Enclosure 1
(Ref. Technical Letter F500-L14-004)

MITRE

Center for Advanced
Aviation System Development

Alternative Runway Configuration for the Nuevo Aeropuerto Internacional de la Ciudad de México

Initial Assessment

Prepared for

Aeropuertos y Servicios Auxiliares

November 2013

1. Introduction

As part of MITRE's support to Aeropuertos y Servicios Auxiliares (ASA), MITRE performed an initial examination of an alternative location for a six-parallel runway configuration located in the proximity of the town of Texcoco, referred to in this document as the Nuevo Aeropuerto Internacional de la Ciudad de México site (hereinafter referred to as NAICM). The runway configuration described in this document is considered as an alternate as it differs from the one already recommended by MITRE during a previous study that ended in July 2012. Specifically, due to issues regarding land acquisition matters, ASA requested that MITRE investigate the possibility of shifting the previous MITRE-recommended runway configuration farther to the west. This document is intended to describe that work.

This document is organized into several sections. Section 2 provides background of MITRE's previous NAICM-related runway configuration siting. Section 3 discusses the alternative NAICM runway configuration. Section 4 discusses MITRE's assessment of selected International Civil Aviation Organization (ICAO) Obstacle Limitation Surfaces (OLSs). Finally, Section 5 provides some important observations.

2. Background

Over the past decade, MITRE has explored dozens of potential runway configurations for a new major airport to be constructed in and around the NAICM site. In order to establish the appropriateness and feasibility of these potential runway configurations, many analyses were conducted by MITRE. For example:

- Weather conditions and prevailing winds
- Hydrological feasibility and bird activity
- Instrument approach and departure procedures
- Airspace constraints
- Runway capacity
- Potential noise exposure on surrounding residential areas

In coordination with ASA, the Dirección General de Aeronáutica Civil (DGAC), and Servicios a la Navegación en el Espacio Aéreo Mexicano (SENEAM), three potential runway orientations were initially investigated: 034°, 021°, and 002°, relative to true (not magnetic) north. For each of these runway orientations, several runway configurations with up to six runways were developed and analyzed.

In siting any runway, special consideration must be given to the appropriate airport classification codes and design standards that are derived from the international standards and recommended practices of various ICAO publications. In ICAO Annex 14, ICAO assigns reference codes, which are related to aircraft performance characteristics and dimensions, and ensure that numerous specifications and aerodrome facilities are suitable for the aircraft intended to operate within that aerodrome.

MITRE consulted ICAO design standards throughout the process of conceptualizing runway configurations. The DGAC instructed MITRE to use the Airbus A380 as the critical aircraft for planning and design purposes for the new airport. The A380 would require airport geometric standards set forth by ICAO Aerodrome Reference Code (ARC) 4F. For example, ICAO recommends that runways have a width of 60 m (not including shoulders).

The identification of the critical aircraft is one of several factors on which runway length requirements are based, along with airport elevation, mean maximum temperature of the hottest month, runway gradient (difference in elevation of each runway end), and distance to the farthest (non-stop) destination airport. The DGAC provided MITRE with a range of recommended runway lengths for planning purposes (4000 m to 4800 m). MITRE used the recommended range to the extent practicable, but expanded the range from 3200 m to 5000 m in order to fit runways within site boundaries and provide additional operational flexibility.

MITRE analyzed the ICAO Runway Strip and Runway End Safety Areas (RESAs) for every proposed runway. A Runway Strip is intended to reduce the risk of damage to aircraft running off a runway and to protect aircraft flying over during takeoff or landing operations. The Runway Strip extends before the runway threshold and beyond the end of the runway for a distance of 60 m and extends laterally 150 m on each side of the runway centerline.

The RESA is intended to reduce the risk of damage to aircraft undershooting or overrunning the runway. The ICAO standard RESA extends 90 m from the end of the Runway Strip and has a width of twice the runway width. The ICAO recommended RESA extends 240 m from the end of the Runway Strip and has a width equal to the graded portion of the Runway Strip (150 m total width in this case).

In addition to runway geometry, the ICAO design standards guide the process of taxiway siting and geometry. Taxiways are constructed primarily to facilitate aircraft movements to and from the runway system. Some taxiways are necessary to provide access between the aprons and runways, whereas other taxiways become necessary, as activity increases, to provide safe and efficient use of the airfield.

Criteria pertaining to taxiway width and separation between runways and parallel taxiways were also considered. ICAO ARC 4F aircraft require a minimum taxiway width of 25 m. The separation between a runway and a parallel taxiway should be 190 m. However, ICAO recommends that runway holding positions be increased for airports at higher elevations. Therefore, MITRE used a runway to parallel taxiway separation of 200 m, which also provides some flexibility for aircraft maneuvering.

Unlike the aforementioned runway and taxiway siting considerations that are dictated by the ICAO design standards, runway orientation is primarily dictated by wind conditions. For the operational safety and efficiency of an airport, it is desirable for the runways of an airport's runway system to be oriented as close as possible to the direction of the prevailing wind. This reduces the impact of crosswinds to the direction of travel of an aircraft that is landing or taking off.

MITRE confirmed the appropriateness of each of the three runway orientations mentioned before per weather conditions and prevailing winds. The 002° orientation relative to true (not magnetic) north finally selected over the two other potential orientations (021° and 034°) took also into account considerations concerning procedure development, airspace, and other runway siting matters.

Additional considerations for runway siting include airport capacity considerations and high-level planning for a terminal complex.

With regard to capacity, the estimated capacity of a six-runway airport that allows for three simultaneous precision instrument approaches and departures was estimated at 182 operations per hour during hours with a balanced number of arrivals and departures.

With regard to terminal complex development, landside facilities are those necessary for handling aircraft, passengers, and freight while on the ground. These facilities provide the essential interface between the air and ground transportation modes. Typical components of the terminal area complex include the terminal building, aircraft parking aprons, and vehicle parking area.

While MITRE is not an expert in terminal construction and development, MITRE did consider the high-level spacing requirements of modern-sized terminal facilities with the potential for expansion in developing each of the preliminary runway configurations. For example, the need for dual parallel taxiways adjacent to the terminal was one consideration. Each alternative was examined to see if it could accommodate the approximate size/footprint of a main terminal. The greater the distance provided between the dual parallel taxiways, the greater the flexibility in allowing the future terminal area to be developed.

The development of the runway configuration that was recommended by MITRE in 2012 was conducted under assumptions provided to MITRE by the DGAC concerning the acquisition of a moderate-to-small area of non-federally-owned land. This configuration, referred to in this document as the *MITRE-Recommended Runway Configuration (July 2012)*, is shown in Figure 1.

This runway configuration allows a distance of at least 3 km from the ends of Runways 01L and 01R to Lago Nabor Carrillo and other wildlife attractants located south of the Autopista Peñón-Texcoco, which meets the United States (U.S.) Federal Aviation Administration (FAA) recommendation for separation between runways and wildlife attractants. However, the placement of the runways in this configuration was mainly based on confidence expressed by federal officials that additional land to the north and east of the boundary of federally-owned land would be acquired. See the red triangular shaped area shown in Figure 1.

The recommended runway configuration shown in Figure 1 provides the minimum lateral separation for conducting parallel approaches (1707 m) between arrival runways for a number of alternative runway-use scenarios, as determined by MITRE through collision-risk analysis and simulations. The nominal runway-use scenario would be to assign arrivals to Runways 35L, 36R, and 01R in north flow, or Runways 17R, 18L, and 19L in south flow. Departures would use the other three runways (i.e., Runways 35R, 36L, and 01L in north flow, or Runways 17L, 18R, and 19R in south flow). This runway configuration also provides 400 m between arrival and departure runways, and 200 m spacing between all runways and taxiways.

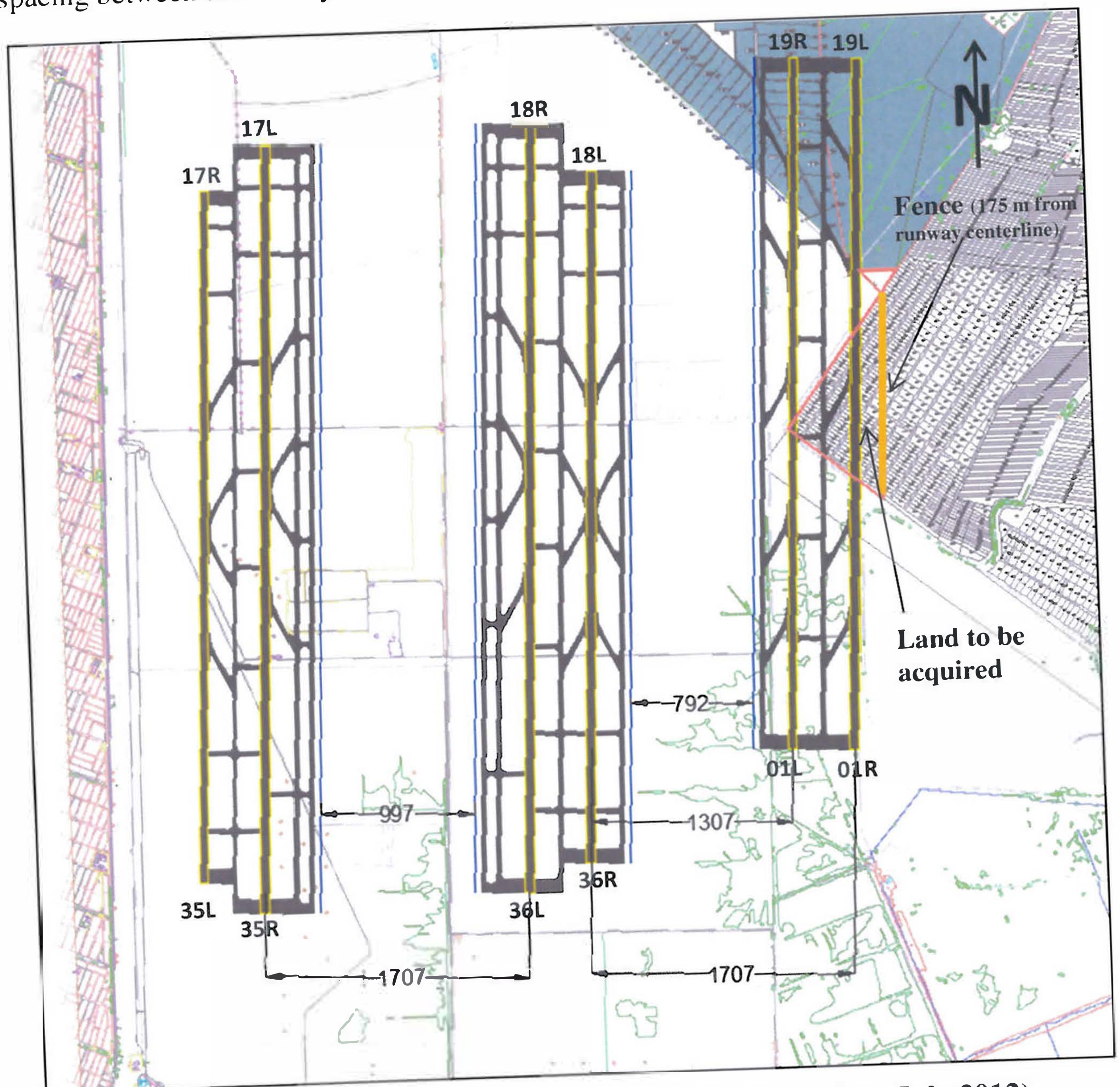


Figure 1. MITRE-Recommended Runway Configuration (July 2012)

The lengths of the runways are given in Table 1.

Table 1. Runway Lengths

Runway	Length (m)
35L/17R	4500
35R/17L	5000
36L/18R	5000
36R/18L	4500
01L/19R	4500
01R/19L	4500

Due to overall capacity considerations, MITRE considers that it is necessary to maintain the possibility of operating three independent arrival streams and three independent departure streams even if one of the six runways should close for maintenance or for other reasons. The *MITRE-Recommended Runway Configuration (July 2012)* provides this flexibility for the north-flow case as follows:

- If Runway 35L is closed, those arrivals would be assigned to Runway 35R, which would operate in mixed mode.
- If Runway 36R is closed, those arrivals would be assigned to Runway 36L, which would operate in mixed mode.
- If Runway 01R is closed, those arrivals would be assigned to Runway 01L, which would operate in mixed mode. Additionally, the nominal roles of Runways 36L/R would be reversed, with arrivals assigned to Runway 36L (to provide 1707 m lateral separation with Runway 01L, and departures assigned to Runway 36R. Departures requiring the full 5000 m runway length would be assigned to either Runway 36L or 35R.
- If any of the nominal departure runways (35R, 36L, 01L) is closed, the departures would be assigned to the other runway of the closely-spaced pair, which would operate in mixed mode, or an available 5000 m runway if that full length were needed.

The runway configuration designed by MITRE provides similar operational flexibility in south flow. Furthermore, with this configuration triple parallel approaches could still be maintained with the closure of both Runway 35L/17R and Runway 36R/18L.

3. NAICM Alternative Runway Configuration

As mentioned above, the recommended runway configuration shown in Figure 1 was developed under the assumption that additional land to the north and east of the boundary of federally-owned land would be acquired. Federal officials were confident at the time that the land required for this runway configuration would be purchased by the federal government. Nonetheless, ASA requested that MITRE examine an alternative runway configuration under the assumption that the triangular area of land to the east (and impinging on Runway 01R and Runway 01L) may not be acquired. In response to that request, a new runway configuration was investigated by MITRE, and that configuration is the subject of this report.

The new configuration, referred to in this document as the *NAICM Alternative Runway Configuration*, utilized, to determine the federal boundary, an AutoCAD drawing provided by Comisión Nacional del Agua (CONAGUA) in June 2011.

A team of MITRE experts was convened in order to develop the *NAICM Alternative Runway Configuration*. The objectives of the group were to fit the runways, taxiways, Runway Strips, and RESAs within the boundary of federally-owned land (in particular avoiding the triangle of land to the east), provide six parallel runways that would allow triple independent parallel approaches and triple independent departures, and maintain these three independent arrival and three independent departure streams even if one of the six runways were to be closed. An additional objective was to maintain sufficient space between runways to allow for the development of terminal facilities. It was obvious that to satisfy these objectives, the runways would need to be shifted to the west and the spacing between some pairs of runways would need to be reduced.

The first step in the development of the *NAICM Alternative Runway Configuration* was to move the westernmost Runway 35L as far west as possible. Moving this runway (and Runway 35R) closer to the residential areas west of the site would have an adverse impact on noise exposure. Note that MITRE has not conducted a detailed noise analysis for the *NAICM Alternative Runway Configuration*.

Based on MITRE's assessment, it was determined that Runway 35L could be moved 370 m to the west. Regarding Runway 35R, MITRE felt that it was important, for both safety reasons and to optimize surface movement, to maintain the taxiway located between these two runways, as well as the 200 m separation between the taxiway and the runways. Therefore, it was determined that Runway 35R could also be shifted 370 m to the west.

Because of practical limitations concerning how far west the westernmost runway could be moved (primarily due to various infrastructure along the western boundary of federally-owned land, including portions of the *dren*—hereinafter refer to as canal or drain—and highway) and the fact that the easternmost runway would need to be shifted west by 605 m in order to remain clear of the triangular area of land to the east, it became clear that the distance between runways would need to be reduced. However, this reduction in separation would need to be done with great care since the resulting geometry would need to not only allow triple parallel approaches and departures under a set of runway-use scenarios that would provide operational flexibility, but also allow sufficient room between runways for the development of large-sized terminal facilities.

As shown in Figure 1, the *MITRE-Recommended Runway Configuration (July 2012)* provided 1707 m of separation between Runway 36R and Runway 01R (as well as between Runway 36L and Runway 01L). MITRE resolved that this relative separation needed to be preserved in order to be able to maintain independent parallel approaches as well as providing some operational flexibility (i.e., maintaining independent parallel approaches and independent departures even with one runway being closed). If, for example, the spacing were reduced so as to only allow independent approaches to Runways 36L and 01R (and one of the 35s), then if either Runway 36L or Runway 01R were closed for maintenance, triple independent parallel approaches would not be possible. Additionally, MITRE felt that the 400 m spacing between Runways 36L and 36R and between Runways 01L and 01R needed to be preserved, in order to maintain the intermediate taxiways with 200 m of separation from the runways. Therefore, the relative spacing of these four runways (36L/R, 01L/R) was held constant, and these four runways were moved as a group to the west.

As mentioned in Section 2, because the *MITRE-Recommended Runway Configuration (July 2012)* provided 1707 m of separation between Runway 35R and Runway 36L, triple parallel approaches could still be maintained with the closure of both Runway 35L and Runway 36R. Although having this much flexibility is advantageous, it is really only necessary to plan for the closure of one runway, since maintenance activities would not likely be simultaneously scheduled for more than one runway. Therefore, the 1707 m separation required to operate independent parallel approaches only needs to be applied between Runway 35L and Runway 36L, and between Runway 35R and Runway 36R. This would allow the group of four runways to be shifted to the west by as much as 770 m (370 m + 400 m). However, since terminal facilities will be constructed between Runway 35R and Runway 36L, having additional spacing would be greatly advantageous. Based on MITRE's assessment, it was determined that the group of four runways would only need to be shifted to the west by 605 m to avoid being impacted by the triangular area of land to the east. The *NAICM Alternative Runway Configuration* is shown graphically in Figure 2. Runway lengths are unchanged from those given in Table 1.

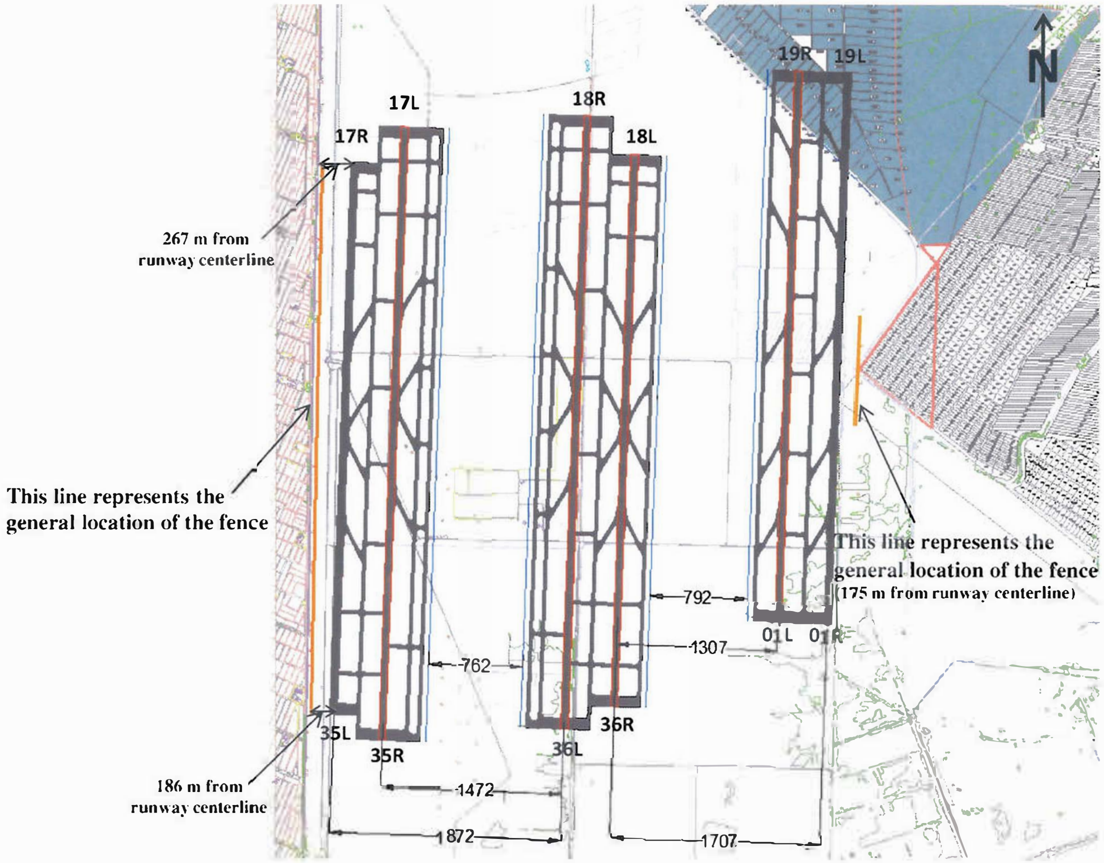
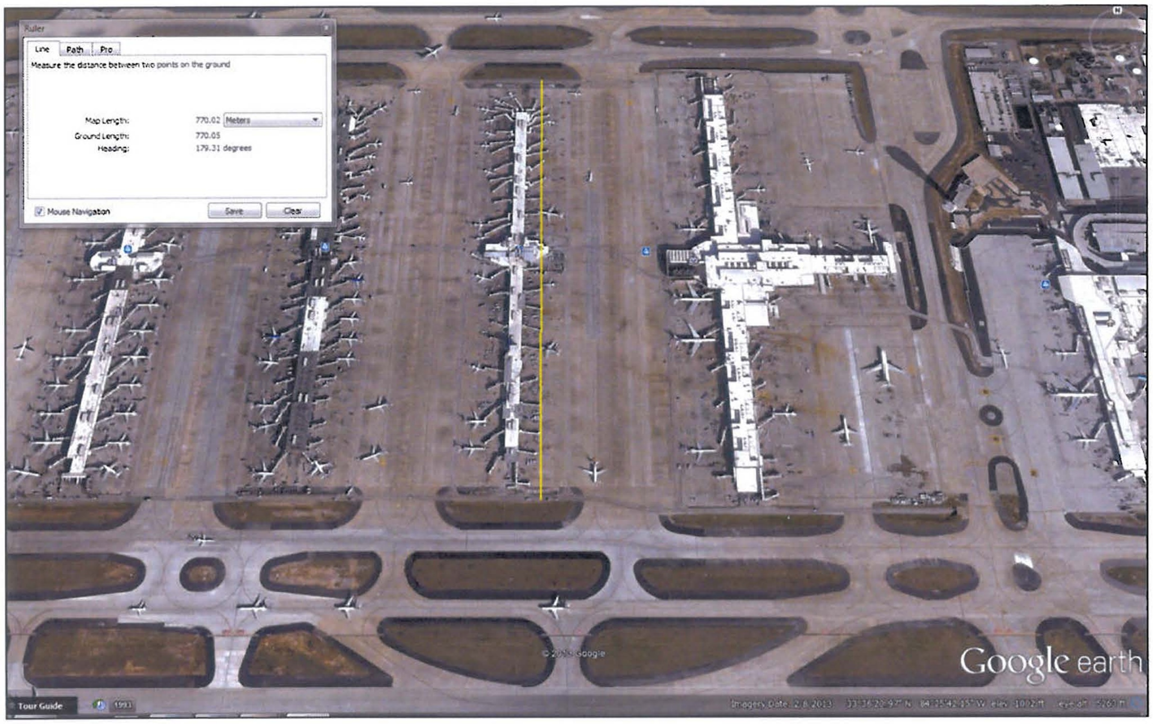


Figure 2. NAICM Alternative Runway Configuration

A major concern in the development of the *NAICM Alternative Runway Configuration* was the amount of space between runways that could be used for terminal facilities. While the *MITRE-Recommended Runway Configuration (July 2012)* had a large area between the western and center pairs of runways, due to the minimum spacing required by aeronautical considerations for independent approaches being applied between Runways 35R and 36L (rather than between Runways 35L and 36L and Runways 35R and 36R), the available space for terminal facilities between these runways has been reduced in the *NAICM Alternative Runway Configuration*. Note that MITRE believes that ASA intends to locate the terminal building between Runways 35R and 36L. Therefore, MITRE considered dual parallel taxiways adjacent to those runways. Dual parallel taxiways were not considered between Runways 36R and 01L. As shown in Figure 2, there is 762 m of spacing available for terminal facilities, which is approximately the distance between the service roads at Hartsfield - Jackson Atlanta International Airport (ICAO Code KATL) except for its longest concourse (see Figure 3).



Source: Google Earth

Figure 3. Approximate Width (yellow line) of Terminal Area at Atlanta

4. Evaluation of ICAO Obstacle Limitation Surfaces

In this section, a brief description of the ICAO OLSs is given, followed by the results of the evaluation of the westernmost runway of the *NAICM Alternative Runway Configuration* with respect to these surfaces. When MITRE shifted the runways to the west relative to the *MITRE-Recommended Runway Configuration (July 2012)*, the potential for new obstacles to penetrate the OLSs was greatest with respect to the westernmost runway, as the obstacle environment to the north and south was well known. Therefore, the results provided in this report focus on this westernmost runway in order to identify any issues early on. Analyses of other runways have been performed and will continue as the project progresses, if the configuration presented in this report is preliminarily adopted.

4.1 Methodology for Evaluating ICAO Obstacle Limitation Surfaces

This section describes, in general terms, MITRE's ICAO obstacle assessment work. Following that, the results of this analysis with respect to the westernmost runway of the *NAICM Alternative Runway Configuration* are given.

ICAO has established OLSs around and over airports to be used for identifying obstacles to air navigation and preventing the development of obstacles that could adversely impact aircraft operations. These surfaces can also be used to assist authorities with the establishment of land use regulations by defining obstacle height limits in order to prevent the development of obstacles that could adversely impact aircraft operations.

These surfaces define the limits of obstacle heights on and around the airport. Ideally, obstacles should not be allowed to penetrate these surfaces to minimize dangers to aircraft either during a visual approach or during the visual segment of an instrument approach. Note that the evaluation of OLSs does not complete the required analysis of obstacle impact. Other factors, such as instrument procedure design surfaces considering U.S. Standard for Terminal Instrument Procedures (TERPS), which are used in Mexico, have to be considered and MITRE is doing so in a separate study.

The following OLSs are required to be established for precision Category (CAT) I Instrument Landing System (ILS) runways, similar to the runways being planned for NAICM:

- **Inner Horizontal Surface**. The purpose of this surface is to protect airspace for visual circling prior to landing. Visual circling is a maneuver used to align the aircraft with the runway for landing when a straight-in landing from an instrument approach is not feasible. The Inner Horizontal Surface is a horizontal plane located 45 m above an established airport datum elevation. The surface has a radius of 4000 m from runway thresholds or the end of the Runway Strip.
- **Conical Surface**. The Conical Surface, as with the Inner Horizontal Surface, is designed to protect airspace for visual circling prior to landing. It slopes upwards and outwards from the Inner Horizontal Surface at a slope of 5% (20:1) to a height of 100 m as measured in a vertical plane perpendicular to the periphery of the Inner Horizontal Surface.
- **Approach Surface**. This surface defines the volume of airspace that should be kept free from obstacles to protect an airplane in the final phase of the approach-to-land maneuver. The Approach Surface is an inclined plane preceding the threshold, it has a slope of 2% (50:1) for the first 3000 m, and then the slope increases to 2.5% (40:1) for the next 3600 m. A horizontal section extends 8400 m beyond the second section of the Approach Surface. The Approach Surface has an inner edge of 300 m starting 60 m from the threshold and extending at a 15% divergence rate on both sides to 4800 m at the outer edge.
- **Transitional Surface**. This surface is also designed to protect aircraft in the final phase of landing. The Transitional Surface is located along the side of the Runway Strip and part of the side of the Approach Surface. The Transitional Surface slopes upwards and outwards at a slope of 14.3% (7:1) up to the Inner Horizontal Surface.

For a precision runway for CAT II/III ILS approaches, which MITRE will also be separately examining for NAICM, ICAO also requires that an Inner Approach Surface, Inner Transitional Surface, and Balked Landing Surface be established. These surfaces are in the immediate vicinity of the runway and are collectively known as the Obstacle-Free-Zone (OFZ). The OFZ must be kept free from fixed obstacles, other than lightweight frangible navigational aids, which must be near the runway to perform their function, and from transient obstacles such as aircraft and vehicles. Mobile obstacles shall not be permitted above these surfaces during the use of the runway for landing.

ICAO also requires that a Takeoff Climb Surface be established. This surface defines a volume of airspace designed to protect aircraft on takeoff by indicating which obstacles should be removed if possible or marked, lighted, and published. The Takeoff Climb Surface is an inclined plane starting at 60 m from threshold or at the end of the clearway, if provided, with a slope of 2% (50:1). The surface has an inner edge of 180 m and diverges on each side at a rate 12.5%. The final width for a straight-out takeoff path is 1200 m and 1800 m if the intended flight track includes changes of heading greater than 15° in IMC, and VMC at night.

Obstacles that penetrate these OLSs should, as far as practical, be removed. If an obstacle cannot be removed, an aeronautical study should be undertaken to assess the impact, if any, on flight operations. Depending on the location of the obstacle in relation to approach and departure paths and other factors, such as ceiling and visibility conditions and other nearby obstacles, it may be possible to avoid operational impacts by taking some safety measures. These include marking and lighting, publication of the obstacle in the AIP, limiting runway use to certain types of approaches (e.g., visual or non-precision approaches), restricting the type of traffic (e.g., general aviation, commercial, etc.), and/or establishing operational procedures to ensure that the obstacles in the area are avoided.

Some countries restrict new construction of tall structures beyond the areas currently recognized in ICAO Annex 14 to ensure safety and efficiency of airport operations. If tall structures are erected in or near areas suitable for instrument approach procedures, they may result in increased approach minima with consequent adverse effects on aircraft operations and runway availability. Moreover, high structures in some areas beyond those mentioned in ICAO Annex 14 can become an impediment for departure or missed approach climb-paths.

As mentioned above, MITRE assessed obstacles in accordance with the ICAO OLSs for the westernmost runway of the *NAICM Alternative Runway Configuration* in order to identify any obstacles that could impact aircraft operations, such as high terrain and man-made obstacles.

In conducting this analysis, future airport facilities (e.g., terminal buildings), aircraft parking aprons, and other airfield components were not considered. Future airport facilities should be located so that they do not penetrate any OLSs or impact any instrument procedure design surfaces.

4.2 Evaluation of ICAO Obstacle Limitation Surfaces

MITRE drew the ICAO Annex 14 Approach Surface for Runway 17R. See Figure 4. Terrain penetrates the horizontal section of the Approach Surface by 17 m. This terrain, which is based on Shuttle Radar Topography Mission (SRTM) data, is beyond the detailed satellite-based survey area that was provided to MITRE by the DGAC in December 2010. Due to the wide tolerance of SRTM data, a vertical buffer of 20 m was added to the data (resulting in a penetration of 37 m). In accordance with guidance set forth in ICAO Annex 14, MITRE extended the 2.5% sloping surface until it cleared the

37 m penetration. Therefore the 2.5% surface continues for an additional 1480 m (i.e., 5080 m rather than 3600 m).

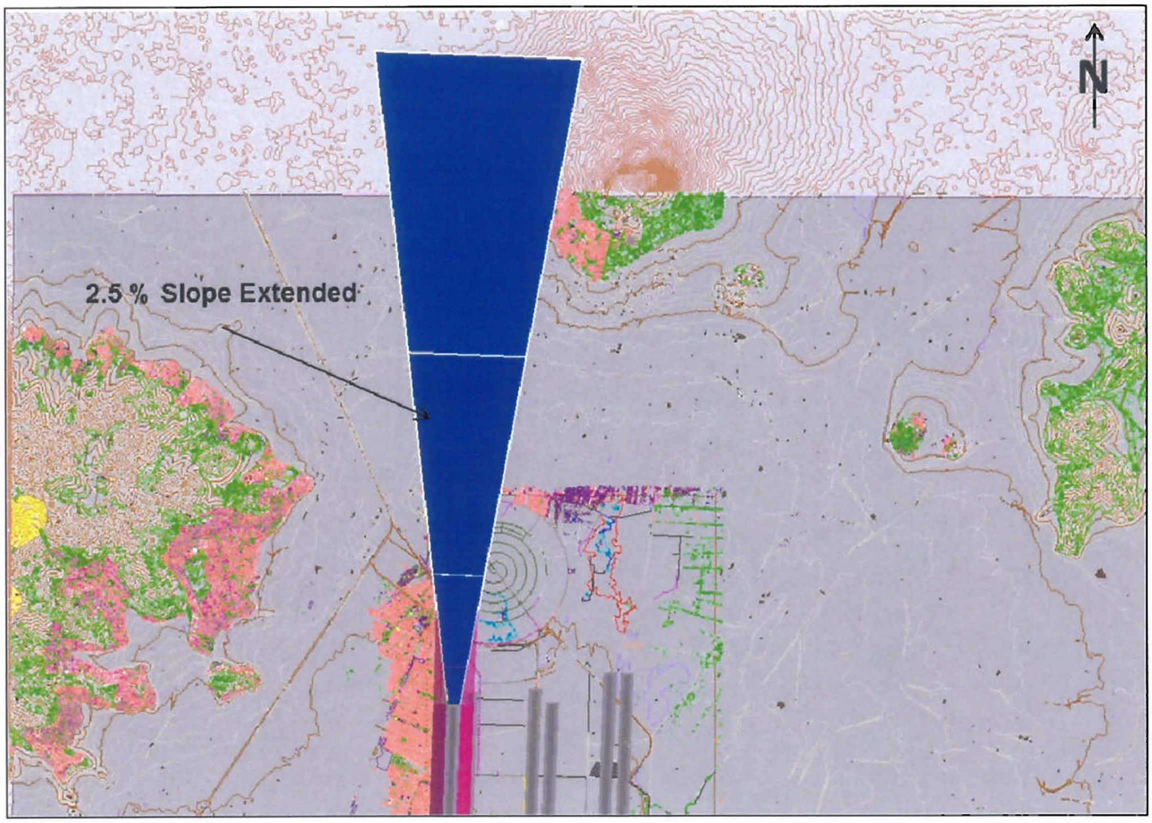


Figure 4. Approach Surface for Runway 17R

The Transitional Surface for Runway 17R is shown in Figures 5 and 6. As can be seen in Figure 5, there are some penetrations within the confines of the boundary of federally-owned land, which include trees and a gravel road, which MITRE expects to be removed as part of the airport construction process. Based on detailed survey data, MITRE knows that there are trees located outside the boundary of federally-owned land that are within 1 m of penetrating the Transitional Surface. The man-made structure depicted in Figure 6 is the most noteworthy obstacle to mitigate, as the penetration is approximately 2 m.

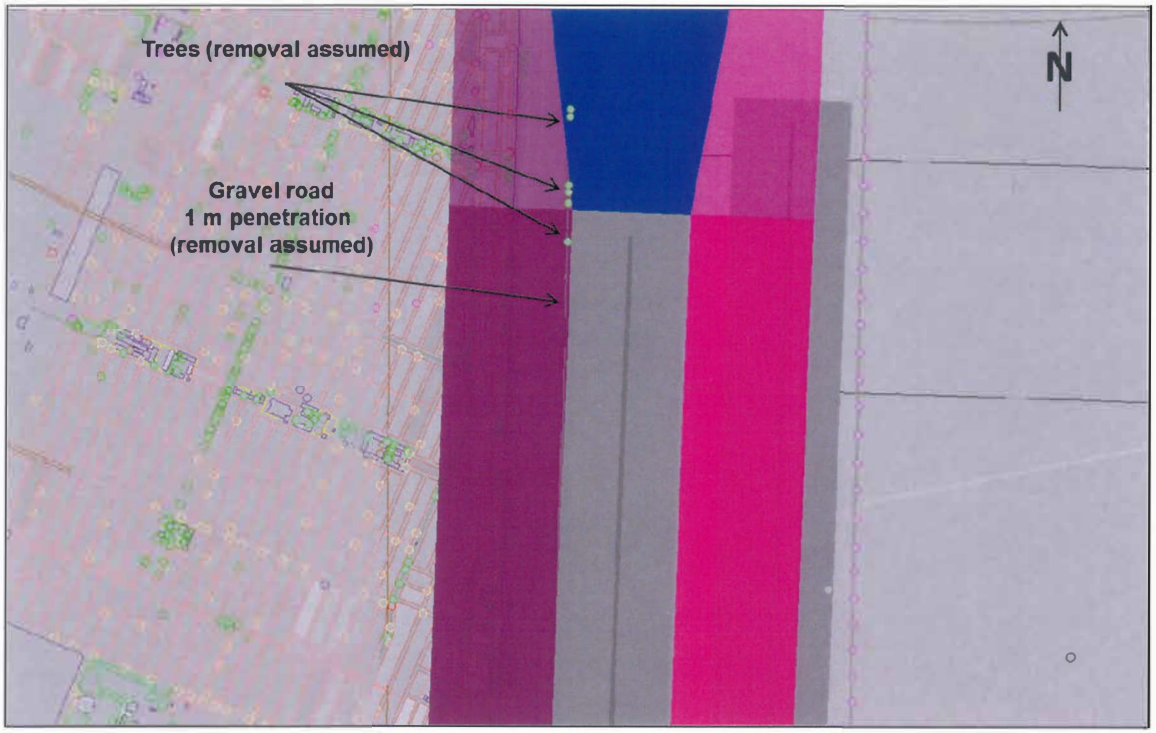
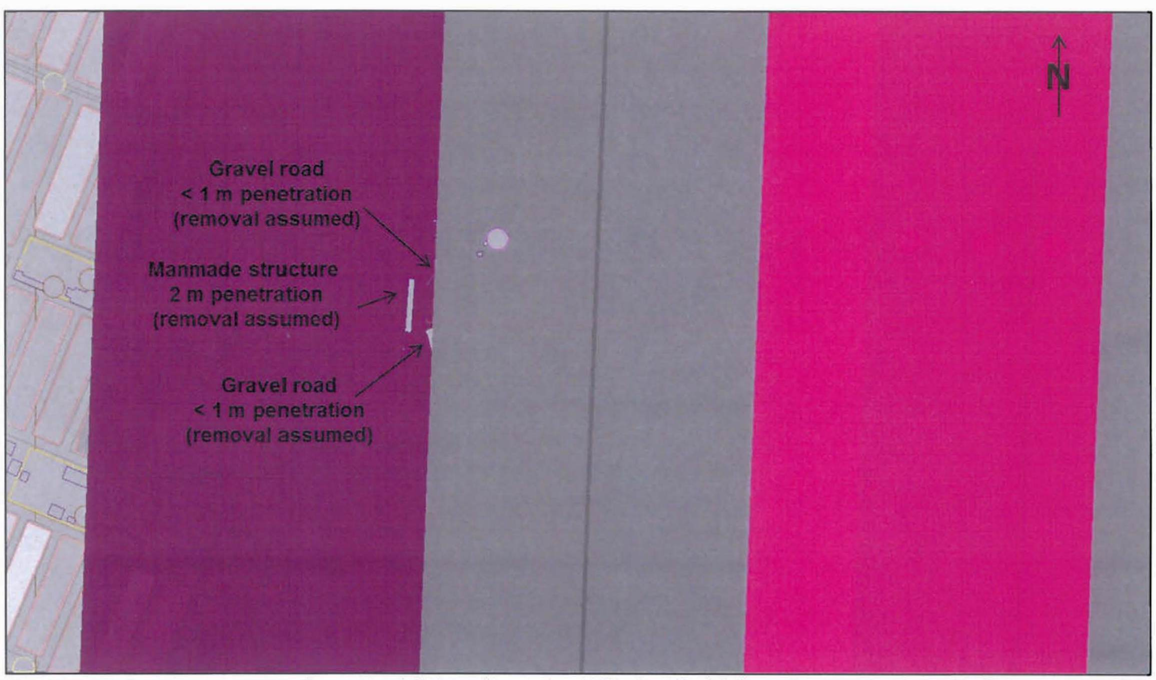


Figure 5. Transitional Surface for Runway 17R



Note: these items are approximately 1619 m from the 17R threshold (i.e., the northern end of the runway)

Figure 6. Transitional Surface for Runway 17R (Continued)

The Approach and Transitional Surfaces for Runway 35L are shown in Figure 7. The penetrations to these surfaces by four light poles are shown in a detailed view, presented in Figure 8. In its analysis of the surfaces for Runway 17R and 35L, MITRE also analyzed the potential for penetration by vehicles, assumed to be 5 m tall, on nearby highways and overpasses. The highway that runs parallel to the western boundary of federally-owned land is, on the average, approximately 5 to 6 m below the height of the Transitional Surface, even considering the assumed 5 m vehicle height. Likewise, MITRE conducted an analysis of the buildings, particularly in the area at which the Transitional Surface crosses the boundary of federally-owned land and extends over the city. MITRE did not identify any penetrations to the Transitional Surface, but noted several buildings that are approximately 6 m below the surfaces.

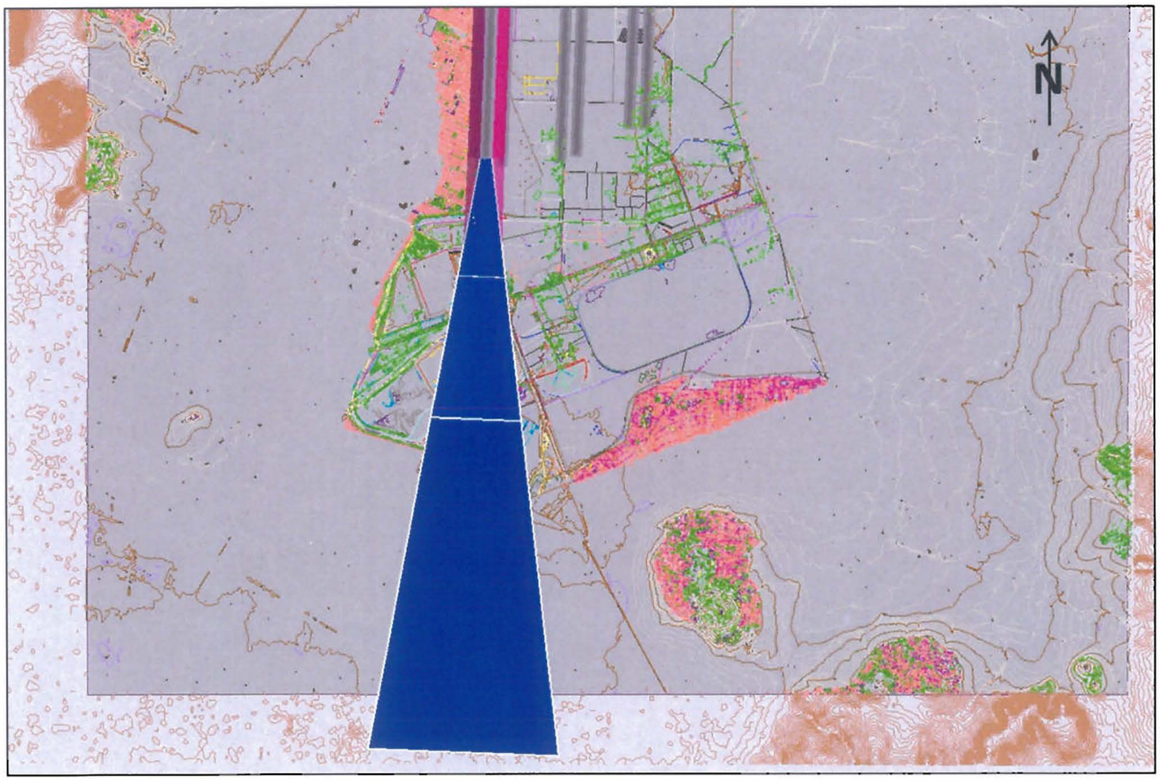


Figure 7. Approach Surface for Runway 35L

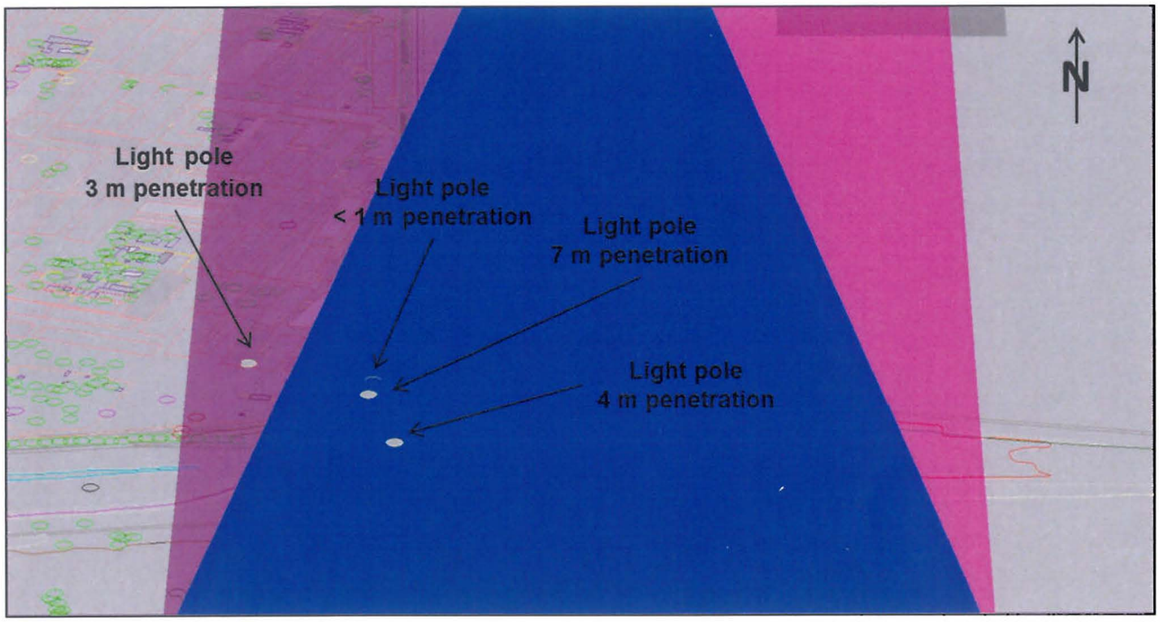
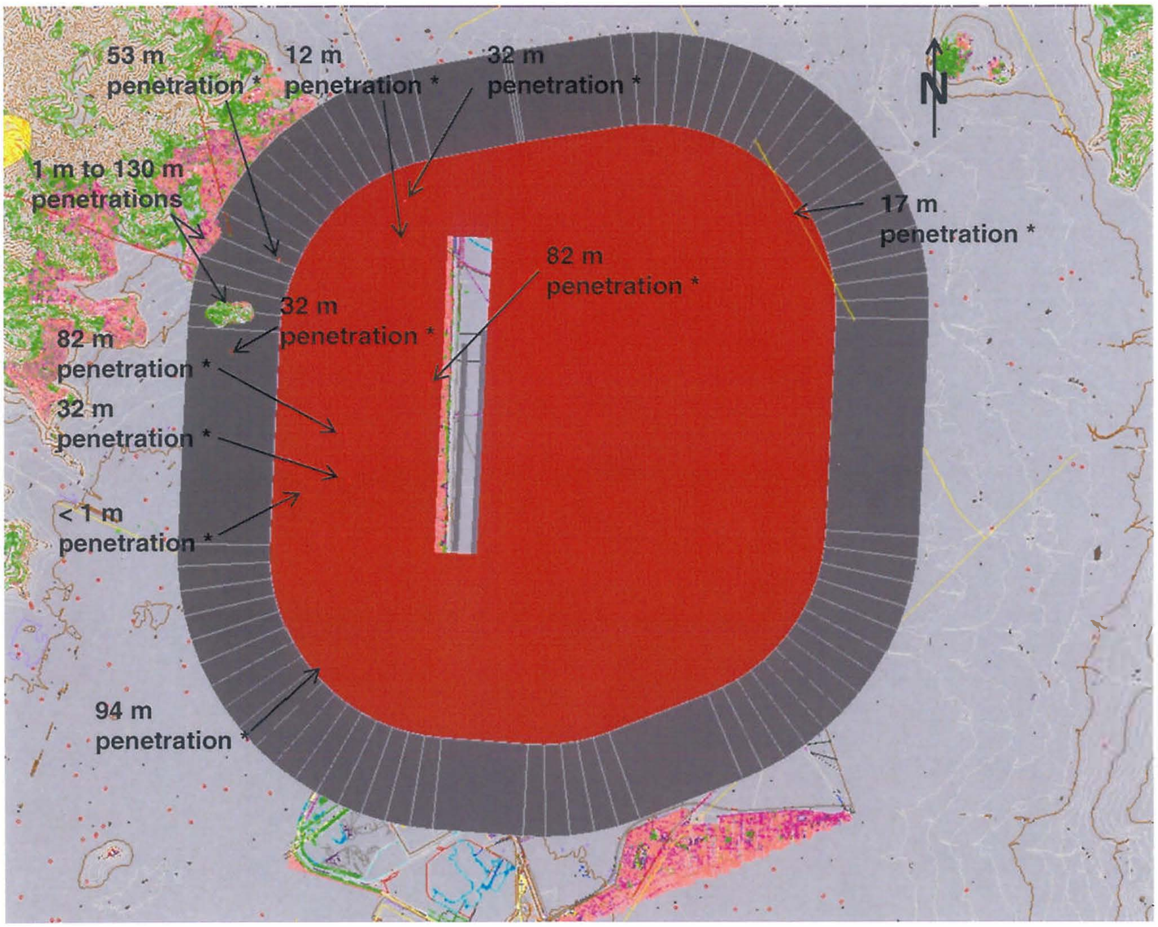


Figure 8. Transitional and Approach Surfaces for Runway 35L

With the shifting of the runways to the west, the Inner Horizontal and Conical Surfaces have expanded westward into the city. To understand the potential impact of this shift, MITRE evaluated the Inner Horizontal and Conical Surfaces for the *NAICM Alternative Runway Configuration*. The results of this analysis are shown in Figure 9. As can be seen in the figure, there are a number of penetrations to the Inner Horizontal Surface and Conical Surface, ranging from less than 1m to approximately 130 m.

MITRE also evaluated the OFZs for Runways 17R and 35L. Many of the previously mentioned obstacles also penetrate the OFZs, such as the gravel road and man-made structures found within the boundary of federally-owned land. These objects are also expected to be removed as part of airport construction. See Figures 10 through 12.



* These obstacles are from a dataset provided to MITRE in 2008, but are either not reflected in the detailed photogrammetric survey conducted in 2010 or are included but with a lower elevation that does not penetrate the surface. MITRE is showing these obstacles so that ASA can investigate.

Figure 9. Inner Horizontal and Conical Surfaces

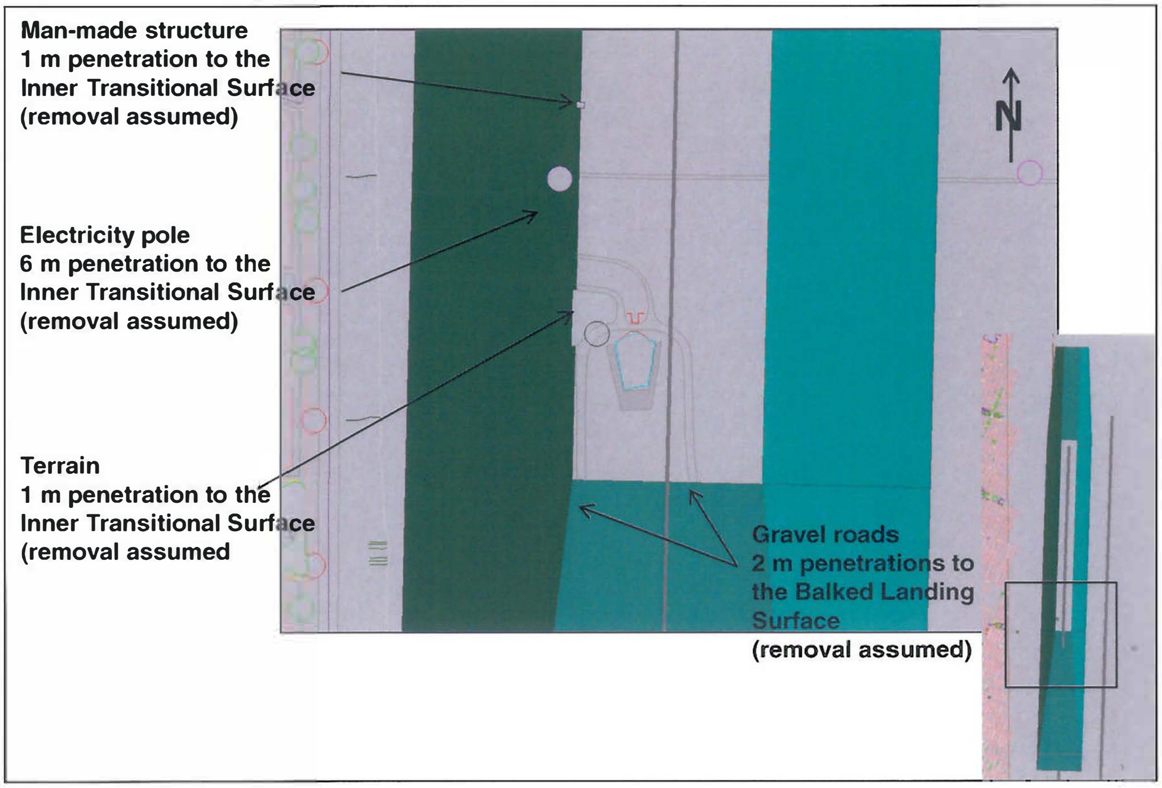


Figure 10. Penetrations to Runway 17R OFZs

Figure 11. Penetrations to Runway 35L OFZs

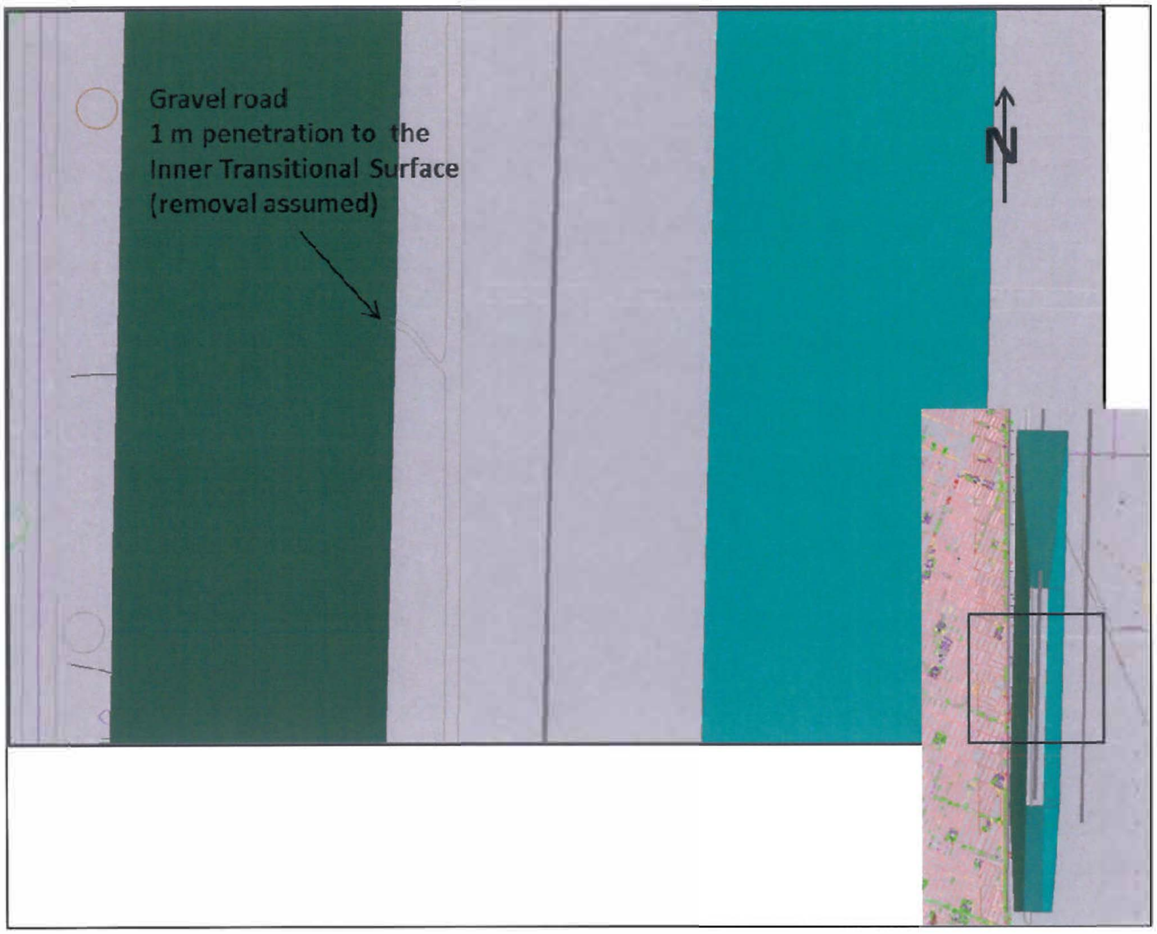


Figure 12. Penetrations to Runway 35L OFZs (Continued)

Figures 13 and 14 show the penetrations to the ICAO Takeoff Climb Surfaces for Runway 17R and Runway 35L, respectively. The Takeoff Climb Surfaces, however, are notional and should not be considered as final as MITRE is in the process of developing these procedures. This is because the Takeoff Climb Surfaces follow the nominal flight tracks of the instrument departure procedures, which have yet to be designed by MITRE for the *NAICM Alternative Runway Configuration*. Nevertheless, MITRE felt it was prudent to examine these surfaces early on (even if only notionally) to identify any potential issues.

Note that the light poles that penetrate the Takeoff Climb Surface for Runway 17R, shown in Figure 13, are the same light poles that penetrate the Approach Surface for Runway 35L, which was previously shown in Figure 8.

There are substantial penetrations to the Takeoff Climb Surface for the turning departure from Runway 35L. This will be a difficult procedure that will likely require very high minimum climb gradients.

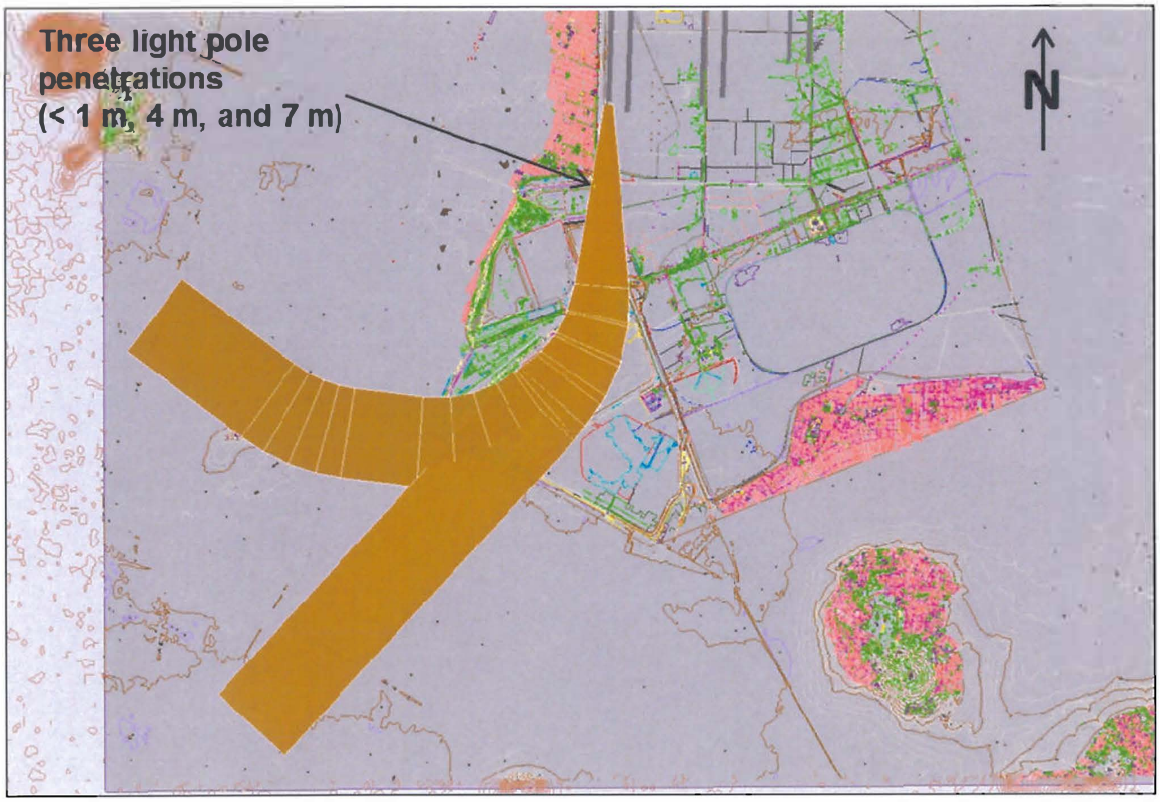


Figure 13. Takeoff Climb Surfaces for Runway 17R

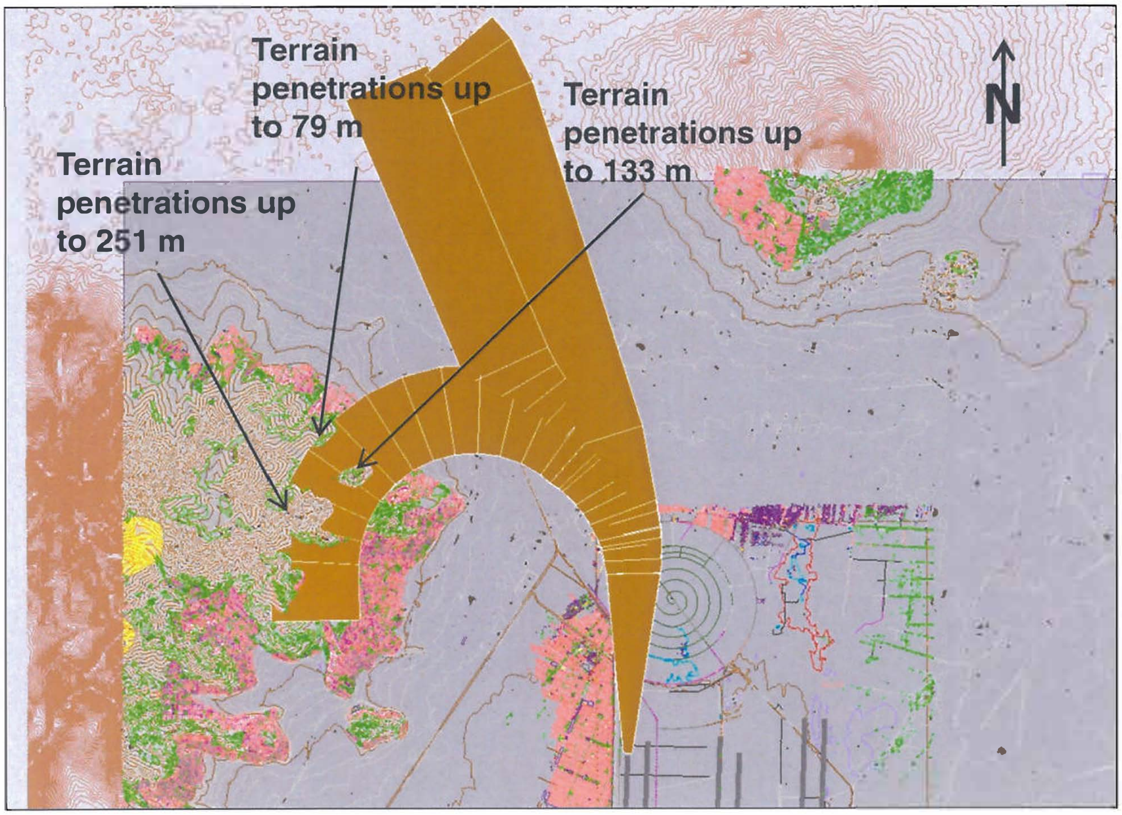


Figure 14. Takeoff Climb Surfaces for Runway 35L

4.3 Runway Strip and RESAs

MITRE performed a visual analysis of man-made structures, vegetation, and terrain within the Runway Strip and RESAs (both standard and recommended dimensions) for Runway 17R/35L that would need to be removed or graded. The results are provided in Figures 15 through 18. Runway 17L/35R is shown in the figures for reference purposes.

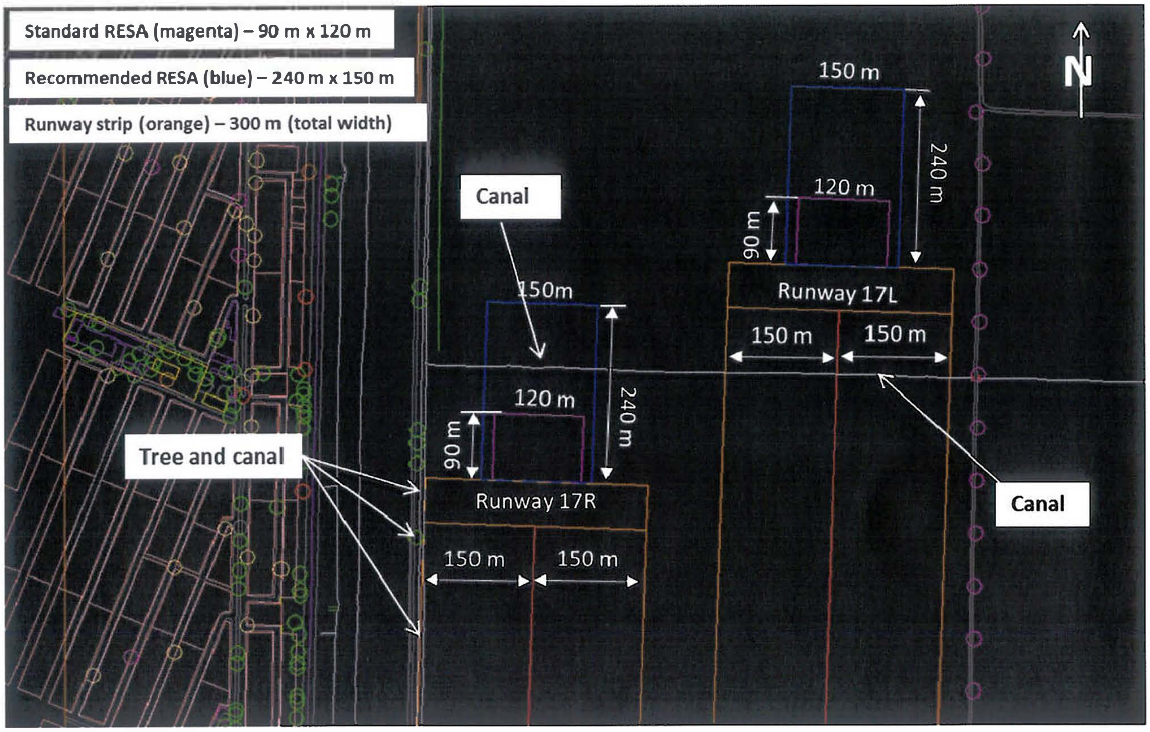


Figure 15. Objects within Runway 17R and Runway 17L Standard and Recommended RESAs and Runway Strips

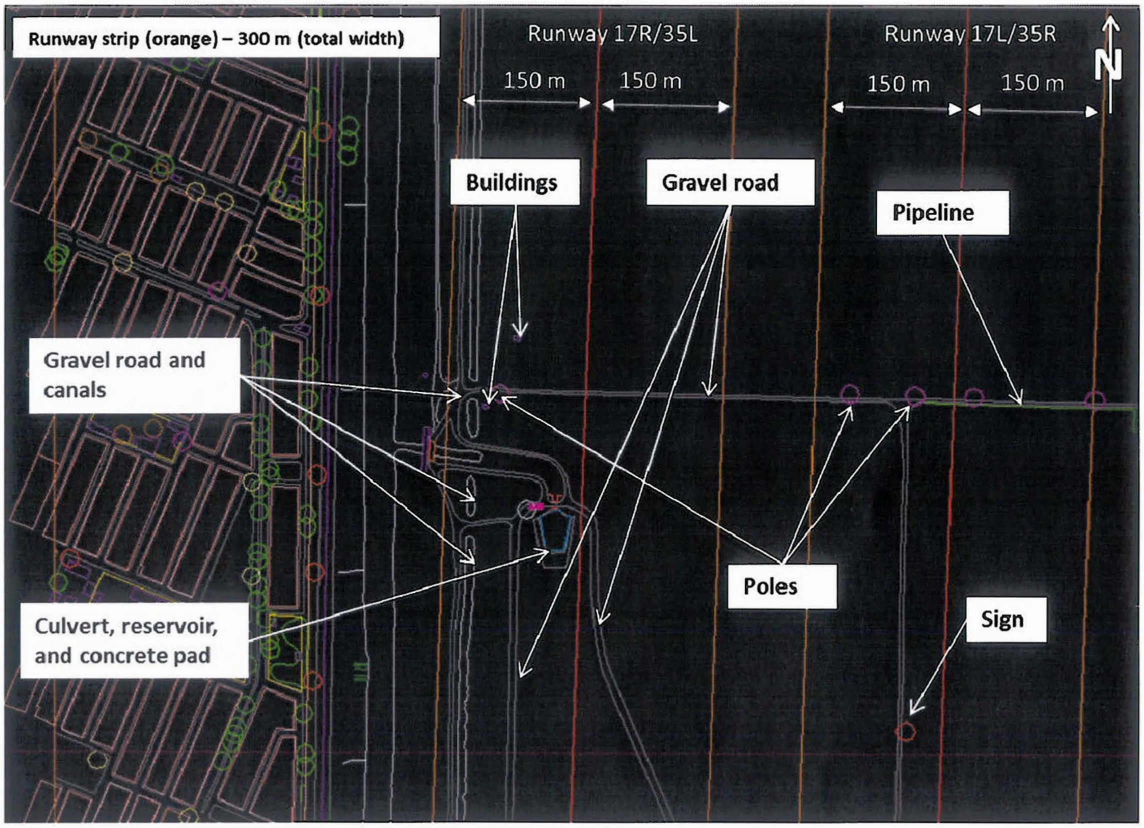


Figure 16. Objects within Runway 17R/35L and Runway 17L/35R Runway Strips

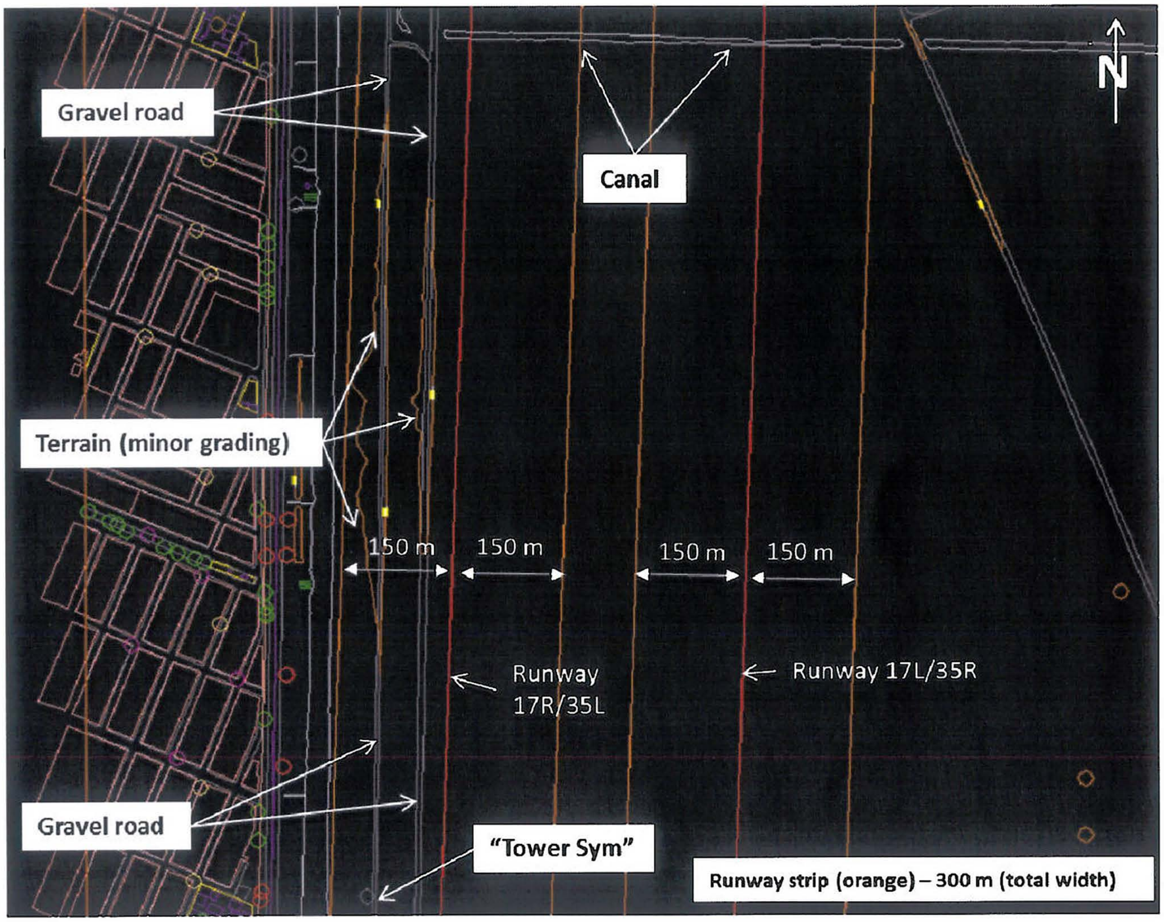


Figure 17. Objects within Runway 17R/35L and Runway 17L/35R Runway Strips (Continued)

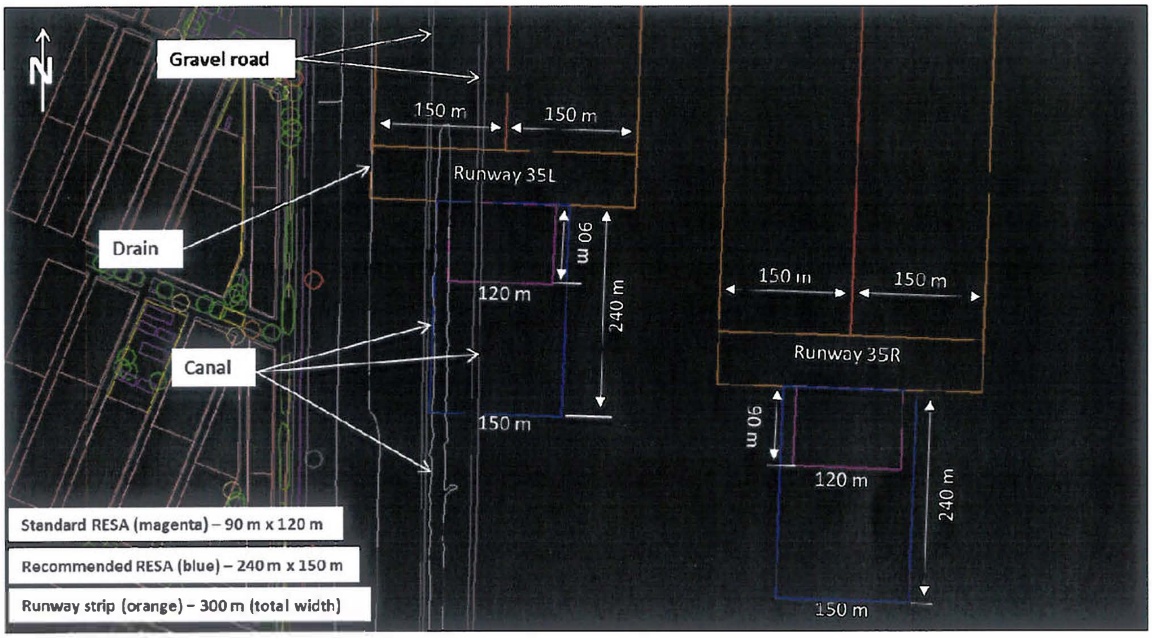


Figure 18. Objects within Runway 35L and Runway 35R Standard and Recommended RESAs and Runway Strips

MITRE has developed three-dimensional (3D) modeling capabilities in order to visualize the obstacle environment. Figure 19, which for clarity intentionally exaggerates the vertical dimension, shows an example of a 3D view that can be used to supplement the analyses described previously.

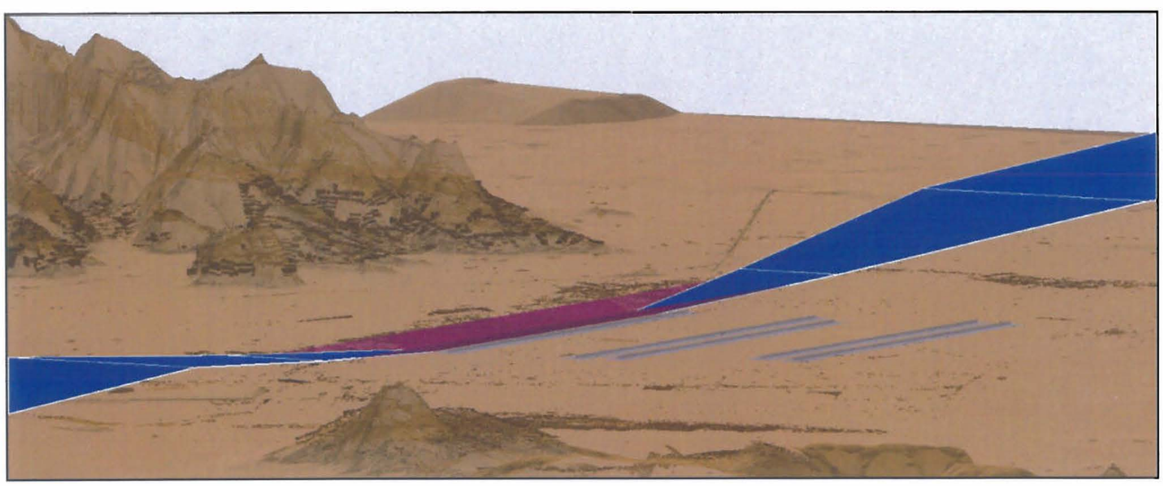


Figure 19. 3D Modeling

5. Observations

The following lists some important initial observations regarding the *NAICM Alternative Runway Configuration:*

- Significantly reduces the amount of non-federally-owned land that would need to be acquired to build NAICM. Depending on the eventual acquisition of land, or refinement of the boundaries of the federally-owned land, the runway configuration ultimately selected could be either this *NAICM Alternative Runway Configuration*, the much preferable *MITRE-Recommended Runway Configuration (July 2012),* or some other unspecified configuration.
- Maintains sufficient separation between runways to perform triple independent approaches and triple independent departures, even under scenarios where any one of the six runways is closed, typically for maintenance.
- Maintains sufficient separation between the closely spaced pairs of runways to allow for a taxiway in between them.
- Provides sufficient room between Runway 35R/17L and Runway 36L/18R to allow for the development of terminal facilities, although the available space is less that that allowed in the *MITRE-Recommended Runway Configuration (July 2012).* Although the available space is somewhat constrained, it is in the order of the available space at Hartsfield-Jackson Atlanta International Airport.
- Establishes the westernmost runway location very close to the infrastructure to the west of the site (e.g., the major drain and highway). Light poles to the south of the westernmost runway penetrate the ICAO Transitional and Approach Surfaces for Runway 35L.
- Leads to likely excessive noise exposure to the west of the airport, worse than that which would result from the *MITRE-Recommended Runway Configuration (July 2012).* Note that MITRE will perform a noise analysis for whatever runway configuration is ultimately selected for NAICM.

Analysis of this configuration is still ongoing. MITRE has already developed candidate CAT I ILS approach procedures (see Enclosure No. 2 to MITRE Technical Letter F500-L14-004, November 2013, entitled *Alternative Runway Configuration for the Nuevo Aeropuerto Internacional de la Ciudad de México - Feasibility Analysis of Independent Approach Procedures*). Additional procedures, such as instrument departures and CAT II/III ILS approaches will be developed in upcoming months. Overall feasibility of the *NAICM Alternative Runway Configuration* is likely but not proven.