APPENDIX D
ANALYSIS OF ARRIVAL THRESHOLD DISPLACEMENTS ON RUNWAYS 12R AND 30L

1. OBSTRUCTION DATA AND AIRSPACE ANALYSIS

The obstruction data used for this analysis was based on the survey completed by Engineering Design Source, Inc. (EDSI) and Kowelman Engineering, Inc. (KEI) (circa 2008). These data sources have been documented on the appropriate sheets of the Airport Layout Plan (ALP) Drawing Set.

Using the large-scale plan and profile views of the existing runway conditions developed as part of the ALP update, an airspace model was used to analyze objects off the ends of the runway within and below the imaginary surfaces. All roads traversing the view of the FAR Part 77 Surfaces and obstructions identified in the source indicated above were drawn in plan and profile view and analyzed according to FAA guidance in Advisory Circular (AC) 150/5300-13, *Airport Design*. Appendix 2 of AC 150/5300-13 provides guidance on the siting of thresholds to meet approach and departure obstacle clearance requirements based on: the runway type, aircraft type, approach minima, and approach procedure type. Runway 12R-30L has CAT I ILS approach capability with precision operations, which requires, per FAA guidance, a 34:1 slope on the approach Obstacle Clearance Surface (OCS), therefore the analysis focused on the 34:1 OCS. The analysis of the obstruction data identified the critical obstruction points for each end of the runway.

It is important to note that the analysis conducted as part of this effort is not an FAA Airspace Study and does not replace the need for the FAA to conduct an actual Airspace Study.

2. RUNWAY EXTENSION / DEPARTURE LENGTH REQUIREMENT

As currently configured and operated, Runway 12R-30L provides full-length departures in both directions; changes to the location of the arrival thresholds will not affect the departure length available. As stated in the Master Plan document, the additional runway length gained by extending Runway 12R-30L is required to support departure operations only; additional arrival length is not required to support the current or forecast fleet. However, based on FAA's request, we are investigating the possibility of removing the displacement of the existing arrival thresholds for Runway 12R-30L. This would provide for a more safe and efficient airport operation, as well as, gain additional runway length by re-locating the arrival thresholds closer to the physical end of pavement.

3. RUNWAY 30L ANALYSES

3.1 RUNWAY 30L OBSTRUCTION ANALYSIS

Review of the 2008 ALP Update and associated ALP narrative report do not provide definitive identification of the object or objects that penetrate the arrival surfaces or control the location of the arrival threshold for Runway 30L. Additionally, the airspace analysis process described above did not identify any objects below the imaginary surfaces, which could be identified as the controlling object for the 201-foot threshold displacement. Simply stated, the object or objects that drove the need for the current arrival threshold displacement for Runway 30L are not known.

A thorough evaluation of the objects within the Runway 30L approach surfaces identified no objects that would preclude the relocation of the arrival threshold to the physical end of runway. As shown in plan and profile views below (see **Exhibits 3.1-1 and 3.1-2**), the obstacles identified in the Runway 30L approach consist of the final three lights of the MALSR Approach Light System (ALS). Relocating the Runway 30L arrival threshold to the end of physical pavement requires the clearing of a 34:1 OCS. The final three approach lights (object numbers 8005, 8008, and 8010; in red) would penetrate the TERPS W surface if left in their current location; however, the relocation of the arrival threshold would require that these lights be relocated and reconfigured, and any penetration would be mitigated at that time.

Exhibit 3.1-1
Runway 30L – TERPS W Surface Plan View

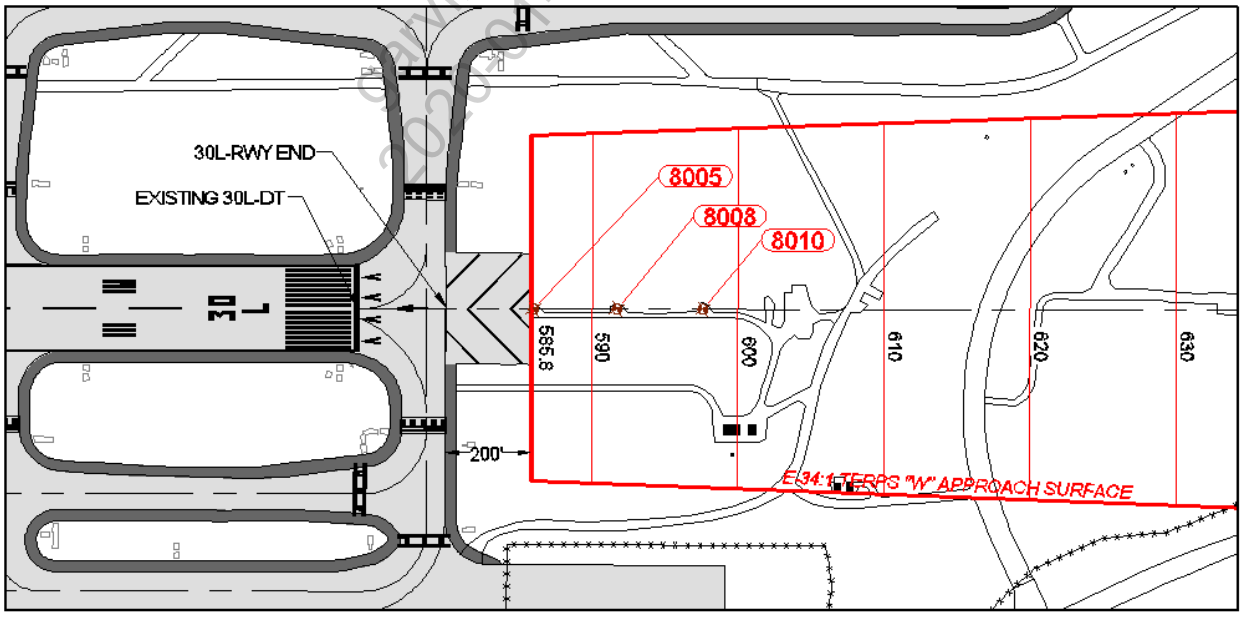
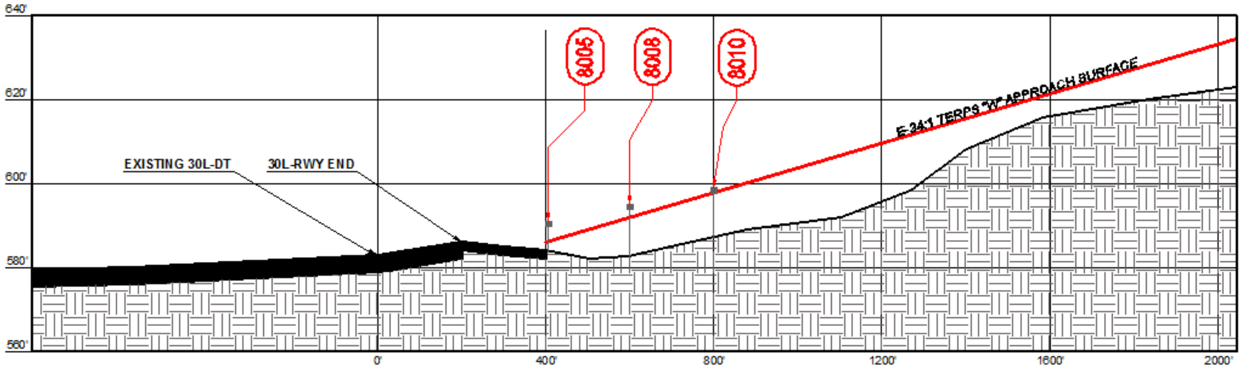


Exhibit 3.1-2
Runway 30L – TERPS W Surface Profile View



3.2 RUNWAY 30L SURFACE GRADIENT DEFICIENCIES

Based on the airspace analysis above, it appears that the entire 201-foot Runway 30L displaced threshold could be regained for arrivals. However, Runway 30L has existing design deficiencies relative to longitudinal grades, grade changes, and vertical curves that need to be addressed independent of the location of the runway end or threshold; these issues are presented below.

- The grade at the approach end of Runway 30L exceeds allowable gradients. The first 201 feet of Runway 30L has a negative slope of 1.6%, which exceeds the maximum allowable longitudinal grade of ±1.5 percent anywhere on the runway, as defined in AC 150/5300-13 section 502.2(a). Additionally this exceeds the maximum allowable longitudinal grade of ±0.8 percent in the first and last quarter of the runway length, as defined in AC 150/5300-13 section 502.2(a). These are an issue both with and without the 201-foot displaced threshold.
- The previous Master Plan (circa 2008) documented an issue concerning a vertical curve in the first quarter of Runway 30L at 750 feet. This is an issue both with and without the 201-foot displaced threshold.

According to the previous 2008 master plan and the current master plan, the aforementioned runway gradient design deficiencies are to be "corrected during reconstruction if feasible." Therefore, the existing Runway 30L arrival threshold could be relocated to the end of pavement (essentially un-displaced) and the length recovered for Runway 30L approaches when the gradient issues and vertical curves described above are corrected.

Another option would be to eliminate the 201-foot displaced threshold by relocating the end of runway to the existing Runway 30L displaced threshold. This option would require Taxiway H to be relocated, as well as addressing the gradient issues and vertical curves described above. This option would shorten the runway by 201 feet. These two alternatives are described below.

3.3 RUNWAY 30L ALTERNATIVES

3.3.1 Alternative 1 – Relocate the Runway 30L Arrival Threshold to the End of Runway Pavement

As previously mentioned, this alternative would entail removing the 201-foot displaced threshold on runway end 30L and using the existing end of pavement and its current elevation as the arrival threshold (see **Exhibit 3.3-1**). This would be the starting point for quarter length calculations and re-grading efforts. Alternative 1 would require several NAVAIDs to be relocated, including the REILS and three lights within the ALS; other lights in the ALS may need to be re-aimed to the glide path. Other NAVIADs, such as the Glide Slope (GS) antenna and Precision Approach Path Indicator Lights (PAPI) would need additional study to see if they should be relocated or it they could provide the same level of service in their current locations, given the 201-foot shift in the landing location on the runway. The Runway 30L LDA would increase by 201 feet with the removal of the existing 201-foot displaced threshold.

3.3.2 Alternative 2 – Eliminate the Runway 30L Displaced Threshold and Convert the Pavement to a Blast Pad

Alternative 2 would entail relocating the end of Runway 30L to the existing 201-foot displaced arrival threshold location and using its current elevation as the new end of pavement (see **Exhibit 3.3-2**). This would be the starting point for the quarter length calculations and re-grading efforts. In this alternative, the runway length would be reduced by 201 feet. The effective length of the Runway would be reduced from 11,019 feet to 10,818 feet. The 201 feet of pavement that was the displaced threshold would have to be demolished and re-graded to meet requirements for a blast pad. This alternative would also require shifting Taxiway Hotel between Taxiways Charlie and Echo, to line up with the newly relocated end of Runway 30L. In this alternative, none of the NAVAIDs would need to be relocated, as the landing threshold would not change. However, a few of the lights in the ALS currently in place at the displaced threshold would need to be replaced, due to the demolition and re-grading required as part of the existing displaced threshold pavement conversion to a blast pad. This alternative reduces the TODA, TORA and ASDA for Runway 30L by 201 feet. The TODA, TORA, ASDA and LDA for Runway 12R would all be reduced by 201 feet as well.

Exhibit 3.3-1
Alternative 1 - Relocate the Runway 30L Threshold to the End of Pavement

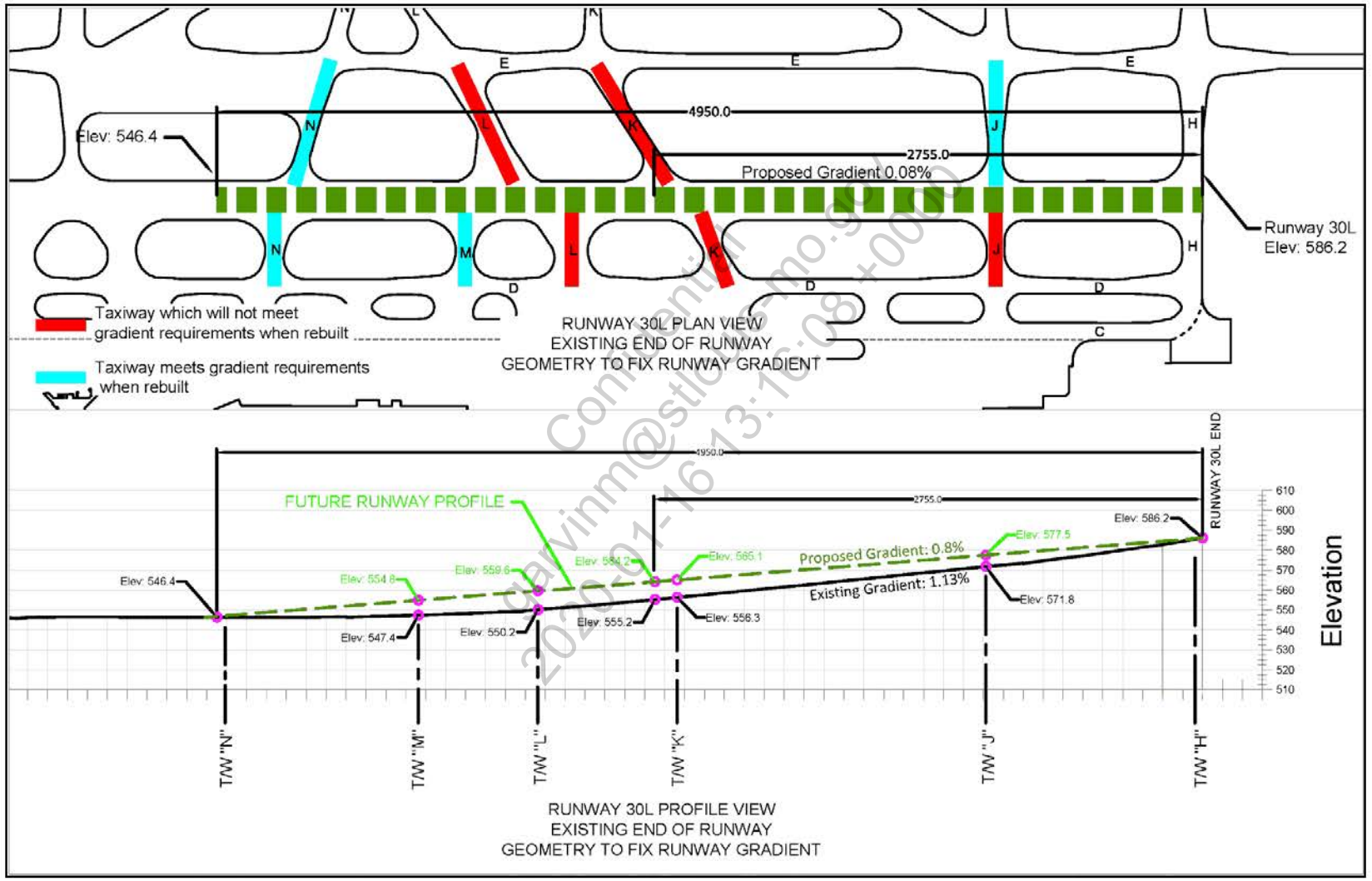
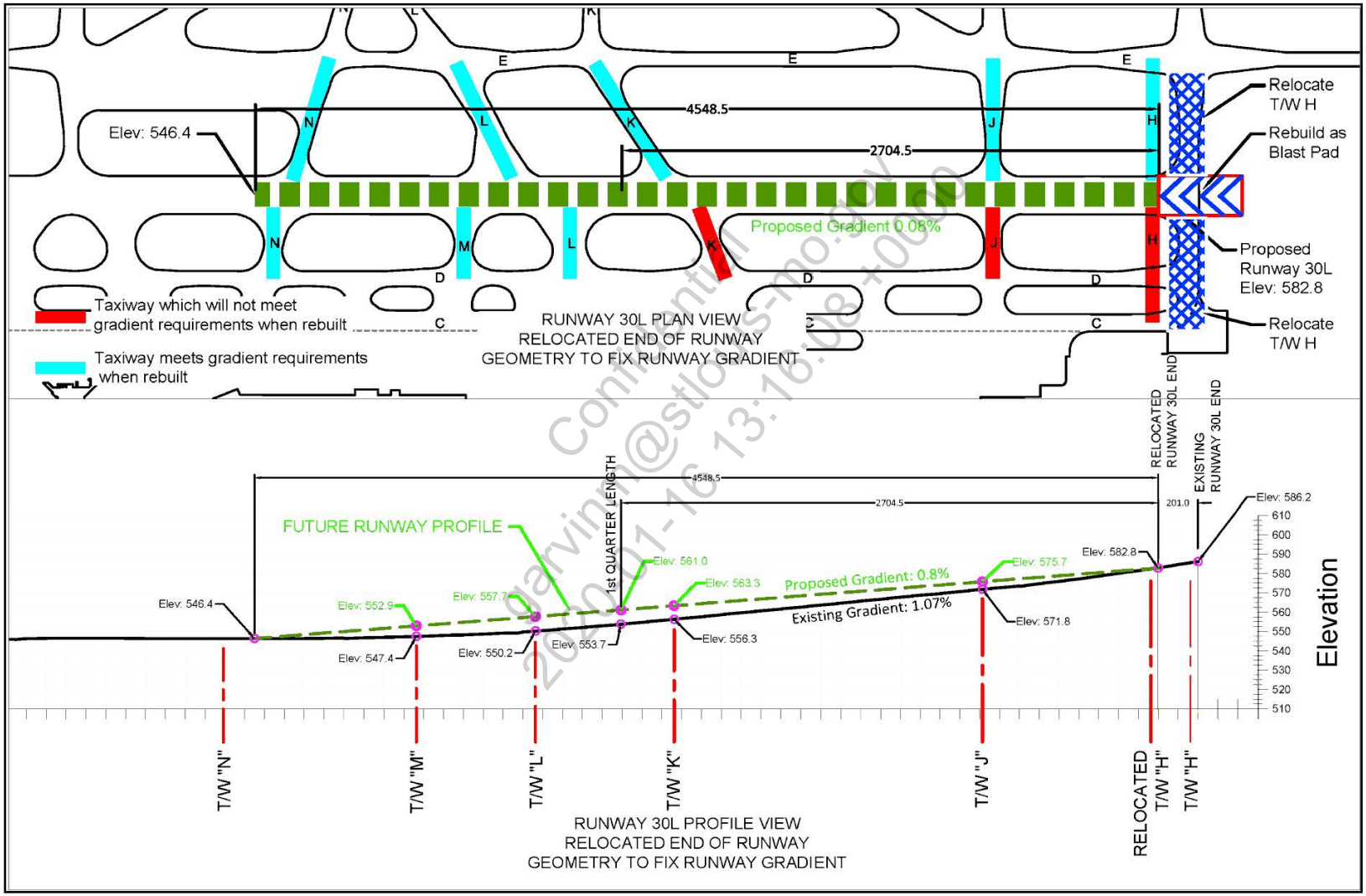


Exhibit 3.3-2
Alternative 2 - Eliminate the Runway 30L Displaced Threshold and Convert the Pavement to a Blast Pad



Exhibits 3.3-1 and 3.3-2 provide a plan and profile view of Alternatives 1 and 2. The profile view provides both an existing and proposed look at the gradient issues; the plan view shows the impacts to the runway and taxiways. Please note that these two alternatives would not only require the redesign of runway entrance and exit taxiways, but the redesign of the parallel taxiway system as well. Analysis revealed that some of the runway entrance and exit taxiways could not be re-graded to meet gradient requirements without affecting parallel Taxiways Charlie, Delta, and Echo. **Tables 3.3-1** and **3.3-2** provide elevation and grade data for the existing taxiway conditions on the Runway 30L end of Runway 12R-30L. Based on this analysis, it is apparent that there are no existing taxiway gradient issues. **Tables 3.3-3** thru **3.3-6** provide the taxiway grades relative to Alternatives 1 and 2, which were discussed above; the tables indicate the non-standard gradient values (highlighted in pink) caused by the re-grading of the runway.

Table 3.3-1
Existing Conditions – South of Runway 30L

EXISTING CONDITIONS					
SOUTH OF RUNWAY 30L					
TAXIWAY	SEPARATION FROM RUNWAY	RUNWAY ELEVATION	TAXIWAY ELEVATION	GRADE CHANGE (RW TO TW)	EXISTING GRADIENT
H	482	586.2	580	6.2	1.29%
J	428	571.8	568	3.8	0.89%
K	428	556.3	556	0.3	0.07%
L	428	550.2	552	-1.8	-0.42%
M	428	547.4	550	-2.6	-0.61%
N	428	546.4	548	-1.6	-0.37%

Table 3.3-2
Existing Conditions – North of Runway 30L

EXISTING CONDITIONS					
NORTH OF RUNWAY 30L					
TAXIWAY	SEPARATION FROM RUNWAY	RUNWAY ELEVATION	TAXIWAY ELEVATION	GRADE CHANGE (RW TO TW)	EXISTING GRADIENT
H	702	586.2	592	-5.8	-0.83%
J	702	571.8	580	-8.2	-1.17%
K	702	556.3	551	5.3	0.75%
L	702	550.2	546	4.2	0.60%
N	702	546.4	542	4.4	0.63%

Table 3.3-3
Proposed Runway Conditions – Threshold at Runway End
South of Runway 30L

PROPOSED RUNWAY CONDITIONS (THRESHOLD AT RUNWAY END)					
SOUTH OF RUNWAY 30L					
TAXIWAY	SEPARATION FROM RUNWAY	RUNWAY ELEVATION	TAXIWAY ELEVATION	GRADE CHANGE (RW TO TW)	EXISTING GRADIENT
J	428	577.5	568	9.5	2.22%
K	428	565.5	556	9.5	2.22%
L	428	559.6	552	7.6	1.78%
M	428	554.8	550	4.8	1.12%
N	428	546.4	548	-1.6	-0.37%

Table 3.3-4
Proposed Runway Conditions – Threshold at Runway End
North of Runway 30L

PROPOSED RUNWAY CONDITIONS (THRESHOLD AT RUNWAY END)					
NORTH OF RUNWAY 30L					
TAXIWAY	SEPARATION FROM RUNWAY	RUNWAY ELEVATION	TAXIWAY ELEVATION	GRADE CHANGE (RW TO TW)	EXISTING GRADIENT
J	702	577.5	580	-2.5	-0.36%
K	702	565.5	551	14.5	2.07%
L	702	559.6	546	13.6	1.94%
N	702	546.4	542	4.4	0.63%

Table 3.3-5
Proposed Runway Conditions – Relocated Runway End
South of Runway 30L

PROPOSED RUNWAY CONDITIONS (RELOCATED RUNWAY END)					
SOUTH OF RUNWAY 30L					
TAXIWAY	SEPARATION FROM RUNWAY	RUNWAY ELEVATION	TAXIWAY ELEVATION	GRADE CHANGE (RW TO TW)	EXISTING GRADIENT
H	428	582.8	580	2.8	0.65%
J	428	575.7	568	7.7	1.80%
K	428	563.3	556	7.3	1.71%
L	428	557.7	552	5.7	1.33%
M	428	552.9	550	2.9	0.68%

Table 3.3-6
Proposed Runway Conditions – Relocated Runway End
North of Runway 30L

PROPOSED RUNWAY CONDITIONS (RELOCATED RUNWAY END)					
NORTH OF RUNWAY 30L					
TAXIWAY	SEPARATION FROM RUNWAY	RUNWAY ELEVATION	TAXIWAY ELEVATION	GRADE CHANGE (RW TO TW)	EXISTING GRADIENT
H	702	582.8	592	-9.2	-1.31%
J	702	575.7	580	-4.3	-0.61%
K	702	557.7	551	6.7	0.95%
L	702	552.9	546	6.9	0.98%

The preliminary order-of magnitude cost for Alternative 1 is estimated at $22.5 million for construction and design engineering costs and Alternative 2 is estimated at 21.3 million; this does not include any obstacle mitigation costs that might be identified during the preliminary design phase. However, it is likely that obstacle mitigation costs for Alternative 2 would be higher than Alternative 1 since the approach surface would be lower in elevation, which will most likely result in more obstructions.

3.4 RUNWAY 30L SUMMARY

The preferred location for the Runway 30L arrival threshold is at the existing end of runway pavement (i.e. Alternative 1). As discussed, there are design deficiencies relative to gradients and grade changes identified on Runway 30L. These deficiencies, along with any potential transverse gradient issues, should be addressed when the Runway is scheduled for reconstruction, and corrected if deemed practicable at that time. Based on this analysis, it would be possible to either: (1) relocate the existing arrival threshold to the end of pavement (essentially un-displaced), or (2) eliminate the 201-foot displaced threshold by relocating the end of runway to the existing Runway 30L displaced threshold and relocate Taxiway H, however, the runway gradients and grade issues will need to be addressed. Based on preliminary order of magnitude costs, Alternatives 1 and 2 are within 10 percent of one another, with Alternative 2 being the least expensive. However, this analysis did not include any obstacle mitigation costs that might be identified during the preliminary design phase; but it is likely that obstacle mitigation costs for Alternative 2 would be higher than Alternative 1 since the approach surface would be lower in elevation and therefore result in more obstructions. In addition, Alternative 2 results in a loss of 201 feet of departure length, which would require an additional 201-foot extension to Runway 12R to meet the runway length requirements identified in the current master plan.

In comparison, the Runway 30L LDA would increase by 201 feet with Alternative 1 (the removal of the existing 201-foot displaced threshold). At this time, the cost differential between Alternatives 1 and 2 is not significant enough to overcome the loss in operational capability resulting from Alternative 2. Therefore, relocating the existing arrival threshold to the end of pavement is the preferred alternative for the current master plan.

4. RUNWAY 12R ANALYSES

4.1 RUNWAY 12R OBSTRUCTION ANALYSIS

As with the 30L approach end, review of the 2008 ALP Update and associated ALP narrative report did not identify an object or objects that penetrate the arrival surfaces to Runway 12R. The airspace analysis process described above did not identify any objects below the imaginary surfaces, which could be identified as the controlling object for the 467-foot threshold displacement. At some point in time, the controlling object, which resulted in the 467-foot threshold displacement, was removed.

While the service road closest to the 12R approach end of the runway clearly results in a penetration of the existing OCS surface and should be closed permanently or relocated to eliminate all traffic, it is not the controlling object for the 467-foot threshold displacement. The current master plan will show the service road to be relocated. Therefore, for this analysis, it is assumed that the service road will not be an obstacle.

Analysis of the traverse points and obstruction data reveal that the critical obstruction within the existing arrival surfaces is Banshee Road. **Exhibits 4.1-1** and **4.1-2** provide the profile and plan view of the existing condition of the TERPS W Approach Surface associated with Runway 12R. As shown, the alignment and elevation of Banshee road, with the appropriate 15-foot adjustment for vehicle traffic, is below the existing TERPS W surface. The most restrictive Banshee Road traverse point is 2.5 feet below the existing TERPS W surface.

Exhibit 4.1-1
Runway 12R – TERPS W Surface Plan View Existing Condition

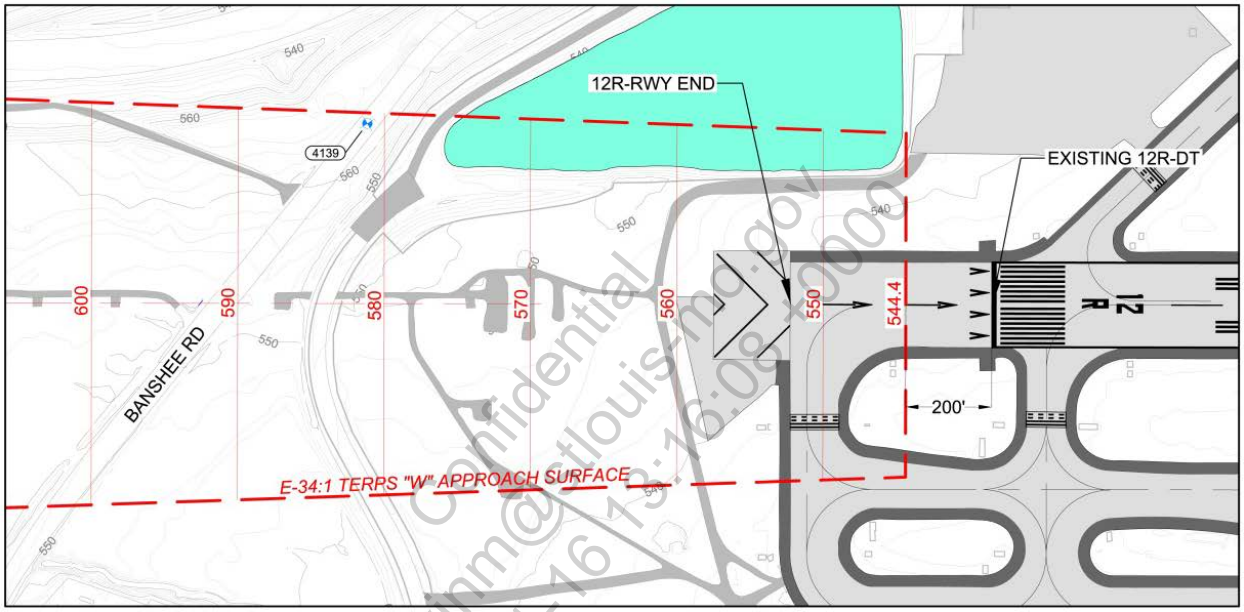
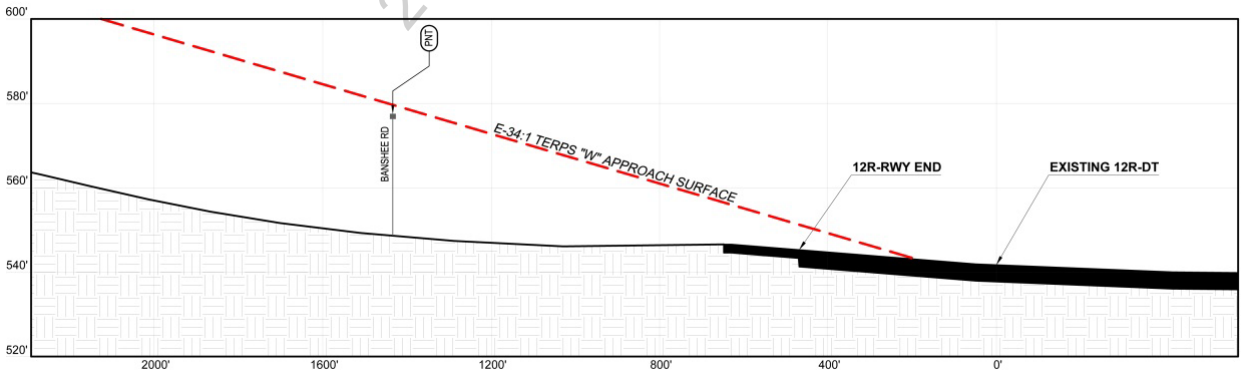


Exhibit 4.1-2
Runway 12R – TERPS W Surface Profile View Existing Condition



To determine the amount of runway length that could potentially be recaptured by relocating the existing arrival threshold, the TERPS W surface was relocated westward along the runway centerline to the point at which the surface begins to contact the point in space 15 feet above Banshee Road. As shown in **Exhibits 4.1-3** and **4.1-4** below, the net gain is 86 feet. Attempts to recapture any additional runway length, beyond the 86 feet, would require the relocation of Banshee Road.

Exhibit 4.1-3
Runway 12R – TERPS W Surface Plan View Potential Threshold Relocation

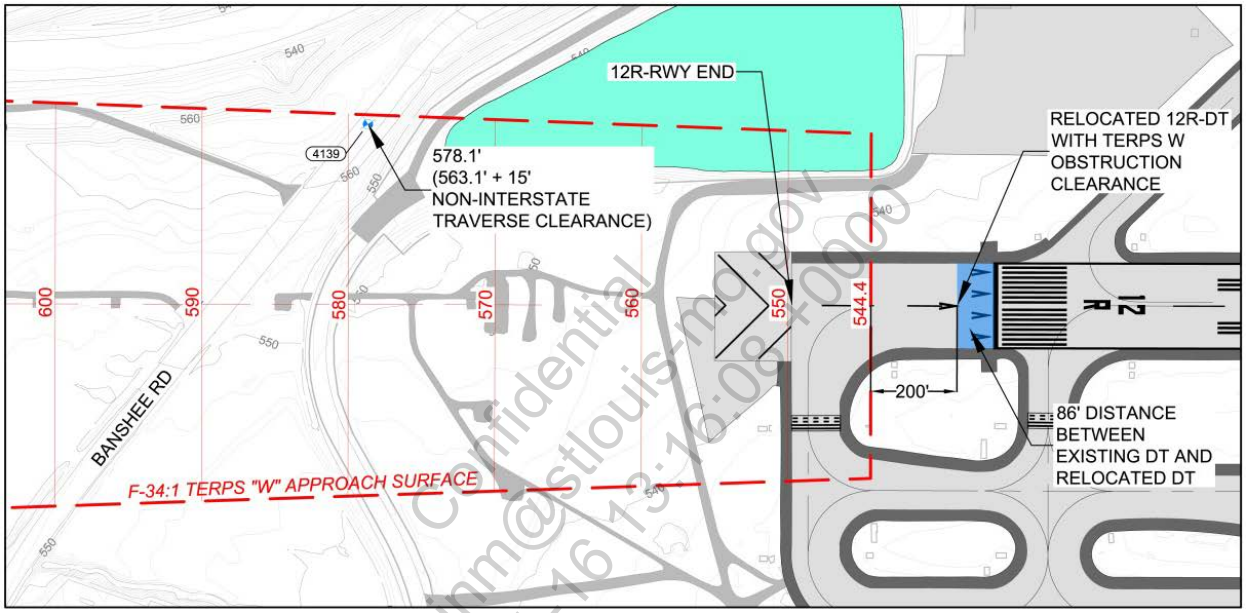
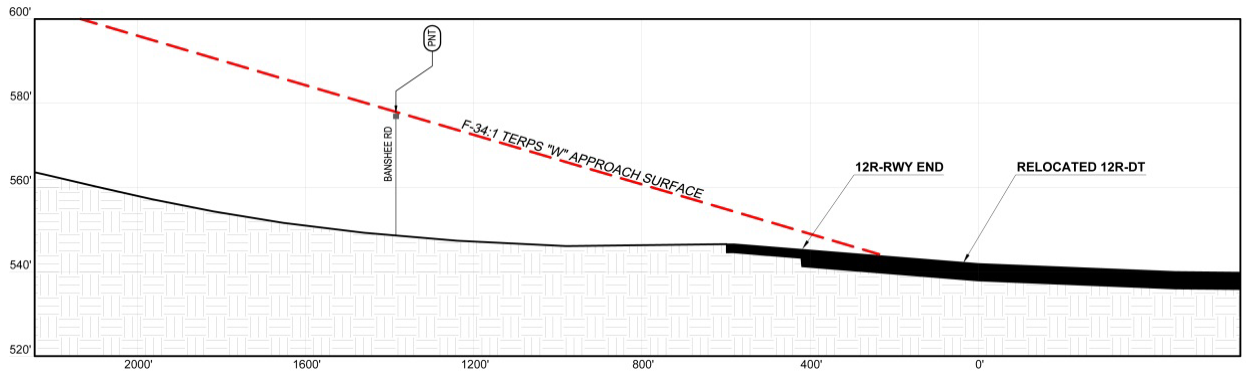


Exhibit 4.1-4
Runway 12R – TERPS W Surface Profile View Potential Threshold Relocation



Because of the planned 581-foot extension to Runway 12R, Banshee Road will need to be relocated to the west to avoid the future Runway Protection Zone, Runway Safety Area and Object Free Area. Therefore, for this analysis, it is assumed that Banshee Road will not be a penetration to an arrival threshold located at the end of the future 581-foot extension or the existing 467-foot displaced threshold. As a result, the entire 1,048 feet (581 feet + 467 feet) could be used for arrivals/LDA. As long as the existing airport service road and Banshee Road are relocated, the future Runway 12R arrival threshold will not require a displacement.

Please note that there will be the need for clearing of terrain and obstacles within the on-airport property in order to satisfy FAR Part 77 Precision approach requirements. However, this will be required with or without the 1,048-foot displaced threshold. All obstacles have been identified in the ALP Plans Package and have a disposition noted.

4.2 RUNWAY 12R SUMMARY

While the Runway 12R extension is required to meet departure length requirements identified by the current master plan, there are no obstructions that necessitate the extension be constructed as a displaced threshold, as long as the existing Airport service road and Banshee Road are relocated. The service road and Banshee Road will have to be relocated as a result of the Runway 12R extension and its safety surfaces, regardless if the extension is constructed as a displaced threshold or not. Therefore, for this analysis, it is assumed that the service road and Banshee Road will not be an obstacle and the 581-foot Runway 12R extension can be built for departures as well as takeoffs (i.e. no displaced threshold). As a result, the future Runway 12R LDA would increase by 1,048 feet with the removal of the existing 467-foot displace threshold and no need to displace the future 581-foot runway extension.

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