Airfield Safety Enhancement Implementation Study
Tucson International Airport

Final Report
May 2015

HNTB

TUCSON INTERNATIONAL AIRPORT
TUCSON AIRPORT AUTHORITY

Table of Contents

List of Figures

List of Tables

1.0 Introduction / Study Background

1.1 Airport Description

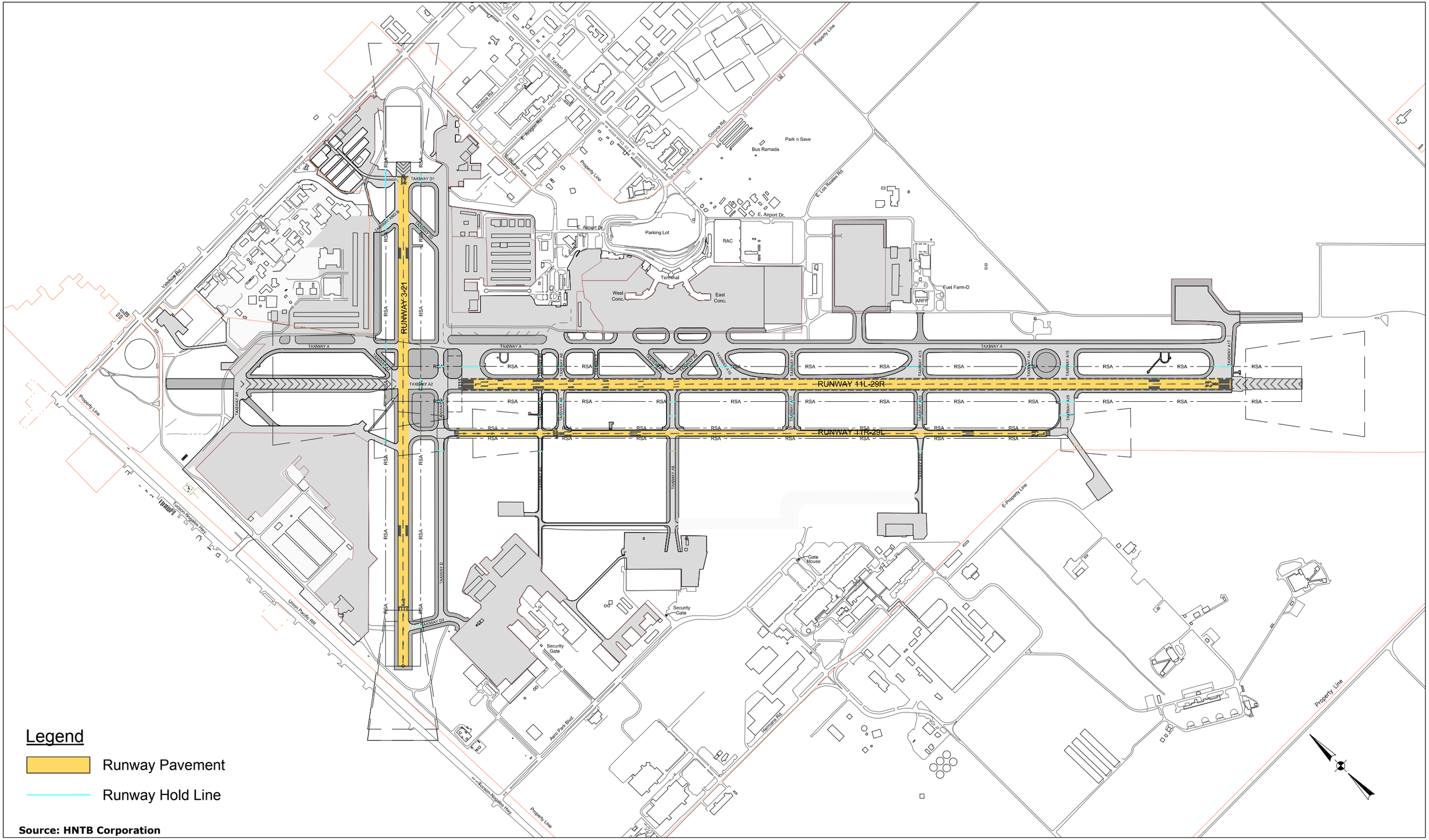
Tucson International Airport (TUS) is a Federal Aviation Regulations (FAR) Part 139 certificated commercial service international airport. The Airport is owned and operated by the Tucson Airport Authority (TAA) and serves Tucson, Pima County and Southern Arizona. It is the second busiest commercial airport in Arizona. TUS is home to a very diverse fleet mix including air-carrier, light general aviation, larger corporate general aviation, helicopters, cargo, and the 162nd Fighter Wing of the Arizona Air National Guard (AANG). Additionally TUS regularly accommodates transient military aircraft, flight training aircraft (of all sizes), and transient General Aviation aircraft.

1.1.1 Existing Airfield Overview

TUS operates three runways **(Figure 1-1)**, Runways 11L-29R, 11R-29L, and 3-21. The two parallel Runways 11L-29R and 11R-29L measure 10,996 feet long by 150 feet wide and 8,408 feet long by 75 feet wide, respectively, with a centerline to centerline separation of 706 feet. Runway 11R has a displaced arrivals threshold of 1,410 feet, resulting in an available landing length of 6,998 feet. Runway 11L-29R is the primary runway and is generally used by commercial air-carrier service, cargo, and military operations. Runway 11R-29L is used primarily for smaller general aviation aircraft. The third, a crosswind runway runs perpendicular to, but does not intersect the two parallel runways and measures 7,000 feet long by 150 feet wide. It is used by all aircraft when wind and weather conditions dictate. The Runway 3 arrivals threshold is displaced by 840 feet resulting in an available landing length of 6,160 feet. TUS's existing Airport Reference Code (ARC) is D-IV, with individual Runway Reference Codes (RRC) of D-IV for Runway 11L-29R, B-II for Runway 11R-29L, and C-III for Runway 3-21.

1.2 History of the Runway Program

In October 2007, the Federal Aviation Administration (FAA) adopted the International Civil Aviation Organization (ICAO) definition of runway incursions, changing its definition of incursions. As a result, incidents without an aircraft in potential conflict (e.g. an aircraft crossing an empty runway without clearance) which were previously classified as surface incidents became classified as a Category C or D runway incursions. As a result, the reported number of incursions at TUS increased, and beginning in 2008, TAA reported an increase in safety concerns. At that time, the FAA began to identify Hot Spots which are locations on an airport movement area with a history of potential risk of collision or runway incursion, and where heightened attention by pilots and drivers is necessary. To address the increased safety concerns and reported incursions, TAA commissioned the Airfield Safety Enhancement (ASE) Study in 2011 to analyze, categorize, and recommend mitigations of perceived safety deficiencies.



Legend

- Runway Pavement
- Runway Hold Line

Source: HNTB Corporation

TUCSON INTERNATIONAL AIRPORT
TUCSON AIRPORT AUTHORITY

Airfield Safety Enhancement Implementation Study

Drawing Scale: 1" = 1,250'

Existing Runway Configuration

Figure
1-1

While there were four FAA identified Hot Spots (there are only two currently as a result of implementation of recommended mitigations), incursions were reported at 16 distinct locations on the airfield. The ASE study was completed in 2012 and recommended near term operational and safety enhancing geometric improvements to the airfield, as well as a longer term redevelopment of the airfield which included aligning the end of Runway 29L with Runway 29R to address runway misidentification issues and providing a center parallel taxiway to provide a place for aircraft to turn off of Runway 11R-29L before proceeding across Runway 11L-29R. Several of the near-term 2012 ASE Study recommendations were implemented following completion of the study and are described below.

In 2014, TAA completed the most recent Airport Master Plan Update which further analyzed enhancements recommended in the ASE Study that had not yet been implemented. The Master Plan Update focused extensively on geometric design options for achieving the planned near parallel runway benefits described in the ASE Study. The resultant preferred runway program, relocation of Runway 11R-29L and construction of a center parallel taxiway, incorporates the runway and taxiway safety elements identified in the ASE Study as well as additional safety elements developed through the master planning process.

1.3 2012 Airfield Safety Enhancement Study

In 2012, TAA completed the ASE Study which comprehensively reviewed TUS's airfield geometry with the goal of reducing airfield incursions and improving overall safety. The ASE Study utilized a modified Safety Management System (SMS) / Safety Risk Management (SRM) approach in evaluating and prioritizing potential airfield enhancements. The ASE Study recommended a number of changes to the existing airfield geometry to address FAA identified Hot Spots along with areas with a high number of incursions. At the onset of the study there were four FAA identified Hot Spots and incursions were reported at 16 distinct locations on the airfield (**Figure 1-2**). The four FAA identified Hot Spots prior to implementation of ASE were located as follows:

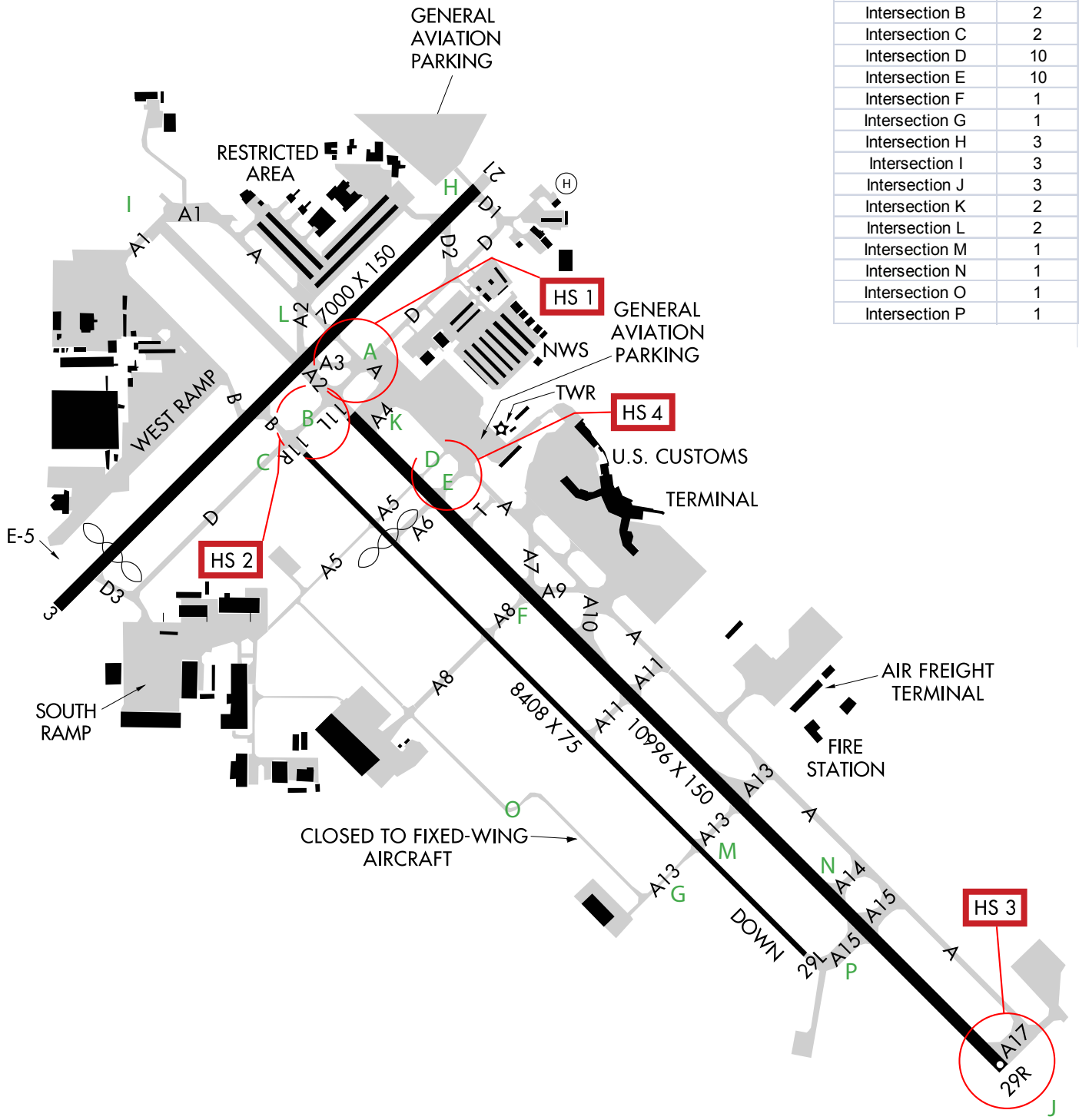
Hot Spot 1: This Hot Spot was located at the intersection of Taxiway A3, Taxiway A, and Taxiway D. At this location Taxiway A3 intersects Taxiway A and Taxiway D at an angle causing pilots to occasionally turn onto the incorrect taxiway.

Hot Spot 2: This Hot Spot was located along Taxiway D between with Runway 11L-29R and Runway 11R-29L. At this location pilots taxiing along Taxiway D have crossed the approach path for Runway 11L-29R or Runway 11R-29L without clearance.

Hot Spot 3: This Hot Spot is located at end of Runway 29R and represents the confusion between Runways 29L and 29R and Runway 29R and Taxiway A. On several occasions pilots on approach during west flow have mistaken Runway 29R for Runway 29L and Taxiway A for Runway 29R, landing on the wrong runway or on Taxiway A. Recently a visiting F-16 performed a touch-and-go on Taxiway A.

Hot Spot 4: This Hot Spot was located at Taxiways A5 and A6 between Taxiway A and Runway 11L-29R. At these intersections pilots have entered Runway 11L-29R without clearance.

Incidents by Intersection	
Intersection A	11
Intersection B	2
Intersection C	2
Intersection D	10
Intersection E	10
Intersection F	1
Intersection G	1
Intersection H	3
Intersection I	3
Intersection J	3
Intersection K	2
Intersection L	2
Intersection M	1
Intersection N	1
Intersection O	1
Intersection P	1



B Intersection ID

HS 1 FAA Identified Hotspot

2010 FAA Identified Hot Spots

TUCSON INTERNATIONAL AIRPORT
TUCSON AIRPORT AUTHORITY

Airfield Safety Enhancement Implementation Study

Drawing Scale: Not to Scale

Figure 1-2

A summary of the number and locations of incidents on the airfield that were recorded by Runway Safety Action Team (RSAT) between November 2005 and November 2010 is also shown on **Figure 1-2**. The highest number of incidents (eleven) occurred at intersection A, which is also Hot Spot 1, and intersections D and E (ten [10] each), which is also Hot Spot 4. While fewer incidents occurred at Hot Spots 2 (four [4] incidents at intersections B and C), and Hot Spot 3 (three [3] incidents at intersection J), the potential for severity is high.

To address these Hot Spots and high incident locations, the recommendations of the ASE study included airfield geometry mitigation strategies generally designed to enhance safety and operational efficiency and to promote three clear goals:

- Minimize or eliminate general aviation (GA) aircraft from accessing Runway 11R-29L by crossing Runway 11L-29R
- Minimize the potential for pilots approaching from the south to misidentify the left and right parallel runways
- Enhance awareness of the interaction between Taxiway D and Runways 11R and 11L

1.3.1 Near-Term Implementation Recommendations

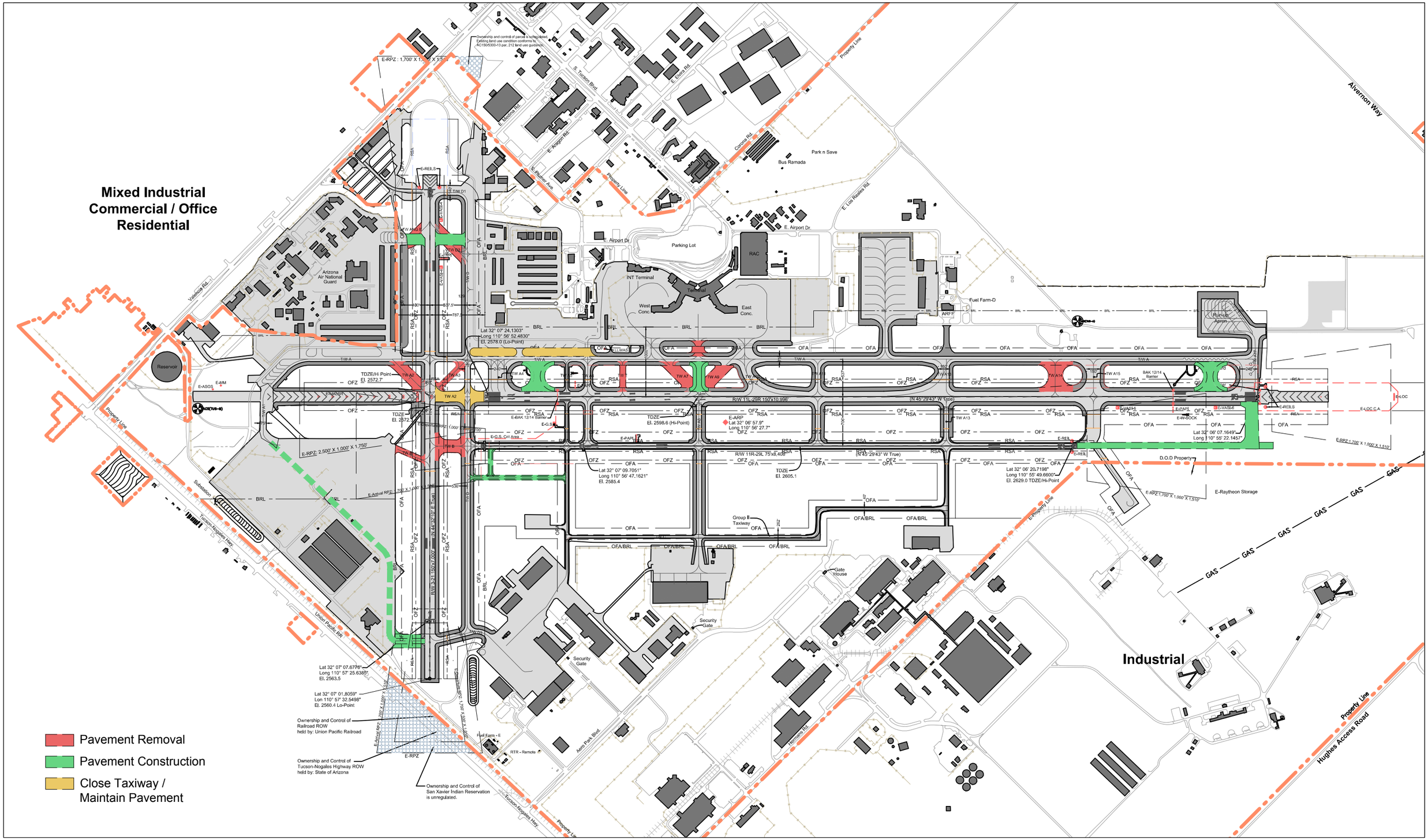
Near-term airfield geometry mitigation strategies were developed under the ASE Study as shown in **Figure 1-3**. Several mitigation strategies addressing Hot Spots were deemed high priorities and were implemented in 2012. These included:

- Removal of Taxiway A3 at Hot Spot 1
- Restriping of Taxiways A5 and A6 with an island barrier in front of the Executive Terminal ramp parallel to Taxiway A at Hot Spot 4
- Painting “TAXI” lettering on the Runway 29R end of Taxiway A identifying it as a taxiway at Hot Spot 3

After implementation of these mitigation strategies, Hot Spots 1 and 4 were eliminated, however, the current Hot Spot map (**Figure 1-4**) shows that former Hot Spots 2 and 3 remain (now known as Hot Spots 2 and 1, respectively). Most of the remaining airfield geometry mitigation strategies identified on **Figure 1-3** were carried forward in the Master Plan alternatives and recommended plan.

1.3.2 Runway Program Recommendations

The ASE Study also found several direct safety benefits resulting from the planned relocation of Runway 11R-29L including continued mitigation of former Hot Spots 2 and 3. With regard to overall airfield design, the ASE study recommended a center parallel taxiway be considered to prevent aircraft from crossing directly between the two parallel runways and allow aircraft to exit their arrival runway and cross the adjacent runway close to its end as recommended in *FAA Engineering Brief 75, Incorporation of Runway Incursion Prevention into Taxiway and Apron Design.*



TUCSON INTERNATIONAL AIRPORT
TUCSON AIRPORT AUTHORITY

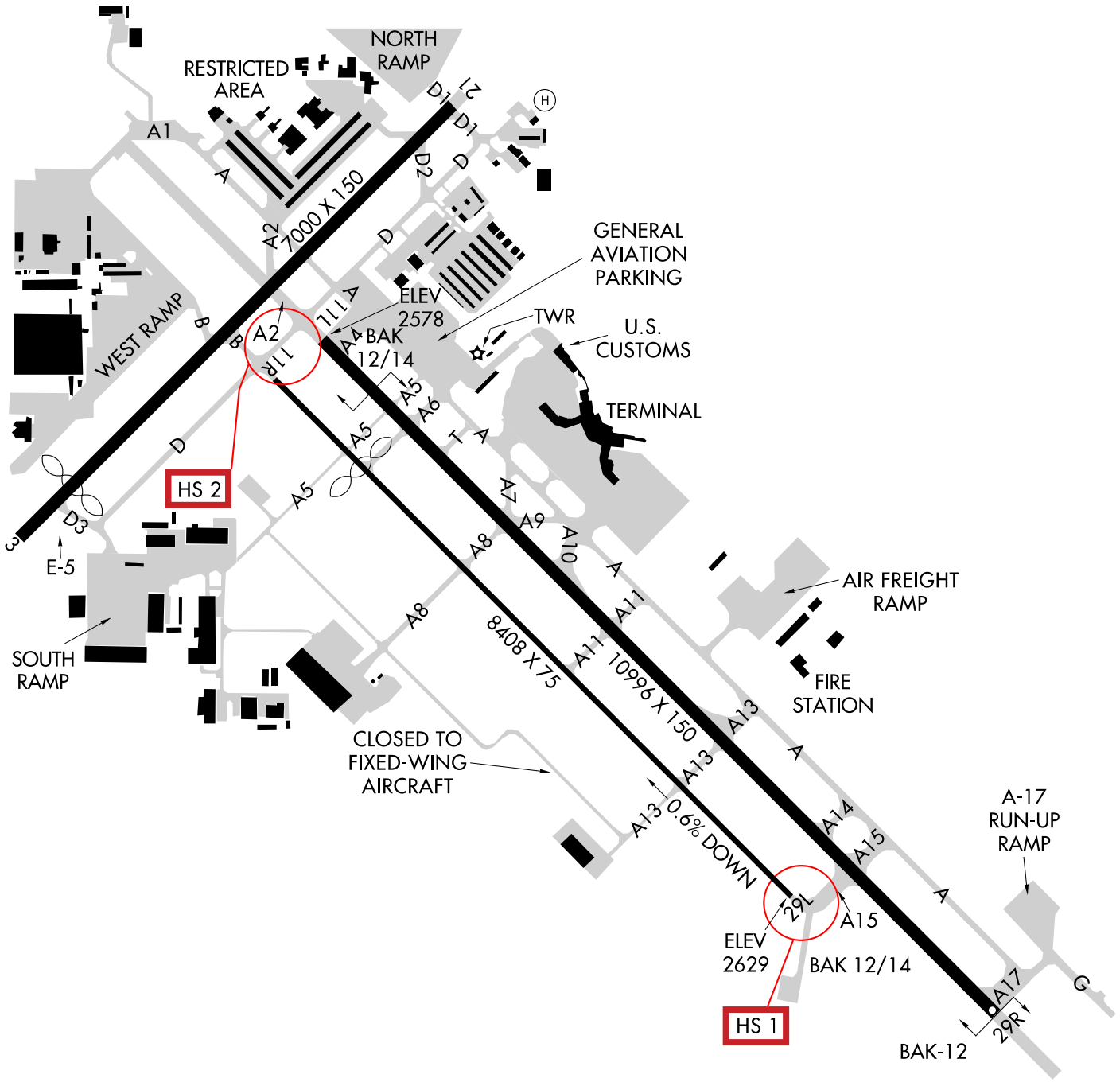
Airfield Safety Enhancement Implementation Study

Drawing Scale: 1" = 1,250'

Source: HNTB/Airfield Safety Enhancement Study
Note: Not all Mitigation Strategies are shown

Airfield Safety Enhancement Recommended Mitigation Strategies

Figure
1-3



2014 FAA Identified Hot Spots

TUCSON INTERNATIONAL AIRPORT
TUCSON AIRPORT AUTHORITY

Airfield Safety Enhancement Implementation Study

Drawing Scale: Not to Scale

Figure 1-4

The ASE study also recommended that a new parallel air carrier runway be constructed to match the 11,000 foot length and 150 foot width of existing Runway 11L-29R. The narrow width and shorter length of Runway 11R-29L causes some pilots to confuse it with a taxiway when approaching Runway 29L. Matching the length and width for both runways and aligning the Runway 29L and 29R thresholds would clearly differentiate Runway 11R-29L from a parallel taxiway, providing safety benefits by reducing the potential for wrong runway landings while also supporting both landing and take-off operations for the forecast fleet mix and providing true redundancy.. Specifically, risk mitigation strategies identified that require more significant airfield changes and may address safety in a more comprehensive manner (e.g. focusing on the entire airfield as well as optimized airfield flow and usage) include:

- Adding a center parallel taxiway with staggered taxiways between the runways that would increase separation distances between the runways to create a safety buffer and prevent straight runway crossings.
- Extending Runway 11R-29L to the southeast aligned with the Runway 29R end and widening it to 150 feet to match Runway 11L-29R to clearly differentiate it from a parallel taxiway and prevent wrong runway landings. According to incident reports provided by the TUS Air Traffic Control Tower (ATCT), between 2011 and 2014, nine (9) wrong runway landings occurred at TUS. (Former Hot Spot 3, Current Hot Spot 1)
- Shifting the Runway 11L and 11R takeoff and landing thresholds to optimize aircraft flows and minimize congestion through geometry changes in the vicinity of Taxiway D and Runways 11R and 11L. This also decreases the risk of a catastrophic event if an aircraft proceeds along Taxiway D without clearance while an aircraft is on approach to Runway 11R or 11L. (Former and Current Hot Spot 2)

1.4 2014 Master Plan Update

The 2014 Master Plan Update determined that a second parallel D-IV capable runway is needed at TUS for several reasons:

- Upgrading Runway 11R-29L to a full D-IV runway will minimize potential pilot confusion for wrong runway landings as the new runway would have its threshold aligned with Runway 11L-29R and have the same width which would clearly differentiate it from a parallel taxiway.
- Runway 11L-29R regularly accommodates a diverse fleet mix of commercial air-carrier, light general aviation, corporate general aviation, military, and cargo arrivals and departures. As a primary commercial airport within the National Airspace System, TUS's commercial operations are often impacted as a result of other airport users. The high variability of aircraft approach speeds of the fleet mix using TUS increases controller workload and require controllers to provide greater in-trail separation of aircraft.
- The runway would provide Air Traffic Control with greater flexibility in sequencing departures and arrivals throughout the day, allowing the segregation of arriving and departing aircraft on different runways, as well as allowing a runway to be dedicated to touch-and-go activities for TUS users

including Bombardier, AANG, general aviation, and Raytheon during less busy times of the day.

With these factors in mind, eight airfield alternatives were developed and reviewed for their ability to meet the identified airfield safety goals while also providing increased operational efficiency and capacity benefits when possible.

1.4.1 Master Plan Alternatives

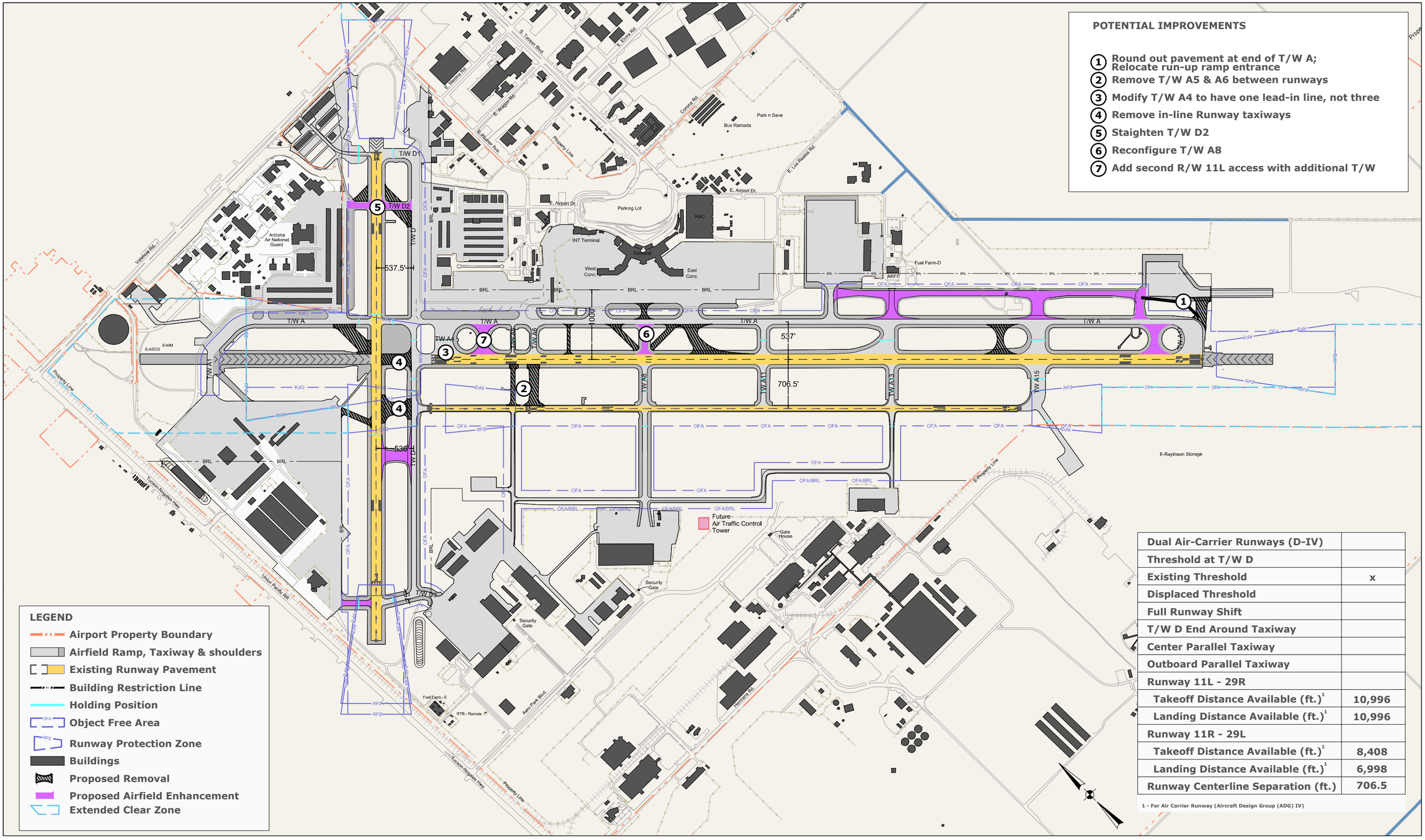
1.4.1.1 Master Plan Airfield Alternative 1

Master Plan Airfield Alternative 1 matches the existing conditions shown in **Figure 1-1** and does not include any physical safety or operational enhancements to TUS's airfield and was used as a baseline to compare with the build alternatives. The No Build alternative does not address the near-term implementable safety enhancing or operational goals. This alternative also does not address the need for a second parallel air-carrier capable runway.

1.4.1.2 Master Plan Airfield Alternative 2A

Master Plan Airfield Alternative 2A (**Figure 1-5**) depicts safety enhancing strategies recommended in the ASE Study. These strategies will largely minimize or eliminate GA aircraft from accessing Runway 11R-29L by crossing Runway 11L-29R, minimize or eliminate pilot confusion, and minimize direct access to existing air-carrier Runway 11L-29R. Alternative 2A and all subsequent alternatives include the following projects:

- Relocate the run-up ramp entrance to prevent aircraft leaving the run-up area with direct runway access
- Round out the south end of Taxiway A to further distinguish it as a taxiway
- Demolish connector Taxiways A7 and A9 to prevent aircraft from directly entering Runway 11L-29R from the Terminal apron
- Demolish connector Taxiways A5 and A6 between the parallel runways to prevent arriving General Aviation aircraft from directly routing across Runway 11L-29R
- Construct a new connector taxiway north of Taxiway A17 to improve aircraft sequencing and queuing
- Construct a new connector taxiway south of Taxiway A4 to improve aircraft sequencing and queuing
- Demolish most of the Runway 3-21 connector taxiways in the vicinity of Runway 11L-29R and Runway 11R-29L to eliminate direct access to the parallel runways from the West Ramp
- Reconstruct Taxiway D2 as a perpendicular taxiway intersection across Runway 3-21
- Extend Taxiway D3 to the west across Runway 3-21 to intersect with the West Ramp



Dual Air-Carrier Runways (D-IV)	
Threshold at T/W D	
Existing Threshold	x
Displaced Threshold	
Full Runway Shift	
T/W D End Around Taxiway	
Center Parallel Taxiway	
Outboard Parallel Taxiway	
Runway 11L - 29R	
Takeoff Distance Available (ft.)[1]	10,996
Landing Distance Available (ft.)[1]	10,996
Runway 11R - 29L	
Takeoff Distance Available (ft.)[1]	8,408
Landing Distance Available (ft.)[1]	6,998
Runway Centerline Separation (ft.)	706.5

1 - For Air Carrier Runway (Aircraft Design Group (ADG) IV)

TUCSON INTERNATIONAL AIRPORT
TUCSON AIRPORT AUTHORITY

Airfield Safety Enhancement Implementation Study

Drawing Scale: 1" = 1,250'

Master Plan Airfield Alternative 2A

Figure 1-5

Alternative 2A depicts existing Runway 11R-29L and does not propose the addition of a second parallel air-carrier capable runway. The needed safety and operational enhancements gained by a second air-carrier capable runway are not addressed by this alternative.

1.4.1.3 Master Plan Airfield Alternative 2B

Master Plan Airfield Alternative 2B (**Figure 1-6**), similar to Alternative 2A, proposes many of the same near-term implementable safety enhancing strategies, but also reconstructs Runway 11R-29L into an Airplane Design Group (ADG)-IV capable Runway. In this configuration, the expanded Runway 11R-29L would be extended to the south to align its threshold with Runway 11L-29R and both runways would be extended north to intersect with Taxiway D. The expanded runway measures 11,330 feet long by 150 feet wide and has a runway centerline to runway centerline separation with Runway 11L-29R of 706.5 feet. This separation still provides for mostly independent operations on the parallel runways in VMC. In addition to widening the runway, new 40 foot wide stabilized runway shoulders would be constructed to meet D-IV standards. Runway 11R-29L would require full-depth pavement reconstruction to meet bearing strength requirements for D-IV aircraft (likely resulting in a thicker pavement section). Many of the taxiway connectors between the two parallel runways would be reconstructed to accommodate significantly larger aircraft than they are currently capable of. This alternative does not propose a center taxiway between the parallel runways, which would further enhance safety and operational efficiency at TUS. A minimum of 800 feet of centerline to centerline separation between the parallel runways would be required for a centerfield taxiway.

Review of Safety and Operational Enhancements

- Improves safety by relocating both runways' thresholds to Taxiway D allowing positive identification of a runway by seeing the runway holdlines and wig-wags
- Provides a dedicated arrival and departure runway or a dedicated/preferred military aircraft runway during periods of peak military activity
- Does not allow sufficient runway separation for a center parallel taxiway between the two runways. This taxiway would enhance safety and operational efficiency by acting as a buffer between the two runways and allowing aircraft to clear the runway quickly
- Increases large aircraft capacity at TUS

1.4.1.4 Master Plan Airfield Alternative 2C

Master Plan Airfield Alternative 2C (**Figure 1-7**) proposes that the Runway 11L and Runway 11R arrival thresholds are displaced by approximately 1,378 feet. The runways thresholds are displaced to allow for B-II aircraft to taxi unrestricted on Taxiway D. The overall length of both runways would be 10,807 feet, which provides slightly less length than Runway 11L-29R currently provides today; however, the reduced length would not significantly impact aircraft operations at TUS. The displaced threshold on the north side of the runways reduces the Runways 11L and 11R Landing Distance Available (LDA) to 9,618 feet from 10,996 feet. The LDA provided in this alternative is still sufficient to accommodate TUS's existing and forecast fleet mix.

POTENTIAL IMPROVEMENTS

1. Round out pavement at end of T/W A; Relocate run-up ramp entrance
2. Add second R/W 11L access with additional T/W
3. Maintain T/W A5 & A6 between runways
4. Modify T/W A4 to have one lead-in line, not three
5. Extend T/W A4 to R/W 11R-29L
6. Widen R/W 11R-29L (Group IV capable)
7. Move R/W 11L & 11R landing threshold to T/W D
8. Extended Blast Pad

LEGEND

- Airport Property Boundary
- Airfield Ramp, Taxiway & shoulders
- Existing Runway Pavement
- Existing Building
- Building Restriction Line
- Holding Position
- OFA Object Free Area
- RPZ Runway Protection Zone
- Proposed Runway Pavement
- Proposed Removal
- Proposed Airfield Enhancement
- Extended Clear Zone

Dual Air-Carrier Runways (D-IV)	x
Threshold at T/W D	x
Existing Threshold	
Displaced Threshold	
Full Runway Shift	
T/W D End Around Taxiway	
Center Parallel Taxiway	
Outboard Parallel Taxiway	
Runway 11L - 29R	
Takeoff Distance Available (ft.)[1]	11,330
Landing Distance Available (ft.)[1]	11,330
Runway 11R - 29L	
Takeoff Distance Available (ft.)[1]	11,330
Landing Distance Available (ft.)[1]	11,330
Runway Centerline Separation (ft.)	706.5

1 - For Air Carrier Runway (Aircraft Design Group (ADG) IV)

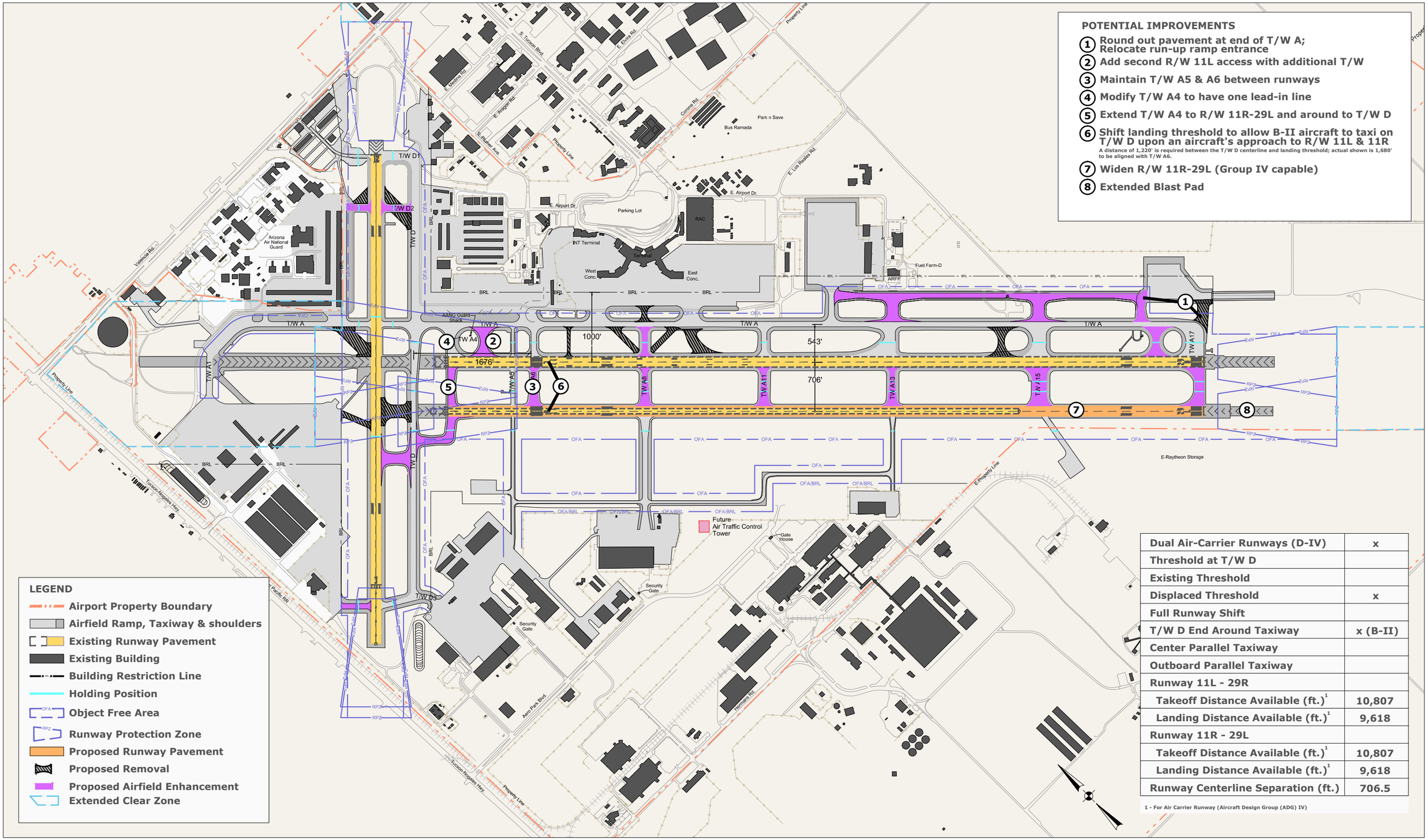
TUCSON INTERNATIONAL AIRPORT
TUCSON AIRPORT AUTHORITY

Airfield Safety Enhancement Implementation Study

Drawing Scale: 1" = 1,250'

Master Plan Airfield Alternative 2B

Figure 1-6



Dual Air-Carrier Runways (D-IV)	x
Threshold at T/W D	
Existing Threshold	
Displaced Threshold	x
Full Runway Shift	
T/W D End Around Taxiway	x (B-II)
Center Parallel Taxiway	
Outboard Parallel Taxiway	
Runway 11L - 29R	
Takeoff Distance Available (ft.)[1]	10,807
Landing Distance Available (ft.)[1]	9,618
Runway 11R - 29L	
Takeoff Distance Available (ft.)[1]	10,807
Landing Distance Available (ft.)[1]	9,618
Runway Centerline Separation (ft.)	706.5

1 - For Air Carrier Runway (Aircraft Design Group (ADG) IV)

TUCSON INTERNATIONAL AIRPORT
TUCSON AIRPORT AUTHORITY

Airfield Safety Enhancement Implementation Study

Drawing Scale: 1" = 1,250'

Master Plan Airfield Alternative 2C

Figure 1-7

The north ends of the parallel runways align with a narrower Taxiway A4 in order to provide additional separation between Taxiways A4 and D. Runway 11R-29L would require reconstruction to meet bearing strength requirements for D-IV aircraft (likely resulting in a thicker pavement section). Many of the taxiway connectors between the two parallel runways would be reconstructed to accommodate significantly larger aircraft than they currently do. This alternative does not propose a center taxiway between the parallel runways, which would further enhance safety and operational efficiency at TUS. Additionally, the Runway 11L Medium Intensity Approach Lighting System with Runway alignment indicator lights (MALSR) would require replacement or reconfiguration because of the arrival threshold shift. The shift also requires the relocation of the Runway 11L glide slope antenna and Precision Approach Path Indicators (PAPI).

Review of Safety and Operational Enhancements

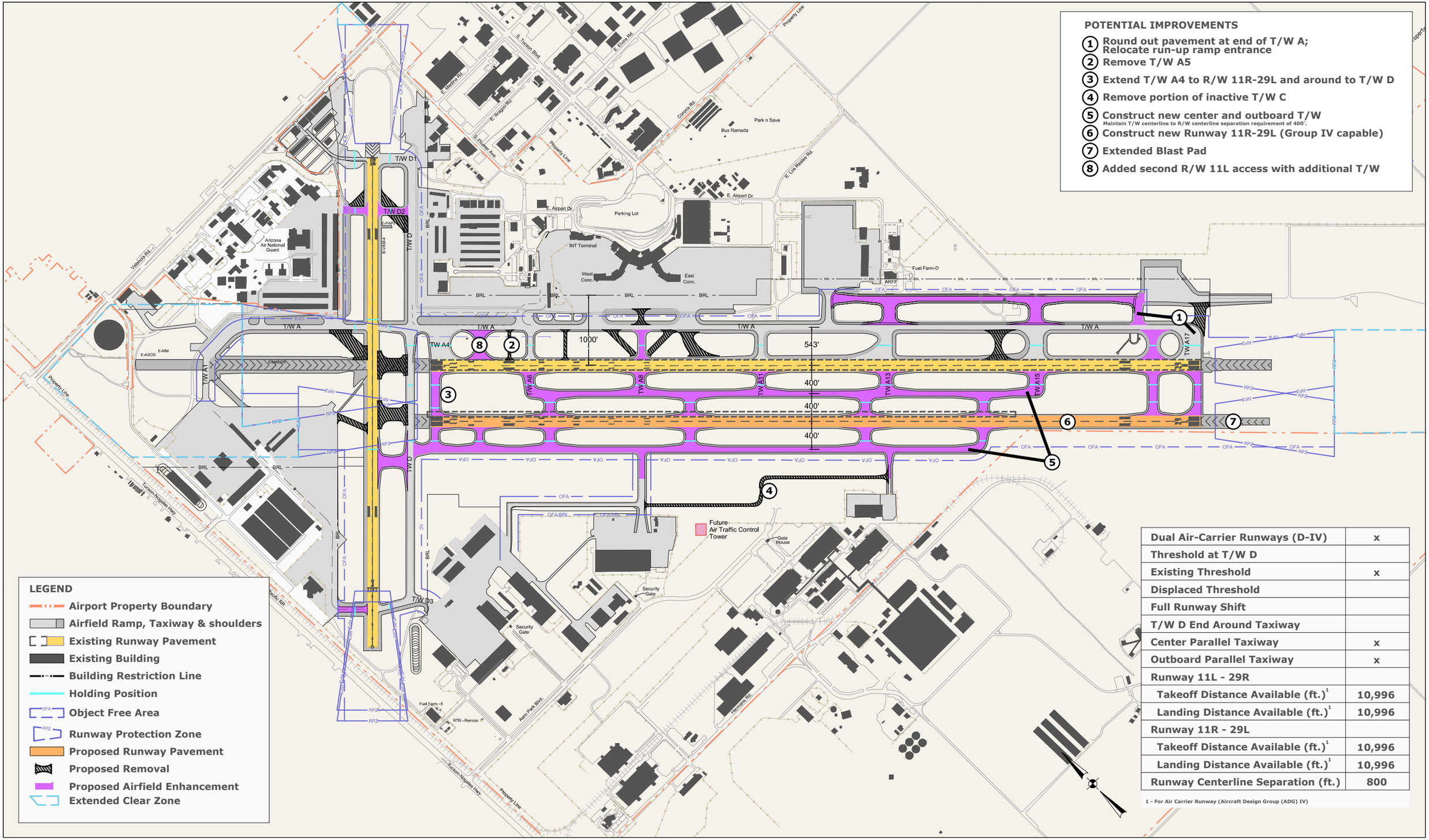
- Provides a dedicated arrival and departure runway or a dedicated/preferred military aircraft runway during periods of peak military activity
- Does not allow sufficient runway separation for a center parallel taxiway between the two runways. A center parallel taxiway would enhance safety and operational efficiency by acting as a buffer between the two runways and allowing aircraft to clear the runway quickly
- The displacement of the runways enables Taxiway D to function as an end around taxiway for B-II aircraft minimizing runway crossings by GA aircraft
- Increases large aircraft capacity at TUS

1.4.1.5 Master Plan Airfield Alternative 3A

Master Plan Airfield Alternative 3A (**Figure 1-8**) proposes a more substantial reconstruction of the airfield by not only upgrading Runway 11R-29L to a D-IV capable-runway, but also by shifting the runway to have a runway centerline to runway centerline separation with Runway 11L-29R of 800 feet. The 800 foot separation allows for the construction of a center parallel taxiway for aircraft to queue prior to crossing the second parallel runway. The center taxiway minimizes the potential for pilots to cross an active runway by forcing them to first turn onto the taxiway and wait for ATCT clearance to cross the other runway. The addition of a parallel taxiway 400 feet southwest of Runway 11R-29L is proposed to provide additional access to Runway 11R-29L. Both runways provide 10,996 feet of runway departure and arrival length and would align the north thresholds at existing Taxiway A4.

Review of Safety and Operational Enhancements

- The proposed 800 feet separation between the parallel runways allows for the construction of a center parallel taxiway which enhances safety and operational efficiency by acting as a buffer between the two runways and allowing aircraft to clear the runway quickly
- Provides more efficient and safer access to Runway 11R-29L and facilities on the south side of the airport via the new outboard parallel taxiway
- Provides a dedicated arrival and departure runway or a dedicated/preferred military aircraft runway during periods of peak military activity
- No impacts to existing departure or arrival runway lengths
- Increases large aircraft capacity at TUS



TUCSON INTERNATIONAL AIRPORT
TUCSON AIRPORT AUTHORITY

Airfield Safety Enhancement Implementation Study

Drawing Scale: 1" = 1,250'

Master Plan Airfield Alternative 3A

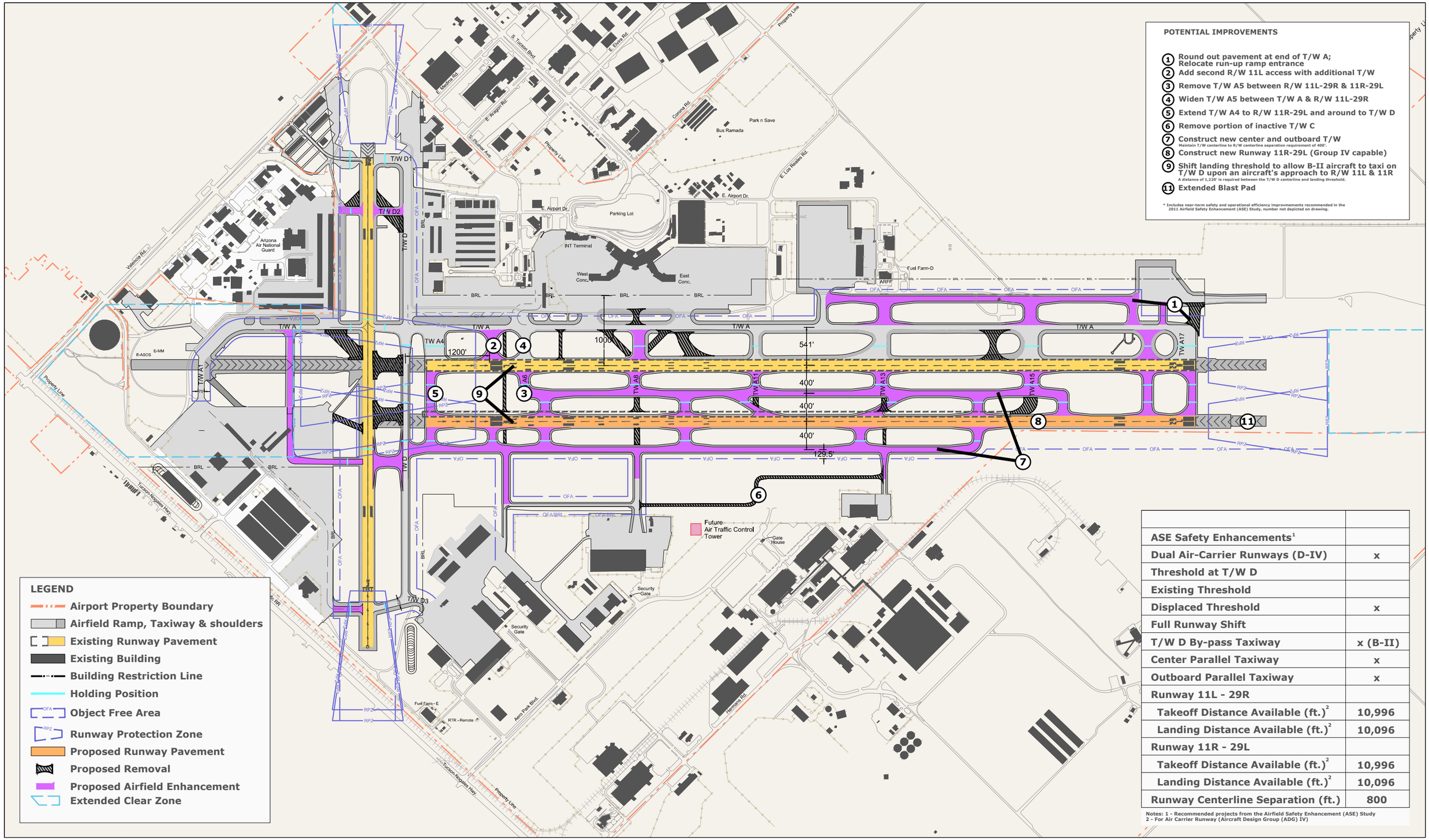
Figure 1-8

1.4.1.6 Master Plan Airfield Alternative 3B

Master Plan Airfield Alternative 3B (**Figure 1-9**) blends the recommendations of Alternatives 2C and 3A. Similarly to Alternative 3A, Alternative 3B proposes the reconstruction of Runway 11R-29L as a D-IV capable runway with an 800 foot runway centerline to runway centerline separation with Runway 11L-29R. The 800 foot separation allows for the construction of a center parallel taxiway between the two runways to allow aircraft to queue prior to crossing the second parallel runway. The center taxiway minimizes the potential for pilots to cross an active runway by forcing them to first turn onto the taxiway and wait for ATCT clearance to cross the other runway. The arrival thresholds on the northwest end of the parallel runways would be displaced by approximately 900 feet to allow for B-II aircraft to taxi unrestricted on Taxiway D. The overall length of both runways remains 10,996 feet, however, only 10,096 feet of arrival runway length is provided in this alternative. Also proposed in this alternative is the addition of a parallel taxiway 400 feet southwest of Runway 11R-29L. This parallel taxiway provides additional access to Runway 11R-29L. This alternative also proposes to add a bypass taxiway west of the Runway 11L and 11R Runway Protection Zones (RPZs) to allow for the unrestricted taxiing of aircraft (regardless of size) to access Runway 11R. Additionally, the Runway 11L MALSR would require replacement and/or reconfiguration because of the arrival threshold shift. The arrival threshold shift results in an increase in average taxi time for aircraft arriving east flow.

Review of Safety and Operational Enhancements

- The proposed 800 foot separation between the parallel runways allows for the construction of a center parallel taxiway which enhances safety and operational efficiency by acting as a buffer between the two runways and allowing aircraft to clear the runway quickly
- The displacement of the runways enables Taxiway D to function as an end around taxiway for B-II aircraft. This minimizes runway crossings by GA aircraft
- Provides more efficient and safer access to Runway 11R-29L and facilities on the south side of the airport via the new outboard parallel taxiway
- Provides a dedicated arrival and departure runway or a dedicated/preferred military aircraft runway during periods of peak military activity
- The reduced arrival runway length would accommodate the existing and forecast fleet mix
- Increases the average taxi time for aircraft arriving in east flow
- The bypass taxiway allows all aircraft to independently cross the airfield and provides better segregation of military operations
- Increases large aircraft capacity at TUS



TUCSON INTERNATIONAL AIRPORT
TUCSON AIRPORT AUTHORITY

Airfield Safety Enhancement Implementation Study

Drawing Scale: 1" = 1,250'

Master Plan Airfield Alternative 3B

Figure 1-9

1.4.1.7 Master Plan Airfield Alternative 4

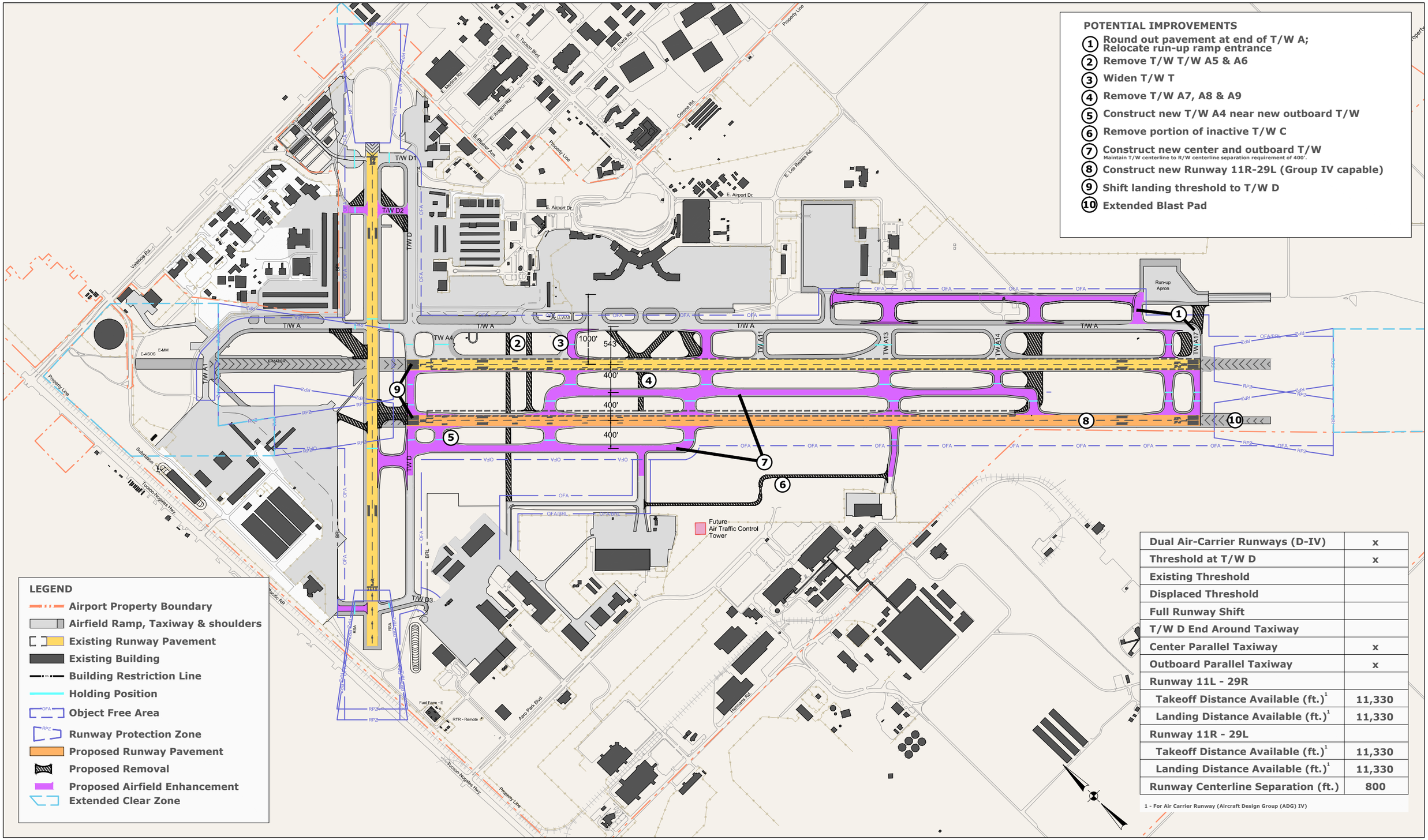
Master Plan Airfield Alternative 4 (**Figure 1-10**) incorporates most of the recommendations from Alternative 3A including reconstructing Runway 11R-29L into a full D-IV capable runway with an 800 foot runway centerline to runway centerline separation with Runway 11L-29R. The main difference between this alternative and Alternative 3A is that the northwest thresholds of both parallel runways would be aligned with Taxiway D. By aligning the thresholds with Taxiway D, both runways will have a runway departure and arrival length of 11,330 feet. The downside to the alignment is that aircraft that desire to taxi across the length of Taxiway D will encounter two runway crossings. The south parallel taxiway in this alternative proposes a smaller initial build-out mainly to service the Bombardier facility. This alternative also requires minor relocation of the MALSR and glide slope for Runway 11L because the arrival threshold will be shifted to the northwest.

Review of Safety and Operational Enhancements

- The proposed 800 foot separation between the parallel runways allows for the construction of a center parallel taxiway which enhances safety and operational efficiency by acting as a buffer between the two runways and allowing aircraft to clear the runway quickly
- Provides more efficient and safer access to Runway 11R-29L and facilities on the south side of the airport via the new parallel taxiway
- Provides enhanced awareness of the runway environ for pilots transiting Taxiway D
- Provides a dedicated arrival and departure runway or a dedicated/preferred military aircraft runway during periods of peak military activity
- Increases large aircraft capacity at TUS

1.4.1.8 Master Plan Airfield Alternative 5

Master Plan Airfield Alternative 5 (**Figure 1-11**) proposes the most substantial reconfiguration of TUS's airfield. In addition to upgrading Runway 11R-29L to a D-IV capable runway, both runways would be shifted to the southeast by approximately 2,700 feet to allow Taxiway D to function as an unrestricted end around taxiway. The southeast end of the parallel runways would be shifted by 2,700 feet to maintain 10,996 feet of runway length. Aircraft traversing Taxiway D would not need to hold short of arriving or departing aircraft on the parallel runways. The reconstructed runways would be separated by 800 feet to allow for the construction of a center parallel taxiway. Alternative 5 also proposes the construction of two partial length parallel taxiways south of Runway 11R-29L. The first partial length parallel taxiway would be located 400 feet south of that runway's centerline and provides access to facilities on the south side of the airport for aircraft arriving on Runway 11R-29L. The second partial length parallel taxiway would be located approximately 1,200 feet south of Runway 11R-29L and would serve the south ramp. Average taxi distances would be substantially increased for both arrivals and departures as a result of the shifting of both runways.



TUCSON INTERNATIONAL AIRPORT
TUCSON AIRPORT AUTHORITY

Airfield Safety Enhancement Implementation Study

Drawing Scale: 1" = 1,250'

Master Plan Airfield Alternative 4

Figure
1-10

POTENTIAL IMPROVEMENTS

1. Displace R/W 11L & 11R to allow end-around taxi on T/W D
2. Construct two new Group IV capable runways
3. Extended Blast Pad

LEGEND

- Airport Property Boundary
- Airfield Ramp, Taxiway & shoulders
- Existing Runway Pavement
- Existing Building
- Building Restriction Line
- Holding Position
- Object Free Area
- Runway Protection Zone
- Proposed Runway Pavement
- Proposed Removal
- Proposed Airfield Enhancement
- Extended Clear Zone

Dual Air-Carrier Runways (D-IV)	x
Threshold at T/W D	
Existing Threshold	
Displaced Threshold	
Full Runway Shift	x
T/W D End Around Taxiway	x (D-IV)
Center Parallel Taxiway	x
Outboard Parallel Taxiway	x
Runway 11L - 29R	
Takeoff Distance Available (ft.)[1]	10,996
Landing Distance Available (ft.)[1]	10,996
Runway 11R - 29L	
Takeoff Distance Available (ft.)[1]	10,996
Landing Distance Available (ft.)[1]	10,996
Runway Centerline Separation (ft.)	800

1 - For Air Carrier Runway (Aircraft Design Group (ADG) IV)

TUCSON INTERNATIONAL AIRPORT
TUCSON AIRPORT AUTHORITY

Airfield Safety Enhancement Implementation Study

Drawing Scale: 1" = 1,250'

Master Plan Airfield Alternative 5

Figure 1-11

Review of Safety and Operational Enhancements

- The proposed 800 foot separation between the parallel runways allows for the construction of a center parallel taxiway which enhances safety and operational efficiency by acting as a buffer between the two runways and allowing aircraft to clear the runway quickly
- Provides more efficient and safer access to Runway 11R-29L and facilities on the south side of the airport via the new parallel taxiway
- The shifting of the runways enables Taxiway D to function as an unrestricted end around taxiway for all aircraft. This minimizes aircraft runway crossings
- Aircraft taxiing on Taxiway D while jet aircraft are departing on either parallel runway would not need to hold short of the runways
- Provides a dedicated arrival and departure runway or a dedicated/preferred military aircraft runway during periods of peak military activity
- Average taxi distances and times would be substantially increased for both arrivals and departures as a result of the shift
- Increases large aircraft capacity at TUS

1.4.1.9 Airfield Alternatives Evaluation

The goal of the Airfield Development Program is to enhance the safety of TUS's airfield. Alternatives 1 and 2A do not provide a second parallel air-carrier capable runway that is needed to segregate traffic at TUS and improve airfield safety. While alternatives 2B and 2C do provide for a second parallel air-carrier runway, these alternatives do not address the need to have increased runway separation between the two parallel runways to accommodate a center taxiway. The center taxiway minimizes the potential for pilots to cross an active runway by forcing them to first turn onto the taxiway and wait for ATCT clearance to cross the other runway. The remaining alternatives (3A, 3B, 4, and 5) provide for a second parallel air-carrier capable runway and a center taxiway. Taxiway D is one of the busiest taxiways at TUS. Alternatives 3A and 4 inhibit flow along Taxiway D while aircraft are arriving and/or departing Runways 11L-29R and 11R-29L. Alternative 3B allows B-II aircraft to taxi unrestricted on Taxiway D while aircraft are on approach to Runways 11L and/or 11R because the arrival thresholds are displaced, provided they have Air Traffic Control (ATC) clearance. Having the landing threshold displaced further enhances safety in the rare occurrence that a pilot instructed to hold short of Runway 11L or 11R on Taxiway D overshoots the runway holdline. While Alternative 5 shifts departing and arriving aircraft away from Taxiway D and other busy taxiways, it requires the most amount of airfield reconstruction. It requires the reconstruction of both parallel runways as opposed to only Runway 11R-29L and also negatively impacts aircraft taxi times. It was determined that Alternative 3B best meets all of the criteria for enhancing safety at TUS while also increasing operational efficiency. Airfield Alternative 3B was carried forward and refined to comprise the Master Plan Recommended Airfield Development Concept.

1.4.2 Master Plan Recommended Airfield Concept

The recommended Master Plan airfield development concept (**Figure 1-12**) consists of a new parallel air-carrier ADG-IV runway, centerfield taxiway, outboard taxiway (southwest of Runway 11R-29L), displacement of the Runway 11L arrival threshold, enhanced south run-up area access, and a bypass taxiway around the Runway 11L and 11R RPZs allowing unrestricted taxiing of aircraft accessing Runway 11R. This new parallel air-carrier capable runway with center and outboard taxiways meet TUS's safety goals and also increase operational efficiency by allowing the appropriate segregation and sequencing of the diverse fleet mix of air-carrier, cargo, military, and general aviation aircraft. The proposed airfield improvements described below provide enhancements to safety and operational efficiency:

- **Construct New Center Parallel Taxiway:** The recommended plan proposes construction of a parallel taxiway between Runway 11L-29R and Runway 11R-29L. This taxiway will minimize the potential for pilots to cross an active runway by forcing them to first turn onto the taxiway and wait for ATCT clearance to cross the other runway. The center parallel taxiway will also provide space for aircraft to queue prior to crossing the second parallel runway increasing safety.
- **Construct Full Length Group IV Parallel Runway:** The construction of the center parallel taxiway requires the relocation of Runway 11R-29L due to the 400-foot runway centerline to taxiway centerline separation needed between the two parallel runways and the new taxiway. The plan proposes to relocate and reconstruct Runway 11R-29L as an 11,000 foot long, 150 foot wide D-IV capable runway. The alignment of the Runway 29R and 29L thresholds along with the wider runway with will help differentiate Runway 11R-29L from a taxiway increasing safety and pilot situational awareness. **Construct New Outboard Parallel Taxiway:** Construct a parallel taxiway 400 feet southwest of Runway 11R-29L. This parallel taxiway provides additional access to Runway 11R-29L. The outboard taxiway will provide convenient airfield access to future aeronautical development along the west side of the airport (south of Bombardier). The length of the taxiway is limited by the existing TUS property boundary. The outboard taxiway provides safety and operational benefits by allowing aircraft to clear the runway quickly after landing and preventing direct taxiway access to Runway 11R-29L from south side facilities.
- **Displace Runways 11L Arrivals Threshold:** Shift the arrival threshold on Runway 11L 921 feet to match Runway 11R and allow for category B-II aircraft to taxi along Taxiway D independent of runway arrival operations. The overall length of both runways would remain 10,996 feet. This project includes reconfiguring the Runway 11L MALSR by shifting stations and installing in-pavement approach lights in the displaced threshold. The existing PAPI and glideslope would also be relocated to accommodate the Runway 11L arrival threshold shift. The glideslope antenna could potentially be replaced with a sideband reference or capture effect (currently a null reference antenna) in order to shrink the footprint of the required glideslope critical area.

RECOMMENDED IMPROVEMENTS

1. Construct full length parallel Runway 11R-29L (Group IV)
2. Construct new center parallel T/W
3. Construct new outboard parallel T/W
4. Shift arrivals threshold to allow B-II aircraft to taxi on T/W D upon an aircraft's approach to R/W 11L & 11R
5. Improve south run-up area access
6. Construct bypass Taxiway
7. Reconstruct itinerant aircraft apron
8. Construct /Maintain extended blast pad
9. Airfield geometry safety recomendations to reconfigure taxiways and remove excess pavement (multiple locations)
10. Extend Taxiway G
11. Terminal Renovation
12. Expand Concourse to the East
13. Expand Consourse to the West
14. Install Solar Canopies
15. Expand Rental Car fueling and wash rack
16. Construct Rental Car storage area
17. Expand Country Club Road
18. Expand Economy Parking Lot
19. Construct Fuel Farm
20. Construct ARFF Station
21. Future Air Traffic Control Tower
22. Solar Canopies under development
23. Extended Clear Zone acquisition area

LEGEND

- Airport Property Boundary
- Existing Airfield Ramp, & shoulders
- Existing Runway Pavement
- Runway Protection Zone
- Buildings
- Extended Clear Zone
- Proposed Removal
- Proposed Airfield Project
- Proposed Runway Pavement
- Proposed Terminal Project
- Proposed Landside Project
- Proposed Support Project
- Proposed Property Acquisition

TUCSON INTERNATIONAL AIRPORT
TUCSON AIRPORT AUTHORITY

Airfield Safety Enhancement Implementation Study

Drawing Scale: 1" = 1,250'

Master Plan Recommended Airfield Concept

Figure 1-12

- **Improve South Run-Up Area Access:** Round out pavement at the intersection of Taxiway A and A17, removing the connection into the south run-up area, to distinguish Taxiway A from a runway. Construct new entrance and exit taxiways to the run-up area to replace the Taxiway A17 connection and provide redundant access points.
- **Construct Bypass Taxiway:** Construct a new bypass taxiway northwest of the RPZs for Runways 11L and 11R. The displaced arrivals thresholds would allow unrestricted taxiing of aircraft (regardless of size) accessing Runway 11R. The project would include removal of the existing concrete apron from the surrounding area and demolition of existing buildings within the area.
- **Close Taxiway A2:** Close and paint out the Taxiway A2 segment between Taxiway A and Runway 3-21 and the Taxiway A2 segments between Runway 3-21 and Taxiway D. This action implements airfield safety best practices and improves operational efficiency.
- **Remove Taxiway T and Taxiway A14:** Remove pavement and close Taxiways T and A14. This action implements airfield safety best practices and improves operational efficiency.
- **Remove Taxiway B between Runway 3-21 and Runway 11R Threshold and construct new taxiway from West Ramp to Taxiway C:** Remove pavement on the Taxiway B segment northwest of Runway 3-21. Close and paint out the Taxiway segment between Runway 3-21 and Taxiway D. Construct a new taxiway extending from the West Ramp to Taxiway A5. Widen Taxiway A5 from outboard Taxiway to Taxiway C. This action implements airfield safety best practices and improves operational efficiency.
- **Remove Lead-in Lines on Taxiway A4 and Taxiway A17:** Remove two lead-in lines on Taxiways A4 and A17, construct new bypass taxiway for Taxiways A4 and A17. This action implements airfield safety best practices and improves operational efficiency.
- **Straighten Taxiway D2 and Taxiway ANG B:** Straighten Taxiway D2 and Taxiway ANG B to orient them perpendicular to Runway 3-21. This action implements airfield safety best practices and improves operational efficiency.
- **Remove Taxiways A7 and A9; Extend Taxiway A8:** Remove pavement on Taxiways A7 and A9, extend Taxiway A8 across Runway 11L-29R to intersect Taxiway A and create high speed taxiway for Runway 29R arrivals. This action implements airfield safety best practices and improves operational efficiency.
- **Construct/Maintain Air National Guard (ANG) Extended Blast Pad:** Construct/maintain the ANG blast pads for Runways 11L-29R and 11R-29L and paint/mark as non-runway/taxiway pavement.
- **No Precision Instrument Approach:** Relocated Runway 11R-29L will not have a precision instrument approach as it would have impacted the now under construction Air Traffic Control Tower's height and location.
- **No New NAVAIDS:** The proposed program does not add any major new navigational aids (NAVAIDS) and proposes to relocate the existing glide slope antenna and install some in-pavement MALSR lights on Runway 11L.

During stakeholder interviews held as part of this Study, the recommended Master Plan airfield development concept was revised per the discussion in **Sections 2.3** and **2.4** of this report.

1.5 Purpose of Airfield Safety Enhancement Implementation Study

The purpose of this current ASE Implementation Study (the Study) is to identify critical implementation issues and further document program justification related to major redevelopment of TUS's airfield, as outlined in the 2014 Master Plan Update. The impetus for this redevelopment is primarily driven by the need to eliminate existing hot spots at TUS to enhance safety, but also includes other collateral objectives related to operational and maintenance efficiencies, system flexibility, noise reduction, capacity enhancements, and systemic airfield traffic management issues unique to TUS's highly diverse commercial, general aviation, military, and specialty operations mix.

TUS's operations mix includes an unusually high number of military aircraft, GA aircraft, and helicopters; the AANG operates the Nation's busiest ANG training fighter wing (F-16, multiple variants) which includes multiple foreign training units. While TUS supports nearly 1,600,000 annual enplanements, the airfield experiences upwards of 70,000 annual GA operations. The mixture of foreign and domestic military aircraft and general aviation activity presents highly unique air traffic management challenges and intrinsic operational risk. In addition, the AANG's fleet of F-16 fighters is aging and their pilots declare frequent emergencies. Since the fighters use Runway 11L-29R today, it does not afford the airport much flexibility in the event of a declaration or the potential operational flexibility if an incident were to occur.

The proposed relocation of Runway 11R-29L is not considered a traditional "safety standards program" because typical safety standards programs pertain to geometry and clearances (i.e. number of taxiway nodes, runway safety areas, runway protection zones, runway and taxiway object free areas, etc.), and there is no defined safety standard that requires a parallel runway to help reduce pilot misidentification of runway ends. Instead, the programming effort cumulatively quantified and evaluated a combination of benefits including risk reduction, standards compliance, capacity, and environmental that support the project. The result will be a project that takes into account safety, unique airport traffic and operating conditions, and the importance of TUS to the surrounding community, the State of Arizona, and the National Airspace System (NAS).

In order to mitigate some of the most pressing safety concerns at TUS, a number of the recommended ASE Study mitigation strategies were implemented in 2012. Two Hot Spots were eliminated but two remain at the 29 and 11 ends of the runways. As shown on **Table 1-1**, the number of annual incursions has continued to remain constant despite the improvements. Since the tabulation of this data, incursions involving runway misidentification have occurred including: a visiting F-16 performed a touch-and-go on Taxiway A mistaking it for Runway 29R and a general aviation aircraft landed on Runway 11L after being cleared for Runway 11R.

Table 1-1: Historic TUS Runway Incursions

Fiscal Year	Total Runway Incursions	Other Events
2008	2	1
2009	31	2
2010	5	0
2011	11	2
2012	8	1
2013	13	2
2014	2	3

Source: HNTB Analysis of FAA Incursion Reports. Note 2014 data only represented 3 months of Fiscal Year 2014.

A summary of TUS declared emergencies (Alerts) data, presented in **Table 1-2**, indicated that there were on-average 57 Alerts reported annually between 2007 and 2014. Typical runway closures lasted between four (4) and twenty (20) minutes, with one Alert 3 closing Runway 11L-29R for eight hours. In some instances the shutdowns affected other aircraft, causing arrivals to go around or divert, or causing departures to be delayed. Primary Runway 11L-29R accounted for about 75 percent of the Alerts in which the runway was specified.

Table 1-2: Summary of TUS Alerts (2007 – 2014)

Calendar Year	Total Alerts
2007	92
2008	67
2009	64
2010	50
2011	40
2012	37
2013	50
2014	56

Source: TAA Operations data

Both parallel runways are approaching the end of their design service lives. General Aviation Runway 11R-29L was originally constructed as a temporary runway and was converted from an existing taxiway. Runway 11R-29L has had several overlays performed in the past decade in order to maintain it as a usable runway surface. It is, however, in need of full depth reconstruction within the next five years to rehabilitate and replace subgrade material that was not originally intended to take the design loads that a runway expects. According to the Airport Pavement Management Study performed by Applied Pavement Technology in September 2012, the current pavement condition index for Runway 11R-29L is 40, which indicates the need for near-term full-depth reconstruction.

The information in this report is used to develop a draft purpose and need statement, **Chapter 4 – Purpose and Need Narrative**, for use in an Environmental Impact Study (EIS) for the runway program. The purpose and need statement will require refinement as the environmental review progresses, but the draft statement is intended to be sufficient to justify movement of the project forward for review under an EIS. The 2014 Master Plan Recommended Airfield Concept carried forward is not anticipated to affect the Triple Hangars that were impacted under previous plans. TAA has also undergone extensive coordination with Raytheon to solidify details of the land acquisition and mitigation and demolition of the twelve (12) non-active weapons storage bunkers (six [6] of the bunkers are within the property be acquired by TAA and disposed of by the Department of Defense [DOD]). In addition it does not appear at this time, and at this level of analysis, that the runway program will have impacts to the 4(f) properties (TIC Hangars).

2.0 Proposed Action

2.1 Existing Conditions

TUS's existing airfield, which is depicted in **Figure 1-1**, includes a pair of closely spaced parallel runways separated by 706 feet and oriented northwest to southeast (11L-29R and 11R-29L) and a non-intersecting crosswind runway (3-21) oriented northeast to southwest. Parallel Runways 11L-29R and 11R-29L measure 10,996 feet by 150 feet and 8,408 feet by 75 feet, respectively, and crosswind Runway 3-21 measures 7,000 feet by 150 feet. TUS's existing and forecast ARC is designated as D-IV, with the Airbus A300-600F operated by FedEx as the critical aircraft.

Runway 11L-29R is TUS's primary runway, accommodating the majority of departure and arrival operations of the very diverse fleet mix encompassing air-carrier, cargo, military, general aviation, and flight testing. Runway 11L-29R's existing Runway Design Code (RDC) is designated as D/IV/2400 and is equipped with a Category I ILS approach on the Runway 11L approach end. Runway 11R-29L accommodates mostly light General Aviation aircraft and has an existing Runway Design Code of B/II/5000. Runway 11R has a displaced arrivals threshold of 1,410 feet, resulting in an available landing length of 6,998 feet. All aircraft will use Runway 3-21 when wind and weather conditions dictate its use, which occurs less than 1% of the year. Runway 3-21's existing RDC is C/III/5000. The Runway 3 arrivals threshold is displaced by 840 feet resulting in an available landing length of 6,160 feet.

The taxiway system connecting the runways and aprons has existing geometrical challenges that contribute to high rates of airfield incursions and additional runway/taxiway intersections that do not meet current FAA design standards.

2.2 No Action Alternative

The No Action Alternative which will be carried through the environmental review process consists of the existing airfield layout with the completion of projects outside of the runway program and maintenance projects that will be required to maintain existing airfield operations if the runway program is not undertaken. These airfield projects are reflected in order to adequately represent the benefits that would be realized when comparing the Proposed Action and No Action Alternatives.

TAA is planning a 4" mill and overlay of Runway 11L-29R in 2016. As Runway 11L-29R is at the end of its useful life and serves all of the air carrier and AANG operations at TUS, this project is required to maintain airfield operations over the next 10 years. The runway's Pavement Condition Index (PCI) for asphalt sections reported in the June 2013 Airside Pavement Management System Update ranges from 36 to 69 with the majority of the sections in the 40s. Due to the condition of the pavement, the 2016 reconstruction is required under both the No Action and Proposed Action. Runway 11L-29R is mostly constructed with asphalt pavement (portions of the runway's touchdown zone are constructed in concrete) and, due to impacts associated with shutting down the runway for construction, the

reconstructed runway will also be completed in asphalt pavement. Although concrete pavement has a longer lifespan, the use of asphalt pavement to reconstruct the runway will allow the construction to be completed faster thereby minimizing the length of the runway closure. According to the 2012 TUS PCI Pavement Management Plan Update, historically, mill and overlays on the existing runways have been required on average every 12 years. Under the No Action Alternative with no additional parallel air carrier runway, consistent with the historic pavement condition data, it is assumed that the runway will require reconstruction every 12 years due to the limited lifespan of asphalt pavement and all future reconstructions will be completed with asphalt pavement in order to minimize the length of the runway shutdown.

Runway 11R-29L is also in need of a full depth reconstruction if the runway program does not move forward. Under the No Build Alternative, Runway 11R-29L is programmed to be reconstructed in the 2018/2019 timeframe.

As part of the design process for the Runway 11L-29R reconstruction project currently underway, TAA is evaluating the safety enhancing strategies that were proposed in the Master Plan's Recommended Airfield Concept for improvements along Taxiway A between Runway 11L-29R and the terminal. TAA is coordinating with FAA to determine which aspects of these improvements will be included within the project scope for construction programmed for fiscal year 2016. These improvements consist of the following projects (shown in **Figure 2-1**):

- **Remove Taxiways T, A6 and A14:** Remove pavement and close Taxiways T, A6 and A14. Widen and shift Taxiway A5 to the west
- **Remove Lead-in Lines on Taxiway A4 and Taxiway A17:** Remove two lead-in lines on Taxiways A4 and A17, construct new bypass taxiway for Taxiways A4 and A17.
- **Remove Taxiways A7, A8 (between Taxiway A and apron), A9 and A10; Extend Taxiway A8:** Remove pavement on Taxiways A7, A8 (between Taxiway A and the terminal apron), A9, and A10. Extend Taxiway A8 across Runway 11L-29R to intersect Taxiway A and create high speed taxiway for Runway 29R arrivals.

In addition, Taxiway A15 is planned to be reconstructed as a high-speed exit to supplement the high-speed exit at Taxiway A13 which will be more difficult for aircraft to utilize once the 11L arrival threshold is displaced as part of the runway program.

Proposed Safety Improvements

RUNWAY 3-21

RUNWAY 11L-29R

RUNWAY 11R-29L

TAXIWAY A

TAXIWAY A1

TAXIWAY A2

TAXIWAY A3

TAXIWAY A4

TAXIWAY A5

TAXIWAY A6

TAXIWAY A7

TAXIWAY A8

TAXIWAY A9

TAXIWAY A10

TAXIWAY A11

TAXIWAY A12

TAXIWAY A13

TAXIWAY A14

TAXIWAY A15

TAXIWAY B

TAXIWAY C

TAXIWAY D

TAXIWAY D1

TAXIWAY D2

TAXIWAY D3

TAXIWAY D4

TAXIWAY E

TAXIWAY E8

TAXIWAY F

TAXIWAY G

TAXIWAY H

TAXIWAY J

TAXIWAY K

TAXIWAY L

TAXIWAY M

TAXIWAY N

TAXIWAY P

TAXIWAY Q

TAXIWAY R

TAXIWAY S

TAXIWAY T

TAXIWAY U

TAXIWAY V

TAXIWAY W

TAXIWAY Y

TAXIWAY Z

Terminal

West Conc.

East Conc.

Parking Lot

RAC

ARFF

Fuel Farm-D

Park n Save

Bus Ramada

Gate House

Security Gate

Security Gate

Security Gate

E. Airport Dr.

E. Airport Rd.

E. Aviation Way

E. Elvira Rd.

E. Los Reales Rd.

S. Tucson Blvd.

Valencia Rd.

Property Line

Tucson-Nogales Hwy.

Union Pacific RR

Aero Park Blvd.

Hermans Rd.

Legend

- Runway Pavement
- New Runway Pavement
- New Taxiway Pavement
- Pavement Removal

Source: HNTB Corporation

TUCSON INTERNATIONAL AIRPORT
TUCSON AIRPORT AUTHORITY

Airfield Safety Enhancement Implementation Study

Drawing Scale: 1" = 1,250'

No Action Configuration

Figure
2-1

2.3 Stakeholder Interviews

An early task in this Study was to review the Master Plan Recommended Alternative with partner stakeholders to identify potential refinements to the plan that could further improve safety, enhance operational efficiency, provide additional capacity, and meet the needs of the TUS's users. In addition to meeting with FAA Phoenix Airports District Office (PHX ADO) and Western Pacific Region staff to review the program on July 10, 2014, a series of interviews were conducted with local TUS project stakeholders on August 5th and 6th to solicit input on the overall runway program and assumptions for the programming analysis. Meetings were held with the following TUS stakeholders:

- FAA Air Traffic Control
- Arizona Air National Guard
- Velocity Air (Flight Training)
- Leading Edge Flight School

During these interviews operational considerations were discussed, and it was requested that several revisions to the Master Plan Recommended Airfield Alternative be considered. These considerations include:

- **Locations of the high-speed taxiway exits**: The displaced Runway 11L arrivals threshold may cause many aircraft to miss the existing high-speed exit at Taxiway A13. It was requested that a new high-speed exit be considered further downstream in place of existing Taxiway A15 to capture these aircraft which help reduce runway occupancy times. The A15 high-speed taxiway exit will be included in the No Action Alternative. It was also requested that two high-speed taxiway exits off of Runway 11R-29L be considered, one in each direction.
- **Length of the Center Parallel Taxiway:** Due to the shortened length of the proposed Runway 11R-29L outboard parallel taxiway which ends at the Raytheon property, it was requested that an extension of the center parallel taxiway be considered. The extension of the center parallel taxiway to the full length of Runway 11R-29L would allow aircraft, who can't make the last exit to the outboard taxiway, to exit at the end of the runway and use the center taxiway to travel back to Taxiway D without having to cross the end of Runway 29R and use Taxiway A.
- **Access to the run-up pad adjacent to Runway 29R**: It was noted that the south run-up pad is used for arming the F-16s when runway operations are in west flow and for a containment area if an F-16 lands with hydrazine problems and needs to be isolated immediately. It is important to maintain easy access to the hold pad in order to quickly move affected aircraft there to protect surrounding aircraft.
- **Runway 11L departure hold area**: It was noted that the elimination of Taxiway A2 will require AANG aircraft to utilize Taxiway A and A4 with other commercial and private aircraft to hold for release. It was noted that the additional aircraft in this area may cause increased congestion.

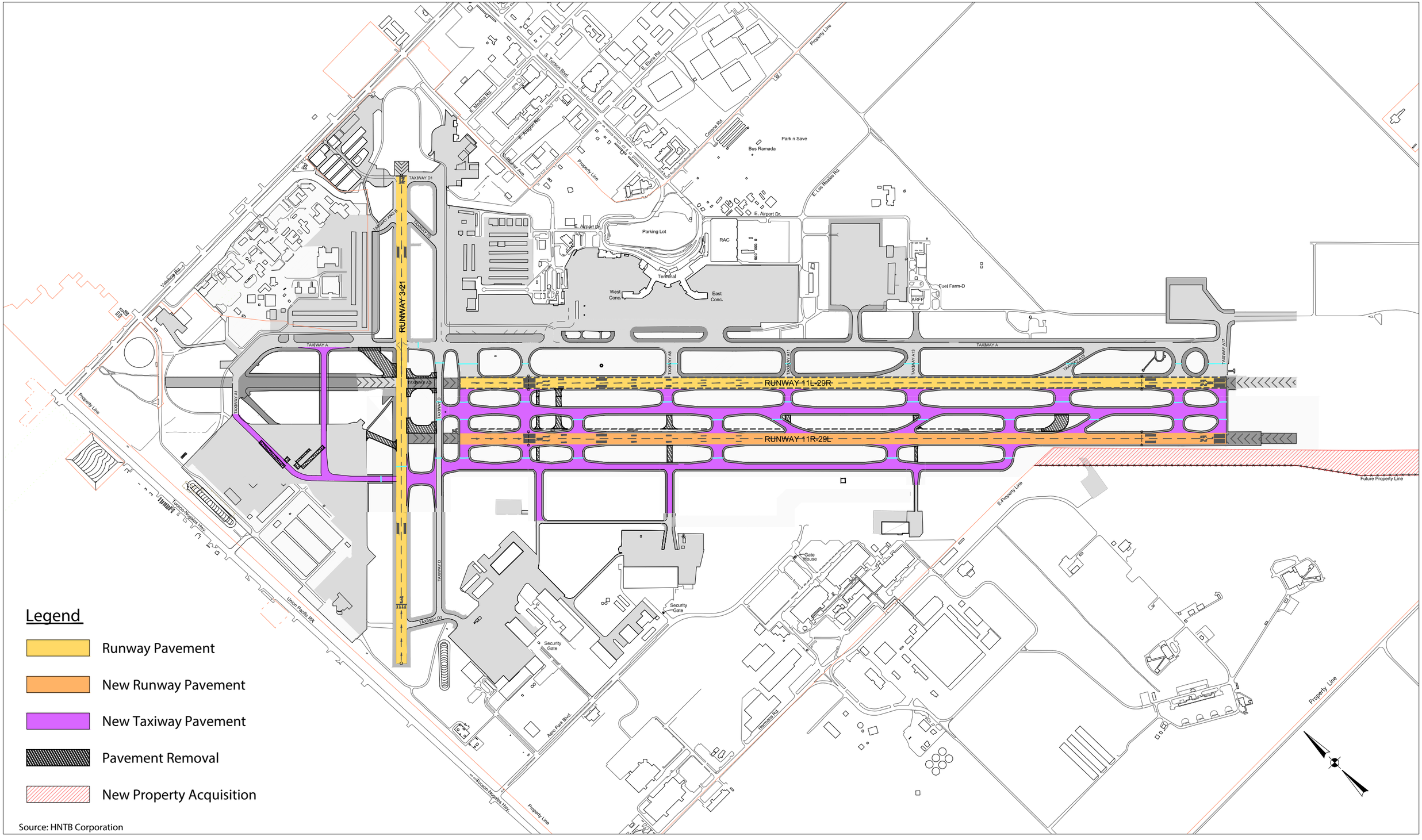
Feedback received at during these interviews was used to develop the Proposed Action presented in **Section 2.4** and analyzed it the programming analysis described in **Chapter 3.**

2.4 Proposed Action

Based on feedback received from TUS project stakeholders during the interviews and subsequent coordination meetings, the center taxiway was extended to match the full length of the Runway 11R-29L. The Proposed Action is shown in **Figure 2-2**. The Master Plan Update cited the need to truncate the center taxiway on the northwest end to protect sufficient area for the relocated glide slope antenna as the existing antenna requires relocation due to the addition of the displaced threshold on the 11L end. The potential location of the glideslope was reviewed with staff from the FAA Western Service Center on September 16, 2014, and it was recommended that the glideslope should be located on the east side of the runway between Runway 11L-29R and Taxiway A. Specific clearance criteria will be reviewed during the design phase of this project.

In further discussions about the length of the center parallel taxiway it was determined that it was needed to accommodate aircraft that have a longer arrivals roll-out, especially in the hot summer months. The Master Plan alignment for the center taxiway would prevent more than 20% of the fleet from being able to make the last exit onto the center taxiway upon arrival, resulting in a large number of aircraft performing a direct runway crossing. The extension of the full length parallel taxiway also improves operational efficiency for aircraft destined for the south or west aprons as those aircraft could now avoid crossing Runway 11L-29R. The TUS FAA ATCT staff also commented that it would help better segregate ground traffic as there would now be a true bypass route in the event of disabled aircraft. With the alignment of the two parallel runways at 150 feet wide with blast pads, the center taxiway will not be visually misconstrued as one of the parallel runways.

Other enhancements made to the Master Plan Recommended Alternative based on stakeholder feedback include leaving Taxiway A17 leading to the south run-up pad, which was identified in the Master Plan for removal, and addition of a high-speed exit at Taxiway A15. Taxiway A17 is needed for emergency egress for AANG aircraft that report hydrazine problems. The quick access to the run-up apron is needed to ensure an incident doesn't occur on the runway and or parallel taxiways. The high speed exit at Taxiway A15 was added to supplement high-speed exit at A13 when the Runway 11R threshold is displaced. It is anticipated that the high speed exit at Taxiway A15 will be completed as part of the Runway 11L-29R reconstruction along with the other safety enhancing strategies identified in **Section 2.2**. These projects are depicted in **Figure 2-1**.



Source: HNTB Corporation

TUCSON INTERNATIONAL AIRPORT
TUCSON AIRPORT AUTHORITY

Airfield Safety Enhancement Implementation Study

Drawing Scale: 1" = 1,250'

Proposed Action Configuration

Figure
2-2

2.5 Construction Phasing Plan and Schedule

A construction phasing plan was developed with the intent to minimize impacts to airport operations during construction and ensure that a minimum of two runways are always operational to provide redundancy. It is important that Runway 3-21 is closed for the shortest time possible as it serves as the backup runway for air carrier and AANG operations. A major component of the recommended phasing is the proposed relocation of the Air Operations Area (AOA) fence to create a landside construction area for the new runway allowing easier contractor access to the construction site and minimizing potential impacts to airfield operations. During each phase the construction limits will be delineated with orange construction fence to prevent incursions into the runway and taxiway safety areas and all erosion control measures identified in the project Stormwater Pollution Prevention Plan (SWPPP), prepared before project implementation, will be completed before any construction work begins. The construction phasing plans are depicted in **Figures 2-3** through **2-9** and described below and the associated construction schedule is shown in **Figure 2-10**.

2.5.1 Construction Phase 1

During Phase 1 construction activities (**Figure 2-3**), all Runways and Taxiways A5, A8, A13, and D will remain open to air traffic to serve facilities on the southwest side of the airfield and maintain access to the runways and terminal area facilities. There will be no disruption of access to the Bombardier, SkyWest or Raytheon aprons.

Phase 1 will require closure of the West Ramp between Taxiway A1 and Runway 3-21, and closing Taxiway B to the west of Runway 3-21. Phase 1 will consist of construction of the following project components:

- The west bypass taxiway will be constructed from the Taxiway A safety area to the intersection of the new southwest outboard parallel taxiway.
- The new southwest outboard parallel taxiway will be constructed in segments between Taxiways D, A5, A8, and A13 safety areas. The tie in pavement for the future cross-field taxiways will be constructed up to the southwest Runway 11R-29L safety area.
- The southwest outboard taxiway will be constructed between the intersection with the west bypass taxiway on the West Ramp and the Runway 3-21 safety area.
- Upon completion of the west bypass taxiway, Taxiway A between Taxiways A1 and A2 will be closed. The west bypass taxiway tie in with Taxiway A will then be constructed. During this time aircraft will be able to utilize the West Ramp and Taxiway B to access Taxiway D and the runways.
- Independent of the other activities, the Raytheon property mitigation and bunker demolition will occur. This requires the construction of replacement AOA fencing to secure the additional future safety areas.

Upon the completion of all construction work on the west bypass taxiway, Taxiway A will be reopened between Taxiways A1 and A2. The west approach pavement of Runway 11L-29R will also be reopened.

Phase 1 construction is estimated to have a duration of 8 months and be completed before construction activities begin on Phase 3 (schedule shown on **Figure 2-10**).

2.5.2 Construction Phase 2

During Phase 2 construction activities (**Figure 2-4**), Taxiways A5, A8, and A13 will remain open to air traffic to serve facilities on the southwest side of the airfield and maintain access to the runways and terminal area facilities. Runway 11L-29R and Runway 11R-29L will also remain open during Phase 2 construction.

Phase 2 will require closing Runway 3-21 And Taxiway D, from the Runway 11L-29R safety area to Taxiway D3. Access to the Bombardier, SkyWest or Raytheon aprons will be maintained and Taxiways A5, A8, and A13 will remain open. Phase 2 will consist of construction of the following project components:

- Taxiway B to the west of Runway 3-21 and all infield pavement between Runway 3-21 and Taxiway D from the Runway 11L-29R safety area and the southwest outboard parallel taxiway, will be removed.
- The southwest outboard parallel taxiway will be constructed between Runway 3-21 and Taxiway D.
- The tie-in between the Phase 1 segment of the southwest outboard parallel taxiway and Taxiway D will be constructed.
- The tie-in between the west bypass taxiway and Runway 3-21 will be constructed.
- The extended blast pad for new Runway 11R-29L, between Runway 3-21 and the Runway 11R-29L safety area will be constructed.
- The center parallel taxiway will be constructed from Taxiway D to the new Runway 11R-29L safety area limit.

Upon completion of Phase 2 construction, Runway 3-21 and Taxiway D will be reopened to air traffic.

Phase 2 construction is estimate to have a duration of 2 ½ months and will be completed before construction activities begin on Phase 3 begins. As shown on the schedule (**Figure 2-10**), Phase 2 construction may proceed concurrently with Phase 1 construction, however, Phase 2 construction cannot begin while Taxiway A is closed between Taxiways A1 and A2 in order to maintain access to the West Ramp.

2.5.3 Construction Phase 3

Phase 3 construction activities (**Figure 2-5**) will consist of constructing the tie in pavement from the southwest outboard parallel taxiway to the Bombardier, SkyWest or Raytheon apron connector taxiways. This work will be phased to maintain access to the Bombardier and SkyWest aprons at Taxiways A5 and A8,

and to reduce the closure time for Taxiway A13 and access to the Raytheon apron. Phase 3 will consist of construction of the following project components:

- Construction Segment 1: Taxiway A5 will be closed between the Runway 11R-29L south safety area and the connecting taxiway between Taxiways A5 and A8. Access to the Bombardier apron at Taxiway A5 will be maintained through the connecting taxiway and Taxiway A8 which will allow movement across the airfield. New Taxiway A5 will be constructed between the connecting taxiway and the southwest outboard parallel taxiway. The southwest outboard parallel taxiway will be tied into the new Taxiway A5 pavement.
- Construction Segment 2: Upon completion of the Taxiway A5 construction, the taxiway will be reopened and access to the SkyWest apron at Taxiway A8 will be through the connecting taxiway and newly constructed Taxiway A5 providing access to the new southwest outboard parallel taxiway and Taxiway D. Taxiway A8 will then be closed between the Runway 11R-29L southwest safety area and the connecting taxiway. New Taxiway A8 will be constructed between the connecting taxiway and the southwest outboard parallel taxiway. The southwest outboard parallel taxiway will be tied into the new Taxiway A8 pavement.
- Construction Segment 3: Upon completion of the Taxiway A8 construction, the taxiway will be reopened and access to the SkyWest apron at Taxiway A8 will be along Taxiway A8 to the southwest outboard parallel taxiway and Taxiway D.
- Taxiway A13 will be closed between the Runway 11R-29L southwest safety area and the apron at Taxiway A13. There will be no access to the Raytheon apron at Taxiway A13 during this construction and the timing of construction activities will need to be coordinated with Raytheon. New Taxiway A13 will be constructed between the southwest outboard parallel taxiway and the Raytheon apron. The southwest outboard parallel taxiway will be tied into the new Taxiway A13 pavement.
- Upon completion of the Taxiway A13 construction, the taxiway will be reopened and access to the Raytheon apron will be along Taxiway A13 and the southwest outboard parallel taxiway to Taxiway D.
- Independent of the other projects, a new 4,000 square foot airfield vault will be constructed southwest of the outboard taxiway.

Phase 3 construction activities will not begin until all construction is completed on Phases 1 and 2. Phase 3 construction activities will be performed in three separate segments as indicated above, with each segment being completed and open to air traffic before proceed with construction on the next segment. As shown on the schedule (**Figure 2-10**), the total duration for Phase 3 is estimated to be 6 months with 2 months being allocated for construction of Taxiway A5 and its connection to the southwest outboard parallel taxiway. The second segment has a 2 month duration for the construction of Taxiway A8. The third segment has 2 month duration for construction of Taxiway A13. Phase 3 will be completed before beginning Phase 4b.

2.5.4 Construction Phase 4a

Phase 4a (**Figure 2-6**) involves closing all runway and taxiway pavement from the Runway 11L-29R southwest safety area to the southwest outboard parallel taxiway northeast safety area and from the Taxiway D southeast safety area to the southeast airport property line. Phase 4a will consist of construction of the following project components:

- A temporary AOA fence will be constructed around the perimeter of the closed area allowing construction to be performed within the landside area eliminating the delays associated with constructing within the active AOA such as badging requirements and vehicle screening.
- A construction access gate will be constructed from outside of airport AOA into the enclosed construction area.

Phase 4a may be constructed concurrently with the construction of the final segment of Phase 3. Phase 4a is estimated to have a duration of one month and will be completed before Phase 4b begins (schedule shown on **Figure 2-10**).

2.5.5 Construction Phase 4b

Phase 4b construction activities (**Figure 2-7**) consist of constructing the new Runway 11R-29L and center parallel taxiway inside the enclosed landside construction area. Access to the construction area will only be allowed from a landside access point. Phase 4b will consist of construction of the following project components:

- All existing pavement and airfield lighting, within the enclosed construction area, will be removed.
- Two new airfield drainage detention basins will be constructed in the northwest portion of the airport.
- Runway 11R-29L will be constructed and the blast pad pavement will tie into the extended blast pad pavement constructed in Phase 2.
- Two new BAK 12/14 ANG arrestor systems will be installed on Runway 11R-29L.
- The blast pad on the southeast end of the runway will be constructed to meet ANG design requirements.
- The southwest outboard parallel taxiway will be constructed from Taxiway A13 to the Runway 11R-29L tie-in at the edge of the Raytheon property.
- The cross-field taxiways will be constructed from Runway 11R-29L to the tie-ins constructed in Phase 1 at the southwest outboard parallel taxiway.
- The center parallel taxiway will be constructed and connected to the tie-in at Taxiway D, which was constructed in Phase 2.
- Cross-field taxiways and high speed exit taxiways will be constructed between the Runway 11L-29R southwest safety area and Runway 11R-29L.

Upon completion of all construction activities in this phase, the temporary AOA fence will be removed and Runway 11R-29L and the center parallel taxiway will be opened to air traffic operations.

Phase 4b construction is estimated to have a duration of 12 months and it will not begin until Phases 3 and 4a are completed (schedule shown on **Figure 2-10**). Phase 4b will be completed before Phase 5 begins.

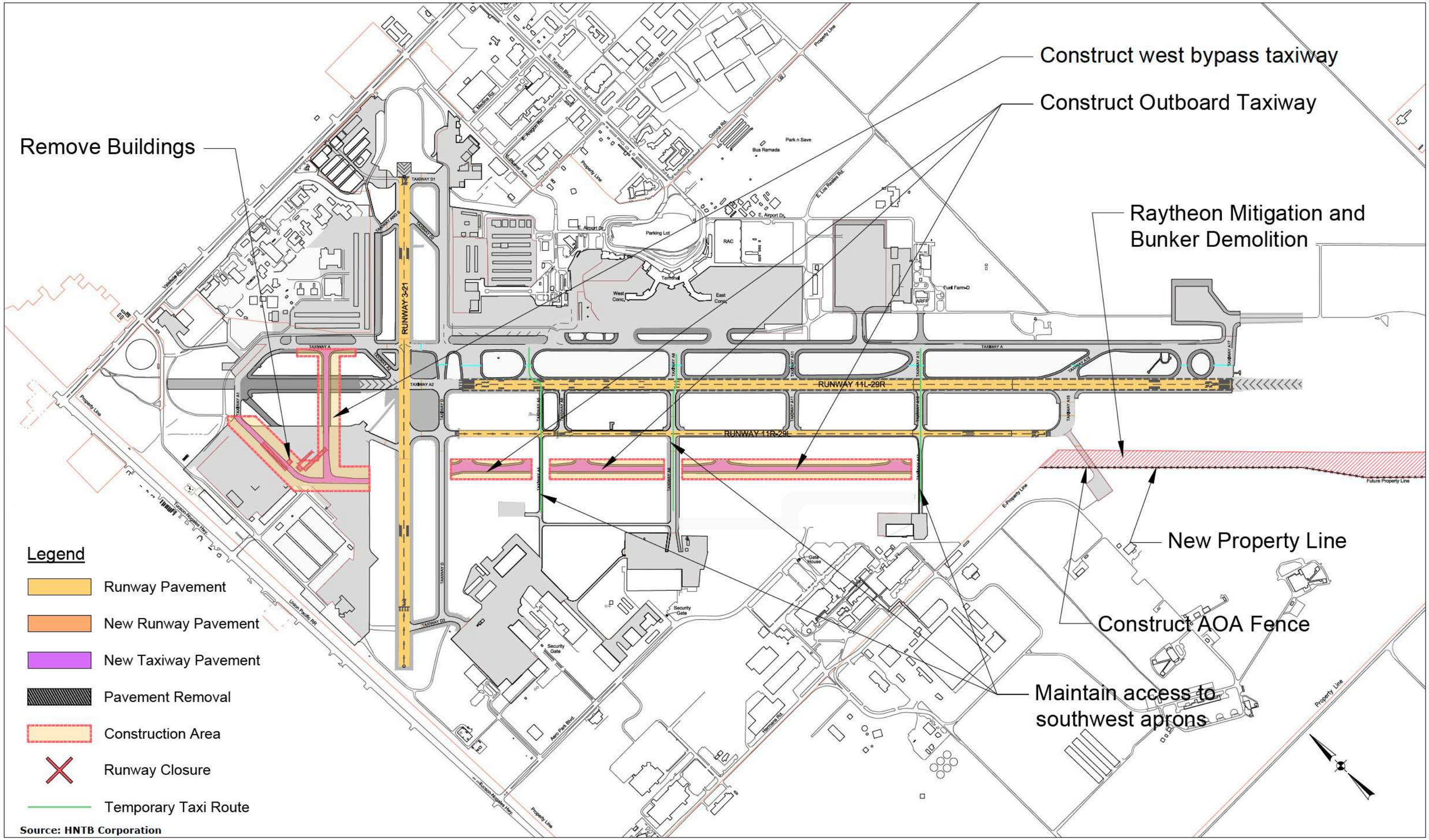
2.5.6 Construction Phase 5

During Phase 5, Runway 11L-29R will be closed, along with all cross-field taxiways between the Taxiway A southwest safety area and the center parallel taxiway northeast safety area (**Figure 2-8**). Taxiway D and all airfield pavement to the southwest of Taxiway D will remain open. Taxiway A will be closed to the southeast of Taxiway A13. Access will be maintained throughout the phase for Aircraft Rescue and Fire Fighting (ARFF) vehicles. Phase 5 will consist of construction of the following project components:

- The Runway 11L glide slope antenna will be relocated to the east side of the runway, the Runway 11L PAPI will be relocated approximately 921 feet to the southeast and the Runway 11L MALSR will be reconfigured or replaced and will include in-pavement stations along the displaced threshold.
- Taxiway A2 and the excess pavement, along the Runway 11L-29R blast pad, will be removed during night time closures of Runway 3-21 and portions of Taxiways A and D. Access from the Terminal Aprons to new Runway 11R-29L will be maintained.
- The tie-ins of the previously constructed cross-field taxiways between the center parallel taxiway and Runway 11L-29R will be constructed.
- An update to the airfield nomenclature will take place including updating signage, surface painted markings, and applicable publications.

Phase 5 construction is estimated to have a duration of 4 months and it will not begin until Phase 4b is complete (schedule shown on **Figure 2-10**). Upon completion of this Phase 5 construction, Runway 11L-29R will be reopened to air traffic.

The pavement removal at the intersection of Runway 3-21 and the blast pad of Runway 11L-29R will be done during nighttime closures that will be coordinated with Airport Operations. These closures may be at any time during Phase 5 and will be at the discretion of Airport Operations. The final runway configuration is depicted in **Figure 2-9**.



TUCSON INTERNATIONAL AIRPORT
TUCSON AIRPORT AUTHORITY

Airfield Safety Enhancement Implementation Study

Drawing Scale: 1" = 1,250'

Construction Phase 1

Figure
2-3

Start Construction Clear of RSA

Remove Buildings

Maintain access to southwest aprons

RUNWAY 3-21

RUNWAY 11L-29R

RUNWAY 11R-29L

TAXIWAY A

TAXIWAY D1

TAXIWAY D2

TAXIWAY A1

TAXIWAY A2

TAXIWAY A3

TAXIWAY A5

TAXIWAY A7

TAXIWAY A11

TAXIWAY A13

TAXIWAY A15

TAXIWAY A17

TAXIWAY A19

Parking Lot

RAC

Terminal

West Conc.

East Conc.

ARFF

Fuel Farm-D

Park n Save

Bus Ramada

Gate House

Security Gate

Aero Park Blvd

Hermans Rd

E. Airport Dr.

E. Los Reales Rd.

Corona Rd.

E. Elvira Rd.

S. Tucson Blvd.

E. Magee Rd.

E. Ajo Way

S. Wilmot Ave.

Valencia Rd.

Tucson-Nogales Hwy.

Union Pacific RR

Property Line

Future Property Line

E Property Line

Legend

- Runway Pavement
- New Runway Pavement
- New Taxiway Pavement
- Pavement Removal
- Construction Area
- Runway Closure
- Temporary Taxi Route

Source: HNTB Corporation

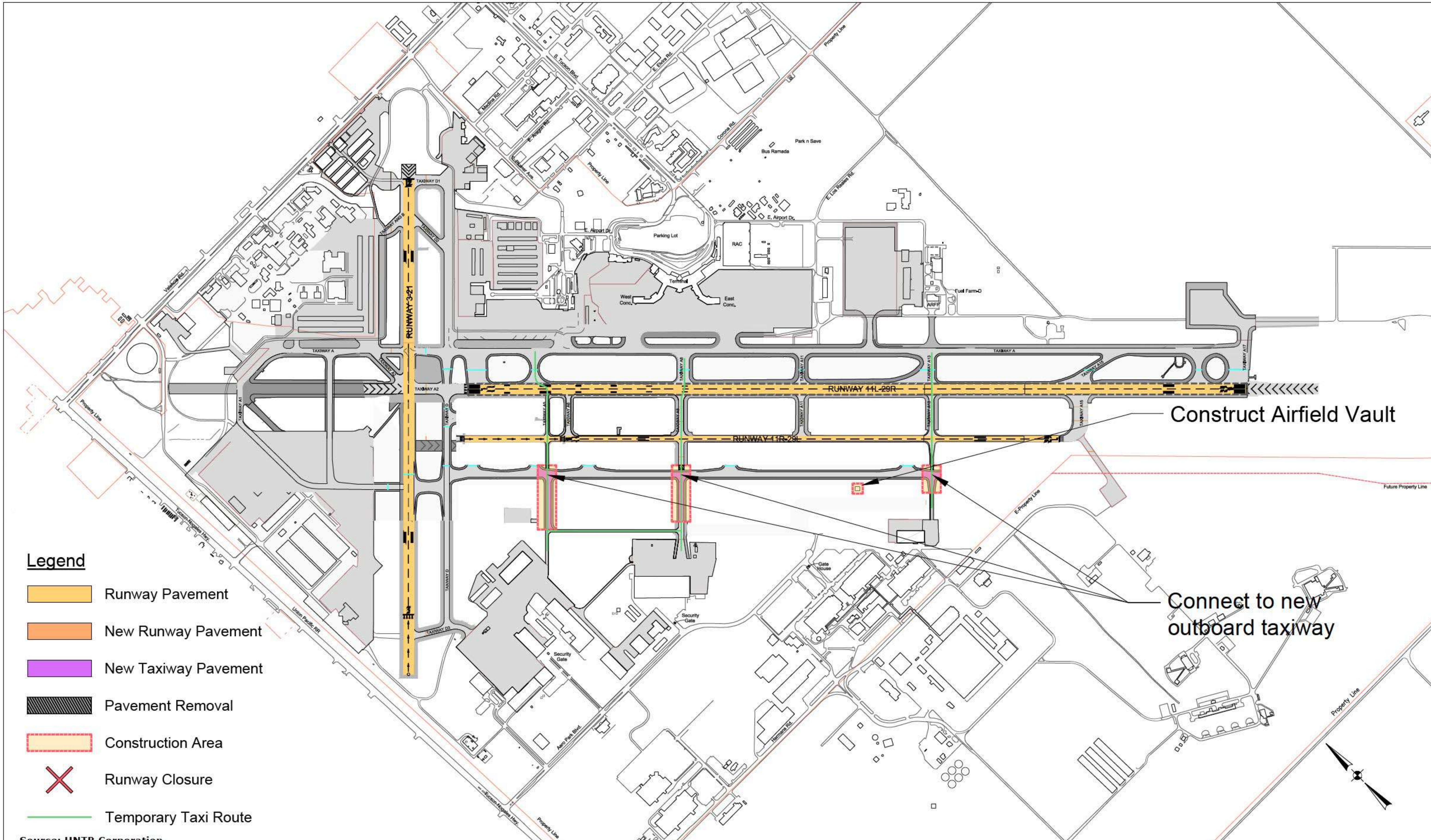
TUCSON INTERNATIONAL AIRPORT
TUCSON AIRPORT AUTHORITY

Airfield Safety Enhancement Implementation Study

Drawing Scale: 1" = 1,250'

Construction Phase 2

Figure
2-4



Source: HNTB Corporation

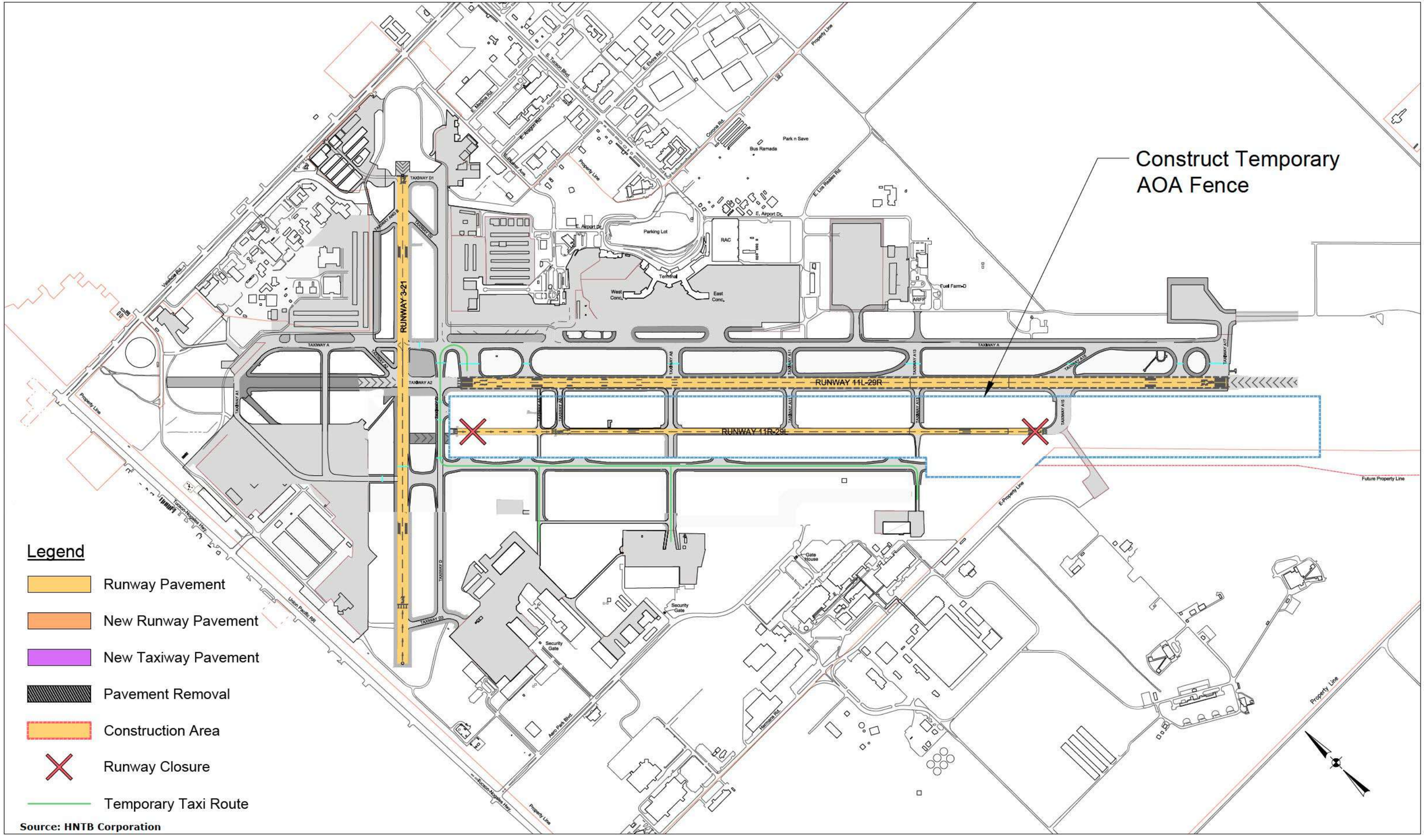
TUCSON INTERNATIONAL AIRPORT
TUCSON AIRPORT AUTHORITY

Airfield Safety Enhancement Implementation Study

Drawing Scale: 1" = 1,250'

Construction Phase 3

Figure 2-5



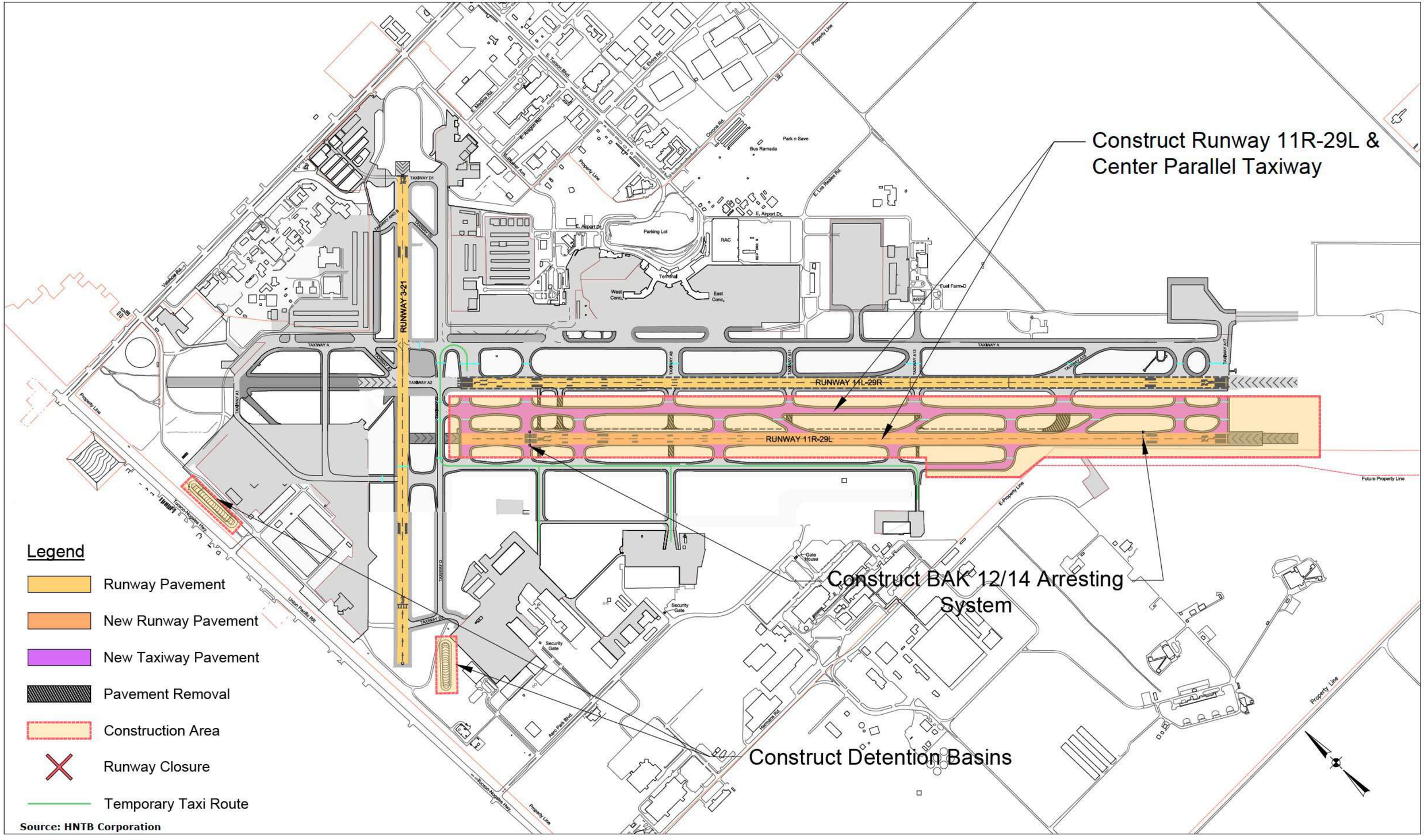
TUCSON INTERNATIONAL AIRPORT
TUCSON AIRPORT AUTHORITY

Airfield Safety Enhancement Implementation Study

Drawing Scale: 1" = 1,250'

Construction Phase 4a

Figure
2-6



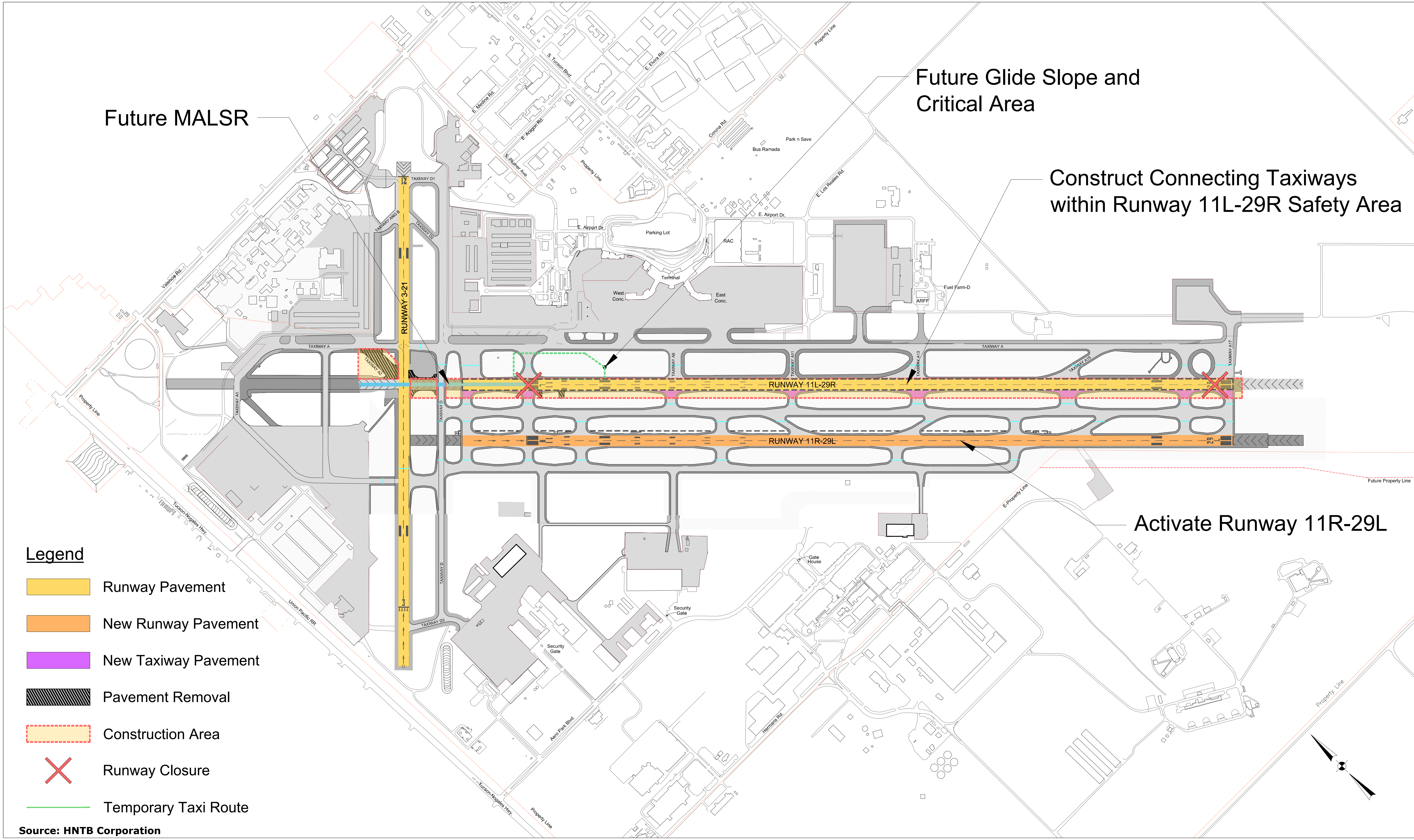
TUCSON INTERNATIONAL AIRPORT
TUCSON AIRPORT AUTHORITY

Airfield Safety Enhancement Implementation Study

Drawing Scale: 1" = 1,250'

Construction Phase 4b

Figure
2-7



Source: HNTB Corporation

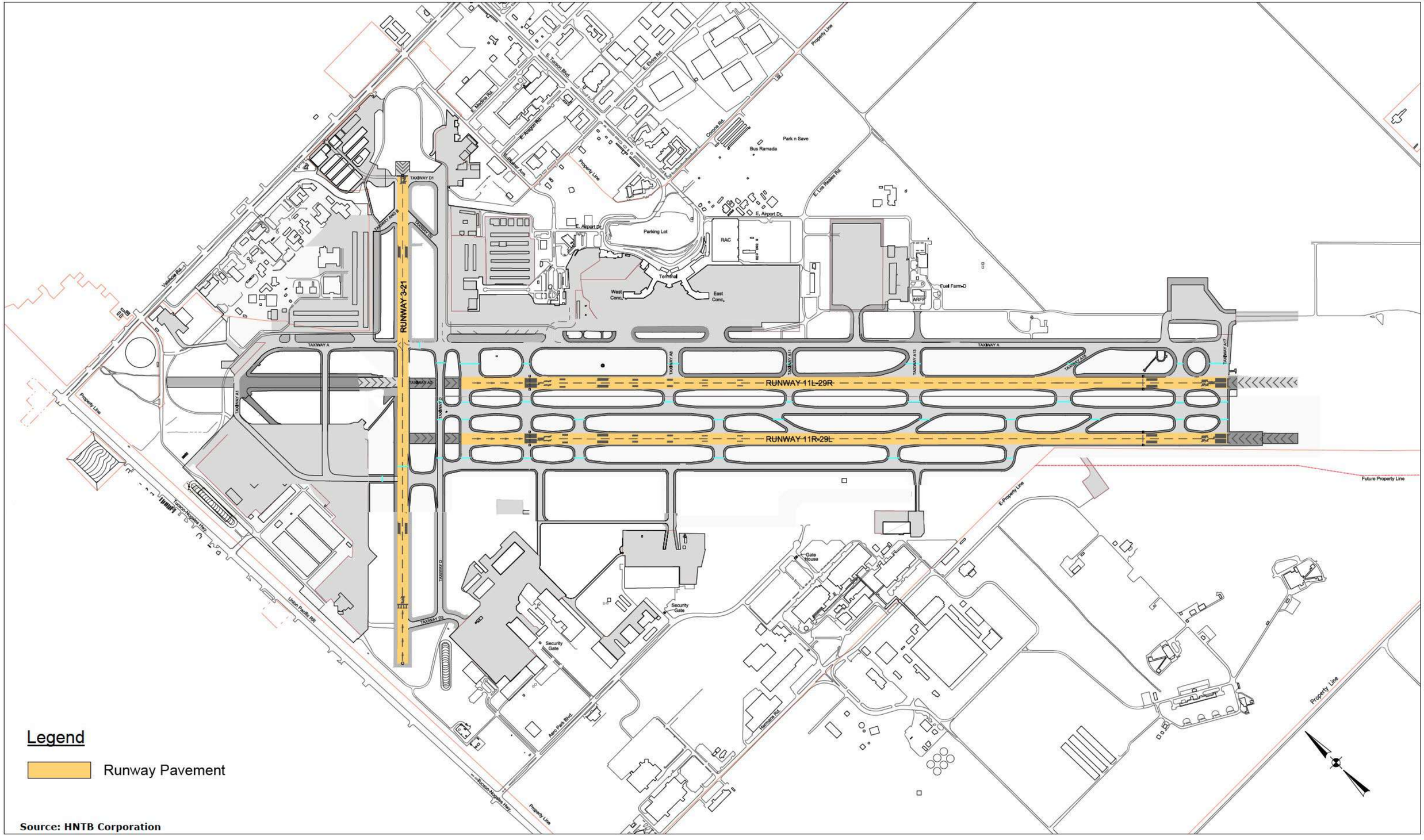
TUCSON INTERNATIONAL AIRPORT
TUCSON AIRPORT AUTHORITY

Airfield Safety Enhancement Implementation Study

Drawing Scale: 1" = 1,250'

Construction Phase 5

Figure
2-8



Source: HNTB Corporation

TUCSON INTERNATIONAL AIRPORT
TUCSON AIRPORT AUTHORITY

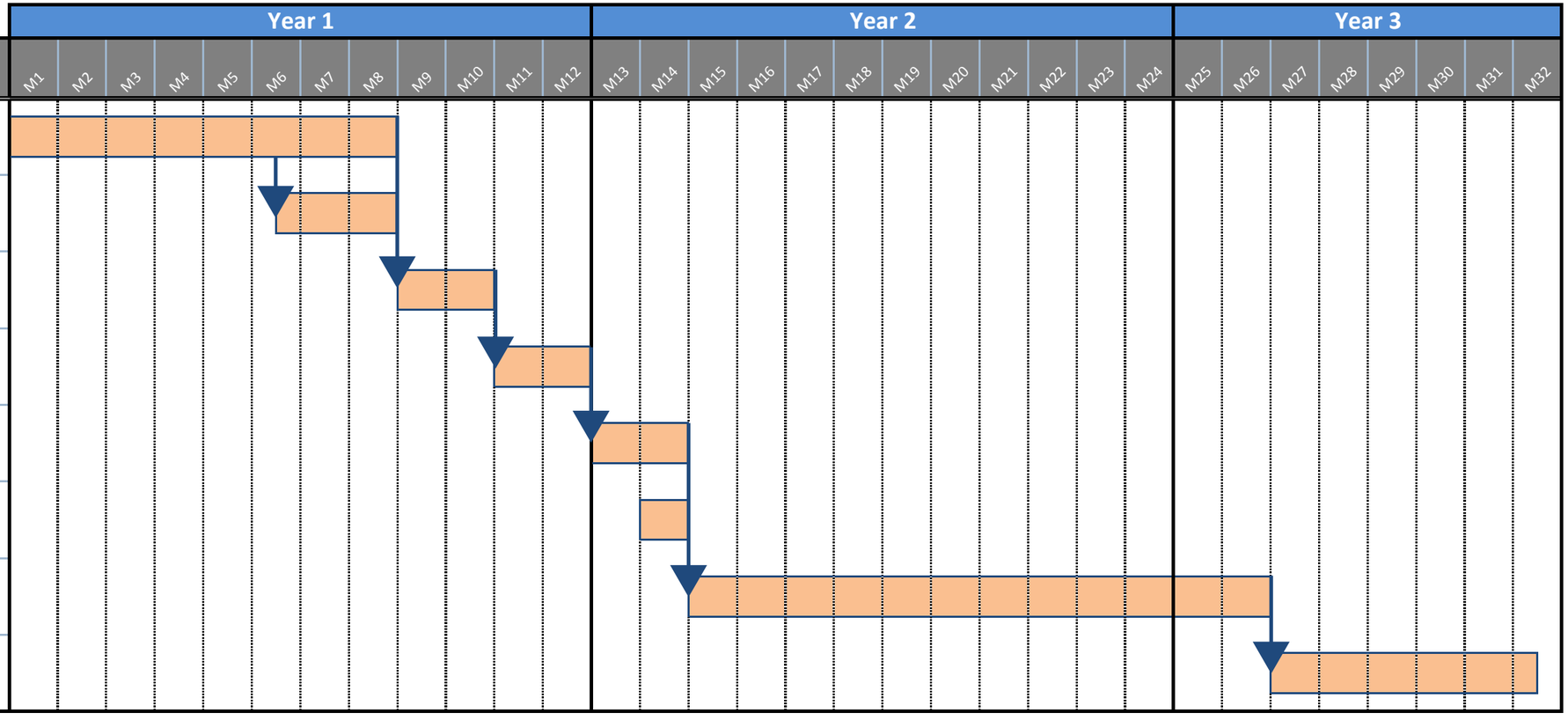
Airfield Safety Enhancement Implementation Study

Drawing Scale: 1" = 1,250'

Final Runway Configuration

Figure 2-9

Phase	Duration
Phase 1 - Southwest Outboard Taxiway	8 months
Phase 2 - Runway 3-21 Intersection	2.5 months
Phase 3A - Taxiway A5	2 months
Phase 3B - Taxiway A8	2 months
Phase 3C - Taxiway A13	2 months
Phase 4A - AOA Fence & Barricades	1 month
Phase 4B - Runway 11R-29L	12 months
Phase 5 - Runway 11L-29R	5.5 months



2.6 Program Cost Estimate

2.6.1 Introduction

A preliminary program cost estimate was prepared for this project. **Table 2-1** lists the probable construction costs based on the Proposed Action plan. The quantities of material were estimated from the plan by performing detailed quantity take-offs. The cost estimate includes a 25 percent contingency to account for level of design of the program. The cost estimate will increase in accuracy with each step of the design development, resulting in a lower construction contingency percentage. The construction cost estimate does not include soft costs, which would typically include TAA Administration costs, design, construction management, inspection or other related costs associated with the project. The unit prices used in the development of this estimate reflects recent construction bids in the Arizona market for similar scopes of work. As the design is further developed, actual unit prices will be adjusted and refined to account for rough cut and fill quantities, adjustment to project construction phasing, any liquidated damage restrictions that will be placed on the contractor to help encourage production, and modifications to the allowable construction windows.

Table 2-1: Proposed Action Construction Cost Estimate

Program Components	2014 Cost
General Items[1]	$4,110,230
Pavement	$80,513,431
Drainage	$2,619,000
Airfield Lighting and Signage	$6,608,300
NAVAIDS	$1,655,000
25% Construction Contingency[2]	$23,068,990
Total Construction Cost	$121,737,451
Additional Program Items	
Drainage Detention Basins	$1,161,510
Enabling Project Activities	$8,646,047
ANG Extended Blast Pads Runway 11R-29L	$809,231
2 ANG BAK 12/14 Aircraft Arresting Systems	$4,300,000
Airfield Signage for Runway 11L-29R Redesignation[3]	$609,375
Total Program Cost	**$137,263,614**

Source: HNTB Analysis based on comparable construction projects.
Note: All dollars are 2014 and do not include escalation.

1. General items includes mobilization, temporary fencing, trailers, etc. and many items are not included in the general conditions
2. Construction contingency not applied to some general conditions, NAVAIDS, and airfield vault.
3. Signage associated with Runway 11R-29L re-designation included in program construction costs.

2.6.2 Unit Prices

Unit prices were developed based on recent airfield construction bids in the western United States and adjusted for local Arizona market conditions. Construction prices are estimated in 2014 dollars. Unit prices are based on the following sources:

1. PHX – Apron Reconstruction (2013)
2. PHX – Hold Bay Rebuild (2013)
3. PHX – North Runway Construction (2009)
4. LAS – Runway 25R Reconstruction (2014)
5. LAX – West Aircraft Maintenance Area (2014)
6. LAX – Taxiway T Construction (2013)
7. LAX – Runway 25L Relocation (2007)
8. FAT – Runway 11L/29R Reconstruction (2013)
9. PDX – Runway 10R-28L Rehabilitation (2011)

2.6.3 Assumptions

2.6.3.1 Pavements

The quantities for the proposed runway, taxiway, and shoulder pavements were estimated from area and volume calculations from preliminary CADD plans. It is assumed that all existing pavement will be removed within the project limits. The pavement prices assume that the contractor will have access to an on-airport concrete batch plant. It is also assumed that the on-site Portland cement concrete (PCC) batch plant would have adequate power and water, and no additional site improvements would be required. For estimating purposes the following pavement section characteristics were assumed for the runway, taxiways, blast pads, and shoulders:

A. Full Strength Runway/Taxiway PCC Sections
   16” P-501 PCC
   8” Econocrete
   6” Crushed Aggregate Base
   6” Subgrade Preparation

B. Shoulder/Blast Pad Asphalt Section
   3” P-401 Asphalt Concrete
   6” Crushed Aggregate Base
   6” Subgrade Prep

Excavation quantities were estimated based on the proposed pavement section volumes. At this stage of the design, no vertical design has been developed so it was assumed that quantity of excavation would be equivalent to the volume of the proposed pavement section.

2.6.3.2 Drainage

Most of the existing drainage on the airfield flows overland in the infield areas and is conveyed via earthen swales and under taxiway and runways via pipe culverts. It is assumed that the Proposed Action would maintain discharge locations, drainage tributary areas and a similar conveyance system. Pipe culverts and headwalls would be constructed under the new facilities to allow storm follow to discharge off the airfield. To address water quality concerns two (2) new airfield drainage detention basins will be constructed in the northwest portion of the airport.

2.6.3.3 Airfield Lighting and Signage

The quantities for airfield and signage were calculated based on the assumption that all taxiways would have new taxiway edge lighting, in-pavement guard lights and elevated wig-wags at the runway hold positions. It was assumed that new runway edge lights and runway centerline lights would be installed for Runway 11R-29L. The amount of conduit and wire was based on the assumption that on average 1-2" concrete encased PVC conduit and two (2) #8 5KV L-824 Cables would be installed in between each fixture.

TAA noted that the FAA has requested that the entire airfield signage be revised and renamed to minimize pilot confusion and improve safety. Therefore, new airfield Lumacurve signage would be installed in areas affected by the construction impacts. In all other airfield areas, the existing sign panel faces will be removed and replaced to address the taxiway re-designation project.

TAA noted that it would be beneficial to construct a new airfield lighting electrical vault under this program. It is assumed that the new airfield lighting vault will be a single story 4,000 square foot concrete masonry unit (CMU) building with approximately 10 Constant Current Regulators (CCR), an Automatic Transfer Switch (ATS), an external fuel tank and include minor site improvements. It is assumed that new electrical 4-4" concrete encased duct bank and associated electrical manholes will be installed to extend power from the new vault to the airfield. It is assumed that the new duct bank will run parallel the entire length of Runway 11R-29L.

2.6.3.4 NAVAIDS

Runway 11R-29L will be a visual approach runway with no formal ILS; however, PAPIs will be installed on each end of the runway. On Runway 11L-29R, the existing Runway 11L threshold will be displaced to the south by approximately 921'. This will require the modification of the existing or installation of a new MALSR and the relocation of the existing glide slope antenna. An FAA reimbursable agreement will need to be developed to cover the FAA's cost associated with design reviews, resident engineering, inspections and flight checks for these NAVAID facilities.

2.6.3.5 Air National Guard Reimbursable Items

It is assumed that two BAK 12/BAK 14 aircraft arresting systems will be installed on Runway 11R-29R for use by the AANG. Fresno Yosemite International Airport installed a single BAK 12/BAK 14 Arresting System during the extension of Runway 11L-29R in 2013. The cost for that system was $2.4M.

A similar installation at Portland International Airport in Oregon produced a low bid for two systems of $4.3M, in 2011. The Port of Portland was reimbursed for the design and construction management costs associated with the arresting gear foundations by the Oregon ANG.

On both ends of Runway 11R-29L, the AANG has requested that additional asphalt blast pad pavement be installed as part of this Proposed Action to help mitigate the effect of jet blast associated with their aircraft operations. The additional costs associated with this asphalt extension were quantified separately to allow TAA to request reimbursement directly from the AANG.

3.0 Programming Analysis

This chapter summarizes the approach, assumptions, and results of the programming analysis used to analyze, evaluate, and quantify, where possible, the benefits and impacts of the Proposed Action. Included are:

- Summaries of comparative safety driven programs at other airports
- Results of a Simmod *PRO!* analyses of current safety issues at TUS and safety benefits resulting from the Proposed Action
- Analysis of capacity and delay benefits that would result from the Proposed Action
- An analysis of life cycle benefits that would result from the Proposed Action
- Evaluation of the potential environmental benefits of the Proposed Action

3.1 Comparative Safety-Driven Programs

Several precedent projects that provide justification based on safety or a combination of safety and capacity outside of the safety standards program were reviewed and are described below.

Los Angeles International Airport Runway 7R-25L, California: Los Angeles International Airport (LAX) experienced numerous runway incursions on the South Airfield, particularly on the taxiways between Runways 7L-25R and 7R-25L. LAX reported 38 total runway incursions between 1998 and 2001. As part of the program to address the high rate of incursions, Runway 7R-25L was relocated to the south by 55 feet enabling a center parallel taxiway to be placed between Runways 7R-25L and 7L-25R. Similar to the airfield program proposed at TUS, this new parallel taxiway requires aircraft landing on the relocated Runway 7R-25L to exit and turn onto the parallel taxiway before proceeding across Runway 7L-25R. The turn onto the parallel taxiway allows space for aircraft to queue before crossing, and results in increased pilot and air traffic controller awareness, and reduced likelihood of inadvertent runway crossings. Since opening of the project in 2008, the number of runway incursions has dropped significantly with accounts from Los Angeles World Airports (LAWA) staff of 3 only minor runway incursions having occurred between 2008 and 2014.

The primary project justifications were to meet FAA Advisory Circular standards, and to improve the operational efficiency of the airfield and accommodate the majority of the existing and future fleet mix, including ADG-VI aircraft.

Brookings Municipal Airport, South Dakota: At Brookings Airport the RPZ had non-complying uses (a safety issue) and safety issues with the “V” intersection of primary Runway 12-30 and cross-wind Runway 17-35. This created pilot confusion and the potential for runway misidentification which resulted in a crash on take-off when an aircraft departed the wrong runway (similar to the incident in Lexington, KY). To resolve the issues with the runway intersection, a new primary runway was constructed which addressed the RPZ and runway geometry issues. The project was not considered a “safety standards program,” but the new runway resolved

several safety issues and provided the opportunity for a longer runway when traffic warrants. The justification also addressed the major reconstruction of the existing runway that would be required in the near future and the funds that could be redirected from the reconstruction of an existing problematic runway to the construction of a new, safer runway.

Corpus Christi International Airport, Texas: Corpus Christi International Airport (CRP) recently started construction on a $31 million (95% Airport Improvement Program [AIP] funded) runway improvement project. It currently has two runways that intersect in a "V" configuration. The Master Plan cited both safety and capacity benefits from the project as the project involves extending both runways for capacity, to accommodate bigger aircraft, and truncating the end of one runway to eliminate the intersection to address pilot misidentification, reduce potential incursions, and enhance safety.

CRPs average daily operations in 2013 were only 193, but 46% of those operations were military. The two runways at CRP are 7,508 by 150 feet and 6,680 by 150 feet and the azimuth of the runways only differs by 40 degrees.

Port Columbus International Airport, Ohio: In August 2013, Port Columbus International Airport (CMH) completed the reconstruction and relocation of parallel Runway 10R-28L. The new relocated runway now provides for independent arrivals and departures for a diverse mix of passenger, cargo, and general aviation aircraft.

The new Runway 10R-29L is 10,113 feet long and is located 702 feet south of the runway it replaced, resulting in a new separation distance of approximately 3,500 feet. The project cost $140 million, of which $88 million was funded by the FAA. Planning for the relocation began in 2004, and involved a new RPZ that required the acquisition of 35 residences and reconfiguration of a golf course. The former south parallel runway is being converted into a taxiway to provide dual parallel taxiways on the south side of the terminal. In 2009, the time of the FAA's Record of Decision (ROD), CMH was averaging 430 operations per day; the level has since fallen to approximately 350 operations per day, similar to TUS.

In the ROD, it was stated that "In reaching this decision, the FAA has given careful consideration to: (a) the role of CMH in the national air transportation system; (b) the aviation safety and operational objectives of the project in light of the various aeronautical factors and judgments presented; and (c) the anticipated environmental impacts of the project."

The Purpose and Need section provided a hybrid justification stating that "The requested actions are specifically linked to the requirements to reconstruct Runway 10R/28L and preserve the flexibility to accommodate capacity needs both on the airfield and in the terminal and landside areas. The cumulative effect of the many issues at CMH is evident in all aspects of the Airport's operations. Structurally sound runways, delay reduction, and lack of passenger handling facilities affect the utility and function of the Airport. The purpose for the proposed Federal Action is to address these needs in a comprehensive, integrated plan for improvement. The

integrated nature of airport infrastructure and operations results in a ripple effect across disciplines when an issue is not addressed. Conversely, when infrastructure and/or operations are improved, a beneficial ripple occurs across disciplines. For this reason, each issue must be addressed in order to wholly fulfill the purpose and need for the project."

In addition, the study determined that noise impacts on the surrounding community would be reduced by the relocation. The stated need for the relocated runway was based on:

- Required reconstruction of the existing runway
- Provision of long-term capacity "not to increase current capacity, but to avoid unwarranted elimination of options that may prove necessary in the future"
- Provision for a full-length taxiway on both the north and south sides of the runway
- Provision for a terminal envelope to avoid unwarranted elimination of options that might prove necessary in the future
- Provision for sufficient ancillary facilities to accommodate future demand
- Reduction of noise impacts on surrounding communities

Omaha Eppley Airfield, Nebraska: Omaha Eppley Airfield (OMA) upgraded its parallel runway (14L-32R) from 5,185 x 150 ft. to 8,500 x 150 ft. in 2001 using FAA funds in part with a Letter of Intent (LOI) received for a portion of the extension. The runway upgrade helped address the frequent misidentification of Runway 14L-32R and provided greater flexibility for air traffic control to segregate the diverse fleet operating at OMA. Taxiway S and Taxiway Z were extended to match the runway extension. Parallel Runway 14R-32L is 9,502 feet by 150 feet. OMA also has a crosswind runway that is 8,154 feet by 150 feet.

The case studies above indicate several instances in which runways have been relocated to address safety issues. Often, the projects were planned to also help increase capacity, improve operational efficiency, and reduce environmental impacts.

3.2 Simmod Approach and Data Inputs

The Simmod *PRO!* airfield and airspace simulation modeling software was used to simulate projected operations at TUS and to examine the safety and operational benefits of the Proposed Action. The main purposes of the Simmod analysis was to document the complexity of air traffic at TUS, to quantify the safety enhancements provided by the Proposed Action, and to test future runway operations under the Proposed Action. The specific goal of this analysis was to quantify how the potential aircraft conflict points (in the airspace and on the airfield) change between the existing condition and the Proposed Action condition with the relocated runway and new center parallel taxiway between runways, in addition to other needed airfield safety enhancing improvements.

This section details the projected activity levels, assumptions, and approach used for this analysis. Identified safety benefits are discussed in **Section 3.3** and associated capacity/delay benefits are discussed in **Section 3.4.1**.

3.2.1 Projected Activity Levels

A future 2024 Design Day Flight Schedule (DDFS) was prepared to assist in modeling future conditions at TUS to evaluate the benefits of the Proposed Action. An average weekday in March, the peak month at TUS, was selected to represent the Design Day.

The FAA's 2013 Terminal Area Forecast (TAF) provided the estimate of annual aircraft operations for 2024. Peak month operations were estimated by applying the ratio of March to annual operations for 2013 to the annual 2024 forecast. Average weekday peak month operations were estimated using the current March ratio of average weekday to average day operations for each activity category. **Table 3-1** shows the calculations used to estimate aircraft operations in each category for the design day.

Many military aircraft missions at TUS consist of two to four aircraft (mostly F-16's) flying in close formation. The ATCT counts each of these missions as a single operation, even when they include multiple aircraft making several overhead passes. To account for this difference, an estimate of total aircraft movements, which exceeds total aircraft operations, is included in the table.

As shown, the 2024 design day activity levels are estimated to include 496 aircraft operations, as counted by the ATCT, and 624 total aircraft movements. The design operations levels were used as the starting point for preparing the 2024 DDFS. The DDFS is essentially a projected schedule that shows the origin or destination, type of operation, aircraft type, airline, if applicable, flight time, and gate or parking location for each flight throughout the design day. The approaches and assumptions used to estimate the DDFS for each category follow:

Scheduled passenger aircraft operations: An existing flight schedule was used as the starting point to develop the DDFS. Scheduled seat departures were assumed to increase at the same rate as the TAF projection of passenger enplanements. Passenger aircraft departures were assumed to increase at the same rate as the TAF projection of commercial (air carrier plus air taxi) operations. The fleet mix was then adjusted to match the forecast of seat departures. The fleet projections accounted for published airline fleet plans, in particular the ongoing transition from 50-seat regional aircraft to 70-seat regional aircraft. It was assumed that new flights would be timed to cover gaps in the existing schedule by each airline. It was assumed that the new merged American Airlines would operate out of Concourse B and that United would move to Concourse A to help balance operations.

Table 3-1: Forecast 2024 Design Day Operations

	-- Itinerant Operations --					-- Local Operations --			
Fiscal Year	**Air Carrier**	**AT & Com.**	**GA**	**Military**	**Sub-total**	**Civil**	**Military**	**Sub-total**	**Total**
TAF Annual Operations[1]									
2013	30,751	20,508	40,336	15,595	107,190	21,980	9,563	31,543	138,733
2024	38,876	21,352	45,225	15,595	121,048	24,577	9,563	34,140	155,188
Annual Operations used for Programming Analysis[1]									
2013	30,751	20,508	40,336	15,595	107,190	21,980	9,563	31,543	138,733
2024	38,876	21,352	45,225	15,595	121,048	24,577	9,563	34,140	155,188
Peak Month Share of Annual Operations									
	9.7%	10.2%	9.5%	8.6%		9.5%	9.0%		
Peak Month Operations[2]									
2013	3,044	2,047	3,975	1,201	10,267	2,118	716	2,834	13,101
2014	3,770	2,173	4,288	1,345	11,576	2,334	865	3,199	14,775
Weekday to Average Day Ratio[3]									
	1.024	1.012	0.939	1.329		1.001	1.368		
Design Day Aircraft Operations[3]									
2013	101	67	120	51	339	68	32	100	439
2024	124	71	130	58	383	75	38	113	496
Design Day Aircraft Movements[4]									
2013	101	67	120	111	399	68	83	151	550
2024	124	71	130	126	451	75	98	173	624

Sources: As noted and HNTB analysis. AT = Air Taxi; Com. = Commuter; GA = General Aviation

[1] Federal Aviation Administration, 2013 Terminal Area Forecast, 2013. The programming analysis assumes same annual forecast numbers as the TAF.

[2] March 2013 operations data from FAA OPSNET. March share of 2024 annual operations assumed to be the same as 2012-2013 average.

[3] Average weekday to average day share calculated using daily OPSNET data from March 2014. The 2014 ratio is assumed to apply in 2024.

[4] The ATCT counts military aircraft flying in formation as a single operation, even if multiple aircraft are involved. The aircraft movement counts include each aircraft movement within an operation.

Cargo aircraft operations: Existing cargo operations were identified using the USDOT's T100 database and the FAA's Traffic Flow Management System Counts (TFMSC) database, and projected to increase at the same rate as the TAF forecast of commercial aircraft operations. Flight times were estimated using data from Flight Explorer.

Air taxi operations: Small non-scheduled, for-hire air taxi operations were calculated as the difference between the FAA counts of air carrier and air taxi operations less scheduled passenger aircraft and cargo aircraft operations. The fleet mix was estimated using the FAA's TFMSC database and flight times were estimated using data from Flight Explorer. These operations were assumed to grow at the same rate as the TAF forecast of commercial operations. They were assumed

to park at the Atlantic, Premier, Tucson Jet, or Million Air Fixed Base Operator (FBO) leaseholds.

Itinerant Instrument Flight Rules (IFR) general aviation operations: The fleet mix for itinerant GA operations was estimated using the FAA's TFMSC database and flight times were estimated using data from Flight Explorer. The hourly distribution of operations from the FAA's Operations Network (OPSNET) database was used as a control when estimating flight times. These operations were assumed to increase at the same rate as the TAF forecast of itinerant GA operations. They were assumed to park at the Atlantic, Premier, Tucson Jet, or Million Air FBO leaseholds, or in the West Ramp area.

Itinerant Visual Flight Rules (VFR) general aviation operations: VFR operations typically consist of smaller single-engine or twin-engine piston-powered aircraft, and do not appear in the FAA's OPSNET or TFMSC databases. For the purpose of the DDFS, the breakdown between single engine and twin engine aircraft was assumed to be proportional to the breakdown in the TUS based aircraft counts, and flight times were estimated to match the hourly distributions for VFR operations that were provided by the TUS ATCT. Itinerant VFR GA operations were assumed to increase at the same rate as the TAF forecast of itinerant GA operations. Most VFR operations were assumed to park in the West Ramp area.

Local general aviation operations: Like itinerant VFR GA operations, local GA operations (mostly touch and go) typically consist of smaller single-engine or twin-engine piston-powered aircraft, and do not appear in the FAA's OPSNET or TFMSC databases. For the purpose of the DDFS, the breakdown between single engine and twin engine aircraft was assumed to be proportional to the breakdown in the TUS based aircraft counts, and flight times were estimated to match the hourly distributions for local operations that were provided by the TUS ATCT. It was assumed that each touch-and-go flight consisted of two to ten passes, with each pass accounting for two aircraft operations. Half of touch and go operations were assumed to come from other airports and half were assumed to originate from TUS. Local GA operations were assumed to increase at the same rate as the TAF forecast of local GA operations.

Itinerant military operations: The fleet mix for itinerant military operations was estimated using the FAA's TFMSC database and flight times were estimated based on schedules provided by the 162 Fighter Wing of the AANG. The vast majority of military operations are by F-16 aircraft. They often fly in missions ranging between two and four aircraft. As noted earlier, operations by each of these missions is counted as one take-off or landing by the ATCT regardless of how many aircraft are in the mission and how many times they circle the pattern prior to landing. Itinerant military aircraft operations were assumed to increase at the same rate as the TAF forecast of military aircraft operations. F-16's were assumed to park in the restricted military area, whereas other military aircraft were assumed to park and refuel at one of the FBOs.

Local military operations: The fleet mix for local military operations is very similar to the mix for itinerant military operations. Typically, military missions consist of two to four aircraft that leave the local airspace to conduct maneuvers and upon return, conduct additional maneuvers in local airspace before landing. The "take-off" portion of the initial approach and subsequent local approaches and the final landing are counted as local operations by the ATCT. The flight times were based on schedule information provided by the 162Fighter Wing.

The categories above encompass a wide variety of aircraft types including small piston aircraft, helicopters, larger corporate turboprops and business jets, scheduled passenger aircraft including regional and mainline jets, heavy cargo and military aircraft such as the A300, B747, and the KC-135, and high-performance military aircraft such as the F-16 and the A-10.

3.2.2 Simmod Approach and Assumptions

The following is a description of the three simulation modeling scenarios that were conducted using Simmod *PRO!* modeling software. The scenarios focused on the No Action and Proposed Action with alternate operations scenarios. No phased construction scenarios were analyzed as this Study focused on the Proposed Action including all connected actions such as the taxiway system. Phased construction could be modeled under follow-on studies if determined that they are needed.

Base Case Airfield and Airspace: The TUS airfield as it essentially exists today was modeled to represent a No Action scenario. The enhancements to the airfield geometry discussed in the No Action alternative in **Section 2.2** were considered and deemed not likely to have a significant effect on modeling results and therefore, were not made part of the base case model.

The base case airfield and airspace was modeled for both east flow (landing and departures on Runways 11L and 11R) and west flow (landings and departures on Runways 29R and 29L).

Runway 3-21 was not used for this or any of the modeling scenarios. In actual practice Runway 3-21 is used during light wind conditions while Runways 11R-29L and 11L-29R are the primary runways in use, but that use of 3-21 is very limited. It was deemed to not be significant to the results of the study and therefore, that limited use was not included in the modeling.

The weather conditions used for modeling were VMC. Instrument Meteorological Conditions (IMC) were not modeled for any of the scenarios.

For the base case the following runway assignments were used:

- Small piston VFR, and small piston touch and go operations were assigned to Runway 11R-29L.
- Small piston IFR operations, along with IFR and VFR large and heavy business, commercial, cargo, and military operations were assigned to Runway 11L-29R.

- Military touch-and-go operations and overhead 360 operations were also assigned to Runway 11L-29R.

The base case Simmod modeling was presented to stakeholders including FAA ATCT, TAA, and the AANG on September 16, 2014. Minor modifications were made to the model based upon input from the meeting.

The assumptions for arriving aircraft under all scenarios included visual approaches and standard arrival separations of 2 ½ to 3 miles, which increased to 4 to 5 miles for heavy aircraft (including Boeing 757 operations).

The assumptions for departing aircraft included a standard separation of 40 seconds to 1 minute, which increased to 1 ½ to 2 minutes for aircraft following a heavy or Boeing 757 aircraft. Reflecting current TUS operations and use as an air traffic controller training facility, departures were assumed to be held back when arrivals were within 3 miles of the Airport (and only 2 miles for small piston aircraft).

Proposed Action with Existing Runway Use System: The Proposed Action as described in **Section 2.4** was modeled. Similar to the base case, the Proposed Action was modeled for both east and west flow. The weather conditions used for modeling were VMC. The runway assignments used for the Proposed Action scenarios were also identical to those used for the base case scenarios.

The Proposed Action Simmod model was presented to stakeholders including FAA ATCT, TAA, and the AANG on October 16, 2014.

Proposed Action with Modified Runway Use System: The airfield and airspace assumptions used for the Proposed Action described above were used for this scenario. The airfield and runway assignments under this modified runway use scenario were determined based upon input from the ATCT and the AANG regarding how the ATCT would most likely operate the airfield with the Proposed Action. The runway assignments under the modified runway use scenario are as follows:

- Departures are primarily assigned to Runway 11L-29R.
- Arrivals are primarily assigned to Runway 11R-29L
- Small piston touch and goes are assigned to Runway 11R-29L
- Military approaches for the overhead 360 maneuver initially make their approach to 11L-29R and circle to the north, but land on 11R-29L.

Some dynamic adjustments in runway assignment were made based upon the traffic situation at the particular time of day; however, the adjustments are not made to the extent that would probably be made by actual controllers reacting in real time to the changing nature of traffic.

3.3 Safety Benefits

The results of the Simmod analysis, along with input from stakeholders, were used to evaluate the potential safety improvements of the Proposed Action from quantitative and qualitative perspectives. In addition, this section discusses TUS's enhanced ability to comply with new safety-related FAA design guidance under the Proposed Action.

3.3.1 Quantitative Safety Benefits Summary

The potential safety issues identified in east flow, which are depicted in **Figure 3-1**, are as follows:

1. Aircraft exit Runway 11R onto a taxiway with direct access to Runway 11L. If there is no imminent activity on Runway 11L, the incursion is not a catastrophic incident (ICAO Severity D).
2. Aircraft exit Runway 11R onto a taxiway with direct access to 11L. If there is an imminent arrival or departure on Runway 11L the incursion could be catastrophic (ICAO Severity A or B).
3. Aircraft on close approach to Runway 11R with another aircraft departing on Runway 11L. Landing on the wrong runway could be catastrophic (ICAO Severity A or B).
4. Aircraft on approach to Runway 11R while another aircraft is on approach to Runway 11L. The aircraft could be within at least 1/2 mile of each other, in which case landing on the wrong runway could be catastrophic (ICAO Severity A or B).

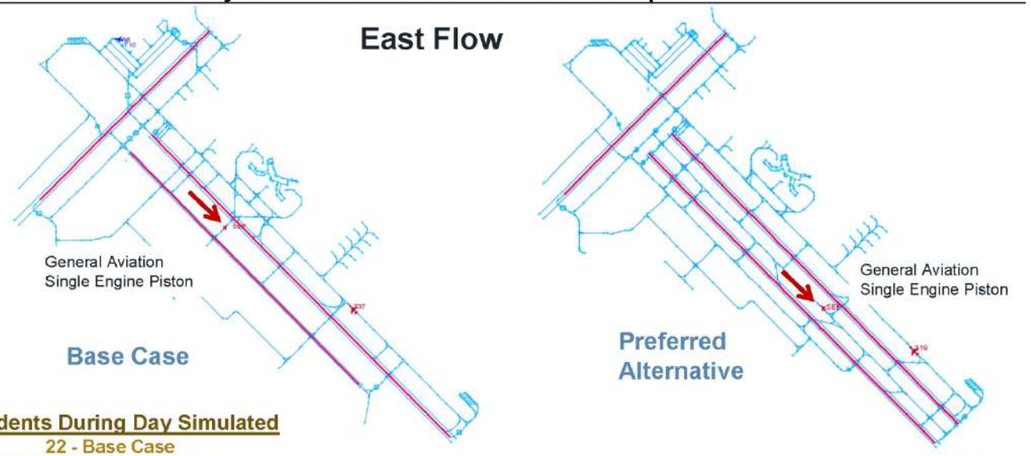
The potential safely issues identified in west flow, which are depicted in **Figure 3-2**, are as follows:

5. Aircraft exit Runway 29L onto a taxiway with direct access to Runway 29R. If there is no imminent activity on Runway 29R, the incursion is not a catastrophic incident (ICAO Severity D).
6. Aircraft exit Runway 29L onto a taxiway with direct access to Runway 29R. If there is an imminent arrival or departure on Runway 29R, the incursion could be catastrophic (ICAO Severity A or B).
7. Aircraft on close approach to Runway 29L with another aircraft departure on Runway 29R. Landing on the wrong runway could be catastrophic (ICAO Severity A or B).
8. Aircraft on approach to Runway 29L while another aircraft is on approach to Runway 29R. The aircraft could be within at least 1/2 mile of each other, in which case landing on wrong runway could be catastrophic (ICAO Severity A or B).

Figure 3-1: Potential Safety Issues in East Flow

Aircraft exits 11R onto taxiway with direct access to 11L

No imminent activity on 11L so incursion is not catastrophic

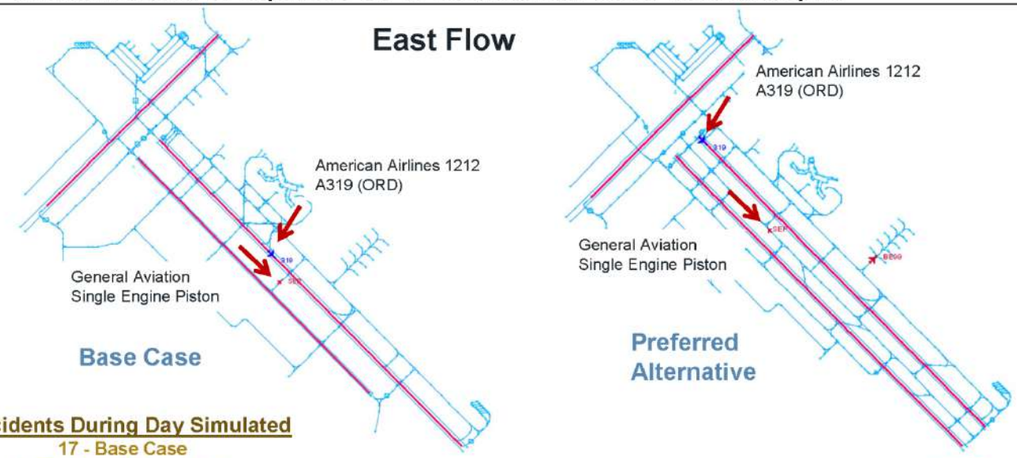


 # Incidents During Day Simulated
22 - Base Case
0 - Preferred Alternative

(ICAO Severity Classification D)

Aircraft exits 11R onto taxiway with direct access to 11L

Imminent arrival or departure on 11L so incursion could be catastrophic

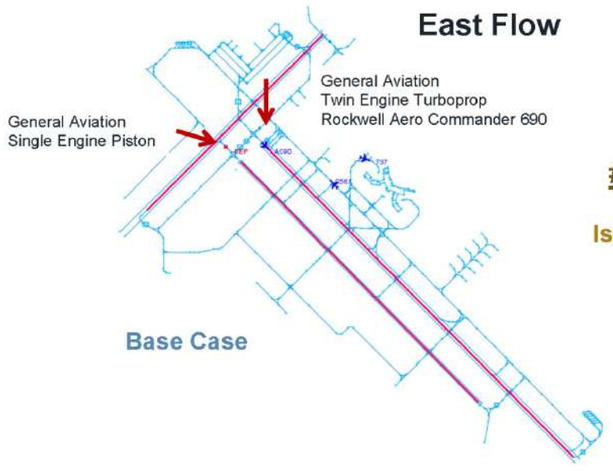


 # Incidents During Day Simulated
17 - Base Case
0 - Preferred Alternative

(ICAO Severity Classification A or B)

Aircraft on close approach to 11R with departure on 11L

Landing on wrong runway could be catastrophic

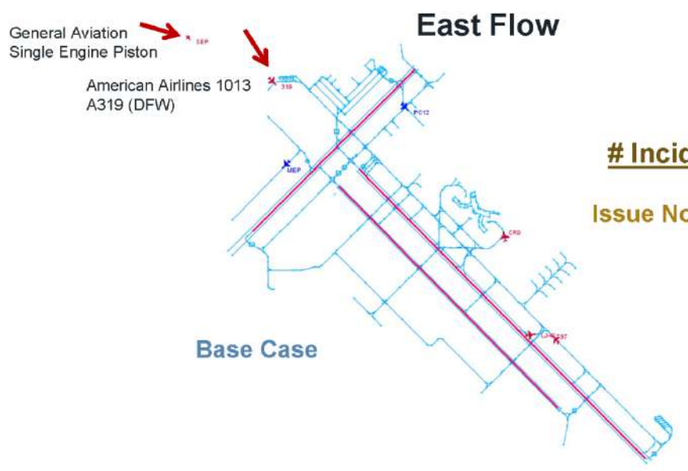


 # Incidents During Day Simulated
12 - Base Case
Issue Not Expected For Preferred Action

(ICAO Severity Classification A or B)

Aircraft on approach to 11R while aircraft on approach to 11L

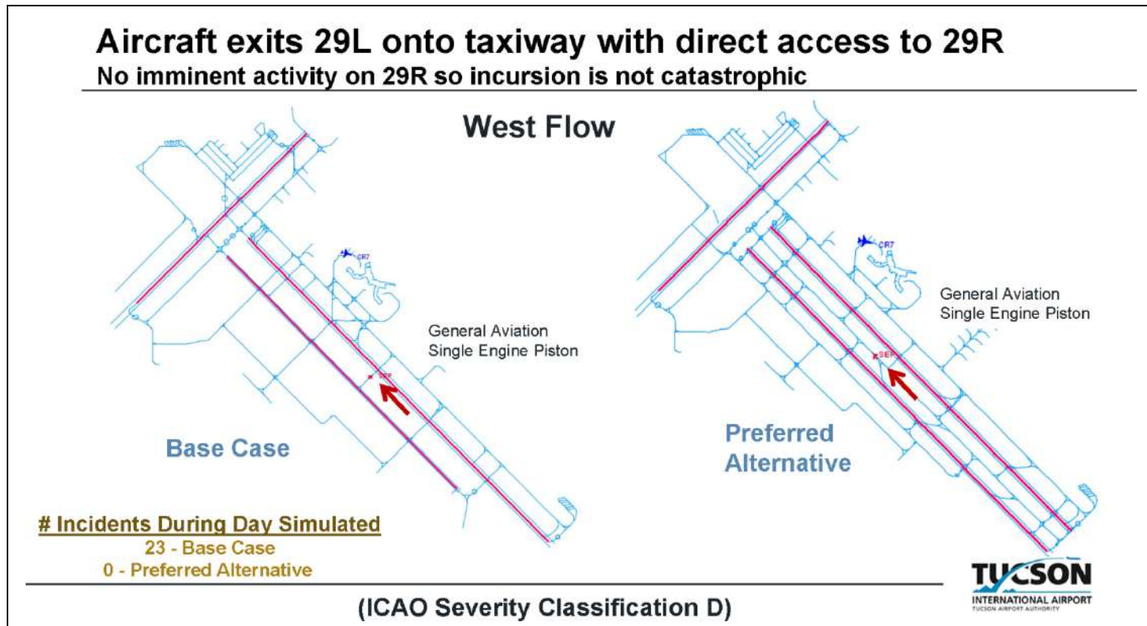
(Aircraft within at least ½ mile) Landing on wrong runway could be catastrophic

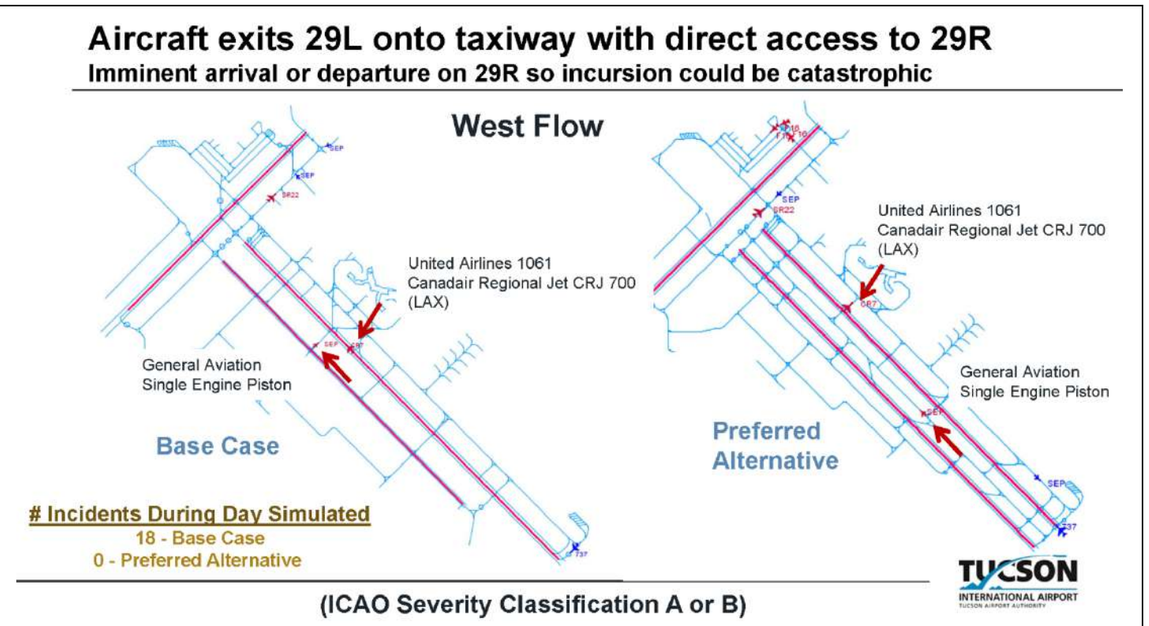


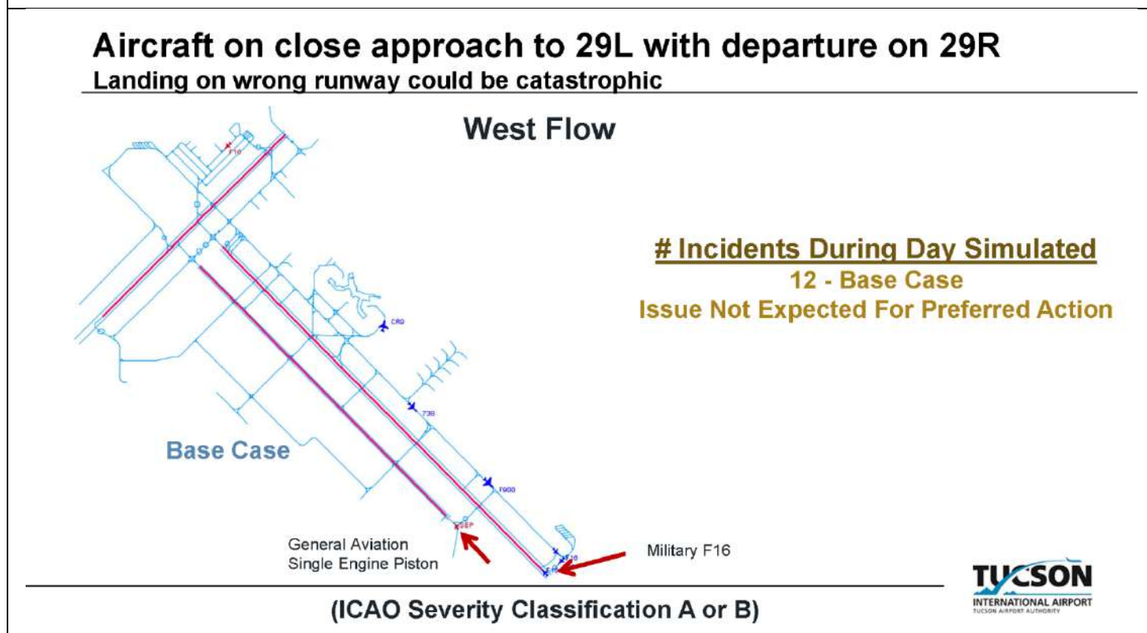
 # Incidents During Day Simulated
12 - Base Case
Issue Not Expected For Preferred Action

(ICAO Severity Classification A or B)

Figure 3-2: Potential Safety Issues in West Flow







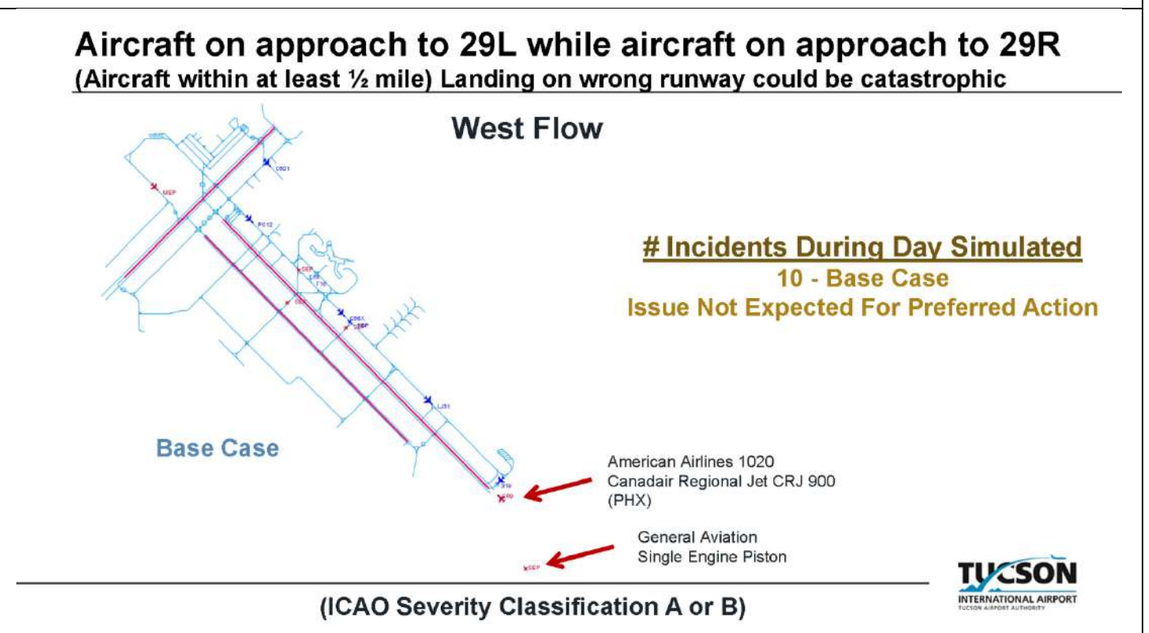


Table 3-2 summarizes the results of the Simmod analysis comparing the frequency of these incursions in the Base Case against the Proposed Action with the existing and modified runway use systems. The existing runway use system was modeled first in order to provide a direct quantitative analysis and comparison of the safety benefits provided by the proposed action. As shown, under east flow there were 63 daily potential incursions modeled in the Base Case. Depending on whether there was another aircraft using the parallel runway, the incursion could have led to a catastrophic collision. The Proposed Action eliminates each of these potential incursion incidents. The results under west flow were similar, also indicating 63 potential incursions with the Proposed Action eliminating each of the potential incursion incidents.

Once the Simmod analysis of the Proposed Action with the existing runway use system was completed, an analysis was conducted of the Proposed Action operated in a way representative of how ATC would likely run traffic with the two air carrier capable runways. The modified runway use system is described in **Section 3.2.2** above.

Operating the Proposed Action under the modified runway use system provides all of the quantitative safety benefits that are provided by the Proposed Action operated under the existing runway use system. In addition, the Proposed Action operated under the modified runway use system provides qualitative safety benefits that are discussed in the next section.

3.3.2 Qualitative Safety Benefits Summary

The Simmod analysis, along with interviews with staff from TAA, the ATCT, AANG, and other tenant stakeholders uncovered a number of qualitative safety benefits that would be provided by the Proposed Action. Several aspects of the qualitative safety benefits also generate a capacity benefit that will be discussed in **Section 3.4.1**.

Compared to most airports of similar size, there is a complex mix of activity at TUS, with significant variations in aircraft performance and pilot experience. The Proposed Action, which provides for two air-carrier capable runways separated by a center parallel taxiway, would resolve or improve several potential safety issues associated with the current airfield layout and mix of activity. For example, the high variability of aircraft final approach speeds increases controller workload and results in greater in-trail separations of aircraft; two air-carrier capable runways remedies this problem. In addition, further lateral separation of the two runways reduces the possibility that aircraft converging on final approach will overshoot their final approach course and stray into each other's flight path.

Table 3-2: Summary of Simmod Results - Estimated Daily Safety Related Incidents

Category	Base Case	Proposed Action
East Flow		
Aircraft Exits 11R onto Taxiway with direct access to 11L - No imminent activity on 11L - Incursion not catastrophic. (ICAO Severity D)	22	0
Aircraft Exits 11R onto Taxiway with direct access to 11L - Imminent arrival or departure on 11L - Incursion could be catastrophic (ICAO Severity A or B)	17	0
Aircraft on close approach to 11R with departure on 11L - Landing wrong runway could be catastrophic (ICAO Severity A or B)	12	N/A
Aircraft on approach to 11R while aircraft on approach to 11L - Aircraft will be within at least 1/2 mile of each other - Landing wrong runway could be catastrophic (ICAO Severity A or B)	12	N/A
West Flow		
Aircraft Exits 29L onto Taxiway with direct access to 29R - No imminent activity on 29R - Incursion not catastrophic (ICAO Severity D)	23	0
Aircraft Exits 29L onto Taxiway with direct access to 29R - Imminent arrival or departure on 29R - Incursion could be catastrophic (ICAO Severity A or B)	18	0
Aircraft on close approach to 29L with departure on 29R - Landing wrong runway could be catastrophic (ICAO Severity A or B)	12	N/A
Aircraft on approach to 29L while aircraft on approach to 29R - Aircraft will be within at least 1/2 mile of each other - Landing wrong runway could be catastrophic (ICAO Severity A or B)	10	N/A

Source: HNTB Analysis

The AANG needs to meet specified reservation times for the military airspace areas they use for training and proficiency. ATC often has to work hard to meet military departure times while they also accommodate arriving air carrier, general aviation and military aircraft. There are frequent occurrences of arriving military aircraft that are low on fuel and further complicate operations. Having two runways that can handle all of the diverse fleet of aircraft that operate at TUS will allow ATC to release departures out in time to meet the reservation times while allowing arriving aircraft to arrive without significant holding delays. The Proposed Action would therefore provide greater safety margins for military aircraft.

A key component of the Proposed Action would be the center parallel taxiway. The new taxiway would provide an impediment to the path of arriving aircraft to enhance pilot situational awareness and reduce ATC workload by ensuring that aircraft will not be able to directly cross another runway without making a conscious turn. In addition, the taxiway allows aircraft to bypass Runway 11L-29R during closure periods or emergency Alerts.

The proposed displaced thresholds on Runway 11L and Runway 11R would reduce the risk of incursion from aircraft errantly taxiing on Taxiway D without clearance to cross the approach end of the runways. Aircraft classified as B-II or smaller transiting on Taxiway D would be underneath the threshold siting surfaces of both runways and would be outside of the runway safety areas and runway obstacle free areas.

On the southeast end, the arrival thresholds would also be the same location and have the same width under the Proposed Action. This would reduce potential pilot confusion that could result in wrong runway landings. There have been several incidents where pilots mistakenly identify Taxiway A for Runway 29R. The image in **Figure 3-3** below depicts the existing approach view from an aircraft on approach to Runway 29R. The Proposed Action will provide visual cues to pilots especially with the ANG-required extended blast pads.

Figure 3-3: Runway 29R Approach View

Source: Google Earth

Finally, the Proposed Action will provide an opportunity to update airfield signage, lights, pavement markings, and nomenclature that will reduce pilot confusion. TUS is overdue for re-designating the parallel runways from 11-29s to 12-30s. The update to the runway designators will enable more intuitive pilot navigation, especially for VFR pilots.

3.3.3 FAA Design Guidance Addressed with this Project

FAA's design advisory circular, Advisory Circular (AC) 150/5300-13A, consolidates a variety of recent research findings related to airfield safety. Previously, airfield safety enhancement bulletins had been published in FAA orders and engineering briefs. The research correlates existing design geometries with incursion history as well as the future potential for an incursion to take place. The FAA found that there

are specific trends in airfield geometry that can result in incursions and have broadly identified them as:

- Aligned taxiways – Aligned taxiways, which are now prohibited, can cause a loss of pilot situational awareness as the taxiway continues directly into a runway. *Existing Taxiway A2 is an aligned taxiway that ties directly into the end of Runway 11L.*
- "High energy intersections" – Airports should not have runway crossing points in the middle 1/3 of the runway to provide enhanced pilot situational awareness. *GA traffic exiting Runway 11R onto Taxiways A8, A11 or A13 must cross Runway 11L-29R in the middle third of the runway.*
- Misaligned runway arrival thresholds – Pilots may misidentify a runway as a taxiway or vise-versa. *The Runway 29L and Runway 29L thresholds are not aligned and pilots have misidentified Runway 29R as Runway 29L and Taxiway A, which is aligned with Runway 29R, as Runway 29R when approaching the Airport from the southeast.*
- Extra-wide taxiway pavements – Signage potentially could be too far out of view for pilots. *Taxiways A4 and A17 have wider than standard taxiway pavement.*
- Runway crossings that lead directly into a ramp – Pilots could mistakenly cross a runway without being cleared.
- Direct runway crossings from an adjacent runway – After landing, pilots could mistakenly continue their taxi path in front of an aircraft landing or departing on an adjacent runway. *Aircraft landing on Runway 11R-29L must cross Runway 11L-29R after exiting the runway.*
- Entrance taxiways to runways – Pilots approaching a runway sometimes mistakenly line up for approach on the parallel taxiway. Rounding out the entrance taxiway to a runway visually enhances both the taxiway and runway. *The end of Runway 29L is rounded out similar to a taxiway entrance.*
- Runway/Taxiway and Taxiway/Taxiway intersections – Right angles provide the best visibility left and right for a pilot at an intersection. *Taxiway A2 ties directly into the end of Runway 11L at an angle.*
- Complex runway/taxiway intersections – Pilots can get confused on the airfield if there are too many decision points.
- Runways beginning near the intersection of a crossing runway – Pilots could mistakenly takeoff or land on the wrong runway.

The Proposed Action would enable TUS to resolve or mitigate all of the above potential safety concerns.

3.4 Additional Benefits

In addition to the safety related benefits of the program other ancillary benefits would be realized. These benefits are summarized in this section.

3.4.1 Aircraft Operational Benefits

The primary purpose of the Proposed Action is to enhance safety at TUS. However, the Proposed Action would also provide ancillary aircraft operational benefits to TUS's users. This section quantifies the operational benefits, defined as travel time and delay savings, that were identified in the Simmod analysis and also discusses qualitative aircraft operational benefits not captured by the Simmod modeling.

3.4.1.1 Quantitative Aircraft Operational Benefits

As noted in **Section 3.2.2** the Proposed Action was tested with both the existing runway use system and a modified runway use system that segregates arrivals and departures between the two air carrier capable runways. The travel time and delay results of the Simmod analysis are summarized in **Table 3-3**. Delay encompasses both aircraft ground and air delay resulting from aircraft queuing prior to departure or slowing or holding in the air upon arrival. It is important to note that the primary purpose of the Simmod analysis was to analyze the safety enhancement benefits of the Proposed Action. Therefore, the potential operational enhancements associated with the proposed new runway and taxiway system were not comprehensively explored.

Under east flow conditions, implementing the Proposed Action under the existing runway use system marginally increases total daily travel time (275 minutes for arrivals and 53 minutes for departures for a total increase of 328 minutes) and delay (increase of 39.7 minutes for departures and decrease of 15.1 minutes for arrivals for a net increase of 24.6 total minutes) when compared to the base (No Action) case. An increase in travel time is not surprising given that the additional parallel taxiway being added between the runways marginally increases taxi distance as aircraft turn onto that taxiway and travel to another taxiway for crossing the adjacent runway; however, this strategy provides a significant increase in safety.

When the Proposed Action is operated under the modified runway use system, the daily delay is reduced by a total of 235 minutes compared to the base case, an amount that is greater than the added travel time. In essence, when the Proposed Action is used effectively under the modified runway use system, it provides a significant increase in safety while providing a reduction in overall travel and delay time.

Table 3-3: Summary of Aircraft Operational Impacts of the Proposed Action

	Arrivals			Departures			Total		
	Operations	Travel Time (min.)	Delay (min.)	Operations[1]	Travel Time (min.)	Delay (min.)	Total Ground Delay & Travel Time (min.)	Total Air Delay (min.)[2]	Total (min.)
East Flow									
No Action	238	2419	124	192	3307	409	6199	60	6259
Pref. Alt with Existing System	238	2693	109	192	3360	449	6578	33	6611
Pref. Alt w/ Modified System	238	2610	35	192	3335	174	6149	6	6155
Benefit									
Pref. Alt with Existing System		-274.9	15.1		-53.1	-39.7	-379.1	26.5	-352.6
Pref. Alt w/ Modified System		-191.5	88.7		-28.1	235.1	50.2	54.0	104.2
West Flow									
No Action	238	1936	323	192	4054	418	6686	323	7009
Pref. Alt with Existing System	238	1973	248	192	4046	369	6574	248	6822
Pref. Alt w/ Modified System	238	1804	97	192	4114	100	6087	97	6184
Benefit									
Pref. Alt with Existing System		-36.6	75.3		7.7	49.3	111.9	-16.2	95.7
Pref. Alt w/ Modified System		132.6	226.3		-60.2	318.2	598.9	18.0	616.9
Weighted Benefit[3]									
Pref. Alt with Existing System		-187.7	37.1		-30.8	-7.1	-199.4	10.9	-188.5
Pref. Alt w/ Modified System		-72.9	139.1		-39.8	265.5	251.0	40.8	291.8

Source: HNTB Analysis
[1] Military missions with multiple aircraft were counted as a single operation for departures.
[2] Air Delay equals Arrival Delay multiplied by the percentage of arrival delay that occurs in air.
[3] Assumes combined day/night split of 63.4% east flow and 36.6% west flow.

Under west flow conditions, implementing the Proposed Action with the existing runway use system increases travel time minimally (36.6 minute increase for arrivals and a 7.7 minute decrease for departures for a net increase of 28.9 minutes), but decreases delay (75.3 minutes for arrivals and 49.3 minutes for departures for a total of 124.6 minutes) on a daily basis when compared to the base case. The new airfield layout is especially effective in west flow as the center taxiway removes some opposite direction operations on Taxiway A and gives aircraft a shorter route to avoid opposite direction operations, which significantly reduces delays and enhances safety.

When the Proposed Action is operated under the modified runway use system, the daily delay is reduced by a total of 318 minutes compared to the base case, an amount that is greater than the added travel time. In essence, when the Proposed Action is used effectively under the modified runway use system, it provides a significant increase in safety while providing significant aircraft operational benefits. **Table 3-3** also provides a breakout between air delay and ground delay. This is important because airborne aircraft incur higher operating costs than aircraft that are taxiing or queuing on the ground.

During the daytime, TUS is operated in east flow approximately 60 percent of the time and in west flow 40 percent of the time. At night, the average distribution is 90 percent east flow and 10 percent west flow. The combined day/night distribution is approximately 63 percent east flow and 37 percent west flow. These distributions were used to calculate a weighted average delay benefit. As shown in **Table 3-3**, the Proposed Action with the existing runway use system would increase combined daily east and west flow delay and travel time by 188.5 minutes. The modified runway use system, however, would decrease combined daily east and west flow delay and travel time by 291.8 minutes.

Table 3-4 utilizes the data in **Table 3-3** to calculate the average delay/travel time per operation and then calculate the annual benefit for the 2024 activity level. As shown, the Proposed Action is estimated to increase total annual delay by about 59,000 minutes with the existing runway use system and decrease total annual delay by about 92,000 minutes under the modified runway use system. It should be noted that the Simmod modeling was applied to a design day in March, which is the peak month. Typically, the average delay per operation and the delay benefit per operation declines during less busy months. Therefore the annual numbers in **Table 3-4** are probably slightly overstated.

Table 3-4: Average Aircraft Operational Benefit per Operation and Annual Delay

	Total Ground Delay and Travel Time	Total Air Delay	Total
Weighted Benefit[1]			
Pref. Alt with Existing System	-199.4	10.9	-188.5
Pref. Alt with Modified System	251.0	40.8	291.8
Itinerant Operations/Design Day[2]	383	383	383
Benefit/Operation (min.) [3]			
Pref. Alt with Existing System	-0.52	0.03	-0.49
Pref. Alt with Modified System	0.66	0.11	0.76
Annual Itinerant Operations in 2024[2]	121,048	121,048	121,048
Annual Delay Benefit (min)[4]			
Pref. Alt with Existing System	(63,017)	3,434	(59,583)
Pref. Alt with Modified System	79,335	12,904	92,239

Source: HNTB analysis
[1] Table 3-3
[2] Table 3-1
[3] Weighted benefit divided by itinerant operations per day
[4] Delay benefit per operation multiplied by annual itinerant operations.

Table 3-5 uses information from the FAA's Economic Values for Evaluation of FAA Investment and Regulatory Decisions to convert the operational benefit estimates in **Table 3-4** to dollar terms. This calculation was prepared only for the Proposed Action with the modified runway use system. It was assumed that the ATCT would operate the new runway system in a way that would take advantage of the investment. As shown, the annual reduction in aircraft operating costs at TUS is estimated at approximately $4.2 million.

As noted by the FAA in their Addendum to FAA Airport Benefit-Cost Analysis Guidance, delay incurred at one airport propagates through the rest of the national airport system. In the Addendum, the FAA estimates that every 1.0 minute of delay incurred at TUS generates an additional 0.59 minutes of arrival delay at other airports. Therefore, the Proposed Action is estimate to generate an additional reduction of $2.4 million elsewhere in the national airport system.

Passengers also incur a cost when they experience delay. The FAA guidance recommends using a value of passenger time of $28.60 per hour. Based on this value, the estimated annual value of the Proposed Action is about $1.4 million to passengers at TUS, and about $825,000 to passengers at other airports.

As shown in **Table 3-5**, the combined annual benefit of the Proposed Action with the modified runway use system is estimated at $8.8 million per year. The data in **Table 3-5** should be interpreted cautiously for the following reasons:

- The primary purpose of the Simmod analysis was to identify safety benefits, so capacity and delay benefits were not comprehensively evaluated.
- The analysis represents a "snapshot" for expected activity levels during a busy day in 2024. Years with lower activity levels would likely generate a lower benefit and years with higher activity levels would likely generate a higher benefit.
- Construction of the Proposed Action would temporarily reduce capacity and increase delay. This impact has not been calculated.

Table 3-5: Economic Value of Delay Benefit Associated with the Proposed Action with Modified Runway Use System

	Total Ground Delay and Travel Time	Total Air Delay	Total
Annual Delay Benefit (min)[1]	79,335	12,904	92,239
TUS A/C Operating Cost/min[2]	$37.77	$92.30	
Annual Aircraft Delay Benefit ($)[3]	$2,996,484	$1,191,062	$4,187,546
System Benefit (min)[4]			54,421
General A/C Operating Cost/min (w/o mil)[5]			$44.32
System Aircraft Benefit ($)[6]			$2,411,946
Passenger Delay			
Delay Benefit per Passenger (min.)[1]			0.76
Passengers (Enplaned & Deplaned)[7]			3,854,346
Pax Delay Cost/Hour[2]			$28.60
Pax Delay Cost/Min[2]			$0.48
Passenger Benefit[8]			$1,399,986
System Passenger Benefit[4]			$825,992
Total Annual Benefit[9]			$8,825,470

Sources: FAA Economic Values for Evaluation of FAA Investment and Regulatory Decisions, 2007, Addendum to FAA Airport Benefit-Cost Analysis Guidance, 2010, and HNTB analysis, 2007.

[1] Table 3-4

[2] FAA Economic Values for Evaluation of FAA Investment and Regulatory Decisions and HNTB analysis.

[3] Annual delay benefit (min.) multiplied by average TUS aircraft operating cost per minute.

[4] TUS multiplier of 0.59 applied to annual delay benefit. From Addendum to FAA Airport Benefit-Cost Analysis Guidance, 2010.

[5] Assumed to be the same as TUS air operating cost without military component.

[6] System benefit (minutes) multiplied by general aircraft operating cost/minute.

[7] FAA Terminal Area Forecast for 2024.

[8] Delay benefit per passenger (in minutes) multiplied by annual passengers multiplied by passenger delay cost per minute.

[9] Annual Aircraft Delay Benefit plus System Aircraft Delay Benefit plus Annual Passenger Delay Benefit plus System Passenger Benefit.

Finally, it should be noted that although travel time and delay both add to aircraft operating costs, they vary greatly in their predictability. Ground travel time is very predictable, and therefore air carriers and the AANG can easily build it into their schedules and operating procedures. Delay, however, is much less predictable. Therefore, a reduction in average delay will generate much more benefit in terms of reliability for commercial carriers to meet their schedules and the AANG to meet their reservation times for their military airspace areas than an equivalent reduction in average ground travel time.

3.4.1.2 Qualitative Aircraft Operational Benefits

In addition to the Simmod analysis, interviews with the airport, tower, AANG, and other tenant stakeholders uncovered additional aircraft operational benefits that would result from the Proposed Action. Some of these benefits also have a safety aspect, and were therefore also noted in **Section 3.3**.

The current high variability of aircraft final approach speeds at TUS increases controller workload and results in greater in-trail separations of aircraft. The two air-carrier capable runways that would be available under the Proposed Action would remedy this problem. Since both runways would have the same length, Air Traffic Control will have the ability to dynamically assign aircraft on either parallel runway without a pilot needing to reject assignment based on runway length and width. This program will maximize the flexibility for Air Traffic Control assignment of aircraft, which also improves safety.

An operational issue that is specific to TUS is that the AANG needs to meet specified reservation times for the military airspace areas they use for training and proficiency. ATC often has to work hard to meet military departure times while they also accommodate arriving air carrier, cargo, general aviation and military aircraft. Having two runways that can handle all aircraft will allow the ATC to release military departures out in time to meet their reservation times while allowing arriving aircraft to arrive without significant delays.

The two air carrier capable runways also provide for better integration of aircraft into the national airspace system. When air carrier aircraft depart from Tucson, the local ATC is often given a small window of time during which the aircraft can depart and fit into the enroute airspace flow. This applies to airports such as LAX, Phoenix Sky Harbor International Airport (PHX), and others. This can occur at the same time that ATC is trying to land military aircraft low on fuel and depart military aircraft that need to meet reservation times for airspace. A second major runway will make it much easier to meet ATC departure windows for aircraft entering the enroute ATC system without delaying other users.

The Tucson ATCT is a significant training location for air traffic controllers and has a high proportion of ATC trainees. FAA ATC trainee staff will often train at the TUS Tower and then move on to other sites across the country. Trainees and junior ATC staff regularly space out in-trail arriving aircraft further than experienced controllers. Additionally, trainees are less likely to sequence a departure between sequential arrivals without additional separation, and are much less likely to release

consecutive departures with minimum separation times. This restricts the capacity of a one air carrier capable runway system. Dual air carrier capable runways will mitigate this.

Also as part of the Proposed Action, the center taxiway would allow aircraft to bypass Runway 11L-29R during closure periods or emergency Alerts and would allow for enhanced sequencing of departing aircraft during big departure pushes.

Finally, under the Proposed Action, the new 11R-29L runway would be constructed with concrete as opposed to asphalt. The frequency of required reconstruction is much less with concrete (approximately every 40 years) than with asphalt (approximately every ten years). During each reconstruction, Runway 11L-29R is closed for approximately thirty days, and the capacity of the airfield is reduced significantly. With the new runway, these closures would occur much less frequently and their impacts would be less severe.

Under existing conditions, when the main runway (11L-29R) is closed for reconstruction, the remaining runways cannot fully accommodate the TUS fleet, requiring payload restrictions for some commercial aircraft and the temporary relocation of AANG operations to Davis-Monthan Air Force Base. Under the Proposed Action, TUS would have two air carrier capable runways and would be able to accommodate all of its tenants even if one of the two runways needed to be temporarily closed.

Runways often need to be closed for reasons other than reconstruction. At TUS, the AANG aircraft sometimes experience equipment malfunctions which require the runway to be shut down for foreign object debris (FOD) inspection, removal of disabled aircraft, or lowering of arrestor cables. These shut downs can sometimes last 20 minutes or more, leaving TUS without a fully capable air carrier runway during that time. Within the last year, TUS had 30 Alerts and 11 runway closures due to AANG emergencies.

3.4.2 Life Cycle Benefits

The Proposed Action would replace the current asphalt Runway 11R-29L with a new, larger ARC D-IV concrete runway. The new concrete runway would require much less maintenance and reconstruction than the current asphalt runway, and therefore generate significant life cycle and sustainability benefits.

Based on recent history at TUS, industry experience, and discussions with TAA, reconstruction of asphalt runways is required every twelve years on average, and reconstruction of concrete runways is required every forty years on average. Runway 11L-29R is next scheduled for reconstruction in 2016, at an estimated cost of $12.8 million. Accounting for the difference in runway dimensions, this would translate to a reconstruction cost of approximately $5 million every twelve years for the existing Runway 11R-29L. With the Proposed Action, the reconstruction cost of the new concrete runway is estimated at $30 million, but would not be required until approximately 2062, assuming the first full year of operation would be 2022.

In addition to more frequent reconstruction, asphalt runways incur more frequent routine maintenance and repair (M&R) than concrete runways. The annual M&R cost associated with the existing asphalt Runway 11R-29L is estimated at approximately $13,000 per year. Based on estimates from Portland International Airport (PDX) an 11,000' by 150' concrete runway would incur an M&R cost of approximately $835,000 every ten years. Note that the PDX estimates may overstate the costs for TUS because Tucson has lower labor costs and less precipitation.

Table 3-6 presents the life cycle benefit of the Proposed Action associated with reconstruction and M&R. Under the base case, the next reconstruction of the existing asphalt Runway 11R-29L is expected around 2019 (see **Chapter 1**) with subsequent reconstructions every twelve years afterwards. Under the Proposed Action, the new concrete runway would not require reconstruction until approximately 2062. It is also assumed that under the Proposed Action TAA would elect to not reconstruct 11R-29L in 2019, since they would be replacing it two years later. Consistent with the FAA's Benefit-Cost Analysis Guidance, costs were discounted 7 percent for each year after 2014. As shown, the net life cycle benefit of the new runway would be approximately $5.5 million even though the new runway would have more than twice as much pavement as the existing runway.

The availability of an air carrier capable Runway 11R-29L under the Proposed Action would also generate potential cost savings during subsequent (post-2016) reconstructions of Runway 11L-29R. The quick turn-around times required to reconstruct or refurbish an essential runway require airports to pay a premium on construction costs. The costs are typically 20 to 30 percent higher due to the need to work two shifts or more, higher penalties for not completing construction on time, and more badging and security costs since it is hard to isolate fast paced projects from the airside. The availability of a full-length Runway 11R-29L would reduce the need for the quick turn-around time and associated costs related to Runway 11L-29R reconstructions.

Though not part of the defined Proposed Action, a new fully air carrier capable runway would provide TUS the option to one day close Runway 11L-29R for the amount of time required to upgrade it to concrete pavement. Thereafter, Runway 11L-29R would also gain from the life cycle benefits of concrete construction.

Table 3-6: Post Construction Life Cycle Benefit of the Proposed Action

	Reconstruction Cost		M&R Cost		Total[5]			Discounted Cost	
Year	Base Case[1]	Proposed Action[2]	Base Case[3]	Proposed Action[4]	Base Case	Proposed Action	Discount Factor[6]	Base Case[7]	Proposed Action[7]
2014							1.000		
2019	$5,000,000	$-	$-	$13,312	$5,000,000	$13,312	0.713	$3,564,931	$9,491
2020			$13,312	$13,312	$13,312	$13,312	0.666	$8,870	$8,870
2021			$13,312	$-	$13,312	$-	0.623	$8,290	$-
2022			$13,312	$-	$13,312	$-	0.582	$7,748	$-
2023			$13,312	$-	$13,312	$-	0.544	$7,241	$-
2024			$13,312	$-	$13,312	$-	0.508	$6,767	$-
2025			$13,312	$-	$13,312	$-	0.475	$6,324	$-
2026			$13,312	$-	$13,312	$-	0.444	$5,911	$-
2027			$13,312	$-	$13,312	$-	0.415	$5,524	$-
2028			$13,312	$-	$13,312	$-	0.388	$5,163	$-
2029			$13,312	$-	$13,312	$-	0.362	$4,825	$-
2030			$13,312	$-	$13,312	$-	0.339	$4,509	$-
2031	$5,000,000	$-		$-	$5,000,000	$-	0.317	$4,214	$-
2032			$13,312	$834,596	$13,312	$834,596	0.296	$1,582,872	$246,927
2033			$13,312	$-	$13,312	$-	0.277	$3,681	$-
2034			$13,312	$-	$13,312	$-	0.258	$3,440	$-
2035			$13,312	$-	$13,312	$-	0.242	$3,215	$-
2036			$13,312	$-	$13,312	$-	0.226	$3,005	$-
2037			$13,312	$-	$13,312	$-	0.211	$2,808	$-
2038			$13,312	$-	$13,312	$-	0.197	$2,624	$-
2039			$13,312	$-	$13,312	$-	0.184	$2,453	$-
2040			$13,312	$-	$13,312	$-	0.172	$2,292	$-
2041			$13,312	$-	$13,312	$-	0.161	$2,142	$-
2042			$13,312	$834,596	$13,312	$834,596	0.150	$2,002	$125,525
2043	$5,000,000	$-		$-	$5,000,000	$-	0.141	$702,814	$-
2044			$13,312	$-	$13,312	$-	0.131	$1,749	$-
2045			$13,312	$-	$13,312	$-	0.123	$1,634	$-

Table 3-6: Post Construction Life Cycle Benefit of the Proposed Action (Continued)

	Reconstruction Cost		M&R Cost		Total[5]			Discounted Cost	
Year	Base Case[1]	Proposed Action[2]	Base Case[3]	Proposed Action[4]	Base Case	Proposed Action	Discount Factor[6]	Base Case[7]	Proposed Action[7]
2046			$13,312	$-	$13,312	$-	0.115	$1,527	$-
2047			$13,312	$-	$13,312	$-	0.107	$1,427	$-
2048			$13,312	$-	$13,312	$-	0.100	$1,334	$-
2049			$13,312	$-	$13,312	$-	0.094	$1,247	$-
2050			$13,312	$-	$13,312	$-	0.088	$1,165	$-
2051			$13,312	$-	$13,312	$-	0.082	$1,089	$-
2052			$13,312	$834,596	$13,312	$834,596	0.076	$1,018	$63,811
2053			$13,312	$-	$13,312	$-	0.071	$951	$-
2054			$13,312	$-	$13,312	$-	0.067	$889	$-
2055	$5,000,000	$-		$-	$5,000,000	$-	0.062	$312,058	$-
2056			$13,312	$-	$13,312	$-	0.058	$776	$-
2057			$13,312	$-	$13,312	$-	0.055	$726	$-
2058			$13,312	$-	$13,312	$-	0.051	$678	$-
2059			$13,312	$-	$13,312	$-	0.048	$634	$-
2060			$13,312	$-	$13,312	$-	0.044	$592	$-
2061			$13,312	$-	$13,312	$-	0.042	$554	$-
2062		$30,000,000	$13,312	$-	$13,312	$30,000,000	0.039	$517	$1,166,004
Total								**$6,283,995**	**$1,611,137**
Net Life Cycle Benefit[8]									**$5,503,200**

Sources: As noted and HNTB analysis.

[1] Estimate based on projected reconstruction costs for RW 11L-29R adjusted for difference in pavement area.
[2] Estimate of $30,000,000 every 40 years from HNTB analysis.
[3] Tucson Airport Authority O&M costs for RW 11L-29R scaled to reflect existing 11R-29L pavement.
[4] Assumes O&M but no reconstruction in 2019 under Proposed Action. Post construction O&M costs based on 12-year maintenance cost estimate for concrete runway at Portland International Airport.
[5] Sum of reconstruction cost and O&M cost.
[6] Discount rate of 7 percent per year from FAA Benefit-Cost Analysis Guidance. Discount factor reduced by 7 percent per year for each year after 2014.
[7] Total cost multiplied by discount factor.
[8] Total discounted no-action cost less total discounted project cost.

3.4.3 Environmental Benefits

The life cycle benefits noted in **Section 3.4.2** also generate sustainability benefits. Construction, especially asphalt construction, releases a significant amount of volatile organic compounds (VOC's) into the atmosphere. As an example, the recent reconstruction of Runway 16R at Van Nuys Airport (VNY) generated an estimated 770 pounds of nitric oxide, 450 pounds of carbon monoxide, 700 pounds of particulates, and 50 tons of carbon dioxide on a daily basis for the 8,000 feet long and 150 feet wide runway.

In addition, construction greatly increases the chances of run-off pollution. Therefore, any alternative that reduces the total amount of construction over the life of the project will also reduce adverse air quality and water quality impacts.

As noted in **Section 3.4.1**, the Proposed Action would also reduce aircraft delay. Reductions in aircraft delay would mean reductions in aircraft engine operation, along with a concomitant reduction in fuel usage and adverse environmental impacts such as noise and emissions.

Finally, a second parallel air carrier runway would result in reduced use of Runway 3-21 by high performance aircraft and fewer overflights of downtown Tucson and the Tohono O'Odham Indian Reservation.

3.5 Programming Analysis Summary

The Proposed Action would enable TUS to comply with FAA guidance on airfield geometry and thereby greatly decrease the number of aircraft runway incursions to generate a significant safety benefit. Collateral benefits associated with the Proposed Action include improved airport operational efficiency, reduced aircraft delay, increased air carrier and AANG schedule reliability, more cost-effective and sustainable airfield asset management, improved air quality, and reduction of noise impacts.

4.0 Purpose and Need Narrative

4.1 Introduction

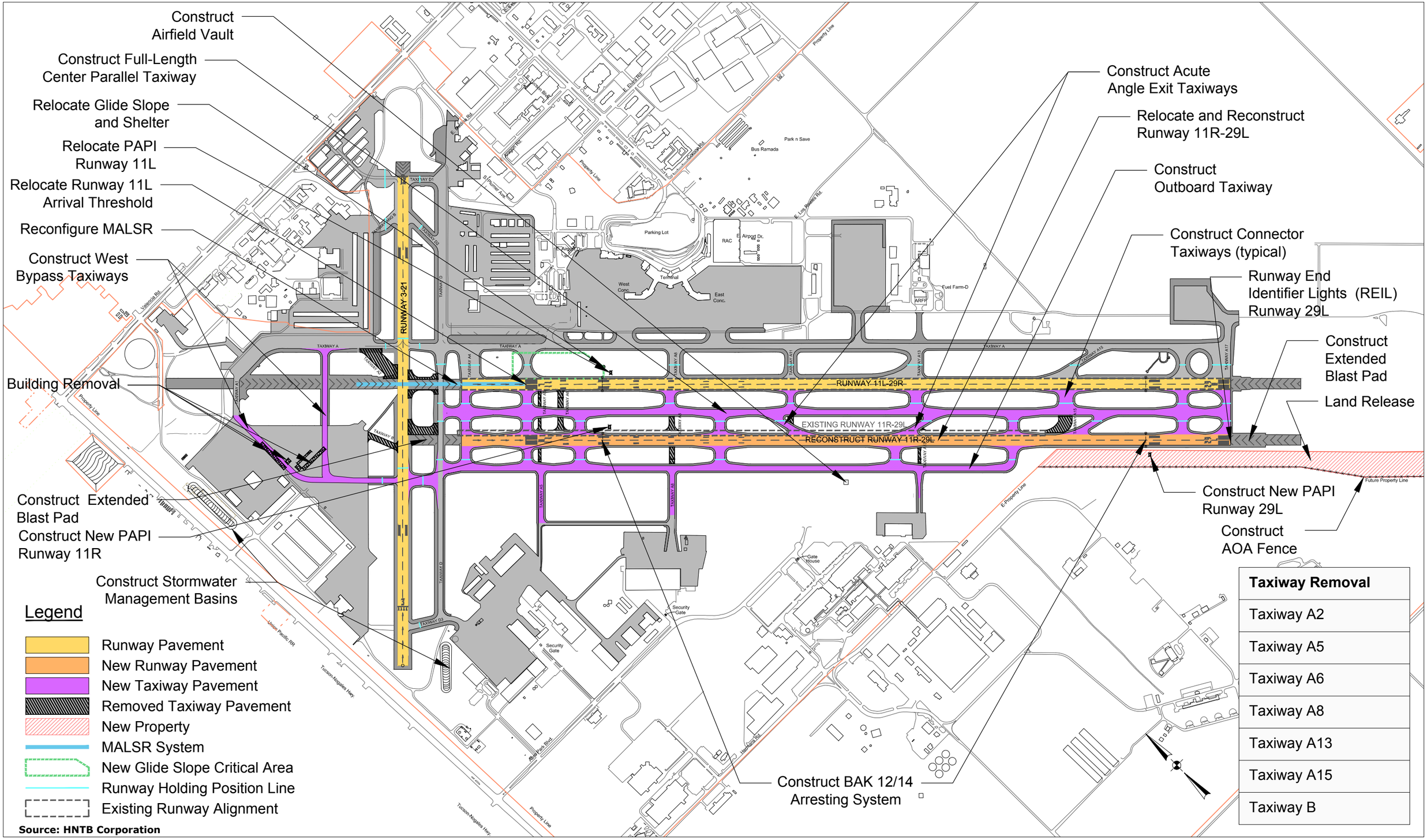
As described in **Chapter 1** of this Study, TAA completed an ASE Study in 2012 which comprehensively reviewed TUS's airfield geometry with the goal of reducing airfield incursions and improving overall safety. The ASE Study developed and subsequently implemented several near-term high priority airfield geometry mitigation strategies. The ASE Study also culminated with a recommended runway program at TUS, which was further studied in the 2014 TUS Master Plan Update. The Master Plan Update focused extensively on geometric design options for achieving the proposed near parallel runway described in the ASE Study. The construction of a center parallel taxiway and the relocation and upgrade of Runway 11R-29L to an air carrier capable runway are the major improvements included in the Master Plan Update recommended alternative. These improvements incorporate the runway and taxiway safety elements identified in the ASE Study as well as additional safety elements developed through the master planning process.

This Study is being developed as a second phase to the 2012 ASE Study to identify critical implementation issues and further document program justification related to major redevelopment of TUS's airfield, as outlined in the 2014 Master Plan Update. As part of this Study, a Purpose and Need narrative is provided in an effort to concisely define the existing deficiencies of the airfield and describe the purpose of the proposed airfield improvements. Defining the Purpose and Need is essential in providing a sound justification for the proposed improvements. In addition, the Purpose and Need narrative will be used as the primary foundation to develop reasonable alternatives to the Proposed Action. This chapter is written in plain English, per FAA requirements, as it is expected that it will ultimately be publicly disseminated as part of a formal environmental review.

4.2 Description of Proposed Action

The Proposed Action (see **Figure 4-1)** consists of the following airfield projects:

- Construct a new full-length center parallel taxiway;
- Relocate and reconstruct Runway 11R-29L to the southwest and upgrade it to meet ARC D-IV runway design standards, including extended blast pads;
- Construct a new outboard parallel taxiway;
- Relocate the Runway 11L arrival threshold;
- Remove Taxiway A2;
- Construct associated taxiways and airfield arresting system;
- Install, relocate, remove or replace NAVAIDs associated with the relocation of Runway 11R-29L;
- Demolish airport buildings to accommodate bypass taxiway;
- Construct an airfield vault;
- Construct stormwater management basins;
- DOD will dispose of and TAA will acquire (at fair market value) approximately 52 acres of DOD Plant 44 property within the new safety area to accommodate airfield development;



Source: HNTB Corporation

Taxiway Removal
Taxiway A2
Taxiway A5
Taxiway A6
Taxiway A8
Taxiway A13
Taxiway A15
Taxiway B

TUCSON INTERNATIONAL AIRPORT
TUCSON AIRPORT AUTHORITY

Airfield Safety Enhancement Implementation Study

Drawing Scale: 1" = 1,250'

Proposed Action Alternative

Figure **4-1**

- TAA will acquire (at fair market value) from DOD and demolish 12 concrete storage bunkers in the new safety area to accommodate airfield development (six [6] of the bunkers are within the property to be acquired by TAA and disposed of by DOD);
- Construct new AOA fence around acquired property; and
- TAA will dispose of and DOD will acquire (at fair market value) approximately 127 acres of property that will provide a safety buffer for DOD operations at Plant 44.

4.3 Purpose and Need for the Proposed Action

4.3.1 Sponsor's Purpose and Need

The purpose of the Proposed Action is to enhance airfield safety and improve operational efficiency at TUS and in the surrounding airspace through improvements to the runway and taxiway system in accordance with current design standards outlined in FAA AC 150/5300-13A, Change 1, *Airport Design*.

Improvements to the TUS airfield are needed to address existing airfield deficiencies in order to further enhance airfield safety at TUS, and to ensure that the existing and anticipated diverse fleet mix using the Airport can be efficiently accommodated on the airfield and in the surrounding airspace. The following sections discuss the purpose and need for the Proposed Action in greater detail.

4.3.1.1 Enhance Airfield Safety

The current deficiencies in airfield geometry at TUS contribute to a significant number of runway incursions and mistaken runway identifications, some of which could be potentially catastrophic. The airfield deficiencies are intensified by the great diversity in aircraft performance and pilot experience among TUS users, and the inability to segregate them within the existing airfield.

A technical airfield review was conducted for the 2012 ASE Study to identify existing hazardous conditions at the Airport that may contribute to safety risks and incursions, and also to assess the FAA identified Hot Spots. Based on the historical surface incursion data used in the 2012 ASE Study, TUS experienced 51 documented surface or runway incursions between November 2005 and November 2010. The majority of incursions occurred at the identified FAA Hot Spots, as shown on **Figure 1-2**; however, incursions at TUS were reported at 16 distinct locations on the airfield in 2012. Two of the four FAA Hot Spots (former Hot Spots 1 and 4) were resolved with safety enhancements in 2012; however, two Hot Spots still exist. The unresolved Hot Spots (shown on **Figure 1-4**) are described as follows:

- **Current Hot Spot 1:** This Hot Spot is located at end of Runway 29L and represents the confusion between Runways 29L and 29R and Runway 29R and Taxiway A. On several occasions pilots on approach during west flow have mistaken Runway 29R for Runway 29L and Taxiway A for Runway 29R, landing on the wrong runway or on Taxiway A. Recently a visiting F-16 executed a touch-and-go on Taxiway A.

- **Current Hot Spot 2:** This Hot Spot is located along Taxiway D between Runways 11L and 11R. At this location, pilots taxiing along Taxiway D have crossed the approach path for Runways 11L and 11R without clearance.

Even with the near term improvements implemented to address former Hot Spots (See **Section 1.3** for discussion), **Table 4-1** illustrates that runway incursions have continued to occur. Since the tabulation of this data, incursions involving runway misidentification have occurred, including: a visiting F-16 performed a touch-and-go on Taxiway A, mistaking it for Runway 29R, and a GA aircraft landed on Runway 11L after being cleared for Runway 11R. Because the Runway 29R and 29L ends are not aligned and are of unequal width, pilots can misidentify Runway 29R as Runway 29L and Taxiway A, which is wider than Runway 11R-29L and aligned with Runway 29R, as Runway 29R when approaching the Airport from the south. According to incident reports provided by the TUS ATCT, between 2011 and 2014, nine (9) wrong runway landings occurred at TUS. Eight of the wrong runway landings were due to pilot confusion associated with Runways 29R and 29L and Taxiway A due to the differences in widths and alignment. One wrong runway landing was associated with approaching Runways 11L and 11R. While reports of wrong runway landings on Runways 11L and 11R are less frequent, the pavement width and condition of existing Runway 11R-29L could lead to misidentification of the runway as a taxiway.

Table 4-1: Historic TUS Runway Incursions

Fiscal Year	Total Runway Incursions	Other Events
2008	2	1
2009	31	2
2010	5	0
2011	11	2
2012	8	1
2013	13	2
2014	2	3

Source: HNTB Analysis of FAA Incursion Reports.
Note: 2014 data only represented 3 months of FY 2014.

To reinforce the need for the airfield improvements, an airfield and airspace simulation model (Simmod *PRO!*) was used to simulate operations at TUS. The model visually documented the complexity of the airport traffic (fleet mix and aircraft speed differentials), identified the main safety issues on the airfield for both east and west flow traffic patterns at TUS, and quantified the number of potential incursions under each flow traffic pattern under current runway conditions. Potential safety issues differ depending on whether the Airport is operating in east or west flow. **Chapter 3**, **Programming Analysis** discusses the Simmod analysis assumptions, methodology used, and includes a discussion of the potential safety issues associated with each of the flows.

Table 4-2 summarizes the potential safety issues and results of the Simmod analysis under east and west flow with existing (base case) airfield conditions. As shown, under east flow there were 63 potential incursions for the design day modeled. Depending on whether there was another aircraft using the parallel runway, any one of these incursions could have led to a catastrophic collision. The results under west flow were similar, also indicating 63 potential incursions for the design day modeled. Significant deficiencies exist with the current TUS airfield geometry, as evidenced by the potential safety related incidents modeled using Simmod *PRO!*.

Table 4-2: Simmod Results (Base Case) – Estimated Daily Safety Related Incidents

East Flow	Potential Incursions
Aircraft Exits 11R onto Taxiway with direct access to 11L - No imminent activity on 11L - Incursion not catastrophic. (ICAO Severity D)	22
Aircraft Exits 11R onto Taxiway with direct access to 11L - Imminent arrival or departure on 11L - Incursion could be catastrophic. (ICAO Severity A or B)	17
Aircraft on close approach to 11R with departure on 11L - Landing wrong runway could be catastrophic. (ICAO Severity A or B)	12
Aircraft on approach to 11R while aircraft on approach to 11L - Aircraft will be within at least 1/2 mile of each other - Landing wrong runway could be catastrophic. (ICAO Severity A or B)	12
West Flow	**Potential Incursions**
Aircraft Exits 29L onto Taxiway with direct access to 29R - No imminent activity on 29R - Incursion not catastrophic. (ICAO Severity D)	23
Aircraft Exits 29L onto Taxiway with direct access to 29R - Imminent arrival or departure on 29R - Incursion could be catastrophic (ICAO Severity A or B)	18
Aircraft on close approach to 29L with departure on 29R - Landing wrong runway could be catastrophic. (ICAO Severity A or B)	12
Aircraft on approach to 29L while aircraft on approach to 29R - Aircraft will be within at least 1/2 mile of each other - Landing wrong runway could be catastrophic. (ICAO Severity A or B)	10

Source: HNTB Analysis. Note: Contents are reproduced from Table 3-2.

The two key improvements that are needed to address the identified potential safety issues are the construction of a full-length center parallel taxiway and the relocation and reconstruction of Runway 11R-29L. Several additional airfield improvements are also needed to enhance airfield safety and safely accommodate the highly diverse fleet mix at TUS. The need for the specific improvements follows.

Construct New Full-Length Center Parallel Taxiway

A new center parallel taxiway is needed to reduce the risk of runway incursions and to safely accommodate aircraft with longer arrival roll-outs.

Reduce Runway/Taxiway Incursions

Currently, many GA aircraft that land at TUS on Runway 11R-29L must cross Runway 11L-29R to reach their destination. Upon exiting Runway 11R-29L after arrival, pilots can inadvertently taxi beyond the runway hold bar and into the path of departing or arriving aircraft; such an event could result in a catastrophic collision, as shown in **Table 4-2**. FAA's design advisory circular, AC 150/5300-13A, Change 1, identifies direct runway crossings from an adjacent runway as an issue in airfield geometry that can result in incursions. The AC recommends designing geometry to avoid having taxiways "lead directly from an apron to a runway without requiring a turn. Such configurations can lead to confusion when a pilot typically expects to encounter a parallel taxiway but instead accidently enters a runway." The AC also recommends limiting runway crossings to "reduce the opportunity for human error by reducing the need for runway crossings. The benefits of such design are twofold – through a simple reduction in the number of occurrences, and through a reduction in air traffic controller workload."

A center parallel taxiway would function as a physical buffer between runways, requiring aircraft to make a physical turn on the taxiway prior to being able to cross a runway, which can greatly enhance both pilot and air traffic controller situational awareness. The potential for pilots to cross an active runway upon landing on and exiting Runway 11R-29L would be minimized by forcing them to first make a conscious turn onto the taxiway and then wait for ATC clearance to cross the other runway. The Simmod airfield simulation analysis indicated that the new center parallel taxiway would reduce the potential incursions from the direct runway crossings to zero (see **Table 3-2** in **Chapter 3**).

Furthermore, a full length center parallel taxiway allows aircraft to cross the inboard runway outside of the "high energy" middle third of the runway close to its end as recommended in AC 150/5300-13A, Change 1, *Airport Design*.

Accommodate Aircraft with Longer Arrival Rolls

A full-length center parallel taxiway would also accommodate aircraft that have a longer arrivals roll-out, especially in the hot summer months when temperatures normally exceed 100° Fahrenheit. A partial-length center parallel taxiway would result in 20% of the fleet missing the last exit to the center taxiway, resulting in a large number of operations that would be performing a direct runway crossing upon arrival.

Additionally, a full length center parallel taxiway would provide improved access to Runway 11R-29L and would ensure all aircraft exiting at the Runway 29L end could access the taxiway without having to cross Runway 11L-29R. Staggered taxiways

between the center taxiway and parallel runways would provide an additional safety benefit by providing increased separation and allowing aircraft to clear the runway quickly after landing.

The construction of the center parallel taxiway requires the relocation of Runway 11R-29L due to the 400-foot runway centerline to taxiway centerline separation needed between the two parallel runways and the new taxiway. While this improvement is needed to accommodate the center parallel taxiway, the relocation and reconstruction of Runway 11R-29L also addresses many other airfield deficiencies and is needed in conjunction with the center parallel taxiway to maximize the ability to enhance safety at TUS.

Relocate and Reconstruct Runway 11R-29L with Extended Blast Pads

The relocation and reconstruction of the current GA runway (Runway 11R-29L) to meet ARC D-IV runway design standards is needed to enhance airfield safety. The upgrade of Runway 11R-29L as a new parallel air carrier runway constructed to match the length (11,000 feet), width (150 feet) and strength of existing Runway 11L-29R would reduce the potential for runway incursions and misidentifications and is critical to safely accommodate the diverse fleet mix that is unique to TUS.

Extended blast pads on both ends of Runway 11R-29L would be constructed to meet ANG design requirements as part of the Proposed Action. Additional asphalt blast pad pavement installed as part of this Proposed Action would help to mitigate the effect of jet blast associated with AANG aircraft operations.

Reduce Runway Incursions

As shown on **Table 4-1**, runway incursions at TUS have continued to occur despite several airfield improvements previously implemented. Although incursions may occur anywhere on the airfield, runways are where the most severe incursions typically occur due to the higher speed of aircraft movement on runways.

Current Hot Spot 1 is associated with the Runway 29L and 29R ends; the 29L and 29R runways ends are not aligned and are of unequal width, which frequently leads to pilot confusion. Pilots can misidentify Runway 29R as Runway 29L and Taxiway A, which is wider than Runway 11R-29L and aligned with Runway 29R making it more visible, as Runway 29R when approaching the Airport from the south and have landed on the wrong runway or incorrectly on parallel Taxiway A on occasion. As noted previously, according to TUS ATCT incident reports, nine (9) wrong runway landings occurred at TUS between 2009 and 2014, eight of which were associated with the Runway 29R/29L ends and Taxiway A when landing from the south. This type of event, resulting from pilot confusion due to the extraordinary displacement of Runway 29L relative to Runway 29R, could be catastrophic.

As shown on **Figure 1-2**, three (3) incursions were reported at this runway end; however, this misalignment is a commonly stated source of confusion for pilots approaching the runway from the south. The Runway 29R and 29L ends need to be

aligned to minimize pilot confusion and eliminate the potential for wrong runway landings. Runway 11R-29L would have the same width (150 feet) and blast pad dimensions as Runway 11L-29R to clearly differentiate it from a parallel taxiway. Therefore, the safety risk at current Hot Spot 1, located at the Runway 29R end, would be addressed with the relocation and reconstruction of Runway 11R-29L.

Safely Accommodate Highly Diverse Fleet Mix

TUS's aircraft operations mix includes a highly diverse fleet mix of air carrier, small and large GA, helicopters, experimental, cargo, and AANG and other military aircraft. The AANG aircraft operate at very high speeds in the immediate vicinity of the airfield and fly maneuvers that are very different from other aircraft including overhead 360° break patterns, simulated flameouts (SFOs) and other procedures that increase complexity of the Airport's traffic pattern. TUS also regularly accommodates transient military aircraft, flight training aircraft (of all sizes), and transient GA aircraft. The AANG operates the United States' busiest ANG training fighter wing (F-16, multiple variants) which includes multiple foreign training units. Additionally, while TUS supports approximately 1,600,000 annual passenger enplanements, the airfield experiences nearly 70,000 annual GA operations. In addition, Bombardier and Rolls Royce both conduct flight testing out of TUS. Ascent Aviation Services conducts significant Maintenance, Repair and Overhaul (MRO) operations at TUS and SkyWest Airlines has a regional jet maintenance facility located on the south side of the airport resulting in additional test flights. This complex mix of activity at TUS also results in significant variations in aircraft performance and pilot experience.

Currently, Runway 11L-29R is the only runway at TUS sufficient to regularly accommodate departing and arriving commercial air-carrier, cargo, and military aircraft. This results in all of these aircraft types with varying approach speeds sharing a single runway. The use of one runway for this mix of high performance foreign and domestic military aircraft and large numbers of civilian aircraft presents unique airfield management challenges and intrinsic operational and safety risk. In addition, the Tucson ATCT is a significant training location for air traffic controllers. Trainees and junior ATC staff regularly space out in-trail arriving aircraft further than experienced controllers, are less likely to sequence a departure between sequential arrivals without additional separation, and are much less likely to release consecutive departures with minimum separation times. With the single runway ATC does not have the required flexibility to segregate civilian traffic as needed at times from high speed traffic or to designate different runways for the various types of operations. A second parallel air carrier capable runway would enhance safety by minimizing mixed-mode operations on a single runway and would also allow for greater safety margins between military and civilian operations. With a second parallel air carrier capable runway, ATC would have the flexibility to separate operations as needed to safely accommodate the varying speeds of aircraft.

Construct Additional Needed Airfield Improvements

The following airfield improvements are also needed to enhance safety and would provide additional opportunities to segregate civilian traffic from high speed military traffic. The need for each of these improvements follows.

- Construct an Outboard Taxiway: An "outboard" parallel taxiway approximately 400 feet southwest of relocated Runway 11R-29L is needed to provide additional access to the runway, particularly for the very active facilities located on the southwest side of the Airport, including the Bombardier and SkyWest Maintenance facilities, and Raytheon's apron. With the reconstruction of Runway 11R-29L as a D-IV capable runway, larger aircraft would be able to land on this runway and turn off on the outboard taxiway to access the facilities on the west side of the airport. Currently, larger aircraft using Runway 11L-29R must cross Runway 11R-29L to reach those facilities. An outboard taxiway would provide safer and more efficient access to Runway 11R-29L and the south side facilities by also allowing aircraft to clear the runway quickly after landing and preventing direct taxiway access to Runway 11R-29L from south side facilities. The length of the taxiway is limited by the TUS property boundary; however this improvement is still needed to reduce the number of runway crossings.

- Shift the Runway 11L Arrival Threshold: Currently, the existing Runway 11L arrival threshold begins at the physical end of the runway near Taxiway D. Occasionally pilots taxiing along Taxiway D have crossed the approach path for Runway 11L-29R or Runway 11R-29L without clearance. With the existing Runway 11L arrival threshold beginning at the physical end of the runway in close proximity to Taxiway D, the potential for catastrophic incident when a pilot taxis across the approach path without clearance while an aircraft is on approach is high. Shifting the Runway 11L arrival threshold on Runway 11L by 920 feet is needed to enhance safety and reduce the risk of catastrophic incident for aircraft that miss the hold bars on Taxiway D. Having displaced thresholds on the parallel runways enables ADG II aircraft taxiing on Taxiway D to be clear of the RSA, ROFA, and underneath the threshold siting surface for both runways. This proposed airfield improvement would help to mitigate Hot Spot 2.

- Remove Taxiway A2: The closure of existing aligned Taxiway A2 is needed to eliminate the potential for aircraft to taxi in direct line with aircraft landing or taking off on Runway 11L-29R and to improve pilot situational awareness. FAA Advisory Circular 150/5300-13A prohibits aligned taxiways and recommends their removal as soon as practicable.

- Construct Associated Taxiways and Aircraft Arresting System: As shown on **Figure 4-1**, additional taxiways are needed to accommodate the relocation and reconstruction of Runway 11R-29L and to improve overall airfield safety and efficiency. A description of each of the connected projects follows.

Construct West Bypass Taxiways: A new bypass taxiway northwest of the RPZs around Runways 11L and 11R is needed to enhance safety by providing additional routing opportunities for AANG aircraft and aircraft utilizing the West Ramp to access Runway 11R-29L without having to cross Runway 11L-29R at Taxiway D. It is anticipated that the bypass taxiways would reduce the total number of direct runway crossings at TUS. The bypass taxiways would enhance access to major MRO tenant Ascent Aviation and would serve as a direct path for AANG aircraft to access Runway 11R-29L from their arming area. The bypass taxiways would allow unrestricted taxiing of aircraft (regardless of size), as they are entirely outside of all RPZs and underneath all critical airspace surfaces.

Construct Acute Angle Exit Taxiways: Acute angle exit taxiways are proposed to allow aircraft to exit new Runway 11R-29L quickly to reduce runway occupancy times. The taxiways connect Runway 11R-29L to the full length center parallel taxiway. The proposed exit taxiways do not lead directly across a runway or ramp area, therefore aircraft must turn onto a taxiway prior to crossing a runway or entrance into a ramp area, thus avoiding any direct runway crossings.

Construct Connector Taxiways (typical): Taxiway connectors are needed for aircraft to access the center and outboard parallel taxiways. New connector taxiways are needed north of Taxiway A17 and south of Taxiway A4 to improve aircraft sequencing and queuing.

Construct Aircraft Arresting System: Installation of two BAK 12/14 Aircraft Arresting Systems are needed for use by the AANG aircraft on reconstructed Runway 11R-29L since this runway would be used for AANG operations. An arresting system is used to stop an aircraft by absorbing its momentum in a routine or emergency landing or aborted takeoff.

- NAVAIDs: To accommodate the relocation and reconstruction of Runway 11R-29L, several navigational aids will be impacted and will need to be installed, replaced, relocated or removed for the project. The following NAVAID modifications are anticipated:
    - Relocation of the Runway 11L Glide Slope Antenna and NAVAID Shelter to the east side of the Runway;
    - Replacement/modification of the Runway 11L MALSR to include in-pavement light stations for the displaced threshold portion of the runway;
    - Relocation of the Runway 11L PAPI;
    - Relocation or replacement of existing Runway 11R PAPI;
    - Installation of new 4 light PAPI for Runway 29L;
    - Removal of the existing Runway 29L end Runway End Identifier Lights (REIL); and
    - Installation of two new REILs for the proposed Runway 29L end.

- Demolish Airport Buildings to Accommodate Bypass Taxiways: To accommodate the west bypass taxiways, four existing hangars and three small buildings on the west side of the Airport within the area will need to be demolished.

- Construct Airfield Electrical Vault: An airfield electrical vault will be constructed southwest of the outboard taxiway to accommodate the equipment associated with the airfield lighting system to serve reconstructed Runway 11R-29L and new taxiways. Types of equipment housed in the vault are likely to include airfield lighting power regulators, electrical distribution systems and airfield lighting controls. The size of the structure will be determined during design.

- Construct Stormwater Management Basins: Two new stormwater management basins are needed in the northwest area of the airport to accommodate additional impervious area on the airfield. A drainage master plan update will accompany this project and provide more detail.

- Land Acquisition to Accommodate Airfield Development Projects: TAA will acquire and DOD will dispose of (at fair market value) approximately 52 acres of DOD Plant 44 property that will be within the Runway Safety Area for the new Runway program. The acquisition will include removal of the existing deed restrictions on the 52 acres. TAA will also acquire and demolish in the safety area, (at fair market value) 12 concrete storage bunkers (six [6] of the bunkers are within the property to be acquired by TAA and disposed of by DOD). TAA will dispose of and DOD will acquire (at fair market value) approximately 127 acres that will provide a safety buffer for DOD operations at Plant 44.

- Construct AOA Fence: The AOA perimeter fence will need to be relocated to accommodate the relocation of Runway 11R-29L and the land acquisition area in the southwest area of the Airport.

Additionally, the major airfield improvements needed would provide the opportunity to update airfield signage, lights, pavement markings, and nomenclature, which have all been evaluated, and are needed to reduce pilot confusion. TUS is also overdue for re-designating the parallel runways from 11-29s to 12-30s. The update to the runway designators are needed to enable more intuitive pilot navigation, especially for VFR pilots.

Additional proposed safety enhancing measures, including adding enhanced lighting and signage along Taxiway D and adjacent connector taxiways, including in-pavement and elevated runway guard lights, and increased pilot education and outreach efforts, would enhance airfield safety, specifically at Hot Spot 2. The previously discussed relocation of Runway 11L arrival threshold would also reduce the risk of a catastrophic incident should an aircraft taxiing on Taxiway D fail to stop at the runway hold lines also helps to mitigate Hot Spot 2.

4.3.1.2 Improve Airfield and Airspace Efficiency

Managing the existing safety issues at TUS leads to increased ATC workload and reduced airfield efficiency. Key airfield elements will need to be reconstructed in the near future, and there is a need to apply this upcoming investment to correct, rather than extend, the current deficiencies. Specifically, TUS needs a second parallel air carrier runway and a center parallel taxiway to improve airfield and airspace operational efficiency while accommodating TUS's unique fleet mix.

Relocate and Reconstruct Runway 11R-29L

The primary development project needed to improve airfield efficiency is the relocation and reconstruction of Runway 11R-29L as a parallel air carrier runway. The new runway would provide ATC with options to segregate and sequence departures as needed and would support the continuation of airfield operations during runway closures.

Improve Efficiency at TUS and in the NAS

Runway 11L-29R is the only runway at TUS able to regularly accommodate the diverse fleet mix at TUS; existing Runway 11R-29L is limited to accommodating primarily light GA aircraft and Runway 3-21 is seldom used due to its short available length. Since all of the larger aircraft operations share a single runway, ATC has very limited flexibility in how and when they sequence aircraft for arrival and departure. As a primary commercial service airport within the NAS, the flight schedules of TUS's commercial operations are often impacted as a result of other airport users. Because approach speeds vary greatly between fleet types, controller workload is heavier and greater in-trail separation is required, which reduces efficient operations at the Airport and in the NAS.

A recurring flight scheduling issue specific to TUS is that the AANG must meet specified reservation times for the military airspace areas they use for training and proficiency. ATC often has to work hard to meet military departure times, or to bring these aircraft in quickly due to low fuel. At the same time, ATC has to accommodate arriving air carrier aircraft, GA aircraft, and helicopters. To further complicate these scenarios, when air carrier aircraft depart from TUS, local ATC is often given a small window of time during which the aircraft can depart and be accommodated into the en-route airspace flow. Given the diverse needs of the mix of airport users at TUS, ATC needs more flexibility to meet required demands while maintaining efficiency at TUS and in the NAS. With parallel air carrier capable runways, ATC would have the dynamic ability to assign aircraft to either parallel runway. Overall operational efficiency would improve if ATC is able to separate airfield and airspace routes for military, commercial, and GA aircraft traffic. Flexibility for ATC assignment of aircraft would be maximized, which would result in more efficient operations at TUS and in the NAS.

Maintain Operations During Runway 11L-29R Closures

The main sources for runway closures at TUS are "Alerts" (declared emergencies) and airfield maintenance. A summary of TUS Alert data, presented in **Table 4-3**, indicated that there were on-average 57 Alerts reported annually between 2007 and 2014. Typical runway closures lasted between four (4) and twenty (20) minutes, with one Alert 3 closing Runway 11L-29R for eight hours. In some instances the shutdowns affected other aircraft, causing arrivals to go around or divert, or causing departures to be delayed. Primary Runway 11L-29R accounted for about 75 percent of the Alerts in which the runway was specified.

Table 4-3: Summary of TUS Alerts (2007 – 2014)

Calendar Year	Total Alerts
2007	92
2008	67
2009	64
2010	50
2011	40
2012	37
2013	50
2014	56

Source: TAA Operations data

The temporary closure of Runway 11L-29R has significant impacts on TUS's tenants. When Runway 11L-29R is forced to close at TUS, the crosswind runway (Runway 3-21) is used as the primary alternative runway for larger aircraft take-offs and landings (e.g. military, large business jets, cargo, and commercial service) due to their runway width and pavement strength requirements exceeding the capabilities of Runway 11R-29L. The majority of commercial service airlines and large corporate aviation users must take a substantial payload reduction to operate on Runway 3-21. In some cases, aircraft are required to have a planned fuel stop en-route to their final destination. Furthermore, Runway 3-21 is not a sufficient alternative for regular use due to its relatively short length, and neither Runway 3-21 nor Runway 11R-29L is sufficient to accommodate some of the larger aircraft landings at all, particularly in high temperatures. Therefore, there are periods when operations are halted or significantly delayed at TUS during Runway 11L-29R closures because no alternative runway is acceptable.

Maintenance – Both parallel runways are approaching the end of their design service lives. TAA is planning a 4" mill and asphalt overlay of Runway 11L-29R in 2016 due to the current pavement condition. Due to the impacts associated with shutting down Runway 11L-29R during reconstruction, the reconstructed runway will continue to be constructed with asphalt pavement, which requires more frequent reconstruction (every 10 years) due to the limited lifespan of asphalt pavement. Concrete pavement has a longer lifespan (40 years), however, reconstructing with asphalt pavement allows the construction to be completed faster, thereby minimizing the duration of the primary runway closure and major disruption to operations. During prolonged closures of the runway due to required

maintenance/rehabilitation of Runway 11L-29R, AANG aircraft must temporarily relocate to Davis-Monthan Air Force Base to operate.

The relocation and reconstruction of Runway 11R-29L to a parallel air carrier runway would allow all operations to continue at TUS during Runway 11L-29R closures and would also allow a longer closure period to reconstruct with concrete pavement, thereby greatly reducing the frequency of runway reconstructions in the future. A full-length parallel runway is needed to maintain efficient operations at TUS during planned closures for airfield maintenance.

Construct New Center Full-Length Parallel Taxiway

To maximize efficiency on the airfield, a new center parallel taxiway would allow ATC additional flexibility to segregate and sequence aircraft operations, and would also help to ensure the continuation of operations during unexpected situations of runway closure.

A full-length center parallel taxiway would help to maintain efficiency on the airfield and in the NAS by enabling aircraft to quickly and efficiently taxi onto and off of the parallel runways. Center parallel taxiways typically have lower average taxi time and taxi delay compared to other taxiway configurations. The full length parallel taxiway also improves operational efficiency for aircraft destined for the south or west aprons as those aircraft could now avoid crossing Runway 11L-29R. With the alignment of the two (2) parallel runways at 150 feet wide and with blast pads, the center taxiway would not be visually misconstrued as one of the parallel runways.

In the event of a runway closure or disabled aircraft, a center parallel taxiway would also simplify the segregation of ground traffic since the taxiway would function as a true bypass route.

4.3.2 FAA Purpose and Need

The FAA's statutory mission is to ensure the safe and efficient use of navigable airspace in the United States pursuant to Title 49 United States Code (USC) 47101(a)(1). In issuing grants to Airport operators to achieve this mission, sponsors must accomplish the improvement in accordance with an FAA-approved Airport Layout Plan (ALP) and various grant-in-aid assurances.

4.4 Requested Federal Action

- Unconditional approval of the portion of the ALP that depicts the proposed relocation and reconstruction of Runway 11R-29L to the southwest and associated improvements.
- Federal actions necessary for processing of an application(s) for Federal funding for the development projects qualifying under the Airport Improvement Program, 49 USC 47101, et seq., as well as Federal actions pertaining to application to impose and use Passenger Facility Charges (PFCs), 49 USC §40117.

- FAA determination for the installation and/or relocation of navigational aids associated with the proposed relocation of Runway 11R-29L.
- FAA approval of air traffic control procedures and modification of flight procedures for relocated Runway 11R-29L. These procedures would be flight tested, and published for general use.
- FAA evaluation and determination of airspace obstructions to the navigable airspace under the standards and criteria of Title 14 Code of Federal Regulations (CFR) Part 77 Objects Affecting Navigable Airspace, and an evaluation of the appropriateness of proposals for on-airport development from an airspace utilization and safety perspective based on aeronautical studies conducted pursuant to the standards and criteria of 14 CFR Part 157, Notice of Construction, Alteration, Activation, and Deactivation of Airport.
- FAA modification or amendment of existing certificates or specifications is required to comply with FAA design standards and to accommodate, in a safe and efficient manner, the passenger enplanements and aircraft activity forecasts.

    - Certification under 14 CFR Part 139, Certification of Airports.
    - Operating Specifications for scheduled air carriers intending to operate at the airport in the future under FAR 14 CFR Part 121, Certification and Operations: Domestic, Flag, and Supplemental Air Carriers and Commercial Operations of Large Aircraft.

- Close coordination with the Airport by appropriate FAA program offices, as required to maintain aviation and airfield safety during construction pursuant to 14 CFR Part 139 under 49 USC § 44706.

4.5 Summary

The existing TUS airfield configuration needs the proposed improvements to enhance airfield safety and accommodate the diverse fleet mix regularly using the Airport. Due to the range of needs and mission requirements of existing and anticipated airport users, improvements to the airfield are needed that will address existing geometric deficiencies that are potential hazards to safety, and to provide ATC with the flexibility to segregate and sequence diverse traffic on the airfield and in the airspace as needed to ensure safe operations at TUS.

With only Runway 11L-29R sufficient to regularly accommodate the larger aircraft at TUS, ATC has very limited flexibility in how and when they sequence aircraft landings and departures. Approach speeds vary greatly between fleet types, therefore controller workload is heavier and greater in-trail separation is required. These factors, combined with regulated military airspace reservation times, limited en-route departure windows, and the training needs at Tucson Tower, impact the ability to manage operations efficiently at the Airport and in the NAS.

Given the importance of TUS to the surrounding community, the State of Arizona, and the NAS, the Proposed Action is essential in being able to address the airfield's existing deficiencies that pose risks to safety at TUS, as well as the Airport's ability to operate efficiently.

STATEMENT OF PURPOSE AND NEED FOR THE PROPOSED ACTION

Sponsor's Purpose and Need

Purpose:

The purpose of the Proposed Action is to enhance airfield safety and improve operational efficiency at Tucson International Airport and in the surrounding airspace through improvements to the runway and taxiway system, in accordance with design standards outlined in FAA AC 150/5300-13A, Change 1, *Airport Design*.

Need:

The need for the Proposed Action is based on the following:

- The existing airfield geometry at TUS is deficient; current deficiencies contribute to a significant number of runway incursions and mistaken runway identifications.
    - TUS experienced 51 documented surface or runway incursions between 2005 and 2010.
    - Incursions were reported at 16 distinct locations and four identified Hot Spots on the airfield in 2012. Despite implementation of several near-term improvements to address/eliminate the Hot Spots and high incident locations, incursions have continued to occur and two Hot Spots still exist.
    - An average of 57 annual declared emergencies (Alerts) were reported between 2007 and 2014.
    - Runway 29 approach thresholds are not aligned and are different widths, creating pilot confusion during runway landings. Nine (9) wrong runway landings were reported between 2011 and 2014 at TUS.
- The existing taxiway system forces direct runway crossings without an impediment, reducing situational awareness for pilots. After landing on and exiting Runway 11R-29L, pilots could mistakenly continue their taxi path in front of an aircraft landing or departing on Runway 11L-29R. A full length center parallel taxiway allows aircraft to cross the inboard runway outside of the "high energy" middle third of the runway as recommended in AC 150/5300-13A, Change 1, *Airport Design*.
- The existing separation between the parallel runways is not sufficient to safely support the highly diverse fleet mix landing and departing at TUS.
- Access to Runway 11R-29L and the south-side facilities is limited; current runway access promotes direct runway crossings. Aircraft need additional routing opportunities to access Runway 11R-29L safely.
- Occasionally pilots traveling along Taxiway D have missed the hold bars and crossed the approach path for Runway 11L-29R or Runway 11R-29L without clearance. With the existing Runway 11L arrival threshold beginning at the physical end of the runway in close proximity to Taxiway D, the potential for catastrophic incident when a pilot taxis across the approach path without clearance while an aircraft is on approach is high.

- Runway 11L-29R is the only existing runway adequate to safely accommodate large aircraft (e.g., air carrier, cargo, military). The use of one runway for the mix of high performance foreign and domestic military aircraft and large numbers of civilian aircraft causes unique airfield management challenges and intrinsic operational and safety risk.
    - The AANG operates the United States' busiest ANG training fighter wing (F-16, multiple variants) which includes multiple foreign training units, all with specific operational needs.
    - The AANG aircraft operate at very high speeds in the immediate vicinity of the airfield and fly maneuvers that are very different from other aircraft including overhead 360 break patterns, simulated flameouts and other procedures that increase complexity of the Airport's traffic pattern.
    - Complexity of non-military operations using Runway 11L-29R includes flight testing by Bombardier and Rolls Royce; significant Maintenance, Repair and Overhaul operations by Ascent Aviation Services, and a SkyWest Airlines regional jet maintenance facility located on the south side of the airport resulting in additional test flights.
    - TUS regularly accommodates transient military aircraft, flight training aircraft (of all sizes) and transient GA aircraft.
    - Airfield deficiencies are intensified by the diversity in aircraft performance and pilot experience among TUS users, and the inability to segregate them within the existing airfield.
- The highly diverse fleet mix with varying approach speeds requires additional work by air traffic controllers and requires increased aircraft separation. ATC does not have the required flexibility to segregate civilian traffic as needed from high speed traffic or to designate different runways for the various types of operations.
- During closure of Runway 11L-29R for emergencies or maintenance, aircraft operations must be halted, delayed or diverted.
    - There were on-average 57 Alerts reported annually between 2007 and 2014. Typical runway closures lasted between four and twenty minutes, with one Alert 3 closing Runway 11L-29R for eight hours.
    - In some instances, the incursions and shutdowns affected other aircraft, causing arrivals to go around or divert, or causing departures to be delayed.

FAA's Purpose and Need

The FAA's statutory mission is to ensure the safe and efficient use of navigable airspace in the United States pursuant to 49 USC 47101(a)(1). In issuing grants to Airport operators to achieve this mission, sponsors must accomplish the improvement in accordance with an FAA-approved Airport Layout Plan and various grant-in-aid assurances.

5.0 Revenue Funding Analysis

This chapter summarizes the funding sources that are potentially available to support implementation of the Proposed Action, along with a proposed funding plan. This chapter also provides an assessment of the anticipated impact on the phasing and duration of the project should the anticipated funds not be available.

5.1 Funding Sources

Funds to support implementation of the Proposed Action are available through various grant-in-aid programs on federal and state levels along with several local sources. The Airport has five potential sources of funding for the project at this time:

1. FAA Airport Improvement Program Funds
2. Passenger Facility Charges
3. Arizona Department of Transportation (ADOT) Grants
4. Third party sources (AANG, etc.)
5. Airport grant matching funds

5.1.1 AIP Funds

Funding is provided to airports for eligible projects through the AIP as determined and awarded by the FAA. AIP funds are divided into two categories: entitlement funds and discretionary funds.

Entitlement Funds: Each primary airport is eligible for annual AIP entitlement grants to fund eligible projects based upon the number of annual passenger boardings at the airport. These funds are calculated as follows:

- $7.80 for each passenger boarding of the first 50,000 passengers
- $5.20 for each additional passenger boarding up to 100,000 passengers
- $2.60 for each additional passenger boarding up to 500,000 passengers
- $0.65 for each additional passenger boarding up to 1,000,000 passengers
- $0.50 for each passenger boarding in excess of 1 million

Also under current law, in any fiscal year in which the total amount made available for nationwide AIP grant funding under Section 48103 of US Code Title 49 is $3,200,000,000 or more, the amount to be apportioned to an airport sponsor shall be increased by doubling the amount that would otherwise be apportioned under the formula and the minimum apportionment to a sponsor is increased to $1,000,000 from $650,000.

Under the terms of Title 49, a large or medium hub airport may use AIP funds to cover 75 percent of project eligible costs; whereas small and non-hub airports may use AIP funds to cover 90 percent of project eligible costs. Additionally, large or medium hub airports that impose PFCs lose 50 percent of their entitlements with $3.00 PFCs and 75 percent of their entitlements with $4.50 PFCs. Since TUS is

classified as a small hub airport, it does not sacrifice AIP entitlements when it imposes PFCs.

Future levels of AIP entitlements will be dependent upon the level of enplanements at TUS and Congressional reauthorization and appropriations of AIP funding above the $3.2 billion threshold. This analysis assumes that AIP funding will be maintained above this critical threshold, however, with the national deficit, the long-term funding of AIP at these levels cannot be guaranteed.

Discretionary Funds: Discretionary funds are awarded at the discretion of the FAA for projects based on a national priority rating system. The highest weights are assigned to safety, reconstruction, and capacity projects. The airport sponsor cannot commence the work on projects funded using discretionary funds until the grant has been awarded and must be able to commence work during the same fiscal year as the grant agreement or within 6 months of the grant agreement, whichever is later. As a small primary airport, TUS can fund up to 91.06 percent of eligible costs with FAA grants; however, the portion covered by discretionary grants may be lower dependent on the amount of available discretionary funds allocated.

5.1.2 Passenger Facility Charges

Airport sponsors for commercial service airports may impose PFCs to support public airport capital needs for eligible projects. PFCs are federally authorized, and the FAA must review PFC applications for specific projects to determine eligibility; however, PFCs are imposed at the local level in consultation with airlines serving the airport. Projects supported by PFCs must accomplish one of the following objectives set forth by statute: (1) preserving or enhancing airport safety, security, or capacity; (2) reducing airport noise; or (3) enhancing competition among airlines. Airports are required to consult with airlines operating at their airports; however airline agreement is not needed to collect or use PFCs. PFCs can be imposed at the level of $1, $2, $3, $4, or $4.50 per enplaned passenger. TUS currently imposes PFCs at the maximum $4.50 level.

5.1.3 ADOT Grants

ADOT has a program similar to the FAA's AIP which distributes grants to Arizona airports to:

- Assist in matching federal grant funds
- Fund projects that may not be funded by the FAA but still achieve the State system goals in safety, security, capacity, environmental, planning, or sustainability
- Assist in airport pavement management
- Assist statewide aviation planning
- Fund low-interest loans for Airport projects

The maximum amount of ADOT funds awarded to an airport in any fiscal year may not exceed 10 percent of the prior three fiscal years average revenue to the Arizona

Aviation Fund. According to the ADOT draft 2014-2018 Airport Capital Improvement Program, this maximum is currently approximately $2.1 million.

5.1.4 Third Party Sources

Third-party sources are typically private parties that fund revenue-generating facilities which will pay back their investment. Third-party investment is rare for airfield projects since they do not generally produce revenue. In this instance, there are specific AANG required or requested project elements of the Proposed Action that would not be eligible for AIP or airport funding, such as the extended blast pads and the aircraft arresting system as they are not required for general aviation or commercial aircraft activity. These project elements would be required to be funded by a military source of funds since they are only needed for military activities.

5.1.5 Airport Grant Matching Funds

General airport revenues, airport reserve funds, or proceeds from issuance of general airport revenue bonds (GARBs), are another source of funding. These funding sources are typically used to match federal or state grants, or to fund projects that are not eligible for, or cannot obtain, funding from other sources.

5.2 Funding Plan

Table 5-1 shows the estimated total project costs along with funding eligibility from the sources discussed in the previous section. The major cost components and sequencing are as follows:

FY 2015 – EIS/Preliminary Design: These costs include the Environmental Impact Statement for the Proposed Action, along with other projects needed to set the stage for construction, including an updated Airports-Geographic Information System (AGIS) study, ALP update, an Airport Wide Drainage Basin Study, and preliminary design of the proposed action. The total estimated cost is $4.3 million.

FY 2018 – Design Packages #1 and #2: Based on the phasing analysis in **Chapter 2**, TAA has organized the projects associated with the Proposed Action into two construction packages for FY 2020 and FY 2021. The design work associated with each construction package is estimated at 8 percent of the total construction costs, resulting in $3.9 million for Design Package #1 and $8.4 million for Design Package #2.

Table 5-1: Estimated Project Costs by Funding Eligibility

			Cost Eligibility			
Year	**Description**	**Cost**	**FAA (91.06%)**	**ADOT (4.47%)**	**TAA (4.47%)**	**AANG**
FY2015	**EIS/Preliminary Design**[1]	$4,304,214	$3,919,418	$192,398	$192,398	$-
FY2018	**Design Package #1**[2]	$3,944,539	$3,558,590	$174,686	$174,686	$36,577
FY2018	**Design Package #2**[2]	$8,464,092	$7,320,127	$359,334	$359,334	$425,297
FY2020	**Construction Package #1**					
	Program Costs[3]	$43,634,284	$39,364,936	$1,932,366	$1,932,366	$404,616
	Soft Costs (21%)	$9,163,200	$8,266,637	$405,797	$405,797	$84,969
	Total Const. Package #1	$52,797,484	$47,631,573	$2,338,163	$2,338,163	$489,585
After FY2021[4]	**Construction Package #2**					
	Program Costs[3]	$93,629,332	$80,974,846	$3,974,935	$3,974,935	$4,704,616
	Soft Costs (21%)	$19,662,159	$17,004,718	$834,736	$834,736	$987,969
	Total Const. Package #2	$113,291,491	$97,979,564	$4,809,671	$4,809,671	$5,692,585
			Costs by Year			
FY2015		$4,304,214	$3,919,418	$192,398	$192,398	$-
FY2018		$12,408,631	$10,878,717	$534,020	$534,020	$461,874
FY2020		$52,797,484	$47,631,573	$2,338,163	$2,338,163	$489,585
After FY2020[4]		$113,291,491	$97,979,564	$4,809,671	$4,809,671	$5,692,585
Total		**$182,801,820**	**$160,409,272**	**$7,874,252**	**$7,874,252**	**$6,644,044**

Sources: TAA and HNTB analysis.
[1]Tucson Airport Authority estimate.
[2]Estimated at 8 percent of construction costs.
[3]Table 2-1.
[4]To be determined by funding availability.

FY 2020 – Construction Package #1: As described above TAA has organized the elements of the Proposed Action into two construction packages. Construction Package #1 includes Phase 1 (South Parallel Taxiway, Raytheon Mitigation, and Removal of Raytheon Bunkers), Phase 2 (Bypass Taxiway and Extended North Blast Pad), and Phase 3 (Airfield Vault and the connection of existing taxiways to the South Parallel Taxiway).

The costs of these projects (from **Table 2-1**) are estimated at $43.6 million. **Table 5-2** provides the breakout of the costs by project. Once TAA soft costs are added to the construction costs, the total estimated cost becomes $52.8 million.

Table 5-2: Estimated Construction Package #1 Costs by Program Component

Program Components	Cost Eligibility				
	Cost	**FAA**	**ADOT**	**TAA**	**AANG**
Southern Parallel TWY	$21,051,858	$19,169,822	$941,018	$941,018	$-
Enabling Project Activities	$8,646,047	$7,873,091	$386,479	$386,479	$-
Construct Bypass TWY	$4,643,597	$4,228,459	$207,569	$207,569	$-
Extended Blast Pad (North)	$404,616	$-	$-	$-	$404,616
Airfield Vault	$3,162,500	$2,879,773	$141,364	$141,364	$-
Connect Existing TWYs to S. Parallel TWY	$5,253,166	$4,783,533	$234,817	$234,817	$-
Overhead Costs	$472,500	$430,259	$21,121	$21,121	$-
Total	**$43,634,284**	**$39,364,936**	**$1,932,366**	**$1,932,366**	**$404,616**

Sources: TAA and HNTB analysis.

After FY 2021 – Construction Package #2: Construction Package #2 includes the Phase 4 projects (2 BAK 12/14 Aircraft Arresting Systems for the AANG, Drainage Retention Basins, Extended South Blast Pad, the new Runway 11R-29L and associated center parallel taxiway) and Phase 5 projects (Vehicle Service Road and AOA Fencing, NAVAID relocation, taxiway connections to Runway 11L-29R and Airfield Renaming and Marking). The phasing of the Construction Package #2 elements should occur after the Construction Package #1 elements but the exact timing will depend on the availability of funding.

The costs of these projects (from **Table 2-1**) are estimated at $93.6 million. **Table 5-3** provides the breakout of the costs by project. Once TAA soft costs are added to the construction costs, the total estimated cost becomes $113.3 million.

Table 5-3: Estimated Construction Package #2 Costs by Program Component

Program Components	Cost Eligibility				
	Cost	**FAA**	**ADOT**	**TAA**	**AANG**
BAK 12/14 Aircraft Arresting Systems	$4,300,000	$-	$-	$-	$4,300,000
Drainage Retention Basins	$1,161,510	$1,057,671	$51,919	$51,919	
Extended Blast Pad (South)	$404,616	$-	$-	$-	$404,616
New RW 11R-29L and Center TWY	$69,481,051	$63,269,445	$3,105,803	$3,105,803	$-
TWY Extensions to End (North half)	$4,433,870	$4,037,482	$198,194	$198,194	$-
TWY Extensions to End (South half)	$2,752,305	$2,506,249	$123,028	$123,028	$-
NAVAIDS	$1,655,000	$1,507,043	$73,979	$73,979	$-
Vehicle Service Road and AOA Fencing	$731,850	$666,423	$32,714	$32,714	$-
TWY Connections to RWY 11L-29R	$6,997,255	$6,371,700	$312,777	$312,777	$-
Airfield Renaming and Marking	$609,375	$554,897	$27,239	$27,239	$-
Overhead Costs	$1,102,500	$1,003,937	$49,282	$49,282	$-
Total	**$93,629,332**	**$80,974,846**	**$3,974,935**	**$3,974,935**	**$4,704,616**

Sources: TAA and HNTB analysis.

Combined, the total cost of these projects is estimated at $182.8 million in 2014 dollars. Since the main part of the construction is anticipated to occur in the 2020-2021 timeframe, there will likely be some construction cost escalation, which will increase the nominal cost of the Proposed Action.

Based on the analysis in **Table 5-1**, the Proposed Action would be eligible for up to $160.4 million in FAA AIP entitlement and discretionary funding. It is understood and acknowledged that, because of competing projects at other airports and other FAA obligations, the FAA may not be able to fund the full eligible amount.

The Proposed Action would be eligible for $7.9 million in ADOT funding. However, by 2021, it is possible that the eligible amount may exceed the maximum that can be awarded to any single airport (10 percent of the prior three fiscal years average revenue to the Arizona Aviation Fund).

The AANG will need to cover the costs of the Proposed Action that are associated with their requirements, primarily the Extended Blast Pads to the north and south, and the Aircraft Arresting Systems. Including design, the AANG share of Proposed Action costs is anticipated to be $6.6 million.

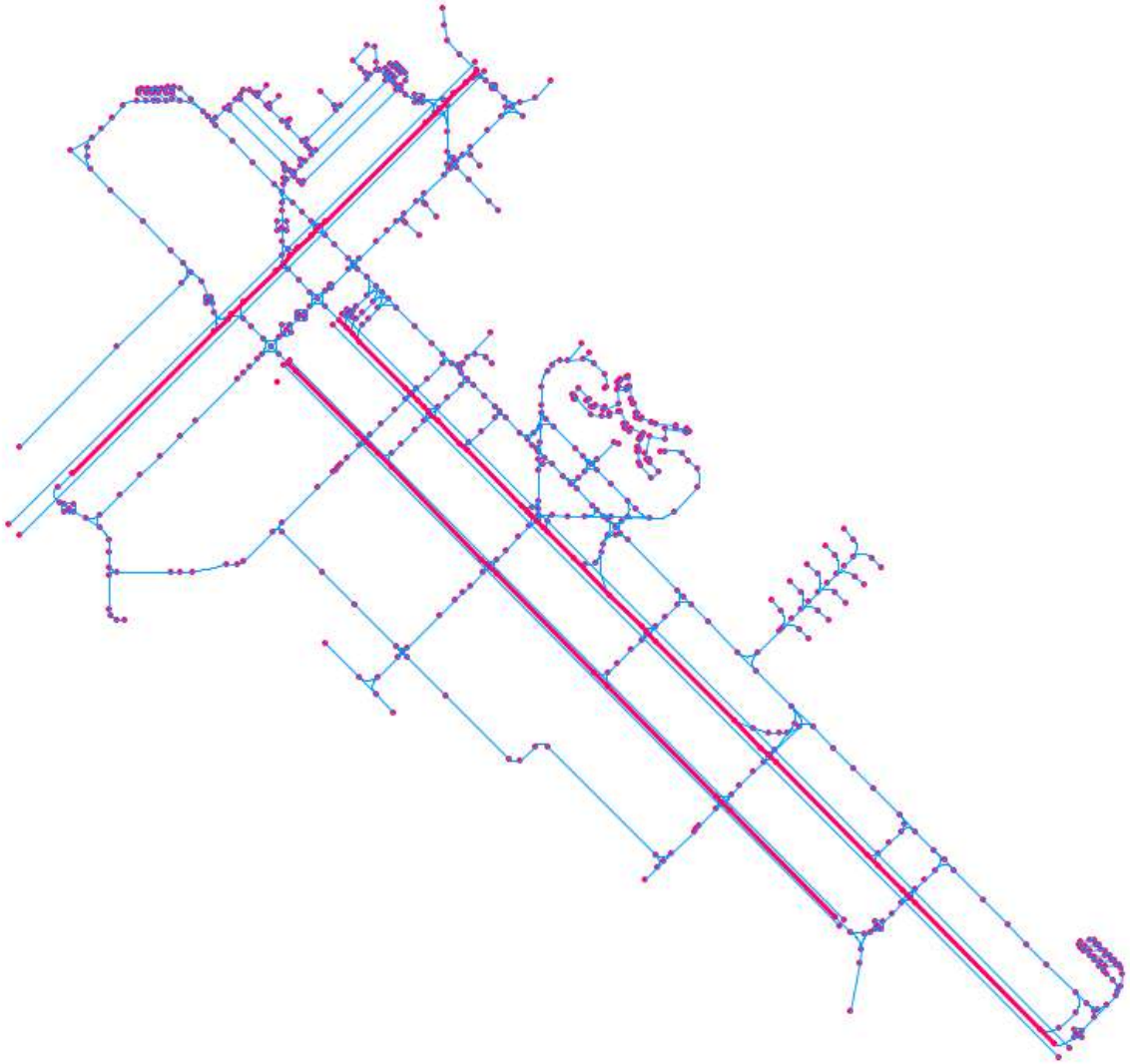
If the FAA and ADOT fund the Proposed Action to its full eligibility, TAA's share of costs would be approximately $7.9 million. As noted earlier, the FAA and ADOT may not be able to fully fund the Proposed Action, in which case TAA's share would rise. Funding for TAA's share would be from airport revenues, airport reserve funds, available PFC pay-as-you-go funds, or, if needed depending on FAA and ADOT funding levels, proceeds from GARBs. Principal and interest associated with the GARBs would be paid from airport revenues and/or PFCs not required for existing PFC-backed debt obligations.

5.3 Funding Impact on Phasing and Duration

As noted in the previous section, there are multiple potential sources of funding for the Proposed Action. If FAA or ADOT funding availability is less then eligibility, TAA has options for increasing the local contribution to the project. Therefore, absent major shortfalls in anticipated funding from Federal and State sources, it is anticipated that TAA will be able to maintain the proposed construction phasing and duration.

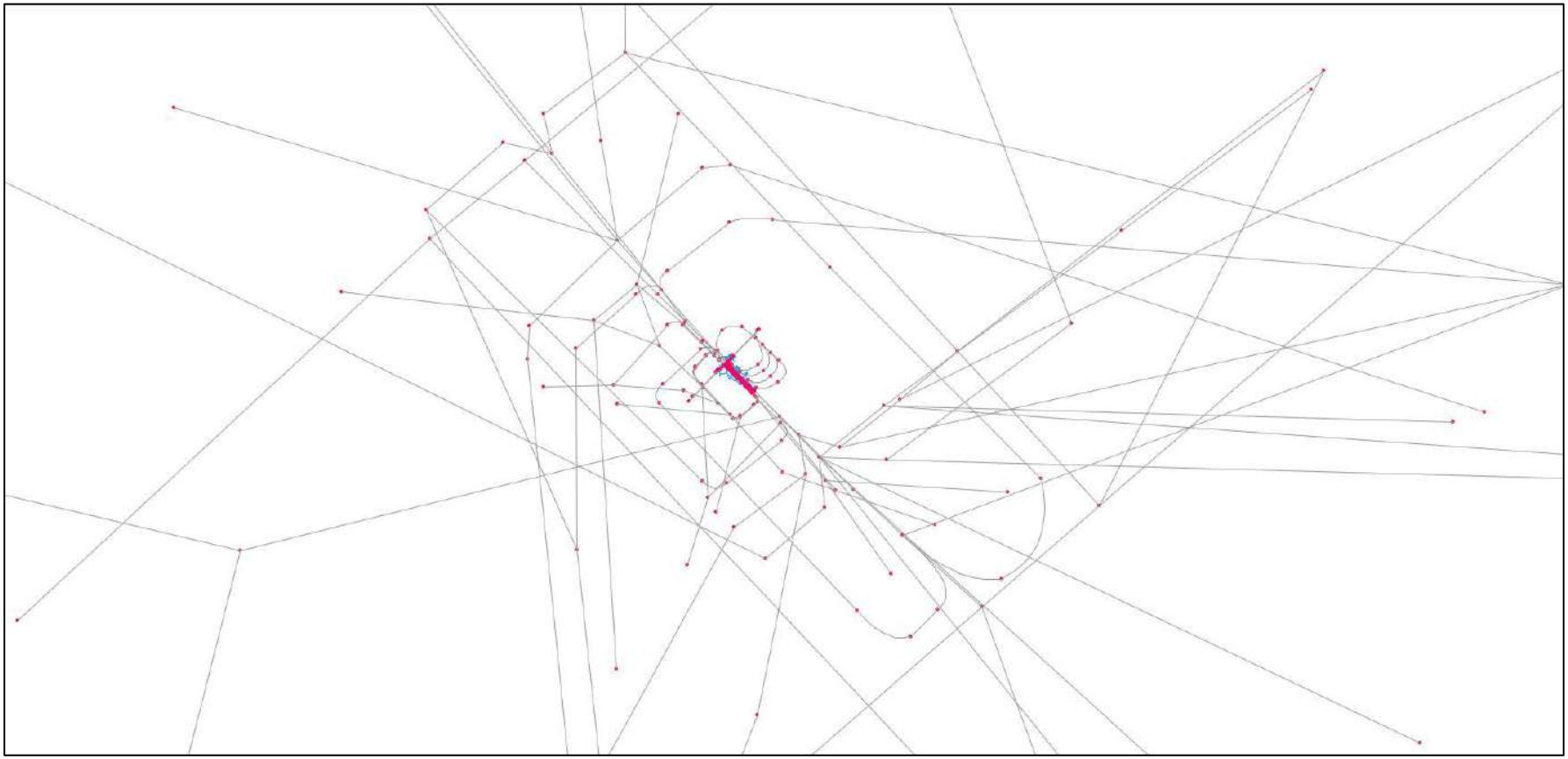
Appendix A: Simmod *PRO!* Model Structure

Figure A-1: Simmod Airfield Link-Node Structure



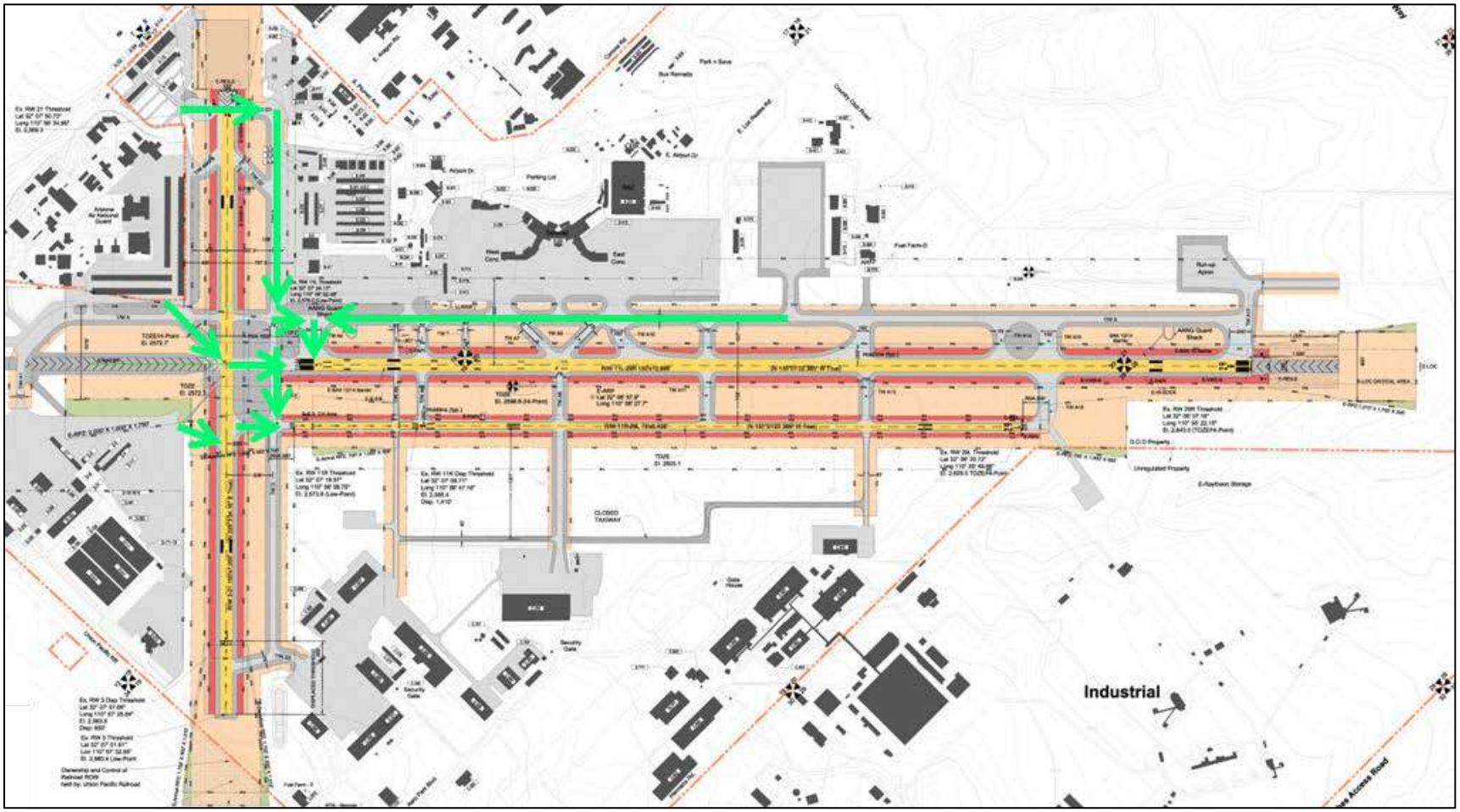
Source: HNTB Simmod *PRO!* airfield and airspace simulation model

Figure A-2: Simmod Airspace Link-Node Structure



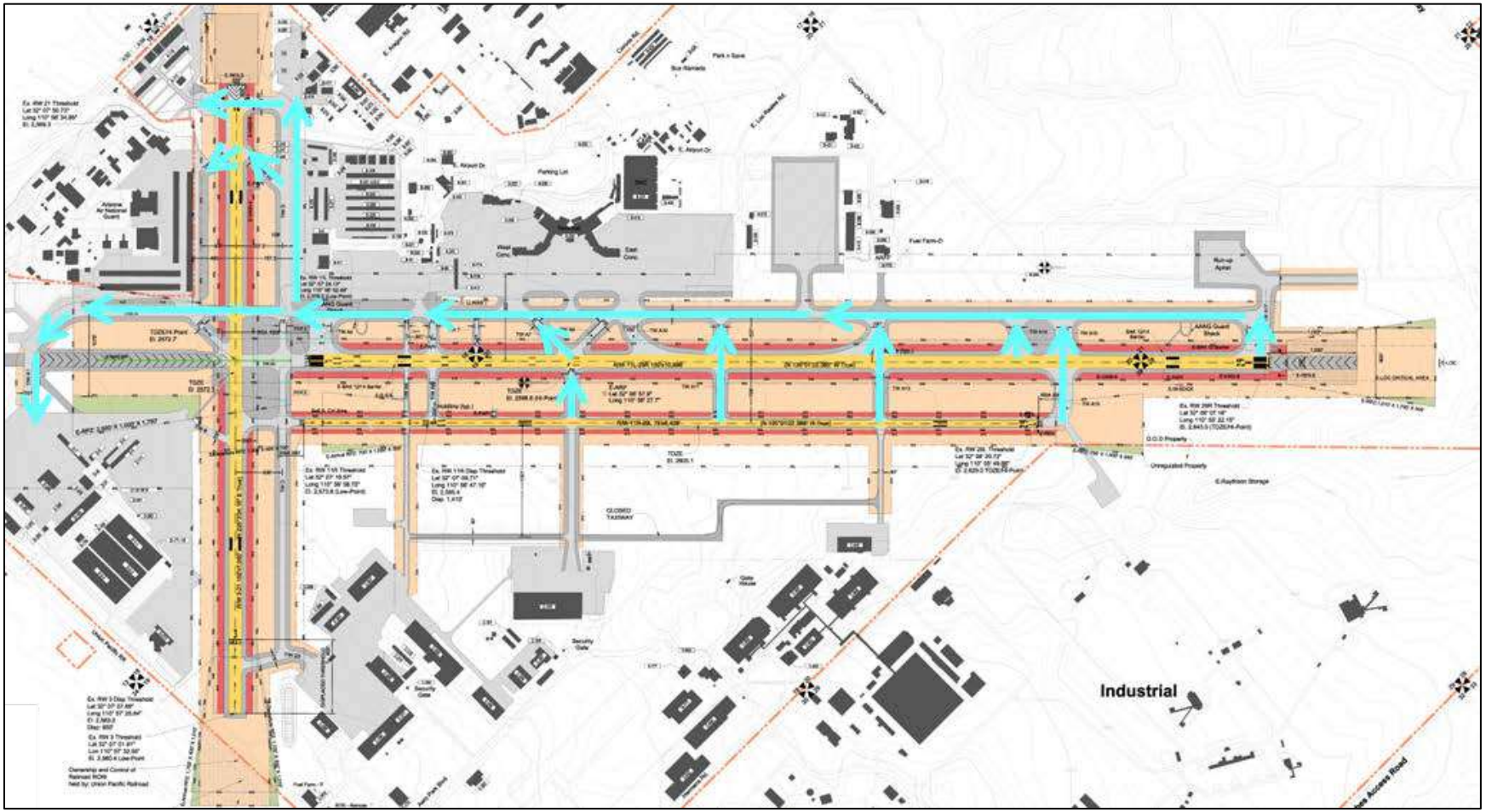
Source: HNTB Simmod *PRO!* airfield and airspace simulation model

Figure A-3: Aircraft Departure Taxi Routes



Source: HNTB analysis based on input from project stakeholders

Figure A-4: Aircraft Arrival Taxi Routes



Source: HNTB observation and analysis based on input from project stakeholders

Figure A-5: Aircraft Arrival Exit Strategies

- Heavy, Large and Military Aircraft
  - 80% Turn Off by Taxiway A13
  - 90% Turn Off by Taxiways A14/A15
  - 100% Turn Off by End of Runway
- Small Aircraft
  - 80% Turn Off by Taxiway A11
  - 90% Turn Off by Taxiway A13
  - 100% Turn Off by Taxiway A15
- Small Piston Aircraft
  - 65% Turn Off by Taxiway A8
  - 90% Turn Off by Taxiway A11
  - 100% Turn Off by Taxiway A13

Source: HNTB observation and analysis based on input from project stakeholders