section.

Right-of-Way Notebook

Complete and legible copies of all documents used in the development of the right-of-way plans (e.g. - deeds, easements, road maps, subdivision plats, utility easements, and other recorded instruments) shall be assembled into a Right-of-Way Notebook and submitted with the right-of-way plans. The notebook shall be organized and cross-referenced with the right-of-way plans, such that property, rights-of-way, and easement information may be readily located. The Right-of-Way Notebook shall also include a right-of-way document summary in the form of a spreadsheet containing the following information:

- Document Number
- Source (e.g. TEP, SW Gas, Name of Subdivision, etc.)
- Type of Document (e.g. - Deed, Utility Easement, Patent, Lease, Subdivision Plan, etc.)
- Township, Range, Section; Recording Docket and Page (with year)
- Plan Sheet Station reference(s) and Page Number
- Any associated notes relevant to the document.

Checklists

Checklists to aid the preparation of right-of-way plans, parcel maps, and legal descriptions are provided in Appendix 3-P.

3.20 CONSTRUCTION DOCUMENTS

Purpose

The package of construction documents includes final construction plans, specifications, bid schedule, and a cost estimate in Pima County's bid sheet format. The construction documents need to be clear and unambiguous about the work to be done, the standards to be met, elements of work, method of measurement, and basis of payment. The construction documents shall reflect current Pima County design practices and standards except as previously agreed upon with Pima County. The documents shall also reflect any special recommendations or requirements stated in the DCR, EAMR, Traffic Report, and other applicable planning documents.

Construction Plans

Unless otherwise approved by Pima County, the following guidelines shall be followed in the preparation of construction plans:

- Prepare drawings at 22" x 34"
- Orient project with north arrow pointing upward or to the right on the plan sheets
- Provide match lines for plans and details that due to size or scale must be broken between sheets or different locations on a single sheet
- Provide details, text, and other drawing components at a sufficient size and clarity to be legible when reduced to half size or microfilmed
- Clearly mark drawings submitted for review and comment with the words "Preliminary, Not for Construction" along with the phase of completion
- Show vertical control of roadways by a single profile and superelevation for direction of travel
- Use the following scales for various plan types *(Note: Other scales may be acceptable in unusual conditions, but Pima County shall be consulted prior to using any scales other than those indicated here.)*

Roadway Plans:	1" = 40' horizontal, 1" = 4' vertical
Storm Drain Mains and Laterals:	1" = 40' horizontal, 1" = 4' vertical
Sewer and Water Modification:	1" = 40' horizontal, 1" = 4' vertical
Minor Channel Improvements:	1" = 40' horizontal, 1" = 4' vertical
Major Channel Improvements:	1" = 100' horizontal, 1" = 5' vertical
Traffic Signal Plans:	1" = 20'
Lighting and ITS Plans:	1" = 40'
Signing Plans:	1" = 40'
Pavement Marking Plans:	1" = 40'
Landscape Plans:	1" = 20'

Roadway Cross Sections:	1” = 40’ horizontal, 1” = 4’ vertical
Minor Channel Cross Sections:	1” = 40’ horizontal, 1” = 4’ vertical
Major Channel Cross Sections:	1” = 100’ horizontal, 1” = 5’ vertical

Plan Phases

The various phases of plan preparation are as follows:

Initial Design Phase

The Initial Design phase plans, inclued with the DCR, shall consist of basic typical sections and initial horizontal and vertical geometry.

Final Design Phase

The Final Design Phase plans, define in detail the roadway and cross drainage geometry consistent with the requirements put forth in the DCR, EAMR, Traffic Report, and other predesign documents. A conceptual design of the pavement drainage system is provided to determine approximate size of mains, discharge locations, and potential utility conflicts. Preliminary pavement marking is provided to ensure traffic operational and capacity requirements are being met. Preliminary plans for bridges and retaining and noise walls are also provided. Preliminary landscape approaches are also presented at this time. The checklist presented in Appendix 3-Q indicates the plan sheets and level of detail for Final Design Phase plans.

Plotted cross sections shall be provided at a minimum of 50-foot intervals and at other key locations such as significant breaks in terrain, driveways, and intersections with side streets. Conflicts with existing water and sewer facilities are identified and the scope of water and sewer modifications determined. A preliminary quantities report and updated cost estimate is provided at this phase. Costs estimates for components that have not been fully identified should include an appropriate level of contingency funding.

Initial PS&E Phase

The Initial PS&E Phase includes appropriate plan revisions in response to Final Design Phase comments, as well as further development of the design. The pavement drainage system is finalized, including profiles of storm drain laterals, and the need for water and sewer modification is identified. Preliminary landscape, signalization and lighting, and staking plans are included. Detailed plans for bridges and other structures are also provided at this phase. Roadside barriers and their associated warrants/supporting documentation are submitted. Plans for any water and sewer modifications are prepared. The checklist presented in Appendix 3-R indicates the plan sheets and level of detail for Initial PS&E Phase plans.

Additionally, the quantity report and cost estimate are updated, and an initial draft of special provisions is provided. Plotted cross sections as necessary to reflect design changes and to show existing and proposed drainage and underground utility features are presented.

The Plans, Special Provisions and Estimate (PS&E) package should all work together, with notes and references on the plans and specifications relative to the scope of work and how an item of work is measured and paid. Quantities and items of work on the plans and in the Special Provisions should be listed by their pay item number whenever possible.

Final PS&E Phase

The Final PS&E Phase completes the review/updating of the detailed construction plans, incorporating revisions in accordance with comments received from the Initial PS&E Phase submittals and any other reviews made in completing the Final PS&E. Note that this includes incorporating and updating the stormwater pollution prevention plans, cost estimate, and special provisions as necessary. Appendix 3-S provides a checklist for the Final PS&E Phase.

Special Provisions

An initial draft of Special Provisions shall be included with the Initial PS&E Phase documents, with the final included with the Final PS&E Phase document submittals. Special Provisions are necessary when work is required that is not sufficiently addressed in the drawings or standard specifications, and to describe the methods of measurement and basis of payment for special bid items. The Special Provisions shall also include mitigation measures identified in the EAMR and approved by the Board of Supervisors (see Section 3.18). Appendix 3-U provides additional guidelines on information to be included within the Project's Special Provisions.

Bid Item, Cost Estimate, and Quantities Report

A bid item list is to be provided with the Initial PS&E Phase plan submittal and shall consist of bid items identified in the department's *Master Bid Item Listing* available on the department's website or new items provided by the department at the request of the designer. Bid item number series are related to the specific numbered sections of the Standard Specifications.

In order to avoid creating new item numbers for special items of work, which may only apply on one type of project, there are several specialty-type item numbers available for use. For example, there are general items of work, such as *Temporary Traffic Signal (Intersection A, B…)*, which are utilized to avoid creating a new item number for a specific intersection, or *Box Culvert No.1,2…*to identify a specific culvert structure size and location. Several items will also have a *(Special)* category in order to allow for non-standard items of work. There are also several Miscellaneous Work 1, 2… items which can be used to describe an unusual item of work and how it is to be measured and paid.

Cost estimates are to be provided as part of the Final Design Phase submission, as well as subsequent submittals, and are to include quantities in the form of a report that provides take-off calculations. These estimates are to follow Pima County's standard format. Any items not covered in the Pima County Master Bid Item List must be forwarded to Pima County for assignment of a bid item number. Quantities for special bid items must be consistent with the special provisions. The following order of submittals shall be adhered to:

- Preparation and submittal of a quantity take-off calculation report covering the major pay items with the Final Design Phase and Initial PS&E Phase submittals

- Preparation and submittal of a quantity take-off calculation report, including all pay items, with the Final PS&E Phase submittal
- Revision of the report as necessary

Note: Preparation of a quantity take-off calculation report provides an excellent QC tool for coordinating the project plans with the specifications and estimate, and for ensuring that major items of work are properly addressed in a logical and consistent manner.

Quantities Report

The format of the Quantities Report shall be as follows:

- Three-hole punched and bound with a hard cover identifying the project by name, project number, level of submittal, and date.
- Immediately following the cover will be the quantity take-off summary, sorted sequentially by pay item number. Each pay item will include the correct verbal description of the quantity, the unit of measurement, the quantity, and the cost.
- Immediately following the quantity take-off summary will be the quantity calculations for each pay item.
- Quantity calculations will be documented on a suitable computation form that identifies the project, the level of submittal, date, the person performing the calculation, the Checker, and the Backchecker.
- No more than one pay item will be documented on a single computation sheet.
- The computation sheets will be in numerical order and in the same sequence as the quantity take-off summary.
- Quantities for each pay item will be identified by station offset and plan sheet if appropriate. Paving and earthwork calculations and lump-sum item calculations will provide sufficient information regarding location and method to facilitate review by the County reviewer.
- Computer generated quantities will include sufficient documentation to adequately review the output.
- The Quantities Report will be sealed, signed, and dated by the responsible engineer in accordance with State Technical Board of Registration Regulations.

Construction Document Submittal to Procurement

A Work Requisition, executed by the Project Manager, shall be submitted to the Procurement Department, Design and Construction Division in order to begin the contracting process.

When preparing a set of contract documents for submittal to Procurement, the following information should be included in the *Invitation to Bid* package, as required in Subsection 102-1, Advertisement for Bids:

- Project number and name
- Location and length of project

- General scope or description of work, principal items, and approximate quantities
- Specified contract time (working days, calendar days or fixed date(s)) for completion of contract work
- Statement of requirements, if there are any special contractor requirements

Procurement will address the following items:

- Date, time and place of the public opening of the bids
- Date, time and place of the prebid meeting
- Type and amount of the Bid Bond
- The DBE goals (and number of On-The-Job Trainees for federally funded projects)
- Manner in which project plans and specifications may be obtained and the cost of same
- Number of days after bid opening within which the contract will be awarded, if awarded
- Number of days that the successful bidder has to return the signed contract, bonds and certificates of insurance

Note: For the last two items, suggested times are 60 days for award of contract and 15 calendar days for the return of signed contract, bonds and insurance after the date of the notice of award letter. For Improvement District Projects, please consult A.R.S. for requirements.

Procurement Submittal

- Final Sealed Plan mylars, with the Cover Sheet signed by the Director and the applicable Division Managers;
- All applicable specifications and special provisions, both hard copy and electronic;
- For special provisions which are greater than 20 pages, Procurement prefers to receive them on a CD in Microsoft Word and pdf adobe file format, with hard copy for Procurement's file. The CD will be copied and included with the Specification Bid book.
- For special provisions less than 20 pages, where the Project Manager desires that they be merged and included as part of the Procurement Bid package, the Project Manager should submit the electronic version as an email attachment. The Project Manager should submit a hard copy with the Work Requisition;
- Engineer's Estimate Excel Spreadsheet (electronic and hard copy);
- Bid Schedule documents as both a Word file and Excel file, and hard copy;
- The Disadvantaged Business Enterprise (DBE) goals provided by the Minority and Women-Owned Business Enterprises (MWBE)/Construction & Design Program Coordinator in the Procurement Department. On Federal Aid projects, this information must be obtained from ADOT's Civil Rights Division. (See the Pima County Certification Acceptance Manual.)
- If non-County funds are used, cite any Special Contract provisions or requirements such as FHWA Form 1273, and/or Minimum Wage (Davis-Bacon) if required by the funding source.
- List of the Arizona Registrar of Contractors License(s) that the Contractor is required to possess in order to perform the Scope of Work

As-Built Plans

The construction plans shall be updated to reflect any changes made during construction. The responsibility for updating, maintaining, and submittal of the "as-built" plans shall be determined during the initial project scoping.

Post Design Services

Members of the Design Team will be called upon to provide services beyond the submittal of the Final PS&E and throughout the construction phase of the project. These services can be divided into two phases: pre-bid services and post design services.

Phase I: Pre-Bid Services

Pre-Bid Services are generally part of the design contract negotiations. These services may include, but are not limited to:

- Attending pre-bid meetings
- Assisting in the preparation of addendums
- Addressing questions on the plans and specifications
- Bid evaluations

Phase II: Post-Design Services

Post-Design Services will be added by contract modification or new contract. These services may include, but are not limited to:

- Attending the pre-construction meeting and partnering meetings if any
- Attending weekly construction meetings at the project site
- Making site observations of the work under construction
- Evaluating and/or recommending changes in the construction documents
- Responding to Requests for Information (RFI)
- Responding to Field Change Orders (FCO)
- Providing design details and revised drawings as needed to support construction
- Reviewing shop drawings, erection procedure plans, form work details, and proposals for substitutions or "approved alternates"
- Evaluating contractor submitted value engineering proposals
- Preparing the "as-built" documents

3.21 PROJECT REVIEW AND APPROVAL PROCESSES

Purpose

During the development of each project, there are several review efforts that are undertaken to assure consistency and appropriateness of project development, document preparation, design, and delivery. Additionally, specific efforts shall be followed during the review and approval of each phase of the project as it is developed, prior to embarking on the next phase of the project. These reviews, along with the appropriate approval requirements are further detailed below.

Report and Plan Review*

Pima County uses an ongoing/continuous focused review and approval process to advance projects. This process is described below, with specific reviews to be applied to each project being defined during the initial project scoping efforts.

Report and Plan Initiation

The designer shall work with Pima County Staff to determine the appropriate reports and plans to be developed for each Phase of the project, a timeline for said efforts, establishment a Quality Control Plan (refer to 3.2) for the overall effort, and identify an issues resolution methodology to be followed.

Report and Plan Development

The designer shall begin the process to develop reports and plans identified for the project. Pima County's Project Manager and other appropriate Pima County personnel will hold regularly scheduled working committee meetings (e.g. - weekly, bi-weekly, etc.) with the Design Team and other appropriate stakeholders to review, comment and provide input/feedback into the reports and plans being developed for the project. Attendees to these working meetings should include representatives from the appropriate disciplines (traffic, flood control, operations, engineering, field engineering, right-of-way, cultural, transit, utility, etc.) and others who may be impacted/involved with the project or deal with specific areas being discussed and reviewed.

Comments, suggestions, recommendations, and other outcomes arrived at during these working meetings shall be documented in written format by the designer to provide documentation relative to the projects development and decisions. Once all of the reports and/or plans have been developed to a point where it is appropriate to move the project to its next milestone (as identified by project Phase), a specific Report and Plan Review meeting (Step 3) shall be scheduled.

Report and Plan Review

Once reports and plans that have been developed/reviewed and are ready for advancement by the appropriate working committee, they shall be assembled into a project "Phase" submittal that will be the basis of review/advancement during a Workshop Review. Note: The assembled submittal shall (a) reflect use of the study/analysis/evaluation processes described in this manual, (b) conform to the plan checklist or the Sample Table of Contents, whichever is applicable as

presented in this manual, and (c) be clearly marked with the name of the individual(s) who performed the review and checking in accordance with the approved Quality Control Plan.

The purpose of each workshop review is to engage and allow the designer and other appropriate parties involved with the project (working committee members, stakeholders, and others impacted by the project) the opportunity to review and discuss the overall project and provide an update of the Reports and Plans associated with the particular "Phase" of the project. The workshop review shall include, as applicable, discussion of major project design components, public involvement issues/concerns, real property, drainage, costs, risks, and any other associated project items that would be appropriate to review/discuss and obtain feedback relative to the phase of project development. Comments made during the workshop review session should be based on the current phase of the project's development. However, other comments about potential future issues (refined design) may be made and noted by the project team for consideration as the project is further developed.

Comments, suggestions, recommendations, and other outcomes arrived at during these workshop review sessions shall also be memorialized by the designer to provide documentation relative to the projects development and decisions. During the workshop review session, it shall be determined if the suggestions can/should be incorporated into the associated Reports and/or Plans and allow the project to move forward to the next phase of development/approval, or if there will need to be a follow-up workshop review session to review and finalize the proposed changes.

Once a decision is reached regarding the associated Reports and/or Plans, it is appropriate to move the project forward to its next phase of development, which may include key milestone approvals (Board, Director, Exit Gate) or advancement to the next Phase of development.

Report and Plan Approval

Based on the type of Report and/or Plan and the Phase of the project, the documents shall be forwarded as appropriate for approval by the Director and Board of Supervisors.

* <u>Note that during these review processes, keys to success include being organized with project information being disseminated in a timely fashion; providing participants with an understanding/expectation of their involvement; appropriate and timely follow-up efforts with participants to assure all comments/issues are brought forward; establishment and adherence to deadlines; and being open and honest relative to comments made and/or received, as the outcome from these efforts is to obtain a better end-product for the project.</u>

Value Engineering Review

A Value Engineering (VE) Review is a systematic method to improve the "value" of a project by optimizing the mix of performance (function) and costs of a project. The intent of this practice is to review the overall project and identify alternative(s) which will meet the project's functional goals at a comparable or reduced cost, further enhance the projects functionality, or validate that the projects design has been optimized. PCDOT will identify projects that will require Value Engineering, with those being in excess of $5M being candidates for this additional review. This review should occur concurrently with the development of the DCR.

Constructability Review

A Constructability Review is a methodology used to review project plans and specifications when the design of the project is reaching its final phase. The intent of this review is to check the project's plans and specifications to assure they are coordinated, identify and clarify any ambiguous or undefined information, and perform an overall review the project's documents to assure they represent a project that can be bid, built, and administered effectively. The ultimate goal of the review is have a well-defined set of contract documents, a plan for construction, with provisions in the specifications to properly manage the construction process and to allow the contractor to bid necessary resources and develop appropriate costs to properly prosecute the work. The Pima County Department of Transportation will identify projects that will require a separate Constructability Review, with those being in excess of $5M or having significant complexity, being candidates for this additional review. This review should occur subsequent to the delivery of Initial PS&E Phase plans and prior to the finalization of the Final PS&E Phase plans and will be based on the detail and complexity of the project being reviewed. Note: There may be constructability issues/concerns which could impact environmental and other permitting requirements. These should be identified and addressed early in the project.

Project Management Exit Gate Process

Pima County has developed a Project Management Process that has various steps and control points associated with the development and advancement of a project. These steps are intended to assure that all stakeholder departments participate in the project development process at a time when their input is needed, and that project criteria are addressed prior to the project moving forward. There are seven specific gates in the process. These are listed as follows:

Gate 1	Project Charter
Gate 2	Preliminary Design Report Review
Gate 3-1	Preliminary Construction Plan Phase (Initial PS&E)
Gate 3-2	Final Construction Plan Phase (Final PS&)
Gate 4	Construction Acceptance
Gate 5	Startup Acceptance
Gate 6	Closeout – Complete Project

The efforts associated with each exit gate is further documented in the *Pima County Project Management Manual and Exit Gate Process Manual*, found at http://www.pima.gov/cip/pmprocess/documents/PMmanual.pdf#TOC

APPENDIX 3-A
Chapter 3 References

Note: These documents are revised periodically; therefore users should double check that they have the specific version of the document specified in this chapter, or, if the reference is undated, that they have the most recent version.

- American Association of State Highway Transportation Officials. 1999. *Guide for the Development of Bicycle Facilities*.

  ———. 2002. *Roadside Design Guide*.
- Arizona Department of Transportation. *Bridge Design and Detailing Manual.*

  ———. *Materials Preliminary Engineering and Design Manual*.
- Arizona State Board of Technical Registration. *Minimum Standards for Arizona Land Boundary Surveys*
- Federal Emergency Management Act Maps as applicable
- Pima County. *Community Participation and Mitigation Ordinance*.

  ———. *Floodplain and Erosion Hazard Management Ordinance*.

  ———. 2009. *Project Management Manual and Exit Gate Process*
- Pima County/City of Tucson. *Standard Details for Arizona Land Boundary Surveys*

  _____.*Standard Specifications for Public Improvements, Pima County and City of Tucson*
- Pima County Department of Transportation. *Traffic Noise Analysis and Mitigation Guidance for Major Road Projects*

  _____. 2012. *Guidelines for Establishing Scour and Freeboard for Bridges in Pima County*
- Pima County Regional Flood Control District. 1984. *Drainage and Channel Design Standards for Local Drainage*
- U.S. Department of Transportation. Federal Highway Administration. 2000. *Manual on Uniform Traffic Control Devices*.

<u>Additional References for Drainage Studies:</u>

- Pima County. 1979. *Hydrology Manual for Engineering Design and Flood Plain Management*.
- U.S. Army Corps of Engineers. 1990. *Flood Hydrograph Package User's Manual*. HEC-1.

  ———. 1990 (rev.). *Water Surface Profiles User's Manual*. HEC-2.

  ———. 2001. *River Analysis System User's Manual, Hydraulic Reference Manual, and Applications Guide*. HEC-RAS.
- U.S. Department of Transportation. Federal Highway Administration. 1983. *Hydraulic Design of Energy Dissipators for Culverts and Channels*. HEC-14

  ———. 1985. *Hydraulic Design of Highway Culverts*. HDS-5

  ———. 1995. *Evaluating Scour at Bridges*. HEC 18. 3rd ed.

  ———. 2001. *Urban Drainage Design Manual*. HEC-22.

APPENDIX 3-B
Quality Control Plan
(Sample)

Introduction

Quality is achieved through our commitment to provide quality products. Individuals responsible for implementing the Quality Control (QC) Plan must be technically qualified and perform their duties carefully; there must be adequate planning, coordination, supervision, and direction; the quality and accuracy of the work must be verified by individuals not directly responsible for the work; and a member of management should provide further auditing and surveillance as appropriate.

The goal of this QC Plan is to provide the basis for performing a quality review of the various documents that will be submitted to Pima County. This purpose of the QC review is to ensure that the documents have been prepared in accordance with the proper standards, formats, and requirements of Pima County, that all mathematical calculations have been performed correctly, and that all comments and concerns of previous County reviews have been addressed.

Personnel Assignments

Following is a listing of the Firm's team members along with their responsibilities for the project and the QC Plan. *[Insert team members' names and responsibilities.]*

Technical Review

Technical review begins at the conceptual level. Firm managers, the County Project Manager, and individuals associated with particular design and review tasks, discuss the practicality of the design concept, general design approaches, and alternatives that might be considered.

The Technical Review Procedures for the project documents include the following general steps: (1) firm managers, the County Project Manager, and engineers thoroughly review the documents; (2) plans are reviewed on a sheet-by-sheet basis; (3) alternatives for items such as culverts, traffic barriers, and side-street and access treatments are discussed, and (4) a consensus is reached and documented.

At a minimum, the review will:

- Determine the adequacy of the design to achieve the desired goals
- Evaluate the general selection and sizing of materials and equipment
- Establish that all viable alternatives have been considered
- Confirm that legal and physical restraints were considered
- Assess whether design theory, concepts, and project layout are logical

- Confirm the applicability of computer programs used
- Determine that the technical specifications are sufficiently comprehensive
- Verify the constructibility of the selected design

Checking Procedures

All documents and supporting data will be reviewed and checked in their final format before being submitted to Pima County. These documents and supporting data include all reports, written project programs, design analyses, drawings, calculations, project or procedure manuals, specifications or special provisions, cost estimates, quantity calculations, and schedules.

All documents will be clearly identified with job numbers, project name, date of preparation, and responsible party (i.e., Originator). All documents will be neat and legible. Any deviations from recognized codes and procedures will be defined in detail.

Checking procedures are detailed below.

Checking Plans

The roles and responsibilities in checking the project plans are described below for the Originator, the Checker, and the Backchecker.

Originator: The Originator, that is the party responsible for developing the plan, will:

- Verify that all information required on the Pima County checklists is present
- Verify that acceptable drafting standards have been incorporated

Checker: The Checker, someone other than the Originator, will:

- Examine the checkprint prepared by the Originator for:
  - Requirements of the project
  - Technical accuracy
  - Drafting standards and accuracy
  - Suitability and adequacy for the required function
  - Compatibility with other associated project documents
- Review the marks on the checkprint
- Redline any incorrect information with the required corrections
- Sign and date the checkprint and return to the Originator or Backchecker

Backchecker: The Backchecker, who may be the Originator – but not the Checker, will:

- Review the Checker's marks on the checkprint

- Indicate if he/she agrees that the original document should be changed
- Check with the Checker if he/she does not agree with the changes. If the Checker and Backchecker both agree that the change should not be made, this will be indicated on the checkprint
- Update the original document to include the agreed upon changes
- Sign and date the checkprint and forward the document to the Reviewer

Rechecker: The Rechecker, who is usually the Checker, will:

- Review the revised original against the checkprint from the Backchecker to ensure that all changes have been made
- If all the changes have not been made, the Rechecker will return the document to the Backchecker for further changes

Reviewer: The Reviewer, someone other than the Checker or Backchecker, will:

- Review the checked document for compatibility with the project requirements, technical adequacy, and constructibility
- Review the checkprints for compliance with the established QC Procedures
- Resolve all review notations and comments with the Originator
- If necessary, have the document originals updated and checked as necessary to include the Reviewer's comments
- Document originals to see that all of the agreed-to-changes have been made accurately
- Sign and date the check prints

Reviewing Calculations and Reports

Calculation reviews will include verifying the reasoning and assumptions, formulas, solutions, and completeness of information provided to ensure that the calculations are referenced to the plans and text, and that sketches are provided where necessary.

The review/quality control process for calculations and reports will follow a procedure similar to the one outlined above for plans.

Quality Control Monitoring

The Project Manager will ensure that the QC checking procedures are followed. Documents shall be professional quality and meet the job requirements and applicable standards.

The Project Engineers are responsible for maintaining the quality of the technical items produced under their direction. Should technical problems arise, the Project Engineer will define the problem and propose alternative solutions. If the recommended solution conflicts with another

engineer's solution, the affected parties will meet with the Project Manager, and the Project Principal if necessary, to come to a solution acceptable to all parties.
The Firm will review all sub-consultant work for compliance with the QC Plan, specifically for the Technical Review and Checking. The designer will also review all work prepared by sub-consultants for compliance with the requirements of the most current edition of the Pima County RDM, and for consistency with all other related reports and plans. All reports submitted will contain a cover letter signed by the individual responsible for the preparation of the report and by the individual responsible for the Technical Review and Checking. The designer will attach a signed letter to all sub-consultant plans and reports that indicates that the designer has reviewed the plan or report.

All submittals to Pima County will include evidence of the QC review process, including verification that each checkprint was accomplished.

Preparation of a Quantity Take-Off Calculation Report

The Firm will prepare a Quantity Take-Off Calculation Report for the project. Preparation of a quantity take-off calculation report provides an excellent QC tool for coordinating the project plans with the specifications and estimate, and for ensuring that major items of work are properly addressed in a logical and consistent manner. To ensure that this task is addressed at the proper level of detail, the following order of submittals will be adhered to:

- Preparation and submittal of a quantity take-off calculation report covering the major pay items with the Final Design Phase and Initial PS&E Phase Submittals
- Preparation and submittal of a quantity take-off calculation report, including all pay items, with the Final PS&E Phase Submittal
- Revision of the report as necessary and submittal with the final plans

<u>Format of Calculation Report</u>

The format of the calculation report will be as follows:

- Three-hole punched and bound with a hard cover identifying the project by name, project number, level of submittal, and date.
- Immediately following the cover will be the quantity take-off summary, sorted sequentially by pay item number. Each pay item will include the correct verbal description of the quantity, the unit of measurement, the quantity, and the cost.
- Immediately following the quantity take-off summary will be the quantity calculations for each pay item.
- Quantity calculations will be documented on a suitable computation form that identifies the project, the level of submittal, date, the person performing the calculation, the Checker, and the Backchecker.
- No more than one pay item will be documented on a single computation sheet.

- The computation sheets will be in numerical order and in the same sequence as the quantity take-off summary.
- Quantities for each pay item will be identified by station offset and plan sheet if appropriate. Paving and earthwork calculations and lump-sum item calculations will provide sufficient information regarding location and method to facilitate review by the County reviewer.
- Computer generated quantities will include sufficient documentation to adequately review the output.
- The Calculation Report will be sealed, signed, and dated by the responsible engineer in accordance with State Technical Board of Registration Regulations.

APPENDIX 3-C
Preliminary Design Notification
(Sample)

Project Name: _____

Project Number: _____ Project Location (Township/Range/Section): _____

Project Description: _____

_____

_____

_____

_____

Utility Coordinator:_____ Phone Number: _____

Estimate Completion of Preliminary Plans for Utilities: _____

Location map

APPENDIX 3-Da
Public Involvement Plan Guidance

Public Involvement Responsibility

Pima County Project Managers are ultimately responsible for ensuring a successful public participation process that is in compliance with the provisions of the *Community Participation and Mitigation Ordinance*. The Project Manager, Design Team, and Community Relations staff should think of themselves as a team in conducting public involvement.

Public Involvement Plan Preparation

A Public Involvement Plan is prepared to guide the outreach to the public over the course of the project development. The plan should meet the requirements of the County's *Public Involvement and Mitigation Ordinance* (see Chapter 1, Appendix 1-A). The checklist that follows provides a basic list of items for consideration in preparing a Public Involvement Plan. Some additional items that might be considered for more complex projects are also provided. The plan should address how each activity will be conducted, including by whom, where, when, and materials needed and how public comments will be solicited, reviewed, and responded to. Public Involvement Plans should be reviewed periodically and revised or updated as needed.

Public Involvement Documentation

The Public Involvement Plan and all related materials (e.g., mailing list, copies of meeting notices, meeting sign-in sheets, public surveys) should be compiled in a file or notebook so that the complete record can is easily accessible for review.

APPENDIX 3-Db
Public Involvement Plan Checklist

☐ **Prepare Public Involvement Plan**

_____ Who will prepare plan and when?

_____ Who will review plan?

_____ Who will review and update plan as necessary during project development?

☐ **Identify Stakeholders**

_____ Who will identify stakeholders, including:

_____ All property owners within at least one-quarter mile

_____ All businesses

_____ The president or secretary of homeowner associations adjacent to the project

_____ Other

_____ When will stakeholders be initially identified?

☐ **Develop Mailing List (based on identified stakeholders)**

_____ Who will develop the mailing list and when?

_____ Who will update the mailing list with the names of those who have requested to be added (e.g., through meeting sign-in sheets and phone calls)?

☐ **Establish Community Advisory Committee (CAC) Membership**

_____ Who will oversee establishment of the CAC?

_____ When will CAC be established?

_____ Who will prepare newspaper ad introducing project and announcing opportunity to become a CAC member? *(Note: Notice must be published in a major newspaper of general circulation not less than 15 days prior to appointment of CAC members.)*

_____ Who will prepare, review, and distribute flyer on CAC membership opportunity?

☐ **Plan CAC Meetings***

_____ When and where will CAC meetings be held?

_____ How will special needs be accommodated (e.g., ADA, translation)?

_____ Who will plan CAC meeting agendas?

_____ Who will be in charge of preparing materials for CAC meetings (e.g., displays, handouts)?

_____ Who will be in charge of documenting questions/issues raised by CAC members?

_____ What project documents will the CAC receive for review and when?

☐ **Notify CAC Members re Meetings**

_____ Who will prepare CAC meeting notices?

_____ Who will review meeting notices?

_____ How will CAC members be notified about meetings?

☐ **CAC Report**

_____ Who will track the preparation of the CAC Report? (*Note: The CAC report must be available 45 days before the Board of Supervisors Public Hearing on either the Location Report or Environmental Assessment and Mitigation Report?*

☐ **Prepare Project Status Reports (re: substantial project change)**

_____ Who will prepare status reports?

_____ How will they be distributed to the CAC?

☐ **Arrange and Conduct Public Open House Meeting(s)***

_____ When (date and time) will Public Open House(s) be held? *(Note: An Open House must be held for a minimum of two hours. Consideration should be given to a time that is convenient for the stakeholders. Also possible conflicting meetings and/or events should be considered in scheduling an Open House.)*

_____ Where will Public Open House(s) be held? *(Note: Must be held in reasonable proximity to proposed project and ADA accessible.)*

_____ Will a formal presentation be incorporated into the Open House format? If "yes," who will arrange presentation, and who will review it for accuracy, and understandability?

_____ Will there be refreshments? If so, who will arrange?

_____ Who will staff Open Houses and who will arrange staffing?

_____ When will Design Team and Community Service staff, as well as other staff as appropriate, meet prior to the Open House to be briefed on the project status so that answers to the public are as consistent and accurate as possible?

_____ Who will identify materials needed for Open Houses (e.g., displays, fact sheets and other handouts, comment sheets, sign-in sheets), and who will prepare?

_____ Who will review Open House materials for accuracy and appropriateness for non-technical audiences?

_____ Who will be responsible for preparing summary(ies) of the Open House(s), including written and oral comments received from participants. *(Note: Open House staff should address both written and oral public comments in the meeting summary.)*

☐ **Prepare and Place Public Open House Notification**

_____ Who will prepare display advertisement?

_____ Who will review display advertisement?

_____ In what newspaper will ad be placed and when? *(Note: Must be a daily newspaper of general circulation in Pima County, and must be published not less than 15 calendar days and not more than 30 calendar days in advance of the Public Open House Meeting.)*

☐ **Develop, Distribute, and Review Surveys re Project**

_____ Who will prepare Survey soliciting public opinion concerning the project design and environmental impact and mitigation as appropriate?

_____ Who will distribute Survey?

_____ Who will review and compile responses to the Survey?

_____ How will Survey responses be considered in design development?

_____ Who will prepare Survey summary for Board of Supervisors review, including the numbers of surveys distributed, the number of completed surveys received, the input received, and how the input was responded to?

☐ **Prepare Public Involvement Information for Inclusion in Project Documents**

_____ In which documents will a discussion of public involvement activities, input received, and response to the input be included (e.g., Location Report, Design Concept Report, Environmental and Mitigation Assessment Report)?

_____ Who will prepare the public involvement information for inclusion in the appropriate documents?

_____ Who will review public involvement text for inclusion in the document(s)?

☐ **Hold Public Hearing**

_____ Who will arrange notice of the Public Hearing? *(Note: Notice must appear in a daily newspaper of general circulation in Pima County not less than 30 calendar days and not more the 45 calendar days before the public hearing. The document to be considered at the Public Hearing must be available for public review at the time the hearing notice is published)* Refer to Appendix 3-O for further information.

☐ **Consider Possible Additional Public Involvement Items**

_____ Press releases and media briefings

_____ Newsletter, Website, and/or other means of providing project information to public

_____ Project presentations to interested organizations and groups

_____ Additional meeting notification (e.g., other print and/or broadcast media)

_____ Other

* *The Pima County Community Participation and Mitigation Ordinance provides suggested timing for CAC Meetings, while Chapter 4 of this Roadway Design Manual specifies timing for a Public Open House and a CAC Meeting for projects designated as environmentally sensitive roadways.*

APPENDIX 3-Dc
Public Involvement Summary*
(Sample)

Public Activities	Date, Time, and Location or Date and Means of Distribution	Notification	Attendance or Distribution Numbers, or Coverage	Methods of Public Input Documentation and Response
Project Mailing List	NA	NA	Total # of names on mailing list at beginning of project and end of project, and categorization (.e.g., property owners within ¼ mile of project)	NA
CAC Formation	NA	# of ad(s), name of newspaper, date(s) of publication, # of notices mailed re membership opportunity and to whom	NA	# of membership applications received and final composition of CAC (e.g., 2 property owners, 3 residents)
CAC Meeting(s)	Date, time, and location of each CAC Meeting	# of ad(s), name of newspaper(s), ad publication date for each CAC meeting	# CAC members in attendance; # of members of general public in attendance for each CAC meeting	Summary such as: "CAC comments from general public in attendance were discussed during meeting and documented and addressed in CAC meeting summary(ies) dated (insert date[s]). Comments were also addressed in (insert names of other project documents, Website, etc. as appropriate)."
CAC Reports	Date CAC Report was submitted to Pima County	NA	Date distributed to each member of the Board of Supervisors	NA

Public Activities	Date, Time, and Location or Date and Means of Distribution	Notification	Attendance or Distribution Numbers, or Coverage	Methods of Public Input Documentation and Response
Public Open House(s)	Date, time, and location of each Open House	# of display ads, name of newspaper(s), ad publication date for each Open House # of invitations distributed and to whom (i.e., all names on project mailing list)	# of public attending each Open House -- based on sign-in sheets (exclusive of any staff names)	Summary such as: "Written comments were collected and oral comments were documented to the greatest extent possible. Many comments and questions were addressed during the Public Open House. Comments were also addressed in (insert names of other project documents, Website, etc.)."
Survey	Date distributed, method of distribution (e.g., first class mail)	NA	# of Surveys distributed and to whom (e.g., all names on project mailing list)	Include statement such as "Results reported to CAC (method & date), Design Team (method & date) and included in (insert names of project documents, Website, etc.)"
Document Review	Name of location(s) project documents were made available for public review.	Indicate how document(s) availability was noticed.	NA	NA
Public Hearing	Date, time, location of public hearing(s) (i.e. after Location Report and/or after EAMR)	# of display ad(s), name(s) of newspaper(s), date(s) of publication for each Public Hearing	NA	Public hearing comments included in hearing transcription.

Public Activities	Date, Time, and Location or Date and Means of Distribution	Notification	Attendance or Distribution Numbers, or Coverage	Methods of Public Input Documentation and Response
Media Outreach	Type of media outreach, date(s) (e.g. press release)	NA	Extent of media outreach effort (e.g., # of press releases distributed, # of editorial board briefings, etc.); coverage gained (e.g., title and date of newspaper, TV, radio stories)	NA
Website	Type and date(s) of posted project information	Identify notifications posted	If hits calculated, include	# of public comment e-mails and e-mail responses. Include with other comments for addressing in project documents.
**				

* *Copies of ads, notices, public comments and responses should be retained for inclusion in the EAMR Appendices (see Section 3.18) and other project documents as appropriate.*

** *For additional public involvement activities undertaken add rows.*

APPENDIX 3-E
Pima County Public Art Program
(BOS Policy C3.3)

PURPOSE

The purpose of this policy is to establish the Pima County Public Art Program, state the goals of the program, set forth its basic program principles, and direct the County Administrator to promulgate administrative procedures to carry out this policy.

PIMA COUNTY PUBLIC ART PROGRAM: ESTABLISHMENT AND POLICY

The Board of Supervisors establishes the Pima County Public Art Program. The Board of Supervisors intends the Pima County Public Art Program to serve multiple community goals and to operate according to provisions set forth in this policy and its implementing administrative procedures.

GOALS OF THE PIMA COUNTY PUBLIC ART PROGRAM

The Pima County Public Art Program will achieve multiple community benefits, including but not limited to the following goals:

- Enrich our environment and our lives, engage our eyes, our minds and our spirit;
- Affirm our uniqueness as a community, celebrate our cultural heritage and diversity, and express the hopes and dreams of people living in vibrant neighborhoods;
- Help to develop public awareness of and interest in the visual arts;
- Increase employment opportunities in the arts, actively encourage emerging artists of culturally diverse backgrounds, and use the arts to advance other community goals, such as youth development and delinquency prevention;
- Increase the likelihood that public art will be an integral part of Pima County capital improvement projects.

BASIC PROGRAM PRINCIPLES

The Board of Supervisors will structure the Pima County Public Art Program according to the following basic program principles:

- Pima County departments carrying out capital improvement projects will appropriate 1% of the planning, design and construction costs of each project for public art. If other governmental entities participating in the funding of a capital improvement project preclude the use of their revenues for public art, the County will reduce the set-aside for public art accordingly.

- The Pima County Public Art Program will emphasize the community's cultural heritage and diversity in terms of race, ethnicity, and gender in the selection of artists, artworks, artistic content and theme, as well as design and materials.
- The Board of Supervisors will appropriate funds for public art projects in the annual capital improvement budget.
- Public art projects will be publicly announced and advertised. Artists and artwork will be selected by means of open entry competitions, by panels chosen to represent a variety of community interests.
- Initiation of the public art process will begin as early as possible in the planning and design process of capital improvements.
- The member of the Board of Supervisors will appoint at least one of two community members to each selection panel for any public art project to be carried out within that member's district.
- The Public Art Program will operate in strict conformance with the Pima County Procurement Code. All artworks created by or purchased through the Pima County Public Art Program become the property of Pima County.
- To the extent determined by the Board of Supervisors, the County will operate the Pima County Public Art Program parallel to the City of Tucson Public Art Program.
- Pima County will contract with the Tucson Pima Art Council to obtain its services in operating the Pima County Public Art Program.
- The Board of Supervisors creates the Public Art Program at its sole discretion. The Board retains final authority to grant exemptions to the policy and procedures on a case-by-case basis.

ADMINISTRATIVE PROCEDURES

The County Administrator will develop Administrative Procedures to carry out the policy of the Pima County Public Art Program. The County Administrator will submit all such administrative procedures, and amendments to the procedures, to the Board of Supervisors for review and approval.

SUNSET PROVISION

The Board of Supervisors will review this policy for continuance by December 31, 2001.

Effective Date:
January 29, 1990
Reviewed/Amended:
February 1, 1997
December 16, 1997
Refer to Administrative Procedure 3-16

ADMINISTRATIVE PROCEDURES
Procedure 3 - 16

I. STATEMENT OF PURPOSE

The purpose of this Administrative Procedure is to establish the procedures for carrying out the Pima County Public Art Program and to assign responsibilities for execution of these procedures.

II. ELIGIBLE WORKS OF ART/ARTISTS AND ORGANIZATIONS

A. Eligible Works of Public Art

For the purposes of the Pima County Public Art Program, eligible works of art will mean:

1. Any tangible work of visual art, including but not limited to, a drawing, painting, mural, fresco, sculpture, mosaic, photograph, works of calligraphy, works of graphic art (including an etching), works in clay, textile, fabric, glass and like materials, or mixed media (including a collage, assemblage, or any combination of the above art media), stained glass, relief or freestanding sculptures, fountains, arches, mobiles, and environments.
2. Works of art installed in public spaces with public visibility and impact.
3. Permanent structures that retain their value for the useful life of the capital improvement to which they are associated or the term of bonds used to fund them.

Eligible works of art will not include objects that are:

1. Massed-produced of standard design (such as playground equipment or fountains),
2. Reproductions of works of art, performing or literary arts (such as dance, voice, music or poetry),
3. Landscaping or signage unless designed by an artist.

Public art will be installed only on publicly owned property. Eligible works of public art may be an integral part of a structure, attached to a structure or detached from the structure within or outside it. Public art may be located on publicly-owned property where there are no structures.

B. Artists Eligible for Participation in the Public Art Program

All professional artists are eligible to participate in the Public Art Program. Professional artists may include, but not be limited to:

1. Individuals who are engaged full-time or part-time in the production of eligible works of art,
2. Teachers of art,
3. Emerging professional artists,

4. Participants in community programs headed by professional artists which use the arts to foster youth development and juvenile delinquency prevention. Artists may participate on there own or in collaboration with other artists or may supervise the work of non-artists.

II. FUNDS FOR THE ACQUISITION OF PUBLIC ART

A. 1 Percent Appropriation for Public Art

Funds for public art become available only pursuant to an annual appropriation in an adopted capital improvement budget. In appropriating funds for public art, the Board will budget 1 percent of the cumulative planning, design and construction costs of a project. The Board of Supervisors will make appropriations for public art on a project-by-project basis. Eligible projects are limited to those projects in an adopted annual budget. Annually, ten percent of the public art set aside will be allocated to fund arts programs associated with youth development and juvenile delinquency programs; these funds will be allocated by processes maintained by the Community Resource department. The Pima County Public Arts Program will permit consolidation of small project-by-project public arts allocations.

B. Exemptions from the 1 Percent Appropriation for Public Art

Only the Board of Supervisors has the authority to exempt projects from the requirements of the Public Art Program. At its own discretion, the Board may exempt a project or choose to raise or lower the set-aside from 1 percent.

Grounds for exempting a capital improvement project from the requirements of the Public Art Program or lowering the set-aside from 1 percent might include, but not be limited, to the following:

1. No construction or other substantial construction-related activities are included in the capital improvement project, such as projects that involve only land acquisition, planning and design, or build-out and remodeling of existing facilities.
2. Capital improvement projects where construction does not result in facilities that have high visibility or impact (such as underground facilities, facilities in areas of the County that are remote, or facilities in which public access is prohibited or controlled).
3. Projects for which the Board of Supervisors determines the diversion of 1 percent of planning, design and construction costs would significantly compromise the operational integrity of the facility.
4. Projects associated with Cultural Resources/Historic Preservation and Neighborhood Reinvestment.
5. Projects associated with Wastewater Management and Solid Waste Management capital improvements, for which the 1 percent set aside will be allocated to fund environmental enhancement.

The Board of Supervisors has sole discretion to raise the public art set-aside for a capital improvement project above 1 percent, for reasons including but not limited to a determination that raising the 1 percent set aside would commensurately enhance the artistic integrity and value of public artwork, in response to strong community support to do so, or where public access or view is high or unique. The County Administrator will advise the Board of Supervisors to whether raising the 1 percent set-aside would adversely affect functionality of the capital improvement project.

C. Capital Improvement Projects with Multiple Sources of Funds

Capital improvement projects are often financed from multiple sources of funds, often provided by other units of government. Each funding source will contribute to public art in proportion to their individual contributions to the overall project. If the contributing jurisdiction, however, declines, for whatever reason, to participate in the acquisition of public art, Pima County will reduce the 1 percent set-aside accordingly.

D. Calculation of 1 Percent Appropriation for Public Art Based Upon Construction Costs

Pima County will base calculation of the 1 percent set-aside for public art upon the actual costs of planning, design and construction of participating capital improvement projects. All costs associated with administration, land acquisition and relocation, and utility relocation are excluded from calculation of the 1 percent set-aside.

IV. PROGRAM RESPONSIBILITIES

A. Pima County Board of Supervisors

The Pima County Board of Supervisors will:

1. Appoint one (1) voting member to the Tucson Pima Art Council Board of Directors.
2. Each Board member designates one (1) member to the Public Art and Community Design Committee of the Tucson Pima Arts Council.
3. Review projects to include public art when they review capital improvement budgets.
4. Appropriate revenues for expenditures on itemized public art projects in the adopted capital improvement budget for the fiscal year within which the public art project will be created.
5. Contract with the Tucson Pima Arts Council for operation and implementation of the Pima County Public Art Program.
6. Select at least on (1) of two community representatives on public art selection panels.

B. County Administrator

The County Administrator will:

1. Provide the Public Art Coordinator with annual updates of the proposed and adopted five-year Capital Improvement Plan of Pima County. Itemize specific public art projects in the recommended capital improvement budget for the fiscal year within which the public art project will be started.
2. Receive comments from the Risk Management Department on public safety issues relating to proposed public art projects.
3. Designate one (1) member of the Public Art and Community Design Committee.
4. Review and approve itemized budgets submitted by the Public Art Coordinator to cover administrative costs as described at Section IX.
5. Prepare and submit to the Board for its approval an annual contract with the Tucson Pima Arts Council for operation and implementation of the Public Art Program.
6. Review recommendations on selection of public art and artists of Tucson Pima Arts Council.

C. Pima County Departments

Pima County departments responsible for implementing budgeted capital implement projects will:

1. Coordinate with the Public Art Coordinator on the implementation of public art projects.
2. Involve the Public Art Coordinator and artists early in design of capital improvement projects regarding public art, to the extent practicable.
3. Solicit comments from the community within which a capital improvement project designated for public art is located, from departmental advisory committees, or from the public using the facility on their desires for public art.
4. Solicit the County's Americans with Disabilities Act Coordinator's comments on access issues about public art projects.
5. Submit a request to the Public Art Coordinator to initiate the public art process, including guidelines for the "call to artists."
6. Notify the County Administrator on the results of public art selection processes and prepare a report on the selected artists and artworks to be forwarded to the Board of Supervisors for their information.
7. Prepare contracts for artists in conformance with the Pima County Procurement Code.

D. Tucson Pima Arts Council

The Tucson Pima Arts Council will:

1. Appoint seven (7) members to the Public Art and Community Design Committee who typify the community, to include minorities and women.
2. Hire a Public Art Coordinator who will be responsible for day-to-day administrative responsibilities of the TPAC contract for the Public Art Program.

3. Contract with Pima County for implementation of the Public Art Program.
4. Review and approve recommendations from the Public Art and Community Design committee for artists and artwork for the Public Art Program.

E. Public Art and Community Design Committee

1. Appoint one (1) arts professional and two (2) artists to public art selection juries for each public art project.
2. Review and approve recommendations from public art selection juries and forward recommendations to TPAC Board of Directors and County Administrator.

F. Public Art Coordinator

The Public Art Coordinator will coordinate day-to-day administrative duties of TPAC regarding the Public Art Program and will:

1. Create a database/file of information on artists and organizations who are eligible for commissions to create works of public art.
2. Develop a database/file of information about arts professionals and artists qualified to serve on public art selection juries.
3. Prepare the "call to artists" in consultation with the implementing department.
4. At least one month before scheduled meeting of a public art selection jury, issue the "call to artists." The Public Art Coordinator will publish the "call to artists" once in a newspaper of general circulation and distribute it by direct mail to eligible artists and organizations. The Public Art Coordinator will employ any other appropriate means to ensure the widest possible circulation of the "call to artists."
5. Convene public art selection juries and preside at all meetings of public art selection juries.
6. Ensure that public art selection juries meet t times that are convenient for the public to attend and strive to achieve the widest possible notification of public art selection jury meetings.
7. Forward recommendations of public art selection juries to the Public Art and Community Design Committee for its review and approval.
8. Forward Public Art and Community Design Committee recommendations to the TPAC Board of Directors for review and approval.
9. Forward the TPAC Board of Directors' recommendations to the County Administrator.
10. Prepare budgets for allowable administrative costs as described at Section IX and submit budgets to the implementing department for review and approval. Monitor all public art projects to certify progress and conformance with the approved project scope, budget, and contractual responsibilities.
11. Recommend payments to the artist(s) as scheduled in contracts.
12. Prepare and submit semiannual progress reports on the Public Art Program to the County Administrator.

13. Perform other duties as required to coordinate the Public Art Program effectively.

V. SELECTION OF ARTISTS AND ARTWORKS

Pursuant to Pima County Procurement Code, Section 11.12.030, the County Administrator developed and approved this contractor selection process for the selection of artists and artworks.

A. Initiation of Public Art Projects

1. The five-year capital improvement plan of the County will list all capital improvement projects and include a tentative allocation of 1 percent of planning, design and construction costs for public art. Capital improvement plans are not budget documents and do not represent appropriation of funds for any purpose.
2. Unless the Board of Supervisors grants an exemption, initiation of the public art process begins in the implementing department, with initiation of planning or design, whether done by County staff or through selection of a project architect or engineer.
3. The implementing department will develop guidelines for each public art project on appropriateness of:
    a. Content,
    b. Design and materials,
    c. Safety,
    d. Compliance with Americans with Disabilities Act access,
    e. Operations and maintenance cost.
4. To the extent practicable, the implementing department will gather pubic comments on these guidelines.
5. The implementing department will also gather comments on access issues from the Pima County Americans with Disabilities Act Coordinator.
6. At its discretion, the department may request assistance from the Public Art Coordinator in development of these guidelines.
7. The implementing department will forward these guidelines to the Public Art Coordinator with a request that a "call to artists" be developed according to guidelines proposed by the department.

B. General Provisions Regarding Selection of Artists and Artworks

1. The County will select artists or organizations through an open and competitive process in which any professional artist is eligible to enter.
2. The Public Art Coordinator will maintain and update registries of qualified artists and organizations. Any qualified artists or organization may request inclusion in these registries and all such registries will be public documents open for inspection to anyone requesting to do so.

3. Selection of artists and artworks will be based upon criteria of artistic quality and responsiveness to guidelines submitted by the implementing department.

C. Call to Artists

1. When the implementing department so requests, the Public Art Coordinator will draft a "call to artists" for the review and concurrence of the implementing department.
2. The "call to artists" will include a description of the capital improvement project to which a work of public art will be associated and the guidelines submitted by the implementing department.
3. The Public Art Coordinator will distribute the "call to artists" as widely as possible. At a minimum, the Public Art Coordinator will publish the "call to artists" at least once in a publication of general circulation, and mail it to a registry of qualified professional artists and organizations.

D. Public Art Selection Juries

A. The Public Art Coordinator will convene a new public art selection jury for each budgeted public art project.

B. Each public art selection jury will consist of seven members, which will include:

   a. <u>One</u> arts professional who does not earn his/her living as an artist, but is knowledgeable about the discipline under review. Such persons may include, but not me limited to, art critics, collectors, educators, trustees or others with an aesthetic knowledge about the particular discipline. The Public Art Coordinator will make this appointment with input from the Public Art and Community Design Committee.

   b. <u>One</u> designee appointed by the implementing department funding the project;

   c. <u>Two</u> artists appointed by the Public Art Coordinator with input from the Public Art and Community Design Committee;

   d. <u>Two</u> community representatives at least one (1) of which will be selected by the Board member within whose district the public art project will be located;

   e. <u>One</u> person who is the project or design principal.

Selection Procedures

1. While not subject to the Open Meetings Law, public art selection jury deliberations will be open to the public. The Public Art Coordinator will publicly notice meetings of public art selection juries and schedule them to be convenient for the public.
2. The Public Art Coordinator will provide instructions to the public art selection jury about their duties and responsibilities under the Public Art Program and the Pima County Procurement Code. Furthermore, the Public Art Coordinator will brief the jury on the guidelines developed by the implementing department for the work of public art.

3. The public art selection jury will hold at least two meetings, advertised and open to the public, for their deliberations.
4. At the first meeting, the public art selection jury will review submissions by artists and organizations and will select no more than three finalists. At this meeting, the public art selection jury will select finalists based upon presentations of prior artwork and ideas for the advertised project.
5. The public art selection jury will ask finalists selected by the jury to submit specific artwork proposals for the juried competition.
6. Finalists will prepare specific proposals for the work of public art associated with the particular capital improvement project. In addition to the artwork proposal, finalists will also submit a project budget. Project costs may include, but not be limited, to the following:
    a. The artist's fee;
    b. Labor of assistants, materials, and contracted services required for production and installation;
    c. Permit fees, as required;
    d. Business, insurance, and legal costs directly related to the project;
    e. Dealer's fees, if any;
    f. Communication, mailing, and other indirect costs;
    g. Transportation and travel expenses, if any;
    h. Site preparation;
    i. Installation of the completed artwork;
    j. Any applicable taxes.
7. Finalists will make presentations at the second meeting of the pubic art selection jury. This meeting will be open to the public and the public may ask questions of the finalists and provide comments directly to the public art selection jury.
8. The public art selection jury will decide the winning artists at this second meeting, or if necessary, a subsequent meeting open to the public. The jury will decide by public vote, with each juror casting one vote. A simple majority of four (4) will be necessary to carry the recommendation of the public art selection jury. The public art selection jury will have the option of making no selection. In this event, the public art selection jury may ask that the finalists submit and present new proposals or refer the process to the Board of Supervisors. The Board may exempt the project from public art or initiate a new selection process.
9. The Public Art Coordinator will submit the recommended public artwork to the County's Risk Manager for review of the project from a public safety standpoint and to the County Americans with Disabilities Act Coordinator for a review as for full accessibility.
10. Upon approval by the Risk Manager and ADA Coordinator, the Public Art Coordinator will submit recommended artwork to the Public Art and Community Design Committee and, if approved, to the Arts Council Board of Directors for formal vote.

11. If approved by the Arts Council Board of Directors, the Public Art Coordinator will prepare a report to the County Administrator. The Public Art Coordinator will describe the artwork recommended and document that the selection process met the requirements of Board of Supervisors Policy C 3.3 and this Administrative Procedure.
12. If in concurrence with the recommendation of the Arts Council, the County Administrator will direct the implementing department to prepare the required contract and copy the Public Art Coordinator of his/her decision. If the County Administrator does not concur with the recommendation o the Arts Council, the County Administrator will transmit the recommendation of the arts council to the Board of Supervisors for a final decision.

VI. PREPARING AND ADMINISTERING A COUNTY CONTRACT WITH THE ARTIST OR ORGANIZATION

A. Pima County will commission and purchase all works of public art through a contract executed with the artist or organization

B. The implementing County department, with the assistance of the Public Art Coordinator if requested, will prepare contracts for works of public art.

C. Contracts will be in the format of the standard County contract for professional services and will include the following:

   1. A schedule for creation of the artwork,
   2. A payment schedule,
   3. Responsibilities of site preparation and installation of the artwork,
   4. Terms and condition of ownership of the artwork by Pima County,
   5. Restrictions, if any, on reproduction of the artwork,
   6. Insurance coverage the County requires.

D. The County will process contracts in accordance with Board of Supervisors Policy D.29.4 and Procurement Procedures, Contracts for Services.

E. The Public Art Coordinator and designee of the implementing department will be responsible for inspecting the art project at required intervals to certify progress and recommend payments pursuant to the schedule in the contract. The Public Art Coordinator and designee of the implementing department will coordinate on-site activity concerning artwork installation.

VII. GIFTS AND DONATIONS

A. proposed for donation to the County. Areas of review will include conservation/preservation expenses, placement of the artwork, and appropriateness of the artwork. The Public Art and Community Design Committee will ask the county risk Manager to conduct a safety and liability review of proposed donations.

B. Based upon the comments of the Public Art and Community Design Committee and the Risk Manager, the County Administrator will decide whether to recommend acceptance of the artwork. C. improvement budget with the intent of donating the artwork to the County, County employees may only be involved in the commissioning if they follow the art selection procedures of the Public Art Program.

VIII. CONSERVATION AND PRESERVATION OF PUBLIC ART

A. Pima County will be responsible for conservation and maintenance of public art owned by the County and purchased through the Public Art Program.

B. The Public Art and Community Design Committee and the Public Art Coordinator will periodically survey the condition of Pima County public art. The Committee will report the condition of each piece of public art to the County Administrator and make prioritized recommendations for restoration and preservation if necessary.

C. If a work of art needs repairs, the County will give the artist the opportunity to make the repairs at a reasonable cost. If the County and artist cannot agree, the County may make other arrangements to repair the artwork.

D. The County will consult with the Public Art Coordinator before undertaking non-emergency conservation, preservation or maintenance activities, but retains sole discretion to undertake such activities.

E. To the extent practicable, the County will consult the Public Art Coordinator before undertaking emergency conservation, preservation and maintenance activities. The County will act without such consultation when public safety requires such action.

IX. ADMINISTRATIVE COSTS THAT MAY BE PAID TO TUCSON PIMA ARTS COUNCIL

A. Performance of its responsibilities under the Public Art Program.

B. Eligible administrative consist will include, but not be limited to costs related to:

   1. Publication and dissemination of the "call to artists,"
   2. Selection of jury panel members,
   3. Presiding over and advertising of public art selection jury meetings,
   4. Reporting on recommendations of public art selection juries to the Public Art and Community Design Committee, Arts Council Board of Directors, and County Administrator.

C. Eligible expenses will include salaries and benefits of staff members of the Tucson Pima Arts Council assigned to the Public Art Program, overhead charges and costs of publication and advertisement, postage, rental of meeting facilities, supplies, and other incidental costs.

D. The Tucson Pima Arts Council may incur only those administrative costs directly related to execution of the selection process for each particular public art project.

E. The County will reimburse the Tucson Pima Arts Council for administrative costs not to exceed 10% of the approved budget for the project. Implementing departments will approve agreements for services for allowable administrative costs before the Tucson Pima Arts Council incurs such costs.

X. References

Pima County Code, Title 11, Procurement

Board of Supervisors Policy D 29.4

Procurement Procedures, Contracts for Services

APPENDIX 3-Fa
Environmental Screening: Questionnaire for Establishing Potential Areas of Impact

Instructions for Completing the Questionnaire

This questionnaire is intended to provide early information about potential effects of the proposed project on the surrounding natural, physical, social, and cultural environment. The full Design Team should review the completed questionnaire during the development of the concept plan with the goal of avoiding or minimizing potential impacts to the extent possible.

A Design Team member who is involved in the assessment of project impacts should complete the questionnaire. For those questions for which the answer is "yes," a brief description and/or explanation should be provided. Additionally the information sources used in answering individual questions should be cited, including reports, correspondences, reference documents, and team members or others who provided technical information.

INTRODUCTORY INFORMATION

Project Identification

- Project Name:
- Pima County Project Manager:

Project Location and Limits

- Location of project within Pima County:
- Limits of project:

  From end to end:

  From side to side:

Funding Source

- Funding source anticipated for use in construction project?

  County funding: Y ____ N ____

  Federal funding: Y ____ N ____

  Other:

Source:

Primary Project Purpose

- Primary purpose of project:

  Modernize roadway (e.g., resurface, restore, rehabilitate, reconstruct, add shoulders, or add auxiliary lanes): Y ____ N ____

  Increase capacity: Y____ N ____

Add bicycle lanes: Y____ N ____

Improve safety: Y ____ N ____

Other:

Source:

Existing Conditions within Project Limits

- Roadway specifications?

  Right-of-way: ____ *feet*

  Pavement width: ____ *feet*

  Number of through lanes in each direction:
- Number of turning lanes?

  Right-turn lanes: ____

  Left-turn lanes: ____
- Existing intersections?

  Number of signalized intersections: ____

  Number of un-signalized intersections: ____
- Existing parking (e.g., on-street)? Y ____ N ____

  Existing bicycle lanes: Y ____ N ____
- Existing sidewalk: Y ____ N ____
- Existing transit stops: Y ____ N ____
- Other:
- Note: If no existing roadway, describe site conditions (e.g., undeveloped land, etc.):

Source:

Project Components

- Anticipated specifications of the project?

  Amount of additional right-of-way to be acquired:

  Under 1 acre ____ 1 - 5 acres ____ 5 - 10 acres ____ Over 10 acres ____

  Change in the vertical or horizontal alignment: Y ____ N ____

  New alignment: Y ____ N ____

  Pavement width to be added: ____

  Number of through lanes to be added: ____

  Number of turn lanes to be added: ____

  Right-turn lanes ____

Left-turn lanes ____

Any associated parking (e.g., on-street): Y ____ N ____

Bicycles lanes to be added: Y ____ N ____

Sidewalk to be added: Y ____ N ____

Landscaping to be added: Y ____ N ____

- Number of intersections to be signalized: ___
- Other:

Source:

Phasing

- Is the project:

  A portion or phase of a unified development plan? Y ____ N ____

  One of a series of projects that may result in a cumulative set of environmental impacts on an identifiable area? Y ____ N ____

Source:

Traffic:

- Existing average daily traffic (ADT) in the project area?

  Street: _____ *ADT:* _____

  Street: _____ *ADT:* _____

  Street: _____ *ADT:* _____

  Street: _____ *ADT:* _____

  Other: _____ *ADT:* _____

- Projected ADT in the project area for the build year?

  Street: _____ *ADT:* _____

  Street: _____ *ADT:* _____

  Street: _____ *ADT:* _____

  Street: _____ *ADT:* _____

  Other: _____ *ADT:* _____

Source:

Land Uses

- Existing adjacent land uses? Check all that apply and circle primary uses.

  Commercial (e.g., retail businesses, service businesses): Y ____ N ____

  Institutional (e.g., schools, hospitals, social services agencies): Y ____ N ____

Residential (e.g., single family houses, apartments, townhouses): Y ____ N ____

Vacant lots: Y ____ N ____

Industrial (e.g., light industry, heavy industry): Y ____ N ____

Recreational (e.g., parks, sports fields): Y ____ N ____

Other:

Source:

Property Ownership

- Existing land ownership:

  Majority public: Y ____ N ____

  Majority private: Y ____ N ____

  About evenly divided between public and private: Y ____ N ____

  Other:

Source:

ENVIRONMENTAL CATEGORIES

Drainage

- Will any storm water drain from the project discharge into detention or retentions basins on site? Y ____ N ____

Source:

Section 401/404

- Are any culverts likely to be installed, replace, or extended? Y ____ N ____
- Are there any bridges being upgraded, extended, or replaced? Y ____ N ____
- Is there any bank protection required in the construction of this project? Y ____ N ____
- Are there any wetlands within the project area? Y ____ N ____
- Are there any riparian areas within the project vicinity? Y ____ N ____
- Is it anticipated that there will be any discharge of dredged or fill material into "waters of the United States"? Y ____ N ____

Source:

Floodplain

- Is the project area within a 100-year floodplain delineated on the Federal Emergency Management Agency Flood Insurance Rate Map? Y ____ N ____ If "yes," will the project substantially modify the topography of the floodplain either by placement or removal of materials within the floodplain? Y ____ N _____

Source:

Biological Resources

- Are there listed threatened, endangered, proposed, and/or candidate species likely to be found in the project vicinity? Y ____ N ____
- Are listed special status species likely to be found in the project vicinity? Y ____ N ____
- Are protected native plants likely to be found in the project vicinity? Y ____ N ____
- Are construction activities anticipated to remove/disturb any vegetation? Y ____ N____
- Is the project within the Conservation Land System? Y ____ N____
- Is the project along a designated Scenic Route? Y ____ N____

Air Quality

- Is the project in an:

  Attainment area? Y ____ N____

  Nonattainment area? Y ____ N____ If "yes," what are the pollutants of concern?

  Maintenance area? Y ____ N____ If "yes," what are the pollutants of concern?

Source:

Noise

- Are there sensitive noise receptors in the area? Y____ N____ If "yes," identify type of noise receptors and briefly describe:

  Residences: ___

  Schools: ___

  Hospitals: ___

  Churches: ___

  Parks: ___

  Other:

- When the project is completed and used as anticipated, is it likely to contribute to any exceedances of noise quality standards. Y ____ N ____

Source:

Utilities

- Will the construction include any utility involvement? Y ___ N ___ If "yes", what kind of work is anticipated?

  Utility relocation: ___

  Temporary disconnection of service: ___

  Utility replacement: ___

- Are there are any scheduled plans for utility upgrades in the vicinity that are not related to the project? Y ____ N ____

Source:

Hazardous Materials

- Is it likely that any hazardous wastes or hazardous substances in the past have been generated, treated, stored, released, discarded or disposed of on site or are any such wastes now accumulated on site? Y ____ N ____ Don't know ____
- Have any test borings been performed? Y ____ N ____ If "yes", were any wastes discovered on the premises in the course of the test borings or excavation work for the project? Y ____ N _____

Source:

Historic Preservation (Based on feedback from Pima County OCRHP)

- Are there any cultural resources (archaeological or historic) in the vicinity of the project area that are listed on or eligible for the National Register of Historic Places? Y ____ N ____
- Are any of these sites considered "Priority Cultural Resources"? Y____ N ____
- If the answer is "yes," to either or both the questions above, please list the resource(s)/site(s):
- Of those properties listed or eligible, are any located near enough to the project to be affected by the project location, construction, or anticipated future traffic? Y ____ N ____ If "yes," please specify the properties and very briefly the anticipated effect.
- Are there any structures likely to be 50 years old or older within or adjacent to the project area? Y ____ N ____ If "yes," please list addresses below:

Source:

Visual Impact

- Is the project likely to affect noticeably the views from adjacent properties?

  Y ____ N ____ If "yes", briefly describe:
- Is the project likely to cause a noticeable change in the foreground, middle-ground, or background views from the road? Y ____ N ____

Source:

Neighborhood/Social Impact

- Is there likely to be any commercial or residential displacement due to the construction of this project? Y ____ N ____
- Are there likely to be any temporary changes in:

  Business access: Y ___ N ___

  Parking: Y ___ N ___

Other:

- Are there likely to be any permanent changes in:

  Traffic service: Y ___ N ___

  Traffic circulation: Y ___ N ___

  Parking: Y ___ N ___

  Other:

- Is the project likely to affect continuity in neighborhoods in the vicinity? Y ___ N ___

Source:

LOCAL JURISDICTION/AGENCY COORDINATION

- Are there local jurisdictions and governmental agencies with whom coordination is anticipated or has begun? Y ___ N ____ If "yes," who are they?

  City of South Tucson ___

  City of Tucson ___

  Oro Valley ___

  Pascua Yaqui Tribe ___

  Tohono O'odham Nation ___

  Town of Marana ___

  Town of Sahuarita ___

  Arizona Department of Environmental Quality ___

  Arizona Department of Transportation ___

  Arizona Game and Fish Department ___

  Arizona State Land Department ___

  U.S. Army Corps of Engineers ___

  U.S. Bureau of Land Management ___

  U.S. Environmental Protection Agency ___

  U.S. Federal Highway Administration ___

  U.S. Fish and Wildlife Service ___

  Other _____

- Note any issues for coordination that have been identified to date:
- Briefly describe coordination efforts planned or underway:

Source:

PUBLIC INVOLVEMENT

- Has a Public Involvement Plan been developed for the project? Y ___ N ____
- Has a Citizen Advisory Committee been formed, or is one being formed? Y ____ N ____
- Have any public meetings been scheduled? Y ___ N ___ If "yes", have any meetings been held to date? Y ___ N ____
- Has any information useful to project development been identified though any public interaction to date? Y ___ N ____ If "yes", briefly describe:
- Is there any known controversy over this project to date? Y ___ N ____ If "yes", briefly describe:

Source:

PERMITS

- Anticipated permits and/or approvals?

  404 Permit: ___

  401 Certification: ___

  Sole Source Aquifer: ___

  State Historic Preservation Officer (SHPO) clearance: ___

  Nonpoint Pollutant Discharge Elimination System (NPDES): ___

  Other

Completed by:_____
(name and title)

Date:_____

APPENDIX 3-Fb
Environmental Screening: Summary Impact Matrix

Instructions for Completing the Summary Impact Matrix

First review the project construction and operation activities listed in the second column of the matrix and then, in the first column, put a checkmark next to each activity that is applicable to the project. Next, review the completed *Questionnaire for Establishing Potential Areas of Impacts* (see Appendix 3-Fa) and then use the symbols below to indicate the potential for adverse impacts on the environmental categories (listed across the top of the matrix) from each of the applicable activities.

If there are additional activities that are important to the construction or operation of the project, or if there are additional environmental categories that should be considered, expand the matrix accordingly.

0 = no involvement *(e.g., if there is no protected wildlife in the area then there would be no involvement with wildlife during project activities)*

X = potential involvement, but no or minimal impact *(e.g., there may be listed wildlife in the vicinity of the project, but no evidence of wildlife in the project area itself, therefore there would be no or minimal impact)*

M = potential moderate impact *(e.g., one protected plant is found that would be affected)*

H = potential high impact *(e.g., a cluster of protected plants are found; the area serves as habitat for a protected species)*

APPENDIX 3-Fb
Environmental Impact Screening Summary Impact Matrix*

PROJECT NAME:_____

PROJECT LIMITS:_____

	Potentially Affected Environmental Categories ➡	**Water quality**	**100-year floodplain**	**Protected waterways**	**Visual Quality / Viewsheds**	**Protected plants / vegetation**	**Protected animals / wildlife**	**Cultural res. (archaeological and historic)**	**Air quality**	**Noise**	**Hazardous materials**	**Land Uses/Community Character**	***
Applicable to project (✓)	**Project Construction and Operation Activities ⬇**												
	Change in the vertical or horizontal alignment												
	New alignment												
	Added capacity (i.e., through lanes)												
	Milling/grading												
	Change in access (e.g., driveways, intersections)												
	Clearing and grubbing												
	Excavation												
	Cut slope												
	Demolition												
	Demolition debris disposal												
	Acquisition of additional right-of-way												
	Temporary Construction Easements												
	Discharge of dredge or fill material												
	Channeling and dredging												
	Hauling												
	New signals												
	Storm water drainage												
	Construction equipment												
	Detour route												
	**												

* See instructions presented on Page 1 of this appendix (3-Fb)
** Add rows as necessary for other construction activities that should be considered
*** Add columns as necessary for other environmental categories that should be considered

APPENDIX 3-Fc
Environmental Screening: Results Memorandum

Instructions for Preparing the Results Memorandum

The Results Memorandum should be a concise document (approximately 2-5 pages) that summarizes the environmental screening process and findings. The memorandum should include the following:

- Screening process description (e.g., when it was undertaken; who conducted the screening; sources consulted, including any field work conducted; when Environmental Coordination meeting was held and with whom)
- Identification of any technical studies completed during the screening process
- Environmental issues identified through the screening process
- Suggestions on addressing issues through design modifications and/or alternative investigation
- Identification of any additional technical analyses needed beyond that specified in original scope of work for the Environmental Assessment and Mitigation Report
- Attachments
- Completed Questionnaire for Establishing Potential Areas of Impact
- Completed Summary Impact Matrix

APPENDIX 3-G
Matrix for Comparison of Alternatives
(Sample)

Instructions for Completing Alternative Comparison Matrix

Note: The following approach to comparing alternatives can be used for alternatives studied in conjunction with the Location Study or for alternatives concepts presented in the Design Concept Report (DCR).

Instructions: Fill in brief description of alternatives considered (e.g., alignment north of wash; alignment south of wash) and categories for comparison (e.g. cost; impacts to biological, cultural, and visual resources; impacts on adjacent neighborhoods; construction duration; effect on utilities).

The effect of alternatives on each category can be designated in different ways – e.g., by simple plus, minus, or zero symbols (+, -, o); by open, half open, or filled circles (A, X, Δ); or by brief word descriptors (none, some, significant). Make sure the meaning of the symbols/words works for each category, and/or provide a key that makes it clear how the symbols should be interpreted for the different categories. Alternatively, a simple numerical ranking system can be used; however totaling the ranking scores for each alternative may be misleading unless the categories are weighted.

The purpose of the matrix is to provide a summary of how alternatives studied compare in terms of different categories that are important. The rationale for the final recommended alternative should be explained in more detail in the text of the document (i.e., Location Report, DCR).

Alternative Comparison Matrix

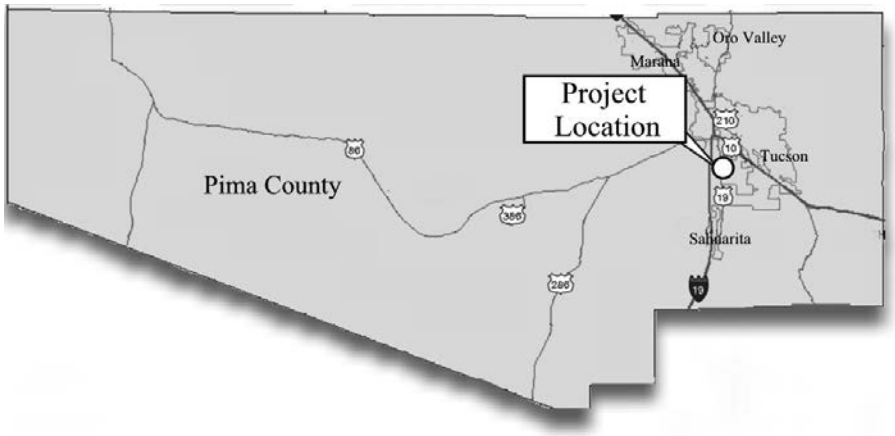
Comparison Categories*	Alt. #1	Alt. #2	Alt. #3	***	Comments on Key Issues in category
Cost					
Displacement of Residents/Businesses					
Impact to Development					
Traffic Operational Impacts					
Impacts to Utilities					
Construction Duration					
Impacts to Biological Resources					
Impacts to Cultural Resources					
Impacts to Visual Resources					
Impacts to Neighborhoods					
**					

* Provide a key if symbols are used.

** Add rows as necessary to include other categories that should be considered in the comparison of alternatives.

*** Add columns as necessary for additional alternatives.

APPENDIX 3-H
Location Map
(Sample)



APPENDIX 3-I
Design Concept Report
Table of Contents

Contents

Executive Summary

Table of Contents (Chapters, Sections, List of Exhibits, Appendices)

Abbreviations

1.0 Project Overview

2.0 Project Description

3.0 Project Area Characteristics

4.0 Traffic and Accident Data

5.0 Design Standards and Criteria

6.0 Major Design Features

7.0 Social, Economic, and Environmental Considerations

8.0 Public Involvement

9.0 Agency Coordination

10.0 Alternatives

11.0 Conclusions and Recommendations

12.0 Cost Estimate

13.0 Budget Considerations

14.0 Delivery Method

15.0 Recommendations and Conclusions

Exhibits

- Location Map
- Alternative Comparison Matrix if appropriate
- Environmental Screening Matrix
- Cost Estimate
- Other Illustrations as appropriate: Diagrams, photos, tables, etc. that help summarize or clarify points made in the text are encouraged. Exhibits may be located within the text or grouped at the end; or alternatively, an exhibit of more than a few pages, may be included as an appendix to the DCR.

Appendices

- Initial Design Phase Concept Plans (see Section 3.20)
- Right-of-Way Requirements Plans
- Public Involvement Results to Date
- Cost Estimate
- Other Items as Appropriate

APPENDIX 3-J
Items for Cost Estimate

The cost estimate should include the following items:

1. Engineering
   a. Design Consultant fee
   b. Pima County administrative cost

2. Utilities
   a. Tucson Water
   b. Pima County Regional Wastewater Reclamation
   c. Other utilities with prior rights
   d. Undergrounding electrical lines
   e. Engineering costs

3. Right-of-Way
   a. Acquisition
   b. Relocation
   c. Cost to Cure
   d. Administration

4. Construction
   a. Clearing and grubbing
   b. Removal of structures and obstructions
   c. Earthwork
   d. Pavement structure
   e. Bridges
   f. Cross-drainage structures
   g. Storm drain system
   h. Bank protection
   i. Noise and retaining walls
   j. Signalization and lighting
   k. Traffic control
   l. Landscaping, irrigation, and plant salvage
   m. Mobilization (An appropriate target percentage is 8 – 10%)
   n. Other major items
   o. Contingency Amounts (Based on Project Phase)
   p. Construction administration including post design consultant services (Note: An appropriate target percentage is 15%)

APPENDIX 3-K
Environmental Mitigation and Assessment Report (EAMR)
Table of Contents

Contents

Executive Summary

Table of Contents (Chapters, Sections, List of Exhibits, Appendices)

Abbreviations

1.0 Background

- 1.1 Project Cost and Funding
- 1.2 Direction by Board of Supervisors
- 1.3 Project Design Process

2.0 Project Purpose And Need

3.0 Project Setting

4.0 Proposed Project

5.0 Environmental Screening

6.0 Environmental Assessment And Mitigation

(Address the following for each category: existing conditions, adverse impacts, recommended mitigation, and associated permits. See Section 3.18 and Appendix 3-N for further explanation.)

- *6.1 Natural/Physical Environment*
  - 6.1.1 Biological Resources*
  - 6.1.2 Drainage/Section 401/404
  - 6.1.3 Floodplain
  - 6.1.4 Air Quality
  - 6.1.5 Noise
  - 6.1.6 Utilities
  - 6.1.7 Hazardous Materials
  - 6.1.8 Construction
  - 6.1.9 Historic/Cultural Resources*
  - 6.1.10 Visual Resources*
- *6.2 Neighborhood/Social Environment*
  - Right-of-Way Acquisition and Displacement
  - Temporary and Permanent Access and Parking Impacts

- Neighborhood Disruption
- Parks and Recreational Areas
- Consistency with Other Plans

7.0 Agency Coordination

8.0 Public Participation

8.1 Public Participation Plan

8.2 Community Advisory Committee

8.3 Public Meetings

8.4 Community Concerns

9.0 Conclusion and Recommendations

10.0 References

Tables

Figures

Project Documents

Exhibits (as applicable)

- Location Map
- Aerial Photo (project limits and prominent physical features)
- Existing Conditions Photos (captioned)
- Noise Measurement Location Map
- View Analysis Location Map and Photos of Analysis Locations
- Existing Land Use Map
- Alternative Transportation Routes Map (e.g., bus routes, sidewalks, and designated trails)
- Park and Recreational Facilities Map
- *Optional:* Photo simulations of the proposed project
- *Other as appropriate*

Appendices (as applicable)

* If project is designated as an Environmentally Sensitive Roadway, see Chapter 4 for information on conducting this assessment.

APPENDIX 3-L
Environmental Assessment and Mitigation Report
Executive Summary Outline

1.0 Project Overview

- Project Name
- Project Number
- Project Location
- Project Limits (Include Location Map – Appendix 3-H)
- Estimated Cost
- Funding Source(s)
- Construction Fiscal Year(s)

2.0 Project Purpose and Need

3.0 Project Elements

4.0 Project Impacts and Recommended Mitigation

- Summary Table (See Appendix 3-M)

5.0 Agency Coordination

6.0 Public Involvement

- Summary Table of Public Involvement Activities (see Appendix 3-Dc)

APPENDIX 3-M
Environmental Assessment and Mitigation Report
Impact and Mitigation Summary
(Sample)

Potential Impacts *(Examples only)*	**Recommended Mitigation**** *(Examples only)*	**Agency Coordination and Consultation** *(Examples only)*	**Parties Responsible For Implementation** *(Examples only)*
Removal of native plants	Replace with native, drought tolerant plants in keeping with mitigation requirements outlined in the Arizona Plant Law, and as applicable, the Environmentally Sensitive Roadway Standards.	Arizona Game and Fish Department	Pima County Contractor
Possible effect of construction activities on desert tortoises	If desert tortoises are found during construction, they must be removed from the construction area	Arizona Game and Fish Department	Contractor
Disturbance of critical habitat	Moratorium during breeding season	U.S. Fish and Wildlife Service, Arizona Fish and Game Department	Pima County Contractor
Particulate disturbance during construction.	Utilize dust abatement during construction		Contractor
Exceeds Pima County noise abatement standard with project in place	Noise walls		Pima County Contractor
Demolition of a designated historic property	Recordation	State Historic Preservation Officer	Designer
*			

* Add rows as necessary for identified impacts.

** If the project roadway is a designated Environmentally Sensitive Roadway, mitigation measures for biological, cultural, and visual impacts must follow the guidelines presented in Chapter 4.

APPENDIX 3-N
Environmental Assessment and Mitigation Report - Environmental Categories and Assessment Guidance

CATEGORY	ASSESSMENT GUIDANCE
	Natural Environment
Biological Resources.	Using the U.S. Fish and Wildlife Service (USFWS) and Arizona Department of Game and Fish (AGFD) lists, identify listed, threatened, endangered, proposed, candidate species, and/or special status species in the vicinity. Using the AGFD list, identify special status species and native plants found in the project area. If protected habitats or species are indicated as being highly likely within the project area, undertake the appropriate surveys following the appropriate protocol. Describe construction and operation activities that may impact species identified in the project area. Identify mitigation measures – e.g., building moratorium during a breeding season, re-vegetation, etc.
Drainage/ Section 404/401	Identify major washes, existing storm drain facilities, and existing cross drainage facilities within the project area. Describe potential impacts to the washes and facilities from the project. Identify recommended measures to mitigate impacts to natural and built drainage facilities. Address whether the project will involve the dredging or filling of any "washes of the United States," which are under jurisdiction of the U.S. Army Corps of Engineers. If the project affects "waters of the United States," discuss whether a Nationwide or an Individual 404 permit will be sought.
Floodplain	Determine whether the project area or a portion of the project area is located within the 100-year floodplain by reviewing a copy of the FEMA, Flood Insurance Rate Map (FIRM) and/or Flood Hazard Boundary Map, and the FIRM Index Panel. If floodplain status cannot be determined, or if there are questions, contact Pima County Flood Control for assistance. Document whether the project area is within the 100-year floodplain and indicate whether the project will affect the floodplain. The latter would generally occur due to placement or removal of materials within the floodplain that substantially modifies the topography within the floodplain. If the project does impact the floodplain, discuss recommended measures to mitigate the effects.
Air Quality	Identify the Environmental Protection Agency designation for the area's conformance with the National Ambient Air Quality Standards (i.e., an attainment area, nonattainment area, or maintenance area). If the project is within a nonattainment or maintenance area, identify pollutant(s) at issue. Describe the results of any air quality monitoring performed in the area by the Pima Association of Governments or the Pima County Department of Environmental Quality.
Noise	Identify the sources of noise from the project when it is built. Identify noise-sensitive sites within the project area (e.g., residences, schools, hospitals, libraries, passive park areas, and other areas where quiet is important). Describe the results of the noise modeling of existing traffic and roadway conditions used to determine existing baseline noise levels at all adjacent properties along the proposed roadway right-of-way. Using noise modeling, identify the noise impacts of the proposed project on the properties adjacent to the property. Discuss the predicted noise levels and recommended mitigation with reference to Pima County's most current noise abatement standard. Exhibit: Plan showing the noise measurement locations with the project area.

CATEGORY	ASSESSMENT GUIDANCE, CONTINUED
	Physical Environment
Utilities	Identify any utilities within the project area (e.g., gas, phone, electric, telecommunications, etc.). Discuss whether the project construction will affect these utilities in any way (e.g., relocation, temporary disruption of service, etc.) If utilities will be affected, note who will do the work (e.g., Pima County, contractor, utility company, etc.) Note who will notify customers about the utility work prior to its commencement and how (e.g., door-to-door notices, mailings, etc.). Include the latter as a mitigation measure under "Conclusions and Recommendations" at the end of the EAMR.
Hazardous Materials	Complete a PISA. Report whether any hazardous material concerns were identified, and if so the recommended mitigation measures. Also state that if any suspected hazardous materials are encountered during construction, work shall cease at the location and the Pima County Engineer shall be contacted to arrange for proper assessment, treatment, or disposal of those materials. Include this latter statement, along with any specific recommendations for dealing with identified hazardous materials, in the "Conclusions and Recommendations" at the end of the EAMR.
Construction Activities	Discuss temporary construction-related impacts such as traffic control, detours, dust abatement, noise, etc. [Note: Any detours planned outside of the project area should be assessed for each applicable environmental category.]
Cultural Resources	Cultural resources typically are defined to include sites, buildings, structures, districts, and objects. Pima County requires consideration of possible effects to cultural resources in accordance with Resolution 1983-104 for which the underlying authority is the Arizona Antiquities Act, ARS δ41-841, et. seq. ARS δ41-844 and ARS δ41-865, which pertain to disturbance of human burials on state, County, or municipal property and on private property, respectively; and Board of Supervisors Policy C 3.17 Protection of Cultural Resources. The Arizona Historic Preservation Act provides the authority for review of Pima County projects by the State Historic Preservation Officer (SHPO). Cultural Resource Survey efforts shall be completed/coordinated thru the Pima County Office of Cultural Resources and Historic Preservation. Typically, two levels of survey are completed as part of the assessment. First, a records search and literature review, and second a field survey. If the records search is completed in conjunction with the Environmental Screening (see Section 3.8), the results should be reported in the EAMR, along with the results of the field survey. As part of surveys that are undertaken, for any archaeological and/or historical sites identified, the determination as to the effect of the project on identified sites, and any mitigation measures (e.g., including additional assessment, recordation, etc.) proposed to address potential effects of the project on cultural resources. Also state that if previously unidentified cultural resources are encountered during activity related to the construction of the project, the contractor should stop work immediately at that location and should take all reasonable steps to secure the preservation of those resources. Include this latter statement, along with any specific recommendations for dealing with identified cultural resource impacts, in the "Conclusions and Recommendations" at the end of the EAMR. Exhibit: Plan showing locations of any designated historical sites within the project area

CATEGORY	ASSESSMENT GUIDANCE, CONTINUED
Visual Resources	Describe the characteristics of the viewsheds in the project area (e.g., level of development, natural drainage features, vegetation, topography). Describe how the project would affect the visual experience for both the viewer looking toward the project (e.g., residents and tenants on/in properties adjacent to the property area) and viewers within the project area (e.g., drivers, bicyclists, pedestrians). For the latter, describe the following views: ➢ Foreground - ≤ ¼ mile from observer ➢ Middleground - ¼ to 1 mile from observer ➢ Background views - beyond 1 mile from observer First describe each of the existing views to and from the project, and then describe how each of the existing views would be affected by the project. Describe what mitigation measures are being taken to address potential adverse impacts and who will be responsible for the implementation of those mitigation measures. Include these mitigation measures under "Conclusions and Recommendations" at the end of the EAMR. Exhibit: Include an aerial indicating the vantage points from which the three views were analyzed and photographs depicting the existing views. If photo simulations of the project in place from the same vantage points are available, they can also be included in the EAMR.
	Neighborhood/Social Environment
Right-of-Way Acquisition and Displacement	Indicate the land uses in the area, zoning in the area, and any known planned development. If new right-of-way and/or temporary easements are required, describe their size (in acres), the location, and parcel ownership. Discuss any displacement of uses that will occur due to the project and how the displacement is being addressed. Exhibit: Include a map showing existing land uses within and adjacent to the project site.
Temporary and Permanent Access and Parking Impacts	Provide a general description of access to and parking for properties within and adjacent to the project area. Address any temporary and permanent restrictions or modifications to access and parking from project construction and operation. Consider access for all types of transportation, including pedestrian, bicycle, and motorized vehicle, as well as for compliance with the Americans with Disabilities Act.
Parks and Recreational Areas	Identify parks and recreational facilities in the project area, including public parks, designated trails, school facilities, national forests or parks, golf courses, and sports fields. Describe whether the project will affect access to the facilities. Exhibit: Provide a map showing existing and/or planned public parks or recreational facilities within or adjacent to the project area.
Consistency with Other Plans	Describe whether the proposed project is consistent with Pima County's Comprehensive Plan, the Pima Association of Governments' Regional Transportation Plan, and other relevant plans. If the project is inconsistent with other relevant plans, identify the elements in conflict and how the conflicts have been addressed.

APPENDIX 3-O
Environmental Assessment and Mitigation Report
Hearing Notice and Approval Process

Action	**Timeframe**
Establish Hearing Date – Review the Board of Supervisor's (Board) Calendar, identify a Board meeting approximately 60 days from the initiation of this effort to allow sufficient time for project notice/mailings, EAMR Board package preparation and submittal, public information postings, and advertisement requirements for legal notice. Project Manager & Key Team Members	N/A
Mailing - Prepare mailing to residents and citizens announcing Board's upcoming hearing and the availability for review of the EAMR at the library. Community Relations	Approximately 35 days in advance of planned hearing date complete and mail to effected residents and citizens mailing. Note: The actual mailing must be received no later than 30 days prior to Board's Hearing date.
Board Package - Submit Board Package for EAMR to Clerk of Board and provide EAMR documents for posting at public library. Project Manger & Community Relations	Approximately 30 to 45 days in advance of the planned Board of Supervisor's hearing date, complete and submit Board Package which will include the following: Agenda Item Summary EAMR CAC Recommendation Letter* Director's Memo to Board* Concurrent with submittal to Board, EAMR is submitted for posting at public library.
Advertise - Prepare and place advertisement notice pertaining to upcoming Board Hearing. Community Relations	Approximately 20 days in advance of the planned Board Hearing, place advertisement notice. Note: The actual advertisement must be published no later than 15 days prior to Board Hearing date.
* Should the CAC letter not be available at the time of assembly of the Board Package, a placeholder shall be included in the Board Package, with the CAC letter and Director's Memo to the Board being submitted as a separate submittal, provided it is done in accordance with the normal agenda item submittal time frame (2-3 weeks in advance of planned hearing date). Note that the CAC shall be contacted and advised that they need to provide whatever comments they have at this time, or the item will need to be withdrawn from the Board Agenda, incurring a project delay.	

APPENDIX 3-P
Checklists
Right-of-Way Plans, Parcel Maps, and Legal Descriptions

Right-of-Way Plans Checklist

- ☐ Plan view(s) for entire project
- ☐ North arrow and scale of 1” = 40'
- ☐ Section, Quarter section, and Sixteenth section lines.
- ☐` Stationing references
- ☐ Existing right-of-way/easements granted to Pima County within the project limits
- ☐ Existing utility easements including Book and Page (with year of recording
- ☐ Street names and wash/river names
- ☐ Differentiated Line Weights/Styles between existing and proposed features
- ☐ Proposed Parcel Takes (shaded)
- ☐ All abutting parcels including:
  - ___Owner names
  - ___Assessors parcel numbers
  - ___Property address
  - ___Subdivision Book and Page (with year of recording) and lot number or “Unsubdivided”
  - ___Parcel identification letter and sheet number in hexagon symbol for affected parcels
- ☐ Proposed new right-of-way/easements with bearings and distances for each line
- ☐ Existing right-of-way/easements including Book and Page (with year of recording), as well as property lines with bearings and distance
- ☐ Right-of-way center or control line with ties to cross streets
- ☐ Proposed improvements adjacent to the parcel
- ☐ Proposed new right-of-way/easements specifying type, providing distance and bearings
- ☐ Existing structures/private improvements on parcels adjoining project improvements
- ☐ Existing utilities (if included as part of a prior rights review).
- ☐ Existing prominent physical features (screened at 50%)
- ☐ Existing and proposed access, if affected
- ☐ Existing and proposed right-of-way width
- ☐ Parcel Area Table for affected parcels:
  - ___Parcel identification letter and sheet number in hexagon symbol
  - ___Pima County Tax ID number
  - ___Docket and page of the parcel deed
  - ___Owner name
  - ___Gross area

___Type of acquisition

___Size of area to be acquired

___Size of remainder

___Size of temporary construction easement

Rectified Digital Orthophoto Checklist

☐ Orthophotos shall be referenced to the project control and the predesign survey requirements. The orthophoto size shall be produced in 22” x 34” format and in the scale of 1” = 40’, with the following layers:

___Existing rights-of-way and easements

___Proposed rights-of-way and easements

___Proposed curb lines and sidewalks

___Curb cuts and driveway openings

___Median cuts and turn bays

___Travel lanes (vehicular and multi-purpose)

Parcel Depiction Checklist

☐ 8-1/2” x 11” parcel map of entire parcel(s) under one ownership, including reference location map

☐ Consulting firm’s name

☐ Date written and date(s) of any revisions

☐ North arrow and scale

☐ Differentiated Line Weights/Styles between existing and proposed features

☐ Proposed new right-of-way/easements specifying type, providing distance and bearings

☐ Assessor’s parcel number, property owner and address

☐ Parcel identification letter and sheet number in hexagon symbol

☐ Area in square feet or acres for part taken

☐ Cross hatch or otherwise indicate part to be acquired

Legal Description Checklist

☐ Consulting firm's name and logo

☐ Sealed by an Arizona Registered Land Surveyor

☐ Assessor’s parcel number

☐ Date written and date of any revision

☐ Property owner name

☐ Type of acquisition such as “Fee Right-of-Way,” “Drainage Easement,” “Temporary Construction Easement,” etc.

APPENDIX 3-Q
Final Design Phase
Initial Construction Plan Checklist

The following describes the plan sheets that should be included as part of the initial construction plan submittal, and the information that should be shown on those sheets.

Cover Sheet

The cover sheet should include the following information:

- ☐ Sheet index
- ☐ Legend of any nonstandard symbols or line types
- ☐ Basis of elevation and bearing
- ☐ Standard and special notes
- ☐ Design data such as design speed and design vehicle
- ☐ Water and sewer modification notes unless separate water and/or sewer modification plans are being prepared

General Notes

General Notes typically include the following:

- ☐ Sheet index
- ☐ Legend of any nonstandard symbols or line types
- ☐ Basis of elevation and bearing
- ☐ Standard and special notes
- ☐ Design data such as design speed and design vehicle
- ☐ Water and sewer modification notes unless separate water and/or sewer modification plans are being prepared

Typical Sections

Base typical roadway sections should show:

- ☐ Construction control line and profile grade control lines if different from construction control line
- ☐ Right-of-way control line and right-of-way widths
- ☐ Median, travel lanes, paved shoulder, lane assignments, shoulder, clear zone widths
- ☐ Cross-slope of pavement, shoulders, and recovery area if applicable

- ☐ Curb location and type
- ☐ Sidewalk location and detail
- ☐ Cut and fill slopes
- ☐ Pavement section referenced by number and showing limits by station as applicable
- ☐ Limits of each typical roadway section by station
- ☐ As applicable, a superelevated section corresponding to each base typical section with axis of rotation shown
- ☐ As applicable, left-turn and right-turn lane sections corresponding to each base typical section
- ☐ Separate typical sections for side streets

Pavement Structure Sections

Pavement structure sections for various roadways and locations should be denoted by consecutive numbers and include the following as applicable:

- ☐ Asphalt layer thickness and mix number
- ☐ Tack coat
- ☐ Aggregate base thickness
- ☐ Chip seal (single/double) if applicable
- ☐ Sub-base and sub-grade treatment

Horizontal Control

Horizontal control for the roadway construction and right-of-way can be shown on the roadway plans or, if too cluttered, on separate sheets. Information should include:

- ☐ Section corner ties needed to establish on the ground the horizontal geometry of the roadway
- ☐ Construction control line including curve data
- ☐ Median geometry
- ☐ Street names
- ☐ Pertinent existing easements
- ☐ Right-of-way along the mainline, side streets, and drainage ways tied to the construction control line

Initial Roadway Plans

Plan view and profile should be combined on single sheets if horizontal curvature and elevation differential allows. If not, separate plan and profile sheets may be provided. Information shown in the roadway plan view includes:

- ☐ Edge of pavement defined
- ☐ Curb return data at major and minor streets
- ☐ Sidewalks if applicable
- ☐ Construction control line labeled and control data provided
- ☐ Property name, tax code number, and lot number if separate right-of-way plans are not being prepared
- ☐ Record property lines
- ☐ Limits of incorporated areas if applicable
- ☐ Culture
- ☐ Utilities
- ☐ North arrow (north to top or to right)
- ☐ Scale shown in bar form to accommodate reduced sizes
- ☐ Existing right-of-way and utility, drainage, and access easements
- ☐ Proposed right-of-way, drainage, slope, utility, and access easements
- ☐ Section lines identified
- ☐ Construction control line stationing labeled at 500-foot spacing
- ☐ Tick marks at 100-foot spacing
- ☐ Side street name, control line, and control data
- ☐ New driveways control and widths
- ☐ Median location and openings
- ☐ Station equations at side streets and drainage crossings
- ☐ Approximate limits of reconstruction for driveways and side streets
- ☐ Anticipated location of cross drainage structures, location and preliminary size, dip crossings
- ☐ Curb access ramps
- ☐ Benchmarks
- ☐ Initial storm drain locations

The following is needed in the roadway profile view:

- ☐ Existing grade profile along control lines appropriately labeled
- ☐ Finish grade profile along control lines appropriately labeled
- ☐ Superelevation diagrams associated with each profile
- ☐ Vertical curve data: BVC, PVI, EVC stations and elevations, curve length, grade breaks, stopping sight distance, and tangent grades shown as positive or negative for ascending or descending grades
- ☐ Accurately plotted cross-drainage structures with size labeled
- ☐ Utility locations, elevations, sizes, and types
- ☐ Profile information shown on a station/elevation grid

Initial Cross Drainage Plans

Plan and profile for channels, culverts, and other cross-drainage improvements are needed as well.

The plan view should include:

- ☐ Control line with tie to roadway control line
- ☐ Right-of-way/ easements
- ☐ Roadway improvements
- ☐ Size, skew, and dimensions of culvert
- ☐ Horizontal definition of channel geometry including typical section
- ☐ Existing utilities

The profile view should include:

- ☐ Finish grade of channel and culvert including invert, top of bank, longitudinal section of culvert, and so forth along an appropriate control line
- ☐ Section of proposed roadway taken along the same control line
- ☐ Existing grade profile along the control line
- ☐ All finish grade and existing grade profiles labeled
- ☐ Existing utilities
- ☐ Headwater elevation of culverts
- ☐ Q_{100} and V_{100} for channels

Initial Storm Drain Plans

The plans should include:

- ☐ Catch basin locations
- ☐ Trunk line and lateral locations with preliminary sizing
- ☐ Trunk line profile

Landscape Plans

Provide a preliminary planting plan on one sheet showing the proposed plant palette and density.

Pavement Marking Plans

Show initial pavement marking plan for the entire roadway with major dimensions only.

Water and Sewer Conflicts

Identify any anticipated conflicts with existing water and sewer facilities and determine the scope of water and sewer system modifications.

Initial Bridge Plans

If bridges or other major structures are involved, the Final Design Phase plans (see Section 3.20) should show layouts and primary features. Bridge information should be based on the recommendations provided in the Structure Selection Report and will include:

- ☐ Longitudinal and transverse cross-sections of major structures
- ☐ Pier and abutment type, locations, and dimensions
- ☐ Superstructure type and major dimensions such as structure depth, type and spacing of girders, and size of cast-in-place boxes
- ☐ Deck thickness and method of construction
- ☐ Existing culture, utilities, and right-of-way
- ☐ Approach slab
- ☐ Abutment drainage system

Provide applicable structural calculations with the Final Design Phase submittal.

APPENDIX 3-R
Initial PS&E Phase
Preliminary Construction Plan Checklist

Initial PS&E Phase plans should include the revisions agreed to from the Final Design Phase Plan Submittal. Additionally the plans should include the following:

Storm Drain Plans

- ☐ Plan view of storm drain system including horizontal control
- ☐ Storm drain main and lateral profiles including the profile of the pipe and the proposed roadway along the pipe centerline, existing grade profile along the pipe centerline, the hydraulic grade line, existing utilities including size and type, pipe size, slopes, type, inverts
- ☐ Catch basin and pipe summary sheets

Landscape Plans

- ☐ Irrigation system
- ☐ Water service location
- ☐ Electric service location
- ☐ Landscape schedule
- ☐ Sight triangles
- ☐ Special details
- ☐ Grading
- ☐ Irrigation equipment schedule

Traffic Signal Plans

- ☐ Note sheet
- ☐ Detection loop layout details
- ☐ Plan sheets including traffic phasing diagrams, detection loop and type, signal poles, heads, conduit, pull-box locations, intersection pavement marking, signing, and electric service location
- ☐ Pole, conduit, and conductor schedule

Lighting and ITS Plans

- ☐ Note sheet
- ☐ Plan sheets showing light poles, pull-box locations, cabinets, and electric service location
- ☐ Pole, conduit, and conductor schedule

Signing Plans

- ☐ Note Sheet
- ☐ Sign layout table
- ☐ Signing summary table
- ☐ Plan sheets reflecting signing layout

Pavement Marking Plans

- ☐ Pavement marking labeled and dimensioned
- ☐ Pavement marking quantities
- ☐ Pavement marking notes
- ☐ Pavement marking details
- ☐ Quantity summary table

Staking Plans

Spot elevations in areas that are not directly covered by profile and typical roadway sections such as major intersections and nonstandard turn bays. Use a scale appropriate for the particular situation. Include dimensions necessary to horizontally locate spot elevations.

Noise Wall Plans

- ☐ Plan view
- ☐ Typical wall cross section
- ☐ Elevation showing top of wall and footing elevations
- ☐ Structural details

Retaining Wall Plans

- ☐ Typical wall cross section
- ☐ Plan view
- ☐ Elevation

Special Provisions

- ☐ Initial Draft Document

Water and Sewer Modification Plans

Provide construction plans for any proposed water, reclaimed water and/or sanitary sewer modifications when required and in accordance with the standards of the appropriate agency.

Bridge Plans

Preliminary layout of structural sheets for bridges and other major structures as applicable.

☐ General plan sheets

___Culture, utilities, and right-of-way

___Base lines

___Curve data

___Point of minimum vertical clearance

___Roadway widths

___Structure width

___Approach slabs

___Centerline of piers

___Skews

___Begin and end bridge stations

___Existing topography (50% screen)

___Bank protection limits

___Boring locations

___Deck drain locations

☐ Profile sheets

___Vertical curves and grades on profile

☐ Elevation sheets

___Distance center-to-center of end bearing

___Minimum vertical clearance

___Berm elevations

___Horizontal clearance

___Rip-rap

___Span length

___Stations and grade elevations

___Bridge length

___Existing ground line

___Datum

___Substructure elements

___Fixed and expansion piers

___Future expansion if applicable

☐ Typical sections

___Traffic lanes and shoulders

___Distance to construction centerline

___Bridge rail type and width

___Structure depth

___Piers

___Out-to-out deck dimension

___Future bridge expansion if applicable

☐ Note sheet

___General notes

___Construction staging notes

___Construction notes

☐ Boring log sheets

___Location of borings

___Legend of soil symbols

___Legend of boring operations

___Dates of borings

___Water table elevation

☐ Foundation layout sheets

___Dimension along centerline of piers to project centerline

___Skew angle

___Pier number

___Existing utilities

☐ Abutment detail sheets

___Plan view

___Front elevation

___Wing wall elevation

___Wing wall section

___Centerline of bearing station at project centerline

___Centerline of bearing skew angle

___Abutment drainage system

☐ Pier detail sheets

___Plan view

___Elevation (looking up-stationing)

___Layout data and skew angle

___Cap beam section

☐ Pre-stressed concrete detail sheets

___Elevation

___Section showing tendon pattern at mid-span

___Section showing tendon pattern at supports

___Concrete strength at transfer and at 28 days

___Framing plan

☐ Pre-stressed concrete girder detail sheets

___Elevation

___Section showing strand pattern at mid-span

___Section showing stand pattern at end of girder

___Concrete strength at transfer and at 28 days

☐ Steel girder detail sheets

___Framing plan

___Section showing diaphragm

___Section showing bracing

___Size of rolled section or welded plates and weld sizes

☐ Deck detail sheets

___Plan view

___Transverse section showing webs and diaphragms

___Barrier details

___Removable barrier details if applicable

___Barrier rails

___Handrail elevation

___Deck drain spacing and details

___Light pole base details if required

___Expansion joint block outs

___Cross sections

APPENDIX 3-S
Final PS&E Phase
Detailed Construction Plan Checklist

Final PS&E Phase plans should include the revisions agreed to from the Initial PS&E Phase submittals. Additionally the plans should include the following:

- ☐ References finalized
- ☐ Sheet numbering finalized
- ☐ Storm Water Pollution Prevention Plan
- ☐ Construction sequencing if necessary
- ☐ Traffic control if necessary
- ☐ Special Provisions (Final)
- ☐ Traffic Signal Plans
- ☐ Lighting and ITS Plans
- ☐ Signing Plans
- ☐ Pavement Marking Plans

APPENDIX 3-T
Storm Drain Inlet Design Data

APPENDIX 3-T
PROJECT NAME
PIMA COUNTY PROJECT NO. XXXXXX
(Design Year)-YEAR STORM DRAIN INLET DESIGN DATA

		Drainage Area Information						Gutter/Road Information								Inlet Information								
																Catch Basin (2.5" Apron Depression)			Slotted Drain					
Inlet (CB-)	Roadway Station	Inlet Drainage Area (Drainage Area I.D.)	Inlet Drainage Area (acres)	Discharge Coefficient	Tc (min)	Rainfall Intensity (in/hr)**	Discharge From Drainage Area (cfs)	Discharge From Upstream Bypass and/or Offsite Flow (cfs)	Inlet Contributing Bypass Flow (CB-)	Discharge To Inlet (cfs)	Road Slope (ft/ft)	Road Cross Slope (ft/ft)	Allowable Spread[1] (ft)	Spread (ft)	Depth (ft)	ADOT/PC/COT Standard Detail	Wing Basin, L (ft)	Intercepted Flow (cfs)	Calculated Length (ft)	Recommended Length* (ft)	Specified Length (ft)	Intercepted Flow (cfs)	Bypass Flow (cfs)	Inlet Receiving Bypass Flow

*Recommended length includes a safety factor of 1.2 for curb inlet, 1.33 for slotted drain (1.5 for slotted drain in a sump), and 1.5 for grates
** Precipitation data source
(1) Allowable spread based on equivalent 1-dry travel lane. (Bridge Decks - No allowable spread)
(2) Discharge from driveway or other offsite location

APPENDIX 3-U
SPECIFICATIONS, GENERAL NOTES, SPECIAL PROVISIONS GUIDELINES

Specifications

Specifications are the compilation of provisions and requirements for the performance of the prescribed work and consist of Standard Specifications, General Notes, and Special Provisions. Standard Specifications refer to the latest edition of the City of Tucson/Pima County Standard Specifications for Public Improvements and are incorporated into the bid documents by reference.

General Notes

General Notes provide general information about the project, contract expectations, and addresses items of special emphasis. There a two types of General Notes: stored and unique. Stored General Notes are used on all projects, and unique General Notes apply only to a specific project. The designer is directed to the Department's website for the latest stored General Notes.

Special Provisions

Special provisions are additions and revisions to the Standard Specifications covering conditions and requirements relevant to a project. Like General Notes, there are two types of Special Provision, Stored and Unique, both of which serve several important functions:

- Provides a means for adapting the Standard Specifications to meet the unique requirements of a specific project;
- Directly modifies the existing Standard Specifications by adding, deleting, or revising language in an existing section, or by adding a new section;
- Adds a stand-alone specification to the bid documents that does not directly modify the Standard Specifications;

The importance of a properly written special provision cannot be over emphasized given their order of precedence in the hierarchy of documents when resolving conflicts, discrepancies, and ambiguities between bid documents. Special Provisions should be developed in conjunction with the project plans and cost estimate to insure agreement with the scope of work, plan notes, and bid item measurement and basis of payment.

Stored Special Provisions

Stored Special Provisions are specifications developed, maintained, and administered by the department. Stored Special Provisions are further broken down into Recurring and Specific.

Recurring Stored Special Provisions are used on all projects. The designer is directed to the department's website for a list of current recurring stored special provisions.

Specific Stored Special Provisions are used only when (1) a project includes specific items of work for which the department has developed a special provision such as drilled shaft

foundations, water pipe, and sewer manholes; and (2) a Standard Specification that pertains to a project makes reference to the Special Provisions for specific information. A list of Standard Specifications requiring specific information to be provided within the Special Provisions or plans may be found in Exhibit 3-U-1 at the end of this appendix.

Stored Special Provisions are ***not*** to be changed except as indicated below. Keep the Stored Special Provision reference with the revision dates intact:

- Subsection 107-21 of the stored special provisions regarding utilities should be revised on each project to reflect the most current list of utility contacts.

- There are several options for Section 701 - Maintenance and Protection of Traffic available as stored special provisions. Check with Field Engineering to determine which version is preferred for the current project.

Unique Special Provisions

Unique Special Provisions are specifications that pertain exclusively to a specific situation on a project that is not covered by a stored special provision or standard specification. A Unique Special Provision is intended for a single use on a specific project. All Unique Special Provisions should be approved by the department before inclusion into the specifications.

Structure of a Special Provision

Special Provisions shall use the same structure as the Standard Specifications including subsection layouts. The use of the standardized structure of the Standard Specifications provides a common outline for special provisions that helps to ensure that all the necessary information is provided. The designer should review the Standard Specifications before writing a special provision in order to become familiar with the structures and typical phrasing used throughout.

The standard structure for Special Provisions consists of the following sections: Description, Materials, Construction Requirements, Method of Measurement, and Basis of Payment.

<u>Description</u>

Briefly, but completely describe the scope of work to be performed, with references to specifications, plans, or other special provisions that further define the work. Where necessary or desirable for clarity, describe the relationship of this work to other work or other phases of construction. Do not editorialize.

<u>Materials</u>

List the materials to be used in the work and clearly indicate the criteria for acceptance of the materials. Define the specifications and properties of each material and the method of test for acceptance. Use references to the Standard Specifications' material sections as much as possible. References may be made to AASHTO, ASTM, or other recognized specifications if the materials are not addressed in the Standard Specifications. Ensure the reference to ASSHTO, ASTM, or other specifications or test methods from agencies outside of the Department are

accurate and up to date. If a certification is required, ensure that the certification type fits the situation and that information required in the certifications is clearly defined.

A prime consideration in establishing materials requirements is whether the material will be tested by the Department and if the Department has the capability to perform the test. Field Engineering, Materials Section can provide guidance for specifying materials testing and acceptance criteria.

Construction Requirements

The construction requirements should be written in the logical order in which field operations are anticipated to proceed. Clearly define the requirements for general conditions, types of construction, and quality of workmanship. Do not leave the contractor in doubt as to what is required.

Describe the sequence of construction operations (method specifications) or the desired end product (performance-based specifications) as preferred. The construction requirements should define tolerance, limits, restrictions, preparations, or the other criteria related construction of the work that must be satisfied for an acceptable product. These requirements can include, but are not limited to, dimensions, on-site test criteria, weather conditions, traffic conditions, or time limits.

Method of Measurement

Describe the components of the completed work that will be measured to determine the pay quantity for the pay item as it is identified in the bid schedule. Define the units of measurement and whether the item will be measured in original position, in transporting vehicles, or in the completed work. Designate modifying factors or other requirements needed to establish a definitive, measurable unit. A prime consideration for method of measurement should be the degree of difficulty that field personnel will encounter in making measurements.

Basis of Payment

Define the measured units for which payment will be made. Include the pay item name as it will appear in the bid schedule and define the scope of work included in payment. Determine and identify which work is to be paid for as an individual pay item, what work is to be included in the cost of that pay item, and what work is to be included in the cost of other pay items. The Basis of Payment must clearly identify to the contractor what work is and is not to be included in the unit of cost of the pay item. For work that is not included in the pay item in the provision, the designer must then determine and clearly state where the cost of such work is to be placed.

Writing a Special Provision

A Special Provision may be written using either a Standard or Item Format. The Standard Format is preferable; however, an Item Format may be more appropriate under certain circumstances. Special Provisions shall use a typeface of Times New Roman, font size 12-point and 8-point for headings. Refer to the stored Special Provisions for samples of heading formatting.

Standard Format

Sections, subsections, paragraphs, and sentences of the Standard Specifications may be modified by appending key phrases to the end of the section or subsection heading as follows:

i. Adding language to an ***existing*** standard specification subsection, the key phrase "of the Standard Specifications is modified to add:" is placed after the subsection heading as reflected in the following example.

   203-8 BORROW

   203-8.01 Description of the Standard Specifications is modified to add:

   It shall be the responsibility of the Contractor to contact RBS Plumbing ….

ii. Adding *a* ***new*** section to the standard specifications, the key phrase " is hereby added to the Standard Specifications:" is placed after the section heading as reflected in the following example.

   SECTION 413 - ASPHALTIC CONCRETE (ASPHALT-RUBBER) is hereby added to the Standard Specifications:

iii. Revising the wording of a paragraph or sentence within an ***existing*** subsection of the standard specifications, the specific paragraph or sentence is identified and the key phrase " of the Standard Specifications is revised to read:" is placed after the section or subsection heading as reflected in the following examples.

   404-3.05 Application of Bituminous Materials the fourth paragraph of the Standard Specifications is revised to read:

   Bituminous materials shall be heated by kerosene burner in such a manner…

   807-3 Contractor's Responsibility the second sentence of the fourth paragraph of the Standard Specifications is revised to read:

   It shall be the responsibility of the contractor to notify property owners 72 hours in advance of the work.

iv. Deleting a section, subsection, paragraph, or sentence of the standard specifications, the key phrase "of the Standard Specifications is hereby deleted:" is placed after the section or subsection heading as reflected in the following example.

   506-5 BASIS OF PAYMENT the last sentence of the third paragraph of the Standard Specifications is hereby deleted.

Item Format

Although not the most desirable format, the item format may be used at times when the modifications to the Standard Specifications will be numerous and cumbersome and when

specifications for a specific construction element may require references to several sections of the Standard Specifications, as well as other non-Pima County/COT specifications. In such instances, the Item Format can provide a method of addressing multiple references in a simple, concise way. The key to this type of special provision is that the specifications focus on the bid item or series of similar bid items.

The Item Format must contain the same five major sections as the Standard Specifications:

1. **DESCRIPTION**
2. **MATERIALS**
3. **CONSTRUCTION DETAILS**
4. **METHOD OF MEASUREMENT**
5. **BASIS OF PAYMENT**

In the Materials and Construction Details sections, references can be made to specific subsections of the Standard Specifications or to other specifications. The other subsections must be written out entirely without references. If a subsection is not applicable, the subsection heading along with the wording "(None Specified)" should still be included. A list of stored special provisions using the Item Format is available from the Department upon request.

Special Provisions Format and General Order

The following is a listing of the order of the specifications. Because specifications are included in the bid documents along with other contract information, they should be numbered as SP-1, 2, etc. Refer to Exhibit 3-U-2 for a sample Special Provision.

I. SPECIAL PROVISIONS COVER SHEET

Cover sheet provided by the Department and is required in all contracts.

II. TABLE OF CONTENTS

III. GENERAL NOTES

Unique General Notes *(Outline provided by the Department, amended by the designer for a specific project, required in all contracts as needed);*

Stored General Notes *(Provided by the Department, required in all contracts).*

IV. SPECIAL PROVISIONS

Special provisions shall listed sequentially by section and item numbers. The designer shall contact the department for the latest list of recurring stored special provisions.

V. APPENDICES

Include environmental permit conditions, county ordinances and special details as required for the project.

EXHIBIT 3-U-1
LOCATIONS IN THE STANDARD SPECIFICATIONS REFERENCING REQUIREMENTS IN THE SPECIAL PROVISIONS OR ON THE PLANS:

208-2	Survivability of geotextile
301-3.03	Rate of application
404-2.01	Type, grade of bituminous material
404-3.05	Type, grade and rate of application of bituminous material
404-3.06	Cover material rate of application
404-3.12	Rate of application of blotter material
404-3.15	Rate of application of tack used for bidding purposes
404-3.16	Rate of asphaltic-rubber material
508-3.03	Testing information (RCP pg. 289)
	Testing information, trench detail and burial depth (HDPE pg.'s 292 & 294)
508-3.05	Testing for replacement sewers
510-2.03	CLSM mix design
510-3.04(D)	(1) DIP; (2) CCP; (3) HDPE Approved Materials List, SDR/DR rating HDPE Fittings; (4) PVC; (5) Steel; (6) Copper Pipe Approved Materials List
510-3.04(E)	(2) Tapping Sleeve Manufactures approved list
510-3.04(F)	(2) CCP Non-destructive testing on welds
601-1	Pre-cast unit specs
603-1	Load test on test piles
610-3.02	Method of cleaning
710-4.03	Method of measurement for detour
706-2.05	Approved manufacture for bituminous adhesive
732	Numerous references - read this Section carefully
734-2.01(D)	Pre-approved list of controller equipment
734-2.01 (E, F)	Location for delivery
736-2.04	Sign legends
803-3.01	Compaction of platting material
805-2.03(A)	Type and rate of mulch
805-3.01	Class and variety of seed and rate of application
805-3.02(B)	Seed planting method and rate; mulch type and rate; tacking agent –type, rate, and manner of application
805-3.03	Rates seed, mulch, tacking agent
806-3.01	Specify planting season
806-3.05	Specify care including weed control
807-1	Landscape establishment period
807-3.03	Irrigation system component testing
906-3	Cattleguard precast requirements
920-2.05	Estimated percentage of cementitious material
1005-3.01	Asphalt cement pressure aging temperature
1006-3.01	Requirement for air entraining admixtures
1006-4.03(A)	Concrete testing requirements
1010-4	Approved list of pipe and appurtenances
1014-4	Fabric survivability rate

EXHIBIT 3-U-2
SAMPLE SPECIAL PROVISIONS COVER SHEET

SPECIAL PROVISIONS

PIMA COUNTY DEPARTMENT OF TRANSPORTATION

Project Name

Pima County Project No. _____

Date

PIMA COUNTY BOARD OF SUPERVISORS

RAMON VALADEZ, CHAIRMAN **DISTRICT 2**

ALLY MILLER	**DISTRICT 1**
SHARON BRONSON	**DISTRICT 3**
RAYMOND CARROLL	**DISTRICT 4**
RICHARD ELIAS	**DISTRICT 5**

PRISCILLA S. CORNELIO, P.E., DIRECTOR

SP-1

SAMPLE REGISTRANT'S SHEET

Special Provisions *Pima County DOT*
[Insert project name] *Project No. xxxxxxxx*

PROFESSIONAL SEALS

These specifications were prepared under the direction of the following individuals:

(a) John H. Doe, PE, Civil Engineer, River Engineering, Inc.
(b) Susan Hines, RLS, Surveyor, Hines Survey.
(c) Pete Martin, RLA, Landscape Architect, Sonoran Design.
.
.
.

Their seals, affixed below, attest that those portions of these specifications which relate to the drawing sheet numbers appearing next to the seal were prepared under their direction.

SP-2

SAMPLE TABLE OF CONTENTS

Special Provisions *Pima County DOT*
[Insert project name] *Project No. xxxxxxxx*

INDEX TO THE SPECIAL PROVISIONS:

General Notes……..5
Section 101 – Abbreviations and Terms……..……10
Section 102 – Bidding Requirements and Conditions……..……11
Section 103 – Awarcd and Execution of Contract…….....12
Section 104 – Scope of Work……..…….12
Section 105 – Control of Work……...……...13
Section 106 – Control of Materials…….……...14
Section 107 – Legal Relations and Responsibility to Public…..……...20
Section 108 – Prosecution and Progress……...21
Section 109 – Abbreviations and Terms……...21
Section 201 – Abbreviations and Terms……...27
Item 2010004 – Preservaton Fencing……32
Section 202 – Removal of Structures and Obstructions……34
Item 2020061 – Relocate Mailbox…….35
Section 203 – Earthwork……35
Section 303 – Aggregate Base Course……...36
Section 404 – Bituminous Treatments……...…39
Section 406 – Asphaltic Concrete……..39

APPENDICES:

Appendix A - Stormwater Pollution Prevention Plan Booklet (Provided on CD)

Appendix B - Categorical Exclusion Environmental Clearance (Mitigation Measures and Approval Letter)

Appendix C - Pima County Noise Ordinance

Appendix D - Geotechnical Evaluation, Romero Road Soils Testing and Pavement Design

Appendix E - Pima County Standard Details

Appendix F - Utility Clearance Letter

SAMPLE PROJECT GENERAL NOTES

Special Provisions *Pima County DOT*
[Insert project name] *Project No. xxxxxxxx*

GENERAL NOTES

1. Project Location

This project is located within Section 22 of Township 13 South, Range 13 East, Gila and Salt River Meridian, Pima County, Arizona.

2. Scope of Work

The project consists of reconstructing a total of approximately 2,495 linear feet of existing two-lane roadway. The construction consists of constructing a three-lane roadway with paved shoulders, concrete curbs and sidewalks, and drainage facilities.

3. Contract Time

The work specified shall be completed within **125** working days.

4. Permits

Before undertaking work at any location covered by this project, the Contractor shall obtain all applicable permits, including but not limited to: water and air quality permits, street closure permits and permits for excavation/construction in the public rights-of-way, from City of Tucson or Pima County, whichever agency has jurisdiction over the area where the work is located.

5. Maintenance & Protection of Traffic

Two-way traffic on Romero Road and side streets shall be maintained by the Contractor on a minimum of a graded and compacted surface. Access for residential, commercial, church and school activities should also be maintained by the Contractor on a minimum of a graded and compacted surface. Access for mail deliveries and garbage pick-up should be accommodated in the Contractor's Traffic Control plan, with temporary closures not to exceed two (2) hours.

The Contractor shall notify residents one week in advance of when construction will occur that will affect access to their residence. The Contractor will advise residents to not park in the areas affected by construction for the duration necessary and shall limit the duration of construction to the minimum possible.

The Contractor shall be responsible for all construction zone traffic control in accordance with Section 701 of the Standard Specifications and these Special Provisions. The Contractor's compensation for maintaining traffic on an approved surface with detours is included under Bid Item 7010005 - Traffic Control.

SAMPLE OF RECURRING STORED SPEC (NOTE THE REFERENCE & DATE)

Special Provisions *Pima County DOT*
[Insert project name] *Project No. xxxxxxxx*

(102BID_REQ, 5/26/06)

SECTION 102 - BIDDING REQUIREMENTS AND CONDITIONS

102-4 CONTENTS OF BID DOCUMENT the 2nd paragraph of the Standard Specifications is revised to read:

All papers bound with or attached to the bid document are considered a part thereof. Bid forms may be detached and submitted as the bid. It is the contractor's responsibility to include and execute all necessary bid forms.

102-9 AFFIDAVIT AND CERTIFICATION FORMS of the Standard Specifications is hereby deleted.

102-11 DELIVERY OF BIDS the last sentence of the Standard Specifications is hereby deleted.

(103FHWA_AWARD_LISC, 11-4-05)

SECTION 103 - AWARD AND EXECUTION OF CONTRACT

103-2 AWARD OF CONTRACT of the Standard Specifications is modified to add:

This contract is funded, either wholly or in part, by federal funds, and the award of contract may be made contingent upon the successful bidder obtaining an appropriate license from the State Registrar of Contractors, in accordance with Arizona Revised Statutes 32-1101 through 32-1170.03. The license must be obtained within 60 calendar days following opening of bid proposals. No adjustment in proposed bid prices or damages for delay will be allowed as a result of any delay caused by the lack of an appropriate license.

Failure to acquire the necessary licensing within the specified period of time shall result in either award to the next lowest responsible bidder, or re-advertisement of the contract, as may be in the best interests of the Agency.

Licensing information is available from:

Registrar of Contractors
800 W. Washington, Sixth Floor
Phoenix, AZ 85007
Phone: (602) 542-1502

SP-5

SAMPLE OF A STORED ITEM SPEC (NOTE THE SECTION REFERENCE & DATE)

Special Provisions *Pima County DOT*
[Insert project name] *Project No. xxxxxxxx*

(203OVEREXC_UNSUITABLE, 1/4/12)

ITEM 2030500 EXCAVATION (OVEREXCAVATION)

1. DESCRIPTION

The work under this item consists of performing all operations necessary to perform the overexcavation required to remove the unsuitable material at the locations shown on the plans and in accordance with requirements of these specifications.

2. MATERIALS (None Specified)

3. CONSTRUCTION DETAILS

The unsuitable removal construction requirements shall be in accordance with the plans, these Special Provisions, Section 203 of the Standard Specifications, and as directed by the Engineer.

4. METHOD OF MEASUREMENT

The method of measurement for unsuitable material removal will be by the cubic yard in the original space occupied. The volume of material removed will be computed according to the provisions of Section 109.

5. BASIS OF PAYMENT

The accepted quantities of unsuitable material removal, measured as provided above, will be paid for at the contract unit price per cubic yard. The price shall include full compensation for the work complete, including hauling, stockpiling, and placement within allowable embankment areas on the project. The allowable embankment areas are defined as those areas that are not within the original space occupied and not within 3’ of the finished subgrade.

SAMPLE OF UNIQUE ITEM-TYPE SPECIAL PROVISION

Special Provisions *Pima County DOT*
[Insert project name] *Project No. xxxxxxxx*

ITEM 9142002 - SIGN WALL AT SUN VIEW APARTMENTS (2201 S. AJO WAY)

1. DESCRIPTION

The work under this item shall consist of furnishing labor, equipment and materials to construct a masonry sign wall 8' (L) x 2'(W) x 6'(H) at location outside of right-of-way as identified by Juan Martinez, apartment manager. Work will include the construction of concrete footings on compacted subgrade.

2. MATERIALS

Concrete Masonry Units. CMU shall be…

Mortar and Grout. Mortar and grout shall conform to the requirements of Section 914 of the Standard Specifications...

Stucco. Stucco finish to be…

Paint. Stucco shall be painted with…

Reinforcement. Reinforcing steel shall meet the requirements of…

3. CONSTRUCTION DETAILS

The wall footings will be constructed in accordance with…

Shop Drawings. Shop drawings shall be submitted for fabrication…

Installation. Only skilled, experienced masons shall be …

4. METHOD OF MEASUREMENT

Masonry Sign Walls will be measured by the lump sum amount for each wall.

5. BASIS OF PAYMENT

The accepted quantities of masonry sign walls, measured as provided above, will be paid for at the contract unit lump sum price for each wall, complete in place, including all excavation, backfill, compaction, formwork, concrete and reinforcement for footings, reinforcement for walls, grout, stucco, painting, and wall treatments, labor, equipment, materials and incidentals necessary to complete the work.

SAMPLE TYPICAL APPENDIX

Special Provisions *Pima County DOT*
[Insert project name] *Project No. xxxxxxxx*

APPENDIX A

STORMWATER POLLUTION PREVENTION PLAN BOOKLET

(PROVIDED ON CD)

APPENDIX 3-V
SAMPLE UTILITY MEMORANDUM OF AGREEMENT

MEMORANDUM OF AGREEMENT BETWEEN PIMA COUNTY DEPARTMENT OF TRANSPORTATION AND XYZ UTILITY COMPANY

1. GENERAL

Pima County Department of Transportation ("Department") has been given approval and authorization by the Board of Supervisors and Regional Transportation Authority to design and construct improvements along Busy Bee Road, Section 21, T12S, R13E, project number 4RBEEE ("Project"). The project consists of reconstructing 5000 feet of roadway from 2-lanes to 3-lanes. The XYZ Utility Company ("Utility") has facilities located within the project's boundaries that impact the Project and will require adjustment, removal, and modification.

The Utility will relocate and remove some of the impacted facilities prior to construction of the Project and is requesting that the remaining facilities be installed, removed, and modified ("Work") be incorporated into the Project.

The Department has determined that it would be in the best interest of the county and Utility to include the Work in the Project with the understanding that all costs of the Work are to be reimbursed to the Department in accordance with the terms and conditions of this Memorandum of Agreement ("Agreement").

2. PURPOSE

The purpose of this Agreement is to establish the roles, responsibilities, and compensation between Utility and Department related to the Work.

3. DESCRIPTION OF WORK

The Work consists of the removal of an estimated 3000 linear feet of 6" PVC conduit (bid item 2020333); removal and backfilling of three (3) 6' x 10' x 12' concrete vaults (bid item 2020018); trench and backfill of 4500 linear feet of 2 foot wide trench per sheet 34 of 233 for the placement of 2- 4" PVC conduit by others (bid item 9300124); and installation of 25-feet of 6" diameter galvanized sleeve through the east bridge abutment as shown on sheet 55 of 233 (bid item 9300178).

The Work shall also include the design, drawings, and special provisions of the work items described in the above paragraph. The Utility has elected to use the Department's consultant, Superior Engineering, Inc., for development of the design, drawings, and special provisions

4. ROLES AND RESPONSIBILITIES

4.1 Pima County Department of Transportation

a. Construct, administer, and supervise the items of Work.
b. Apply for a Pima County Right-of-way Use Permit.
c. Coordinate with the Utility's designated contact the excavation and backfill of bid item 9300124 and 9300178 in accordance with the project's special provisions.
d. Notify the Utility within 24 hours of the start of all Work items.

e. Include within the project's contract documents the Work drawings, bid items, and special provisions provided by the Utility (item d, Section 4.2).

4.2 XYZ Utility Company

a. Reimburse the Department for all cost incurred in the performance of the Work.
b. Utility will contract directly with Superior Engineering, Inc. for development of the design, drawings, and special provisions.
c. Provide timely inspection.
d. Submit to the Department on or before January 12, 2014 for inclusion into the Project's contract documents the drawings, bid items, and special provisions associated with the Work described in Section 3.

5. COMPENSATION AND BILLING

5.1 Costs

The Utility will reimburse the Department for all costs incurred in the performance of the Work identified in Section 3. The cost of the work is estimated to be $98,095. This amount represents $9,000 (2020333); $7,000 (2020018); $67,000 (9300124); $2,300 (9300178); and $12,795 (15% administration and inspection fee).

5.2 Billing

Upon completion and acceptance of the Work by the Utility, the Department will invoice for the cost of the Work on a monthly basis. Payment is to be received within forty-five (45) business days of receipt of the invoice.

6. MODIFICATION AND TERMINATION

This Agreement may be modified or terminated at any time only by mutual written consent of XYZ Utility Company and Pima County Department of Transportation.

7. ENTIRE AGREEMENT

This Agreement constitutes the entire agreement hereto and supersedes any prior understanding or written or oral communications between XYZ Utility Company and Pima County Department of Transportation respecting the subject matter hereof.

8. EFECTIVE DATE, TERM AND SIGNATURE

This Agreement shall be effective on the date on which both parties sign hereto, whichever date is later, and end June 30, 2014, or until the Agreement is terminated pursuant to the terms contained herein, whichever event occurs first.

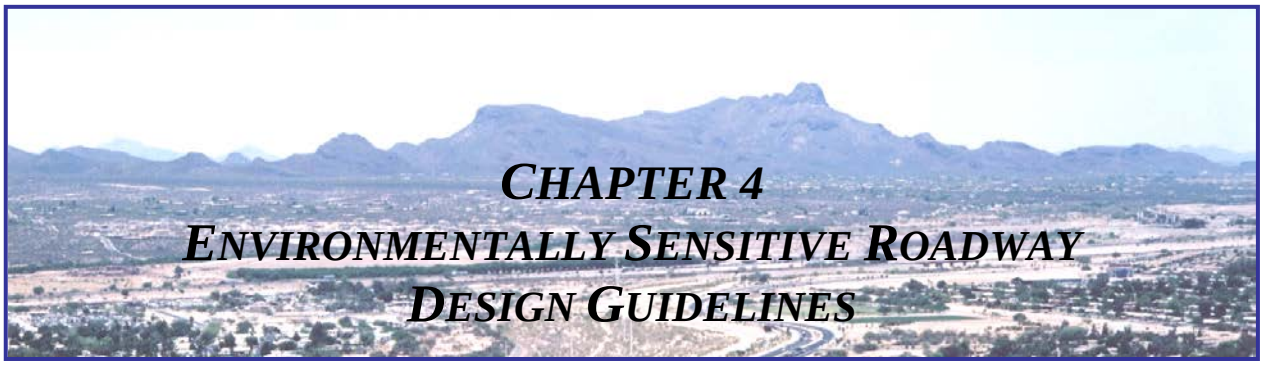
Authorized signatures and dates

_____ _____

(Insert name), XYZ Utility Company Director Date

_____ _____

(Inset name), Deputy Director, Department Date



CHAPTER 4
ENVIRONMENTALLY SENSITIVE ROADWAY DESIGN GUIDELINES

4.1 INTRODUCTION

The Environmentally Sensitive Roadway Design Panel (the Panel) developed general recommendations for roadway improvement projects within environmentally sensitive areas in July 2001. The Panel was formed in response to community concerns about potential conflict between preserving environmentally sensitive areas, transportation design and construction practices, and the ongoing need for infrastructure improvements. The Panel's initial goal was to develop special design guidelines that would bridge the gap between community concerns and the County's design of new or improved roadways in environmentally sensitive areas.

The Panel re-convened in 2002 to expand upon its initial recommendations. The 2002 Panel consisted of experts from multiple disciplines. Members included roadway engineers, wildlife biologists, cultural resources experts, and a landscape architect. The resulting guidelines, presented in this chapter, provide roadway design specifications that will minimize impacts to our region's resources. The approach defined in this chapter is intended to provide roadway design teams with environmental information early in the design effort. This information should allow design teams to adjust specific design elements to better account for biological, cultural, and historic resources in the roadway corridor. Additionally, the chapter provides some mitigation tools necessary to conduct transportation projects in environmentally sensitive lands. For example, greater flexibility in the range of acceptable design values for specific roadway features is identified for ESR design. This document is not, however, an exhaustive resource of mitigation ideas. Further information on how to treat or mitigate potential effects of roadway projects can be obtained from pertinent websites that are cited in this chapter and listed in Appendix 4-A.

4.2 ENVIRONMENTALLY SENSITIVE LANDS AND ROADWAY DESIGNATION

Environmentally Sensitive Lands (ESL) are those areas that are unique and ecologically or culturally sensitive. The public has made known its interest in and the importance of these areas. In Pima County, ESL are determined by certain Sonoran Desert Conservation Plan (SDCP) Conservation Lands System categories and/or the designation of a Scenic and/or Historic Route. ESL may exhibit several characteristics, such as the presence of habitat for special status species (e.g., endangered species), vegetation communities that are growing in scarcity (e.g., cottonwood-willow riparian plant community), cultural resources (e.g., historic buildings), and designated scenic routes. A transportation project within ESL is defined as an ESR and should be designed and constructed to minimize disturbances to the area resources. Specifically, an ESR is a roadway that meets any of the following criteria:

- Location within or crossing any of the areas on the SDCP Conservation Lands System Map, which are identified as:
  - Biological Core
  - Multi-Use or Recovery Area
  - Important Riparian Area
  - Agriculture within Recovery Area
  - Existing Development
  - Scientific Research Area
- Location within or crossing a High or Moderate Archaeological Sensitivity Zone or a Priority Cultural Resource
- Identified as a Historic Roadway or Route
- Identified as a Scenic Route

The information referenced in criteria A and B above, with the exception of Priority Cultural Resources, is found on the Pima County Website (see Appendix 4-B). Scenic Routes are identified on the *Pima County Major Streets and Scenic Routes Plan* (see Appendix 4-A).

Examples of the website maps used to determine ESR criteria are presented in Appendix 4-C. From the SDCP Conservation Lands System Map, the example project area, shown in red, clearly involves three ESR criteria: (1) High Archaeological Sensitivity Zone, (2) Multiple Use or Recovery Area, and (3) Important Riparian Area. The *Pima County Major Streets and Scenic Routes Plan* indicates that the project area also meets the ESR criteria of being a designated Major Scenic Route. The Historic Roadways or Routes data layers will be developed in the future and posted on the web. Map data on Priority Cultural Resources is restricted. The Pima County Cultural Resources Office should be contacted to determine if a roadway project meets the ESR criteria of being located within or crossing a Priority Cultural Resource or is a known historic roadway or route. To access site-specific information on the Pima County website, “zoom in” to a scale of 1:128,000.

4.3 ENVIRONMENTAL RESOURCE ASSESSMENT AND MITIGATION PROCESS

Once it is determined that a project will contain roadways that meet the ESR criteria, there are a number of steps that the responsible party must take. These steps are related to the following three design elements, which are discussed in Sections 4.4, 4.5, and 4.6 respectively.

- Biological Resource Preservation and/or Enhancement
- Cultural or Historic Resource Preservation and/or Enhancement
- Visual and Aesthetic Resource Preservation and/or Enhancement

A process has been developed for each of these resource design elements. The process begins with the discovery/identification of the individual resources within each element, which produces initial inventories for each resource element. The next stage of the process is an inventory analysis in which the Design Team assesses the potential impacts of the project on each of the resources and then identifies potential treatment options. Design elements used to create these treatment options may include:

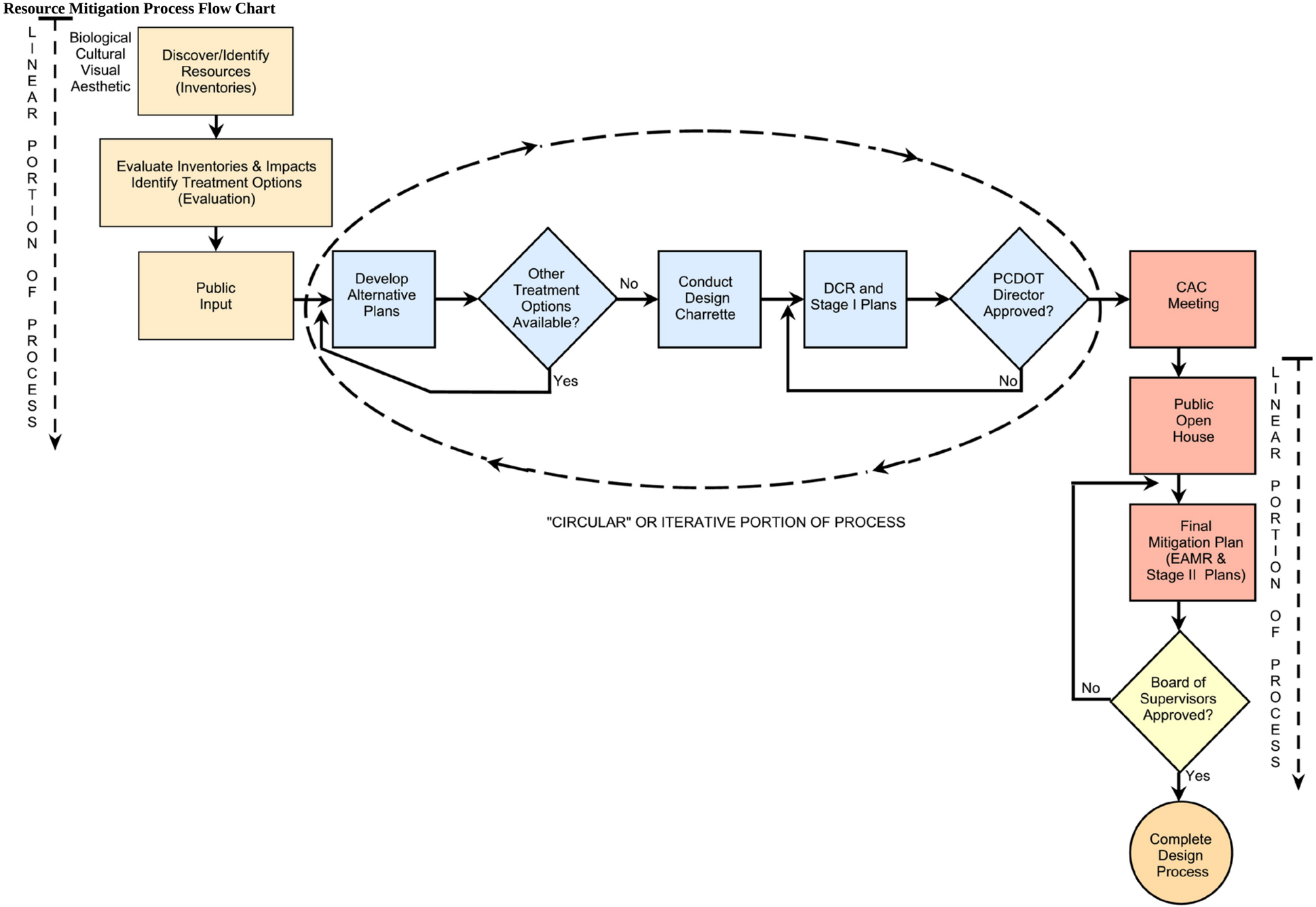
- Art
- Lighting
- Bicycle facility
- Noise wall or other abatement
- Bridge structural elements
- Pavement type/surface
- Construction phasing/sequencing
- Signage
- Cultural inventory/treatment
- Utility locations
- Drainage and culvert design
- Viewsheds
- Equestrian facilities
- Vegetation preservation/management
- Landscape Improvements
- Wildlife crossings

Sufficient information has now been gathered to allow the Design Team to solicit public input and initial reaction to the inventories and to the array of possible treatments/mitigation measures. The public input may take several forms, including CAC meetings, public open houses, or other outreach techniques as deemed appropriate.

Up to this point in the process, the Design Team has been operating in a linear mode, with resource studies being conducted separately from each other. The process now enters the stage in which the individual assessments are combined and various holistic solutions coalesce. This is a dynamic stage, with feedback loops that promote an "iterative" or "circular" process. The stage begins with the Design Team performing a functional analysis based on the treatments/mitigation measures that were previously examined by the public. Next, in a design charrette (i.e., an intensive workshop), the Design Team analyzes the opportunities and constraints of the project. The objective is to discuss major design issues that impact the environment and to formalize design solutions. The outcome of the charrette is a conceptual design that incorporates the most effective resource preservation and enhancement treatments. This conceptual design is then incorporated into the Design Concept Report (DCR), which documents the planning process (see Chapter 3, Section 3.17). The DCR is submitted to Pima County for review and comment.

With the completion of the DCR, the design concept is presented to the public for review and comment. Again, the public involvement may take several forms, including CAC meetings, public open houses, or other public outreach techniques as appropriate. The public involvement is a precursor to finalization of the mitigation portion of the EAMR (see Chapter 3, Section 3.18) and the approval of the Pima County Board of Supervisors. Board approval triggers the completion of the construction documents through the standard roadway development procedures of Pima County's *Community Participation and Mitigation Ordinance* (see Chapter 1, Appendix 1-A). Figure 4-1 summarizes the Environmental Resource Mitigation Process.

Figure 4-1
Environmental Resource Mitigation Process Flow Chart



4.4 BIOLOGICAL RESOURCE PROCESS

This section describes steps to identify biological resources and evaluate the impacts of proposed roadway projects. In addition to determining the presence/absence of special status species and their habitat, this process also measures vegetation so that appropriate re-vegetation of the site can be undertaken. For ESR projects, vegetation measurement shall be conducted by a qualified biologist/botanist or registered landscape architect and will consist of following two procedures: (1) Tree Caliper Measurement and (2) the Releve Method. Appendix 4-D provides a detailed description of vegetation measurement, while Appendix 4-E and Appendix 4-F provide information regarding appropriate plant species and landscaping guidelines, respectively. Since ESRs are located in ESL, it is imperative that the post-project environment duplicate the pre-project environment to the greatest extent possible.

In addition, all projects must address and comply with all Pima County environmental ordinances (e.g., Riparian, Buffer Overlay), with the exception of the Pima County Native Plant Preservation Ordinance (NPPO). **The NPPO protects only certain species, and does not serve to recreate complete plant assemblages; therefore, the Pima County NPPO does not apply to ESR projects.**

Steps in the Process

Following are the key steps in the Biological Resource Process. Key terms are defined at the end of this section.

Step 1: Discover/Identify Existing Resources

Step 1 consists of researching background information and conducting site visits and surveys as appropriate.

Background Information[1]

- Contact the USFWS through its website (see Appendix 4-B) and the AGFD by letter/future website to request information on special status species in the project area.
- Determine whether the project area lies within or in close proximity to any SDCP Conservation Land System designations for the project area, including Critical Landscape Linkages. For this purpose, the project area is defined as 1/4 mile from the project right-of-way.
- Determine distance of project to or inclusion within SDCP Priority Conservation Areas and or Modeled Potential Habitat for any of the SDCP Priority Vulnerable Species.
- Determine if the project area is within (or contains portions of) riparian areas inventoried as part of the SDCP Riparian Study (termed Harris Riparian on MapGuide).

[1] The Pima County MapGuide web page (see Appendix 4-A) can be used to access the information needed for Step 1: B, C, D, and E. To access detailed information such as the Conservation Land System, "zoom in" to a scale of 1:128,000.

- Determine if the project area is within a designated Preserve Area.
- Determine if the project area is within (or contains portions of) riparian areas classified as Title 16 Floodplain and Erosion Hazard Management Watercourses as determined by Pima County Code (see Appendix 4-B for relevant website).

Conduct Site Visit and Various Surveys

- Conduct site visit to determine if habitat for any special status species exists.
- Conduct species-specific surveys for federally protected Threatened and Endangered Species as warranted based on habitat outcome.
- Inventory plants using the two methodologies outlined in Appendix 4-D to measure the vegetation. Do not use the Pima County NPPO measurement techniques. In some instances, the project area (or portions thereof) may have been previously graded or disturbed. If this is the case, vegetation in an adjacent undisturbed area will serve as a representative. To measure adjacent vegetation use the sampling method described in Appendix 4-D.
- Document presence of any special elements (e.g., springs, caves).
- Coordinate with Pima County staff to determine if there are any concerns including those of non-special status species. Coordination may include meetings with USFWS and AGFD.
- Determine location for specific biological linkages, if any.

Step 2: Evaluate Effects

- Evaluate effects (impacts) to SDCP Riparian areas, if any.
- Evaluate effects (impacts) to habitat of any special status species (from USFWS and AGFD responses).
- Evaluate effects (impacts) to special status species (from USFWS response and AGFD response) known to be present on the project site.
- Conduct any additional surveys and site visits as needed or directed.
- Determine if the project meets the development density for the specific SDCP Conservation Land System Classification designation.
- Evaluate effects (impacts) to non-special status species and biological linkages based on outcome of meeting with Pima County staff.

Step 3: Identify Potential Conservation Measures/Treatment Options
(with assistance from USFWS and AGFD)

- Determine if SDCP Riparian areas, Title 16 Watercourses, and special status species habitat can be avoided to minimize effects to special status species.
- Determine appropriate mitigation measures (e.g., conservation easements, re-vegetation, road crossing design, off-site compensation) for project area based on special status species presence. Additional site visits may be needed.

- Submit assessment to appropriate agencies for concurrence.
- Monitor project to assure mitigation measures have been accomplished.

Key Definitions

Special Status Species: Defined as federally protected threatened and endangered species, Sonoran Desert Priority Vulnerable Species, plant species protected by the Arizona Native Plant Law, Bureau of Land Management/U.S. Forest Service Sensitive Species, and species identified by AGFD as Wildlife Species of Special Concern.

Priority Conservation Area: An area that supports essential (core) habitat for Priority Vulnerable Species (see below) based on expert knowledge. There are four levels of conservation areas. Definitions of each level can be found in the Biological Information on MapGuide, For Use By Public Works Staff, July 2002.

Modeled Potential Habitat: The County mapped environmental characteristics (e.g., riparian areas, elevation, soil composition) and known species locations using GIS. These maps were compared to known habitat requirements for each of the Pima County vulnerable species to determine the potential distribution of that habitat across Pima County. On the website, a High-Medium-Low color scale is used to depict the distribution of potential habitat.

Priority Vulnerable Species: These consist of 55 species of concern within Pima County that are proposed for protection under the Conservation Lands System.

4.5 CULTURAL RESOURCES PROCESS

The effect of construction on cultural resources must be considered as a part of roadway planning and design. Cultural resources are those places and things that have been created by the people who have lived, over many centuries, in what is today Pima County. These resources include: archaeological resources, historic resources, historic roads, and traditional cultural places. Cultural resources collectively represent Pima County's prehistory and history over many thousands of years, providing tangible links to our heritage. These resources are fragile, finite, irreplaceable, and non-renewable, and have scientific, educational, recreational, aesthetic, and spiritual values.

Pima County has determined that protecting cultural resources is in the public interest. Consequently, these resources must be considered during project planning and design. To facilitate planning and design, this section defines cultural resources, explains how their value is determined, describes the cultural resource review process, and examines treatment options that can be used to mitigate effects should cultural resources be impacted by a proposed Pima County roadway project.

Key Terms

Here, the term *cultural resource* is used to refer broadly to four kinds of phenomena: (1) archaeological resources, (2) historic resources, (3) historic roads, and (4) traditional cultural places. Following established Pima County protocol (Pima County, August 2000), cultural resources are defined below.

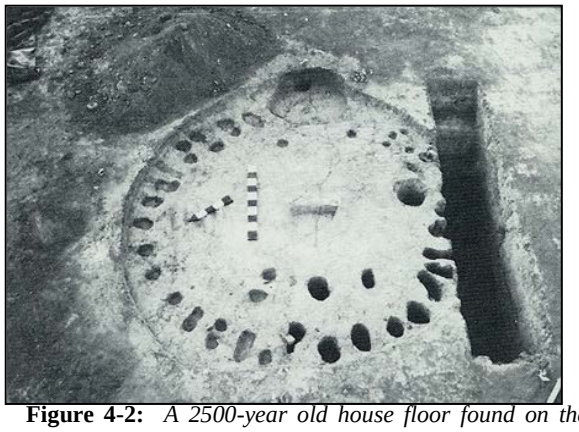


Figure 4-2: *A 2500-year old house floor found on the flood plain of the Santa Cruz River is an archaeological resource.*

Archaeological resources are any material remains of past human life or activities that are preserved in their original setting and are important to understanding prehistory or history. These sites or districts may include occupation sites; work areas; farming sites; burials/other funerary remains; artifacts; campsites; hearths; rock art; intaglios; trails; battle sites; religious or ceremonial sites, caves and rock shelters; architectural/other remains of structures of all kinds, including pit houses, pueblo rooms, adobe or rock foundations; and other domestic features, usually dating from prehistoric or aboriginal periods, or from historic periods at least 50 years old, for which only archaeological vestiges remain. This definition has been broadly applied to include prehistoric and historic sites of all time periods, functions, and spatial distributions, extending from the earliest human occupation some 12,000 years ago to the 20th century.

Historic resources are sites, districts, structures, objects, or other evidences of human activities that represent facets of the history of the nation, state, or locality. Also included are places where significant historical or unusual events occurred even if no evidence of the event remains, and places associated with persons significant in our history that have gained importance in the last 50 years.

Historic resources include a wide variety of sites, buildings, structures, and objects, including residences, commercial establishments, engineered features such as roads and bridges, schools, churches, military forts, cemeteries, parks, streetscapes, and properties that are listed on the National Register of Historic Places either individually or as groups of properties defined as districts.

Figure 4-3: *A 19th century Queen Anne revival style house in Tucson is a historic resource.*

Historic roads, while technically a subset of historic resources, are of particular relevance and importance to roadway design and construction. Consequently, a historic road is considered here as a discrete resource type. Historic roads have contributed to our culture in a meaningful way through design, experience, or association. This quality may be based on aesthetic, engineering, or cultural significance. Roads with aesthetic qualities are generally designed to enhance traveler experience by passing through parks or scenic landscapes. Roads with significant engineering qualities exhibit functional characteristics where design and technology are combined to facilitate efficient transportation. Historic roads may also be important as corridors or routes across the landscape that were used during broadly defined periods of exploration, migration, and settlement. In some cases, the original surfaces of historic roads may no longer exist.

Figure 4-4: *The bridge over Cienega Creek, built in 1921 is a historic road feature.*

Traditional cultural places are important because of their association with a living community's cultural practices or beliefs that are: (a) rooted in community history and (b) important in maintaining the continuing cultural identity of the community. The cultural significance of a traditional cultural place is derived from the role the property plays in historically rooted beliefs, customs, and practices of a community. Cultural resources that meet this definition are typically, but not exclusively, identified as significant to Native American communities. Examples include places where traditional plants used in ceremony are gathered, natural landscape features associated with an event or figure important in creation myths, or springs revered because of life giving water.

Figure 4-5: *The Santa Rita shrine on Arivaca Road is a place of traditional cultural value.*

National Register of Historic Places

The National Register of Historic Places is the nation's honor roll of places considered important to the American public on the national, regional and/or local level. The Register was created as part of the National Historic Preservation Act of 1966, and is maintained by the National Park

Service (NPS). NPS developed criteria to assess the eligibility of cultural resources for listing in the Register. Pima County applies these criteria to all public works projects when cultural resources may be affected. Only cultural resources that are listed or are eligible for listing in the National Register are considered for further treatments/mitigation. The criteria are defined in the U.S. Department of the Interior Regulations 36 CFR Part 60. To be eligible, a cultural resource must be 50 or more years old and meet at least one of the criteria listed below.

"The quality of significance in American history, architecture, archaeology, engineering and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:

a. that are associated with events that have made a significant contribution to broad patterns of history; or
b. that are associated with the lives of persons significant in our past; or
c. that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
d. that have yielded, or have the potential to yield, information important in prehistory or history."

National Register determinations are made during a review process that is specifically designed to assess and treat impacts to cultural resources during public works projects.

Steps in the Process

To determine whether a proposed road project must follow the ESR review process because of the presence of cultural resources, the map of archaeological sensitivity zones should be consulted. This map is presented on the Pima County website (see Appendix 4-B). Projects located within the high or medium sensitivity zone will be treated as ESRs, and subject to the guidelines presented below. Additionally, specific cultural resources may be affected for which further information is needed. The Pima County Cultural Resources Office should be contacted with a letter and vicinity map that detail the nature and location of the project. The staff will determine whether the project could potentially affect priority cultural resources – that is places that have been determined by Pima County to be of extraordinary importance to the history and culture of the County. Road projects that will affect these priority sites will be required to follow the review process outlined below.

The review process that Pima County follows for assessing and treating the effects of public works projects on cultural resources mirrors the federal process as detailed in federal regulations at 36 CFR 800. Table 4-1, presented at the end of this section, outlines the process steps.

Step One: Identify and Assess Cultural Resources

The first step involves collecting data on cultural resources within the project area as defined by the Pima County Department of Transportation. A professional archaeological consultant, along

with a registered architect if warranted, conducts background research to determine whether or not the project area has previously been surveyed to current standards. This researched information should include: what cultural resources are known within the project area, who did the work, when it was done, how it was done, and what was found. Often, additional information is needed and the archaeologist conducts a field survey of the project area. The results of the background research and survey are documented in a report, which is reviewed by the staff of the Pima County Cultural Resources Office. If no cultural resources will be affected by the proposed project, the process ends and the cultural resource requirements for the project have been met.

If cultural resources are located within the project area, they are assessed based on the National Register criteria discussed previously. The staff of the Pima County Cultural Resource Office consults with the SHPO in Phoenix by sending the SHPO a copy of the survey report to make a National Register determination. In some cases, other parties such as state and federal agencies are consulted if they have regulatory involvement in the project. To assess National Register eligibility, on occasion additional information may be needed that requires subsurface testing to characterize the nature of archaeological deposits. The findings are documented in a report and sent to the consulting parties as needed. Once National Register determinations have been completed for all the cultural resources that may be affected, the project then goes to the next step in the review process.

Step Two: Evaluate Effects to National Register Eligible Cultural Resources

The second step entails the professional architectural consultant and/or registered architect evaluating the potential effects of the proposed project on those qualities that make the cultural resources located in the project area eligible for listing in the National Register. If the effects will be adverse, then treatment options for either avoiding effects or mitigating those effects are formulated, and a plan is prepared by a professional archaeologist or architect as applicable. Examples of various treatment options are provided in Table 4-2 and further discussed in Section 4.7. These options may include avoiding cultural resources through project redesign, or preserving them in place using physical barriers to ensure their protection. Rehabilitation and reuse are also treatment options where cultural resources are incorporated into the design of the project. Another option is to relocate the resource, if practical, to another location. Lastly, treatment can consist of data recovery to record and analyze information that would otherwise be lost through construction. Which treatment option is selected will depend on the types of cultural resources that will be affected and what can most practically be achieved given limitations of time and money.

Treatment options will be further refined as a result of the design charrette (see first page of Section 4.3) during which potential impacts are evaluated with the road Design Team. Once the project design is selected, the preferred treatment option is detailed in the mitigation plan, which is submitted to the SHPO and other consulting parties for their review and comment. The mitigation plan is then revised as needed to reach agreement on the best course of action to be taken.

Step Three: Implement Mitigation Plan

The last step in the review process involves implementing the mitigation plan to either avoid the National Register eligible cultural resources or conduct a program to mitigate adverse effects to those resources. This will require coordinating the work with the construction phasing discussed in Section 4.4. As a matter of convention, once any required mitigation fieldwork is completed, then, upon approval by staff of the Pima County Cultural Resource Office, construction may begin in the project area while laboratory research, analysis, artifact curation and report preparation is ongoing. When the report is complete, the SHPO is consulted one last time to ensure that the end result of the mitigation plan is acceptable, although by this time road construction may already be underway or even finished. Copies of a final report are sent to all relevant parties.

Conclusion

Pima County recognizes the importance of considering the effects of its actions on cultural resources and has determined as a matter of policy that steps should be taken to avoid or lessen these effects. Public works projects have been subject to this policy since 1983 and the cultural resources review process has been consistently included in Pima County roadway projects since 1989.

Avoidance of cultural resources or preservation in place is always the preferred means of mitigating potential effects of road construction. Cultural resources are finite in number and so each one that is lost is another that will not be available for future generations. Typically, the cultural resource review process is engaged during the environmental assessment phase of project planning, and the survey is conducted once plans have been developed. However, opportunities for avoidance and preservation in place are often limited because not enough is known about cultural resources before design begins. The ESR procedures described in this chapter incorporate more cultural resource information earlier in the planning process, encouraging a collaborative approach between project designers and cultural resource professionals to achieve preservation more often.

For more information about historic preservation related topics, consult the applicable websites listed in Appendix 4-B.

Table 4-1
Cultural Resources Review Process

Identify/Assess Resources			**Evaluation of Effects**	**Mitigation of Effects**
Resource Types	*Inventory/ Testing*	*National Register Criteria*	*Treatment Options/Planning*	*Mitigation Plan*
- Archaeological - Historic - Historic Roads - Traditional Cultural Places	- Background Research - Informant Interview - Field Survey - Field Testing	- Apply NR Criteria a. Historic Events b. Historic People c. Type, Period, Method, etc. d. Information Potential	- Avoidance - Preserve/Protect - Rehab/Reuse - Relocate - Mitigate/Record	- Implement Plan - Complete Field Work - Proceed with Road Project
	Report Prepared		Mitigation Plan Prepared	Mitigation Report Prepared
	Internal Review	External Review	Internal/External Review	Internal/External Review
		Consult w/SHPO and other parties as needed	Consult w/SHPO and other parties as needed	Consult w/SHPO and other parties as needed

Table 4-2
Examples of Treatment Options by Cultural Resource Type

Archaeological Resources: **Sites, Objects, Districts/Complexes**	**Historic Resources:** **Buildings, Structures, Objects, Districts, Landscapes**
Treatment Options - **Avoidance** Redesign Realign - **Preserve/Protect** Intentional Burial Physical Barriers Covenants/Easements Donation - **Data Recovery** Testing/Excavation Mapping, photography, records research Informant Interview	Treatment Options - **Avoidance** Redesign Realign - **Preserve/Protect** Covenants/Easements Donation - **Restore/Reuse/Retrofit** Restore to original condition. Incorporate historic elements into new design - **Relocate** Move from harms way - **Record/research** Drawings, photography, records research Informant Interview
Historic Roads: **Aesthetic, Engineered, Cultural**	**Traditional Cultural Places:** **Shrines, Burials, Rock Art, Gathering Places, Natural Features, Springs/Drainages, Landscapes**
Treatment Options - **Avoidance** Redesign Realign - **Adaptive Reuse** Incorporate historic elements into new design Retain historic setting - **Record/Research** Drawings, photography, records research Informant interview - **Public Information/Education** Signage, information kiosks, popular publications, lectures	Treatment Options - **Avoidance** Redesign Realign - **Preserve/Protect** Intentional Burial or reburial - **Restore/Reuse** Repair Provide new access to - **Relocate** Move away from harm - **Record/Research** Map, photograph (if appropriate), research Informant interview - **Ceremonial Treatment** On site ceremony/ritual

4.6 VISUAL AND AESTHETIC RESOURCE PROCESS

This section provides an overview discussion of the process to: (1) identify visual and aesthetic resources, (2) analyze and evaluate the visual impacts associated with different types of roadway projects, and (3) develop treatments/mitigation measures to address impacts to important visual resources and to maintain and/or enhance the aesthetic character of the roadway corridor.

Key References

The following documents may be reviewed in conjunction with the process outlined in this section and shown in Figure 4-6. The Visual and Aesthetic Resource Evaluation Process for ESR design projects is based on a combination of the principles presented in seven documents on visual analysis included in Appendix 4-A.

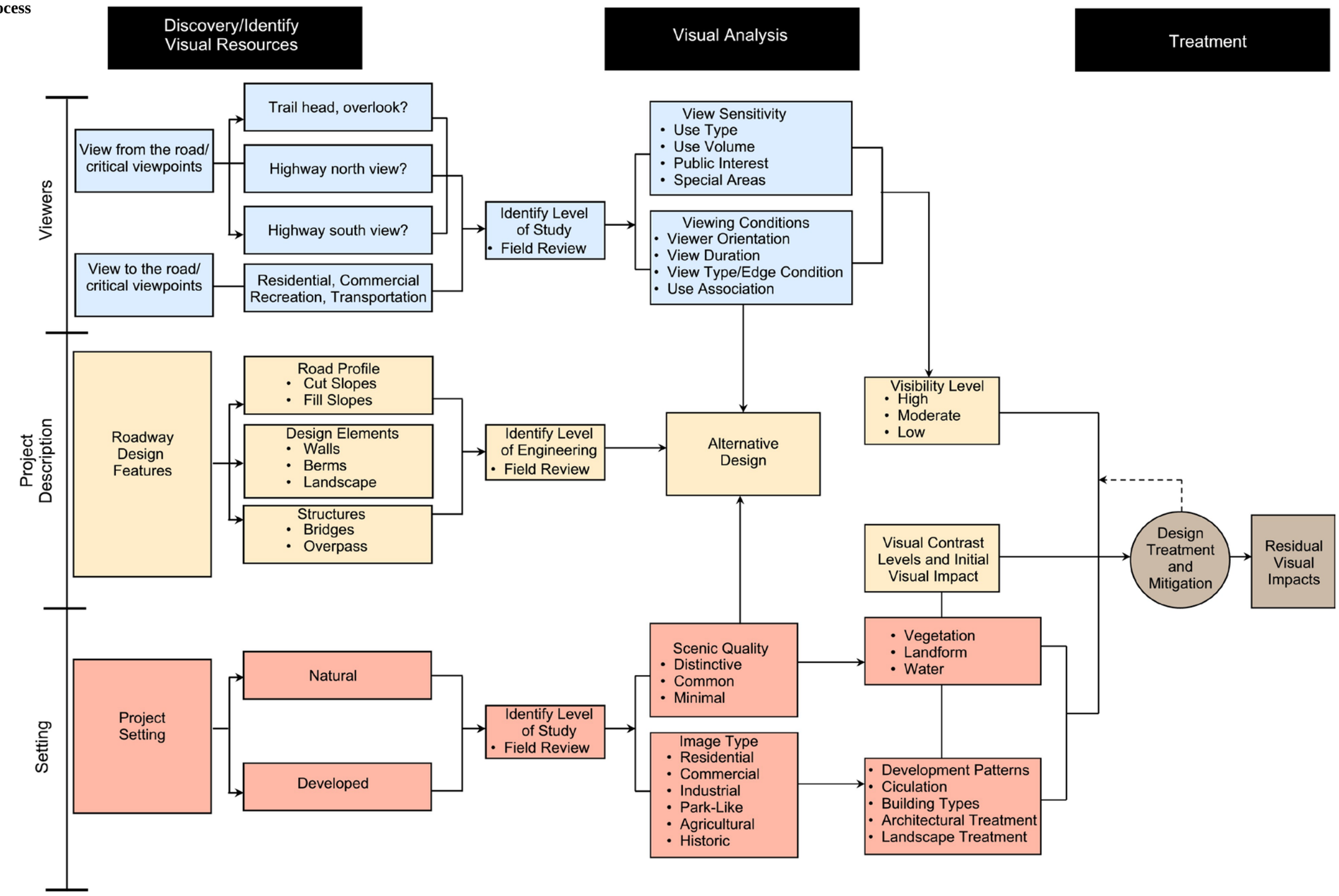
Highlighted below are steps for characterizing visual resources within a project area, evaluating the effects of the project on those resources, and developing and prioritizing treatments/mitigation measures to mitigate the project effects. These steps are intended as guidelines for the integration of aesthetic considerations into the planning and design of roadway projects. Appendix 4-G provides a more detailed discussion of the specific techniques that may be used to conduct this process.

Steps in the Process

Step 1: Discovery/Identification of Visual Resources

The first step in the Visual and Aesthetic Resource Evaluation includes a field review to identify and inventory the visual elements associated with (1) viewers from and to the roadway area, (2) the setting of the project, and (3) elements of the project that will result in a change to the setting.

Figure 4-6
Environmentally Sensitive Roadway Design
Visual Resource Study Process



The intent of this step is to initially characterize the visual resources, to identify those elements of the project that may affect those resources, and to determine the potential level of visual analysis and treatment required for the project. Also during this step, any specific visual practices and standards of agencies that have jurisdiction in the project area should be identified.

Viewers

From the Roadway – Include roadway users (vehicle occupants and in some cases bicyclists) as well as special viewpoints associated with the roadway (trailheads, scenic overlooks, rest areas etc.). It is important to note that when identifying highway viewers, both directions of traffic should be considered in the evaluation. In situations where sidewalks or trails are a part of the project, views from these facilities should be considered.

To the Roadway – Include adjacent property users, including those involved in residential, commercial, industrial, and recreational uses.

Setting

Landscape settings of proposed roadway projects may be natural or developed. Natural settings are those that consist of elements including landform, vegetation, and water and that demonstrate little if any human modifications or disturbance. (Natural settings may include ranching and grazing lands.) Developed settings include those areas in which residential, commercial, industrial, recreational, or agricultural (e.g., cotton fields, orchards) uses have been established.

Project Description

In order to evaluate the effects of a proposed roadway project on the viewers and the setting, it is important that project design features (including potential treatments/mitigation measures) be well defined. In some cases, the project description may entail the development of a new road, requiring the removal of vegetation within an entire corridor area and the modification of landform through grading (cut and fill slopes). Other projects may include only the widening of an existing roadway, resulting in selective vegetation clearing and the use of retaining walls. Finally, some projects may only involve the addition of small project features to address very localized issues (e.g., barriers, landscaping, guardrails, lighting, signage).

Step 2: Conduct Visual Analysis

The visual analysis begins with identifying initial visual impacts, which are based on the effects that the proposed project will have on the views from and to the roadway and contrasted with the existing views from and to the roadway. The level of this analysis should be determined at the conclusion of Step 1, including a confirmation of specific tasks and the level of detail required for the analysis. Following is an overview of the tasks that may be required for the visual analysis. A detailed description of these tasks, with examples, is provided in Appendix 4-F.

Viewers

The analysis of viewers includes (1) the sensitivity of users with views from and to the project, and (2) the viewing conditions, or variables, associated with those views. Collectively, this information may be used to determine overall visibility levels (i.e., high, moderate, or low) associated with the different types of viewers that may have views from, or to the roadway.

Sensitivity of Viewers – Viewer sensitivity levels are the measure of viewer concern for change in scenic quality or the image of a particular setting in which a roadway is being developed, modified, or improved. Criteria for the identification of viewer sensitivity include user type, user volume, public interest (national, state, or local), and association with special areas or unique viewer expectations (e.g., scenic highways, special recreational areas, or historic areas).

Viewing Conditions – Viewing conditions are defined by a set of viewer variables that assist in characterizing views from and to the roadway project from sensitive view locations, and include the following:

- *Viewer Orientation:* including parallel versus perpendicular views from the road
- *Duration of View:* including consideration for roadway speed limit
- *View Distance:* near foreground to background
- *Visibility/Edge Condition:* open, filtered, or screened
- *Viewer Use Association:* viewer expectations and special designation areas
- *Silhouette:* contrast of element with sky
- *Magnitude:* size of element

Visibility Level Synthesis – Using these criteria, a synthesis of overall visibility levels may be assigned to segments of the road characterizing views from and to the roadway area, as well as from specific viewing locations associated with the roadway (as necessary).

Setting

Analysis of the project setting includes the characterization of similar patterns of landform, vegetation, land use, and unique features. Description of these factors permits an evaluation of the potential effect of the proposed roadway design project in conjunction with scenic quality (natural setting), or visual image types (developed settings).

Natural Setting – Natural landscapes or settings may be characterized based on similar patterns of the following elements:

- Landform
- Color
- Vegetation
- Scarcity

- Water
- Cultural Modifications (including ranching and grazing)

These elements are combined to determine the overall scenic quality of the natural setting. In general, those areas with greatest diversity exhibit the highest level of scenic quality, while areas with little or no variety are considered less visually appealing.

Developed Settings – The visual image of developed settings (counterpart to scenic quality in a natural setting) is based on types of use and development patterns that are defined by visual character, land use patterns, and viewer orientation. The visual character is concerned with the composition of design elements including form, line, color, and texture. These elements influence the visual dominance, and focus within each setting. In general, these patterns may be classified into five image types: residential, commercial, park-like, industrial, and open/agricultural images.

Visual Contrast

As warranted, the visual contrast analysis is a systematic process that is used to analyze the potential visual impacts of the proposed roadway improvement and associated activities. The degree to which the roadway project affects the visual and aesthetic quality of a natural or developed setting depends on the contrast created between the project and the existing setting. The contrast can be measured by comparing the design features associated with the project description with the major features in the existing setting (natural or developed). The basic design elements of form, line, color, and texture are used to make this comparison and to describe the visual contrast created by the project in a natural setting, while the effects to image type are used to define contrast in developed areas. Using this information, the impacts may be summarized to discuss the modification to the natural setting or visual image type of an area and the effects to views from and to the roadway.

This analysis process provides a means for determining the visual impacts and for identifying the measures and treatments to mitigate these impacts. It is important that potential mitigation measures be identified early in the process since their identification will assist in project design and the development of specific alternatives.

Step 3: Identify Optional Treatment

The purpose of this step of the visual resource and aesthetics evaluation process is to identify potential treatment options that may be utilized to enhance viewing conditions and/or address the impacts to viewers and the project setting as previously defined. This step focuses specifically on the selection of relevant design elements or treatments as earlier described, the evaluation of how these solutions address visual and aesthetic opportunities and impacts, and how treatments/mitigation measures should be prioritized for implementation. Examples of design treatments/mitigation measures, and how these measures may be applied to different types of roadway projects are presented in Section 4.7.

4.7 MITIGATION TOOLS

Mitigation of environmental impacts can take many forms. Depending upon perspective, certain mitigation measures may be more desirable than others. Within the context of this ESR design guide, it is important to define the range of possible mitigation measures that may be available to designers, and to help them choose the most appropriate ones for implementation. The following sections represent a toolbox to assist designers with the process of identifying, assessing and selecting treatment options and roadway design techniques that best satisfy the environmental preservation and enhancement goals of each project.

Environmentally Sensitive Roadway Design Guidelines

Many sources currently exist for design of roadway facilities, ranging from local to national. The primary references for Pima County projects are listed below. These publications provide guidance to designers, offering a full scope of acceptable and safe design criteria.

- Chapters 2 and 3 of this manual
- American Association of Transportation Officials, *Policy on Geometric Design of Highways and Streets*, 2001. *(AASHTO Policy 2001)*
- AASHTO, *Roadside Design Guide*, 2002 (*AASHTO Guide 2002*)
- AASHTO, 1996, and revisions 1997 - 1999, *Standard Specifications for Highway Bridges*

There are a number of key roadway elements that impact ESR designs. These elements range from design speed (impacting the driver's ability to see and avoid wildlife on the roadway) to lane widths (impacting overall roadway width and resultant resource disturbance) to drainage design (facilitating wildlife crossings and enhancing riparian habitats). The potential variation within each of these elements can have minimal to devastating impacts on environmental resources. For example, a four-lane arterial road can range in width from 96 feet to 70 feet. Over a one-mile project length, that 26-foot difference could mean the preservation of over three acres of environmentally sensitive land. Other design elements can also have major impacts.

Guidelines follow for minimizing impacts on ESR projects. These guidelines are broken down into Roadway Elements and Construction Phasing.

<u>Roadway Elements</u>

The list below provides suggested limits for key elements of the ESR design. In all cases, the final approval of the use of these design criteria is the responsibility of the County Project Manager and the County Department of Transportation Engineering Manager.

- *Design Speed/Posted Speed:* ESR design speed should be 30 to 50 miles per hour, with the posted speed 5 mph less that the design speed.
- *Lane Width:* ESR lane widths can be the minimum widths shown in Chapter 2, Table 2-1.

- *Shoulder Width:* ESR paved shoulder width is 6 to 9 feet, with 6 feet as the standard width. The designer has a range of acceptable values to narrow the road width, widen the shoulder, or to allow for a wider median while maintaining a given total width.
- *Bridge Width:* ESR bridge geometrics follow current RDM and AASHTO guidelines.
- *Bridge Structural Capacity:* ESR bridge structure follows AASHTO guidelines.
- *Superelevation Rate (horizontal alignment):* Maximum rates are 0.08 and 0.06 for rural and urban/suburban roads, respectively, for design speeds of 45 mph and above. For design speeds of 40 mph and below, apply the simplified curve formula, $e + f = V^2 / 15R$, as described on pages 192-198 of *AASHTO 2001 Policy*. The designer can use these higher rates to reduce the radius of the horizontal curve.
- *Vertical Alignment:* See *AASHTO 2001*. The designer needs to consider the specific conditions (biological, cultural, historical) along the ESR corridor and may lengthen the vertical curve if warranted. Shortening of vertical curves should be done only through the Pima County design exception process.
- *Grade:* Maximum grade of 10% is allowed in mountainous areas, 5% in rolling terrain. The designer can use steeper grades to reduce cuts and fills.
- *Stopping Sight Distance:* See *AASHTO 2001*.
- *Cross Slope:* 2% for through lanes and shoulders.
- *Number of Through Lanes:* Maximum of 4-lanes (2 per direction).
- *Vertical Clearance:* See *AASHTO 2001*.
- *Horizontal Clearance:* For ESR design speeds between 30 mph and 45 mph, the horizontal clearance (from face of curb to obstruction) is 2.0 feet minimum for curb sections. For sections with no curb, the minimum clearance is 10 feet (measured from through travel lane to obstruction). For an ESR design speed of 50 mph along an uncurbed roadway, the designer should use the clear zone distance from the *AASHTO Roadside Design Guide*. When the roadway has curbs, an ESR design speed of 50 mph requires a 2.0-foot minimum horizontal clearance.
- *Median Width:* For ESR projects, the required horizontal clearance to obstructions in medians corresponds to item M., above. Width of median can vary from 20 to 40 feet. At signalized intersections, a maximum width of 30 feet should be used. Note that a tree having an expected mature diameter greater than 4 inches is considered an obstruction, while lesser vegetation or landscape may not be an obstruction.
- *Alternative Modes:* Bus pullouts and pedestrian sidewalks all must be assessed for impacts, and width reduction (or elimination) may be necessary depending on the resources being impacted. ESR roadways will include bicycle lanes with a 6-foot standard width, but in constrained circumstances this width may be reduced by 1 foot.
- *Drainage:* See Pima County *Roadway Design Manual*. The designer may wish to call for larger than required drainage culverts to allow for wildlife crossings. Additionally, the designer may choose to allow flows more frequent than the 100-year event ($Q<Q_{100}$) to flow across the road if circumstances warrant this type of treatment.

- *Noise:* Noise walls are considered appropriate only when shown to enhance biological or cultural/historical resources or to mitigate negative impacts on these resources. The ESR designer is encouraged to use "barrier" mitigation wherever possible, including rubberized asphalt pavements.
- *Right-of-Way:* ESR corridors (150 to 300 feet) may be planned for wider-than-normal public rights-of-way to enhance or to mitigate impacts of the road design.

Construction Phasing

Historically, roadway contractors have had a great deal of flexibility in scheduling construction activities. Once a project has been awarded, the site becomes the contractor's responsibility – essentially his/her property – for the duration of the contract. As a general rule, the first activity to commence is site clearing and grubbing and the relocation of affected utilities that are in the way. This particular activity can have immediate and negative effects on natural and cultural resources. These impacts may continue for the entire duration of the project, creating unexpected and irreversible environmental impacts. Other construction activities also affect natural and cultural resources.

Wildlife travel patterns, important seasonality issues (such as breeding), and significant features should be identified during the design phase of the project. Construction specifications and sequencing of work need to address these issues. For most ESR projects, it is advisable for the designer to develop construction-sequencing plans as a part of the contract documents. This will help ensure that the construction team properly implements the environmental goals of the project, and that the contractor is afforded a workable project while creating/maintaining corridors or habitat.

Biological Resource Conservation Treatments/mitigation Options

Biological resources (e.g., riparian areas, special status species habitat) of ESR projects within ESL should be preserved. The project area should be evaluated to determine if SDCP Riparian areas, Title 16 Watercourses, and special status species habitat are avoidable. If avoidance is not possible, there are several option for treatments/mitigation measures. These include, but are not limited to:

- Conservation Easements
- Revegetation
- Wildlife Road Crossing Design
- Off-site Compensation

All mitigation plans, especially those concerning special status species, should be developed in conjunction with Pima County, AGFD, and USFWS. Projects should include a monitoring component to ensure that treatments/mitigation measures have been accomplished. The options for treatments/mitigation measures are presented in more detail below.

Conservation Easements

A conservation easement is a legal agreement voluntarily entered into by a property owner and a qualified conservation organization such as a land trust or government agency. The easement contains permanent restrictions on the use or development of land in order to protect its conservation values. Easement restrictions vary greatly between agencies/organizations.

Revegetation

Revegetation of all ESR areas shall be done with the appropriate plant species, including seed mix plants. Every effort should be made to revegetate with plant species that were removed and/or are commonly found in the project environment, matching density, relative location patterns (e.g., small cactus under shrubs), slope, and soil preferences whenever possible. A list of plants native to Pima County is presented in Appendix 4-E. These plants should be used in all ESR areas. Certain plant species shall not be used under any circumstances (see also Appendix 4-E). All transplant vegetation and seed mixes are to be planted and irrigated correctly. Planting and irrigation guidelines are presented in Appendix 4-F. Trees with anticipated mature diameter of 4 inches or greater should not be located in medians or within clear zones. Vegetation should not be located at intersection corners or in medians that would restrict driver visibility to oncoming or crossing vehicles.

Wildlife Road Crossing Design

Land bridges, herp walls, lighted crossings, and bridges that span rather than cut drainages are all features that could be incorporated into Pima County transportation plans. In northwestern Arizona, the Federal Highway Administration (FHWA) is planning to construct a land bridge near Lake Havasu to allow bighorn sheep to cross Interstate 40. A Florida land bridge serves dual purposes: the edges are vegetated with native species with a sand base for animal passage, and the center is designed for pedestrian and equestrian use.

Figure 4-7: *Example of a large wildlife crossing.*

Wildlife walls and fences funnel animals to designated crossings. Sound walls are an effective barrier to wildlife and can serve as wildlife walls as well. However, 10-foot sound/noise walls are not the ideal addition to the landscape, and their use for ESR design is discouraged. Shorter walls can be just as effective for wildlife. A wall 3-4 feet high will allow birds to fly over while encouraging other wildlife species to use designated crossings.

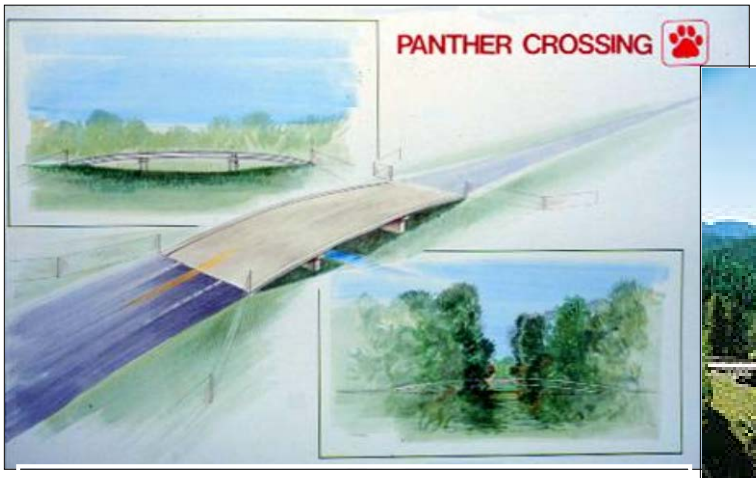
Figure 4-8: *Herp wall along a roadway.*

Herp walls are designed specifically to funnel lizards, snakes, small turtles and amphibians into designated crossings (Figure 4-8). Herp walls are smooth, short walls placed along the edge of the road that have a top lip that prevents reptiles and amphibians from crawling onto the road.

Lighting is another very important and often overlooked component of effective wildlife crossing design. Lizards and snakes prefer bright, warm habitats to cool, dark tunnels, therefore culverts intended for wildlife are not always conducive to the habitat requirements of reptiles. Additionally, deer will not enter a dark tunnel with an exit that is perceived to be very small (perceived exit size is dependent on size and length of crossing structure) or that may conceal predators. Incorporating light into these structures encourages more animals to use them. Grates can be placed in the road or medians to allow natural sunlight into the crossing, or solar lights can be placed in the interior. (See University of Arizona pedestrian underpasses as an example of solar lighting in a tunnel.)

Crossings designed for one species may not serve other species. For example, design of roads in pygmy-owl habitat incorporate native vegetation to the edge of the road to allow adequate crossings. However, vegetation should be kept away from the edge of the road to discourage other animals from crossing in areas other than designated crossings. It is important to identify the target species or group of animals so that appropriate designs are chosen.

In some instances, bridges that completely span a drainage are more effective than traditional box culvert design (Figure 4-9). Larger mammals (e.g., deer, bear) are more likely to use a wide-open crossing rather than a closed box culvert. Such crossings also preserve riparian habitat by spanning entire floodplains, rather than only floodways with associated destruction of adjacent overbank areas that contain considerable amounts of riparian habitat.



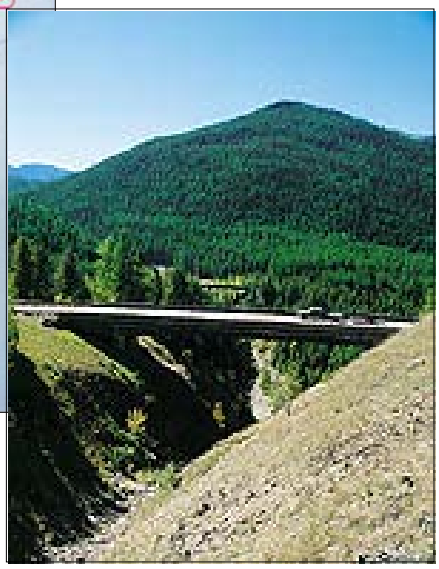


Figure 4-9: *Examples of bridges designed to span drainages.*

An important aspect of designing a wildlife crossing is determining the most effective placement for wildlife use. Corridor studies using landscape topography, wildlife ecology, computer modeling, and radio-telemetry techniques are all valuable resources for determining appropriate crossing locations. These studies should be conducted during the "Discover/Identify Existing Resources" stage of the Biological Resource Process. (See Section 4.4 of this document.)

The following is a list of tools for creating wildlife crossings. It is not exhaustive since each species may require unique design features tailored to their needs.

- Install speed humps, speed tables, traffic circles, or other "traffic calming" elements to slow traffic
- Set lower speed limits
- Provide wildlife friendly lighting to discourage wildlife from foraging near the road (i.e., avoid bright lights that attract insects, thereby attracting insectivores)
- Widen clear zones to deter wildlife from the edge of road
- Install wildlife crossing signs to inform motorists
- Install large lighted culverts for large mammal crossings
- Install small lighted culverts for smaller wildlife
- Install herp walls to encourage reptiles and amphibians to use appropriate culverts
- Install grates in medians to allow natural sunlight into culverts
- Use solar lighting to illuminate dark culverts
- Plant native vegetation in medians and other landscape/re-vegetated areas
- Span drainage floodways when feasible
- Create land bridges
- Conduct a wildlife corridor study to determine best placement of wildlife crossings
- Create "escape cover" around wildlife crossings by using dense native vegetation
- Eliminate "escape cover" (i.e., vegetation) near hazardous areas to deter wildlife from crossing road
- Use fencing in conjunction with plant material to guide wildlife to appropriate crossings

Additional sources of information on wildlife crossings are provided in Appendix 4-C of this document.

Off-Site Compensation

Off-site Compensation also is referred to as a *conservation bank.* Like a financial bank, a conservation bank is a place that contains important resources, in this case natural resources. The conservation bank protects these resources just like a bank protects money. When a project is planned that will impact endangered species or other natural resources, such as wetlands,

credits in a conservation bank can be purchased. The bank owner then uses the money to protect the resources in the bank.

Traditionally, project developers have been asked to preserve a portion of the area they are developing. Often this is a good policy. However, sometimes it may be better for endangered species to have larger areas protected in banks. It also is more efficient and cost effective to manage a bank instead of small, isolated properties.

The term "mitigation bank" is sometimes used to refer to conservation banks. This is appropriate in the case of non-Federal projects and projects that require U.S. Army Corps of Engineers wetlands permits. Federal law allows non-Federal property owners, such as private landowners, corporations, tribes, or state or local governments, to *mitigate*, i.e., compensate for, impacts to the environment.

Appendix 4-B includes an address for a USFWS website that contains more information on conservation banks.

Cultural Resources Treatment Options

As discussed in Section 4.5 the cultural resource review process consists of three steps: (1) identification and assessment, (2) evaluation, and (3) treatment. Treatment is the stage in the process in which the characteristics that make a cultural resource important are protected, or the effects of project related disturbance to those characteristics are mitigated prior to construction. The measures used to accomplish treatment range from complete avoidance of cultural resources to research and recording prior to their destruction through construction.

When cultural resources are identified within a proposed road right-of-way, the manner in which potential effects can be treated will vary depending on a host of factors including, but not limited to, the resource type and the characteristics that make it important, its location within the proposed right-of-way, whether it is possible or even desirable to avoid the resource, limitations of time and money, and public awareness of and sentiment regarding the resource. For this reason, engineers and designers are advised to consult with the Pima County Cultural Resources Manager during the planning and design stages of ESR projects. By law, state and federal agencies may also need to be consulted before a consensus can be reached on the proper treatment for a cultural resource that may be affected by road construction.

Typically, if archaeological sites cannot be avoided, a data recovery program is developed identifying a set of research questions and methods that guide field and laboratory work. The objective is to collect the information content of the site before it is lost to construction and to add new information to a body of knowledge of how people lived in the past. Buildings, structures, and other engineered features, such as roads and bridges, are typically recorded in the field and through archival research to capture the history of their design, construction, and use over time. This work is usually done in reference to broad themes in American history on the national, state, and local levels to provide meaningful context to the research. On occasion, cultural resources valued by traditional communities, such as Native American communities, may be affected by a proposed road project. In these instances, experts in applied anthropology

use a combination of fieldwork, oral interview and archival research to recover information about these resources and to work with the communities to conduct appropriate means of treating effects. Treatment can be time consuming and expensive, requiring careful planning so that the work can be done well in advance of construction but after enough of the planning has been done to identify potential effects on the ground.

To provide a sense of the kinds of treatment that may be employed in road construction projects, Tables 4-3 through 4-6 contain typical treatment options for each resource type and corresponding design recommendations for how to achieve treatment. Each table lists the treatment options from top to bottom in a range from the most beneficial to cultural resources to the least beneficial. Avoidance and preservation in place is always the preferred treatment option. This means that impacts to cultural resources are deliberately avoided and preservation measures are adopted to ensure protection. It is important to note that treatment often involves a combination of treatment options to mitigate the effects of construction on cultural resources. Tables 3 through 6 are not intended to be comprehensive or exhaustive. Each ESR project that may affect cultural resources will involve unique circumstances, so alternative treatment options may be possible with different design implications.

Table 4-3
Archaeological Resources: Sites, Objects, Districts/Complexes

Treatment Options	Design Recommendations
- **Avoidance** Redesign Realign	- Include a buffer zone of 50 feet minimum between the edge of the construction zone and the edge of the archaeological resource to ensure avoidance.
- **Preserve/Protect** Intentional Burial Physical Barriers Covenants/Easements Donation	- Add 12-24 inches of topsoil to “cap” the resource by intentional burial. Archaeological testing must be conducted prior to capping. - Fencing, earthen berms, or other permanent barriers can be used to ensure avoidance in conjunction with a buffer zone. - Covenants and easements are legal instruments to ensure avoidance. Same design implications as avoidance. - Donation can occur as a part of avoidance strategy where preservation responsibility is assumed by a third party. Same design implications as avoidance.
- **Data Recovery** Testing/Excavation Mapping, photography, records research Informant Interview	- Data recovery collects information through scientific investigation in accordance with the Secretary of the Interior’s Standards and Guidelines. No design implications.

Table 4-4
Historic Resources: Buildings, Structures, Objects, Districts, Landscapes

Treatment Options	Design Recommendations
- **Avoidance** Redesign Realign	- Include a buffer zone of 50 feet minimum between the edge of the construction zone and the edge of the historic resources to ensure avoidance.
- **Preserve/Protect** Covenants/Easements Donation	- Design to minimize road vibrations that may affect nearby historic resources. Do not add visual elements, such as lighting or signage, that may detract from historic character. Use landscaping and/or public art to enhance historic feeling and association. - Covenants and easements are legal instruments to ensure avoidance. Same design implications as avoidance. - Donation can occur as part of an avoidance strategy where preservation responsibility is assumed by a third party. Same design implications as avoidance.
- **Restore/Reuse/Retrofit** Restore to original condition Incorporate historic elements into new design	- Requires modifying a historic resource in accordance with the Secretary of the Interior's Standards and Guidelines. Design implications are situational and may be significant.
- **Relocate** Move from harm	- Removal of historic resource from project area as an alternative to demolition. Requires design input for site of relocation.
- **Record/Research** Drawings, photography, records research Informant Interview	- Recover information in accordance with the Secretary of the Interior's Standards and Guidelines. Consult with knowledgeable individuals prior to demolition. No design implications.

Table 4-5
Historic Roads: Aesthetic, Engineered, Cultural

Treatment Options	Design Recommendations
- **Avoidance** Redesign Realign	- Include a buffer zone of 50 feet minimum between the edge of the construction zone and the edge of the resources to ensure avoidance.
- **Adaptive Reuse** Incorporate historic elements into new design Retain historic setting Mitigate road noise	- Reduce traffic speeds. Retain historic elevations, lane widths, shoulders and road curvature. Do not add new sidewalks, curbs or lighting. Use landscaping to preserve rural feeling and association where appropriate. Use rubberized asphalt to dampen road noise.
- **Record/Research** Drawings, photography, records research Informant interview	- Recover information in accordance with the Secretary of the Interior's Standards and Guidelines. No design implications.
- **Information/Education** Signage, information kiosks, popular publications, lectures	- Place information kiosks/signage in highly visible areas with roadside turnoffs to provide public access. Use in conjunction with recordation and research.

Table 4-6
Traditional Cultural Places:
Shrines, Burials, Rock Art, Gathering Places, Natural Features, Springs/Drainages, Landscapes

Treatment Options	Design Recommendations
- **Avoidance** Redesign Realign	- Wide buffers are recommended. Distances established through negotiations with traditional community. Design implications are situational and may be significant.
- **Preserve/Protect** Intentional burial or reburial	- Human graves are to be treated in accordance with state law and the wishes of lineal descendants or those culturally affiliated. This may require removal and reburial outside of the project area prior to construction. No direct design implication.
- **Restore/Reuse** Repair Provide new access to resource	- Restore for reuse, and/or provide new access to resource. Design implications are situational and require negotiations with traditional community.
- **Relocate** Move from harm	- Relocate to outside of the project right-of-way. Project design implication may be minimal.
- **Record/Research** Map, photograph (if appropriate), research Informant interview	- Recover information in accordance with the Secretary of the Interior's Standards and Guidelines. Consult with knowledgeable individuals prior to disturbance. No direct design implications.
- **Ceremonial Treatment** On site ceremony/ritual	- Possible outgrowth of above. On site ritual treatment required before resource disturbance. No design implications.

Visual and Aesthetic Resource Treatments/mitigation Options

As described in Section 4.6, the purpose of this step of the Visual and Aesthetic Resource Evaluation Process is to identify and prioritize potential design treatments/mitigation measures that may be used to maintain or enhance views in ESL in which roadway projects are proposed. This step focuses specifically on the selection of relevant design elements, treatments, or mitigation measures and the evaluation of how these solutions address visual and aesthetic impacts and opportunities. As part of this step, the areas identified for visual mitigation may be prioritized to meet visual goals, as well as other environmental and design goals for the project. Depending on the specific project, monitoring the implementation of the selected treatments/mitigation measures may be required during and following construction.

Following are a listing of sample types of treatments/ mitigation measures. This list is followed by three case examples illustrating how these measures can effectively address visual and aesthetic concerns.

Sample Treatments/Mitigation Measures

As described in Section 4.7 and illustrated in Figure 4-6, the development of treatments/ mitigation measures is the "circular" portion of the visual resource analysis process, which focuses on the identification of alternative plans. These alternative plans, which include design treatments/mitigation measures, are evaluated based on: (1) their effects to the visibility level of

views about which people care and (2) their ability to reduce the contrast of proposed roadway design features within natural or developed settings and to enhance the overall aesthetic of the roadway corridor.

Visibility Levels

Measures that are typically used to address visibility concerns are related to either the "screening" of undesirable views, or the "opening" of views to areas of high scenic quality or to areas that are aesthetically pleasing (e.g., developed setting). Techniques for screening include, but are not limited to, the use of vegetation, landform (e.g., berming), or structural elements (e.g., walls, fences, planters). In general, the opening of views is accomplished most often through selective clearing, or the removal of vegetation, and/or through the elimination or modification of roadside elements and structures (e.g., billboards). In making the determination regarding either the screening or opening of views, viewer orientation and duration of views are especially critical, along with the character or setting of the area being viewed.

Setting

The key to identifying appropriate treatments and measures to mitigate impacts to the setting is to determine the contrast between the proposed roadway project (including specific design elements) and the natural and/or developed character of the project area. In those areas where the contrast is pronounced, using elements that repeat the general form, line, color, and/or texture of the surrounding area will help to reduce that contrast, resulting in a project that better blends with its setting. This applies to all of the following examples.

Vegetative Treatments – The addition of new landscaping enhancements to existing landscaping and re-vegetation or reclamation practices should be consistent with the existing or planned setting of an area.

Landform Treatments – Minimizing the amount of cut and/or fill slopes (alignment) and the use of berms, slope laybacks, and rock sculpting can be effective measures to reduce the contrast of roadway features (especially in a natural setting). When using retaining walls, consideration for the size, form, color, and texture of materials is important.

Structural and Design Treatments – The addition of structures, including walls, bridges, and overpasses (vehicular and pedestrian), as well as detailed design elements including lighting, signage, and pavement types/surfaces should (where possible) not detract from the scenic quality of a natural area and should act as unifying elements in developed settings. In selective cases, however, these elements may be created to serve as public art also and, therefore, be intended to attract attention.

Case Examples

Following are examples of alternative design treatments/mitigation measures that may be developed for different types of roadway projects.

Case 1: Development of a New Road

Project requires the location of a small portion of new roadway, resulting in the removal of vegetation within an entire corridor area and modification of landform through grading (i.e., cut and fill slopes), including the modification of drainages. The results of the visual analysis may indicate moderate to high visual impacts to both the setting and the viewers' viewing experience, especially if the impacts are within a natural area with distinctive scenic quality elements and a high level of viewer sensitivity and visibility both from and to the new section of road.

Analysis may also show that construction of the new roadway could result in strong contrast to landform based on cut and fill requirements and on the removal of vegetation within the corridor area. Design treatments/mitigation measures that could assist in reducing contrast and enhancing the aesthetic character of the corridor may include, but are not limited to:

- Color treated retaining walls to addresses form and color contrast associated with significant landform modifications.
- Selective clearing, re-vegetation and reclamation, and landscaping to reduce form, line, color and texture contrast associated with removal of vegetation within the entire corridor. Focus of revegetation and reclamation may be concentrated in the drainage areas since those areas tend to be of higher scenic quality.
- Use of small bridges to address the contrast associated with grading and some vegetation removal. This option could, however, simply end up adding structures in an otherwise natural setting. The introduction of bridges, therefore, should be carefully considered.
- Landform modification through berming, slope modification, and rock sculpting.

Case 2: Widening of an Existing Roadway

Project requires addition of another lane, resulting in modest vegetation clearing, but no significant additional landform modification (e.g., grading). The vegetation clearing could either enhance or detract from views from and to the road depending upon the location of the clearing. Key to this evaluation is the type and volume of users in the area, and the scenic quality or developed image of the setting. If the setting is natural, then the quality of the setting should be identified as distinctive, common, or minimal. If the setting is developed, the widening could affect the current image of the area based on the image type or open up views to undesirable areas. Design treatments/mitigation measures that could assist in enhancing views could include, but are not limited to:

- Selective clearing, transplanting, and or replacement of vegetation in a manner that complements views from the road (e.g., opens up views to distinctive natural features or maintains screened views to industrial areas).
- Selection of vegetation types that are complementary to the surrounding area.
- Selective use of berming, fencing, or walls to screen views as appropriate.

Case 3: Roadway Improvement Resulting in the Addition of Pedestrian Access and Signage

Project requires signage and traffic control, resulting in possible placement of elements/features that could impair the visual quality of the setting. Treatments/mitigation measures that could help reduce visual clutter and impaired views include design features, such as signage, lighting, paving, and use of berms, that are compatible with the forms, colors, and textures of the surrounding image types, whether residential, park-like, or commercial.

4-8 POST-CONSTRUCTION ASSESSMENT

At the post-construction stage of the ESR design process, project impacts on environmental resources have been identified, treatment options considered, mitigation plans developed, and construction completed. As the operations phase of the roadway commences, the community has the opportunity to observe the effectiveness of its investment in the environmental mitigation effort. A number of the treatments/mitigation measures presented in this chapter, as well as many of the treatments/mitigation measures that will be created as a result of implementing the ESR process, will have limited documentation of long-term effectiveness. To ensure that the implemented preservation and enhancement plans are accomplishing their stated goals, it is imperative that follow-up studies of these projects be conducted.

If the purpose of post-construction assessment is to ensure the effectiveness of mitigation efforts, the first step is to clearly define the goals. Goals will be developed through the process outlined in previous sections of this guide, particularly Section 4.3. Environmental goals of a given project should be clearly communicated to all stakeholders as the project proceeds from planning to design to construction and eventually to operation. Some of the goals will be short-term, intended to preserve resources through the disruption created by construction. Others will be longer-term, such as pygmy owl corridor enhancement, and will need long-term follow-up monitoring to assess effectiveness.

The Design Team has the primary responsibility of developing assessment programs for ESR projects, even though the team will not typically be engaged by Pima County post-construction. The design of monitoring programs should be scientifically valid, with adequate frequency of measurements, and should be consistently applied to as many projects as possible to build a significant base of assessment data as quickly as possible. These assessment programs should be designed to be carried out by Pima County's existing operations and resource management personnel, so that the cost of collecting follow-up data does not adversely affect the ability to implement the programs.

Once the feedback information has begun to flow through to Pima County, a structure is needed to receive and analyze that information. A standing staff committee, with appropriate consultant support, should be formed and tasked with managing this important monitoring of data. On a regular basis, the committee should review the information that has been gathered and assess the success of the mitigation plans that were initially created for the individual projects under review. The committee should, when possible, contact the original authors of the project's environmental goals and follow-up programs to receive their input. Finally, evaluating the effectiveness of the mitigation plans and implementing suitable actions should close the feedback loop. Possible actions could include further treatments/mitigation measures, abandonment of efforts, direction to ongoing Design Team, and modification of monitoring schemes.

APPENDIX 4-A
Chapter 4 References

Note: These documents are revised periodically; therefore users should double check that they have the specific version of the document specified in this chapter, or, if the reference is undated, that they have the most recent version.

- American Association of State Highway and Transportation Officials. 2001. *A Policy on Geometric Design of Highways and Streets*.
- ———. 2002. *Roadside Design Guide*.
- American Society of Landscape Architects. 1979. *Visual Impact Assessment for Highway Projects*. Washington, D.C.: U.S. Department of Transportation, Federal Highway Administration.
- Bonham, C. D. 1989. *Measurements for Terrestrial Vegetation*. John Wiley & Sons, Inc.
- Hornbeck, L.H. and Okerlund Jr., G.A. 1971. *Visual Values for the Highway User*. Washington, D.C.: U.S. Department of Transportation, Federal Highway Administration.
- U.S. Department of Agriculture. U.S. Forest Service. 1974. *National Forest Landscape Management*, Vol. 2, Chapter 1. Handbook Number 462.
- ———. 1977. *National Forest Landscape Management*. Vol. 2, Chap. 4, "Roads." Handbook Number 483.
- ———. 1995. *Landscape Aesthetics, A Handbook for Scenery Management*. Handbook
- ———. 1995. *Visual Prioritization Process, User's Manual*. Prepared for the U.S. Department of Transportation, Federal Highway Administration.
- U.S. Department of Interior, Bureau of Land Management. 1984. *Visual Resource Management System*. Manuals 8410 and 8431.

APPENDIX 4-B
Websites

1. Arizona Department of Transportation cultural resource program with additional links: http://www.dot.state.az.us/ABOUT/envplan/cultural.html#environmental

2. Arizona State Historic Preservation Office and its programs: http://www.pr.state.az.us/partnerships/shpo/shpo.html

3. Arizona State Museum: http://www.statemuseum.arizona.edu

4. Pima County:

   Website MapGuide for information on Biological Core, Multi-Use or Recovery Area, Important Riparian Area, Agriculture within Recovery Area, Existing Development, Scientific Research Area, and Archaeological Sensitivity Zone: http://www.dot.co.pima.az.us/gis/maps/mapguide/mgmap.cfm?path=/cmo/sdcpmaps/sdcp.mwf

   Pima County Major Street and Scenic Routes Plan

   http://www.dot.co.pima.az.us/gis/maps/majscenic/MSSRc02_01.pdf

   Title 16 Floodplain and Erosion Hazard Management Watercourses
   http://www.dot.co.pima.az.us/flood/riparian

5. National Register of Historic Places, maintained by the National Park Service, including properties listed in Pima County: http://www.cr.nps.gov/nr/

6. Southern Arizona Division of the State Historical Society: http://www.arizonahistoricalsociety.org/

7. U. S. Fish and Wildlife Service:
   Special Status Species: http://arizonaes.fws.gov
   Conservation Banks: http://sacramento.fws.gov/es/cons_bank.htm

8. Wildlife Crossing Information
   Proceedings of the International Conference on Ecology and Transportation 2001: http://itre.ncsu.edu/cte/ICOET/ICOET2001.html

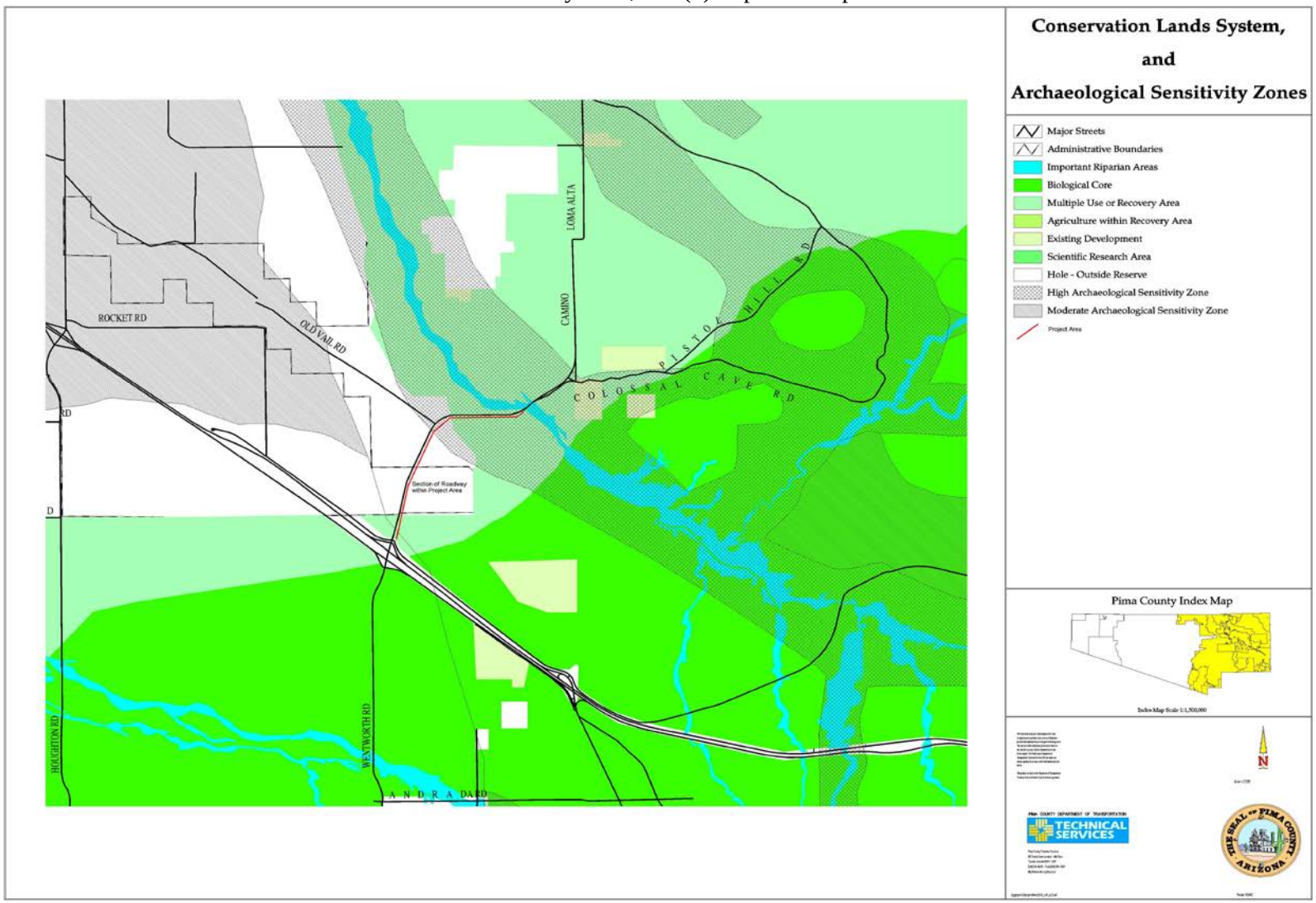
   The Humane Society: http://www.hsus.org/ace/13409

   The Defenders of Wildlife; Habitat and Highways Campaign: http://www.defenders.org/habitat/highways/

   Federal Highway Administration; Critter Crossings
   http://www.fhwa.dot.gov/environment/wildlifecrossings/

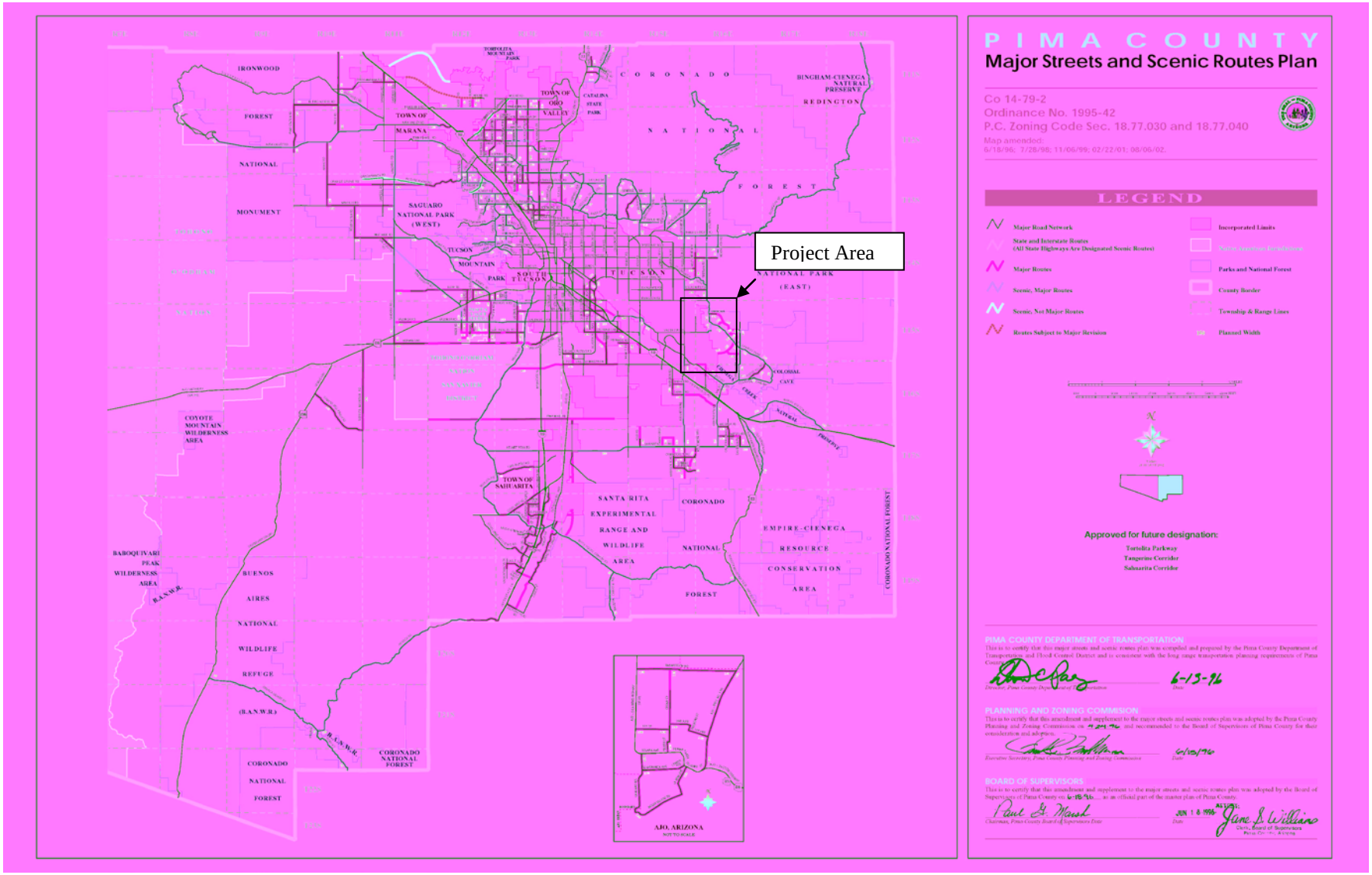
APPENDIX 4-C
Sample ESR Project Maps

Map 1: The example project area, shown in red, clearly involves three ESR criteria: (1) High Archaeological Sensitivity Zone, (2) Multiple Use or Recovery Area, and (3) Important Riparian Area.



APPENDIX 4-C, continued

Map 2: The Pima County Major Streets and Scenic Routes Plan indicates that the project area also meets the ESR criteria of being a designated Major Scenic Route.



APPENDIX 4-D
Vegetation Measurement

As part of the biological resource identification process, the vegetation of the project area should be accurately characterized so that appropriate re-vegetation can occur upon completion. The goal is to recreate the entire pre-project vegetation community as closely as possible. The current Pima County Native Plant Preservation Ordinance (NPPO) will not accomplish this because not all plants on a site are protected by the NPPO. Also, in some instances the area has been degraded prior to the start of the project, leaving no vegetation framework to adequately determine how to re-vegetate the area. The following methods utilize species diversity and density measures to accomplish the goal of vegetation re-creation.

Species diversity requires the identification of all species present in the project area. ***Density*** refers to the actual number of plants per a given area.

Steps in Measurement Process

Measuring vegetation is a two-step process as described below.

Step 1: Inventory of Protected Plant Species

Complete an inventory of all saguaros and Pima County protected tree species. Saguaros and protected trees should be assess for viability and transplantability as well as documenting size and location (in a manner similar to the Native Plant Preservation inventory requirements.) The diameter of all protected trees (including non-viable individuals) is measured with a forestry caliper (at 24 inches from the ground), and all trees greater than or equal to 3 inches are to be inventoried. For trees that have multiple stems at the point of caliper measure, the largest 3 stems are measured, and the individual is included in the inventory if the sum is greater than 3 inches. The diameter measurements are totaled for each protected species.

Mitigation of trees shall be based upon total caliper inch for each species and the existing densities as determined by the Releve Method or other approved methods (see Step 2 below). Mitigation for each species shall be calculated by multiplying 125% of the sum caliper inch by the percentage of the site that is disturbed outside of the development envelope. Replanting density must match pre-project conditions as closely as possible. The final caliper inch value is to be distributed into appropriately sized trees. For example, if the pre-project site contained ten (10) mesquite trees, all over 10 inches in diameter, it is not appropriate to replant using a larger number of smaller trees to attain the appropriate caliper inch value.

Example

- 100 caliper inch of palo verde
- 10-acre site where 25% remains disturbed outside of the development envelope, i.e., 2.5 acres of plantable area remains

Result: 100 cal inch x 25% x 125% = 31.25 cal inches that must be replaced in the 2.5 acres

Mitigation of saguaros will be 1:1. Preserve in place as many saguaros and other cactus as possible. Only those saguaros 10 feet high and under that are assessed as being viable and transplantable should be considered for salvaging. Replacement saguaros shall be in the 4 to 6 foot range. Special consideration shall be given to individual specimen species.

The Releve Method will be used to determine the seed mix, and assist the landscape designer in determining the appropriate number of other cactus and non-protected tree and shrub species that will be appropriate in the landscaping in the various vegetation entities.

Cactus not required for the revegetation should be offered to neighbors or non-profit succulent or plant organizations. Permits will be required from the Arizona Department of Agriculture for transplanting cactus protected by the Arizona Native Plant Law.

Step 2: Determine Seed Mix and Re-Planting Densities

The **Releve Method** is a widely recognized technique that vegetation ecologists use to sample an area for such variables as species diversity, cover, density, and abundance (Bonham 1989). This technique uses circular plots (releves) to obtain the information necessary to assess a vegetation community to develop appropriate re-seeding and re-vegetation parameters. The method will be employed to produce two types of information that will be used for two purposes: (1) to determine a seed mix and (2) to determine the re-planting density of Pima County protected cactus and shrub species.

This method should be applied in the spring and fall to most accurately measure the annual/ephemeral flora. If the area to be re-seeded is degraded prior to the project, this method should be applied to a nearby site with undisturbed vegetation and similar topography. Density measurements will be used to determine appropriate numbers for the re-planting of all Pima County protected cactus and shrub species.

It is crucial that the personnel conducting this method are highly skilled in plant identification, including ephemeral/annual species.

Following are the steps in the Releve Method, as modified for application to transportation construction projects:

a. **Entitation.** Once the project area is defined, field personnel visually assess how many *vegetation entities* (discrete assemblages of species) are represented. If the area is relatively homogenous, with the same assemblage of species represented throughout, then there is only one (1) entity to be sampled. In many instances, however, there will be two (2) or more discrete species assemblages. In the Sonoran Desert, a common example is an upland community with a wash running though it. The wash may contain an assemblage of species distinct from the surrounding uplands.

b. **Establishment of Plots.** Each entity will be sampled with random circular plots (releves). The appropriate number and size of these plots will depend upon the size and diversity of the project area. The larger and/or more diverse an entity is, the more and/or larger plots are

required to accurately sample the area. In a typical Arizona Uplands community in Pima County, a general rule of thumb would be a minimum of four (4) 20-foot radius plots per acre for small projects. A project area should have a minimum of five (5) plots, regardless of size.

The locations of plots must be established *randomly*. The investigator should not *choose* where to establish plots (for example, in a location convenient to the desired outcome). Instead, locations must be chosen in an unbiased fashion. Here are several approaches to accomplishing this task:

- Entities can be defined on a topographic map of the project area in the field, and then transferred to a mapping program such as Arc View. A common feature of mapping software is a random-point generator. The investigator can ask the program to randomly distribute a given number of points onto the map, and obtain Global Positioning System coordinates for those points. It is then possible to navigate to those exact coordinates in the field to set up the releves.
- Releves can be located across a project area in a systematic way by applying a grid overlay. Releves can then be located at regular intervals (for example, every 500 meters). An advantage of this method is the ability to easily add more points if necessary by adding to the grid.

c. **Data Collection.** Once at a random plot location, the center of the plot and plot boundaries are temporarily defined with flagging. Every species of plant is identified and individuals of the species are counted, including ephemeral/annual species. Unknown plants are collected and brought to the University of Arizona Herbarium or to a qualified botanist for positive identification.

Field personnel also record species present in the area that are not captured by the releves. These plants are listed in parentheses. If the releves are not capturing species that appear to be dominant in the landscape, then additional and/or larger releves are required.

Applying the Releve Method to ESR Projects

<u>Using the Releve Method to Determine Replanting Densities</u>

Once the releves have been completed, a master list of all species with density values is produced *for each entity sampled*. For each entity, density values are individually averaged for all species. The average values are used to determine the appropriate replanting densities per acre for tree, shrub and cactus species. Some of these values may not be used in the final landscaping plan because the Tree Caliper Measurement Method and saguaro replanting requirements will be used to determine replanting densities for species that were inventories The species list should be evaluated to exclude invasive.

See Table 1 for an example.

Using the Releve Method to Determine Seed Mix Composition

The master list is evaluated to exclude invasive or non-native species. Next, each species is evaluated for availability of seed; if there is no seed source available, then those species are omitted from consideration in the seed mix. In many cases, a particular species will be recorded as present in the area, but absent from the actual releve (indicated by parentheses). These plants are considered for inclusion in the seed mix at low levels.

The density values for all species to be included in the seed mix are totaled. In addition, most cactus species (except saguaro) are excluded because the seeds are not commercially available and live plants will be included in the replanting. The mean for each species is then divided by the total number of plants to arrive at a seed mix percentage value. These values are then adjusted for availability and size through consultation with seed experts. These values will be the basis for the finalized seed mix. It may become necessary to adjust the PLS/acre or species composition because of changes in seed availability. Table 1 is a spreadsheet that presents hypothetical releve data, including all plant species present, density values, and conversion to seed mix percentages.

In order for this process to be effective, it is imperative to contract seed suppliers ***as early as possible in order to ensure availability, especially because many of the species included are not generally collected because of lack of demand.***

Table 1. Hypothetical Releve Analysis. In this example, all large shrubs, trees, subshrubs, forbs, and grasses have been included in the seed mix (except for the invasive grass species *Pennisetum ciliare*). Re-planting densities were calculated for cactus species.

	Density (plants per 20 ft releve, 0.028 acre)					**Average (per 20 ft releve, 0.028 acre)**	% of seed mix	**Average (per 20 ft releve, 0.028 acre)**	re-planting density (per acre)
	Releve 1	**Releve 2**	**Releve 3**	**Releve 4**	**Releve 5**				
Large Shrubs and Trees									
Acacia constricta	1	0	3	1	3	**1.6**	**1.5**		
Fouquieria splendens	3	0	2	0	1	**1.2**	**1**		
Larrea tridentata	6	2	4	3	5	**4**	**3.6**		
Parkinsonia microphylla	0	0	2	4	0	**1.2**	**1**		
Prosopis velutina	0	1	2	1	0	**0.8**	**0.8**		
Cacti									
Carnegiea gigantea	0	2	0	1	0			**0.6**	**21.4**
Echinocereus fasciculatus	3	2	0	6	1			**2.4**	**85.7**
Ferocactus wislizeni	0	1	2	1	1			**1**	**35.7**
Mammillaria grahamii	4	5	8	0	5			**4.4**	**157**
Opuntia engelmanii	1	2	1	0	1			**1**	**35.7**
Opuntia versicolor	0	1	1	0	0			**0.4**	**14.2**
Subshrubs, Forbs, and Grasses									
Abutilon incanum	0	1	4	0	3	**1.6**	**1.5**		
Ambrosia deltoidea	23	15	19	24	4	**17**	**15.5**		
Bouteloua aristidoides	4	6	9	5	1	**5**	**4.5**		
Encelia farinosa	9	17	2	8	6	**8.4**	**7.6**		
Erioneuron pulchellum	55	42	30	24	10	**32.2**	**29.3**		
Lesquerella gordonii	0	11	4	8	0	**4.6**	**4.1**		
Muhlenbergia porteri	5	1	7	4	0	**3.4**	**3**		
Pennisetum ciliare	1	0	0	1	3	**0**			
Psilostrophe cooperi	2	4	6	4	0	**3.2**	**3**		
Senna covesii	1	6	4	9	0	**4**	**3.6**		
Zinnia acerosa	16	22	16	30	24	**21.6**	**20**		
					total	**109.8**	**100%**		

APPENDIX 4-E
Pima County Approved Plant Species for Environmentally Sensitive Roadways

Trees		Minimum Size
Arizona (Velvet) Ash	*Fraxinus velutina*	15 gal.
Arizona Sycamore	*Platanus wrightii*	15 gal.
Arizona Walnut	*Juglans major*	15 gal.
Arizona White Oak	*Quercus arizonica*	24” box
Blue Palo Verde	*P. florida*	15 gal.
Desert (Sweet) Acacia	*Acacia smallii*	15 gal.
Desert Willow	*Chilopsis linearis*	15 gal.
Foothill Palo Verde	*Parkinsonia microphylla*	24” box
Fremont Cottonwood	*Populus fremontii*	15 gal.
Goodding Willow	*Salix gooddingii*	15 gal.
Ironwood	*Olneya tesota*	24” box
Mesquite	*Prosopis velutina*	15 gal.
Mexican Blue Oak	*Quercus oblongifolia*	24” box
Mexican Elder	*Sambucus mexicana*	15 gal.
Net Leaf Hackberry	*Celtis reticulata*	15 gal.
Texas Mulberry	*Morus microphylla*	15 gal.
Western Soapberry	*Sapindus saponaria*	15 gal.

Shrubs and Subshrubs		Minimum Size
All Scale	*Atriplex polycarpa*	5 gal.
Arizona Rosewood	*Vauquelinia californica*	15 gal.
California Buckwheat	*Eriogonum fasciculatum*	1 gal.
Catclaw Acacia	*Acacia greggii*	5 gal.
Creosote Bush	*Larrea tridentata*	5 gal.
Desert Fern	*Lysiloma microphylla*	15 gal
Desert Hackberry	*Celtis pallida*	5 gal.
Desert Senna	*Senna covesii*	1 gal.
Fairy Duster	*Calliandra eriophylla*	5 gal.
Four-wing Saltbush	*Atriplex canescens*	5 gal.
Indigo-bush	*Dalea greggii*	5 gal.
Long-leaved Joint Fir	*Ephedra trifurca*	5 gal.
Mimosa	*Mimosa dysocarpa*	5 gal.
New Mexico Locust	*Robinia neomexicana*	5 gal.
Red Barberry	*Berberis haematocarpa*	5 gal.
Shrub Live Oak	*Quercus turbinella*	15 gal.
Wait-a-minute Bush	*Mimosa biuncifera*	5 gal.
Whitethorn Acacia	*Acacia constricta*	5 gal.

Shrubs and Subshrubs - *continued*		**Minimum Size**
Brittlebush	*Encelia farinosa*	5 gal.
California Buck-thorn	*Rhamnus californica*	5 gal.
Chuperosa	*Beloperone californica*	5 gal.
Desert Honeysuckle	*Anisacanthus thurberi*	5 gal.
Desert Lavender	*Hyptis emoryi*	1 gal.
Desert Olive	*Forestiera neomexicana*	5 gal.
Desert Zinnia	*Zinnia acerosa*	1 gal.
Golden Eye	*Viguiera deltoidea*	1 gal.
Gray-thorn, Gray-leaved Abrojo	*Zizyphus obtusifolia*	5 gal.
Hop Bush	*Dodonea viscosa*	5 gal.
Jojoba	*Simmondsia chinensis*	5 gal.
Limber Bush	*Jatropha cardiophylla*	1 gal.
Mexican Manzanita	*Arctostaphylos pungens*	5 gal.
Ocotillo	*Fouquieria splendens*	8 cane
Paper Flower	*Psilostrophe cooperi*	1 gal.
Rayless Encelia	*Encelia frutescens*	5 gal.
Rock Sage	*Salvia pinguifolia*	5 gal.
Seep Willow	*Baccharis glutinosa*	5 gal.
Silk Tassel	*Garrya wrightii*	5 gal.
Squaw Bush	*Rhus trilobata*	5 gal.
Squaw Bush	*Condalia warnockii*	5 gal.
Sugar Sumac	*Rhus ovata*	5 gal.
Triangle-leaf Bursage	*Ambrosia deltoidea*	1 gal.
Trumpet Flower	*Tecoma stans*	5 gal.
Turpentine Bush	*Ericameria laricifolia*	1 gal.
White bursage	*Ambrosia dumosa*	1 gal.
White-stemmed Milkweed	*Asclepias albicans*	5 gal.

Cacti and Other Succulents		
Banana Yucca	*Yucca baccata*	5 gal.
Barrel Cactus	*Ferocactus wislizenii*	6”
Barrel Cactus	*Ferocactus covillei*	6”
Bigelow Nolina	*Nolina bigelovii*	5 gal.
Buckhorn Cholla	*Opuntia acanthocarpa*	2’
Cane Cholla	*Opuntia spinosior*	2’
Chain-fruit Cholla	*Opuntia fulgida*	2’
Desert Night-blooming Cactus	*Peniocereus greggii*	5 gal.
Desert Spoon	*Dasylirion wheeleri*	5 gal.
Engelmann Prickly Pear	*Opuntia engelmannii*	5 pad
Golden-flowered Agave	*Agave chrysantha*	5 gal.

Cacti and Other Succulents - *continued*		**Minimum Size**
Hedgehog Cactus	*Echinocereus engelmannii*	1 gal.
Hedgehog Cactus	*Echinocereus fasciculatus*	1 gal.
Palmer Agave	*Agave palmeri*	5 gal.
Pincushion Cactus	*Mammillaria microcarpa*	1 gal.
Purple Prickly Pear	*Opuntia violacea*	5 pad
Saguaro	*Carnegiea gigantea*	4’
Soaptree Yucca	*Yucca elata*	5 gal.
Staghorn Cholla	*Opuntia versicolor*	2’
Teddy Bear Cactus	*Opuntia bigelovii*	2’

Herbs		**Lbs./Acre**
Adonis Blazing Star	*Mentzelia multiflora*	1
American Carrot	*Daucus pusillus*	1
Arizona Lupine	*Lupinus arizonicus*	1
Bluedicks	*Dichelostemma pulchellum*	1
Desert Lupine	*Lupinus sparsiflorus*	1
Desert Mallow	*Sphaeralcea ambigua*	1
Desert Mariposa	*Calochortus kennedyi*	1
Eriastrum	*Eriastrum diffusum*	1
Four O’ Clock	*Mirabilis bigelovii*	1
Gordon Bladderpod	*Lesquerella gordoni*	1
Indian Root	*Aristolochia watsoni*	1
Lance-leaved Ditaxis	*Ditaxis lanceolata*	1
Large Yellow Evening Primrose	*Oenothera primiveris*	1
Larkspur	*Delphinium scaposum*	1
Lizard Tail	*Gaura parviflora*	1
Long-capsuled Primrose	*Camissonia chamaeneroides*	1
Mexican Gold Poppy	*Eschscholtzia mexicana*	1
Orange Caltrop	*Kallstroemia grandiflora*	1
Prickly Poppy	*Argemone* sp.	1
Rock Gilia	*Gilia scopulorum*	1
Sand Verbena	*Abronia* sp.	1
Small-flowered Blazing Star	*Mentzelia albicaulis*	1
Spiderling	*Boerhaavia* sp.	1
Trailing Four O’ Clock	*Allionia incarnata*	1
Twist Flower	*Streptanthus arizonicus*	1
Virgin’s Bower	*Clematis drummondii*	1
White Desert Primrose	*Oenothera caespitosa*	1
White Prairie Clover	*Petalostemum candidum*	1

Herbs - *continued*		**Lbs./Acre**
Bigelow Linanthus	*Linanthus bigelovii*	1
Chia	*Salvia columbariae*	1
Common Horehound	*Marrubium vulgare*	1
Desert Bell	*Phacelia campanularia*	1
Desert Tobacco	*Nicotiana trigonophylla*	1
Goodding Verbena	*Verbena gooddingii*	1
Nama	*Nama demissum*	1
New Mexico Verbena	*Verbena neomexicana*	
Owl Clover	*Orthocarpus purpurascens*	1
Paintbrush	*Castilleja* sp.	1
Scorpionweed	*Phacelia crenulata*	1

Grasses and Grasslike Plants		
Alkali Sacaton	*Sporobolus airoides*	2
Arizona Cotton-top	*Digitaria californica*	1
Big Galleta	*Hilaria rigida*	3
Blue Grama	*Bouteloua gracilis*	2
Bluebunch Wheatgrass	*Agropyron spicatum*	2
Bush Muhly	*Muhlenbergia porteri*	2
Deer Grass	*Muhlenbergia rigens*	1
Feather Fingergrass	*Chloris virgata*	2
Hairy Grama	*Bouteloua hirsuta*	1
Needle and Thread Grass	*Stipa comata*	2
New Mexico Feathergrass	*Stipa neomexicana*	1
Purple Threeawn	*Aristida purpurea*	2
Red Threeawn	*Aristida longiseta*	2
Sand Dropseed	*Sporobolus cryptandrus*	3
Sideoats Grama	*Bouteloua curtipendula*	2
Slim Tridens	*Tridens muticus*	2
Southern Cattail	*Typha domingensis*	2
Spider Grass	*Aristida ternipes*	1
Spike Dropseed	*Sporobolus contractus*	2
Tanglehead	*Heteropogon contortus*	2
Three-square Bulrush	*Scirpus americanus*	1
Tobosa Grass	*Hilaria mutica*	2
Western Wheatgrass	*Agropyron smithii*	3

Inappropriate Species. ***DO NOT USE THE FOLLOWING PLANTS*****.**	
Buffle Grass	*Pennisetum ciliare*
Downy Chess	*Bromus tectorum*
Fountain Grass	*Pennisetum setaceum*
Giant Reed	*Arundo donax*
Red Brome	*Bromus rubens*
Mediterranean/Arabian Grass	*Schismus* sp.
Wild Oat	*Avena* sp.

APPENDIX 4-F
Landscaping Guidelines

A. Plant Materials

- Comply with approved plant list with minimum allowed sizes (see Appendix 4-D)
- Encourage contract growing for plant species currently unavailable
- Plant material to be grown and stockpiled by Pima County

B. Planting Guidelines (Native Plants)

- Planting pit should be five (5) times *wider* than rootball, but no *deeper* than rootball
- Planting pit should have minimum drainage of 6 inches of water in one-half hour
- Four (4) vertical cuts about ¼ inch deep should be made 4 (four) times around rootball and twice on bottom
- Top of rootball should be level or slightly above soil surface
- Planting pit should be backfilled with approved backfill mix. Water should be allowed to settle (do not pack)
- After water is absorbed and soil settled, remainder of pit should be filled with backfill mix and lightly tamped to grade
- Do not prune unnecessarily. Pruning should be done immediately after planting. Up to 1/3 of growth should be removed, including all deadwood, sucker growth, and bruised and broken branches

Hydromulching

- Seed should be fresh, clean, and latest season's crop
- Seed rates are expressed as pounds of pure live seed per acre
- Fertilizer should be commercially produced with a guaranteed analysis of 16-20-0, ammonium phosphate
- Fiber should be virgin wood cellulose fiber with no growth or germination inhibiting factors. Ph range should be between 4.5 and 6.5
- Tackifier should be plantago organic muciloid tackifier, which is an organic muciloid liquid concentrate diluted with water and containing no agents toxic to seed germination
- Soil sulfur should be agriculture grade, 99.5 % sulfur
- Soil should be tilled to a depth of 6 inches
- All weeds and other undesirable vegetation should be uprooted
- Seedbed should be watered to a depth of at least 4 inches immediately after seeding. Water should be applied at such a rate as to prevent puddling or erosion.

Site Soil

- Topsoil and backfill should be native unamended soil, free of objectionable material and toxins harmful to plant growth
- Ph should range between 6.5 and 8.0
- Soil should be screened to pass through a 3/8 inch sieve

C. Irrigation

The purpose of irrigation zoning is to:

- Create irrigation zones based on specific water needs of plant materials
- Conserve water
- Create healthier growing environments
- Achieve higher success rates in plant longevity
- Provide more efficient long-term maintenance

Irrigation components should be standardized for ease of maintenance as follows:

- PVC in right-of-way, no drip polyline
- Low flow bubblers on trees
- Drip on shrubs/groundcover with multiport emitters
- Spray on hydroseed

APPENDIX 4-G
Visual and Aesthetic Resource Evaluation Process

The procedures outlined in this appendix include detailed and specific techniques for characterizing and evaluating visual and aesthetic resources. The implementation of specific procedures and the level of detail associated with this evaluation process should be determined on a case-by-case basis, and applied accordingly as determined in Step 1 below. Specific evaluation tables that have been included as a part of this process are presented as examples (including ratings). Such tables should be used as necessary and modified according to specific conditions.

Steps in Process

Step 1: Discovery/Identification of Visual and Aesthetic Resources

The first step in the Visual and Aesthetic Resource Evaluation (see Figure 4-6 of Chapter) includes a field review by the study team resulting in the identification and inventory of the visual elements associated with (1) viewers from and to the roadway area, (2) the setting of the project, and (3) elements of the project that will result in a change to the setting. The intent of this step is to initially characterize the visual resources, to identify those elements of the project that may have an effect on these resources, and to determine the potential level of analysis and treatment required for the project. Also during this step any specific visual practices and standards of agencies that have jurisdiction in the project area should be identified (e.g., FHWA, U.S. Forest Service, Bureau of Land Management).

Viewers

From the Roadway – Viewers from the roadway include roadway users (i.e., motorists and bicyclists), as well as viewers at special viewpoints associated with the roadway (e.g., trailheads, scenic overlooks, rest areas). When identifying roadway viewers, both directions of traffic should be considered in the evaluation. In situations where additional sidewalks or pathways are a part of the project, the associated views should also be considered.

To the Roadway – Viewers to the roadway include roadway "neighbors," who may consist of users of adjacent residences, businesses, and industrial and recreational facilities.

Setting

Landscape settings of proposed roadway projects may be natural or developed. Natural settings are those that consist of landform, vegetation, and/or water elements, and that demonstrate little if any man-made modifications or disturbance. (Natural settings may include ranching and grazing lands if they do not dominate or detract from natural conditions, i.e., over-grazing.) Developed settings include those areas in which residential, commercial, industrial, recreational, or agricultural uses (e.g., cotton fields, orchards) have been established.

Project Description

To evaluate the effects of a proposed roadway project on the setting and views from and to the roadway, project design features should be well defined. For example, projects may entail (a) the development of a new road requiring the removal of vegetation within an entire corridor area and the modification of landform through grading (cut and fill slopes), (b) only the widening of an existing roadway, resulting in selective vegetation clearing, and the use of retaining walls, or (c) only the addition of small project features to address very localized issues (e.g., barriers, landscaping guard rails, lighting, signage).

Step 2: Visual Analysis

The visual analysis begins with identifying initial visual impacts, which are based on the effects of the proposed project on the setting and views from and to the roadway and contrasted with the existing views from and to the roadway.

Viewers

The analysis of project effects on potential viewers includes the sensitivity of users with views from and to the project from key observation points, the viewing conditions, and any variables associated with those views. Collectively, this information is used to determine the overall visibility levels (high, moderate, or low) of users with views from and to the roadway.

Viewer Sensitivity – Viewer sensitivity measures peoples' concern for change in scenic quality or the image of a particular setting in which a roadway is being developed, modified, or improved. Criteria for the identification of viewer sensitivity include user type (e.g., transportation, residential, recreational); user volume (high, moderate, or low); public interest (national, state, or local); and association with special areas or unique viewer expectations (e.g., scenic highways, special recreational, historic areas). Table 1 shows how these criteria may be used to identify sensitivity levels (high, moderate, or low).

Viewing Conditions – Viewing conditions are defined by a set of viewer variable criteria that assists in characterizing views from and to the roadway with the project in place. Table 2 illustrates three possible condition levels (high, medium, low) associated with the following viewer variable criteria:

- Viewer Orientation, including parallel versus perpendicular views from the road
- Duration of View, including consideration for roadway speed limit
- View Distance, near foreground to background
- Visibility/Edge Condition, open, filtered or screened

Visibility Level Synthesis – Using the criteria presented in Tables 1 and 2, a synthesis of overall visibility levels is assigned to segments of the road characterizing views from and to the roadway area, as well as from specific viewing locations associated with the roadway (e.g., overlooks and trailheads). Table 3 presents a sample visual level synthesis.

Table 1
Sample Sensitivity Level Evaluation

Location (Key Observation Points)	**User Type**[1]	**Use Volume**	**Public Interest**[2]	**Special Areas**	**Sensitivity Level**
Travel Routes/Trails					
U.S. Highway 17	Res, Rec, SS	High	N,S,L	–	High
Lower Bushcreek Road	Res, Rec, SS	High	N,S,L	Planned Scenic Byway	High
Big Canyon Road	Rec, SS	High	N,S,L	Planned National Recreation Area	High
County Road 1 (Historic Tour)	Res, Rec, SS	High	N,S,L	Bar "S" Historic Ranch	High
Use Areas					
Sonoran Monument	Rec, SS	High	N,S,L	–	High
USFS Campgrounds					High
Big Mountain	Rec, SS	Moderate	N,S,L	–	
Green Meadows	Rec, SS	Moderate	N,S,L	–	
Creekside Campground	Rec, SS	Moderate	N,S,L	–	
Red Mountain Campground	Rec, SS	Moderate	N,S,L	–	
Travel Routes/Trails					
Cedar/Trail Creek Road	Res, Rec, SS	Moderate	S,L	–	Moderate
Lower Wildflower Road	Res, Rec, SS	Moderate	L	–	Moderate
Wildhorn Road	Res, Rec, SS	Moderate	L	–	Moderate
Fox Flats Road	Comm	Moderate	S????, L	–	Moderate
Arizona Gulch Road	Res, Rec, SS	Moderate	L	–	Moderate
Divide Road N. (County 2)	Res, Rec, SS	Moderate	L	–	Moderate
Travel Routes/Use Areas					
Highline Business Park	Comm	Moderate	L	Industrial Area	Low
Business Loop 156	Truck route	High	L	Light Industrial Area	Low

[1]*Residential (Res), Recreation (Rec), Sight Seeing (SS), Commuters (Comm)*
[2]*National (N), State (S), Local (L)*

Table 2
Sample Viewing Condition Evaluation

Viewer Variable Criteria	Viewing Condition Level		
	High	**Moderate**	**Low**
Viewer Orientation – perpendicular vs. parallel views	Viewer attracted, or directed specifically to or from the proposed roadway action	Viewer is neither strongly attracted/directed toward nor away from the location of the proposed roadway action	Viewer attracted or directed away from the location of the proposed roadway action
Duration – considers speed of travel	View is continual or fixed (e.g., residential areas, resorts)	View is intermediate or temporal (e.g., roads and highways, parks, overlooks, campgrounds, commercial areas)	View is brief (e.g., perpendicular road crossings)
Distance – views from and to the roadway	Views from or to the roadway are within the near foreground area (immediate right-of-way), and the foreground area (edge of right-of-way to 0.25 mile)	Views from or to the roadway are within the middle-ground area (0.25 to 3 miles)	Views from or to the roadway are within the background area (3 to 5 miles and beyond)
Visibility – the "edge condition" of the roadway	Views from or to the roadway are open	Views from or to the roadway are partially screened or filtered	Views from or to the roadway are screened or blocked

Table 3
Sample Visibility Level Synthesis

	Viewer Variables		
Location *(Key Observation Point)*	**Sensitivity Level**	**Viewer Orientation**	**Distance**
Wildhorn Road	M	M	L
Sonoran Monument	H	M	H

Setting

Analysis of the project setting includes the characterization of similar patterns of landform, vegetation, land use, and unique features by units. Characterizing these factors permits an evaluation of the potential effect of the proposed roadway project in conjunction with scenic quality (i.e., natural setting), or visual image types (i.e., developed settings).

Natural Setting – Natural landscapes or settings may be characterized in units based on similar patterns of the following elements:

- *Landform*: Topography becomes more interesting as it gets steeper, more massive, or more severely or universally sculpted. Outstanding landforms may be monumental (mountains) or subtle, including low rolling hills or flat valley bottoms, displaying few, if any, interesting landscape features.

- *Vegetation*: Plant life is considered in terms of the variety of patterns, forms, and textures it creates, including short-lived displays when they are known to be recurring or spectacular. Consideration may also be given to smaller scale vegetation features that add striking and intriguing detail elements to the landscape (e.g., Joshua trees, saguaro cactus, ponderosa pine).
- *Water*: Water adds movement or serenity to a scene. The degree to which water dominates the scene may often be the primary consideration in selecting a scenic quality rating (particularly in Arizona).
- *Color*: Overall color(s) of the basic components of the landscape (e.g., soil, rock, vegetation) as they appear during seasons or periods of high use is considered.
- *Scarcity:* Scarcity provides an opportunity to give added importance to one or all of the scenic features that appear to be relatively unique or rare within the region of the proposed roadway project.
- *Cultural Modifications:* Cultural modifications to the landform/water and vegetation and in the addition of structures should be considered for possible enhancement of or detraction from the scenery in a natural setting. Such modifications may complement or improve the scenic quality of a unit or, conversely, may become a negative intrusion and detract from the scenery in a natural setting. Ranching activities, hacienda, and historic settings should all be considered.

The six natural setting elements above are combined (i.e., added) to determine the overall scenic quality of the natural setting as illustrated in Table 5. Three potential ranges of scenic quality are used to express the landscape scenic value of each unit within the context of views from and to the road in a natural setting:

- *Distinctive Scenic Quality:* These units are natural areas containing the greatest diversity of features such as landform, vegetative patterns, water forms, and rock formations that are of an unusual or outstanding visual quality not common in the surrounding area.
- *Common Scenic Quality:* These units are natural areas containing features with a variety of landforms and vegetative patterns that tend to be common throughout the surrounding area and are not outstanding in visual quality.
- *Minimal Scenic Quality:* These units are natural areas characterized by little or no variety of landform and vegetation, and may include specific locations that have been culturally modified in a negative fashion.

It is important to note that the terms used to define the range of scenic quality may need to be modified for public outreach since, for example, an individual living in an area of "minimal scenic quality" may not consider it to be minimal.

Developed Settings – The visual image of developed settings (counterpart to scenic quality in a natural setting) is based on types of use and development patterns that are defined by visual character, planning concepts, and viewer orientation. Visual character regards the composition of design elements including form, line, color, and texture. These elements influence visual dominance and focus within each setting. The planning concept is primarily based on circulation

and building types. Circulation and building types act as major organizing elements that structure the visual environment. Circulation types may include gridded, curvilinear, loop-road, and cul-de-sacs. Building types may be clustered, detached, or attached building placements. Orientation of views from these areas is based on the planning concept. Inward oriented patterns tend to be structured, often with a layout that responds to a central focus or feature. Outward oriented development patterns often have a random or open character.

In general, these patterns may be grouped and classified into the following five image types:

- *Residential Image Type:* A variety of development patterns that display an integration of the visual character and planning concept. There is often a strong repetition of design elements that are organized around circulation patterns.
- *Commercial Image Type:* Clustered development patterns with high visibility and often orientated specifically to the roadway. Structures and architectural treatments are often highly unified.
- *Park–Like Image Type:* Open and landscaped areas that dominate the development pattern, including active recreation areas as well as other greenbelt open space. Many of the light industrial, office park, and institutional development patterns fit this context as well. In these patterns, a central building or group of buildings generally are placed in an open space setting giving the development a park-like image.
- *Industrial Image Type:* Development patterns in which structures dominate the visual character. Buildings and facilities are often large scale and complex. Open space treatment is limited primarily to the perimeter of the development and is not integrated into the overall planning concept.
- *Open/Agricultural Image Type:* Patterns that lack formal development and are generally vacant, rural, or used for crop production. The agricultural image may vary according to the time of year and type of crop.

Similar to the natural setting, special consideration may be given to those image types that are of an historic nature or that exhibit unique architectural features. For example, a commercial area in a historic downtown location should be given special consideration.

Visual Contrast

The visual contrast analysis is a systematic process that is used to analyze the potential visual impacts of the proposed roadway project and associated activities. The degree to which the roadway project affects the visual and aesthetic quality of a natural or developed setting depends on the contrast between the setting with the project in place and the existing setting without the project in place. The contrast can be measured by comparing the design features associated with the project description with the major features in the existing setting (natural or developed). The basic design elements of form, line, color and texture are used to make this comparison and to describe the visual contrast created by the project in a natural setting, while the effects to image type are used to define contrast in developed areas.

Table 5
Sample Scenic Quality Evaluation Chart

Key Factors	Scenic Quality Rating Criteria and Score*		
Landform	High vertical relief as expressed in prominent cliffs, spires, or massive rock outcrops, or severe surface variations or highly eroded formations including major badlands or dunes, or detail features dominant and exceptionally striking and intriguing. **5**	Steep canyons, mesas, buttes, cinder cones, and drumlin, or interesting erosion patterns or variety in size and shape of landforms, or detail features that are interesting though not dominant or exceptional. **3**	Low rolling hills, foothills, or flat valley bottoms, or few or no interesting landscape features. **1**
Vegetation	A variety of vegetative types as expressed in interesting forms, textures, and patterns. **5**	Some variety of vegetation, but only one or two major types. **3**	Little or no variety or contrast in vegetation. **1**
Water	Clear and clean appearing, still, or cascading white water, any of which are a dominant factor in the landscape. **5**	Flowing or still, but not dominant in the landscape. **3**	Absent or present, but not noticeable. **0**
Color	Rich color combinations, variety or vivid color or pleasing contrasts in the soil, rock, vegetation, and water. . **5**	Some intensity of variety in colors and contrast of the soil, rock, and vegetation, but not a dominant scenic element. **3**	Subtle color variations, contrast, or interest, generally mute tones. **1**
Influence of Adjacent Scenery	Adjacent scenery that greatly enhances visual quality. **5**	Adjacent scenery moderately enhances overall visual quality. **3**	Adjacent scenery has little or no influence on overall visual quality. **0**
Scarcity	One of a kind, unusually memorable, or very rare within region. Consistent chance for exceptional wildlife or wildflower viewing, etc. **5**	Distinctive, though somewhat similar to others within the region. **3**	Interesting within the setting, but fairly common within the region. **1**
Cultural Modifications	Modifications add favorably to visual variety (may include ranching or historic features). **5**	Modifications add little or no visual variety to the area. **0**	Modifications are extensive and scenic qualities are substantially reduced. **-4**

Scenic Quality
Distinctive = 19 or more
Common = 12 to 18
Minimal = 11 or less

This analysis process provides a means for determining the visual impacts and for identifying the treatment and measures to mitigate these impacts (see Step 3 below). Where possible this process should be employed early on to assist as a design tool during both project planning and design.

The steps in the visual contrast analysis for natural and developed settings are as follows:

Natural Setting – The steps for evaluating the contrast in a natural setting include the following:

- *Obtain Project Description:* To effectively evaluate the visual impacts of a proposed new or modified roadway, obtain a detailed project description. The level of detail in the description should be commensurate with the type of project proposed.
- *Select Key Observation Points (KOPs):* The contrast rating should be done from the most critical viewpoints associated with views from and to the roadway. Factors that should be used in selecting critical viewpoints are a by-product of the viewer analysis (see Step 2 in this Appendix 4-F) and should include the number and sensitivity of viewers and the orientation and duration of views.
- *Prepare Visual Simulation (Optional):* Visual simulation is an invaluable tool for effective evaluation of impacts. Simulations are strongly recommended for potentially high impact or special projects. The level of sophistication should be commensurate with the quality of the visual resource and the severity of the anticipated impact. Simulations help public groups visualize and respond to roadway development proposals, which makes public participation in the planning process more effective.

The contrast rating process should be completed in the field from the selected KOPs and/or through the use of photographs taken from KOP locations. The process may be undertaken by a landscape architect team that is trained in visual resource assessment or by an individual landscape architect, depending on the sensitivity and impacts of the project and the availability of qualified personnel.

The contrast rating is completed by determining the degree of contrast (e.g., strong, moderate, weak, or none) that the introduction of roadway design features could have on the features of the natural setting (e.g., landform/water, vegetation, structures). As illustrated in Table 6, this rating is accomplished by evaluating changes in the setting to form, line, color, and texture for each of the design features. In general, the contrast ratings are expressed as follows:

- *No Contrast:* Design features associated with the proposed roadway are not visible or perceived from or to the roadway.
- *Weak Contrast:* Design features associated with the proposed roadway can be seen but do not attract attention to views from or to the roadway.
- *Moderate Contrast:* Design features associated with the proposed roadway begin to attract attention and begin to dominate the views from or to the roadway.
- *Strong Contrast:* Design features associated with the proposed roadway cannot be overlooked and dominate views from or to the roadway.

The results of the contrast analysis may be combined with the viewer visibility levels (Table 3) and used to determine the level of change, or visual impact that the proposed project will have on the natural setting as viewed from and to the roadway (Table 7).Furthermore, the contrast analysis will assist in identifying design treatments or mitigation measures that will reduce the visual impacts to an acceptable level and/or enhance the natural setting. If the project is located on land administered by the U.S. Bureau of Land Management or the U.S. Forest Service, the contrast analysis is used to determine whether a project complies with agency visual management objectives.

Table 7
Sample Visual Impact Model

	Overall Viewer Visibility Levels		
Visual Contrast	**High**	**Moderate**	**Low**
High	High Impact	High Impact	Moderate Impact
Moderate	High Impact	Moderate Impact	Low Impact
Low	Moderate Impact	Low Impact	Low Impact

Developed Setting – Similar to the evaluation of contrast in the natural setting, evaluating the contrast in developed areas also requires the definition of the design features associated with the project description. In developed settings, this often may include the use of walls and other structural treatments, as well as consideration for detailed design elements including signage, lighting, associated pedestrian facilities, and landscape treatments.

These design features are then analyzed in conjunction with the visual image types previously identified, and used to document effects to the following:

- *Circulation:* Do the design features associated with the proposed roadway disrupt existing circulation patterns and access to any of the image types associated with the developed setting?
- *Structural:* Do the design features associated with the proposed roadway require structural removal, or affect existing building location and design continuity?
- *Open Space Modifications:* Do the design features associated with the proposed roadway result in the removal or alteration of existing open space within or surrounding the image type?
- *Viewer Orientation:* Do the design features associated with the proposed roadway change significant views either from or to the roadway, including the consideration of effects on viewer orientation within each image type?

Using this information, the impacts may be summarized to discuss the modification to the development pattern or visual image, and effects to views from and to the roadway.

Table 6
Sample Visual Contrast Rating Worksheet

Project Information			
Project Name: _____			
Key Observation Point: _____			
Date: _____			
Existing Landscape Characteristics			
	Land/Water	**Vegetation**	**Structures**
Form			
Line			
Color			
Texture			
Proposed Activity Description			
	Land/Water	**Vegetation**	**Structures**
Form			
Line			
Color			
Texture			

Contrast Rating ☐ Short Term ☐ Long Term

DEGREE OF CONTRAST		**FEATURES**												*Levels of change* ☐ Very Low ☐ Low ☐ Moderate ☐ High
		Land/Water Body				**Vegetation**				**Structures**				
		Strong	**Moderate**	**Weak**	**None**	**Strong**	**Moderate**	**Weak**	**None**	**Strong**	**Moderate**	**Weak**	**None**	*Does project design meet visual resource management objectives? (if applicable)* ☐ Yes ☐ No Explain. (Continue on reverse, if necessary)
FEATURES	**Form**													*Additional mitigating measures recommended* ☐ Yes ☐ No (If "yes," describe. Continue on reverse side if necessary)
	Line													
	Color													
	Texture													

Step 3 - Design Treatment or Mitigation Measures

The purpose of this step of the Visual and Aesthetics Resource Evaluation Process is to identify potential treatment options that may be utilized to enhance viewing conditions and/or address the impacts to views from and to the roadway as previously discussed. This step focuses specifically on the selection of relevant design elements or treatments to mitigate effects; the evaluation of the effects of the measures on addressing visual and aesthetic opportunities and impacts, and the prioritization of identified treatments/mitigation measures.

As described earlier and indicated in Figure 1, this is a "circular" portion of the process that allows for the identification of alternative plans, including design treatments/mitigation measures that are evaluated based on (1) effects to the visibility level associated with sensitive views, and (2) ability to reduce contrast of proposed roadway design features in either a natural or developed setting and to enhance the overall aesthetic of the roadway corridor.

Examples of design treatment and mitigation measures that may be applied to different types of roadway projects are described in Section IV, Mitigation Tools, of this guide.