5.0 MAJOR DESIGN FEATURES OF THE SELECTED ALTERNATIVE

5.1 INTRODUCTION

In this section, the major design features of the selected alternative (Alternative 1) for Northern Parkway are presented. Northern Parkway is divided into four major segments for design purposes. The west segment from Sarival Avenue to 115th Avenue is classified as an AASHTO Urban Principal Arterial with full access control. The east segment from 115th Avenue to 103rd Avenue and from 91st Avenue to 71st Avenue uses the MCDOT Urban Principal Arterial design standards and has limited direct access from adjacent properties and streets. Between 103rd Avenue and 91st Avenue Northern Parkway would be shifted to the south to form a bypass. Northern Avenue will remain in this section to provide access to Loop 101 and to abutting properties. The bypass will be designed to AASHTO Urban Principal Arterial standards with full access control. The last segment is the Grand Avenue Flyover, which would connect Northern Parkway with Grand Avenue (US 60) south of Northern Avenue. The flyover would be designed to ADOT ramps standards. Design features for these segments as well as intersecting streets, ramps, eastbound and westbound Northern Avenue, and neighborhood connecting streets are summarized in the following sections.

5.2 DESIGN CONTROLS

The design controls for Northern Parkway were a little difficult to determine since there are no national or local design standards for a parkway and because conditions along the corridor do not allow application of a uniform continuous set of standards for the entire length of the project. The parkway concept will operate at a level less than a freeway but greater than an arterial street. Local, state, and national standards for both freeways and arterial streets were analyzed as part of developing geometric design standards for Northern Parkway. The following is a list of roadway geometric standards reviewed as part of the development of the Northern Parkway design standards:

- City of Peoria Infrastructure Development Guidelines – 2007
- City of Glendale Design Guidelines for Site Development and Infrastructure Construction – 2002
- Maricopa County Department of Transportation Roadway Design Manual – 2004
- Arizona Department of Transportation Roadway Design Guidelines – 2007
- American Association of State Highway and Transportation Officials (AASHTO), A Policy on Geometric Design of Highways and Streets – 2004 (Green Book)

The following sections summarize the Northern Parkway design standards.

5.2.1 Northern Parkway West

This segment includes Northern Parkway from Sarival Avenue to 115th Avenue. Access from adjacent property would not be allowed onto the parkway. GSI would be provided at Sarival Avenue, Reems Road, Litchfield Road, Dysart Road, and El Mirage Road. Access to Northern Parkway from the north-south arterials would be via one-way connector roadways or ramps located in each quadrant of the intersection. The Sarival interchange will be configured in a half diamond with ramps located only east of the intersection and the parkway elevated over Sarival. The Reems Road and Litchfield Road GSI would also be diamond type interchanges with the parkway elevated over the arterials. At Dysart and El Mirage Road interchanges, the arterial ramp intersection would be configured as a SPUI with the parkway elevated over the SPUI. Table 5-1 contains the design standards for this segment of the parkway.

Typical sections for the west portion of the parkway are shown in Volume 2 of the DCR, Sheets G3 to G7. These typical sections show three 12-foot wide through lanes in each direction plus a 12-foot wide auxiliary lane between the GSI ramps. No auxiliary lane would be included between Reems Road and Litchfield Road since there are 2 miles between these GSI. Eastbound and westbound traffic are separated by a continuous concrete median barrier and a 12-foot wide paved shoulder on each side of the barrier due to the anticipated volume of trucks exceeding 250 vph. A 10-foot paved shoulder plus a 2-foot unpaved shoulder would be included at the outside edges between the ramps. At the bridge structure and approaches to the GSI where barrier is required, the paved outside shoulder would be 12 feet. The total paved roadway width would be 142 feet between GSI and 122 feet at the structures and approaches. East of the El Mirage Road east ramps, the parkway would consist of four lanes in each direction and the paved width would be 146 feet.

Ramps are also shown on the same typical sections in Volume 2, Sheets G3 to G7. The main body of the ramps would consist of two lanes with a total roadway width of 29 feet measured to the back of curb. The ramps would narrow to a single lane at the gore locations. The off-ramps would widen to three lanes at the cross-street intersection to provide for turning lanes.

Table 5-1 Northern Parkway West Design Standards – Sarival Avenue to 115th Avenue

Description	Design Criteria			
	Mainline	**Reference[1]**	**Ramp**	**Reference[2]**
General				
Roadway Classification	AASHTO Urban Principal Arterial		ADOT Ramp	
Access Control	Full control of access	p503		
Design Speed (mph)	60	p503	50	p500-9
Posted Speed (mph)	55		45	
Design Year	2030		2030	
Design ADT (vpd)	100,000		5000-8000	
Design Vehicle	WB-50		WB-50	
Design Level of Service	D	p504		
Horizontal Alignment				
Superelevation (Max)	6%	p505	6%	p500-11
Stopping Sight Distance (ft)	570	p272, p277		
Minimum Radius w/NC (ft)	11,100	p168		
Minimum Radius	1,330	p168		
Minimum Length of Curve	500	p229		
Max Angle Break w/o Curve	45'			
Vertical Alignment				
Gradient (Max)	3%	p506	4% up, 5% down	p500-10
Gradient (Min)	0.30%	p236	0.40%	p500-10
Grade Break (Max)	0.20%		2%	p500-11
Length of Curve (Min)	180	p269, p276	400	p500-10
Length of Crest Curve (Max)	1000	p272		
Crest Vertical Curve K value (min)	151	p272		
Sag Vertical Curve K value (min)	136	p277		
Vertical Clearance (ft)	16.5	[3]		
Cross Sectional Elements				
Lane Widths (ft)	12	p504	12	p500-15
Right Shoulder Width (ft)	10[4]	p505	8	p300-11
Left Shoulder Width (ft)	12	p505	2	p300-11
Cross Slope	2%	p504	2%	
Median Type	Concrete Barrier	p513		
Median Width (ft)	22	p513		
Side Slopes (In Clear Zone)	6 to 1	p512	4 to 1	p500-13
Side Slopes	3 to 1	p512	3 to 1	p500-13
Drainage				
Pavement	10-year storm			
Culvert Cross Drainage	100-yr no freeboard			
Bridge	100-yr with 3 ft freeboard			

[1] Page numbers refer to AASHTO A Policy on Geometric Design of Highways and Streets, 2004
[2] Page numbers refer to ADOT Roadway Design Guidelines, 2006
[3] Allows for 16 ft min. plus 0.5 ft for future pavement overlays
[4] 10 ft paved shoulder plus 2 ft gravel shoulder, 12 ft paved shoulder adjacent to barriers

Two-lane eastbound and westbound frontage roads would be included from Dysart Road to El Mirage Road (see Volume 2, Sheet G6). The roadways would include curb and gutter and measure 32 feet to back of curbs. Off-ramps at Dysart Road and El Mirage Road would widen to four lanes providing dual left-turn lanes, an exclusive right-turn lane, and a separate through lane. U-turn movements would also be provided at Dysart Road and at El Mirage Road.

5.2.2 Northern Parkway East

This segment includes Northern Parkway from 115th Avenue to 103rd Avenue and from 91st Avenue to 71st Avenue. Existing access from collector and local streets, and driveways would be accommodated along mainline Northern Parkway and ramps. Table 5-2 contains the design standards for this segment of the parkway.

Typical sections for the east portion of the parkway are shown in Volume 2, Sheets G8, G10, and G11. These typical sections show three through lanes plus auxiliary lane in each direction divided by a raised 14-foot wide landscaped median. The section between 112th Avenue and 107th Avenue would include curb and gutter and a 6-foot wide shoulder next to the outside lane to provide enhanced sight distance for right-turn movements onto Northern Parkway from driveways and streets. A 6-foot wide sidewalk offset 9 feet from the back of curb would also be included from 112th Avenue to 107th Avenue. Between 107th Avenue and 103rd Avenue the 6-foot sidewalk on the north side would be offset 7 feet from the back of curb while no sidewalk would be provided on the south side due to existing constraints.

East of 91st Avenue to 71st Avenue, Northern Parkway consists of three 12-foot wide through lanes in each direction with a 12-foot wide auxiliary lane between the GSI (see Volume 2, Sheet G11). Eastbound and westbound traffic are separated by a concrete median barrier and a 2-foot wide shy distance on each side of the barrier on the grade separated structures and approaches and a 14-foot wide raised landscaped median with 2-foot shy distance between the GSI. A 6-foot wide paved shoulder including vertical curb and gutter is also included at the outside edges. This area is included to help the sight distance for right-turn movements from driveways and streets intersecting Northern Parkway. The total paved roadway width between GSI varies from 119 feet to 126 feet. At the grade separated structures and approaches the total roadway width is 82 feet. Six-foot wide sidewalks are included in the typical sections for the parkway and ramps, and are offset a minimum of 7 feet from the back of curb except for the segment from 89th to 87th avenues which has a 5-foot sidewalk and 5.5-foot offset.

Table 5-2 Northern Parkway East Design Standards – 115th Avenue to 103rd Avenue and 91st Avenue to 71st Avenue

Description	Design Criteria			
	Mainline	**Reference[1]**	**Ramp**	**Reference[2]**
General				
Roadway Classification	MCDOT Urban Principal Arterial		ADOT Ramp	
Access Control	Partial Access Control		Partial Access Control	
Design Speed (mph)	55	p5-17	50	p500-9
Posted Speed (mph)	45		45	
Design Year	2030		2030	
Design ADT (vpd)	93,000 and 75,000		1400-9500	
Design Vehicle	WB-50		WB-50	
Design Level of Service	D	p2-3		
Horizontal Alignment				
Superelevation (Max)	4%	p5-19	6%	p500-11
Stopping Sight Distance (ft)	495	p5-34, p5-36		
Minimum Radius w/NC (ft)	10,000	p5-22		
Minimum Radius	1,200	p5-22		
Minimum Length of Curve	500	p5-18		
Max Angle Break w/o Curve	1 degree			
Vertical Alignment				
Gradient (Max)	5%	p5-32	4% up, 5% down	p500-10
Gradient (Min)	0.25%	p5-31	0.40%	p500-10
Grade Break (Max)	0.30%	p5-31	2%	p500-11
Length of Curve (Min)	165	p5-33	400	p500-10
Length of Crest Curve (Max)	1200	p5-34		
Crest Vertical Curve K value (min)	114	p5-34		
Sag Vertical Curve K value (min)	115	p5-36		
Vertical Clearance (ft)	16.5	[3]		
Cross Sectional Elements				
Lane Widths (ft)	12	p5-1	12	p500-15
Right Shoulder Width (ft)	5.5	p5-9	8	p300-11
Lane Width Next to Vert. Curb	14	p5-1	2	p300-11
Cross Slope	2%	p5-9	2%	
Median Type	Raised, Vert. Curb	p5-9		
Median Width (ft)	14	p5-9		
Side Slopes (In Clear Zone)	1.50%	p5-9	4 to 1	p500-13
Side Slopes	4 to 1		3 to 1	p500-13
Sidewalk Width, offset (ft)	5, 7	p5-9	5, 7	
Curb and Gutter	MAG Std Det 220, Vert	p5-9		
Clear Zone (ft)	3	p5-43	3	
Drainage				
Pavement	10-year storm			
Culvert Cross Drainage	100-yr no freeboard			
Bridge	100-yr with 3 ft freeboard			

[1] Page numbers refer to MCDOT Roadway Design Manual, 2004
[2] Page numbers refer to ADOT Roadway Design Guidelines, 2006
[3] Allows for 16 ft min. plus 0.5 ft for future pavement overlays

Ramps are also shown in Volume 2, Sheet G11. The main body of the ramps consists of two lanes and the 6-foot wide sight distance area for a total roadway width of 32.5 feet measured to the back of curb. The ramps narrow to a single lane at the gore locations. The off-ramps widen to four lanes at the cross-street SPUI intersections to provide dual left-turn lanes, an exclusive right-turn lane, and a separate through lane. U-turn movements are accommodated at all the GSI.

5.2.3 Northern Parkway (Bypass)

This segment includes Northern Parkway from 103rd Avenue to 91st Avenue. In this segment, through traffic will be shifted to the bypass mainline roadway while Northern Avenue is maintained to provide local access to adjacent property and a connection to SR 101L/Agua Fria Freeway (Loop 101). Northern Parkway will be completely access controlled from 103rd Avenue to 91st while the adjacent Northern Avenue will provide normal municipal arterial street access to adjacent property. Table 5-3 contains the design standards for this segment of the parkway.

Table 5-3 Northern Parkway (Bypass) Design Standards – 103rd Avenue to 91st Avenue

Description	Design Criteria Mainline	Reference(1)	Ramp	Reference(2)
General				
Roadway Classification	AASHTO Urban Principal Arterial		ADOT Ramp	
Access Control	Full control of access	p503	access control	
Design Speed (mph)	55	p503	50	p500-9
Posted Speed (mph)	45		45	
Design Year	2030		2030	
Design ADT (vpd)	94,000		7000-12000	
Design Vehicle	WB-50		WB-50	
Design Level of Service	D	p504		
Horizontal Alignment				
Superelevation (Max)	6%	p506	6%	p500-11
Stopping Sight Distance (ft)	495	p272, p277		
Minimum Radius w/NC (ft)	9,410	p168		
Minimum Radius	1,060	p168		
Minimum Length of Curve	500	p229		
Max Angle Break w/o Curve	45'			
Vertical Alignment				
Gradient (Max)	4%	p506	4% up, 5% down	p500-10
Gradient (Min)	0.30%	p236	0.40%	p500-10
Grade Break (Max)	0.20%		2%	p500-11
Length of Curve (Min)	165	p269, p276	400	p500-10
Length of Crest Curve (Max)	1000	p272		
Crest Vertical Curve K value	114	p272		
Sag Vertical Curve K value	115	p277		
Vertical Clearance (ft)	16.5	(3)		
Cross Sectional Elements				
Lane Widths (ft)	12	p504	12	p500-15
Right Shoulder Width (ft)	12(5)	p505	8	p300-11
Left Shoulder Width (ft)	12(4)	p505	2	p300-11

Description	Design Criteria Mainline	Reference[1]	Ramp	Reference[2]
Cross Slope	2%	p504	2%	
Median Type	Concrete Barrier	p513		
Median Width (ft)	10	p513		
Side Slopes (In Clear Zone)	6 to 1	p512	4 to 1	p500-13
Side Slopes	3 to 1	p512	3 to 1	p500-13
Drainage				
Pavement	10-year storm			
Culvert Cross Drainage	100-yr no freeboard			
Bridge	100-yr with 3 ft freeboard			

(1) Page numbers refer to AASHTO A Policy on Geometric Design of Highways and Streets, 2004
(2) Page numbers refer to ADOT Roadway Design Guidelines, 2006
(3) Allows 16 ft min. plus 0.5 ft for future pavement overlay
(4) Anticipated truck traffic greater that 250 vph
(5) 10 ft wide adjacent to auxiliary lanes (AASHTO p. 814)

Typical sections for the bypass portion of the parkway are shown in Volume 2, Sheets G9 and G10. These typical sections show three 12-foot wide through lanes in each direction separated by a continuous concrete median barrier and 12-foot wide median shoulder on each side of the barrier. A 12-foot wide auxiliary lane is added between the 103rd Avenue east ramps and the 93rd Avenue west ramps. A 10-foot wide paved shoulder is included next to the auxiliary lane and a 12-wide paved right shoulder is included in other areas of the segment adjacent to barrier. The parkway will be depressed at 103rd Avenue and elevated on bridge structure or embankment with retaining walls from west of 99th Avenue to east of 91st Avenue. The retaining wall minimizes the amount of right-of-way required in this especially valuable portion of the corridor. The elevated section requires continuous concrete barrier on the outside edges of the roadway section.

5.2.4 Northern Parkway (Grand Flyover)

This segment includes Northern Parkway from 71st Avenue to Grand Avenue (US 60) south of Northern Avenue. This segment provides free flow connection over the 67th Avenue overpass for eastbound Northern Parkway traffic to southeast-bound Grand Avenue and northwest-bound Grand Avenue to westbound Northern Parkway traffic. Table 5-4 contains the design standards for this segment of the parkway.

The typical section for the Grand Avenue Flyover portion of the parkway is shown in Volume 2, Sheet G12. This typical section shows one 12-foot wide through lane in each direction separated by a continuous concrete median barrier and 4-foot wide median shoulder on each side of the barrier. A 10-foot wide paved shoulder is included at the outer edge of each travel lane. The segment from 71st Avenue to Grand Avenue is elevated on bridge structure or embankment with retaining wall. This requires continuous concrete barrier on the outside edges of the roadway section. The total roadway width of the flyover ramp is 54 feet.

Table 5-4 Northern Parkway (Grand Flyover) Design Standards – 71st Avenue to Grand Avenue

Description	Design Criteria Mainline	Reference(1)
General		
Roadway Classification	ADOT Ramp	
Access Control	Full control of access	
Design Speed (mph)	50	p500-9
Posted Speed (mph)	45	
Design Year	2030	
Design ADT (vpd)	14,300	
Design Vehicle	WB-50	
Design Level of Service		
Horizontal Alignment		
Superelevation (Max)	6%	p500-11
Stopping Sight Distance (ft)		
Maximum Curvature w/NC	1 degree	p200-18
Minimum Radius (ft)	955	p200-18
Minimum Length of Curve		
Max Angle Break w/o Curve		
Vertical Alignment		
Gradient (Max)	6%	p500-10
Gradient (Min)	0.40%	p500-10
Grade Break (Max)	2%	p500-11
Length of Curve (Min)	400	p500-10
Cross Sectional Elements		
Lane Widths (ft)	12	p500-15
Right Shoulder Width (ft)	8(2)	p300-11
Left Shoulder Width (ft)	2(3)	p300-11
Cross Slope	2%	
Median Type	Concrete Barrier	
Median Width (ft)	6	
Side Slopes (In Clear Zone)	4 to 1	p500-13
Side Slopes	3 to 1	p500-13
Drainage		
Pavement	10-year storm	
Culvert Cross Drainage	100-yr no freeboard	
Bridge	100-yr with 3 ft freeboard	

(1) Page numbers refer to ADOT Roadway Design Guidelines, 2006
(2) 10 ft when adjacent to barrier
(3) 4 ft when adjacent to barrier

5.2.5 Northern Avenue

Northern Avenue will remain and be improved along several segments of Northern Parkway. The design standards used for Northern Avenue will depend on the location and jurisdictional boundaries. Peoria Major Arterial Street standards will govern the design of Northern Avenue from 103rd Avenue to 91st Avenue while City of Glendale Major Arterial Street standards will be followed from 71st Avenue to approximately the 65th Avenue alignment east of Grand (see Table 5-5).

Table 5-5 Northern Avenue Design Standards – 103rd Avenue to 91st Avenue and 71st Avenue to 65th Avenue

Description	Design Criteria 103rd to 91st Avenue	Reference(1)	71st to 65th Avenue	Reference(2)
General				
Roadway Classification	City of Peoria Major Arterial Street		City of Glendale Major Arterial Street	
Access Control	Partial Access Control		Partial Access Control	
Design Speed (mph)	45		45	
Posted Speed (mph)	35		40	
Design Year	2030		2030	
Design ADT (vpd)	50,000 and 29,000		50,000	
Design Vehicle	WB-50		WB-50	
Design Level of Service	D		D	
Horizontal Alignment				
Superelevation (Max)	4%		4%	
Stopping Sight Distance (ft)				
Minimum Radius w/NC (ft)				
Minimum Radius	500	Figure 3-4	500	Figure 3-4
Minimum Length of Curve	500		500	
Max Angle Break w/o Curve	7 degree	Figure 3-4	7 degree	Figure 3-4
Vertical Alignment				
Gradient (Max)	6%	p3-16	8%	Figure 3-4
Gradient (Min)	0.40%	Figure 3-4	0.20%	Figure 3-4
Grade Break (Max)	1.00%	Figure 3-4	1.00%	Figure 3-4
Length of Crest Curve (Min)	160A	Figure 3-4	160A	Figure 3-4
Length of Sag Curve (Min)	105A	Figure 3-4	160A	Figure 3-4
Crest Vertical Curve K value				
Sag Vertical Curve K value				
Vertical Clearance (ft)	16.5	p3-5	16.5	(3)
Cross Sectional Elements				
Lane Widths (ft)	12		12	
Right Shoulder Width (ft)				
Left Shoulder Width (ft)				
Cross Slope	2%	Figure 3-4	2%	Figure 3-4
Median Type	Raised, Vert. Curb	Detail 292	Raised, Vert. Curb	Detail G-303
Median Width (ft)	16	Detail 292	16	Detail G-303
Side Slopes (In Clear Zone)				
Side Slopes	4 to 1	p3-5		
Sidewalk Width, offset (ft)	6	p3-6	6, 7	Figure 3-4
Curb and Gutter	MAG Std Det 220, Vert	Figure 3-4	MAG Std Det 220, Vert	Figure 3-4
Clear Zone (ft)	2	p3-5	1.5	
Drainage				
Pavement	10-year storm	p4-6	10-year storm	p5-5
Culvert Cross Drainage				
Bridge				

(1) Page numbers refer to City of Peoria Infrastructure Development Guidelines, 2005
(2) Page numbers refer to City of Glendale Design Guidelines for Site Development and Infrastructure Construction, 2002
(3) Allows for 16 ft min. plus 0.5 ft for future pavement overlays

Northern Avenue will remain as a separate roadway adjacent to the Northern Parkway bypass between 103rd and 91st avenues. In this location, the westbound roadway will be along existing Northern Avenue and provide access to properties on the north side. The eastbound roadway will be new construction on the south side of the parkway bypass. It will provide access to properties on the south side. See Volume 2, Sheets G9 and G10. Both the eastbound roadway and the westbound roadway will consist of three through lanes in 39-foot wide roadways measured from back of curb. Sidewalks will either be existing or new 6-foot wide sidewalks with a minimum of 7 feet setback from the back of curb.

Between 99th and 95th avenues, Northern Avenue will be a two-way street with three through lanes in each direction separated by a raised landscaped median. Access will be provided to properties on the north side and in addition to traffic signals at 99th Avenue and Loop 101 ramps, a traffic signals will be located midway between 99th Avenue and Loop 101 to enhance this access. A grade separation structure may be constructed on the parkway bypass to provide access to properties south of the parkway bypass (97th Avenue alignment).

The existing Northern Avenue at Loop 101 will be widened to include three lanes in each direction and dual left-turn lanes in each direction per ADOT standards. A portion of the abutment slopes for Loop 101/Northern Avenue Bridge will need to be removed and replaced with a retaining wall to accommodate the extra lanes under Loop 101 (see Volume 2, Sheet G12).

The Northern Parkway Grand Avenue flyover begins in the center of the Northern Parkway roadway section just east of 71st Avenue and connects to Grand Avenue south of Northern Avenue in the center of the Grand Avenue roadway section. This will result in splitting eastbound Northern Avenue traffic and westbound Northern Avenue traffic into separate roadways. The westbound Northern Avenue will generally follow the existing Northern Avenue alignment north of the flyover roadway while the eastbound Northern Avenue will be an entirely new roadway on the south side of the parkway (see Volume 2, Sheet G12). Both the eastbound roadway and the westbound roadway will consist of three through lanes in 39.5-foot wide roadways measured from back of curb. Sidewalks will either be existing or new 6-foot wide sidewalk with a minimum of 7 feet setback from the back of curb. Concrete barriers will protect the flyover retaining wall on the inside lane of the Northern Avenue roadways while the outside edge will be curb and gutter.

Northern Avenue will be widened to four lanes in each direction at Grand Avenue to facilitate through movements through the intersection. In addition, a westbound right-turn lane will be provided.

5.2.6 Grand Avenue (US 60)

For Grand Avenue south of Northern Avenue, the flyover structure will divide northwest-bound traffic from southeast-bound traffic. The southeast-bound roadway will follow the existing Grand Avenue and will be constrained by existing conditions while the northwest-bound roadway would be a new three-lane roadway 43 feet wide (back of curb) with a 6-foot sidewalk and 7-foot minimum offset from the back of curb (see Table 5-6). The widening of Grand Avenue to accommodate this flyover extends southeastward to the 63rd Avenue/Orangewood intersection with Grand Avenue.

Table 5-6 Grand Avenue (US 60) Design Standards

Description	Design Criteria Mainline	Reference[1]
General		
Roadway Classification	ADOT Urban Principal Arterial	
Access Control	Partial Control of Access	
Design Speed (mph)	50	p100-3
Posted Speed (mph)	45	
Design Year	2030	
Design ADT (vpd)	67,000	
Design Vehicle	WB-50	
Design Level of Service	D	p100-7
Horizontal Alignment		
Superelevation (Max)	4%	p200-5
Stopping Sight Distance (ft)		
Maximum Curvature w/NC	1 degree 9 minutes	p200-16
Minimum Radius (ft)	927	p200-16
Minimum Length of Curve	500	p200-23
Max Angle Break w/o Curve	45 minutes	p200-23
Vertical Alignment		
Gradient (Max)	6%	p200-26
Gradient (Min)	0.40%	p200-26
Grade Break (Max)	0.2%	p200-27
Length of Curve (Min)	150	p200-27
Cross Sectional Elements		
Lane Widths (ft)	12	p300-2
Right Shoulder Width (ft)	4	p300-10
Left Shoulder Width (ft)	2	p300-10
Cross Slope	2%	p300-1
Median Type	Raised Curbed	
Median Width (ft)	16	p300-22
Side Slopes (In Clear Zone)	1%	p300-47
Side Slopes	4 to 1	p300-47
Drainage		
Pavement	25-year Design Storm	p600-6
Culvert Cross Drainage	-	
Bridge	-	

[1] Page numbers refer to ADOT Roadway Design Guidelines, 2007

5.2.7 Intersecting Arterial Streets

Existing or future arterial streets would intersect Northern Parkway at a GSI with the parkway being elevated over the arterial street. At 103rd Avenue the parkway would be depressed under the arterial. Since the Northern Parkway improvements are to be phased over 20 years or more, it is anticipated that the existing cross street configuration may change prior to construction of the parkway. For estimating purposes, it was assumed that if the intersecting arterial is currently an unimproved two-lane roadway, the Northern Parkway improvements will match future arterial improvements that will be constructed by others, and no tapers are included. Where the intersecting arterial is currently improved to four lanes or more with curb and gutter, it is assumed that no widening by others will occur prior to the Northern Parkway improvements. The intersection widening required for the dual left-turn lanes and other turn lanes plus tapers to match existing street would be included in the Northern Parkway project. The actual arterial improvements to be included with the Northern Parkway project will be determined during final design. Table 5-7 summarizes the arterial cross street current jurisdiction, street classification, typical section, right-of-way width, and lane configuration used for arterial improvements associated with the parkway. The local jurisdiction design standards will be used in final design.

Table 5-7 Intersecting Arterial Street Typical Section and Lane Configuration

Arterial	Jurisdiction	Classification	Typical Section	ROW Total Width (ft)	Lt-Turn Lanes	Through Lanes	Rt-Turn Lanes
Sarival South	Glendale	Major Arterial	A-4	130	0	6	1
Sarival North	Glendale	Major Arterial	A-4	130	2	6	0
Reems South	MCDOT	Minor Arterial	5.8	130	1	4	0
Reems North	MCDOT	Minor Arterial	5.8	130	2	4	0
Litchfield South	MCDOT	Principal Arterial	5.7	130	2	4*	0
Litchfield North	MCDOT	Principal Arterial	5.7	130	2	5*	1
Dysart South	MCDOT	Principal Arterial	5.7	140	2	6	1
Dysart North	El Mirage	Principal Arterial	MCDOT5.7	140	2	6	0
El Mirage South	MCDOT	Minor Arterial	5.8	130	2	4	0
El Mirage North	El Mirage	Principal Arterial	MCDOT5.7	130	2	5	1
107th South	MCDOT	Minor Arterial	5.8	110	1	4	0
107th North	Peoria	Minor Arterial	PE-010-3	110	1	4	0
Glen Harbor South	Glendale	Minor Arterial	A-1	110	2	4	1
103rd Avenue North	Peoria	Minor Arterial	PE-010-3	110	2	4	0
99th Avenue South	Glendale	Major Arterial	A-4	130	2	4*	1
99th Avenue North	Peoria	Minor Arterial	PE-010-3	110	2	4	1
93rd Avenue South	Glendale	Minor Arterial	A-1	110	2	4	1
93rd Avenue North	Peoria	-	-	-	2	4	0
91st Avenue South	Glendale	Major Arterial	A-4	130	2	6	1
91st Avenue North	Peoria	Major Arterial	PE-010-2	130	2	6	1
83rd Avenue South	Glendale	Minor Arterial	A-1	110	2	4	1
83rd Avenue North	Peoria	Minor Arterial	PE-010-3	110	2	4	1
75th Avenue South	Glendale	Minor Arterial	A-1	110	2	4	0
75th Avenue North	Peoria	Minor Arterial	PE-010-3	110	2	4	1

Note: Typical Sections per City of Glendale Design Guidelines, City of Peoria Infrastructure Development Guidelines, and MCDOT Roadway Design Manual.
* Ultimate six lanes

Litchfield Road would be depressed at the Northern Parkway intersection and improvements on Litchfield Road would extend north and south until the road matches the existing grade. Dysart Road south, Glen Harbor Boulevard, 91st Avenue, and 75th Avenue are considered improved roadways and improvements and tapers associated with the parkway would be included in this project.

5.2.8 Neighborhood Access Streets

Northern Parkway is adjacent to several residential neighborhoods with direct access to Northern Avenue, which will change due to the installation of the continuous raised median or median barrier. The right-in/right-out access to the neighborhoods and businesses as well result in some out-of-direction travel and complicate neighborhood circulation. Several neighborhood access streets would be constructed to ease neighborhood circulation and access. These streets would be constructed prior to installation of median access control features on the parkway. These streets as well as some of the design standards are listed in Table 5-8. The local jurisdiction design standards will apply.

Table 5-8 Neighborhood Access Streets Typical Sections and Design Standards

Street	Jurisdiction	Typical Section	Design Speed	Min. Radius	Concept Plan Sheet #
Butler Drive (Dysart Road to 127th Avenue)	El Mirage	Peoria 296	–	150	P160-162
127th Avenue (Northern Pkwy to Butler Drive)	El Mirage	Peoria 296	–	150	P140-142
Royal Palm Road (111th Lane to 111th Avenue)	Peoria	PE-010-6	30	150	P153
Augusta Avenue (west of 107th Avenue)	MCDOT	5.11	30	-	P154, P136
Royal Palm Road (108th Drive to 107th Avenue)	Peoria	PE-010-6	30	150	P155, P137
Orangewood Avenue (107th Avenue to Glen Harbor Boulevard)	Glendale	C-4	40	100	P156
Hayward Avenue (91st Avenue to 89th Avenue)	Glendale	C-3	40	100	P157, P144
Griswold Road (87th Avenue to 83rd Avenue)	Peoria	PE-010-5	40	100	P158, P159, P160
SRP Access (east of 75th Avenue)	Peoria	PE-010-6	30	150	P161, P147
Connector Road (SE quadrant Grand & Northern)	Glendale	C-3	30	100	P131, P151

Note: Typical Sections per City of Glendale Design Guidelines, City of Peoria Infrastructure Development Guidelines, and MCDOT Roadway Design Manual.

5.3 HORIZONTAL AND VERTICAL ALIGNMENTS

5.3.1 Horizontal Alignment

The Northern Parkway horizontal alignment is shown in Volume 2, Sheets G18 through G37. The horizontal curves are summarized in a table on Sheet G38. Large flat curves are desirable to avoid the need for superelevation especially in curbed sections in developed areas east of 115th Avenue. Using the 2004 AASHTO "Green Book" curve tables 3-25 and 3-26, it was determined that curves with a radius of 11,100 feet or more on the west portion of the parkway would avoid the need for superelevation. The MCDOT standards used on the east part of the project, a curve with a radius of 10,000 feet or more had the same result (see previous section for geometric standards). Some curves on the alignment do require superelevation and the superelevation rates and transition lengths are given on the profile sheets in the concept plans (Sheets P01 to P171).

Sarival Avenue to Litchfield Road

The horizontal alignment begins at Station 83+26.29 located at the W ¼ corner of Section 31, T3N, R1W, which is the centerline of the existing Sarival Avenue.

The alignment begins by following the mid-section line. Just east of Sarival Avenue, the alignment shifts to the north so that at Reems Road, the alignment is located 130 feet north of the mid-section line. This shift avoids impact to the Falcon Dunes Golf Course and Detention Basin. The alignment remains parallel to the mid-section line until the Bullard Avenue alignment. Here the alignment shifts to the south so that east of the BNSF Railroad tracks, the alignment is 150 feet south of the mid-section line and parallel to it. This shift avoids removal of several homes.

Litchfield Road to Dysart Road

West of Litchfield Road the alignment again shifts south so that the alignment is 105 feet south of the Northern Avenue section line and centerline at Dysart Road. The fact that the alignment is 105 feet south of the existing Northern Avenue centerline allows the existing north right-of-way line of Northern Avenue to be used for the ultimate right-of-way line for Northern Parkway. This avoids impacts to property owners on the north side of Northern Avenue and allows maintaining traffic on the existing Northern Avenue while the parkway is constructed.

Dysart Road to 115th Avenue

The alignment remains 105 feet south of the Northern Avenue section line until the Agua Fria River (east of El Mirage Road). Here the alignment shifts to the north so that the alignment is 40 feet north of the Northern Avenue section line at the 115th Avenue alignment. This avoids impacts to the Glendale Landfill on the south side of Northern Avenue.

115th Avenue to 107th Avenue

Near 112th Avenue the alignment curves to the south to avoid six homes in the Suncliff IV subdivision on the north side of Northern Avenue. East of 111th Avenue, the alignment shifts to 30 feet north of the section line to avoid about 20 homes in Country Meadows Units 9, 10 and 2 on the south side of Northern Avenue.

107th Avenue to 91st Avenue

At 107th Avenue the alignment shifts 20 feet south to avoid homes in the Country Meadows Unit 4 neighborhood and at 103rd Avenue the alignment shifts further south for the Northern Parkway bypass. The bypass alignment is 160 feet south of the Northern Avenue Section Line between 103rd Avenue and 99th Avenue. East of 99th Avenue the alignment shifts further south to cross Loop 101 and avoid the existing Loop 101 bridges over Northern Avenue. East of Loop 101 and west of 91st Avenue the parkway alignment is parallel to and 102 feet south of the Northern Avenue section line.

91st Avenue to 83rd Avenue

West of 91st Avenue the alignment shifts north so that it is 15 feet south of the section line at 87th Avenue and shifts north again so that it is 20 feet north of the Northern Avenue section line at 83rd Avenue. These shifts avoid impacting homes on the south side of Northern Avenue.

83rd Avenue to Grand Avenue

West of the 79th Avenue alignment the alignment shifts south and follows the Northern Avenue section line until 73rd Avenue where the parkway alignment angles to the south.

Near 68th Avenue, the alignment for the parkway or Grand Avenue flyover curves south and ends along Grand Avenue just north of the BNSF Railroad track spur crossing at Station 738+01.87.

The total length of the alignment is 65,476 feet or 12.40 miles.

5.3.2 Vertical Alignment

The Northern Parkway vertical alignment will follow the existing terrain as much as possible. The existing terrain is very flat. The minimum grade will be 0.3 percent and the maximum grade will be 3.0 percent for the west segment. The East segment will have a minimum grade of 0.25 and a maximum grade of 5 percent per MCDOT standards for a urban principal Arterial. The bypass segment will also have a minimum grade of 0.3 percent and a maximum grade of 4 percent. ADOT ramps standards allow a maximum grade of 6 percent for the Grand Avenue

flyover and a minimum slope of 0.4 percent. The proposed profile grade line vertical alignments are shown on the profile sheets in Volume 2.

Sarival Avenue to 115th Avenue

From Sarival Avenue to Reems Road the profile grade line between GSI is governed by the existing topography and is sloping down at 0.5 percent. East of Reems to Litchfield Road the profile grade is governed by several box culvert crossings and ranges from 0.3 percent down to 0.3 percent up. Between Litchfield Road and Dysart Road the profile grade slopes down at 0.3 percent. The profile grade goes up at 0.3 percent between Dysart Road and El Mirage Road generally following the existing grade. East of El Mirage Road to about Station 396+00 (east of the Agua Fria River), the profile grade slopes down at 0.3 percent and is about 15 to 20 feet above the natural ground elevation.

Grades at the approaches to the elevated overpasses at Sarival Avenue, Reems Road, Dysart Road and El Mirage Road will be approximately 3 percent.

115th Avenue to 103rd Avenue

The 0.3 percent down slope continues until about 112th Avenue (Station 423+00) where the profile goes up at 2.5 percent and follows the existing grade. A 2,000-foot vertical curve crests at about 109th Avenue (Station 448+00) and then slopes down at 0.6 percent to a low spot at 107th Avenue. Still following the existing grade the profile slopes up at 0.3 percent to a high point east of 106th Avenue and then back down at 0.3 percent until the approach to the 103rd Avenue underpass.

103rd Avenue to 91st Avenue

The downgrade to the underpass is 4 percent while the upgrade east of the underpass climbs out at 3.5 percent. The 3.5 percent upgrade continues up over the New River and is approximately 30 to 50 feet above natural ground elevation to allow the EB Northern Avenue, 99th Avenue, Loop 101 and ramps, 93rd Avenue and 91st Avenue to remain at-grade and pass under the Northern Parkway Bypass.

91st Avenue to 71st Avenue

East of 91st Avenue and west of 83rd Avenue, the profile grade line follows the existing topography and the slopes vary from 0.35 up to 0.35 percent down grade. Between 83rd Avenue and 75th Avenue the profile grade is 0.45 percent up and follows the existing grade. The grade continues up east of 75th Avenue but only at 0.3 percent until 71st Avenue where the flyover upslope begins. The grades approaching the elevated overpasses at 83rd and 75th avenues will be 4 percent.

Grand Avenue Flyover

The flyover upgrade is 5 percent while the downgrade is 5.6 percent. The flyover peaks near 68th Avenue about 65 feet above the existing ground elevation and matches existing elevation on Grand Avenue near the BNSF railroad track spur crossing.

5.4 ACCESS CONTROL

Access control or access management is defined as regulation of private and public access to and from properties abutting public roadways. The primary purpose of access control is to increase safety and operational efficiency of roadways by controlling where and how vehicles enter, exit or cross the roadway. Case studies have shown that access management can reduce crashes up to 50 percent. It can increase roadway capacity between 25 and 45 percent while reducing travel time and delay by 40 to 60 percent. Access management also creates an economic benefit and positive effect on property values by preserving market areas for businesses and improving customer safety and convenience.

Several access management features are included in the Northern Parkway concept as follows:

- Continuous raised median or barrier
- No driveway or street connections to Northern Parkway west of 115th Avenue
- Elimination of traffic signals by providing GSI
- Partial access control on the parkway east of 115th Avenue

An access control plan should be developed as part of the final design effort.

5.4.1 Northern Parkway West

No direct access would be allowed to Northern Parkway from Sarival Avenue to the 115th Avenue. GSI with connecting ramps would allow access to and from Sarival Avenue, Reems Road, Litchfield Road, Dysart Road, and El Mirage Road. No other street or driveway access would be allowed. No access will be allowed along connecting ramps or along intersecting arterials at GIS within 300 feet of the ramp arterial intersection. There is an existing driveway between the Agua Fria River and 115th Avenue that is being used by West Valley Sand and Gravel located north of Northern Avenue that may be maintained. A chain link right-of-way fence is proposed for the west segment of the parkway. This fence may be replaced with other types of fencing or walls by adjacent landowners as the area develops.

Eastbound and westbound frontage roads are proposed along Northern Parkway between Dysart Road and El Mirage Road. These frontage roads will provide direct access to existing and proposed developments in this segment of the parkway. No access along the frontage road will

be allowed between the intersecting arterial (Dysart or El Mirage Road) and the back of gore for the ramp (see ADOT Roadway Design Guidelines, Figure 506). The right-of-way fence in this segment will be placed between the frontage road and the mainline parkway to physically separate local traffic and pedestrians from through parkway traffic.

5.4.2 Northern Parkway East

Limited direct access would be allowed on Northern Parkway from 115th Avenue to 103rd Avenue and from 91st Avenue to 71st Avenue. Existing streets and driveways that currently connect to Northern Avenue and currently in use would remain for Northern Parkway. A continuous raised median or concrete median barrier would eliminate left-turn movements into or out of existing streets and driveways. Left turns and U-turns would be allowed at GSI at 103rd Avenue, 93rd Avenue, 91st Avenue, 83rd Avenue and 75th Avenue. In addition, left turn and U-turn movements from Northern Parkway would be allowed under a protected signal phase at 111th Avenue and 107th Avenue as well as left turns from these streets. In addition, a turn-around roadway will be provided under the flyover bridge between 70th and 68th avenues for eastbound to westbound movements.

New driveway and street access to Northern Parkway is not desirable. Direct new access from individual properties will be prohibited unless this is the only access to the property.

5.4.3 Northern Parkway Bypass and Flyover

In these segments of the parkway from 103rd Avenue to 91st Avenue and from 71st Avenue to Grand Avenue, the parkway through traffic is separated from the local arterial street traffic. No direct access from streets or driveways would be allowed to the bypass section or the flyover section. Direct access would be allowed to the adjacent Northern Avenue eastbound and westbound roadways. Access to Northern Avenue would be controlled by the local jurisdiction as an arterial street. From an access perspective, eastbound and westbound Northern Avenue would function like frontage roads.

5.4.4 Northern Avenue and Grand Avenue Connector Roadways

The prohibition of left-turn movements at the intersection of Grand Avenue and Northern Avenue as described in Section 4.10 requires that these movements be accommodated by connector roadways. Existing connector roadways in the northeast and southwest quadrants were constructed by ADOT as part of the 67th Avenue Overpass project. New connector roadways will be installed in the southeast quadrant of Northern Avenue and Grand Avenue as part of the Northern Parkway Project (see plan sheet P131 and P158). Access to these new connector roadways will be partially controlled and access to the new NWB Grand Avenue north of the BNSF crossing will be partially controlled as well.

5.5 RIGHT-OF-WAY

5.5.1 Northern Parkway West

The right-of-way requirements for the west portion of the project are driven by AASHTO clear zone requirements and the Northern Parkway Drainage Channel located on the north side of the parkway from Sarival Avenue to Dysart Road. The channel is located within the roadway right-of-way. The right-of-way width generally varies from 225 to 290 feet between GSI and 320 to 435 feet at the GSI.

The right-of-way at Sarival Avenue and Reems Road overpasses accommodate 3:1 embankment slopes.

The south right-of-way is the mid-section line and property line between Reems Road and Bullard Avenue. This right-of-way line is 130 south of the Northern Parkway centerline and does not narrow down between the grade-separated structures, which avoids creating a narrow parcel between the property line and the new south right-of-way line. The additional right-of-way provided is planned for drainage retention and landscaping.

The Litchfield Road GSI is also planned for 3:1 embankment slopes. The right-of-way width varies and exceeds 400 feet in width at Litchfield Road. In addition, right-of-way is required for a retention basin located northwest of the intersection.

Between Dysart Road and El Mirage Road, Northern Parkway is shifted south of the existing Northern Avenue. The existing north right-of-way line on the north side of Northern Avenue will also be the north right-of-way line of Northern Parkway. New right-of-way will be acquired south of the existing right-of-way. A frontage road is also included in this segment of the parkway resulting in increased right-of-way varying from 290 to 350 feet.

Right-of-way for a future GSI at 115th Avenue (not part of Alternative 1) will be included in the right-of-way quantities (see concept sheets P61-P69).

Drainage Features

Right-of-way for new drainage features located apart from Northern Parkway is also required. A drainage outfall channel is needed on the west side of Reems Road to drain the Northern Parkway Channel. An additional 70 feet of right-of-way is required for this channel beyond the right-of-way needed for Reems Road.

An existing 50-foot wide drainage easement exists along the west side of the BNSF Webb Spur railroad tracks located 0.5 mile west of Litchfield Road. The existing drainage channel needs to be enhanced to accommodate Northern Parkway Channel flow and future AT&SF regional drainage channel. This 50-foot easement would be acquired along with an additional 95 feet. In

addition, approximately 40 acres will be acquired in partnership with FCDMC for a regional drainage basin east or the regional channel and north of Northern Avenue. The basin is planned to be within the Luke AFB runway APZ 1.

A new 42-inch storm drain pipe is needed to drain the depressed section of Litchfield Road. In addition to the right-of-way required for the Litchfield Road improvements, another 22 feet of right-of-way is needed on the east side of Litchfield Road north of Northern Avenue (see drainage concept plans D74 and D75).

A new channel is also required on the west side of Dysart Road to drain the Northern Parkway channel (see Sheets D76 and D77). This channel requires an additional 70 of right-of-way on the west side of Dysart Road from Northern Parkway to the Dysart Drain.

5.5.2 Northern Parkway East

The right-of-way requirements for the east portion of the project from 112th Avenue to 103rd Avenue and from 91st Avenue to 71st Avenue are dependent on the roadway width, existing development, and placement of an offset sidewalk. The right-of-way generally varies from 140 to 160 feet between GSI and 250 to 255 feet at GSI.

Between 112th Avenue and 108th new right-of-way will be acquired from the north side of Northern Avenue. The area to be acquired consists of land owned by neighborhood HOAs primarily used for landscaped drainage basins. Right-of-way would be acquired to the back walls of residential properties along the north side. The existing right-of-way and walls would remain on the south side of Northern Parkway.

Similarly, the north right-of-way line and wall for residential properties between 106th Avenue and 103rd Avenue would remain and new right-of-way would be acquired to the south side of the existing Northern Avenue.

Between 89th and 87th Avenue the right-of-way is defined by existing residential walls on both sides of Northern and is approximately 140 feet in width.

Existing HOA drainage basins at 112th Avenue and 111th Avenue will be modified and a drainage easement is recommended to protect the drainage capacities of these basins. The City of Peoria owns a basin near 85th Avenue and Northern and the City of Glendale owns a basin west of 63rd Avenue that extends down to Grand Avenue. Both of these basins will require modifications and temporary construction easements (TCE).

5.5.3 Northern Parkway Bypass

The Northern Parkway bypass extends from 103rd Avenue to 91st Avenue. The existing north right-of-way line will generally be maintained while new right-of-way would be acquired south of the existing right-of-way. The width of the total right-of-way varies from 305 feet to 342 feet.

5.5.4 Northern Parkway/Grand Avenue Flyover

The flyover structure plus eastbound and westbound Northern Avenue fit into 180 feet of right-of-way. Along Grand Avenue, new right-of-way will be required on the east side of Grand Avenue varying in width from 8 to 87.5 feet of additional right-of-way.

5.5.5 Intersecting Arterial Streets

Table 5-9 shows the required right-of-way for the intersecting arterial streets at the intersection with Northern Parkway and the normal right-of-way width away from the intersection. Glendale intersection Detail A-4 in Standard Detail G-323 would be used for the intersection of 91st Avenue and for Northern Avenue at Grand Avenue. Improvements to the north leg of 93rd Avenue would be constructed in a TCE granted by Peoria Crossings.

Table 5-9 Intersecting Arterial Street Right-of-Way Width

Arterial	Jurisdiction	Typical Section	Width at Intersection (ft)	Standard Width (ft)
Sarival N	Glendale	A-4	130	–
Sarival S	Glendale	A-4	130	–
Reems N	MCDOT	5.8	140	–
Reems S	MCDOT	5.8	110	–
Litchfield N	MCDOT	5.7	150	130
Litchfield S	MCDOT	5.7	150	130
Dysart N	MCDOT	5.7	155	–
Dysart S	MCDOT	5.7	160	130
El Mirage N	MCDOT	5.8	140	–
El Mirage S	MCDOT	5.7	140	–
Glen Harbor Boulevard	Glendale	A-1	130	100
103rd Avenue	Peoria	PE-010-3	110	–
99th Avenue S	Glendale	A-4	150	–
99th Avenue N	Peoria	PE-010-2	110	–
93rd Avenue S	Glendale	A-1	120	–
93rd Avenue N	Peoria	-	100 (TCE)	–
91st Avenue S	Glendale	A-4	150	130
91st Avenue N	Peoria	PE-010-2	140	110
83rd Avenue S	Glendale	A-1	130	–
83rd Avenue N	Peoria	PE-010-3	130	–
75th Avenue S	Glendale	A-1	130	Varies
75th Avenue N	Peoria	PE-010-3	130	Varies
Northern (E of Grand) WB	Glendale	A-4	162.5	Varies

5.5.6 Neighborhood Access Streets

Table 5-10 shows the right-of-way requirements for the neighborhood and other access roadways. The SRP roadway may be constructed within a TCE by the parkway contractor, or SRP may select their own contractor to do the work.

Table 5-10 Neighborhood Access Streets Right-of-Way Requirements

Street	Jurisdiction	Typical Section	Right-of-Way Width (ft)
Royal Palm Road (111th Lane to 111th Avenue)	Peoria	PE-010-6	50
Augusta Avenue (west of 107th Avenue)	MCDOT	5.11	50
Royal Palm Road (108th Drive to 107th Avenue)	Peoria	PE-010-6	50
Orangewood Avenue (107th Avenue to Glen Harbor Boulevard)	Glendale	C-4	70
Hayward Avenue (91st Avenue to 89th Avenue)	Glendale	C-3	70
Griswold Road (87th Avenue to 83rd Avenue)	Peoria	PE-010-5	60
SRP Access (east of 75th Avenue)	Peoria	PE-010-6	70 (TCE)
Connector Road C (SE quadrant Grand & Northern)	Glendale	C-3	70

5.6 DRAINAGE

5.6.1 Drainage Analysis Criteria and Standards

The drainage analysis criteria for this project were established in the previous Northern Parkway DCR. The following criteria were derived from the Recommended Drainage Design Criteria, specifically the page relevant to the City of Glendale, City of Peoria, City of El Mirage, and Maricopa County (Table 3 in Appendix E of the October 2003 DCR).

Table 5-11 Rainfall Design Criteria

Drainage Design Standard	Design Storm Frequency
Pavement Runoff	10-yr peak Rational
Catch Basins	10-yr peak Rational
Minor Storm Drain Trunk Line (Roadway at/above grade)	10-yr peak Rational
Minor Storm Drain Trunk Line (Depressed Roadway)	50-yr peak Rational
Major Storm Drain Trunk Line (Diverted Offsite Flow)	10-yr, 6-hr (HEC-1)
Onsite Flow Remains Within Right-of-Way	100-yr peak Rational
Culvert Crossings Design	50-yr, 6-hr
Culvert Crossing, Roadway Overtopping, 6-inch Max	100-yr, 6-hr
V-Ditch / Channels (Onsite Flow)	10-yr peak Rational
Channels (Diverted Offsite Flow, No Freeboard)	100-yr, 6-hr
Channels (Diverted Offsite Flow, w/ Freeboard)	10-yr, 6-hr
Bridge Low Chord (1 foot freeboard)	100-yr, 6-hr (or 24-hr)
Zero-rise of Water Surface Elev Upstream of New Bridges	100-yr river flow
No Increase in Flow at Existing Crossings	100-yr peak flow
Retention for Existing Offsite Developments (Used only for retention basins affected by the project)	100-year, 2-hr
Retention of Offsite Runoff to Attenuate Peak Runoff from Project Site	100-year, 6-hr

5.6.2 Watersheds

The Northern Parkway study corridor crosses two major south-flowing watercourses: The Agua Fria River and New River. Each riverbed forms watershed boundaries for three distinct watersheds:

- Western Watershed — White Tank Mountains to Agua Fria River
- Central Watershed — Agua Fria River to New River
- Eastern Watershed — New River to Grand Avenue

5.6.3 Western Watershed Existing Drainage

The western watershed is characterized by a region that slopes gently to the east or southeast. The individual fields have been re-graded for agriculture and many of the arterial roads are at or below the surrounding ground. This effect combines with the raised lined irrigation ditches and tail water ditches in the region to cause regular flooding along the arterial roadways.

The existing drainage features in this watershed include:

- Olive Avenue and BNSF Railroad
- Falcon Dunes Detention Basin (and Golf Course)
- Reems Road drainage ditch (east of Reems Road, south of Butler Drive)
- Dysart Drain (outfall channel for Falcon Dunes Detention Basin)
- Falcon Dunes - North and East Inlet Channels
- BNSF Railroad Spur and drainage ditch and tailwater ditch (at 143rd Avenue, west of railroad embankment)
- A wash that crosses Northern Avenue midway between Dysart Road and El Mirage Road

5.6.4 Western Watershed Planned ADMP Drainage

The Loop 303 Corridor/White Tanks Area Drainage Master Plan Update was completed for the FCDMC in 2005. The pertinent planned drainage features to be considered are:

- Loop 303L roadway and drainage channel (on west side of new roadway)
- Reems Road Drainage Channel and Offline Detention Basins (north of Butler Drive)
- Reems Road Concrete Box Culvert
- BNSF Drainage Channel (formerly AT&SF Channel) and offline detention basins
- Northern Avenue drainage channel from Loop 303 to Falcon Dunes detention basin

5.6.5 Western Watershed Hydrology Modifications

The ADMP report presents the Existing Case model and the Projects-In-Place model, which has the aforementioned planned drainage features incorporated into the model. The Northern Parkway 100-year hydrologic model used the Projects-In-Place model including the proposed drainage features for the Northern Parkway project. This model does not consider the ultimate diversions into the BNSF Drainage Channel and detention basins.

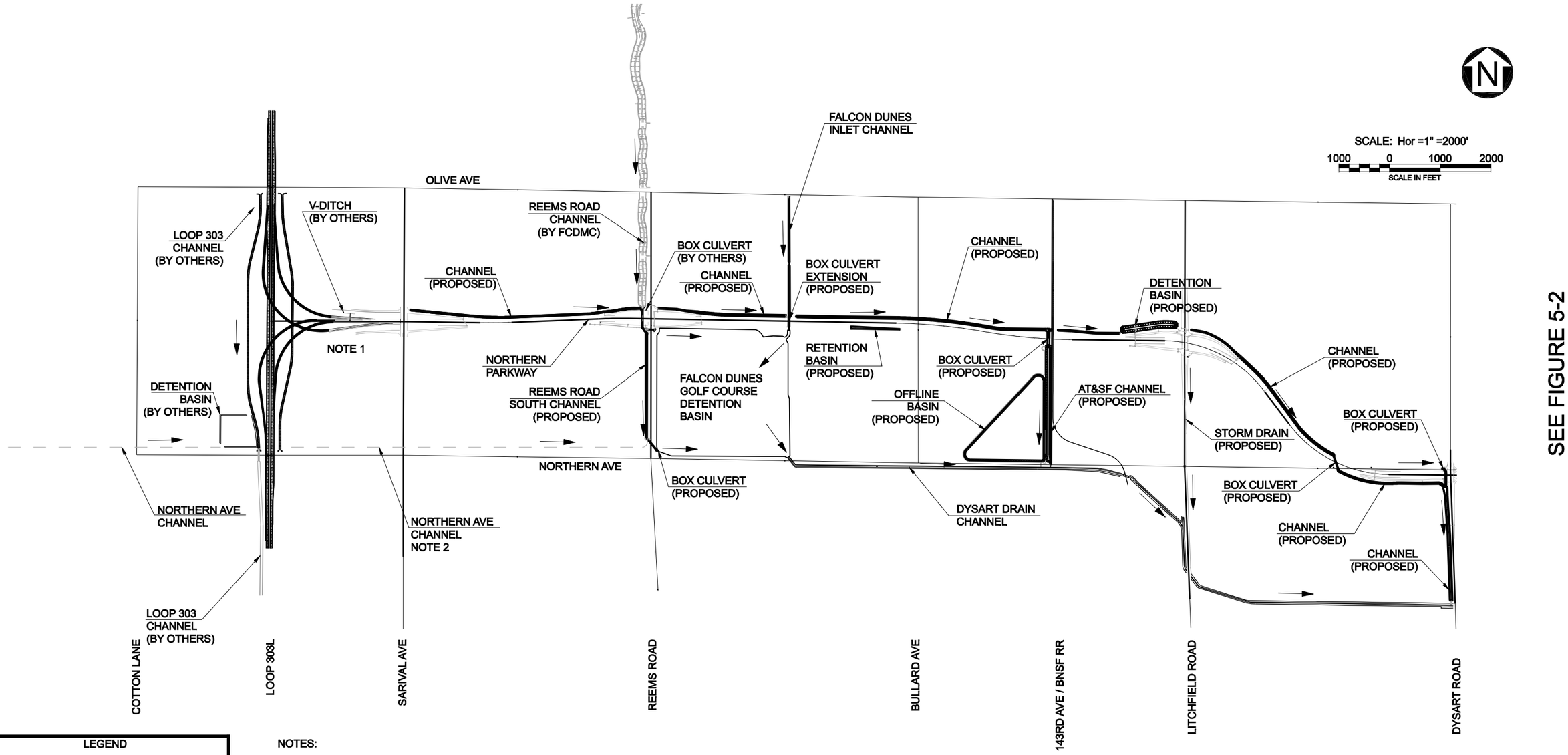
A third hydrologic model was created based on the Projects-in-Place model, but would include the diversions into the BNSF Drainage Channel and the ultimate FCDMC detention basins. This model also included an offline detention basin located along the BNSF Channel reach, immediately north of the outfall into the Dysart Drain. This model achieves a zero-increase in 100-year flow at the BNSF Channel confluence with the Dysart Drain.

5.6.6 Western Watershed Proposed Drainage

The primary drainage features proposed as part of the parkway project for the western watershed are shown in Figure 5-1 and are as follows:

- Northern Parkway Drainage Channel (along north side of new roadway)
- Reems Road South Channel and Concrete Box Culvert
- Extend Concrete Box Culvert at Falcon Dunes East Inlet Channel
- New Concrete Box Culvert and the AT&SF Channel (west of BNSF Railroad Spur and 143rd Avenue)
- New offline detention basin located immediately west of the AT&SF Channel, within the Luke AFB APZ zone
- New retention basin near Bullard Road (south of Northern Parkway)
- New detention basin to the northwest of Litchfield Road GSI
- New storm drain network at depressed Litchfield Road crossing and storm drain trunk line outlet to Dysart Drain
- New concrete box culvert 0.5 mile west of Dysart Road
- New concrete box culvert just west of Dysart Road GSI
- New Dysart Road Channel (from Northern Parkway to Dysart Drain)
- New or extended pipe culverts across the roadway (0.5 mile east of Dysart Road)

All of the onsite and offsite runoff that reaches Northern Parkway between Loop 303 and Dysart Road will be diverted to the Dysart Drain at four locations.



SEE FIGURE 5-2

LEGEND

STORM DRAIN (PROPOSED) & FLOW DIRECTION

CHANNEL & (PROPOSED) FLOW DIRECTION

RETENTION / DETENTION BASIN

NOTES:

1) ALL LOOP 303 - NORTHERN PARKWAY TRAFFIC INTERCHANGE RUNOFF WILL BE ROUTED SOUTHWARD ALONG LOOP 303 DETENTION BASINS AND CHANNEL.

2) LOOP 303/WHITE TANKS ADMP CONCEPT - EAST OF LOOP 303, NORTHERN AVENUE CHANNEL NOT NEEDED WHEN NORTHERN PARKWAY IS BUILT.

3) ALL ITEMS SHOWN ARE EXISTING UNLESS STATED OTHERWISE.

FIGURE 5-1
PROPOSED NORTHERN PARKWAY DRAINAGE IMPROVEMENTS - WEST

P:\City_of_Glendale\NorthernDCR30\DCR\Final\Figures\Fig5-1 Drain_Overvw_SH1.dgn
P:\City_of_Glendale\NorthernDCR30\DCR\Final\Figures\20100426\Fig5-1_ProposedNPDrainageImprovementsW_11x17L.pdf RJW 08-24-2010

5.6.7 Agua Fria River Bridge

The 650-foot long, 5-span Agua Fria River bridge would be constructed as part of the ultimate roadway coincident with the construction of the river channelization of a portion of the Agua Fria River in accordance with the Agua Fria Watercourse Master Plan. CADD files showing the location of the channelized river were obtained from FCDMC. The bridge as described in Section 5.12.6 is centered on the river channel. A 12'x12' CBC would be installed crossing under the roadway on the west side of the river channel. The CBC will provide a grade-separated crossing that will connect the future river channel O&M roads and may also serve future multi-use trail traffic. A coordinated effort will be initiated to develop a strategy for timely channelization of the Agua Fria River downstream of Northern Parkway.

5.6.8 Central Watershed Existing Drainage

The central watershed divides at approximately 105th Avenue, with half draining westward to the Agua Fria River and the other half draining eastward to New River. The significant existing drainage features in this watershed are:

- HOA retention basin just west of 112th Avenue
- HOA detention basin just west of 111th Avenue
- HOA detention basin just east of 111th Avenue
- City of Peoria retention basin between 109th and 108th avenues
- MCDOT culverts and storm drain crossing 107th Avenue

5.6.9 Central Watershed Hydrology

The existing hydrology was included in the Glendale-Peoria ADMP Update.

5.6.10 Central Watershed Proposed Drainage

The new roadway will have vertical curb and gutter or barrier along the entire segment. The existing retention basins along the north side of Northern Avenue will require modification due to the Northern Parkway construction. The result will be a reduction of storage volumes in all four existing retention/detention basins. The 111th Avenue detention basin will be enlarged to account for the lost volume and to account for additional runoff from the wider Northern Parkway. Drainage improvements to this segment of Northern Parkway are shown in Figure 5-2 and summarized as follows:

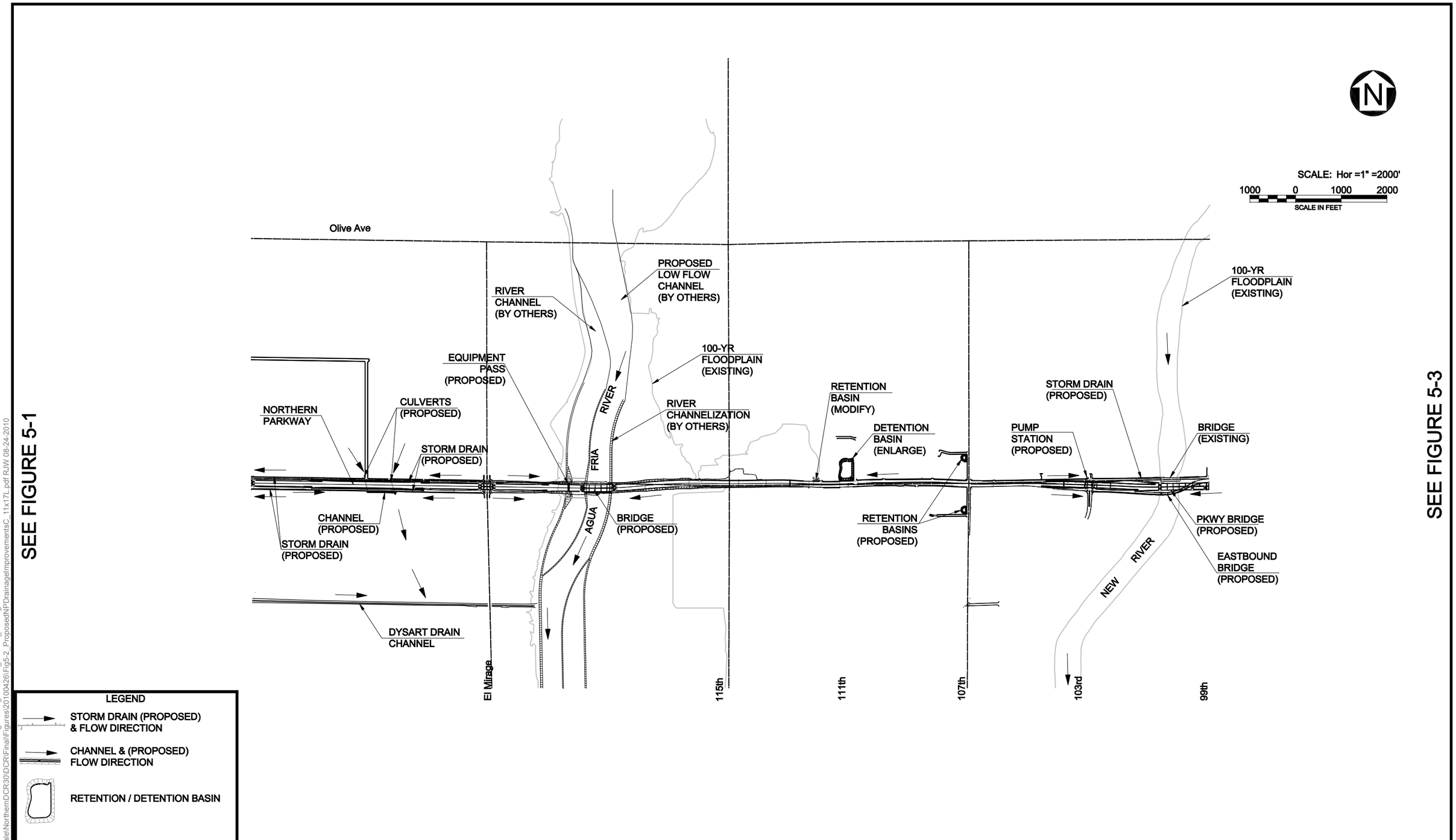


FIGURE 5-2
PROPOSED NORTHERN PARKWAY DRAINAGE IMPROVEMENTS - CENTRAL

P:\City_of_Glendale\NorthernDCR30\DCR\Final\Figures\Fig5-2 Drain_Overvw_SH2.dgn
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- New catch basins will be constructed at key points along the new roadway to meet the FCDMC 10-year gutter flow requirements
- Enlarge detention basin west of 111th Avenue
- New retention basin along 107th Avenue near Royal Palm Road extension
- New retention basin along 107th Avenue near new Augusta Avenue
- Existing storm drain trunk lines will be used and extended at 107th Avenue, eastward to 105th Avenue
- New storm drain system on the upper (at grade) level of 103rd Avenue interchange
- New storm drain system on the depressed Northern Parkway segment under 103rd Avenue that drains to a new pumping station
- A new pumping station that carries the 100-year peak flow of 55 cubic feet per second (cfs) will be constructed at the northwest corner of the intersection of 103rd and Northern. The 48-inch diameter outflow pipe will convey pump station flow and also carry westbound Northern Avenue and offsite runoff eastward to New River.

5.6.11 New River Bridges

In addition to the existing Northern Avenue Bridge over the channelized New River, two other bridges located south of the existing bridge will be required for the Northern Parkway concept as follows:

- The new eastbound Northern Avenue will have a new 410-foot, three-span bridge that will span New River.
- A new 1,127-foot, eight-span bridge for Northern Parkway (bypass) will cross over New River, eastbound Northern Avenue, and 99th Avenue.
- River banks and operation and maintenance roads along New River will need to be raised one foot for approximately 200 feet upstream.

5.6.12 Eastern Watershed Existing Drainage

This west-sloping watershed has the following existing major drainage features:

- Storm drain along Northern Avenue, at Loop 101 freeway
- Loop 101 drainage channel (on east side of Loop 101 freeway) and an 8-barrel CBC that crosses Northern Avenue
- Storm drain along Northern Avenue, east of Loop 101 freeway to 86th Avenue
- Regional (City of Peoria) detention basin between 86th and 85th avenues (north side of road)

- Storm drain along Northern Avenue, east of 85th Avenue to 69th Avenue
- Detention basin (City of Glendale) between 66th Avenue and 63rd Avenue (south of Northern Avenue and east of Grand Avenue)

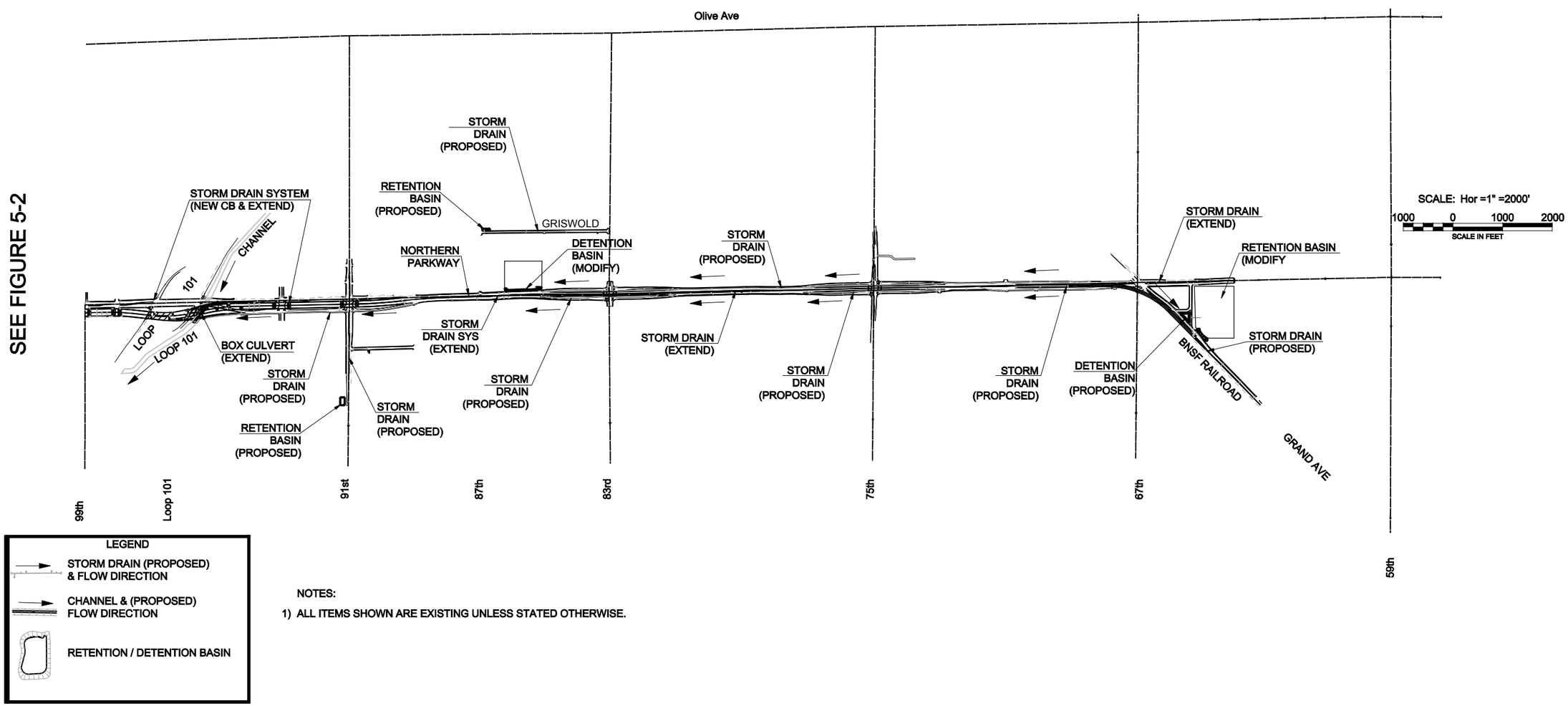
5.6.13 Eastern Watershed Hydrology

The Maryvale Area Drainage Master Study shows significant flows along most segments of this watershed. The 100-year storm flows or roadway-overtopping depths will not be increased as a result of Northern Parkway construction. Large 100-year offsite flows will be passed through the bridged intersections of 91st Avenue and 75th Avenue. The bridge opening is 240 feet wide which should be wide enough to accommodate 100-year flow assumed to be flowing within the street right-of-way width of 110 to 130 feet wide. Between GSI, the new profile grade will match the existing Northern Avenue grade. The continuous raised median will be provided with gaps in the curb to allow roadway overflow similar to current conditions. The 10-year onsite runoff along this segment was estimated using the Rational method. There were no Area Drainage Master Plan elements for Northern Avenue to the west of Grand Avenue. The 65th Avenue detention basin, which was the only planned drainage feature along Northern Avenue to the east of Grand, has already been built.

5.6.14 Eastern Watershed Proposed Drainage

Offsite sheet-flow runoff will continue to reach the new westbound Northern Avenue lanes in the same manner as the existing case. New catch basins and lateral extensions will be installed on existing storm drains where possible. The new onsite drainage features are shown in Figure 5-3 and are as follows:

- New storm drain network for Northern Avenue at 99th Avenue intersection
- New catch basins and extended laterals on existing storm drain at Loop 101 interchange
- The existing concrete box culvert at Loop 101 channel crossing will be extended 300-feet southward to cross under the new elevated Northern Parkway Bypass and 93rd Avenue Ramp B
- New storm drain along south side of new Northern Parkway (from Loop 101 channel to 89th Avenue);
- Keep existing storm drain and extend laterals on north side of road
- Use existing storm drain, extend or add laterals (89th Avenue to 86th Avenue)
- Minor adjustment of southern side slope of 85th Avenue Detention Basin



NOTES:

1) ALL ITEMS SHOWN ARE EXISTING UNLESS STATED OTHERWISE.

FIGURE 5-3
PROPOSED NORTHERN PARKWAY DRAINAGE IMPROVEMENTS - EAST

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- New storm drain trunk line, laterals, and catch basins along westbound Northern Avenue (86th Avenue to 69th Avenue)
- New storm drain trunk line, laterals, and catch basins along eastbound Northern Avenue (86th Avenue to 67th Avenue), utilizing existing storm drain where new roadway is at or near existing grade
- New storm drain along 91st Avenue, south of Hayward Avenue including a new retention basin
- New storm drain and retention basin at northeast corner of Griswold Avenue and 87th Avenue
- New storm drain and detention basin along northbound Grand Avenue (drains into existing 63rd Avenue Detention Basin)
- Slope adjustments to the southwest side of 65th Avenue Detention Basin and relocation of shared outlet for existing storm drain trunk lines

5.7 FLOODPLAIN CONSIDERATIONS

5.7.1 Mapped floodplains

The existing mapped floodplains were identified along the following:

- Reems Road and Northern Avenue near the Falcon Dunes Golf Course
- The west side of the BNSF Webb Railroad Spur (143rd Avenue)
- Within the concrete banks of the Dysart Drain
- The Agua Fria River (floodplain and floodway)
- Northern Avenue from the Agua Fria River to 112th Avenue
- New River, between the existing soil cement channel banks
- The east side of Grand Avenue (does not reflect the newly constructed 65th Avenue Detention Basin)

5.7.2 Planned Regional Drainage Alterations

The proposed drainage conditions throughout the Northern Parkway western watershed are contingent upon the SR 303 freeway being completed in the same time frame as Northern Parkway construction. During final design for Northern Parkway, the designer must determine whether the SR 303 drainage measures will actually be in place. If Northern Parkway is constructed first, the final designer must adjust the hydrologic model to show the existing flood routing in the areas to the north and west of the project area. For the purpose of this DCR, the SR 303 drainage features are assumed to be in place.

Because it is not certain that the upper reaches of the AT&SF channel will be in place by the time Northern Parkway is constructed, the Litchfield Road detention basin and the Dysart Road Drainage Channel should be sized for the larger existing case flows. This judgment must be made by the final design team.

Reems Road

The new Reems Road channel and concrete box culvert (built by FCDMC) will divert that 100-year channel flow into the Falcon Dunes North Inlet Channel. The third barrel of the CBC will be available for use with the Northern Parkway project.

The new Reems Road South Channel will be built with this project, starting at the aforementioned FCDMC box culvert. The new channel will carry the 100-year flow to the south of Northern Parkway. The Reems Road South Channel will discharge into a new concrete box culvert constructed just north of Northern Avenue. That CBC will discharge into the existing southwest inlet to the Falcon Dunes Detention Basin. As a result, Reems Road and Northern Avenue near Falcon Dunes will be removed from the floodplain. An Intergovernmental Agreement (IGA) will be negotiated to share construction costs for these conveyances.

143rd Avenue (AT&SF Channel)

The AT&SF channel is included in the long range ADMP. However, the portion of the channel to the north of Northern Parkway is not anticipated by FCDMC for 10 to 20 years. However, it is desirable to construct certain components of the downstream end of this future channel to avoid disruption to Northern Parkway when the ultimate channel is constructed.

The southernmost reach of the new AT&SF channel will be constructed to carry the ultimate 100-year flow collected by the Northern Parkway channel and the future diverted flows from the north. The collected flow will be conveyed under the parkway through a four-barrel concrete box culvert. The CBC will discharge into a new channel sized for the ultimate 100-year flow. A new regional offline detention basin will be constructed adjacent this downstream reach of the AT&SF channel. The offline detention basin will effectively keep the 100-year discharge from increasing at this confluence with the existing Dysart Drain. The footprint of the detention basin corresponds to the Luke AFB runway accident potential zone one (APZ1) which restricts development potential. An IGA between MCDOT, City of Glendale, and FCDMC will be negotiated to share construction costs for these conveyances.

Litchfield Road

The proposed detention basin just northwest of the new Litchfield Road GSI will capture and attenuate the flows that reach Litchfield Road there. The basin outlet will discharge into the new Litchfield Road storm drain (75 cfs) that will collect runoff from the new depressed portion of

Litchfield Road. The new storm drain will discharge directly into the Dysart Drain. The total flow in the Dysart Drain will decrease approximately 300 cfs with the proposed case hydrologic model. Therefore, no changes are anticipated for the Dysart Drain delineated floodplain.

Dysart Road

Flows that collect at the proposed Dysart Road GSI will cross Northern Parkway through a new two-barrel CBC. That flow will join with Northern Parkway flow from the west and discharge into the new south-flowing Dysart Road Drainage Channel that will be designed for the 100-year flow. The flow in the Dysart Drain is expected to decrease by approximately 100 cfs in the proposed case hydrologic model. Therefore, no changes are anticipated for the Dysart Drain delineated floodplain. A cost sharing project has been proposed between the FCDMC, MCDOT, and the City of Glendale to construct the Northern Parkway Channel and Dysart Road Channel.

Agua Fria River

The Agua Fria River 100-year floodplain north and south of Northern Parkway will be contained within the future soil-cement river bank lining as specified in the Agua Fria Watercourse Master Plan. A Conditional Letter of Map Revision (CLOMR) will be required upon completion of the channel and bridge construction. The 500-foot top width channel and 500-foot wide terrace will also lower the 100-year water surface. The 600-foot top width channel beneath the proposed 650-foot bridge will contain the 100-year water surface with the required freeboard. The 500-year flow will be contained within the banks of the channelized portion, and will pass under the new bridge, between the channel banks.

The new Agua Fria River bridge will be able to pass the 500-year flow, even if the channel improvements are not completed. However, without the channel, the 100-year water surface would rise above the allowable floodway elevation, which is unacceptable to FEMA.

New River

The New River floodplain may rise slightly at the new bridge piers set within the existing New River channel. However, the 100-year water surface rise is expected to be significantly less than one foot. A CLOMR should not be required at this crossing because the floodplain limits are still within the existing channel banks.

Grand Avenue

No changes to the floodplain are anticipated from the modifications at Grand Avenue.

5.8 UTILITIES

Utility facility maps were obtained from both municipal and private utility companies identified along the Northern Parkway corridor. These utility locations were placed in CADD files, and potential conflicts were identified. In general, two relocation strategies were determined. In access controlled segments of the parkway (Sarival Avenue to 115th Avenue), new utilities would not be allowed within the right-of-way except for utilities crossing the right-of-way. In other segments of the parkway (115th Avenue to Grand Avenue), existing utilities would be relocated along ramp roadways to avoid bridge structures, Mechanically Stabilized Embankment (MSE) walls and backfill, or remain in the existing right-of-way.

Utility relocation plan sheets will be prepared as part of the final design plans. Separate irrigation relocation plan sheets for the area from Sarival Avenue to El Mirage Road are included in Volume 2. Storm drain relocations are shown on the drainage plan sheets located in Volume 2 of the report. The utility relocation plan sheets will be distributed to the utility companies for review and comment. In addition, each utility company will be asked to provide prior rights documentation. Utilities in conflict with Northern Parkway improvements and in the existing right-of-way by permit will be relocated into the new right-of-way at the cost of the utility company. The cost of relocating utilities with prior rights and municipal utilities will be included in the cost estimate for Northern Parkway.

5.8.1 Loop 303 to Dysart Road

This segment of Northern Parkway is located on a new alignment so there are no utilities within the proposed right-of-way except those that cross the alignment at existing intersecting roadways. Northern Parkway is fully access controlled in this segment and new utilities generally would not be allowed within the new right-of-way. New utilities may cross perpendicular at mid-mile locations if constructed prior to the parkway improvements and there would be no conflict with the planned parkway improvements. Future utilities may also cross Northern Parkway provided appropriate utility pipe sleeves as identified and located the final design are installed. No above ground utility features such as manholes, pedestals, valve boxes, vaults, or poles may be installed in the right-of-way in this segment of the parkway. New north-south utilities could be considered crossing under the parkway bridge at GSI locations. New east-west utility lines in this section of the corridor should be placed along Northern Avenue 0.5 mile south or along Olive Avenue, which is 0.5 mile north of the parkway. Existing underground utilities along the intersecting arterial streets would be maintained at the GSI. Existing overhead utilities would be placed underground to cross at the GSI and at other locations. Fire protection facilities may need to be included in this access controlled portion of the parkway for roadway fire emergencies.

There is an irrigation well and pump at Sarival Avenue, a domestic water well located 0.5 mile west of Litchfield Road, and an irrigation well 0.5 mile west of Dysart that will all require relocation.

5.8.2 Dysart Road to El Mirage Road

The proposed alignment in this segment of the parkway is located south of the existing Northern Avenue so no utility relocation is anticipated in the new right-of-way. There are however existing utilities within the existing Northern Avenue right-of-way that may require relocation for the WB frontage road. New utilities would not be placed under the new mainline roadway but could be placed along the frontage roads on both sides of the parkway.

5.8.3 El Mirage Road to 115th Avenue

New utilities should avoid this accessed controlled segment of the parkway and be located outside the roadway right-of-way.

5.8.4 115th Avenue to 103rd Avenue

This section of Northern Parkway allows limited access to the parkway. Existing underground utilities will remain under the parkway pavement and within the existing right-of-way. New or relocated utilities could be placed in the new right-of-way. Above-ground utilities such as overhead power lines and street light poles will be relocated in-kind within the new right-of-way. A City of Peoria lift station located west of 112th Avenue will require relocation as well as the EPNG's "pig-launcher" facility located at the northeast corner of Northern Avenue and 109th Avenue. The pig launcher is located at the junction of an EPNG north-south 20-inch gas line and an EPNG 16-inch gas line located along Northern Avenue extending east to the SRP Agua Fria Generating Station near 75th Avenue. The pig launcher would be relocated into the existing 109th Avenue right-of-way, which will require the closure of 109th Avenue north of Northern Parkway. The cost of relocating the EPNG facility and blocking off 109th Avenue are assumed to be part of the Northern Parkway project costs.

5.8.5 103rd Avenue to 91st Avenue

This segment includes both the Northern Parkway bypass and Northern Avenue improvements with a new separate eastbound roadway from 103rd to 99th avenues and from Loop 101 to 91st Avenue. The depression of the parkway at 103rd Avenue requires the relocation of the 16-inch EPNG line, 18-inch Peoria sanitary sewer line, and a 12-inch Glendale waterline. East of Loop 101, a Peoria 36-inch sanitary sewer line, 6 and 12-inch Glendale waterlines, a 72-inch storm drain pipe, and 24-inch and 36-inch SRP irrigation pipes require relocation to accommodate the 91st Avenue bridge structure and MSE walls. An SRP water well at the northwest corner of 91st Avenue and Northern Avenue will require relocation.

5.8.6 83rd Avenue Segment

The 83rd Avenue GSI and MSE walls require the relocation of a Glendale 12-inch waterline, a Peoria 12-inch waterline, SRP 12kV overhead power line, 16-inch EPNG line, a 24-inch Peoria sewer line, a 6-inch Peoria force main sewer line, a Southwest Gas (SWG) 4-inch pipe, a 72-inch storm drain line and a City of Peoria water well site located on the northwest corner of 83rd Avenue and Northern.

5.8.7 75th Avenue Segment

The 75th Avenue GSI and MSE walls require the relocation of a SWG 2-inch and two 12-inch lines, Glendale 6-inch and 12-inch waterlines, a 16-inch Peoria waterline, a 24-inch Peoria sanitary sewer line, the 16-inch EPNG line, SRP 12kV and 69kV overhead power lines, a 42-inch storm drain and a 30-inch SRP irrigation pipe.

5.8.8 Grand Avenue Segment

The construction of the Grand Avenue flyover approach roadway along Northern Parkway will require the relocation of a Glendale 12-inch waterline, Glendale 21-inch and 8-inch sewer lines, two 12-inch SWG lines, and 69kV SRP overhead power line. East of 67th Avenue, two 69kV SRP power lines require relocation. The construction of the Grand Avenue flyover also requires the relocation of a Glendale 8-inch waterline, an 8-inch sanitary sewer line owned by Glendale and an Arizona Public Service Company (APS) 12kV overhead power line along Grand Avenue.

5.9 IRRIGATION

5.9.1 Sarival Avenue to El Mirage Road

Northern Parkway traverses irrigated farmland between Sarival Avenue and 0.5 mile west of El Mirage Road. Irrigation facilities such as concrete-lined ditches, earthen tailwater ditches, tailwater sumps, pipes, headwalls, pumps and wells in this segment of the parkway, are generally owned by the property owners. One exception is that Maricopa Water District owns a concrete lined ditch along the west side of Reems Road that will cross under the parkway. Preliminary irrigation relocation plans are included in Volume 2 of this DCR. These plans were developed to ensure that irrigated farming operations could be maintained after the construction of the parkway. Some of the properties currently being farmed are part of pending development projects that may make the irrigation relocation plans obsolete. The current phasing plan recently approved by the Northern Parkway Management committee provides for right-of-way acquisition and construction of this segment of the parkway by 2011 west of Dysart and by 2019 east of Dysart. The property owners and farmers will need to be contacted again to update the irrigation relocation plans as part of the final design effort.

5.9.2 99th Avenue to 67th Avenue

Irrigation water is provided by SRP to irrigated farm operations between 99th Avenue and 67th Avenue. Most of the irrigation facilities in this segment of the parkway are owned by SRP; however, some facilities are owned by private property owners. Facilities include concrete lined ditches, earthen ditches, pipes, headwalls, pumps and wells. Some of the properties currently being farmed are part of pending development plans that may remove irrigation facilities. SRP and private property owners will be contacted during final design to coordinate relocation of the irrigation facilities.

5.10 TRAFFIC MANAGEMENT

5.10.1 ITS Facilities

A comprehensive traffic management plan will be developed in final design to include Intelligent Transportation Systems (ITS) traffic management strategies on how to manage traffic flow, enhance safety, and manage traffic in the event of an incident or accident. ITS can be simply defined as using technology to aid the management of traffic. Generally agencies consider installing ITS or ITS elements for arterial streets and facilities of higher classifications like expressways and freeways. Given that Northern Parkway will move significant amounts of traffic, equipping it with some level of ITS at the time the parkway is constructed is important for two reasons:

- To help move traffic more efficiently and safely. Use of ITS can improve travel time, enable traffic signal optimization and incident management.
- Retrofitting ITS equipment after construction is much more costly.

In general, ITS for a given corridor would include a communications network—often a combination of fiber optics and wireless technology. It would likely include traffic surveillance cameras, electronic variable message signs, and a system of vehicle detection. To enable traffic engineers and technical staff to make use of the system, connectivity to one or more traffic management centers is necessary.

The regional AZTECH program was developed to identify “Smart Corridors” and implement ITS technology on selected major arterial corridors. Bell Road and Grand Avenue are two of the selected corridors. Technology to be implemented includes signal coordination, traffic flow monitoring, and variable message signs.

Several agencies are potentially involved in the Northern Parkway corridor so it is important to determine what agency or agencies will be responsible for using and maintaining ITS on the parkway.

The project budget may not be able to fund full ITS implementation during the first construction phase. It is important at a minimum to build a conduit and junction box network during the first phase. While the ground is being disturbed for utility and roadway work, it is very cost effective to install the conduit and junction boxes.

5.10.2 Traffic Signal Coordination

During interim phases to the project, signalized intersections would be required on the parkway. Traffic signals would be timed to give priority to the higher traffic volume Northern Parkway. Green time allocation would be required for vehicles and pedestrians traveling the north/south streets. The amount of pedestrian signal time required for crossing Northern Parkway when actuated would be substantial and would diminish the ability of Northern to move traffic. During the final design phase, a pedestrian survey should be conducted to quantify the number of pedestrians in the vicinity of the signalized intersections. If significant pedestrian traffic exists pedestrian grade separations should be considered to improve the intersection efficiency and pedestrian safety.

Traffic signals would be placed and remain at 111th Avenue and 107th Avenue which are 0.5 mile apart. These two signals should be coordinated so that traffic would not stop at more than one of these signals during uncongested conditions.

Depending on which jurisdiction or jurisdictions will manage traffic along Northern Parkway, communications connectivity needs to be provided between traffic signals and the jurisdictional traffic management center(s). This connectivity provides immediate notice of signal mal-functions, enables accurate signal timing, and enables signal-timing changes to be remotely downloaded from the traffic center to the intersection. Although green time for Northern Parkway will be a priority, consideration should be given to other jurisdictions affected by signal timing. The operational concept for the GSI signals should take into account the Northern Parkway ramp movements as well as north/south arterial traffic coordination. Modern signal equipment and proper timing can ensure balanced flows through the GSI in all directions as long as adjacent traffic signals are not located too close to the GSI. Jurisdictional operation and maintenance responsibilities for these signals will need to be defined and connectivity to the appropriate traffic management center(s) established for traffic management through the GSI.

Since ultimately there will only be two traffic signals on Northern Parkway, passive and/or active tools should be considered to warn drivers well in advance of an upcoming traffic signal. Passive devices would consist of static signs. Signs can also have an active component, which could include warning beacons flashing when the upcoming signal has the red indication for Northern Parkway or will have the red by the time the vehicle arrives at the intersection. This type of active control requires communications (hard-line or wireless) between the beacons and the traffic signal.

5.10.3 Change of Speed Between West Segment to East Segment

Northern Parkway is designed as a fully access controlled, free-flow facility for approximately 6 miles between Sarival Avenue and 111th Avenue. Traffic signals are planned at the Northern Parkway intersections of 111th Avenue and 107th Avenue. Throughout the access controlled portion (west segment), the roadway design speed is 60 mph with an anticipated posted speed limit of 55 mph. East of 111th Avenue the design speed is 55 mph with an expected speed limit of 45 mph.

This type of "end of free flow" condition is not unusual in the Phoenix metropolitan area, but does create driver expectation issues that need to be addressed in the design. Many drivers will travel for miles in the eastbound direction uninterrupted and will not anticipate the sudden stop. Eastbound Drivers must be alerted to the presence of the upcoming traffic signal at 111th Avenue, the change in access control, and posted speed limit. Below are tools that should be considered for eastbound traffic in various combinations for the design phase.

Signs

- "Traffic Signal Ahead" symbol signs (W3-3) posted according to the *Manual on Uniform Traffic Control Devices* in the median and on the roadside.
- Speed reduction signs (W3-5) posted according to the *Manual on Uniform Traffic Control Devices* in the median and on the roadside.
- The change in the speed limit clearly posted.

Flashing Beacons

Given the importance of alerting eastbound drivers of the pending traffic signal, alternating flashing beacons can be incorporated with the "Traffic Signal Ahead" warning signs. An alternative to this would be to install "Stop Ahead When Flashing" signs in combination with flashing beacons. These signs would have connections to the traffic signal.

Rumble Strips

Rumble strips can be created by cutting grooves into the pavement surface or mounting raised pavement markers to the pavement surface. Grooves are used in many rural highway conditions to alert drivers when they are starting to cross the centerline of a two-way roadway or the edge of the roadway. On tollways, rumble strips are often used to warn drivers of upcoming toll plazas. They are also used to alert drivers of upcoming curves or other design changes. Raised pavement markers create ongoing maintenance issues in order to replace the markers that detach from the pavement surface. Given the high volume of traffic expected to use Northern Parkway, pavement grooves have the advantage of reduced maintenance. They would be placed at two locations

approaching the 111th Avenue traffic signal, with the first set of grooves installed where drivers will hear and feel their impact and see the signal ahead warning signs.

Traffic Signal Design

- The traffic signal design needs to ensure adequate size and number of traffic signal indications.
- "Dilemma Zone" vehicle detection: Detection in the form of inductive loops, video, or other technology can be used in advance of the traffic signal to identify vehicles positioned where they will likely not be able to stop for the pending red light due to speed and location. The traffic signal controller can be configured to extend the green light to a point to allow drivers within the defined dilemma zone time to make a decision, stop, or clear the intersection.

5.11 LIGHTING

5.11.1 Sarival Avenue to 115th Avenue

Street lighting is planned to be continuous throughout the length of the project. On the west end of the project, lighting poles are planned to be installed within the concrete median barrier including elevated sections at GSI. Ramp lighting will be located along the outside edge of the ramp. Lighting will also be provided along the outside edge of the frontage roads located between Dysart and El Mirage roads.

Lighting at the Litchfield Road GSI has special lighting requirements due to its proximity to the runways at Luke AFB as follows:

- Streetlights should not exceed 30 feet above the natural ground elevation in the area
- Light from the street lights should be directed downward
- The intensity of the streetlights should be as low as feasible
- Streetlight poles within the APZ1 should be frangible or breakaway type.

Lighting at the BNSF Webb Spur overpass has special lighting requirements due to its proximity to the runways at Luke AFB as follows:

- Streetlights should not exceed 52 feet above natural ground in the area
- Light from the street lights should be directed downward
- The intensity of the streetlights should be as low as feasible
- Streetlight poles within the APZ1 should be frangible or breakaway type.

5.11.2 115th Avenue to Grand Avenue

In the urban section east of 112th Avenue, the street light poles will be located along the north and south edges of Northern Parkway behind the curb and gutter. Lighting along the outside of the curb is planned to be continuous along both sides of the roadway. This outside lighting would continue along the ramps/connector roads. On the elevated grade-separated overpasses, the light poles are planned to be placed in the median barrier. Lighting will also accommodate pedestrian requirements as contained in the latest edition of the Illumination Engineering Society of North American Lighting Handbook (IES). Special high-mast area lighting may be used at Loop 101 and at Grand Avenue. At signalized locations, including the SPUIs, lighting will be provided as extensions to the traffic signal poles. Adjacent to residential neighborhoods, special consideration will be made to shield homes and backyards from unwanted illumination.

Street lighting should be evaluated further during final design level of engineering. Street lighting standards vary from jurisdiction to jurisdiction so when ownership and maintenance responsibilities for the parkway and lighting system are better defined, standards can be followed accordingly.

5.12 STRUCTURES

New bridges are required at each of the GSI of Northern Parkway with existing arterial streets, over Loop 101, over Grand Avenue, and over New River and Agua Fria River. Bridge types and lengths are summarized in Table 5-12. Preliminary plan sheets for each structure are included in Volume 2 of this DCR.

Table 5-12 Structure Summary

Location	No. of Spans	Max Span Length	Overall Length	Structure Type
Sarival Avenue GSI Overpass	2	105'	215'	Precast/Prestressed I-Girder
Reems Road GSI Overpass	2	100'	193'	Precast/Prestressed I-Girder
BNSF Railroad	1	59'	64'	Precast/Prestressed I-Girder
Litchfield Road GSI Overpass	2	102'-6"	210'	CIP Post-Tensioned Box Girder
Dysart Road GSI Overpass	1	240'	246'	CIP Post-Tensioned Box Girder
El Mirage Road GSI Overpass	1	240'	246'	CIP Post-Tensioned Box Girder
Agua Fria River Bridge	5	129'	650'	Precast/Prestressed I-Girder
103rd Avenue GSI Underpass	1	130'	135'	Precast/Prestressed I-Girder
EB Northern Avenue New River Bridge	3	135'	410'	Precast/Prestressed I-Girder
EB Northern Parkway at New River	5	140'	665'	Precast/Prestressed I-Girder
EB Northern Pkwy at 99th Ave	1	140'	145'	Precast/Prestressed I-Girder
WB Northern Parkway at New River/99th Ave	8	156'	1127'	Precast/Prestressed I-Girder
97th Avenue Overpass	1	110’	116’	Precast/Prestressed I-Girder
SB SR 101L On-Ramp Overpass	1	48'	49'	Proprietary Precast Arch
Northern Parkway SR 101L Overpass	2	120'	246'	Precast/Prestressed I-Girder
NB SR101L Off-Ramp Overpass	1	110'	115'	Precast/Prestressed I-Girder
93rd Avenue Ramp A	3	190'	471'	CIP Post-Tensioned Box Girder

Location	No. of Spans	Max Span Length	Overall Length	Structure Type
93rd Avenue Ramp B	1	120'	125'	Precast/Prestressed I-Girder
EB Northern Ave – Eastbound Lanes	2	223'	448'	CIP Post-Tensioned Box Girder
EB Northern Ave – Westbound Lanes	2	205'	382'	CIP Post-Tensioned Box Girder
93rd Avenue GSI Overpass	1	246'	252'	CIP Post-Tensioned Box Girder
91st Avenue GSI Overpass	1	246'	252'	CIP Post-Tensioned Box Girder
83rd Avenue GSI Overpass	1	240'	246'	CIP Post-Tensioned Box Girder
75th Avenue GSI Overpass	1	240'	246'	CIP Post-Tensioned Box Girder
Grand Avenue Flyover	10	238'	2,071'	Steel Plate Girder

5.12.1 Structure Type Considerations

The primary factors that govern the selection of structure types for the Northern Parkway project are as follows:

Maintenance of Traffic During Construction

It will likely be necessary to maintain traffic on the major arterials during construction of GSI. This ordinarily favors prefabricated girder types such as precast-prestressed I-girders or steel plate girders that can be erected with a series of overnight or weekend closures of the surface street. However, there are many locations on the Northern Parkway alignment where the required span lengths are too great for precast-prestressed I-girders and the relatively high cost of steel plate girders is not justified. In these locations a cast-in-place post-tensioned concrete superstructure is proposed. Temporary falsework will be constructed to support the concrete superstructure during casting and prior to post-tensioning. Two-lane falsework openings are assumed with a minimum vertical clearance of 14'-6" to the underside of the falsework to provide at least two lanes of traffic in each direction.

Structure Depth

At many of the grade separation locations the depth of the proposed superstructure governs the new roadway profile grade. In these locations shallow superstructure types are preferred for the purpose of minimizing embankment and retaining wall quantities. Among the feasible structure types considered for this project, cast-in-place post-tensioned concrete box girders offer the shallowest structure depth.

Maximum Span Length

The roadway geometry in several of the traffic interchange locations dictates span lengths that cannot be achieved by precast-prestressed I-girders. In order of increasing unit cost the preferred structure types in these locations are (1) cast-in-place post-tensioned box girders, and (2) steel plate girders.

Constructability

Much of the Northern Avenue project will be constructed near and/or over existing roadways and developed properties. The range of feasible construction techniques for bridges in these areas is limited by the ability to obtain access to the area beneath and surrounding the new structures. There are also numerous site-specific factors including structure height, roadway curvature, and periodic stream flows. The structure type recommendations for each site reflect an assessment of constructability under the anticipated future conditions.

Construction Cost

Construction cost estimates are based on detailed quantity estimates for each structure and current (2009) unit costs (see Appendix E).

Recommended Structure Types

The structure types recommended in this study are those that are judged to meet all technical requirements for the least cost based on experience. Detailed structure type studies will be required prior to final design.

Retaining Wall Types

At many of the overpass locations, the roadway approach embankments are confined between retaining walls in order to minimize right-of-way requirements. The walls vary in height from a few feet to over 45 feet. The recommended wall type for this application is MSE.

The MSE wall type consists of steel reinforcing elements embedded in engineered embankment materials to create a self-supporting soil mass. Precast concrete panels at the edges of the embankment serve to retain face soils and create attractive wall appearance. In very tall walls, these panels may be designed to form one or more terraces between the bottom and top of wall in order to mitigate adverse visual impacts often associated with tall retaining walls.

5.12.2 One-Span Single Point Urban Interchange Overpasses

New one-span overpasses will be constructed to carry Northern Parkway over the SPUI at:

1. Dysart Road
2. El Mirage Road
3. 93rd Avenue
4. 91st Avenue
5. 83rd Avenue
6. 75th Avenue

Superstructures

For all but 91st Avenue and 93rd Avenue bridge superstructures will consist of one-span cast-in-place and post-tensioned concrete box girders with a bearing-to-bearing span length of 240 feet. At 91st Avenue and 93rd Avenue the bearing-to-bearing span length is 246 feet. The out-to-out structure width will be 124'-10" for all six of the bridges except 83rd and 75th avenues, which have a width of 84'-10". All superstructures will have a depth of 11'-0".

It is assumed that traffic will be maintained on the existing arterials during construction of the new overpasses. Temporary falsework will be required to support the concrete superstructures during casting and prior to post-tensioning. The proposed profile grades provide adequate space to construct two-lane falsework openings with a minimum vertical clearance of 14'-6" to the underside of the falsework to provide at least two through lanes of traffic in each direction.

Substructures

Substructures will consist of drilled shaft foundations supporting round concrete columns and seat-type abutments. Consistent with recently instituted practice in Arizona, the columns and abutments are proposed to be located ahead of MSE approach embankments in lieu of embedding them in the embankments. This approach provides for constructing the approach embankments and wall fascias without interference from the bridge substructure, thus enabling adequate compaction and preventing excess settlement of the bridge approaches.

5.12.3 Sarival Avenue and Reems Road GSI Overpasses

The proposed bridges carry both directions of Northern Parkway over Sarival Avenue and Reems Road. Both bridges are located on tangent sections of Northern Parkway and on 1,000-foot crest vertical curves. The roadways beneath the bridges consist of a total of eight lanes at Sarival Avenue and seven lanes at Reems Road, 8-foot wide median islands, and sidewalks on each side.

Superstructures

At Sarival Avenue, the new superstructures will carry four lanes of traffic EB and three lanes of traffic WB with 11'-5" inside shoulders and 12-foot outside shoulders. The clear roadway width will be 71'-5" in the EB direction and 59'-5" in WB direction. The EB out-to-out structure width will be 62'-4½" and the WB out-to-out width will be 74'-4½". The total out-to-out width for both EB and WB structures is 136'-10".

At Reems Road, the new superstructures will carry three lanes of traffic EB and WB with 11'-5" inside shoulders and 12-foot outside shoulders. The clear roadway width will be 59'-5" in each direction and the out-to-out structure width will be 62'-4½". The total out-to-out width for both

EB and WB structures is 124'-10". Separate EB and WB superstructures is assumed at this time, but a single superstructure carrying both directions of traffic should be evaluated during final design based on comparisons of construction costs and a detailed evaluation of movements due to transverse expansion and contraction.

The overall bridge lengths will be 215 feet at Sarival Avenue and 193 feet at Reems Road. Both bridges will have 2-span superstructures. The Reems Road overpass will have unequal span lengths to accommodate the unequal NB and SB crossroad roadway widths with a maximum span length of 100 feet over SB Reems Road. The Sarival Avenue overpass will consist of two 105-foot spans.

Precast-prestressed I-girder superstructures are recommended consisting of 7 lines of AASHTO Type V Modified girders for both EB and WB structures, erected as simple spans and made continuous with mild reinforcing over the intermediate pier. Deck expansion joints will be located at each abutment.

AASHTO Type IV girders are also feasible for the proposed span lengths and may be more economical for these superstructures. The final selection of girder type should be made on the basis of detailed cost comparisons that include the roadway embankment and retaining wall costs associated with the difference in girder depth.

Substructures

Both superstructures will be supported by multiple-column piers with dropped-type pier caps and shallow “stub” abutments at the tops of 2:1 paved slopes.

At Sarival Avenue and at Reems Road, the abutments and the intermediate piers may be supported by either spread footings or drilled shaft foundations depending on subsurface conditions.

5.12.4 BNSF Overpass

The proposed bridge will carry Northern Parkway over one set of existing railroad tracks. Feasible superstructure depths are those that will provide 23'-0" vertical clearance between Northern Parkway and the top of track.

The bridge is located within a curved section of the Parkway having a 11,100-foot radius and 2 percent slopes away from the median barrier for drainage. The proposed eastbound and westbound superstructures are separated by a 1" open gap.

Superstructure: A single 59-feet long span is proposed to satisfy horizontal clearance requirements of the railroad. The eastbound superstructure will have a constant out-to-out width of 62'-5". The width of the westbound superstructure will vary to accommodate a gore area

originating from Litchfield Road Ramp A. The recommended structure type is precast, prestressed AASHTO Type III girders with a cast-in-place concrete deck giving a total structure depth of approximately 4'-9". Deck expansion joints will be located at each abutment.

Substructure: The abutments are proposed to be full-height. It may be desirable to use the superstructure as a prop between the abutments to reduce the size of the foundations. Foundations will consist of either drilled shafts or spread footings depending on subsurface conditions.

Retaining Walls: Retaining walls are needed adjacent to both abutments to retain the 3:1 embankment.

5.12.5 Litchfield Road GSI Overpass

The proposed bridge will carry Northern Parkway over a diamond interchange at Litchfield Road. The intersection is located 0.5 mile north of the Luke AFB where the profile grade elevation of Northern Parkway is limited by airport operational height restrictions. The profile grade of Litchfield Road is limited by drainage considerations. Feasible superstructure depths are those that will fit between the Northern Parkway and Litchfield Road roadway surfaces and provide a minimum 16'-6" vertical clearance. Litchfield Road beneath the bridge consists of two through lanes and two left turn lanes in each direction, an 8-foot wide median island, and sidewalks on each side.

The bridge is located within a 2,500-foot radius horizontal curve with a superelevation of 4.8 percent. Separate eastbound and westbound superstructures are proposed in order to limit the difference in elevation between the north and south sides of the deck, minimize the profile grade elevation and minimize the associated earthwork costs.

Superstructure

A 2-span layout is proposed with equal span lengths of 102 feet. Each superstructure will have an out-to-out width of 62'-4½" providing an overall width of 124'-10" including a 1" open gap between superstructures. The recommended structure type is cast-in-place and post-tensioned concrete box girders with a total structure depth of 4'-6". Deck expansion joints will be located at each abutment.

Substructure

The superstructures will be supported by multiple-column piers with integral pier caps and shallow “stub” abutments at the tops of 2:1 paved slopes. Foundations will consist of either drilled shafts or spread footings depending on subsurface conditions.

5.12.6 Agua Fria River Bridge

The proposed Agua Fria River bridge is a five-span structure carrying Northern Parkway over the future channelized watercourse. The total structure length is 650'-0" and the out-to-out width is 148'-10". A small portion of the west end of the bridge is on a horizontal tangent while the remaining majority of the bridge is within an 11,100-foot radius curve with no superelevation. The profile grade is constant at 0.30 percent.

Superstructure

Separate eastbound and westbound structures are proposed due to the width of the roadway section and to allow phasing of half the bridge at one time. Each superstructure will have an out-to-out width of 74'-4¼", providing an overall width of 148'-10" including a 1" gap between superstructures. Each superstructure will be constructed with 8 lines of AASHTO Type VI Modified precast-prestressed I-girders. For economy of fabrication, all span lengths will be equal at 129'-0".

The precast girders will be erected as simple spans and made continuous for live loads with mild reinforcing in the concrete deck slab. Deck expansion joints will be located at each abutment.

Substructure

Substructures will consist of drilled shaft foundations supporting round concrete columns and dropped-type pier caps. Abutments will be seat-type and supported directly on drilled shaft foundations. Cantilever-type wingwalls are assumed for the purpose of cost estimating, noting that retaining walls supported on spread footings appear to be equally feasible at this time. Due to the width of the overall structure, separate pier caps are proposed for the EB and WB bridges.

Hydraulics and Scour

The roadway profile grade and structure depth provide a minimum 2'-0" freeboard to the 100-year water surface elevation.

The 100-year flow is expected to be contained entirely within the future channel banks and will not jeopardize the approach roadways. The bridge substructure should be designed to withstand this event along with scour around pier foundations while carrying the design live loads. Flows larger than the 100-year flow may overtop the future channel banks and scour the embankment material supporting the roadway approaches. The bridge substructure should be designed to withstand the 500-year event or alternatively the Standard Project Flood (SPF) under the assumption of fully scoured approach embankments and full scour around pier and abutment foundations. This approach will ensure the bridge can be rapidly returned to service in the event a major flooding event damages the approach roadways.

5.12.7 103rd Avenue GSI Underpass

The proposed bridge carries 103rd Avenue over Northern Parkway (bypass) and supports a SPUI connecting 103rd Avenue with the Northern Parkway entrance and exit ramps. The new bridge deck will match existing grade and Northern Parkway will be depressed beneath 103rd Avenue.

Superstructure

There are several viable alternatives for this structure including:

1) One-span or two-span rectangular deck using cast-in-place/post-tensioned concrete box girders
2) One-span or two-span rectangular deck using precast-prestressed concrete box beams or I-girders
3) One-span or two-span curved deck using cast-in-place/post-tensioned concrete box girders

The total structure length is estimated to be 135'-0", which is feasible with a single span structure, but a two-span structure is also feasible by adding a median pier. The two-span configuration would require a shallower superstructure depth than the one-span configuration, which could translate into a savings on retaining walls adjacent to the structure, but the median pier may be viewed as an obstruction in the Parkway and create a safety concern. For the purpose of this study a one-span structure was assumed.

The advantages of constructing a rectangular deck include lower construction costs than a curved deck and shorter construction duration. A curved deck offers superior aesthetics and reduced maintenance requirements due to less deck area available to pedestrians. For the purpose of this study a rectangular deck was assumed.

The advantages of constructing with precast-prestressed concrete girders include lower costs than cast-in-place construction and shorter construction duration. Cast-in-place and post-tensioned box girders offer somewhat better aesthetics. For the purpose of this study precast-prestressed concrete I-girders were assumed.

The proposed rectangular deck will have “excess” deck area behind the 103rd Avenue sidewalks between the curved backs of sidewalks and straight deck edges. In a similar situation, at the Grand Avenue intersection with 59th Avenue and Glendale Avenue, the excess deck areas were enhanced with landscaping and utilized as pedestrian plazas. This bridge offers a similar opportunity if a rectangular superstructure is constructed.

The proposed superstructure is 204'-5" wide consisting of 24 lines of simply-supported AASHTO Type VI precast-prestressed concrete I-girders with a reinforced cast-in-place concrete deck. The girders will be placed on a skew of approximately 7 degrees in order to minimize the area of excess deck behind the sidewalks. To help resist lateral earth pressure behind the abutments, the superstructure can be used as a strut between the abutments.

A detailed structure selection study prior to final design will be particularly important at this location in order to identify all the important factors influencing the selection of a superstructure type. The final superstructure details should reflect the relative importance of initial construction cost, structure aesthetics, maintenance requirements and pedestrian use of the intersection.

Substructure

Substructures will consist of seat-type abutments supported by drilled shaft foundations. In addition to gravity loads from the superstructure, the drilled shafts will be subject to lateral soil loads from the bridge approach areas. These forces will be substantial and will be the primary factor governing the drilled shaft diameter and reinforcing requirements. It is recommended that the bridge be designed to use the superstructure as a "strut" between abutments for the purpose of reducing the lateral load demands on the drilled shafts and minimizing drilled shaft construction costs.

In the final condition the drilled shaft foundations will be covered with cast-in-place concrete fascias on each side of the depressed Northern Parkway roadway.

Construction Sequence

A top-down construction sequence is envisioned as follows:

1) Construct the abutment drilled shaft foundations
2) Construct the abutment caps
3) Erect the girders between abutments
4) Cast the bridge deck
5) Excavate beneath the bridge to the level of the Northern Parkway subgrade
6) Construct cast-in-place concrete wall fascias to cover the exposed portions of drilled shaft foundations
7) Construct the Northern Parkway roadway surface and traffic barriers beneath the bridge

Retaining Walls

Due to right-of-way considerations, depressed Northern Parkway (bypass) through the bridge area will be confined between retaining walls on the north and south sides. These walls will be constructed from the top down as the roadway excavation proceeds. The recommended wall type is soil nail. This wall type consists of grouted steel reinforcing bars (nails) drilled horizontally into the existing soils on a regular grid spacing within the range of 4 feet to 6 feet, horizontally and vertically. After nail installation is complete, the exposed cut surface is covered with a cast-in-place concrete fascia to create an attractive and permanent wall surface.

5.12.8 New River/EB Northern Avenue/99th Avenue

In the WB direction the proposed eight-span bridge crosses over the New River watercourse, eastbound Northern Avenue and 99th Avenue for a total length of 1,127 feet. In the EB direction the proposed structure consists of two independent bridges separated by a segment of embankment. The first EB bridge across the New River watercourse and eastbound Northern Avenue has five spans with a total length of 665 feet. The second EB bridge across 99th Avenue has one span with a total length of 145 feet. The two EB bridges are separated by 317 feet of embankment confined by retaining walls. The out-to-out width of the WB and EB bridges is 72'-5", except for the first two spans of the WB bridge where the deck flares out to accommodate an off-ramp to 103rd Avenue.

The entire structure is located on a horizontal tangent.

Superstructure

The superstructure will consist of AASHTO Type VI precast-prestressed I-girders except at spans 5 and 6 of the WB Bridge where the superstructure will consist of AASHTO Type VI-S due to the 156-foot long span lengths. The WB Bridge will have 7 lines of girders in Spans 2 through 8 with additional girder lines in Span 1 due to the large variation in deck width. The two EB Bridges will have 7 lines of girders throughout. Span lengths will range from 130 feet to 156 feet measured along the construction centerline, noting that girder lengths in Span 1 will vary due to the girder splay.

The precast girders will be erected as simple spans and made continuous for live loads with mild reinforcing in the concrete deck slab. Continuity will be accomplished with two four-span units requiring three expansion joint locations.

Substructure

Piers will consist of drilled shaft foundations supporting round concrete columns and dropped-type pier caps. Abutments will be located ahead of MSE approach embankments and supported

on round formed columns with drilled shaft foundations. Abutment wingwalls will be integral with the MSE walls supporting the approach embankments.

Hydraulics and Scour

The roadway profile grade and structure depth provide a minimum 3'-0" freeboard to the SPF water surface elevation for the levee.

The 100-year flow is expected to be contained entirely within the existing channel banks and will not jeopardize the approach roadways. The bridge substructure will be designed to withstand this event along with scour around pier foundations while carrying the design live loads. The bridge substructure should be designed to withstand the 500-year event or alternatively the SPF assuming full scour around pier and abutment foundations. This approach will ensure the bridge can be rapidly returned to service in the event a major flooding event damages the approach roadways.

5.12.9 EB Northern Avenue New River Bridge

The proposed bridge is a three-span structure located immediately downstream of the Northern Parkway (bypass) New River Bridge. It carries Northern Avenue eastbound traffic over the existing New River watercourse. The total structure length is 410'-0" and the out-to-out width is 47'-8".

The bridge is located entirely within a 1,000-foot radius horizontal curve and within a 250-foot crest vertical curve. The superelevation is a constant 3.1 percent.

Superstructure

The superstructure will consist of six lines of AASHTO Type VI precast-prestressed I-girders. For economy of fabrication, all span lengths will be equal at 135'-0".

The precast girders will be erected as simple spans and made continuous for live loads with mild reinforcing in the concrete deck slab. Deck expansion joints will be located at each abutment.

Substructure

Piers will consist of drilled shaft foundations supporting round concrete columns and dropped-type pier caps. Abutments will be seat-type and supported directly on drilled shaft foundations. Cantilever-type wingwalls are assumed for the purpose of cost estimating, noting that retaining walls supported on spread footings appear to be equally feasible at this time.

Hydraulics and Scour

The roadway profile grade and structure depth provide a minimum 3'-0" freeboard to the SPF water surface elevation for the levee.

The 100-year flow is expected to be contained entirely within the existing channel banks and will not jeopardize the approach roadways. The bridge substructure will be designed to withstand this event along with scour around pier foundations while carrying the design live loads. Flows larger than the 100-year flow may overtop the existing channel banks and scour the embankment material supporting the roadway approaches. The bridge substructure should be designed to withstand the 500-year event or alternatively the SPF under the assumption of fully scoured approach embankments and full scour around pier and abutment foundations. This approach will ensure the bridge can be rapidly returned to service in the event a major flooding event damages the approach roadways.

5.12.10 97th Avenue Overpass

The proposed structure is a one-span bridge with a bearing-to-bearing length of 110'-0" and an overall length of 116'-0". The out-to-out deck width is 144'-10".

The bridge is located within a 4,000-foot radius horizontal curve and 600-foot vertical sag curve. The deck is superelevated at a constant 2.30 percent.

Superstructure

The superstructure will consist of 18 lines of AASHTO “Super VI” precast-prestressed I-girders. A cast-in-place/post-tensioned box girder superstructure is also feasible and suitable for this location, but I-girders were selected for ease of construction over future traffic on 97th Avenue and to avoid relatively high (approximately 35 feet) falsework to support cast-in-place construction.

Substructure

Abutments will be located ahead of MSE approach embankments and supported on round formed columns with drilled shaft foundations. Abutment wingwalls will be integral with the MSE walls supporting the approach embankments.

5.12.11 SB SR 101L On-Ramp Overpass

The proposed structure carries Northern Parkway (bypass) over the existing Northern Avenue/ SR 101L southbound entrance ramp. Because the ramp is relatively narrow (42 feet) and the grade differential is relative high (approximately 60 feet) a buried arch-type structure is proposed. The portal-to-portal length of the buried structure will be 144'-10".

Superstructure

The superstructure will consist of precast concrete arch segments with a clear opening width of approximately 48 feet. The vertical clearance at the edges of the ramp beneath will be 16'-6" minimum.

A precast arch structure is preferred to cast-in-place concrete arch or portal frame alternatives due to the need to maintain traffic on the existing ramp. The precast segments can be fabricated off-site in lengths of approximately 8 feet and erected side-by-side to form a linear arch structure similar to a precast concrete box culvert. A proprietary system, such as manufactured by Conspan Bridge Systems, may be the most cost-effective approach for both design and construction.

Substructure

Bridge foundations are assumed to be continuous spread footings which will either support the precast arch segments directly or will support concrete stem walls below the arch segments.

Alternative Structure Types

In the event it is possible to detour ramp traffic around the construction zone it may be feasible and more cost effective to construct a cast-in-place concrete portal frame in lieu of a precast arch. A detailed structure type study prior to final design will be particularly important at this location to identify and investigate traffic control and construction sequence options and optimize the structure type.

5.12.12 SR 101L Overpass

The proposed bridge carries Northern Parkway (bypass) over existing SR 101L. A 2-span layout is proposed with abutments located approximately 18'-0" from the edges of the existing roadway and a pier located in the existing SR 101L median. The abutment locations allow for the future addition of one outside lane in each direction of SR 101L and an HOV lane in the existing median in each direction. The addition of the HOV lanes is currently scheduled for Phase III of the MAG RTP while the general purpose lanes are scheduled for Phase IV. The Northern Parkway Bypass may be constructed after the Loop 101 widening. The span lengths are equal at 120'-0" with an overall structure length of 246'-0 and the out-to-out width ranging from 144'-10" to 110'-3".

The bridge is located entirely within a 2,500-foot radius horizontal curve and 800-foot crest vertical curve. The superelevation is a constant 2.90 percent.

Superstructure

The superstructure will consist of 16 lines of AASHTO Type VI modified precast-prestressed I-girders. A precast superstructure type is preferred to a cast-in-place type in order to avoid constructing falsework over SR 101L.

Substructure

Abutments will be located ahead of MSE approach embankments and supported on round formed columns with drilled shaft foundations. Abutment wingwalls will be integral with the MSE walls supporting the approach embankments.

5.12.13 NB SR 101L Off-Ramp Overpass

The proposed single span bridge carries Northern Parkway over an existing off-ramp that connects NB SR 101L to Northern Avenue. The span length is 110'-0" with an overall structure length of 115'-0", the out-to-out width is 125'-2" and the skew is approximately 40 degrees.

Most of the bridge is located on a tangent section of the Parkway, but a short segment of the EB bridge falls within a horizontal curve. Due to the transition from a curved segment to a tangent segment, the cross slope of the roadway varies.

Superstructure: The proposed superstructure will consist of 14 lines of AASHTO Type V precast-prestressed I-girders. A precast superstructure type is preferred over a cast-in-place type in order to avoid constructing falsework over the off-ramp. The EB and WB directions will be separated by a 1" open gap.

Substructure: Abutments will be located ahead of MSE approach embankments and supported on round formed columns with drilled shaft foundations. Abutment wingwalls will be integral with the MSE walls supporting the approach embankments.

5.12.14 EB Northern Avenue Overpass

The proposed bridges carry Northern Parkway (bypass) over the eastbound Northern Avenue east of SR101L. A 2-span layout is proposed with span lengths of 219 feet and 223 feet for the EB structure and span lengths of 205 feet and 171 feet for the WB structure. The overall structure length is 448 feet and 382 feet for the EB and WB structures, respectively. The out-to-out deck width is 62'-6½" per bridge with a 1" gap between bridges for a total out-to-out width of 125'-2" for both bridges. The bridge is located partly on tangent and partly within a 3,000-foot radius horizontal curve and 300-foot sag vertical curve. The superelevation of the deck varies with a maximum of 2.90 percent.

Superstructure

The superstructure will consist of a cast-in-place/post-tensioned box girder with an overall depth of 11'-0". Expansion joints will be located at each abutment.

Substructure

The pier will consist of a straddle bent supported by columns outside the north and south edges of eastbound Northern Avenue.

Abutments will be located ahead of MSE approach embankments and supported on round formed columns with drilled shaft foundations. Abutment wingwalls will be integral with the MSE walls supporting the approach embankments.

5.12.15 93rd Avenue Ramp A

The proposed bridge is a 3-span structure carrying 93rd Avenue Ramp A (WB on-ramp) over the SR 101L NB exit ramp, the adjacent ADOT drainage channel, and eastbound Northern Avenue. The east end of the ramp is located on the left edge (south side) of the proposed westbound Northern Avenue and the west end is located on the north side of the elevated westbound Northern Parkway (bypass).

A 3-span layout is proposed with span lengths of 165 feet, 190 feet, and 110 feet and an overall length of 471'-0". The span lengths vary due to constraints on feasible pier locations. The out-to-out deck width is 25'-2".

The bridge is located partly on tangent and partly with a 2,000-foot radius horizontal curve. The deck superelevation is 2.60 percent maximum.

Superstructure

The proposed superstructure consists of a 2-cell cast-in-place/post-tensioned concrete box girder continuous over intermediate piers. Spliced precast-prestressed concrete I-girders may also be feasible for the proposed span lengths and should be given detailed consideration in a structure type study prior to final design. The primary advantage of the I-girder option may be improved constructability due to avoiding the need for falsework. The primary disadvantage may be higher costs due to increased complexity.

Substructure

Pier 1 will consist of a single bladed column supported either by a spread footing or drilled shaft foundation. Pier 2 will consist of a straddle bent with one column located in the Northern Avenue Median and the other column located beyond the south edge of the new EB Northern Avenue roadway.

Spread footings were assumed for all piers for cost estimating purposes. Abutments will be located ahead of MSE approach embankments and supported on round formed columns with drilled shaft foundations. Abutment wingwalls will be integral with the MSE walls supporting the approach embankments.

Alternative Structure Types

Spliced precast-prestressed concrete I-girders may also be feasible for the proposed span lengths and should be given detailed consideration in a structure type study prior to final design. The primary advantage of the I-girder option may be improved constructability due to avoiding the need for falsework. The primary disadvantage may be higher costs due to increased complexity.

5.12.16 93rd Avenue Ramp B

The proposed structure carries 93rd Avenue Ramp B (EB off-ramp) over the SR 101L NB exit ramp and the adjacent ADOT drainage channel. A single-span structure is proposed with a length of 125'-0" and out-to-out deck width of 25'-2".

The bridge is located partly on tangent and partly with a 2,500-foot radius horizontal curve. The superelevation is 2.90 percent maximum.

Superstructure

The superstructure will consist of 3 lines of AASHTO Type VI precast-prestressed I-girders. A precast superstructure type is preferred to a cast-in-place type in order to avoid constructing falsework over the SR 101L NB Off-Ramp.

Substructure

Abutments will be located ahead of MSE approach embankments and supported on round formed columns with drilled shaft foundations. Abutment wingwalls will be integral with the MSE walls supporting the approach embankments.

5.12.17 Grand Avenue Flyover

The proposed structure connects Northern Parkway with existing Grand Avenue (US 60) for the east-to-southeast and northwest-to-west traffic movements. The new bridge will span eastbound Northern Avenue, existing 67th Avenue Overpass, existing 67th Avenue Connector B, existing BNSF Railroad tracks, and existing southeast-bound Grand Avenue. A 10-span structure is proposed with span lengths ranging from a maximum of 238'-0" in Span 9 to a minimum of 182'-0" in Span 10. The overall structure length is 2,071'-0" and the out-to-out deck width is 57'-2".

The horizontal alignment includes both tangent and curved sections. The vertical profile includes both crest and sag curves and grades up to 5.6 percent. The deck within the 1,800-foot radius curved portion of the alignment is superelevated 4.6 percent.

Superstructure

The superstructure will consist of 7 lines of steel plate girders with an overall structure depth of 9'-6". Several factors lead to the selection of steel for this structure including:

1) The span lengths exceed the maximum feasible span lengths of precast-prestressed concrete I-girders even if spliced I-girders are considered.
2) Reducing the span lengths to allow concrete I-girders to be feasible (140 feet or less) would require 5 additional piers including 4 additional straddle bents.
3) There are few areas beneath the structure where falsework for cast-in-place concrete construction can be located.
4) The height of the new bridge above existing ground (over 65 feet at the high point) would make falsework for cast-in-place construction very expensive.

Steel plate girders can accommodate the proposed span lengths, do not require significant falsework to erect, and can be constructed in a shorter schedule than a cast-in-place concrete alternative.

The proposed layout consists of 3 continuous frames separated by hinges in Spans 3 and 7. Expansion joints will be located at the hinges and at the abutments.

Substructure

Piers 1, 2, 3, 6 and 9 will each consist of two blade-type columns supported by spread footings or drilled shaft foundations. Piers 4, 5, 7 and 8 will consist of cast-in-place concrete straddle bents supported by spread footings or drilled shaft foundations. For the purpose of cost estimating spread footings were assumed for all foundations.

All pier caps will be dropped-type with the exception of Pier 9 due to vertical clearance requirements over southeast-bound Grand Avenue. The Pier 9 cap will consist of a cast-in-place concrete or steel diaphragm integral with the steel plate girders supported by the pier.

5.13 GEOTECHNICAL STUDY AND PAVEMENT DESIGN

5.13.1 Summary Results of the Geotechnical Study

Subsurface conditions were evaluated for this project by drilling 23 borings along Northern Avenue between 67th Avenue and Dysart Road and along Butler Drive alignment between

Litchfield Road and Sarival Avenue. The drilling was performed from June 23, 2006 to July 28, 2006 and from September 13, 2006 to September 21, 2006. The borings that were drilled in the vicinity of various crossroad intersections along the project corridor were extended to depths of about 60 to 80 feet below ground surface (bgs). The borings that were drilled within Agua Fria River were extended to a depth of about 99 feet bgs.

The soils encountered onsite can be primarily classified as alluvial deposits. These alluvial soils consisted of a variety of soils types including silts, sands, clays, and gravels. The fines content of the onsite soils ranges from 6 to 80 percent. The plasticity index of the onsite soils ranges from 5 to 84 percent. The soils are generally medium dense to very dense, and firm to hard. Groundwater was not encountered in any of the borings within the depths explored, and moisture contents of the soils were generally low.

5.13.2 Bridge Foundation

Foundation Type

Foundation systems that are typically considered for bridges include deep foundations such as drilled shaft foundations or concrete-filled steel pipe piles, and shallow spread footings. In current Arizona practice, pile foundations are no longer in common use due to the development of high-torque auger drilling equipment that is used to rapidly construct cost-effective drilled shaft foundations.

Drilled shaft foundations can be constructed with minimal disturbance to existing developed areas, and are suitable for construction through newly placed embankment fill or from existing grade, and are the recommended foundation type for supporting bridge abutments at the service interchanges along the Northern parkway alignment. More specifically, drilled shaft foundations will always be used for stub abutments whether the abutment is built on embankment fill or existing grade; conversely, spread footings may be considered for tall abutments built on existing grade. Drilled shaft foundations and shallow spread footing foundations may be considered to support bridge piers at the service interchanges. Shallow spread footings are typically considered to be more cost effective than drilled shafts, especially in depressed roadway segments and where near surface medium dense to dense soil is present, which allows for relatively shallow excavation depths. However, depressed roadway sections are also susceptible to flooding in the event of power loss at a pump station, and the foundation soils may become waterlogged for an extended period of time. Accordingly, use of spread footings in depressed roadway sections will require careful evaluation of foundation soils to determine if they are sensitive to moisture induced settlement or volume change.

In locations with high embankment fills, and where relatively high service loads are expected, drilled shaft foundations will probably be more cost effective than large spread footing foundations.

Preliminary Recommendations for Drilled Shaft Foundations

Recommended design procedures and other preliminary considerations related to the design and construction of drilled shaft foundations are presented in this section. Final design parameters should be developed after completion of a detailed geotechnical field investigation throughout the corridor.

The axial capacity of drilled shaft foundations should be evaluated for this project using the β- and α- procedures as presented in AASHTO Standard Specifications for Highway Bridges Section 4.6.5.1 (2002). A minimum factor of safety equal to 2.5 is recommended to obtain service (design or allowable) loads from ultimate axial capacity as per AASHTO Section 4.6.5.4. An appropriate Group Reduction Factor (GRF) should also be applied to the structure service loads where drilled shaft center-to-center spacing is less than 8 shaft diameters.

Once a shaft is sized based on axial capacity considerations, a lateral load analysis should be performed. Use of the LPILEPLUS program (Reese and Wang, 1997) or a similar program is recommended for this purpose. For a group of shafts, an appropriate GRF should be applied prior to the analysis. Alternatively, the GROUP program (Reese and Wang, 1996) can be used for lateral load analysis of shafts in a group. Note that the final length for a given shaft will be the larger of the lengths required from axial and lateral load analyses. The following parameters may be used for preliminary lateral load analysis:

Table 5-13 Parameters for Lateral Load Analysis

Parameter	Preliminary Value
Soil Unit Weight	105 pcf
Soil Friction Angle	30 degrees
Soil Cohesion	0 psf
Lateral Modulus	100 pci

Additional preliminary recommendations for design and construction of drilled shaft foundations are provided below:

1. The structural engineer may make a preliminary estimate of the drilled shaft foundation configurations using the allowable axial capacity design charts provided in the URS Northern Parkway Preliminary Geotechnical and Pavement Technical Report.

2. Drilled shaft diameter should be a minimum of 3 feet, and minimum drilled shaft embedment should be 25 feet below lowest adjacent finished grade.
3. Anticipated settlement of drilled shaft foundations should be evaluated during the final design phase of each bridge structure after completion of a thorough subsurface investigation. Based on the preliminary borings performed for this study, it is estimated that drilled shaft foundations should settle by no more than ¼ inches under working loads, and that most of the settlement would be completed during construction as service loads are initially applied.
4. It is anticipated that drilling of the shafts to design depths can be accomplished with conventional, single-flight power augers. Some sloughing of the granular soils should be expected. Therefore, temporary casing may be required on site, and field concrete quantities may exceed the calculated geometric volumes. Shaft concrete should be placed immediately after drilling and cleaning of the excavation.

Preliminary Recommendations for Spread Footing Foundations

The soils encountered during the preliminary geotechnical investigation along the Northern Parkway alignment, and at the proposed traffic interchanges at SR 101L and US 60 are generally medium dense to very dense sands, and firm to hard clays, which are suitable for supporting spread footing foundations at bridge structures. Preliminary dimensions of spread footing foundations may be obtained using the maximum allowable bearing pressures shown in Table 5-14. The bearing pressures presented in Table 5-14 should be based on the equivalent uniform bearing pressure distribution per AASHTO, Standard Specifications for Highway Bridges (2002), Section 4.4.7.1.

Table 5-14 Maximum Allowable Bearing Pressure for Spread Footings at Bridge Structures

Spread Footing Depth Below Existing Grade (ft)	Maximum Allowable Uniform Bearing Pressure (psf)
0 to 10	4,000
> 10	6,500

Spread footings designed based on the allowable bearing pressures presented in Table 5-14 are anticipated to experience total settlement of less than one inch. This settlement is expected to occur rapidly during application of construction loads. Differential settlement of spread footings is expected to be less than ¾-inches.

Abutment and Retaining Walls

For preliminary abutment and retaining wall evaluation, lateral soil pressure should be estimated according to the expected degree of wall restraint, as follows:

- Unrestrained, drained walls that are free to displace a distance of at least 0.1 percent of the wall height should be designed for the active lateral earth pressure condition, represented by an equivalent fluid pressure ($\gamma\ \chi\ K_A$) of 34 pounds per square foot (psf) per foot of soil depth. For sloping backfill, the equivalent fluid pressure should be increased to 42 psf per foot for a backfill slope of 3H:1V, and should be increased to 50 psf per foot for a backfill slope of 2H:1V.
- Relatively rigid or braced walls, for which the deflection required to develop active earth pressures is not expected, should be designed for an "at-rest" earth pressure conditions, represented by an equivalent fluid pressure ($\gamma\ \chi\ K_O$) of 53 psf per foot of soil depth.

  The lateral soil pressures given do not include hydrostatic pressure, and retaining walls should be constructed with drainage system and weep holes to prevent saturation of the wall backfill.

  Live load surcharge pressure equivalent to a vertical height of two feet of earth should be applied to walls when traffic can come within a horizontal distance from the top of the wall equal to one-half its height.

  Lateral loads will be resisted by friction along the base of spread footing foundations and by passive resistance against buried foundations and foundation walls. In accordance with Section 4.4.1.4 of AASHTO Standard Specifications for Highway Bridges (2002), the passive lateral soil resistance should be neglected within the upper three feet of finished grade because of the likelihood of future disturbance. Below a depth of three feet, wall footings and shear keys may be designed assuming a passive lateral soil resistance represented by an equivalent fluid pressure ($\gamma\ \chi\ K_P$) of 360 psf per foot of depth. This value for the passive resistance assumes that the foundation element is in full contact with properly compacted backfill and that the finished grade extends horizontally beyond the footing or shear key at least two times the depth of embedment in the direction of the potential wall movement. Also note that a footing must translate as much as 0.02 times the embedded depth to develop full passive resistance. Accordingly, a factor of safety should be applied to the passive pressure to limit potential deflections.

  Wall footings cast directly on underlying soil may be preliminarily designed using a coefficient of base friction of 0.38. Footings constructed with a foundation key may be designed using a coefficient of base friction of 0.60. These values may be used in conjunction with passive pressure when evaluating lateral load resistance without reduction.

Retaining wall footings should be preliminarily designed for a maximum allowable uniform bearing pressure of 3,000 psf. The bearing pressure imposed by a wall footing should be estimated according to the equivalent uniform bearing pressure distribution per AASHTO Standard Specifications for Highway Bridges (2002) Section 4.4.7.1. The actual contact pressure distribution (i.e., trapezoidal, corresponding to the maximum toe pressure presented in ADOT Standard Detail B-18.20) should be used for structural design. The allowable bearing pressure may be increased by a maximum of 50 percent for short-term overload stresses (e.g., wind loads) in accordance with Table 3.22.1A of AASHTO (2002).

5.13.3 MSE Backfill Soil Requirements

Material used as reinforced backfill for MSE walls in the slope shall consist of suitable granular materials consisting of USCS soil types GP, GW, SW, SP, or SM meeting the gradations presented in Table 5-15 as determined in accordance with ASTM D-422. USCS soil types CL, CH, ML, MH, OL, or SC shall not be used in any portion of the reinforced slope construction. The plasticity index of the fine fraction shall be less than 7.

Table 5-15 Recommended Gradation for MSE Wall Backfill Soil

Sieve Size	Percent Passing
4 inch	100
No. 4	20-100
No. 40	0-60
No. 200	0-35

Reinforced backfill shall be placed, spread, and compacted in such a manner that minimizes the development of slack in the reinforcement. Reinforced backfill shall be placed and compacted in lifts not to exceed 6 inches where hand compaction is used, or 10 inches where heavy mechanical compaction equipment is used. Reinforced backfill shall be compacted to a minimum of 95 percent of the maximum density as determined by ASTM D 698. The moisture content of the backfill material prior to and during compaction shall be uniformly distributed throughout each layer and shall be within 2 percent of optimum moisture content.

5.13.4 Pavement Design

URS developed preliminary pavement designs for the proposed project alignment using geotechnical subgrade data generated during a limited field and laboratory investigation program, and using guidelines published by ADOT in the Preliminary Engineering and Design Manual (PEDM). These designs pertain to construction of new pavements for the project and do not address the existing pavement structure or any interim pavement rehabilitation projects that may be constructed by local jurisdictions. Several different pavement configurations were evaluated. Details of this evaluation process are included in the *URS, Northern Parkway*,

Preliminary Geotechnical and Pavement Report, submitted under a separate cover. Key points from this report are summarized below.

Preliminary Design Traffic (18-kip ESALs):

Traffic forecasts are presented in Section 2.0 of this DCR, for the existing conditions (2005), 2015, and 2030. These data were used to estimate design traffic loads for a design life of 20 years. Since Northern Parkway improvements are phased over 20 years beginning in 2010, various 20-year spans were assumed for design of the pavement sections, depending on phasing of the improvements. Vehicle classifications were based on a MAG report entitled "1992 Study of Occupancy and Vehicle Classification in the Metropolitan Phoenix Area." The Equivalent 18-kip Single Axle Loads (ESALs) computed at different segments of the project alignment are presented in Table 5-16.

The design traffic loads have been adjusted from total ESALs by applying the appropriate lane distribution according to the roadway lane configurations, as shown in Table 5-16. The two-way design traffic loads have been adjusted by a directional distribution factor of 0.6 to obtain the one-way design 18-kip ESALs.

Table 5-16 Design Traffic Loads

Location	Maximum Average Daily Traffic Volume*	Lane Distribution Factor	Design Period	Percent Heavy Trucks	Estimated Rigid One-Way 18-kip ESALs	Estimated Flexible One-Way 18-kip ESALs
Northern Parkway Mainline – Sarival to 103rd Avenue	100,400 (Two-way)	0.7	2010-2030	8.7	40,064,600	38,402,100
Northern Parkway Bypass, 103rd Avenue to 91st Avenue	94,400 (Two-way)	0.8	2020-2040	4.1	51,648,700	49,097,300
Northern Parkway Mainline, 91st Avenue to Grand Avenue	89,400 (Two-way)	0.7	2020-2040	4.1	42,065,800	39,987,800
West Northern Parkway Service Interchange Ramps	8,100 (One-way)	1.0	2010-2030	4.1	5,739,010	5,455,600
East Northern Parkway Service Interchange Ramps	11,900 (One-way)	1.0	2020-2040	4.1	12,479,300	11,862,9001
Northern Avenue	51,700 (Two-way)	0.7	2015-2035	2.3	11,018,200	11,389,500
Northern Parkway/US 60 TI Ramps	14,300 (Two-way)	1.0	2020-2040	4.1	8,998,400	8,553,900

* Maximum ADT Volumes for Year 2030.

Preliminary Design R-value

Limited field investigations provided an assessment of the subgrade along the proposed alignment for the Northern Parkway. Sieve analyses and Atterberg Limits tests were performed on bulk samples collected from these borings. These data were used to estimate R-values based on guidelines provided in the PEDM.

The correlated R-values ranged from 19 to 49. However a design R-value of 20 was utilized for the preliminary evaluation of pavement structures at or below existing grade, to account for the potential presence of poor subgrade soils and per ADOT policy.

The soils that exhibit R-values of less than 20 provide poor subgrade support. Further, these soils, may be expansive under some moisture and loading conditions, and may be corrosive to ferrous metals. Therefore, these soils could necessitate the utilization of reinforcement using geogrids or geosynthetics and/or comprehensive earthwork operations including but not limited to over excavation and/or remove and replace. It is recommended that a detailed geotechnical evaluation consisting of subsurface exploration and laboratory testing, be conducted to better evaluate and delineate poor subgrade soils.

Additional Pavement Design Parameters

The preliminary pavement design presented herein was performed in general accordance with PEDM pavement design procedures using the previously discussed traffic loads and subgrade R-value as input parameters. The following additional pavement design parameters were used to develop pavement structural sections. Consideration was given to non-reinforced and jointed reinforced Portland Cement Concrete Pavement (PCCP) for the various locations throughout the Northern Parkway corridor.

- Pavement Design Life = 20 years
- Reliability (Z_R) = -2.327 for a level of reliability of 99 percent
- Combined Standard Error of the traffic prediction and performance prediction (S_0) = 0.25 for rigid pavements and 0.35 for flexible pavements, in accordance with current ADOT practice
- Initial Design Serviceability Index (P_O) = 4.2, as determined from Table 202.02-2 of the PEDM
- Design Terminal Serviceability Index (Pt) = 3.0, as determined from Table 202.02-2 of the PEDM
- $\Delta PSI = P_O - Pt = 1.2$
- Seasonal Variation Factor for the project area = 1.0

- Resilient modulus = 12,000 psi, as derived from the design R-value of 20
- Loss of support = 0
- Average modulus of rupture for Portland cement concrete (PCC) (S'_C) = 670 psi, compressive strength of PCC (f'_C) = 5,000 psi, and modulus of elasticity of PCC (E_C) = 4,000,000 psi
- Modulus of Subgrade Reaction (k) = 619 pci as derived from Table 202.03-2 and Figures 202.03-1 of the PEDM
- Load Transfer Coefficient (J) = 3.9 for plain jointed PCCP and 2.8 for jointed reinforced (doweled) PCCP according to Table 202.03-1 of the PEDM

Preliminary Rigid Pavement Structural Sections

A summary of the recommended pavement sections for the various roadway elements is presented in Table 5-17.

Table 5-17 Preliminary Rigid Pavement Structural Sections

Roadway Element	Plain Jointed PCCP (inches)	Joint Reinforced (Dowels) PCCP (inches)	Aggregate Base (AB) (inches)
Northern Parkway Mainline – Sarival to 103rd Avenue	–	12.5	4
Northern Parkway Bypass – 103rd Avenue to 91st Avenue	–	13	4
Northern Parkway Mainline – 91st Avenue to Grand Avenue	–	12.5	4
West Northern Parkway Service TI Ramps	11	–	4
East Northern Parkway Service TI Ramps	12	–	4
Northern Avenue	–	10	4
Northern Parkway/US 60 TI Ramps	11.5	–	4

We recommend using AC (base mix) in lieu of AB in depressed locations for the rigid pavements constructed for this project.

Preliminary Flexible Pavement Structural Sections

If flexible pavements are used, the preliminary pavement structural sections shown in Table 5-18 are recommended. The structural thicknesses presented in the table were computed using structural coefficients of 0.44 and 0.14 for asphaltic concrete and aggregate base, respectively and an R-value of 20. During final design, actual R-values may result in slightly thinner pavement structural sections.

Table 5-18 Preliminary Flexible Pavement Structural Sections

Roadway Element	Asphaltic Concrete (inches)	Aggregate Base (Class 2) (inches)
Northern Parkway Mainline – Sarival to 103rd Avenue	11	10
Northern Parkway Bypass – 103rd Avenue to 91st Avenue	12	8
Northern Parkway Mainline – 91st Avenue to Grand Avenue	11	10
West Northern Parkway Service TI Ramps	8	8
East Northern Parkway Service TI Ramps	9	9
Northern Avenue	9	9
Northern Parkway/US 60 TI Ramps	9	8

Recommended Pavement Structure – Sarival to 115th Avenue

It is recommended that the pavement sections for Northern Parkway from Sarival to 115th Avenue are as shown in Table 5-19. Concrete was selected for this segment since it is completely accessed controlled, no utilities, minimal maintenance opportunities, and high volumes of traffic including a high percentage of trucks.

Table 5-19 Recommended Pavement Structure – Sarival to 115th Avenue

Roadway Element	Plain Jointed PCCP (inches)	Joint Reinforced PCCP (inches)	Aggregate Base (Class 2) (inches)
Northern Parkway Mainline		12.5	4
Service TI Ramps	11	-	4

Recommended Pavement Structure – 115th Avenue to Grand Avenue

Asphalt concrete pavement was selected for the mainline segments from 115th to 103rd avenues and from 91st to Grand avenues due to the presence of underground utilities. An additional 1-inch surface course of rubberized asphalt concrete friction course (ARFC) is recommended for noise mitigation purposes. The ramps for service TIs in these areas will also consist of the asphalt concrete pavement.

The bypass section between 103rd Avenue and 91st Avenue should be joint reinforced PCCP due to this segment being fully access controlled with no utilities. The AB in the depressed section at 103rd Avenue should be replaced with Asphaltic concrete.

The recommendation for Northern Avenue is asphalt concrete due to the presence of underground utilities.

The Grand Avenue flyover recommendation is PCCP since it is an access controlled segment and maintenance would be difficult. Grand Avenue pavement section would match the existing pavement on Grand Avenue.

Table 5-20 Recommended Pavement Structure –115th Avenue to Grand (US 60)

Roadway Element	ARFC (inches)	Asphaltic Concrete (inches)	Plain Jointed PCCP (inches)	Joint Reinforced PCCP (inches)	Aggregate Base (Class 2) (inches)
Northern Parkway Mainline (115th to 103rd)	1	11		-	10
Northern Parkway Mainline (91st to Grand)	1	11		-	10
Service TI Ramps	-	9		-	9
Northern Parkway (Bypass) (103rd to 91st)	-	-		13	4
Northern Avenue	-	9		-	9
Grand Avenue Flyover	-	-	11.5	-	4
Grand Avenue	-	9	-	-	10

Assumed Pavement Sections

Table 5-21 contains assumed pavement sections where pavement design calculations have not been performed. The pavement sections for the intersecting arterial streets and neighborhood connector streets will be determined in final design. The 9-inch PCCP pavement structure for Northern Avenue at Loop 101 is existing and will be matched as the pavement is widened.

Table 5-21 Assumed Pavement Sections

Description	Surface Treatment	Paving	Base
Intersecting Arterials	–	6" AC	10" ABC
Northern Avenue at Loop 101	–	9" PCCP	5" AC base
Neighborhood Connector Streets	–	3" AC	6" ABC

5.13.5 Earthwork

Significant earthwork is expected for the final configuration of the project due to the presence of several elevated grade separation intersection structures for Northern Parkway. The preliminary geotechnical data from this investigation was evaluated to estimate earthwork factors. A shrinkage factor of about 10 to 20 percent can be utilized for this project. A ground compaction factor of 0.2 feet shall be compensated for on embankment sections. Based on preliminary estimation, the project will need to borrow about 2.4 million CY of material. FCDMC has indicated that the construction of the Reems Road Channel will generate about 0.5 million CY of waste material which will be available for Northern Parkway per IGA. A total of 3.3 million CY of waste may be generated from Loop 303 construction from I-10 to US 60/ Grand. A portion of this material may be available for Northern Parkway as well. In addition, the channelization of the Agua Fria River may generate about 400,000 CY of excess material.

5.13.6 Slope Design

Temporary slopes less than 20 feet deep should be excavated in accordance with OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926, Subpart P. In accordance with these standards, undisturbed native soils and existing fill should be considered "Type C" soils for preliminary evaluation, and excavations that are less than 20 feet deep should be constructed at maximum allowable unshored slopes of 1.5H:1V in these soils. Should steeper slopes be required due to the proximity of existing structures or other obstruction, a geotechnical engineer should evaluate the stability of the required slope by further testing and classifying the soils.

Heavy excavation equipment should be maintained at least ten feet away from the edge of any excavation, and the perimeter of all temporary excavations should be protected against surface water runoff to prevent raveling and erosion into the excavation.

Unprotected permanent cut and fill slopes should be constructed no steeper than 3H:1V. Permanent cut and fill slopes protected by erosion control measures, such as through the establishment of vegetative cover, can be constructed as steep as 2H:1V and 2.5H:1V, respectively.

5.13.7 Channel Design

Earthwork for open channels should be performed in accordance with Section 215 of the MAG Uniform Standard Specifications for Public Works Construction. Near-surface soils encountered during the geotechnical investigation performed for this phase of the project were typically medium dense to dense sands and firm to hard clays. For preliminary evaluation, it may be assumed that channel excavations could be made so as to place concrete directly against the excavated surfaces provided that maximum unsupported side slopes of 2H:1V are constructed. It is anticipated that excavation along the project corridor will be accomplished with conventional equipment based on the soil conditions encountered.

Channel joints should be constructed so that they are water tight to prevent potential soil volume changes due to increased moisture content. To evaluate the potential for moisture induced soil volume change the following geotechnical laboratory testing procedures are recommended during the design phase:

- Collect relatively undisturbed near-surface soil samples and perform response to wetting tests (hydro consolidation) tests to evaluate volume change characteristics for the channel subgrade soils.
- Laboratory testing should be performed to determine the dispersive characteristics of clayey soils encountered along channel alignments.

5.13.8 Special Geotechnical Engineering Issues and Goals

The proposed Northern Parkway alignment traverses an area of known and documented ground subsidence and earth fissuring. In fact, the greatest measured ground subsidence in Arizona (approximately 18 feet between 1957 and 1991) has been documented at Luke AFB, located 0.5 mile south of the project alignment between Litchfield Road and 0.5 mile west of Reems Road. The proposed Northern Parkway alignment crosses the Luke AFB subsidence "bowl" or "trough." Furthermore, a documented earth fissure exists between El Mirage Road and Dysart Road extending from Glendale Avenue to the north side of Northern Avenue.

In light of the documented ground subsidence and earth fissures in the vicinity of Northern Parkway, a preliminary assessment of these geologic phenomena was performed. The scope of work within this DCR was limited to a review of published information on ground subsidence and fissuring that could potentially impact the proposed construction. A summary of discussions and preliminary recommendations related to ground subsidence and earth fissures is provided below. Additional details are included in the *Northern Parkway*, *Preliminary Geotechnical and Pavement Report* to be submitted under a separate cover.

The project alignment is located in the West Salt River Valley. This is an area of known groundwater decline and associated ground subsidence and earth fissuring. In 1995, the United States Geologic Survey (USGS) in cooperation with the United States Air Force published an administrative report entitled *Investigation of Hydrogeology, Land Subsidence, and Earth Fissures, Luke Air Force Base, Arizona* (Study), by Herbert H. Schumann and Christie M. O'Day of the USGS. This report provides a comprehensive description of the hydrogeology and ground subsidence issues around Luke AFB. The following paragraphs related to ground subsidence and earth fissuring in the vicinity of the Northern Parkway alignment were largely summarized from the above-mentioned reference.

The Study indicates that between 1952 and 1977, groundwater levels in the vicinity of Luke AFB declined by as much as 300 feet. Between 1976 and 1983, the groundwater decline was generally arrested, and water levels rose by as much as 50 feet in some wells. However, the water levels remained well below their highs prior to large-scale pumping, and groundwater levels measured in 1991 were approximated those measured in 1977. The overall decline in groundwater levels has resulted in ground subsidence and the development of earth fissures.

Figure 5-4 is taken from the report by Schumann and O'Day discussed earlier in this section. The figure shows estimates of ground subsidence between 1957 and 1991. These estimates were made by comparing elevation data from historic topographic quadrangles published by the USGS. Figure 5-4 shows that the maximum ground subsidence estimated for the area is approximately 18 feet and was measured at the intersection of Olive Avenue and Reems Road,

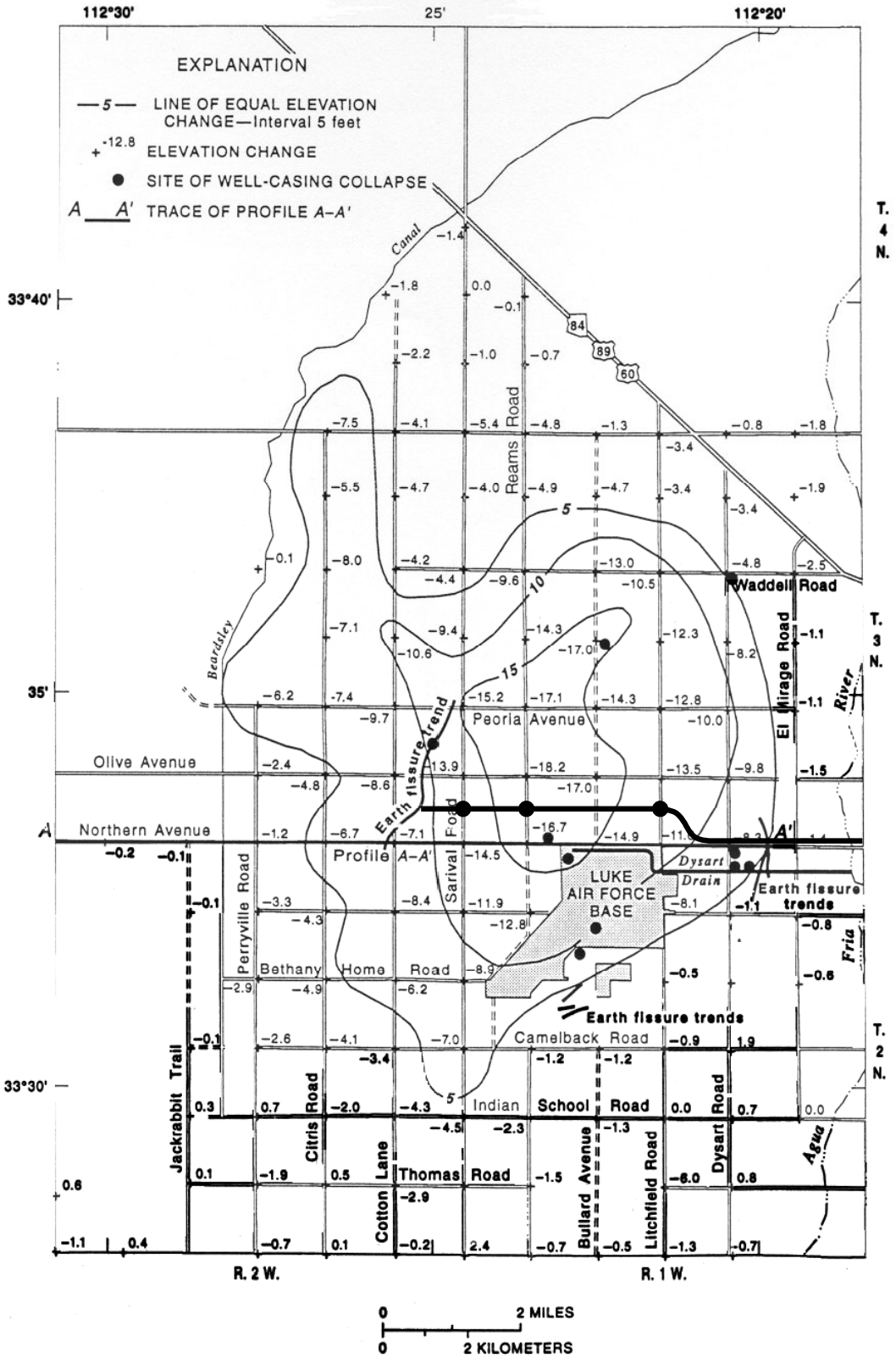
approximately 0.5 mile north of the Northern Parkway alignment. This is the highest ground subsidence recorded in Arizona.

Figure 5-4 also depicts three zones of documented fissuring. The first zone is located east of Luke AFB along Northern Avenue between Dysart Road and El Mirage Road; a second zone is north of Camelback Road due south of Luke AFB; and a third zone is along Olive Avenue between Sarival Avenue and Cotton Lane. The first zone discussed above directly impacts the Northern Parkway alignment. The final design phase should include a thorough assessment of the alignment for potential zones of fissuring. This is particularly critical because several grade separation structures are planned for different intersections along the project corridor.

Recommended Future Activities

The analysis for this DCR was limited to general discussions on ground subsidence and earth fissuring along the Northern Parkway alignment, based on published information. As discussed in the preceding paragraphs of this section, the alignment for Northern Parkway is located within a zone of significant, documented ground subsidence and earth fissuring. Careful and detailed assessment of these two geologic hazards and their impacts on the development of the proposed project should be a critical component of the final design phase. The final design phase of the project should include (but not be limited to) the following components:

- Obtain groundwater level information and prepare well hydrographs to assess groundwater trends post-1991.
- Evaluate estimates of future population growth in area and assess to the extent practical, the impact of projected water demand on future subsidence and earth fissure development.
- Contact and obtain (where possible) additional benchmark survey data in the project area in order to develop more realistic estimates of projected ground subsidence.
- Obtain and examine interferograms to assess magnitudes and patterns of subsidence along the alignment. The FCDMC is using this technique extensively to evaluate subsidence at flood control dams in the County.
- Examine aerial photographs to identify and study fissures in the area.
- Perform a detailed site reconnaissance to identify earth fissures.
- Perform low-sun angle aerial photography and attempt to identify fissure traces.
- Perform soil-structure interaction studies to evaluate the impact of ground subsidence and earth fissuring on the proposed construction.



Reference: Base map from U.S. Department of the Interior, U.S.G.S., Administrative Report; Investigation of Hydrogeology, Land Subsidence, and Earth Fissures, Luke Air Force Base, Arizona, 1995.

FIGURE 5-4
LAND SUBSIDENCE IN PART OF THE WESTERN SALT RIVER VALLEY, 1957-1991

5.14 CONSTRUCTABILITY AND TRAFFIC CONTROL

Implementation of the Northern Parkway concept as described in this DCR and as shown in the concept plans in Volume 2 are planned to be phased over the 20-year MAG RTP program and some features may be constructed after the 20-year plan. The improvements included the current plan through 2025 are summarized in Appendix C.

5.14.1 Loop 303 to Dysart Road

The initial construction for Northern Parkway will occur between Sarival Avenue and Dysart Road. This initial construction will consist of at-grade features in their ultimate location including the outside two lanes plus auxiliary lanes in each direction, GSI ramps, BNSF Webb Spur overpass, ultimate right-of-way, ultimate drainage facilities, and traffic signals at Sarival Avenue, Reems Road, and Litchfield Road. Construction of these improvements may begin as early as 2011 and be complete by 2012.

Construction of these improvements and the associated traffic control is anticipated to be fairly simple since Northern Parkway is on an entirely new alignment in this segment of the parkway. Cross street through traffic on Sarival Avenue, and Reems Road, will be maintained during the construction of the new intersections with Northern Parkway and installation of the traffic signals.

Construction of the new Litchfield Road at-grade intersection is more complicated. Litchfield Road must be lowered approximately 10 feet to accommodate the future overpass on Northern Parkway per Luke AFB requirements. A detour road will be constructed to maintain traffic during the construction of Litchfield Road. Then the depressed ramp roadways will be constructed forming new depressed intersections with Litchfield Road.

Transition from the ultimate outside lane construction to the existing Northern Avenue west of Dysart Road is complicated by the presence of traffic on Northern Avenue. Interim thruway construction of two lanes in each direction will match the existing widened signalized intersection of Northern Avenue and Dysart Road. The existing Northern Avenue connection from Dysart Road to Litchfield Road will be terminated and replaced with Northern Parkway. These improvements would probably need to occur on one side of Northern Avenue at a time to maintain traffic.

Construction of the third lane in each direction to complete the ultimate concept would occur after 2025 unless additional funding sources are identified. The widening and installation of the concrete median barrier would occur in the median and require using a portion of the outside shoulder to shift traffic slightly away from construction activities.

Sarival Avenue Overpass:

The construction of the Sarival overpass and approach roadway will need to coincide with the construction of the Loop 303/Northern Parkway system interchange due to its proximity to Loop 303 and since the overpass would serve no purpose without the connection to Loop 303. The Loop 303/Northern Parkway system interchange is part of the Loop 303 project scheduled for Phase II of the MAG RTP (2011-2015). Transition from the ultimate Loop 303 interchange to the interim four-lane Northern Parkway would need be accomplished in the vicinity of Sarival Avenue and will require extensive coordination with ADOT.

Construction of the ultimate Sarival Avenue bridge structure (2-span pre-cast I-girder) and parkway would have impacts to traffic on Sarival Avenue. Construction will have to take place over traffic. The bridge could be constructed one-half at a time with several shifts in traffic and/or require minor closures during critical construction operations.

Reems Road Overpass:

Construction of the overpass and approach roadways at Reems Road should not present too many challenges. The ultimate bridge structure would be installed but striped for only two lanes in each direction. The FCDMC Reems Road Channel and box culvert are complete. The Reems Road South channel box culvert north of Northern Avenue (see concept plan sheet D70) can be constructed one-half at a time to keep Reems Road open. When the 2-span pre-cast I-girder structure is constructed, minor nighttime closures would be required during critical phases. Construction of the Reems Road overpass and approach roadways is anticipated in 2014.

Litchfield Road Overpass:

The construction of the Litchfield Road GSI is somewhat complicated. Due to its proximity to Luke AFB and its location within Accident Potential Zone 1 (APZ 1) for both runways, Luke AFB and Federal Aviation Administration (FAA) approval must be obtained. FAA Form 7460, Notice of Proposed Construction or Alteration must be completed and submitted to the FAA. The ultimate overpass structure would be constructed but striped for two lanes in each direction. Construction of the 2-span cast-in-place box girder bridge will have to take place over traffic. Falsework openings with a minimum vertical clearance of 14.5 feet per ADOT standards will provide two lanes of traffic in each direction. Construction of the Litchfield Road overpass and approach roadways is anticipated for 2015.

5.14.2 Dysart Road to 111th Avenue

Construction in this segment begins with the construction of the 2-lane eastbound frontage road, eastbound off-ramp at Dysart Road, and eastbound on-ramp at El Mirage Road. A temporary 2-lane road would transition from the El Mirage eastbound on-ramp across the Agua Fria River

to the ultimate eastbound Northern Parkway roadway (four lanes) to 112th Avenue where the existing Northern Avenue is 4-lanes (FY 2013). The existing Northern Avenue would be converted for westbound traffic. The new eastbound frontage road and ramps combined with the existing Northern Avenue pavement would provide four lanes for through traffic. At the completion of these improvements, four through traffic lanes would be provided from Sarival Avenue to US 60 (Grand Avenue).

Traffic can be maintained on the existing Northern Avenue while the eastbound frontage road and ramps are constructed south of the Northern Avenue. Construction of the ultimate eastbound Northern Parkway west of 112th Avenue would require the removal of the existing Northern Avenue. The new pavement may need to be constructed one lane at a time to maintain traffic on the existing roadway prior to removing the old pavement.

Following the construction of the eastbound frontage road and ramps, Northern Parkway mainline improvements would be constructed from Dysart Road to the Agua Fria River Bridge. These improvements include the outside two lanes and auxiliary lane in each direction, ultimate overpass structures at Dysart Road and El Mirage Road, westbound ramps at Dysart and El Mirage roads, westbound frontage road from Dysart to El Mirage roads, connector streets at 127th Avenue and Butler Drive, and one half of the Agua Fria River Bridge. Constructing these improvements from Dysart Road to 111th Avenue would be completed by 2020.

Construction of the third lane in each direction to complete the ultimate concept would occur after 2025 unless additional funding sources are identified. The widening and installation of the concrete median barrier would occur in the median and require using a portion of the outside shoulder to shift traffic slightly away from construction activities.

Dysart Road Overpass

Construction of the single span cast-in-place bridge structure at Dysart Road will require construction over traffic with falsework openings as required by ADOT standards.

El Mirage Road Overpass

Similarly, the construction of the El Mirage Road structure (single span cast-in-place box girder) will be accomplished under traffic conditions with falsework opening to maintain two lanes of traffic.

Agua Fria River Bridge

The construction of the Agua Fria River bridge is dependent on the Agua Fria River channelization in accordance with the adopted watercourse master plan. This construction should have little impact on Northern Avenue traffic since it will be located south of the existing roadway.

5.14.3 111th Avenue to Loop 101

Improvements in this segment would include widening Northern Parkway to its ultimate configuration from 111th Avenue to 103rd Avenue (three lanes plus auxiliary lane in each direction), constructing the west ramps at 103rd Avenue, constructing the new eastbound Northern Avenue roadway from 103rd Avenue to 99th Avenue, widening Northern Avenue to six lanes and dual lefts from 99th Avenue to the east ramps for Loop 101, and tapers east of the Loop 101 to match existing Northern Avenue. This project segment also includes the connector streets of Royal Palm Road—111th Lane to 111th Avenue, Royal Palm Road—108th Drive to 107th Avenue, Augusta Avenue—west of 107th Avenue, and Orangewood Avenue—107th Avenue to Glen Harbor Boulevard. It is anticipated that these improvements would be completed by 2024.

Construction of the Northern Parkway bypass to complete the ultimate concept would occur after 2025 unless additional funding sources are identified.

111th Avenue to 107th Avenue

Construction in this segment would begin with the connector streets. This will maximize the alternative routes available to the neighborhoods during construction along Northern Avenue. Construction along Northern Avenue between 111th and 107th avenues would begin on the north side with traffic maintained on the existing Northern Avenue pavement. Upon completion of the north half of Northern Parkway, traffic would switch to the north half while the south half is reconstructed.

107th Avenue to 103rd Avenue

Between 107th and 103rd avenues the construction sequence would be opposite with the south half construction occurring first followed by the north half. Construction of the eastbound off-ramp at 103rd Avenue would occur when the south half is constructed while the westbound on-ramp would be constructed when the north half of the parkway is constructed. Additional temporary pavement would need to be installed to maintain three lanes of traffic on the ramps where the ultimate configuration is one-lane ramps. The 103rd Avenue GSI and Northern Parkway bypass road would be constructed during a latter phase.

103rd Avenue to Loop 101

The new eastbound Northern Avenue roadway and New River Bridge would be constructed between 103rd Avenue and 99th Avenue while traffic is maintained on the existing Northern Avenue. Traffic will then utilize the new roadway while the existing roadway is reconstructed.

Between 99th Avenue and Loop 101, widening will occur on both sides of the existing Northern Parkway and can take place simultaneously under traffic conditions.

Northern Parkway Bypass

The Northern Parkway Bypass would need to be constructed at one time from 103rd Avenue to 91st Avenue. These improvements include three lanes plus auxiliary lane in each direction; grade separations at 103rd Avenue, eastbound Northern Avenue, 99th Avenue, 97th Avenue, Loop 101 SB on-ramp, Loop 101 mainline, Loop 101 NB off-ramp, eastbound Northern Avenue, 93rd Avenue and 91st Avenue, and a bridge over the New River.

Since the alignment of the bypass is separated from Northern Avenue, east-west traffic can be maintained on eastbound and westbound Northern Avenue during construction of the parkway bypass. Pre-cast I girders are planned for 103rd Avenue, eastbound Northern Avenue, 99th Avenue, 97th Avenue, Loop 101 mainline, and Loop 101 NB off-ramp. Construction over these cross streets can be accomplish with just minor night time closures. Overpasses at eastbound Northern Avenue (east of Loop 101), 93rd Avenue, and 91st Avenue are cast-in-place and will require falsework construction and ADOT clearance requirements.

5.14.4 Loop 101 to Grand Avenue

The existing Northern Avenue from Loop 101 to 91st Avenue would be widened to three lanes in each direction temporarily by 2025. In addition, temporary throwaway intersection improvements would be constructed at 91st, 83rd, 75th, and Grand avenues by 2025. Construction of these improvements under traffic conditions would require significant traffic control measures.

Constructing the ultimate improvements from Loop 101 to Grand Avenue is complicated due to the more developed character of the area. Construction of these improvements would occur after 2025. Improvements to intersecting arterials and neighborhood access streets would be constructed prior to improvements in adjacent segments of Northern Parkway to provide additional access and travel options for the traveling public during construction. This will help minimize traffic in the construction zones on Northern Parkway. Maintaining access to homes, businesses, and streets will be required.

Loop 101 to 87th Avenue

The eastbound Northern Avenue roadway from Loop 101 to 91st Avenue and the eastbound 91st Avenue on-ramp would be constructed while maintaining traffic on the existing Northern Avenue. Once the eastbound roadway and ramp open for traffic, modifications to the existing Northern Avenue would be made to make it the westbound Northern Avenue roadway and westbound off ramp at 91st Avenue. The 93rd Avenue and 91st Avenue SPUI intersections would

be constructed without the elevated bypass bridge structures. The bypass structures would be constructed with the bypass roadway.

87th Avenue to 79th Avenue

The north one-half of Northern Parkway and the north ramps at 83rd Avenue (westbound-on and westbound-off) would be constructed first while maintaining traffic on Northern Avenue. Westbound traffic would then be shifted to the north half and north ramps. Widening on the south side and the south ramps (eastbound-on and eastbound-off) would be constructed next and eastbound traffic would then use these south roadway improvements. The 83rd Avenue bridge and approach roadways could then be constructed. Construction of the single-span cast-in-place bridge structure would occur over traffic with openings in the falsework as required by ADOT maintaining two lanes of traffic in each direction.

79th Avenue to 71st Avenue

Construction of improvements in this segment would be similar to the previous segment except north side and south side improvements could occur simultaneously since the improvements are symmetric about the existing Northern Avenue centerline.

71st Avenue to Grand Avenue

East of 71st Avenue the eastbound Northern Avenue roadway would be constructed first to Grand Avenue. At the same time, Northern Avenue east of Grand would be widened to the south. Widening to the north of the existing Northern Avenue would occur when eastbound traffic is moved to the new eastbound roadway. Grand Avenue NWB roadway would be constructed at the same time. Then the flyover approaches and bridge would be constructed. Eastbound Northern traffic and SEB Grand Avenue traffic would need to be diverted to the westbound roadway and SEB Grand traffic would need to share the NWB roadway during critical bridge construction activities over these roadways.

5.14.5 Construction Staging Areas

Construction staging areas have not been specifically identified along the corridor; however, there are locations along the corridor where the entire parcel has been identified for acquisition due to the severity of the anticipated impact to the property. The entire parcel will not be required for roadway right-of-way. The excess property could be used for construction staging activities and then sold to the public after the construction is complete. The largest areas of excess property are located on the south side of Northern Avenue and east of El Mirage Road, and along the east side Grand Avenue south of Northern. Staging areas cannot be adjacent to residential properties.