



SMITH ENVIRONMENTAL AND ENGINEERING

*Delivering Smart Solutions for Planning, Permitting, Design*

ROCKY MOUNTAIN METROPOLITAN AIRPORT  
ENVIRONMENTAL ASSESSMENT PROJECT  
PALEONTOLOGICAL REPORT



[WWW.SMITHDELIVERS.COM](http://WWW.SMITHDELIVERS.COM)

Westminster Office: 12071 Tejon Street Suite 470 Westminster, CO 80234 phone: 720.887.4928 fax: 720.887.4680  
Fort Collins Office: 760 Whalers Way Building C, Suite 120 Fort Collins, CO 80525 phone: 970.206.4432 fax: 970.206.4435

PALEONTOLOGICAL REPORT

ROCKY MOUNTAIN METROPOLITAN AIRPORT  
ENVIRONMENTAL ASSESSMENT PROJECT

Prepared for:

Reynolds, Smith and Hills, Inc.  
5600 S. Quebec Street, Suite 340C  
Greenwood Village, CO 80111

Prepared by:

Smith Environmental and Engineering  
12071 Tejon Street, Suite 470  
Westminster, CO 80234  
720-887-4928

March 1, 2011

## TABLE OF CONTENTS

1.0 INTRODUCTION.....	1
1.1 PURPOSE AND NEED OF THE RMMA PROJECT .....	1
1.2 STUDY AREA.....	2
2.0 METHODS .....	4
3.0 RESULTS .....	5
4.0 IMPACTS.....	8
4.1 PALEONTOLOGICAL RESOURCES.....	8
4.1.1 Direct Impacts .....	8
4.1.2 Indirect Impacts.....	8
4.1.3 Cumulative Impacts .....	8
5.0 CONCLUSIONS .....	9
6.0 REFERENCES.....	10

## LIST OF FIGURES

FIGURE 1. Study Area .....	3
FIGURE 2. Rock Exposed Locations .....	7

## APPENDIX A – PHOTOS OF THE STUDY AREA

## 1.0 INTRODUCTION

Smith Environmental and Engineering (SMITH) contracted SWCA Environmental Consultants to perform a paleontological resource inventory assessment of the proposed Rocky Mountain Metropolitan Airport (RMMA) Runway Safety Area (RSA) expansion project (Project). The surveys and analysis were performed to identify the extent of and impacts to paleontological resources within the Study Area, which encompasses the Project Area. Information obtained by this study will be incorporated into the Project's Environmental Assessment (EA).

The paleontological resource investigation was conducted in compliance with Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended in 2000 (16 USC 470); Colorado Historical, Prehistorical, and Archaeological Resources Act of 1973 (CRS 24-80-401 to 410); and Colorado's Register of Historic Places Statute (CRS 24-80.1) of 1975. This inventory also meets the requirements specified in the Colorado Cultural Resource Survey Manual, Colorado Historical Society, Office of Archaeology and Historic Preservation (OAH 2007).

The purpose of this report is to identify paleontological resources throughout the Study Area, determine potential impacts by the Proposed Action, and make mitigation recommendations for the Project's EA. The Paleontological resource field investigation was completed in January 2011 to identify geologic formations underlying the Study Area and locate, record, and evaluate exposed geologic features for fossil-bearing features. These data provide a basis for completing the impact assessment. Section 106 of the NHPA (16 USC 470), provides the basis for the conceptual mitigation recommendations presented herein, which are also needed for the RMMA EA.

Paleontological resources that are at risk of impacts by the actions of the FHWA are protected under Section 106 of the NHPA (16 USC 470f).

The objectives of this study are 1) to identify all paleontological resources (both fossils and fossil-bearing strata) within the Study Area; 2) make an initial impact assessment based on the current 25% design; and 3) make the appropriate recommendations regarding the treatment of all identified resources.

### 1.1 PURPOSE AND NEED OF THE RMMA PROJECT

The RMMA proposes to implement RSA improvements for the west end of Runway 11L/29R and to realign the State Highway (SH) 128 and Interlocken Parkway intersection. The need for the RSA improvements is mandated by the Federal Aviation Administration (FAA) and has been identified as a primary component in the Airport Master Plan Update (RMMA 2010). The proposed realignment of the State Highway 128 and Interlocken Parkway intersection is necessary because the proposed RSA improvements encroach on the existing vehicle intersection.

The principal objectives of the Airport Master Plan Update are intended to meet the facility demand requirements, satisfy the strategic objectives and goals of the RMMA, and adhere to operational standards set by the FAA and the RMMA. In order to best meet these objectives, the RMMA has identified the RSA improvement on the west end of Runway 11L/29R and the realignment of the SH 128 and Interlocken Parkway intersection as the Proposed Action of an EA currently being

developed. The information from this study will be incorporated into the Environmental Consequences section of the EA.

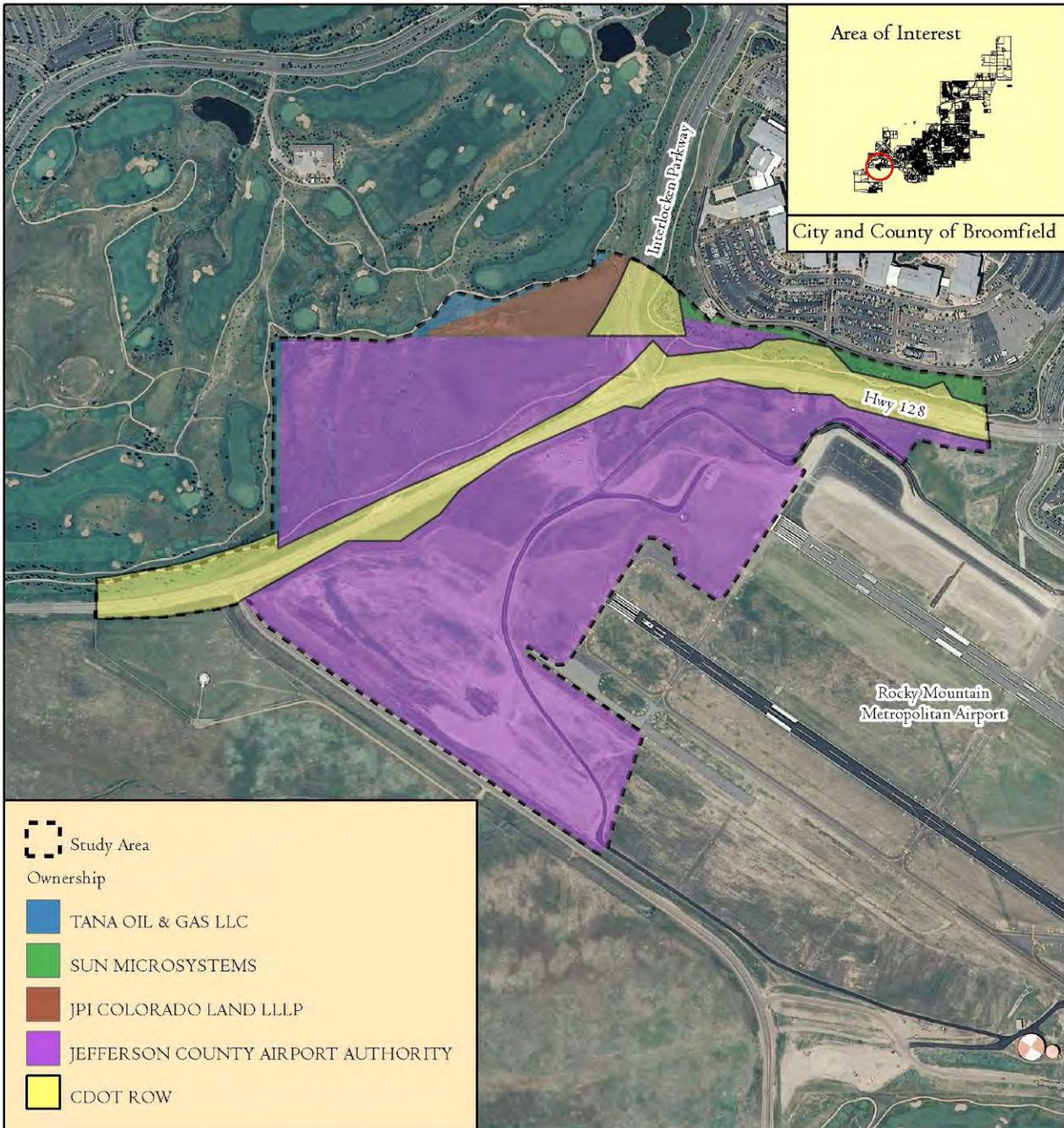
## 1.2 STUDY AREA

The Study Area is located in the rolling hills of the City and County of Broomfield (CCOB) and Jefferson County, Colorado (see Figure 1). The Study Area totals 134 ac, of which 69 ac are located within the boundary of the RMMA (Airside) and 65 ac are located outside of the RMMA boundary (Landside). The portion of the Study Area south of SH 128 has been extensively disturbed by the construction of the runways and associated airport roads. The portion of the Study Area to the north of SH 128 has been moderately disturbed on the west side of Interlocken Parkway and has been completely landscaped to the east of Interlocken Parkway. The Study Area is located in Sections 32-33, T. 1 S., R. 69 W. (Latitude 39.917181 ° N, and Longitude -105.130779° W), on the Louisville USGS Quadrangle, in Broomfield and Jefferson Counties, Colorado (see Figure 1).

The Study Area encompasses five land ownerships; Tana Oil and Gas LLC, Jefferson County Airport Authority, Sun Microsystems, JPI Colorado Land LLLP, and the Colorado Department of Transportation (CDOT) and Interlocken Parkway Right of Ways (ROW) (see Figure 1).

The Soil Conservation Service (SCS), now the Natural Resource Conservation Service (NRCS) performed an Order 2 survey that mapped the soils in the Study Area as Nunn, Kutch, and Samsil series, which are well drained (NRCS 1975, 1980). Soil mapping is probably not accurate as the soils were (upper three to five ft) were removed and graded since the date of these surveys. Sandstone bedrock also outcrops in the northwest portion north of SH 128.

Vegetation consists of mixed grasses, prickly pear, and yucca in the moderately disturbed northwest portion, landscaped Kentucky bluegrass (*Poa pratensis*) and trees in the northeast portion, and mowed western wheatgrass (*Pascopyrum smithii*) and smooth brome (*Bromopsis inermis*) on the Airside (south of SH 128). Several unnamed intermittent drainages are located within one half mile of the Study Area.



 Study Area  
 Ownership  
 TANA OIL & GAS LLC  
 SUN MICROSYSTEMS  
 JPI COLORADO LAND LLLP  
 JEFFERSON COUNTY AIRPORT AUTHORITY  
 CDOT ROW


**SMITH ENVIRONMENTAL AND ENGINEERING**  
 12071 Tejon Street, Suite 470  
 Westminster, Colorado 80234  
 (720) 887-4928  
 (720) 887-4680 (fax)

Rocky Mountain Metro Airport  
Environmental Assessment

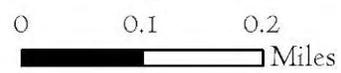


FIGURE 1  
STUDY AREA

Broomfield County,  
Colorado  
December, 2010

## 2.0 METHODS

The scope of the analysis included a geologic map and literature review, a museum records search, and a field survey. Based on the results of the analysis, the geologic units within the Study Area were ranked according to the Potential Fossil Yield Classification System (PFYC) (BLM 2007). This study was completed under State of Colorado Paleontological Permit number 2010-68.

### 3.0 RESULTS

According to published geologic maps (Machette 1977, Spencer 1961), the Study Area is underlain by three geologic units in ascending stratigraphic order, from oldest to youngest: late Cretaceous Laramie Formation, late Cretaceous Arapahoe Formation and Pleistocene Verdos Alluvium. The Laramie Formation underlies most of the Study Area to the north of State Highway 128. Only the uppermost part of the Laramie Formation is present within the Study Area. The Arapahoe Formation underlies the extreme easternmost portion of the Study Area. The Verdos Alluvium underlies most of the Study Area to the south of State Highway 128 including the existing RMMA.

The Laramie Formation is of Upper Cretaceous (Maastrichtian) age, and was deposited between approximately 69 and 68 million years ago. In northern Colorado, the Laramie Formation has been described as consisting of an approximately 650 foot thick upper part composed mostly of gray claystone, shale, sandy shale, and scattered lenticular beds of sandstone and lignite; and an approximately 100 foot thick lower part consisting of light gray to light yellowish-gray sandstone and sandy shale interbedded with clay, shale and several beds of coal (Colton 1978). The Laramie Formation has been interpreted as a complex of channel, overbank, deltaic, and paludal deposits that were deposited shortly after, and in association with, the retreat of the Western Interior Cretaceous Sea (Weimer and Land 1975). It was deposited on a low-lying coastal plain in swamps and estuaries that existed before the Laramide uplift of the Rocky Mountains in Colorado.

The Laramie Formation is important because it is one of the few formations of its age to preserve terrestrial fossil plants (Johnson et al. 2003, Knowlton 1922). Vertebrate fossils are far less common than plants, consisting mostly of poorly preserved bone fragments. However, a number of identifiable dinosaur fossils including teeth and bones of ceratopsians, hadrosaurs, and other dinosaurian taxa are known from the Laramie Formation in Weld County and from the Denver Basin (Carpenter 2002). A relatively rich microvertebrate fauna from a locality in Weld County was described by Carpenter (1979). Wilson et al. (2010) describe more recently discovered latest Cretaceous (Lancian) mammalian fossils from northeastern Colorado. Locally preserved trace fossils including dinosaur and mammal tracks are also preserved in the Laramie Formation, most notably in the City of Golden. Because it contains locally abundant and well-preserved plant fossils but vertebrate fossils are uncommon, the Laramie Formation is considered to have moderate paleontological sensitivity (PFYC Class 3a).

The Upper Cretaceous Arapahoe Formation consists of coarse- and fine-grained arkosic sandstone, siltstone, claystone, and thin pebble beds in the upper part, and white, yellowish-gray, and yellowish-orange coarse-grained sandstone with poorly sorted pebble conglomerate in the lower part. The conglomerate contains cobbles and boulders of shale, chert, and petrified wood (Scott 1972). Silicified wood and dinosaur bone have been found in the unit. However, it is believed that these fossils were reworked from the underlying Laramie Formation. Concretions and layered concentrations of ironstone and dinosaur bones have also been reported (Scott 1972). Because of facies-related thickness changes, it is difficult in most places to distinguish the Arapahoe Formation from overlying and underlying units based on lithology even a short distance to the east of the Front Range foothills, and the Arapahoe is commonly combined with the overlying Denver Formation on geologic maps. Because it is sparsely fossiliferous and the fossils it does contain are poorly preserved, the Arapahoe Formation is considered to have low paleontological sensitivity (PFYC Class 2).

The Pleistocene (Kansan) Verdos Alluvium consists of light brown to reddish-brown poorly sorted stratified gravel containing lenses of clay, silt and sand, with larger and more abundant boulders near the mountains (Lindvall 1979). Clasts are mostly weathered and coated with calcium carbonate (Lindvall 1978, Scott 1972). It is as much as 40 feet thick, and contains a two to four ft thick calcium carbonate enriched zone (relict soil) near its top. Locally, it contains thin beds of white volcanic ash, and has been dated at approximately 600,000 years old based on its correlation with the Pearlette Ash of Kansas (Scott 1963). Fossils are uncommon in the Verdos Alluvium, but specimens identified as horse and camel have been found in the unit (Scott 1978), and any additional fossils would be of scientific importance. The Verdos Alluvium is only sparsely fossiliferous, but any new fossil discoveries would be of great scientific importance. Therefore, it is considered to have low to moderate paleontological sensitivity (PFYC Class 3a).

According to the records of the Denver Museum of Nature and Science (DMNH) and University of Colorado Museum, no previously recorded fossil localities have been documented within the Study Area. However, well preserved plants have been documented at localities (e.g. DMNH Loc. 2125) in the Laramie Formation along US Highway 36 and the Northwest Parkway to the north (unpublished museum fossil locality data), and palm tree fronds were discovered during the construction of the Flatirons Crossing Shopping Mall. Pleistocene mammal remains have been collected from the vicinity of Rocky Flats to the southwest. The presence of fossil localities in the vicinity of the Study Area indicates the potential for discoveries within it wherever construction impacts to bedrock Laramie Formation and surficial deposits of Verdos occur, although the likelihood of fossils in the Arapahoe Formation is low.

No surface fossils were observed within the Study Area during the field survey. Exposures of weathered Laramie Formation were observed in the north-central portion of the Study Area (see Appendix A). These include grayish-orange medium- to coarse-grained massive sandstone containing rip-up clasts of light olive gray flaky silty mudstone. This unit is overlain by interbedded pale brown blocky silty mudstone, yellowish-gray platy silty mudstone and massive grayish yellow friable sandstone with containing cobble-sized inclusions. To the west of this location a number of ex-situ boulders (presumably mined from the Laramie Formation nearby) occur. These consist of indurated yellowish-gray fine- to medium-grained massive sandstone. The third location with exposed rock within the Study Area is in the northwest portion in an ephemeral drainage. Here there are exposures of grayish-orange and very pale orange coarse-grained laminated sandstone that weathers to moderate yellowish-brown. The rock exposure locations described are shown in Figure 2 (P9-110118-1, 2, and 3, respectively).

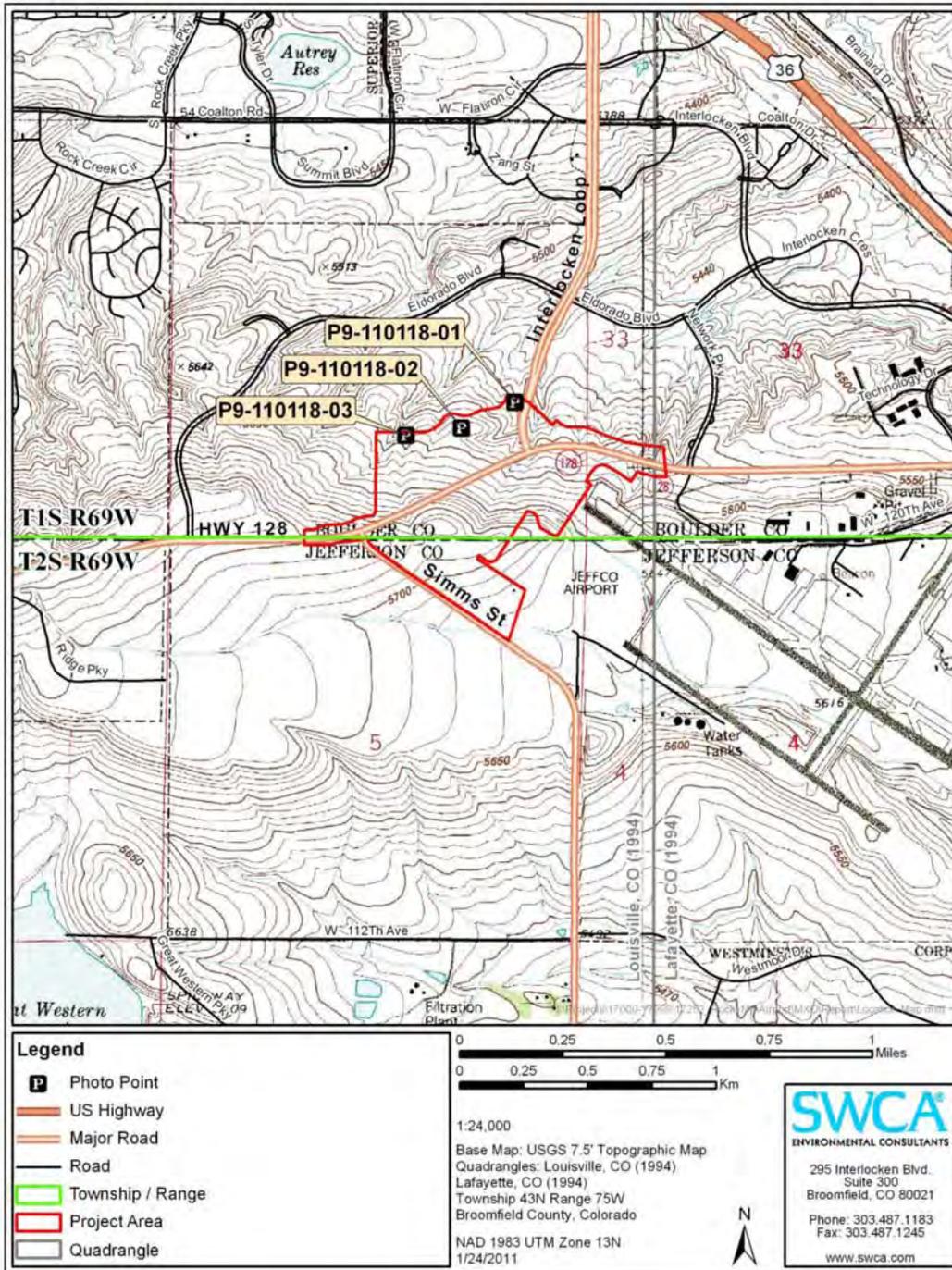


Figure 2. Rock exposure locations indicated by the photo point.

## 4.0 IMPACTS

### 4.1 PALEONTOLOGICAL RESOURCES

#### 4.1.1 Direct Impacts

A review of the construction design plans indicated that construction in areas underlain by moderate sensitivity Laramie Formation will require only shallow excavations of limited extent for the proposed realignment of State Highway 128, Interlocken Loop, and the Chiller Plant. Excavations for gas and electrical facilities are anticipated to be of limited geographic extent and shallow depth. The largest excavation, for the proposed borrow pit, will most likely only disturb sediments of the low to moderate sensitivity Verdos Alluvium that are unlikely to contain scientifically important fossils because fossils in this unit are sparse. Additionally, the field survey completed for this assessment has determined that no fossils are present on the surface of the area surveyed, and no previously recorded fossil localities are located within the RMMA Study Area.

#### 4.1.2 Indirect Impacts

SMITH believes that indirect impacts to paleontological resources will not occur because no indirect actions will be caused by the Project.

#### 4.1.3 Cumulative Impacts

There are several airport expansion/development and roadway improvement projects that will occur in the Colorado Front Range that may cause impacts to paleontological resources in the future, including the Jefferson Parkway; developments associated with the airport Master Plan Update (RMAA 2010) that are not part of the Proposed Action; roadway improvements and rail development along US 36; and the Conoco-Phillips development just north of the Flatirons Mall. If any of these projects impact paleontological resources, a state certified paleontologist will need to inspect the project.

## 5.0 CONCLUSIONS

SMITH contracted SWCA to complete a paleontological resource investigation for the proposed RMMA runway expansion in Broomfield, Colorado. This assessment was conducted to identify any significant fossil-bearing strata or properties within the Study Area and to evaluate them for their paleontological sensitivity.

Based on the results of this study, immediate paleontological clearance is recommended, and paleontological monitoring during construction is not likely to result in the discovery of scientifically significant fossils from either the Laramie Formation or Verdos Alluvium. SMITH concludes that there will be no direct impacts to paleontological resources by the proposed Project. Indirect impacts will not occur because no indirect actions will be caused by the Project. Proposed projects in the foreseeable future may impact Paleontological resources and will be subject to the National Historic Preservation Act. As Project activities progress, there is always the potential for paleontological materials to be located within the Study Area. If any sub-surface bones or other potentials are found by construction or other Project personnel, it is recommended that work in the immediate vicinity be temporarily halted, and a qualified and State of Colorado permitted paleontologist be called immediately to assess the discovery and make further recommendations.

## 6.0 REFERENCES

- Bureau of Land Management. 2007. Potential Fossil Yield Classification System: BLM Instruction Memorandum No. 2008-009 (PFYC revised from USFS, 1996).
- Carpenter, K.. 1979. Vertebrate fauna of the Laramie Formation (Maastrichtian), Weld County, Colorado: University of Wyoming Contributions to Geology, v. 17, no. 1, p. 37-49.
- Carpenter, K.. and D. B. Young. 2002, Late Cretaceous dinosaurs from the Denver Basin, Colorado; Paleontology and stratigraphy of Laramide Strata in the Denver Basin (Part I): Rocky Mountain Geology, 37(2):237-254.
- Colton, R.B., 1978, Geologic map of the Boulder – Fort Collins – Greeley area, Colorado: U.S. Geological Survey Map I-855-G, 1 sheet (scale 1:100,000).
- FAA. 2006. Order 1050-1E CHG 1. USDOT FAA National Policy. Electronic distribution. March 20, 2006.
- Johnson, K.R., Reynolds, M.L., Werth, K.W., and Thomasson, J.R.. 2003, Overview of the late Cretaceous, early Paleocene, and early Eocene megaflooras of the Denver Basin, Colorado: Rocky Mountain Geology, v. 389, no. 1, p. 101-120.
- Knowlton, F. H., 1922. The Laramie flora of the Denver Basin, with a review of the Laramie problem: U. S. Geological Survey Professional Paper P 0130.
- Lindvall, R.M., 1978, Geologic map of the Fort Logan Quadrangle, Jefferson, Denver, and Arapahoe Counties: U.S. Geological Survey Map GQ-1427, scale 1:24,000 (1 sheet).
- Lindvall, R. M.. 1979. Geologic map of the Arvada Quadrangle, Adams, Denver, and Jefferson Counties, Colorado: USGS Map GQ-1453, scale 1:24,000.
- Machette, M.N.. 1977. Geologic map of the Lafayette Quadrangle, Adams, Boulder and Jefferson counties, Colorado: U.S. Geological Survey Map GQ-1392 (scale 1:24,000).
- NRCS SCS. 1975. Soil survey of the Boulder County Area, Colorado. USDA and NRCS in cooperation with the Colorado Agricultural Experiment Station. U.S. Government Printing Office. Washington D.C.
- NRCS SCS. 1980. Soil survey of the Golden Area, Colorado; Parts of Denver, Douglas, Jefferson, and Park Counties. USDA and NRCS in cooperation with the Colorado Agricultural Experiment Station. U.S. Government Printing Office. Washington D.C.

- OAHP. 2007. Colorado Cultural Resource Survey Manual. Guidelines for Identification: History and Archaeology. Office of Archaeology and Historic Preservation. Denver, Colorado.
- RMMA. 2010. Rocky Mountain Metropolitan Airport's 2010 Master Plan Update. Rocky Mountain Metropolitan Airport™, 11755 Airport Way Broomfield, CO 80021
- Scott, G.R.. 1963. Quaternary geology and geomorphic history of the Kassler Quadrangle, Colorado: U.S. Geological Survey Professional Paper 421-A, 70 p.
- Scott, G. R.. 1972. Geologic map of the Morrison Quadrangle, Jefferson County, Colorado: USGS Map I-790-A, scale 1:24,000.
- Scott, G.R.. 1978. Geologic map of the Sterling Quadrangle: U.S. Geological Survey Map, I-1092, scale 1:250,000.
- Spencer, F.D.. 1961. Bedrock geology of the Louisville Quadrangle, Colorado: U.S. Geological Survey Map GQ-151 (scale 1:24,000).
- Weimer, R.J. and Land, C.B., 1975. Maastrichtian deltaic and interdeltic sedimentation in the Rocky Mountain region of the United States: Geological Association of Canada Special Paper 13, p. 632-666.
- Wilson, G.P., Dechesne, M., and Anderson, I.R.. 2010. New Latest Cretaceous Mammals from Northeastern Colorado with Biochronologic and Biogeographic Implications: *Journal of Vertebrate Paleontology* 30(2)499-20.

APPENDIX A – PHOTOS OF THE STUDY AREA



Photo 1. . Photo point P9-110118-1.



Photo 2. Photo point P9-110118-2.



**Photo 3.** Photo point P9-110118-3.