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Opportune Landing Site Program

Field Data Archive

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Keran J. Claffey, Elke S. Ochs, and Charles C. Ryerson

December 2008



COVER: Measuring soil moisture and soil density on 20 April 2005 in a soil pit on the Dean Ford Farm in Dupont, Indiana, for the OLS program. (Photo by Lynette Barna)

Opportune Landing Site Program

ERDC/CRREL TR-08-23
December 2008

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Final report

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Abstract: A goal of the Air Force Research Laboratory Opportune Landing Site (OLS) program was to locate smooth, flat, obstruction-free unimproved areas that are safe for aircraft operations. The ERDC was tasked to evaluate the quality of OLS as located by OLS Multi-Spectral (OLS-MS) software developed by the Boeing Company utilizing Landsat multispectral imagery. ERDC also was tasked with predicting soil moisture and soil strength at OLS. ERDC conducted extensive field work at four Runway Assessment Sites (RAS) in Indiana, New Mexico, and California, and a Soil Assessment Site (SAS) in Indiana. RAS are sites for analyzing OLS, and SAS are sites for analyzing properties of soils of interest that are not located on RAS. Field measurements were made seasonally and included site geometry, vegetation cover, and soil conditions, including soil strength and soil moisture. This Field Data Archive contains quality controlled and processed data resulting from field work conducted in 2005 and 2006. The report describes the organization of structured electronic files in a computer-accessible data archive to provide a common information resource.

Contents

Errata	vi
Preface	vii
1 Introduction.....	1
2 Database Contents	2
3 Database Organization	3
4 Conclusions.....	4
References.....	5
Appendix A: Directory Structure with Content Descriptions for the CRREL-Provided Field Data Archive for the Opportune Landing Site Program.....	7
Report Documentation Page	

Errata

Subsequent to the creation of the files contained within this Opportune Landing Site Program Field Data Archive, the decision was made to not publish a Field Data Collection Plan (FDCP) as referenced in many of the data files. Instead, material from the FDCP was incorporated into individual field site reports as specified below. Therefore, any references to the FDCP should be interpreted as references to the field data report for the location where the pertinent data were acquired.

For data pertaining to the California Runway Assessment Site number 1 (CA_RAS1), the reference document is

Affleck, R.T., C.C. Ryerson, L.A. Barna, and K.J. Claffey (2008a). Suitability Measurement and Analysis for El Centro Naval Air Facility OLS. Engineer Research and Development Center, Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire. ERDC/CRREL Technical Report TR-08-18.

For data pertaining to the New Mexico Runway Assessment Site number 1 (NM_RAS1), the reference document is

Affleck, R.T., C.C. Ryerson, L.A. Barna, and K.J. Claffey (2008b). Suitability Measurement and Analysis for Fort Bliss Naval Air Facility OLS. Engineer Research and Development Center, Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire. ERDC/CRREL Technical Report TR-08-16.

For data pertaining to the Indiana Runway Assessment Site number 1 (IN_RAS1), the Indiana Runway Assessment Site number 2 (IN_RAS2), or any of the Indiana Soil Assessment Sites (IN_SAS), the reference document is

Barna, L.A., C.C. Ryerson, and R.T. Affleck (2008). Opportune Landing Site Southeastern Indiana Field Data Collection and Assessment. Engineer Research and Development Center, Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire. ERDC/CRREL Technical Report TR-08-22.

The authors regret any inconvenience this may cause users of data within the OLS Field Data Archive.

Preface

This report is a deliverable product in support of Customer Order No. GWRVA00472412, “Opportune Landing System,” conducted in collaboration with Boeing, the Air Force Research Laboratory (AFRL), and Syngentics Corporation. Dr. Charles C. Ryerson, Terrestrial and Cryospheric Sciences Branch (TCSB), Cold Regions Research and Engineering Laboratory (CRREL), US Army Engineer Research and Development Center (ERDC), Hanover, New Hampshire, was the Program Manager at ERDC-CRREL, and James McDowell, Air Vehicles Directorate, Air Force Research Laboratory, Wright-Patterson Air Force Base, and Kenneth Eizenga, General Dynamics, Dayton, Ohio, were consecutive overall Program Managers.

Funding for this work was provided by the US Transportation Command (TRANSCOM) through the Air Force Mobility Command (AMC) and the Air Force Research Laboratory Air Vehicles Directorate (AFRL/RB) at Wright Patterson Air Force Base. This report was prepared by Forrest R. Scott, Sensor Concepts and Applications, Inc., Phoenix, Maryland, under contract number W913E5-04-C-0003; Lynette A. Barna and Rosa T. Affleck, Force Projection and Sustainment Branch (FPSB), CRREL; Keran J. Claffey, TCSB, CRREL; Elke S. Ochs, Remote Sensing/GIS and Water Resources Branch and Ice Engineering Group, CRREL; and Dr. Charles C. Ryerson, TCSB, CRREL.

The authors thank the individuals who were, in part, responsible for information contained in this database. C. Berini, T. Hall, L. Danyluck, G. Gooch, P. Seman, C. Clark, S. Orchino, R. Lichvar, and K. Bjella of ERDC-CRREL conducted field work, post-field studies, and laboratory assessments. Dr. R. Rollings of Rollings Consulting provided valuable technical advice. R. Curry, North Vernon Indiana Municipal Airport Manager; Mr. and Mrs. Dean Ford; Mr. Don Biehle, Manager, South Eastern Purdue Agricultural Center; El Centro Naval Air Facility Range Master; Mr. C. David, as well as S. Offutt, C. Carrig, D. Dodge, and D. Duran of the Fort Bliss Directorate of Environment, provided access to their facilities for field work. R. Haren of the Air Force Research Laboratory (AFRL) Sensors Directorate provided advice regarding appropriate field sites, as did Professor R. Vincent of Bowling Green State University, and R. Almassy and Dr. P. Blake of The Boeing Company. US TRANSCOM through the Air Force

Air Mobility Command and the Air Force Research Laboratory Air Vehicles Directorate (AFRL/RB) at Wright Patterson Air Force Base provided funding. The OLS Program was managed by J. McDowell of AFRL/RB, and subsequently by K. Eizenga of General Dynamics, Inc.

This report was prepared under the general supervision of Dr. Justin B. Berman, Chief, Research and Engineering Division, CRREL; Dr. Lance D. Hansen, Deputy Director, CRREL; and Dr. Robert E. Davis, Director, CRREL.

At the time this report was published, Colonel Gary E. Johnston was Commander and Executive Director of ERDC. Dr. James R. Houston was Director.

1 Introduction

Opportune Landing Sites (OLS) are locations where aircraft can land and take off on surfaces unimproved by engineers for aircraft operations. An OLS can be desert, agricultural land, or any other area that is sufficiently large, smooth, flat, free of obstructions, and sufficiently firm to allow aircraft operations. As stated above, these sites are not modified by engineers for aircraft operations, but they do have characteristics suitable for aircraft operations.

The Opportune Landing Site Program, funded by US Transportation Command (TRANSCOM) through Air Mobility Command and the Air Force Research Laboratory, assessed the capability of modeling and simulation techniques for locating OLS and for predicting their strength (Ryersson and McDowell 2007). The Engineer Research and Development Center's Cold Regions Research and Engineering Laboratory's (ERDC-CRREL) tasks in the program were to evaluate the capability of Boeing software for locating OLS and to infer the strength of OLS soils. ERDC-CRREL's tasks were accomplished in part through extensive field work in Indiana, New Mexico, and California, described in detail by Barna et al. (2008) and Affleck et al. (2008a, b).

This document contains a database created from field work conducted in 2005 and 2006. The database contents are created from seasonal on-site measurements and from field samples subsequently analyzed in ERDC-CRREL's Soils Laboratory. Data resulting from these activities are organized into structured electronic files in a computer-accessible data archive to provide a common information resource.

2 Database Contents

The database contains documents and data files produced or referenced by ERDC-CRREL's field team in conducting the field work. The data contents relate to the selection process for the specific field study areas, the environmental conditions existing at or near those sites over the study period, and assessments of the physical state of the ground for multiple seasons. Most of the data were acquired during on-site field visits, Intensive Operational Periods (IOP), or via automated weather and soil state monitoring stations installed during the initial site visit and set to collect readings for several months unattended. A small portion of the data in the archive has been acquired from non-ERDC-CRREL sources in order to augment various elements of the records.

Detailed field data collection procedures are described in the final analyses of each field site (Affleck et al. 2008a, b; Barna et al. 2008). However, most of the data files within this archive are self-documented. The documentation explains file contents and headers of data tables, and provides supplemental information regarding data layout.

3 Database Organization

Top level directories within the OLS database are named for the states where field data collection sites are located. The CA directory has data products for the field site located in California at the El Centro Naval Air Facility (ELC). The data products in the IN directory contain data for field sites located in Indiana: the Ford Farm (FRD), the North Vernon Airport (NVA), and the Southeast Purdue Agricultural Center (SPC). The NM directory has data for the New Mexico field site located on Fort Bliss (FTB) at the Otera Mesa.

Each top-level directory contains multiple secondary-level directories named for the subject addressed (SOIL, SURVEY, etc.), or is named based on a combination of site identifier, data content type, and end date of the data acquisition period. IN_RAS1_FRD_Pictures_20050422, for example, refers to photos taken at Indiana runway assessment site #1 located at the Ford Farm during the intensive operational period (IOP) ending on 22APR05. Some secondary-level directories have sub-directories based on sub-categories of measurement types. For instance, under the SURFACE directory, the user will find sub-directories relating to types of vegetative species documented (VEG_SPECIES), extent of vegetative cover recorded (VEG_COVER), micro-relief measurements taken (PROFILE), and locations for drainage ways, animal holes, etc. (FEATURES).

A complete list showing every major directory within the OLS data archive, along with a brief description of the data content, is provided in the Appendix. Also, “ReadMe” files are located in most of the directories within the OLS data archive. Most files also contain point-of-contact information for the OLS ERDC-CRREL team member responsible for the data recorded within the files.

4 Conclusions

This database provides extensive information regarding OLS surface conditions, soil conditions, and meteorology at the sites described. Sufficient information is available in many cases to form relationships and test hypotheses of soil strength, for example, to soil properties. Therefore, it serves as a record to validate conditions found at sites chosen as suitable for aircraft landings by the Boeing OLS-MS software, and as a source of information for developing and evaluating soil moisture and soil strength prediction algorithms.

Information in this database has been extensively reviewed for quality assurance. Poor-quality data have not been included in the database. However, data of questionable accuracy or reliability are noted in INFO pages and headers. Information is not guaranteed to be correct or complete and any conclusions drawn from such information are the responsibility of the user.

We do not assume liability for any damages caused by inaccuracies in this data or documentation. The data and documentation also remain subject to revision, removal, and augmentation without further notice. We make no warranty, express or implied, as to the accuracy, completeness, or utility of this information, nor does the fact of distribution constitute a warranty.

References

- Affleck, R.T., C.C. Ryerson, L.A. Barna, and K.J. Claffey. 2008a. Suitability Measurement and Analysis for Fort Bliss Naval Air Facility OLS. Engineer Research and Development Center, Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire. ERDC-CRREL Technical Report TR-08-16.
- Affleck, R.T., C.C. Ryerson, L.A. Barna, and K.J. Claffey. 2008b. Suitability Measurement and Analysis for El Centro Naval Air Facility OLS. Engineer Research and Development Center, Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire. ERDC-CRREL Technical Report TR-08-18.
- Barna, L.A., C.C. Ryerson, R.T. Affleck, K.J. Claffey, and B. Tracy. 2008. Opportune Landing Site Southeastern Indiana Field Data Collection and Assessment. Engineer Research and Development Center, Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire. ERDC-CRREL Technical Report TR-08-22.
- Ryerson, C.C., and J. McDowell. 2007. Anywhere-Anytime: Enhancing Battlespace Vertical Mobility. AIAA 2007-1103, American Institute of Aeronautics and Astronautics 45th Aerospace Sciences Meeting and Exhibit, 8–11 January, Reno, Nevada, 9 p.

Appendix A: Directory Structure with Content Descriptions for the CRREL-Provided Field Data Archive for the Opportune Landing Site Program

OLS_DATA_ARCHIVE (Overview materials, reference documents, archive content, layout information, installation instructions, etc.)

CA (Files relating to the El Centro [ELC], California field site)

CA_RAS1_ELC_Pictures_20050715 (Photo files documenting CA runway assessment site #1 conditions and measurements for 1st IOP)

CA_RAS1_ELC_Pictures_20051021 (Photo files documenting CA runway assessment site #1 conditions and measurements for 2nd IOP)

CA_RAS1_ELC_Pictures_20060424 (Photo files documenting CA runway assessment site #1 conditions and measurements for 3rd IOP)

OLS_MS (Data files and reference materials relating to software runs used in CA runway assessment site selection process)

Field_July05 (Runway UTM coordinates provided to field team for locating CA runway assessment sites [RAS])

P39r37 (LandSAT geotiff files used in software run for the CA sites)

P39r37_Results_10-200-3000_R032605 (Inputs and output files for the CA runway assessment site software run)

Recon_Maps (Examples of maps created for field team use in the CA runway assessment site selection process)

SAMP_GRID (Data file depicting CA runway assessment site #1 [RAS1] sampling points by measurement types, locations, and seasons)

SAMP_MAP (Data file depicting CA runway assessment site #1 [RAS1] layout with reference to UTM and survey station points)

SOIL (Files relating to the CA runway assessment site #1 soil measurements conducted both in the field and in the ERDC-CRREL soil laboratory)

DCP (Data files for the Dynamic Cone Penetrometer [DCP] soil strength readings obtained at the CA RAS1 field site)

SFM (Data files for Soil Field Measurements [SFM] [strength, moisture, density, etc.] taken at the CA RAS1 field site)

SLA (Data files for Soil Laboratory Analysis [SLA] conducted on the soil samples taken at the CA RAS1 field site)

SURFACE (Files for characterization of surface conditions at the CA runway assessment site #1)

FEATURES (File for symbolic representation of features noted on the CA RAS1)

PROFILE (Data file for laser level measurements of micro-relief along centerline of CA RAS1)

VEG_COVER (Data file referencing photo filenames depicting surface vegetative cover to points on the CA RAS1)

VEG_SPECIES (Data file of plant photos with species names for vegetation found on the CA RAS1)

SURVEY (Data file for transit and GPS survey measurements obtained during CA RAS1 site layout)

WXS (Data files for weather, soil temperature, and soil moisture measurements from CRREL monitoring station near the CA RAS1)

ALT_WX (Data files for weather measurement obtained from alternative (non-CRREL) sources near the CA RAS1)

NCDC (Data and informational files for weather records downloaded from the National Climatic Data Center Web site)

IN (Files relating to the Ford Farm (FRD), North Vernon Airport (NVA), and Southeast Purdue Agricultural Center (SPC), Indiana field sites)

IN_RAS1_FRD_Pictures_20050422 (Photo files documenting IN runway assessment site #1 conditions and measurements for 1st IOP)

IN_RAS1_FRD_Pictures_20050805 (Photo files documenting IN runway assessment site #1 conditions and measurements for 2nd IOP)

IN_RAS1_FRD_Pictures_20051104 (Photo files documenting IN runway assessment site #1 conditions and measurements for 3rd IOP)

IN_RAS1_FRD_Pictures_20060303 (Photo files documenting IN runway assessment site #1 conditions and measurements for 4th IOP)

IN_RAS2_NVA_Pictures_20050422 (Photo files documenting IN runway assessment site #2 conditions and measurements for 1st IOP)

IN_RAS2_NVA_Pictures_20050805 (Photo files documenting IN runway assessment site #2 conditions and measurements for 2nd IOP)

IN_RAS2_NVA_Pictures_20051104 (Photo files documenting IN runway assessment site #2 conditions and measurements for 3rd IOP)

IN_RAS2_NVA_Pictures_20060303 (Photo files documenting IN runway assessment site #2 conditions and measurements for 4th IOP)

IN_SAS1_SPC_Pictures_20050422 (Photo files documenting IN soil assessment site #1 conditions and measurements for 1st IOP)

IN_SAS1_SPC_Pictures_20050805 (Photo files documenting IN soil assessment site #1 conditions and measurements for 2nd IOP)

IN_SAS1_SPC_Pictures_20051104 (Photo files documenting IN soil assessment site #1 conditions and measurements for 3rd IOP)

IN_SAS1_SPC_Pictures_20060303 (Photo files documenting IN soil assessment site #1 conditions and measurements for 4th IOP)

OLS_MS (Data files and reference materials relating to software runs used in IN runway assessment site selection process)

Field_April05 (Runway UTM coordinates provided to field team for locating IN runway assessment sites [RAS])

L5_20-33_20050317 (LandSAT geotiff files used in software run for the IN sites)

L5_20-33_20050317_Results_18-60-2000_R032605 (Inputs and output files for the IN runway assessment site software run)

Recon_Maps (Examples of maps created for field team use in the IN runway assessment site selection process)

SAMP_GRID (Data files depicting IN runway and soil assessment site sampling points by measurement types, locations, and seasons)

SAMP_MAP (Data files depicting IN soil and runway assessment site (SAS and RAS) layouts with reference to UTM and survey station points)

SOIL (Files relating to the IN site soil measurements conducted both in the field and in the CRREL soil laboratory)

DCP (Data files for the Dynamic Cone Penetrometer (DCP) soil strength readings obtained at the IN field sites)

SFM (Data files for Soil Field Measurements (SFM) (strength, moisture, density, etc.) taken at the IN sites)

SLA (Data files for Soil Laboratory Analysis (SLA) conducted on the soil samples taken at the IN sites)

SURFACE (Files for characterization of surface conditions at the IN sites)

FEATURES (Files for symbolic representation of features noted on the IN sites)

PROFILE (Data file for laser level measurements of micro-relief along centerline of IN RAS1 and RAS2)

VEG_COVER (Data file referencing photo filenames depicting surface vegetative cover to points on the IN RAS1, RAS2, and SAS1)

VEG_SPECIES (Data file of plant photos with species names for vegetation found on the IN sites)

SURVEY (Data files for transit and GPS survey measurements obtained during IN site layout)

WXS (Data files for weather, soil temperature, and soil moisture measurements from CRREL monitoring station near the IN sites)

ALT_WX (Data files for weather measurement obtained from alternative (non-CRREL) sources near the IN sites)

KOVO (Data and informational files for weather records provided by the North Vernon Municipal Airport)

NCDC (Data and informational files for weather records downloaded from the National Climatic Data Center Web site)

SEPAC (Data and informational files for weather records downloaded from the Southeast Purdue Agricultural Center Web site)

NM (Files relating to the Fort Bliss [FTB], Otera Mesa, New Mexico field site)

NM_RAS1_FTB_Pictures_20050722 (Photo files documenting NM runway assessment site #1 conditions and measurements for 1st IOP)

NM_RAS1_FTB_Pictures_20051028 (Photo files documenting NM runway assessment site #1 conditions and measurements for 2nd IOP)

NM_RAS1_FTB_Pictures_20060421 (Photo files documenting NM runway assessment site #1 conditions and measurements for 3rd IOP)

OLS_MS (Data files and reference materials relating to software runs used in NM runway assessment site selection process)

Field_July05 (Runway UTM coordinates provided to field team for loNMting NM runway assessment sites [RAS])

33_37_20030518 (LandSAT geotiff files used in software run for the NM sites)

33_37_20030518 Results_10-200-3000_R032605 (Inputs and output files for the NM runway assessment site software run)

Recon_Maps (Examples of maps created for field team use in the NM runway assessment site selection process)

SAMP_GRID (Data file depicting NM runway assessment site #1 [RAS1] sampling points by measurement types, locations, and seasons)

SAMP_MAP (Data file depicting NM runway assessment site #1 [RAS1] layout with reference to UTM and survey station points)

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DCP (Data files for the Dynamic Cone Penetrometer [DCP] soil strength readings obtained at the NM RAS1 field site)

SFM (Data files for Soil Field Measurements [SFM] [strength, moisture, density, etc.] taken at the NM RAS1 field site)

SLA (Data files for Soil Laboratory Analysis [SLA] conducted on the soil samples taken at the NM RAS1 field site)

SURFACE (Files for characterization of surface conditions at the NM runway assessment site #1)

FEATURES (File for symbolic representation of features noted on the NM RAS1)

PROFILE (Data file for laser level measurements of micro-relief along centerline of NM RAS1)

VEG_COVER (Data file referencing photo filenames depicting surface vegetative cover to points on the NM RAS1)

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SURVEY (Data file for transit and GPS survey measurements obtained during NM RAS1 site layout)

WXS (Data files for weather, soil temperature, and soil moisture measurements from CRREL monitoring station near the NM RAS1)

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14. ABSTRACT A goal of the Air Force Research Laboratory Opportune Landing Site (OLS) program was to locate smooth, flat, obstruction-free unimproved areas that are safe for aircraft operations. The ERDC was tasked to evaluate the quality of OLS as located by OLS Multi-Spectral (OLS-MS) software developed by the Boeing Company utilizing Landsat multispectral imagery. ERDC also was tasked with predicting soil moisture and soil strength at OLS. ERDC conducted extensive field work at four Runway Assessment Sites (RAS) in Indiana, New Mexico, and California, and a Soil Assessment Site (SAS) in Indiana. RAS are sites for analyzing OLS, and SAS are sites for analyzing properties of soils of interest that are not located on RAS. Field measurements were made seasonally and included site geometry, vegetation cover, and soil conditions, including soil strength and soil moisture. This Field Data Archive contains quality controlled and processed data resulting from field work conducted in 2005 and 2006. The report describes the organization of structured electronic files in a computer-accessible data archive to provide a common information resource.					
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