New Hampshire DOT

Research Record

Instrument Landing System (ILS)

at the

Mount Washington Regional Airport

Whitefield, NH

Feasibility Study Report

Prepared by the Federal Aviation Administration in cooperation with the New Hampshire Department of Transportation and the U.S. Department of Transportation, Federal Highway Administration

Technical Report Documentation Page

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16. Abstract

The Federal Aviation Administration (FAA) entered into a Reimbursable Agreement with the New Hampshire Department of Transportation, Division of Aeronautics to investigate the feasibility of establishing a full Instrument Landing System (ILS) on Runway 10 at the Mount Washington Regional Airport in Whitefield, New Hampshire. The purpose of the study was to evaluate whether a full ILS system could be successfully sited at the Airport given the terrain and airfield layout limitations, and to provide a cost estimate for the project.

The FAA determined that an End Fire Glide Slope (EFGS) can be properly sited and would provide the best results for a precision approach when combined with new Localizer and DME antenna systems. The FAA recommends proceeding to field test and flight check the full EFGS antenna system to verify the math modeling engineering analysis. Cost estimates are provided in section 9 of this report.

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DISCLAIMER

Federal Aviation Administration

Instrument Landing System (ILS) Engineering Analysis for Runway 10 Mount Washington Regional Airport Whitefield, NH

May 9, 2008

FEDERAL AVIATION ADMINISTRATION
Air Traffic Organization
Eastern Service Area Technical Operations
Engineering Services
Boston Navaids Engineering Center
Nashua, NH 03062

08-0450

Executive Summary

The Federal Aviation Administration (FAA) has entered into a Reimbursable Agreement with New Hampshire Department of Transportation Division of Aeronautics to investigate the feasibility of establishing a full Instrument Landing System (ILS) on Runway 10 at Mount Washington Regional Airport in Whitefield, New Hampshire. The purpose of the study is to investigate if a full ILS system could be successfully sited at the Airport given the terrain and airfield layout limitations and provide a cost estimate for the project. The FAA has determined that an End Fire Glide Slope (EFGS) can be properly sited and would provide the best results for a precision approach when combined with new Localizer and DME antenna systems. The FAA recommends proceeding to field test and flight check the full EFGS antenna system to verify the math modeling engineering analysis. Cost estimates are provided in section 9 of this report.

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1.0 Introduction
The Federal Aviation Administration (FAA) has entered into a Reimbursable Agreement with New Hampshire Department of Transportation Division of Aeronautics to investigate the feasibility of establishing a full Instrument Landing System (ILS) on Runway 10 at Mount Washington Regional Airport in Whitefield, New Hampshire. The agreement between the two parties was signed on October 31, 2007. The purpose of the study is to investigate if a full ILS system could be successfully sited at the Airport given the terrain and airfield layout limitations.

1.1 Airport Ownership and Description
The town of Whitefield, New Hampshire owns and operates the Mount Washington Regional Airport.

The airport has one asphalt runway that is designated as runway 10-28. The runway is 4001 feet long by 75 feet wide with Medium Intensity Runway Lights (MIRL). Runway 10 currently has a Localizer/Non Directional Beacon (NDB) approach and a RNAV (GPS) approach. All details on the existing approach minimums and potential future minimums can be found in Appendix 1 – Feasibility Study – Expected Landing Minimums if Glide slope Equipment is added to support a full ILS system, dated August 30, 2006. The existing localizer antenna system is a non-fed system that is maintained by an airport contractor. There is a FAA owned 4-box Precision Approach Path Indicator (PAPI) on runway 10. There is a FAA owned Runway End Identifier Lights (REIL) system on runway 28 and a non-fed REIL on Runway 10.

2.0 Participants
The Boston Navaids Engineering team initially met with the Airport Manager on February 17, 2008 and then again on March 25, 2008. The survey team members include:

Bruce Hutchings, Mount Washington Regional Airport Manager, Whitefield, NH
Chris Patrick, FAA Boston Navaids Engineering, Systems Engineer, Nashua, NH
Dave Wyer, FAA Boston Navaids Engineering, Civil Engineer, Burlington, MA
Pete Maccini, FAA Boston Navaids Engineering, Electronic Engineer, Nashua, NH
Mark Yogodzinski, Boston Navaids Engineering, Electronic Engineer, Nashua, NH

Other key personnel associated with the study:
Dave Gigowski, FAA Eastern Service Area Program Manager, Atlanta, GA
Carol Niewola, New Hampshire DOT, Division of Aeronautics, Concord, NH
Michael Clark, FAA Office of Government and Industry Affairs, Washington, DC

3.0 Related Projects
There is a study currently being performed by the airport that identifies all obstructions pertaining to a new Localizer Performance with Vertical Guidance (LPV) approach procedure. The information from this LPV obstruction survey and study will provide data that can directly pertain to the development of ILS approach minimums to runway 10.

4.0 Airport Master Plan Status

The Airport began a Master Plan Update in August of 2007 which will identify the ILS on Runway 10 as a potential project. The Master Plan Update will result in an updated Airport Layout Plan (ALP) by 2009. The existing ALP is in Appendix 7.

5.0 Existing Equipment for Runway 10

5.1 Existing PAPI

There is a 4-box PAPI (NBP Corp.) on Runway 10 that is owned and maintained by the FAA. The PAPI is located 805 feet from the Runway 10 threshold. The PAPI provides a 3.5 degree approach decent angle to the runway and has a 45 foot threshold crossing height (TCH). If a glide slope antenna is installed, the existing PAPI would require relocation in accordance with Order 6850.2A, Visual Lighting Systems. The cost to relocate the existing PAPI is provided in Appendix 2.

5.2 Existing Localizer

The existing non-fed localizer contains a Wilcox Mark 1F localizer that radiates at 109.5 MHz. The localizer identifier is I-HIE. The localizer antenna array is a traveling wave type that is no longer supported in the FAA inventory. The age and condition of the antenna array warrants replacement. The terrain in front of the localizer array does not meet the current grading standard for localizer critical areas. Additionally, there is seasonal flooding and intermittent ponding due to beaver activity in the area.

5.2.1 Existing Localizer Shelter/Telephone Lines

The existing building is a 1970 vintage trailer type shelter that contains the localizer electronic equipment as well as the compass locator receiver that monitors the Non Directional Beacon (NDB). The site is accessed by vehicle on an abandoned railway bed. The age, size, and condition of the shelter necessitate replacement.

Currently the facility is monitored with dial-up telephone service. The telephone lines are owned and maintained by Fairpoint Communications. The lines take a direct path back to the airport terminal area adjacent to the runway and are on airport property.

5.3 Existing NDB

The NDB is located in Whitefield, NH, 5.7 nautical miles from the runway 10 threshold. The facility is owned and maintained by the State of New Hampshire. This facility is part of the current Localizer/NDB approach to Runway 10. The NDB supports the LOC/NDB approach and a missed approach to Runway 10. The facility's identifier is GMA and transmits at 386 kHz. It is not anticipated that the installation of a complete ILS/DME at Whitefield would impact the NDB.

5.4 Existing REIL

There is an existing REIL on Runway 10. The location of the REIL would have no impact on the proposed glide slope installation.

6.0 Navaid Engineering Analysis for Runway 10

6.1 Localizer/DME Site

The existing non-fed localizer array, electronic equipment, and shelter should be relocated and replaced with FAA standard Thales 14 element Mark 20A equipment. A 14 element Log Periodic Dipole (LPD) antenna system is preferred to avoid future issues associated with tree growth and vegetation encroachment within the localizer critical area. As previous stated, the existing localizer site has non-standard grading, drainage, and vegetation concerns that should be improved. The proposed localizer array should be located 100 feet further from the threshold than the current antenna array. This would provide an additional 100 feet of ground plane surface that would improve the localizer signal. Additionally, some grading of this area to provide symmetry about the runway centerline would improve the performance of the localizer. The grading required would encroach into wetland buffer areas but should remain clear of the wetland. Limits of the grading would need to be determined and environmental impacts would need to be assessed. There are high tension power lines located on the side and rear of the antenna array but at a distance which would not impact the localizer or DME antenna performance.

From the August 30, 2006 Boston Flight Procedures study (see Appendix 1), it was determined that "DME will enhance the approach design by providing alternatives for the fixes along the localizer course and provide a better missed approach holding option". Therefore, the installation of a DME at the Localizer site was investigated and determined to be a feasible option. The proposed DME antenna mast could be mounted onto the exterior of the Localizer shelter if sited in a clear area off of the access road. Another option is to mount the antenna on a pivotal antenna mast. Both options are standard New England installations, however both options would require some vegetation removal to ensure line of sight with the aircraft. The current DME equipment used by the FAA and recommended for Whitefield is the Thales DME Model 415SE. The DME electronic equipment would be wall mounted inside the proposed new Localizer shelter.

A new 10' X 12' fiberglass localizer building would be required to mount the additional DME equipment. The building location would be adjacent to the current building site located outside the Runway Safety Area (RSA) and would not penetrate any FAA Part 77 or TERPS surfaces. New communication lines would be extended from the existing building termination point to the new building location. The telephone lines are required for Link Control Unit (LCU) status to the FAA's Atlantic Operation Control Center (AOCC). The Glide slope would have a Radio Frequency (RF) Link to the localizer for LCU status.

6.2 Glide slope

The existing conditions at Mount Washington Regional Airport create significant challenges for siting a glide slope facility. There is an active, uncontrolled railroad track that runs parallel to Runway 10-28 which is located approximately 450 feet from runway centerline (see Appendix 7). The presence of this railroad will limit the glide slope antenna options. The sloping topography and presence of a pond just west of the approach end of Runway 10 will also define the type of glide slope. The location of the airport access road, in which uncontrolled large truck traffic to a local manufacturing plant adjacent to the airport, will also have impact on the glide slope design. All of these issues factored into the analysis of glide slope antenna options.

There are four types of glide slope antenna systems currently fielded in the FAA inventory. Three of the most common FAA antenna types are image type glide slopes which use the surrounding topography as a reflective surface for the signal. The type of image glide slope is defined, in part, by the length and width of the uniform sloping terrain directly in front of the antenna. The three image type antenna systems are the Null Reference glide slope, Sideband Reference glide slope, and Capture Effect glide slope. Image type glide slopes require a tower for the mounting two or three antennas. The tower is considered non-frangible and must be located a minimum distance from the runway centerline based on criteria defined in "United States Standard for Terminal Instrument Procedures" (TERPS) 8260.3B, Change 19, dated 5/15/2002, section 2.14. The three image type glide slopes were investigated and the results are as follows:

Capture Effect Glide slope

The total height of a Capture Effect glide slope (CEGS) tower for Whitefield, NH was calculated to be approximately 53 feet. Based on TERPS, the Capture Effect glide slope tower would be located approximately 375 feet from the runway centerline. At that location, the critical area extends to 475 feet from the runway centerline, which is beyond the railroad tracks. An active railroad cannot be within the critical area, therefore, a Capture Effect glide slope will not be suitable for use. See Appendix 4 for CEGS critical area layout.

Null Reference Glide slope

The total height of a Null Reference glide slope tower was calculated to be approximately 35 feet. Based on TERPS, the Null Reference glide slope tower would be located approximately 290 feet from the runway centerline. At that location, the critical area extends to 390 feet from the runway centerline, which puts the critical area very close to the property line between the airport and the railroad. The Null Reference glide slope critical area appears to fit within the airport property. However, Null Reference glide slopes are designed for approaches where the area just beyond the critical area, defined as the "far field", is uniformly sloping thus providing sufficient reflective surface without any obstructions. The topography, pond, and airport road at Mount Washington Regional Airport do not fall into the "far field" siting conditions required for a Null Reference glide slope. Further analysis by math model evaluation verified that the signal would not be within flight check CAT I tolerances due to the limited antenna performance.

Sideband Reference Glide Slope

The total height of a Sideband Reference glide slope tower was calculated to be approximately 30 feet. Based on TERPS, the Sideband Reference glide slope tower would be located approximately 260 feet from the runway centerline. At that location, the critical area extends to 360 feet from the runway centerline, which is within the airport property. The Sideband Reference glide slope is similar to the Null Reference glide slope, however, the Sideband Reference Glide slope is slightly less impacted by "far field" topography roughness. Again, math model evaluation was performed to assess the application of this type of glide slope given the site conditions and obstructions. The modeling verified that the sideband reference glide slope signal would not perform within flight check CAT I tolerances.

Therefore, it was determined that the three Image Type glide slopes would not be applicable for a CAT I ILS approach to Runway 10. Next, the Non Image glide slope, known as the End Fire glide slope (EFGS) was investigated.

Non-Image Glide Slope:
The EFGS looks and operates very differently than the image type glide slopes (see Appendix 3 for EFGS photos and Appendix 6 for EFGS antenna layout). The EFGS antenna system does not require a steel tower because the numerous antennas are not more than 6 feet off the ground. As a result, the antenna system can be partially located inside the RSA and the far edge of the critical area would be no further than 165 feet off of the edge of runway. The critical area would extend no longer than 1,400 feet to the end of the landing threshold (see Appendix 5 critical area layout). By locating the system closer to the runway, the effects from the railroad are further minimized. This type of system does not require as much uniform terrain in the "far field" and is less susceptible to obstruction impacts. Further analysis and math model evaluation was performed to assess the application of this type of glide slope and the results were favorable. It was determined that the installation an End-fire glide slope model 106 antenna array type FA-10029 with Mark-20A glide slope electronics would be the best option for Runway 10. It is recommended that the airport proceed to the next step to ensure the facility will provide adequate flight data. Typically, the FAA performs field antenna testing and flight check test prior to the installation of the actual antenna system. This flight test will verify that the glide slope signal in space is adequate for a CAT I ILS approach.

The end-fire glide slope has been proven to tolerate New England snow conditions during uniform snow coverage condition as demonstrated at airports in Augusta and Waterville, ME and Providence, RI. However, on occasion, the EFGS critical area may need to be cleared of snow which would be the responsibility of the airport. A benefit of the EFGS is that the antenna system has self (field) monitoring of the radiated signal. This is very desirable in an uncontrolled airport environment such as at Mount Washington Regional Airport where there is no airport security fence.

A new 10' X 12' fiberglass glide slope building would be required to contain the glide slope electronic equipment. The PAPI electronic equipment will be also be mounted to the wall in the shelter. The building location would be adjacent to the antenna system outside the Runway Safety Area (RSA) and TERPS surfaces. Remote interface capability to the AOCC would be required through RF link to the Localizer LCU. There would be some grading required for the building installation and the rear EFGS antenna system. The extent of the grading would be determined in the design phase.

6.3 Approach Lighting

A Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights (MALSR) is considered an integral part of the FAA's standard Category I ILS approach. However, when the lowest Category I minimums cannot be achieved, which is the situation on Runway 10, the MALSR visibility credit may not be applicable. Also, given the terrain and environmental impacts due to a pond on the Runway 10 extended centerline, the cost benefit analysis as well as the environmental impacts would not justify the installation of a MALSR. As a result, this study will not investigate installation of an approach light system for Runway 10.

6.4 Summary of Recommendations

Boston Navaids Engineering recommends the following:

- Relocate and replace the existing non-fed localizer antenna array, electronic equipment, and building. Replace the localizer equipment with the current Thales 14 element Mark 20A equipment, which is FAA supply supportable.
- Install a new Thales DME-415SE at the new localizer building site, which is FAA supply supportable.
- Install a new End Fire glide slope model 106 antenna array type FA-10029 with Mark-20A glide slope electronics, which is FAA supply supportable.
- Relocate the existing Runway 10 PAPI to be coincident with the proposed electronic glide slope signal.
- Determine the need to retain the non-fed NDB facility to support the approach/missed approach procedures. If the facility is still required, relocate the NDB monitoring equipment to the new Localizer shelter.

7.0 Environmental Considerations

In accordance with FAA Order 1050.1E, "Policies and Procedures for Considering Environmental Impacts" (June 8, 2004), an ILS project would require an environmental assessment. Paragraph 401i lists, "Establishing or relocation of Instrument Landing Systems" as an action requiring an environmental assessment. Additionally, some of the grading changes and vegetation removal required for the Glide slope, Localizer, and DME installation may require State and Local permitting agency approval.

8.0 Obstruction Survey

The data obtained from the current LPV survey will provide FAA Flight Procedures Division the necessary information to determine the lowest achievable ILS minimums for Runway 10.

9.0 Cost Estimate

The cost of installing a new End Fire Glide slope, replacing the existing Localizer antenna array and electronic equipment, installing a new DME, relocating the existing PAPI, and installing the ILS buildings and infrastructure can be found in Appendix 2. The total cost required for planning, procuring, engineering, constructing, and certifying the aforementioned facilities is $1,480,150. This assumes the Airport is responsible for all environmental compliance and permit acquisitions.

The recommendation to field test and flight check the full EFGS would cost approximately $80,000 which is not included in the design/installation cost.

Appendix 1

FEASIBILITY STUDY

TO DETERMINE EXPECTED LANDING MINIMUMS IF GLIDESLOPE EQUIPMENT IS ADDED TO SUPPORT A FULL INSTRUMENT LANDING SYSTEM (ILS)

MOUNT WASHINGTON REGIONAL / WHITEFIELD, NH

Boston Flight Procedures Office (BOS-FPO)
12 New England Executive Park, Burlington, MA 01803
August 30, 2006

Overview

The Boston Flight Procedures Office conducted an aeronautical feasibility study to determine expected ILS Category I landing minimums on runway 10 if Glideslope equipment is installed.

Airport

The Mount Washington Regional Airport is a public use airport located in Northern New Hampshire. There are approximately 30 single-engine and 6 multi-engine aircraft based there. There are no scheduled air carrier operations to the airport. General aviation and business aircraft account for approximately 7000 operations annually.

There are presently two approach procedures published for Mount Washington Regional (one ground based and one space based). Published straight-in minima for the existing procedures are:

LOC/NDB RWY 10: MDA 1740-1 mile visibility (HAT 683).

RNAV (GPS) RWY 10: MDA 1940 – 1 ¼ mile visibility (HAT 883) for categories A/B aircraft and 2 ¾ for category C aircraft.

Runway 10-28 is 4001 X 75 with threshold elevations of 1048 feet MSL (RWY 10) and 1072 feet MSL (RWY 28). A Precision Approach Path Indicator (PAPI) is installed serving runway 10. The airport was surveyed by the National Geodetic Survey in July, 1992.

Coordination with the Air Traffic Control

Air traffic control airspace and procedures representatives were contacted and asked to provide comment. There are no known issues concerning installation of a glideslope effecting air traffic control operations.

Initial Review to Determine Obstruction Penetrations to be Mitigated.

There are penetrations to the Glidepath Qualification Surface (GQS) that will need to be cleared to qualify a vertically guided approach to runway 10. Penetration is a tree (or trees) identified as an airport obstruction (KHIE0058) located 2339 ft from the runway 10 threshold.

Assumptions

- Glideslope will meet criteria for siting (to be determined by ANI/AF).
- Average non-surveyed tree height is assumed to be 100' AGL in the final segment and 200' AGL in the missed approach segment.
- Assumed man-made obstruction height in other segments 200' AGL
- Full time altimeter source at Mount Washington Regional Airport.

Review of TERPS Criteria Required to Support an ILS Procedure.

This study was performed to requirements outlined in FAA Order 8260.3B and applicable changes. Criteria for construction of the precision final approach segment are outlined in VOLUME 3, Precision Approach (PA) and Barometric Vertical Navigation (BaroVNAV) Approach Procedure Construction. General criteria for approach construction are outlined in chapter 2. Specific requirements for obstacle data accuracy and navigational aid (NAVAID) use and limitations are defined in FAA Order 8260.19C, Flight Procedures and Airspace.

Initial Evaluation of TERPS Waivers required to Support the ILS.

Waivers to the approach design, if necessary are processed through the National Flight Procedures Group (NFPG) in Oklahoma City, OK to the Flight Standards Division, AFS-400. Requests for waiver of a standard will only be considered when there is no other way to resolve a procedural problem, or provide a required service. If a waiver is proposed for obstacle penetration of an ILS final or straight missed approach surface, then a Collision Risk Model (CRM) study is requested through AFS-420.

EVALUATION

The W surface is a 34:1 obstacle clearance surface (OCS) beginning 200 feet out from the runway 10 threshold. The area has a beginning width of 400 feet either side of the extended centerline. There are multiple 34:1 OCS penetrations which require adjustment of the Decision Altitude (DA) up to 1457' MSL (HAT 400). A tree (possibly more than one) penetrates the Glidepath Qualification Surface (GQS) by 19 feet. A penetration to the GQS disqualifies the runway for vertically guided instrument approach procedure. The tree(s) must be removed or reduced in height sufficiently or the runway will not qualify for an ILS approach.

The X surface is 300 feet wide at it's beginning and extends along the outside edge of the W surface. It rises at 34:1 from the beginning point of the trapezoid (200 feet out from the runway threshold). The X surface also rises at a rate of 4:1 perpendicular to the centerline. There are multiple penetrations to the X surface, however, adjustment to the DA to clear W surface penetrations also clear the X surface penetrations.

The Precision Obstacle Free Zone (POFZ) is an area 400 feet either side of the centerline beginning at threshold extending 200 feet out. It is required to be clear of any obstruction above the runway end elevation. Obstructions in the POFZ limit approach minimums to 250 HAT and ¾ mile visibility. Minimums below 400 HAT and 1 mile visibility are not expected for an ILS at this airport.

The Inner Approach Obstacle Free Zone applies to runways where approach lights are installed. It is a 50:1 obstacle clearance slope beginning 200 feet from threshold extending 200 feet beyond the last approach light and is 400 feet wide, centered over the approach lights. Approach light are not installed serving runway 10. If approach lights can be installed, credit for visibility reduction of up to ½ mile can be taken.

The Visual portion of the Final Approach Segment was evaluated based on existing obstructions. The Visual Area is 400 feet wide beginning 200 feet out from threshold. There is a 34:1 surface and a 20:1 surface associated with the visual area. Penetration to the 34:1 surface restricts visibility no less than ¾ mile. Any penetration to the 20:1 surface restricts visibility to 1 mile. We do not anticipate published visibility below one mile.

Missed Approach

There is high terrain from south of the airport counterclockwise to the Northwest of the airport. Direction of missed approach is limited to a left turn back toward the West. A problem exists if holding at GMA NDB is planned. A climb-in-hold evaluation is required which expands the holding pattern protected area. When the expanded area is evaluated significant issues with high terrain are encountered. There are not many alternatives to holding. One alternative could be the addition of Distance Measuring Equipment (DME) associated with the ILS system. Approach design would be better with segments defined by DME. Missed approach holding could be established at a new intermediate segment fix defined by DME along the localizer course. Penetrations to the missed approach surface could also be overcome by adding a published climb gradient. In this case a waiver may be required.

Required Actions by the Airport to Support the Project.

The airport authority should determine existence of the trees identified as penetrations to the GQS in the final approach segment. Mitigation of GQS penetrations will qualify a vertically guided approach to runway 10. Updated survey data would provide the most current obstruction data.

Conclusion

An ILS approach to runway 10 will not achieve lowest CAT I minimums of 200-1/2. Potential minimums of 400-1 1/2 are possible if GQS issues are mitigated. Strong consideration should be given to installation of DME equipment at the same time a

Glideslope antenna is added. DME will enhance approach design by providing alternatives for fixes along the localizer course and provide a better missed approach holding option. A three degree glideslope appears to be achievable. If needed a climb gradient in the missed approach segment could resolve terrain issues in the missed approach protected area.

Remarks

Runway 10 will at some time in the near future be evaluated for development of a satellite-based approach with Lateral Precision and Vertical (LPV) guidance. Development criteria for an LPV approach is similar to criteria used for ILS development. Satellite based approaches do not require the ground infrastructure needed for an ILS approach. Therefore, it could be less costly and potentially provide the same minimums that an ILS could provide. LPV may require updated avionics equipment in user aircraft. The FAA is on a course to transition the air navigation infrastructure from ground based to a satellite based system

Appendix 2

Title:	Rwy 10 ILS Engineering Analysis	**Estimate Date:**	04/30/2008
Location:	HIE_ ILS, 10 Whitefield NH,		
Estimator:	Cecilia Eichel		

Tree Report

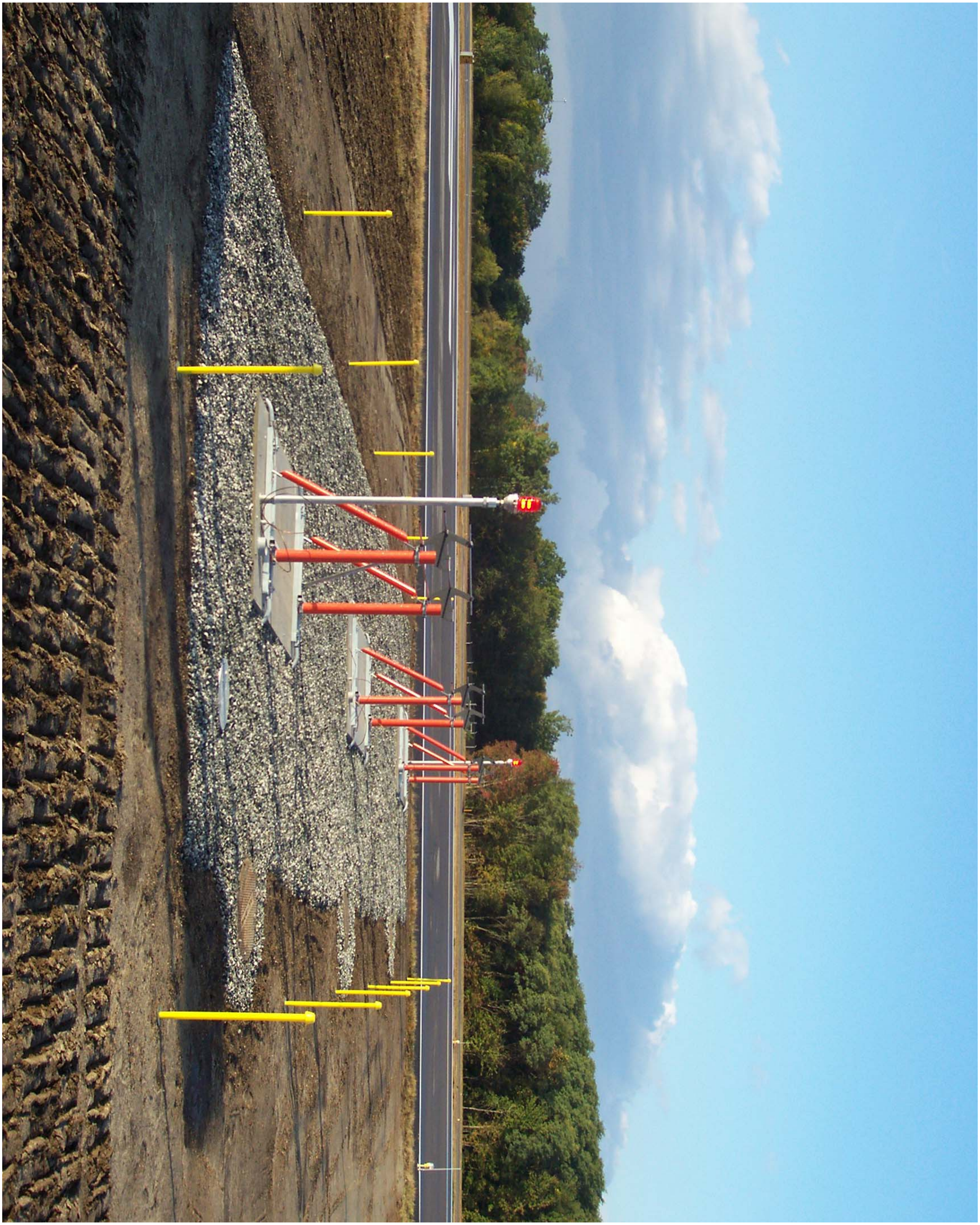
Description	Role	Quantity	Labor	Const Equip	Material	Sub	Other	PML	Total
HIE - WHITEFIELD, NEW HAMPSHIRE									
- ILS - ILS - MARK 20 LOC, MODEL 106 EFGS, DME									
- - 4.0 Implementation									
- - - 4.1 Program Management									
- - - - 4.1.2 Contract Management									
- - - - - 40121 Solicit and Award Construction Contract									
CONSTRUCTION CONTRACT PROCUREMENT									
FAA Civil Engineer	CIVE	1.0 DAY	520	0	0	0	0	0	**520**
TSSC Civile Engineer	CIVET	2.0 DAY	1,120	0	0	0	0	0	**1,120**
Subtotal: CONSTRUCTION CONTRACT PROCUREMENT			1,640	0	0	0	0	0	1,640
- - - 4.2 Engineering									
- - - - 4.2.1 Project Planning									
40213 Conduct Site Survey									
TSSC Civil Engineer	CIVET	2.0 DAY	1,120	0	0	0	0	0	**1,120**
TSSC Civil Engineer	CIVET	2.0 DAY	1,120	0	0	0	0	0	**1,120**
TSSC Electrical Engineer	ELTET	2.0 DAY	1,120	0	0	0	0	0	**1,120**
Subtotal: 40213 Conduct Site Survey			3,360	0	0	0	0	0	3,360
- - - - 4.2.2 Plants Design									
40221 Plants Engineering									
TSSC Civil Engineer	CIVET	35.0 DAY	19,600	0	0	0	0	0	**19,600**
TSSC Electrical Engineer	ELTET	18.0 DAY	10,080	0	0	0	0	0	**10,080**
TSSC Drafting	DRFDT	35.0 DAY	16,800	0	0	0	0	0	**16,800**
FAA Civil Engineer	CIVE	1.5 DAY	780	0	0	0	0	0	**780**
Subtotal: 40221 Plants Engineering			47,260	0	0	0	0	0	47,260
- - - 4.5 Construction									
- - - - 40503 Material Plant Available (GFM)									
MARK 20A LOC									
DEDF 14ELGS&SPARES		1.0 EA	0	0	0	0	0	106,000	**106,000**
Note: *DEDF 14ELEMENT ANTENNA WITH LOCALIZER GLIDESLOPE COMMON SPARES KIT. DEDF 14ELEMENT ANTENNA WITH LOCALIZER GLIDESLOPE*									
LOC/GS COMMON SPRS		1.0 EA	0	0	0	0	0	9,500	**9,500**

Description	Role	Quantity	Labor	Const Equip	Material	Sub	Other	PML	Total
MARK 20A LOC ...CONTINUED									
Note: *LOCALIZER/GLIDESLOPE COMMON SPARE PARTS INCLUDING ALL FIELD REPLACABLE CIRCUIT CARD ASSEMBLIES AND FUNCTIONAL MODULES. LOWEST REPAIRABLE UNIT (LRU) FOR THE MARKER BEACONS. $7,647.00; APP TO: MARK 20A. MFG: AIRSYS CAGE 1C4A3 REPLACED LOCALIZER/GLIDESLOPE COMMON SPARE PARTS INCLUDING ALL FIELD BY CAGE 65597.*									
PIR, MARK 20A		1.0 EA	0	0	0	0	0	12,000	**12,000**
Note: *A PORTABLE ILS RECEIVER(PIR) IS USED TO ADJUST AND TEST THE ILS EQUIPMENT. THE PIR SUPPLIED SHALL BE CAPABLE OF PERFORMING ALL MEASUREMENTS AND TEST THE ILS EQUIPMENT. A PORTABLE ILS RECEIVER(PIR) IS USED TO ADJUST AND*									
RMM LINK CNTR UNIT		1.0 EA	0	0	0	0	0	28,500	**28,500**
Note: *REMOTE MAINTENANCE MONITOR LINK CONTROL UNIT FR CAT II/III ILS MFR: WILCOX ELECTRIC; APP/TO: ILS REMOTE MAINTENANCE MONITOR LINK CONTROL UNIT FR CAT II/III ILS*									
Subtotal: MARK 20A LOC			0	0	0	0	0	156,000	156,000
MODEL 106 ENDFIRE GLIDE SLOPE									
EFGS MODEL 106		1.0 SY	0	0	0	0	0	220,900	**220,900**
Note: *END-FIRE GLIDE SLOPE ANTENNA SYSTEM (EFGS) INCLUDES MODEL 106 EFGS ANTENNA SYSTEM P/N A-906-147B IAW SPEC IFICATION FAA-E-2714/A; ANTENNA SYSTEM TEST PROBE (P/N L-906-6 5A) - EF10; EXTENDER BOARD FOR ALL PLUG-IN CIRCUIT BOARDS; FAA END-FIRE GLIDE SLOPE ANTENNA SYSTEM (EFGS) SITE SPARES IAW SECTION C/SOW C.1.1.2. THE NSN FOR MODEL 105 IS 8200-00-000-4174-1.*									
DEHYDTR-MONT-FLTR		1.0 EA	0	0	0	0	0	4,000	**4,000**
Note: *DEHYDRATOR, LINE MONITOR AND REPLACEMENT FILTER PACK. DEHYDRATOR P/N MT 300-101, ANDREW LINE MONITOR P/N MH-8B-001, REPLACEMENT FILTERS P/N AE01K-B5018-001 DEHYDRATOR, LINE MONITOR AND REPLACEMENT FILTER TO BE USED WITH THE END-FIRE GLIDE SLOPE ANTENNA SYSTEM.*									
ENDFR SITESPS,MK20		1.0 EA	0	0	0	0	0	550	**550**
Note: *MARK 20 CAT II/III ILS ENDFIRE GLIDESLOPE SITE SPARES MARK 20 CAT II/III ILS ENDFIRE GLIDESLOPE SITE*									
AIR DIELECTIC CABLE		1.0 ea	0	0	0	0	0	50,000	**50,000**
Subtotal: MODEL 106 ENDFIRE GLIDE SLOPE			0	0	0	0	0	275,450	275,450
DISTANCE MEASURING EQUIPMENT (DME)									
LPDME		1.0 SY	0	0	0	0	0	45,000	**45,000**
Note: *415SE LOW POWER DME W/SPARES 415SE LOW POWER DME W/SPARES*									
OSCILLOSCOPE		1.0 EA	0	0	0	0	0	2,000	**2,000**
Note: *OSCILLOSCOPE, 100 MHZ ANALOG, DUAL TIME BASE; MFR: FLUKE, APP/TO: TEST, NO PART NO. OSCILLOSCOPE, 100 MHZ ANALOG, DUAL TIME BASE; MFR: FLUKE;*									
SPARE PARTS PECUL		1.0 KT	0	0	0	0	0	25,000	**25,000**
Note: *DME SPARE PARTS PECULIAR FOR OPS STOCK. NSN WILL BE USED FOR SHIPPING THE SPARE PARTS ONLY; MFR: AIRPORT SYSTEMS INTERNATIONAL , INC., APP/TO: DME DME SPARE PARTS PECULIAR FOR OPS STOCK. NSN WILL BE USED FOR*									
Subtotal: DISTANCE MEASURING EQUIPMENT (DME)			0	0	0	0	0	72,000	72,000
PLATFORM PURCHASE FOR ILS SYSTEMS									
10'x12' LOC Shelter through Depot		1.0 EA	0	0	20,000	0	0	0	**20,000**
10'x12' GS Shelter through Depot		1.0 EA	0	0	20,000	0	0	0	**20,000**
10'x12' Shelter - LOC Electronic Install @ Depot		1.0 EA	0	0	0	20,000	0	0	**20,000**

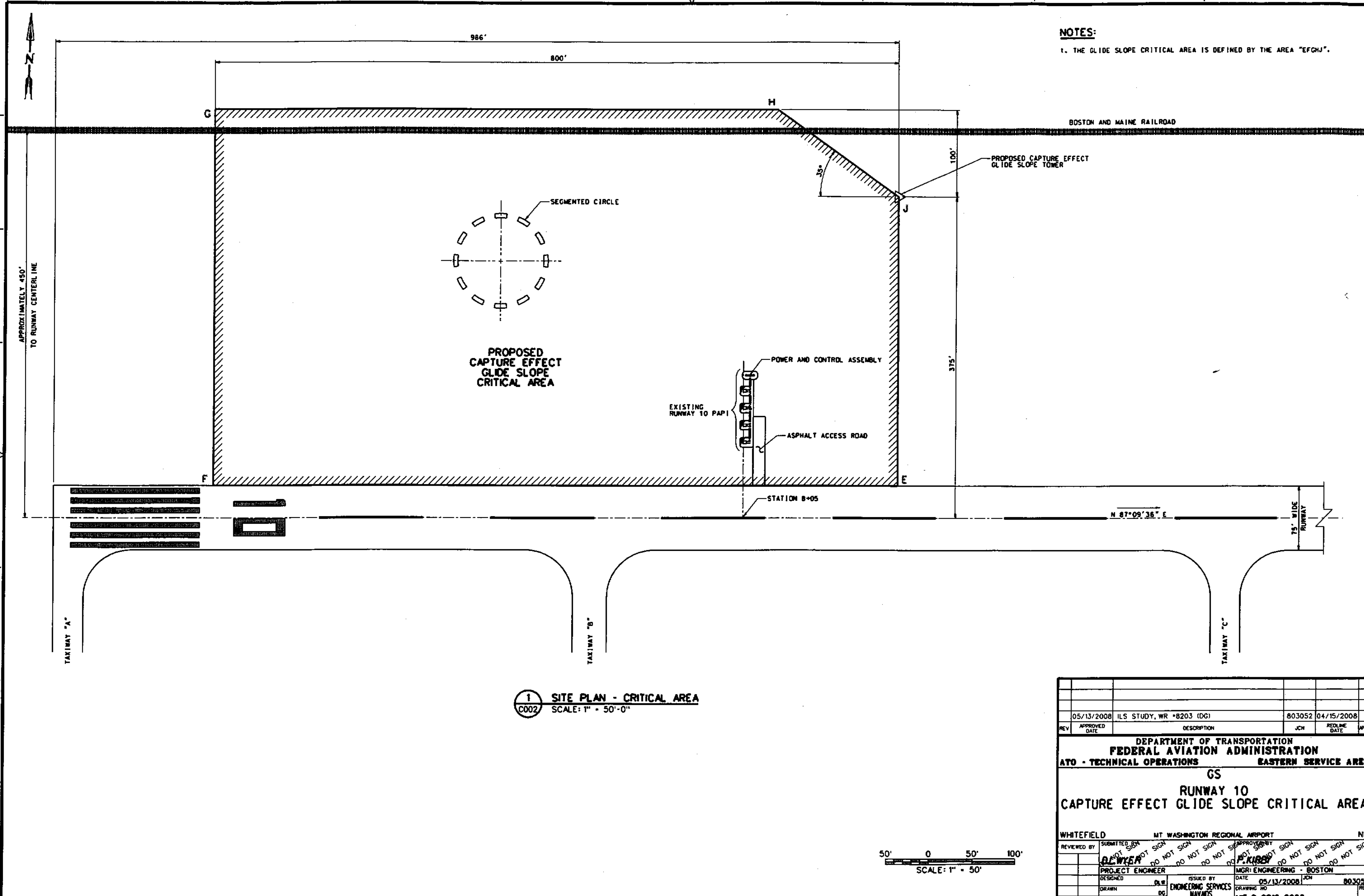
Description	Role	Quantity	Labor	Const Equip	Material	Sub	Other	PML	Total
PLATFORM PURCHASE FOR ILS SYSTEMS ...CONTINUED									
10'x12' Shelter - EFGS Electronic Install @ Depot		1.0 EA	0	0	0	20,000	0	0	**20,000**
SCH A & B Items		2.0 LS	0	0	0	0	6,000	0	**6,000**
MISC Electronic Purchases		1.0 LS	0	0	5,000	0	0	0	**5,000**
Test Equipment & E & R Charges		1.0 LS	0	0	10,000	0	0	0	**10,000**
Subtotal: PLATFORM PURCHASE FOR ILS SYSTEMS			0	0	55,000	40,000	6,000	0	101,000
Resourses - Engineering Support									
FAA Civil Engineer	CIVE	1.0 DAY	520	0	0	0	0	0	**520**
TSSC Civil Engineer	CIVET	1.0 DAY	560	0	0	0	0	0	**560**
TSSC Electronic Engineer	ELTET	1.0 DAY	560	0	0	0	0	0	**560**
FAA Electronic Engineer	ELTE	1.0 DAY	520	0	0	0	0	0	**520**
Subtotal: Resourses - Engineering Support			2,160	0	0	0	0	0	2,160
- - - - 40505 Plant Construction									
MARK 20A LOC & DME									
Site prep for LOC/DME antennas & Shelter		1.0 LS	0	0	0	11,500	0	0	**11,500**
Install Power & Telco duct banks		1.0 LS	0	0	0	11,500	0	0	**11,500**
Install LOC/DME System (foundations, cable, electonics, antenna)		1.0 LS	0	0	0	115,000	0	0	**115,000**
Install Equipment Shelter		1.0 LS	0	0	0	40,250	0	0	**40,250**
Install Security Fence, Gate & Signs		1.0 LS	0	0	0	17,250	0	0	**17,250**
Subtotal: MARK 20A LOC & DME			0	0	0	195,500	0	0	195,500
MODEL 106 EFGS									
Site prep for EFGS antennas & Shelter		1.0 LS	0	0	0	57,500	0	0	**57,500**
Install Power & Telco duct banks		1.0 LS	0	0	0	17,250	0	0	**17,250**
Install EFGS System (foundations, cable, electonics, antenna)		1.0 LS	0	0	0	345,000	0	0	**345,000**
Install Equipment Shelter		1.0 LS	0	0	0	40,250	0	0	**40,250**
Install Access Rd to Equipment Shelter		1.0 LS	0	0	0	28,750	0	0	**28,750**
Install Security Fence, Gate & Signs		1.0 LS	0	0	0	23,000	0	0	**23,000**
Subtotal: MODEL 106 EFGS			0	0	0	511,750	0	0	511,750
Relocate Existing PAPI Equipment									
Relocate PAPI LHAs		1.0 LS	0	0	0	51,750	0	0	**51,750**
Relocate PAPI PCA to GS Shelter		1.0 LS	0	0	0	11,500	0	0	**11,500**
Remove PAPI access rd		1.0 LS	0	0	0	3,450	0	0	**3,450**

Description	Role	Quantity	Labor	Const Equip	Material	Sub	Other	PML	Total
Subtotal: Relocate Existing PAPI Equipment			0	0	0	66,700	0	0	66,700
Resourses - Engineering Support & RE									
FAA Civil Engineer	CIVE	1.0 DAY	650	0	0	0	0	0	**650**
FAA Electonic Engineer	ELTE	2.0 DAY	1,040	0	0	0	0	0	**1,040**
TSSC Electronic Engineer	CIVET	1.0 DAY	700	0	0	0	0	0	**700**
TSSC Resident Engineer	RESET	50.0 DAY	34,000	0	0	0	0	0	**34,000**
Subtotal: Resourses - Engineering Support & RE			36,390	0	0	0	0	0	36,390
- - - 4.6 Test and Checkout									
40605 Installation/Checkout									
FAA Electronic Engineer	ELCE	2.0 DAY	1,040	0	0	0	0	0	**1,040**
Subtotal: 40605 Installation/Checkout			1,040	0	0	0	0	0	1,040
40609 Conduct Flight Inspection									
Flight Check		1.0 DAY	0	0	0	0	6,000	0	**6,000**
Subtotal: 40609 Conduct Flight Inspection			0	0	0	0	6,000	0	6,000
- - - 4.7 Joint Acceptance Inspection/Commissioning/Closeout									
- - - - 4.7.1 Joint Acceptance Inspection									
40711 Conduct CAI & JAI									
FAA Civil Engineer	CIVE	2.0 DAY	1,040	0	0	0	0	0	**1,040**
TSSC Resident Engineer	RESET	2.0 DAY	1,360	0	0	0	0	0	**1,360**
Subtotal: 40711 Conduct CAI & JAI			2,400	0	0	0	0	0	2,400
40717 Clear JAI Exceptions									
FAA Civil Engineer	CIVE	1.0 DAY	650	0	0	0	0	0	**650**
TSSC Resident Engineer	RESET	1.0 DAY	850	0	0	0	0	0	**850**
Subtotal: 40717 Clear JAI Exceptions			1,500	0	0	0	0	0	1,500
Grand Total: Rwy 10 ILS Engineering Analysis			**95,750**	**0**	**55,000**	**813,950**	**12,000**	**503,450**	**1,480,150**

Appendix 3



Appendix 4



1 C002 **SITE PLAN - CRITICAL AREA**
SCALE: 1" = 50'-0"

NOTES:

1. THE GLIDE SLOPE CRITICAL AREA IS DEFINED BY THE AREA "EFGHJ".

REV	APPROVED DATE	DESCRIPTION	JCN	REDLINE DATE	APVD
	05/13/2008	ILS STUDY, WR #8203 (DG)	803052	04/15/2008	

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
ATO - TECHNICAL OPERATIONS — EASTERN SERVICE AREA

GS
RUNWAY 10
CAPTURE EFFECT GLIDE SLOPE CRITICAL AREA

WHITEFIELD — MT WASHINGTON REGIONAL AIRPORT — NH

REVIEWED BY	SUBMITTED BY	APPROVED BY
	D.C.WYER — PROJECT ENGINEER	P. KIRBY — MGR: ENGINEERING - BOSTON
	DESIGNED DLW	DATE 05/13/2008 — JCN 803052
	DRAWN DG	ISSUED BY ENGINEERING SERVICES NAVAIDS
	CHECKED	DRAWING NO HE-D-GS10-C002

DO NOT SIGN DO NOT SIGN DO NOT SIGN DO NOT SIGN DO NOT SIGN DO NOT SIGN DO NOT SIGN

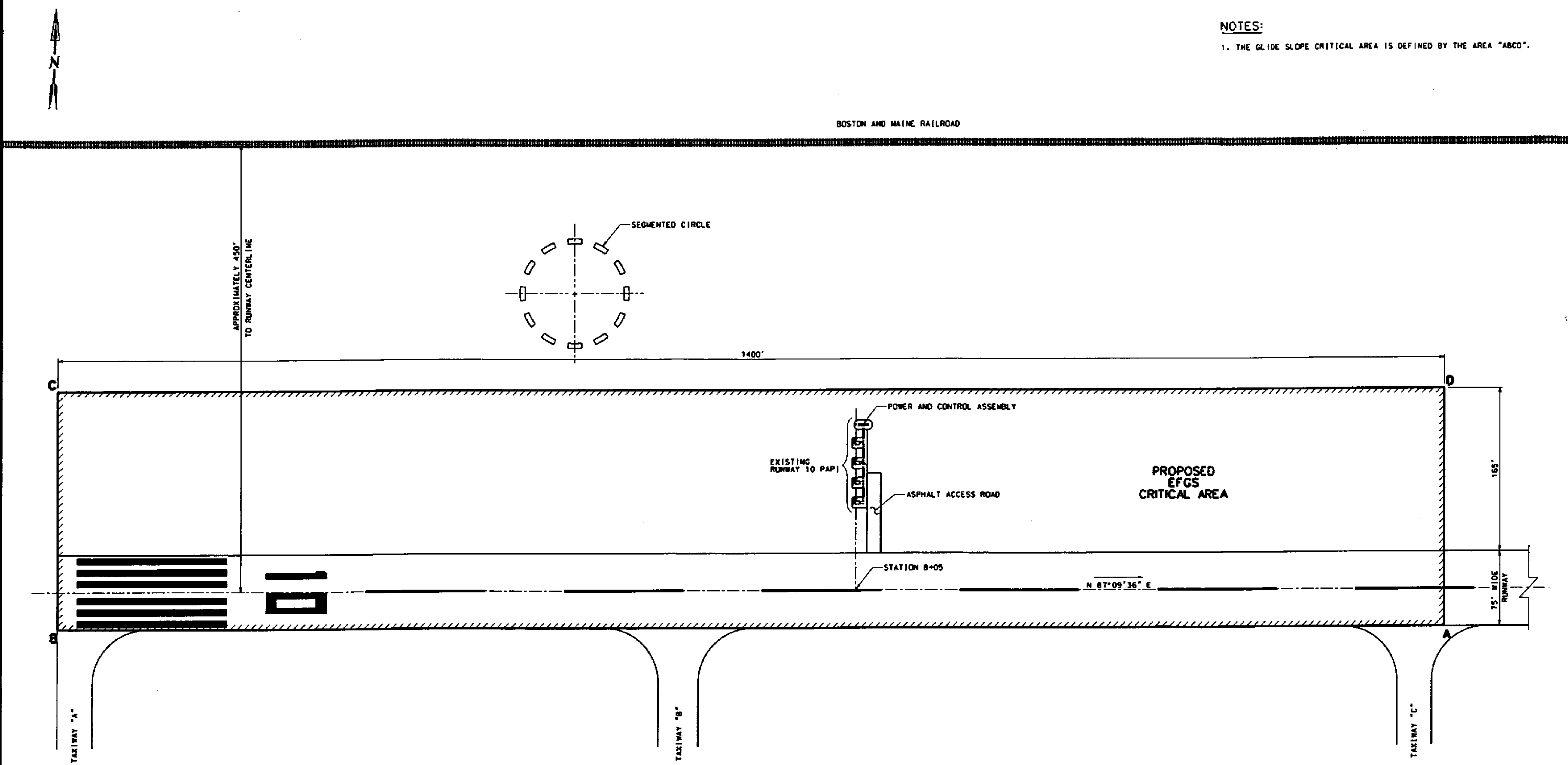
ISSUED FOR CONSTRUCTION

he-d-gs10-c002.dgn 5/13/2008 10:17:05 AM DanielCTR Goenner

Appendix 5

NOTES:

1. THE GLIDE SLOPE CRITICAL AREA IS DEFINED BY THE AREA "ABCD".



1 C001 SITE PLAN - CRITICAL AREA
SCALE: 1" = 50'-0"

50' 0 50' 100'
SCALE: 1" = 50'

REV	APPROVED DATE	DESCRIPTION	JCN	REDLINE DATE	APVD
	04/16/2008	ILS STUDY, WR #8203 (EKS)	803052	04/15/2008	

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
ATO - TECHNICAL OPERATIONS — EASTERN SERVICE AREA

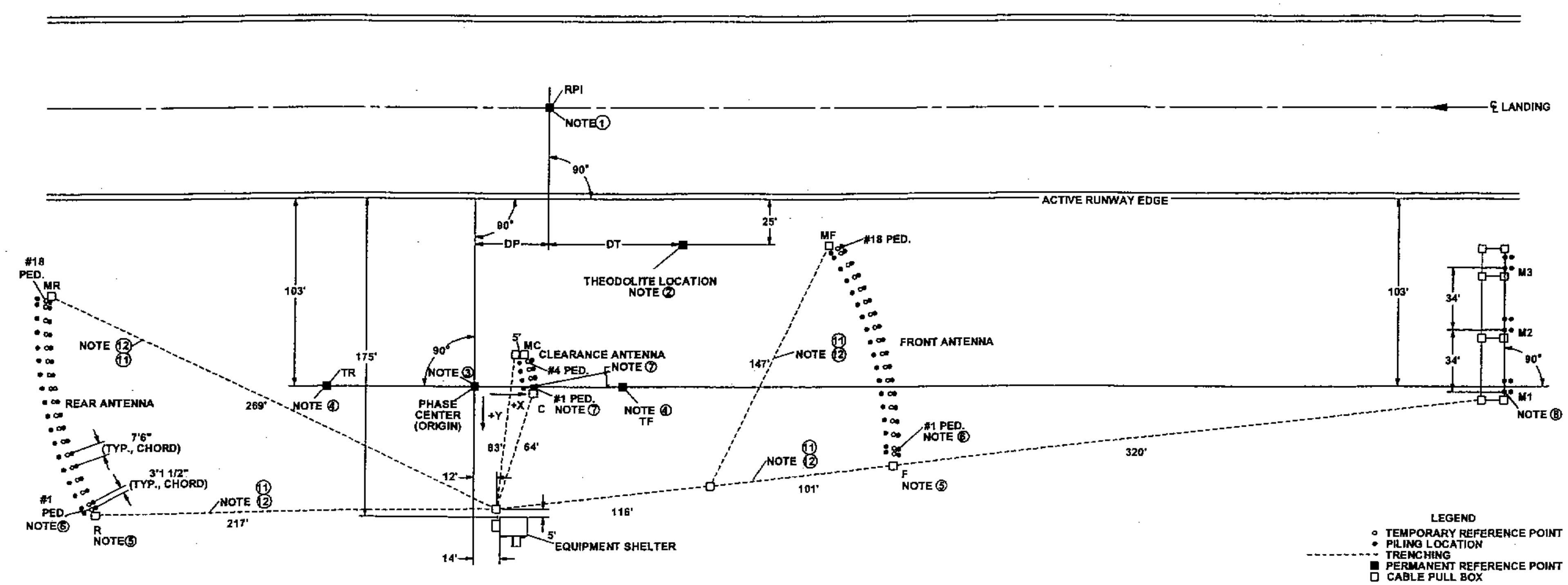
GS
RUNWAY 10
END-FIRE GLIDE SLOPE CRITICAL AREA

WHITEFIELD — MT WASHINGTON REGIONAL AIRPORT — NH

REVIEWED BY	SUBMITTED BY: B.C.WYER — DO NOT SIGN	APPROVED BY: P.KIRBY — DO NOT SIGN
	PROJECT ENGINEER	MGR: ENGINEERING - BOSTON
DESIGNED: DLB	ISSUED BY: ENGINEERING SERVICES NAVAIDS	DATE: 04/16/2008 — JCN: 803052
DRAWN: DG		DRAWING NO: HE-D-GS10-C001 — REV
CHECKED		

ISSUED FOR CONSTRUCTION

Appendix 6



Typical End Fire Glide Slope Antenna Layout

Figure 9-1. Construction Drawing,
Sheet 1 of 5.

Appendix 7

AIRPORT DATA	EXISTING	PROPOSED
AIRPORT ELEVATION	1,074' MSL	1,073.3' MSL
AIRPORT REFERENCE POINT (ARP)	LAT. 44° 22' 03" N LONG. 71° 32' 40" W	LAT. 44° 22' 03" N LONG. 71° 32' 45" W
MEAN MAX. TEMP. (HOTTEST MO.)	77.3°F	SAME
DESIGN AIRCRAFT	BEECH 58	BEECH KING AIR
FUEL AVAILABILITY	100 LL	SAME
AIRPORT REFERENCE CODE (ARC)	BI – UTILITY	BII – UTILITY
AIRPORT/TERMINAL NAVAIDS	LIGHTED WINDCONE & SEGMENTED CIRCLE	SAME
ACREAGE OWNED IN FEE SIMPLE	187± ACRES	SAME
ACREAGE OWNED IN EASEMENT	106± ACRES	SAME
USE/OWNERSHIP	PUBLIC/PUBLIC	SAME

EXISTING	BUILDINGS	PROPOSED
1	AIRPORT TERMINAL	1
2	STORAGE / MAINTENANCE HANGAR	
3	PRIVATE STORAGE HANGAR	
4	CONCRETE FOUNDATION	
5–11	CONVENTIONAL HANGAR	18–24
12–13	T-HANGAR	25–27
14	SELF-SERVICE FUEL FARM & FUELING APRON	14

RUNWAY DATA	EXISTING		PROPOSED	
	RUNWAY 10	RUNWAY 28	RUNWAY 10	RUNWAY 28
RUNWAY LENGTH	3,495'		4,001'	
RUNWAY WIDTH	75'		SAME	
PAVEMENT STRENGTH	30,000 LBS. SINGLE WHEEL		SAME	
APPROACH SURFACES	20:1 NON-PRECISION	20:1 VISUAL	SAME	SAME
RUNWAY MARKINGS	NON-PRECISION	VISUAL	SAME	
RUNWAY LIGHTING	MIRLS		SAME	
RUNWAY NAVAIDS	VASI-4L, LOCALIZER, NDB	REILS	PAPI-4L LOCALIZER, NDB	SAME
EFFECTIVE GRADIENT	0.87%		0.487%	
RUNWAY SAFTEY AREA	120'x240'		150'x300'	
RUNWAY OBJECT FREE AREA	250'x240'		500'x300'	
TAXIWAY LIGHTING	NONE		MITLS	
TAXIWAY MARKING	CENTERLINE, SIGNAGE		SAME	
TAXIWAY OBJECT FREE AREA	89'		131'	
RUNWAY END ELEVATIONS	1,043.5' MSL	1,073.9' MSL	1,047.94' MSL	1,073.3' MSL
RUNWAY END COORDINATES	44° 22' 02.5"N 71° 33' 04.1"W	44° 22' 04.2"N 71° 32' 16.0"W	44° 22' 02.2"N 71° 33' 12.4"W	44° 22' 04.2"N 71° 33' 17.4"W

LEGEND	EXISTING	PROPOSED
AIRPORT PROPERTY LINE		N/A
ABUTTERS' PROPERTY LINE		N/A
FUTURE RUNWAY DEVELOPMENT	N/A	
PAVEMENT		
PAVEMENT TO BE REMOVED	N/A	
CONTOURS *	— 590 —	N/A
TREE LINE		N/A
AVIGATION EASEMENT LINE		N/A
FENCE LINE		N/A
BUILDINGS		
WIND CONE		N/A
UTILITY POLE		N/A
REIL		
VASI		N/A
PAPI	N/A	
OBJECT FREE AREA (OFA)		
RUNWAY SAFETY AREA (RSA)		
BUILDING RESTRICTION LINE (BRL)		
WETLANDS (DELINEATED)		N/A
WETLANDS (SKETCHED)		N/A
WETLANDS (UNDETERMINED)		N/A
OVERHEAD ELECTRIC	— OH —	N/A

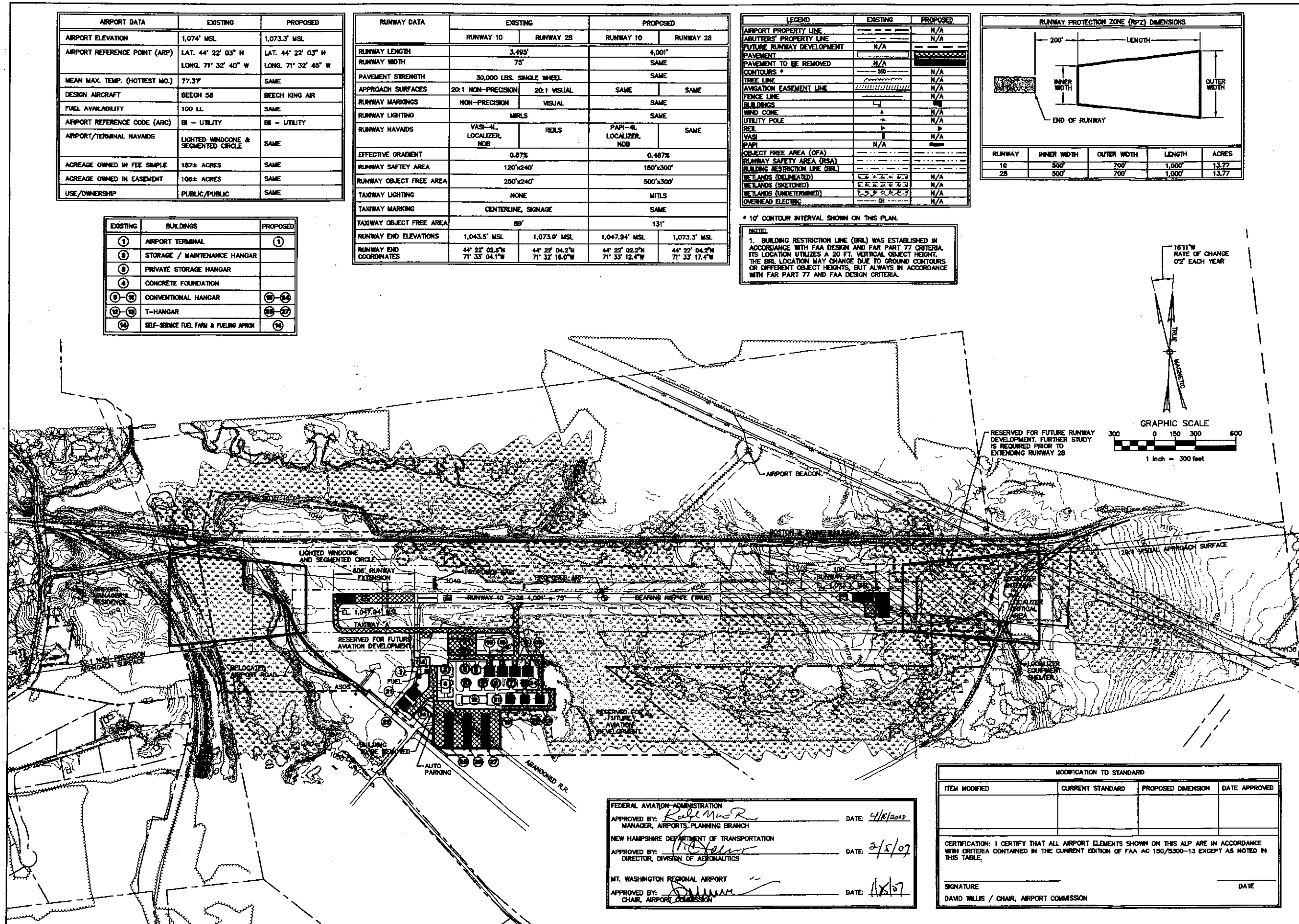
* 10' CONTOUR INTERVAL SHOWN ON THIS PLAN.

NOTE:

1. BUILDING RESTRICTION LINE (BRL) WAS ESTABLISHED IN ACCORDANCE WITH FAA DESIGN AND FAR PART 77 CRITERIA. ITS LOCATION UTILIZES A 20 FT. VERTICAL OBJECT HEIGHT. THE BRL LOCATION MAY CHANGE DUE TO GROUND CONTOURS OR DIFFERENT OBJECT HEIGHTS, BUT ALWAYS IN ACCORDANCE WITH FAR PART 77 AND FAA DESIGN CRITERIA.

RUNWAY PROTECTION ZONE (RPZ) DIMENSIONS

RUNWAY	INNER WIDTH	OUTER WIDTH	LENGTH	ACRES
10	500'	700'	1,000'	13.77
28	500'	700'	1,000'	13.77



FEDERAL AVIATION ADMINISTRATION
APPROVED BY: [signature] DATE: 4/8/2008
MANAGER, AIRPORTS PLANNING BRANCH

NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION
APPROVED BY: [signature] DATE: 2/5/07
DIRECTOR, DIVISION OF AERONAUTICS

MT. WASHINGTON REGIONAL AIRPORT
APPROVED BY: [signature] DATE: 1/8/07
CHAIR, AIRPORT COMMISSION

MODIFICATION TO STANDARD

ITEM MODIFIED	CURRENT STANDARD	PROPOSED DIMENSION	DATE APPROVED

CERTIFICATION: I CERTIFY THAT ALL AIRPORT ELEMENTS SHOWN ON THIS ALP ARE IN ACCORDANCE WITH CRITERIA CONTAINED IN THE CURRENT EDITION OF FAA AC 150/5300-13 EXCEPT AS NOTED IN THIS TABLE.

SIGNATURE DATE

DAVID WILLIS / CHAIR, AIRPORT COMMISSION

Dufresne-Henry
Portland, Maine
Tel. (207) 775-3211 • FAX (207) 775-6434
www.dufresne-henry.com

Rev.	Description	By	Date

MT. WASHINGTON REGIONAL AIRPORT
AIP NO. 3-33-0017-09

ULTIMATE AIRPORT LAYOUT PLAN

WHITEFIELD NEW HAMPSHIRE

Project No.	8100068
Proj. Manager	JEG
Proj. Designer	JEG
Drawn By	LRK
Checked By	JEG
Scale	1"=300'
Approved	JMW
Date	JULY 2005

Sheet 3 of 7

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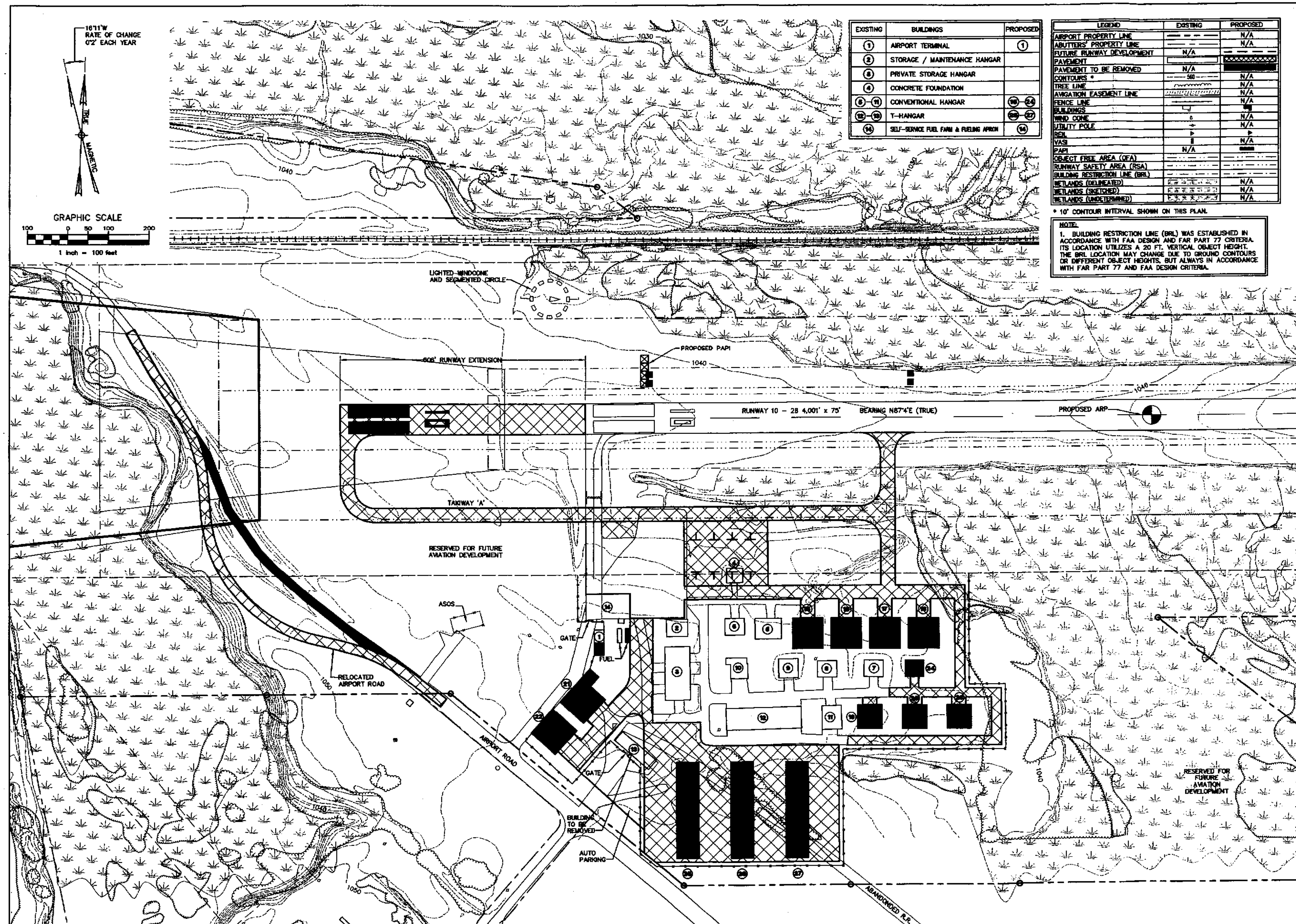

EXISTING	BUILDINGS	PROPOSED
1	AIRPORT TERMINAL	1
2	STORAGE / MAINTENANCE HANGAR	
3	PRIVATE STORAGE HANGAR	
4	CONCRETE FOUNDATION	
5–11	CONVENTIONAL HANGAR	16–24
12–13	T-HANGAR	25–27
14	SELF-SERVICE FUEL FARM & FUELING APRON	14

LEGEND	EXISTING	PROPOSED
AIRPORT PROPERTY LINE		N/A
ABUTTERS' PROPERTY LINE		N/A
FUTURE RUNWAY DEVELOPMENT	N/A	
PAVEMENT		
PAVEMENT TO BE REMOVED	N/A	
CONTOURS *	560	N/A
TREE LINE		N/A
AVIGATION EASEMENT LINE		N/A
FENCE LINE		N/A
BUILDINGS		
WIND CONE		N/A
UTILITY POLE		N/A
REIL		
VASI		N/A
PAPI	N/A	
OBJECT FREE AREA (OFA)		
RUNWAY SAFETY AREA (RSA)		
BUILDING RESTRICTION LINE (BRL)		
WETLANDS (DELINEATED)		N/A
WETLANDS (SKETCHED)		N/A
WETLANDS (UNDETERMINED)		N/A

* 10' CONTOUR INTERVAL SHOWN ON THIS PLAN.

NOTE:

1. BUILDING RESTRICTION LINE (BRL) WAS ESTABLISHED IN ACCORDANCE WITH FAA DESIGN AND FAR PART 77 CRITERIA. ITS LOCATION UTILIZES A 20 FT. VERTICAL OBJECT HEIGHT. THE BRL LOCATION MAY CHANGE DUE TO GROUND CONTOURS OR DIFFERENT OBJECT HEIGHTS, BUT ALWAYS IN ACCORDANCE WITH FAR PART 77 AND FAA DESIGN CRITERIA.

Dufresne-Henry
Portland, Maine
Tel. (207) 775-3211 • FAX (207) 775-6434
www.dufresne-henry.com

Rev.	Description	By	Date

MT. WASHINGTON REGIONAL AIRPORT
A/P NO. 3-33-0017-08

TERMINAL AREA PLAN

WHITEFIELD NEW HAMPSHIRE

Project No.	8100058
Pro. Manager	JEG
Proj. Designer	JEG
Drawn By	LRK
Checked By	JEG
Scale	1"=100'
Approved	JMW
Date	JULY 2005

Sheet 4 of 7

D