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28 July 2022
File No. 0204990-001

Pioneer Landscaping Materials, Inc.
13745 Garrett Road
Peyton, Colorado 80831

Attention: Dr. Angela Bellantoni

Subject: Soils & Geology Report
Solberg Pit
Peyton, Colorado

Dear Dr. Bellantoni:

This soils and geology report has been developed for Pioneer Landscaping Materials, Inc. (Pioneer) Solberg Pit as part of the greater permit submittal for the expansion of the Pioneer Solberg Quarry (Site) located in El Paso County, Colorado. This report provides a summary of the soil and geologic conditions located at the Site and has been developed following the recommendations provided in the Engineering Criteria Manual developed by the County of El Paso.

General Location and Description

LOCATION

The existing Solberg Pit and proposed 79-acre expansion area, adjoining the existing permitted acreage to the west, is located on private lands on Curtis Road in Peyton, Colorado. The Site is located in a rural portion of the County with surrounding land uses of ranches and low density homesites. No existing facilities exist near the Site. The mine entrance is located on Curtis Road south of Garrett Road. Other streets near the Site include Jones Road to the south and McCandlish Road, Renneberger Road, and Good Fortune Road to the north. The legal description of the Site is the west ½ of the northwest ¼ of Section 21, Township 13 South, Range 64 West of the 6th prime meridian in El Paso County, Colorado.

DESCRIPTION OF PROPERTY

The existing construction materials mining operation has a permitted entitlement area of approximately 234 acres, and a proposed amendment area of approximately 79 acres, for a total area of approximately 313 acres. The area is slightly rolling hills with an elevation range of 6,724 feet to 6,628 feet at the existing legal non-conforming pit.

Mining at the Site began in 1982. The plan of operations for the Site consists of excavating surficial sand and gravel materials down to a depth of approximately 35 feet. Materials excavated from the quarry area ground are taken to the onsite processing plant. At the processing plant a conveyor draws raw materials transported from the quarry, which are then washed to remove unwanted silts and clays and then separated out and classified by size. The sand and gravel separated during this process are dewatered and stockpiled. The stockpiled sand and gravel are then transported off the Site via haul trucks.

As previously noted, mining has occurred in the eastern portion of the Site since 1982 and is expanding towards the west. Site features include an existing quarry and associated processing, washing, and material stockpile areas. Operations areas include maintenance and fueling areas, truck scales and scale house, and a series of fines multiple settling ponds.

PROPOSED SITE ACTIVITIES

Proposed activities at the Site are limited to the continued mining and processing of surficial geologic materials and related mineral processing activities. These include the use of temporary structures, construction of haul roads, excavation of materials, processing and stockpiling of materials, and reclamation of disturbed areas. No blasting is required to mine the unconsolidated sand and gravel and no chemicals are used to wash and process the aggregates.

Existing mining occurs on the eastern 234 acres of the Site; the proposed expansion of the Site includes a 79-acre expansion of mining operations to the west. This expansion is needed to supplement dwindling reserves on the originally permitted parcel. The expansion of mining to the additional parcel will not significantly alter the Site’s operational areas or practices located in the eastern portion of the Site. In the expansion area, surficial mining and related mineral processing activities will continue to occur.

At closure of the Site, reclamation of the Site will occur. In accordance with the existing reclamation plan, the Site will be turned into a naturalized open space. The naturalized open space will be revegetated, and the drainages of the Site will be re-established. Proposed mining excavations at the Site are to be graded to a reclamation slope of 3H:1V (Horizontal:Vertical). Pioneer is not proposing any inert back fill onsite other than the redistribution of fines separated during washing and processing or salvaged soils.

Site Geology

United States Geological Survey (USGS) maps, historical aerial photographs, and site investigations related to the mining activities have been reviewed for the Site geology. The results of our review are provided in the following sections.

HISTORICAL AERIALS

Historical aerials from 1953 to 2022 from the USGS, Google Earth, and ESRI were compared to evaluate the changes to the facility over the past 69 years (Appendix A). Early images of the Site from 1953, 1972, and 1975 were collected from the USGS library and were taken at low resolution which limits the ability to evaluate individual features at the Site. Images from 1985 and later are of higher resolution and more easily readable. Progressing through the pictures reveals that mining can first be observed in 1985 and the gradual expansion of mining can be seen in each subsequent photo. An increase of low density ranchettes and residential structures in the nearby areas, including new roads and homes, can be observed between 1985 and 1999. From 1999 on, there has been little change in land use around the Site. Drainage and streams in and around the Site appear to stay in their same location throughout the images with little to no change.

SURFICIAL DEPOSITS

Haley & Aldrich, Inc. (Haley & Aldrich) reviewed the USGS Falcon Quadrangle Geologic Map, El Paso County, Colorado (Appendix B) for a description of surficial geologic deposits in the area. The USGS defines the Site area as alluvial and eolian depositional environments. Specifically, the Site is made up of three surficial geologic units designated as Qes, Qg2, and Qa. The operation only harvests the unconsolidated surficial materials present at the Site which averages approximately 30 feet in depth. USGS defines these deposits as follows:

- *Qes: **Eolian sand** – (Holocene to upper Pleistocene) Yellowish-brown to tan, fine- to coarse-grained, frosted sand and silt deposited by wind. Typically, this unit is faintly, stratified and non-cohesive; dune forms are not present. The unit is likely deposited as a sandsheet by winds capable of moving very fine gravel-sized clasts. Eolian sand is moderately compacted, easily excavated, and drains well. Unit locally may exceed 5 feet in thickness.*
- *Qg2: **Pediment gravel two** – (middle Pleistocene) Brownish-red to reddish-tan, poorly sorted, moderately to poorly stratified pebble and cobble gravel derived from the upper Denver Basin Group of Thorson (2011) and older gravel deposits. Clasts are subrounded to rounded and are moderately weathered. Locally, the unit is stained by iron-oxides. Top of the unit is 30 to 40 feet above adjacent modern streams, and the unit locally exceeds 30 feet in thickness. Unit correlates to Slocum Alluvium of the Denver area (Scott and Wobus, 1973). The deposit forms a stable building surface, but excavations may be prone to slumping. The unit is a potential source of sand.*
- *Qa: **Alluvium, undivided** – (Holocene to upper Pleistocene) Gray brown to tan-brown, poorly sorted sand and fine gravel in valley heads in the upper parts of drainages and in main trunk streams where differentiation of specific alluvial units was not possible. The unit includes sheetwash and stream-deposited alluvium that are undivided. Maximum exposed thickness of the unit locally exceeds 20 feet.*

SOIL

The ground cover at the Site generally consists of bare earth in the areas of mining disturbances and low-lying vegetation in the areas that have yet to be mined or are already reclaimed. The low-lying vegetation generally consists primarily of a mixture of grass and weeds, with the occasional low-growing brush. These areas would be considered herbaceous in good hydrologic condition, as defined in Soil Conservation Service TR-55 Table 2-2d. Through the mining process the soils have been observed to be of a sand and gravel material.

The general soil conditions of the Site vary from group A to group B as defined by the U.S. Department of Agriculture Web Soil Survey. These soils are characterized as having a low to moderate runoff potential and moderate to high infiltration rate even when thoroughly wetted.

SURFACE DRAINAGE

The Site is located within the Chico Creek drainage basin between two unnamed tributaries of the West Black Squirrel Creek. Existing surface drainage at the Site flows from the northwest to the southeast. Stormwater flow at the Site is kept separated between the unaffected stormwater which is directed around the mining and processing disturbed areas and stormwater that lands in the disturbed areas. There are no creeks or streams located on the Site. Flow of water at the site occurs from stormwater falling directly onto the Site. Stormwater that lands outside of the disturbed areas flows to the southeast as part of the existing natural drainages. Stormwater that falls within the disturbed area is directed to onsite ponds for storage, recharge, and recycled use at the processing plant. The onsite ponds have an emergency spillway which directs flow to a culvert located in the northeast corner of the Site. Sediment drops out of the stormwater into the sediment basin prior to flowing off the Site through the existing culvert.

BEDROCK UNITS

Haley & Aldrich reviewed the Site area for surficial or near surface bedrock geologic units within the USGS Falcon Quadrangle Geologic Map, El Paso County, Colorado (Appendix B). Bedrock units at the Site come from the Paleogene and cretaceous periods, specifically Eocene, Paleocene, and Upper Cretaceous period. Bedrock is not targeted in the mining process and may only be exposed when the overlying unconsolidated sediments are extracted. The USGS defines these bedrocks as follows:

- TKjc: Jimmy Camp Formation – (Paleocene) greenish-brown pebbly arkosic sandstone interbedded with dark greenish-gray micaceous claystone with minor amounts of organic material. The pebbles are andesite, dacite, and occasional granite that may reach 6 inches in diameter. Iron concretions and petrified wood are common. The sandstone beds are cross-bedded or massive, poorly sorted, micaceous, and contain coarse sand-sized grains of quartz and feldspar. Thickness may reach 1,000 feet in the Elsmere area: however, the exposed thickness in the Falcon Quadrangle is approximately 200 feet. The Jimmy Camp Formation is described in detail by Thorson (2011).
- TKdb: Denver Basin Group, undivided – (Upper Cretaceous to Paleocene) Includes the Pikeview Member and Pulpit Rock Member of Thorson (2011) and is located below the Jimmy Camp Formation.

- Physical Characteristics – Pikeview and lower Pulpit Rock formations include sandstone, conglomeratic sandstone, and interbedded shale and siltstone (Colorado Geological Survey).
- Hydrologic Characteristics – Although this unit can be a water table aquifer near outcrop areas, this bedrock unit is not exposed at the Site. The aquifer is generally confined; the most permeable of Denver Basin aquifers consist of fluvial fan deposits that thin in an eastward direction, divided into upper and lower members in its northern extent (Colorado Geological Survey).

Based on the Falcon Quadrangle Geologic map there are no observed fracture zones or topography suggesting faulting near the Site. The beds near the Site strike north-south (approximately 000 degree) and the beds dip 5 degrees to the west. The bedrock in the area has a syncline fold.

AREAS AND VOLUMES

The existing construction materials mining operation has a permitted area of approximately 234 acres, and the proposed amendment area is approximately 79 acres, for a total area of approximately 313 acres. Over the remaining life of the mine, it is anticipated there will be approximately 10,470,000 cubic yards of cut and 490,000 cubic yards of fill. It is anticipated the cut/mined material will consist of aggregate materials. Mining of the material should follow the approved mining plan. There are no anticipated problems with excavation. Fill placement should follow the approved reclamation plan. There are no anticipated issues with fill placement as long as the reclamation plan is followed.

GEOLOGIC HAZARDS

The Site has been evaluated for geological hazards based on mapping completed by the Colorado Geologic Survey. Based on our evaluation of the existing hazard mapping, it was found that the Site has low to no risk of landslides, avalanches, rockfall, mudflows, or debris flows. The Colorado Geologic Survey hazard map for El Paso County has been included as part of Appendix C.

The mining of unconsolidated alluvial materials from open excavations does not pose any special geologic hazards aside from the possibility of localized slope failures due to over steepened pit faces. This potential risk is mitigated by the 3H:1V pit slope construction stipulated in the approved reclamation plan and frequent safety inspections by local regulators and the federal Mine Safety and Health Administration. Processed materials stockpiled on the property form natural slopes at the angle of repose of the materials that also do not pose any special geologic hazards. There are no earthen dams or retention facilities the failure of which would cause a hazard to Pioneer employees or persons outside the property boundaries.

Radon is a naturally occurring gas that is present in many diverse geologic settings. The Site and the rest of El Paso County is in an Environmental Protection Agency (EPA) Radon Zone 1, as is the rest of El Paso County. Zone 1 is considered high radon potential (probable indoor radon average >4 picocuries per liter (pCi/L). The EPA Colorado map of Radon zones is provided in Appendix B. While radon may be present at the Site in some of the geologic units, the mining operation does not operate in a way to accumulate or concentrate radon.

Summary and Conclusions

The Solberg Pit is located in Peyton, Colorado within El Paso County. Mining at the Site has occurred since 1982, and Pioneer is proposing a 79-acre expansion of contiguous lands to the west. Proposed activities at the Site are limited to the mining of surficial materials and related aggregate mineral processing activities. Materials on the Site will be excavated to a maximum depth of 35 feet. The regional as well as Site soils and geology has been reviewed and we have found the following:

- Surficial deposits that are to be mined at the Site are defined by the USGS as unconsolidated alluvial, and eolian deposits.
- Bedrock units below the Site come from the Paleogene and cretaceous periods, specifically Eocene, Paleocene, and Upper Cretaceous period. Mining will occur in the unconsolidated materials overlying the existing bedrock and does not negatively impact the bedrock.
- Naturally formed geologic hazards (radon) at the Site exist, but the proposed mining activities do not increase the risks or dangers of these geologic hazards.
- The Site does not utilize blasting in mining or chemicals in processing that could adversely impact soils, surface or groundwater resources at the Site.
- The Site will reclaim and revegetate disturbed lands to a minimum slope of 3H:1V and ensure the productive post-mining land use of the property.

This soils and geology report has been developed for Pioneer Solberg Pit as part of the greater permit submittal for the expansion of the Pioneer Solberg Quarry. On the basis of the information contained in this document, it is the opinion of the undersigned that this geologic summary has been developed following the recommendations provided in the Engineering Criteria Manual developed by the County of El Paso.

Sincerely yours,
HALEY & ALDRICH, INC

Zachary Smith
Senior Engineer

Rich Brown
Senior Geologist

Enclosures:
Figure 1 – Site Location Map
Appendix A – Historical Site Aerial Photographs
Appendix B – USGS Geology Maps
Appendix C – Site Hazard Maps

References

1. Colorado – EPA Map of Radon Zones. Environmental Protection Agency, 2022.

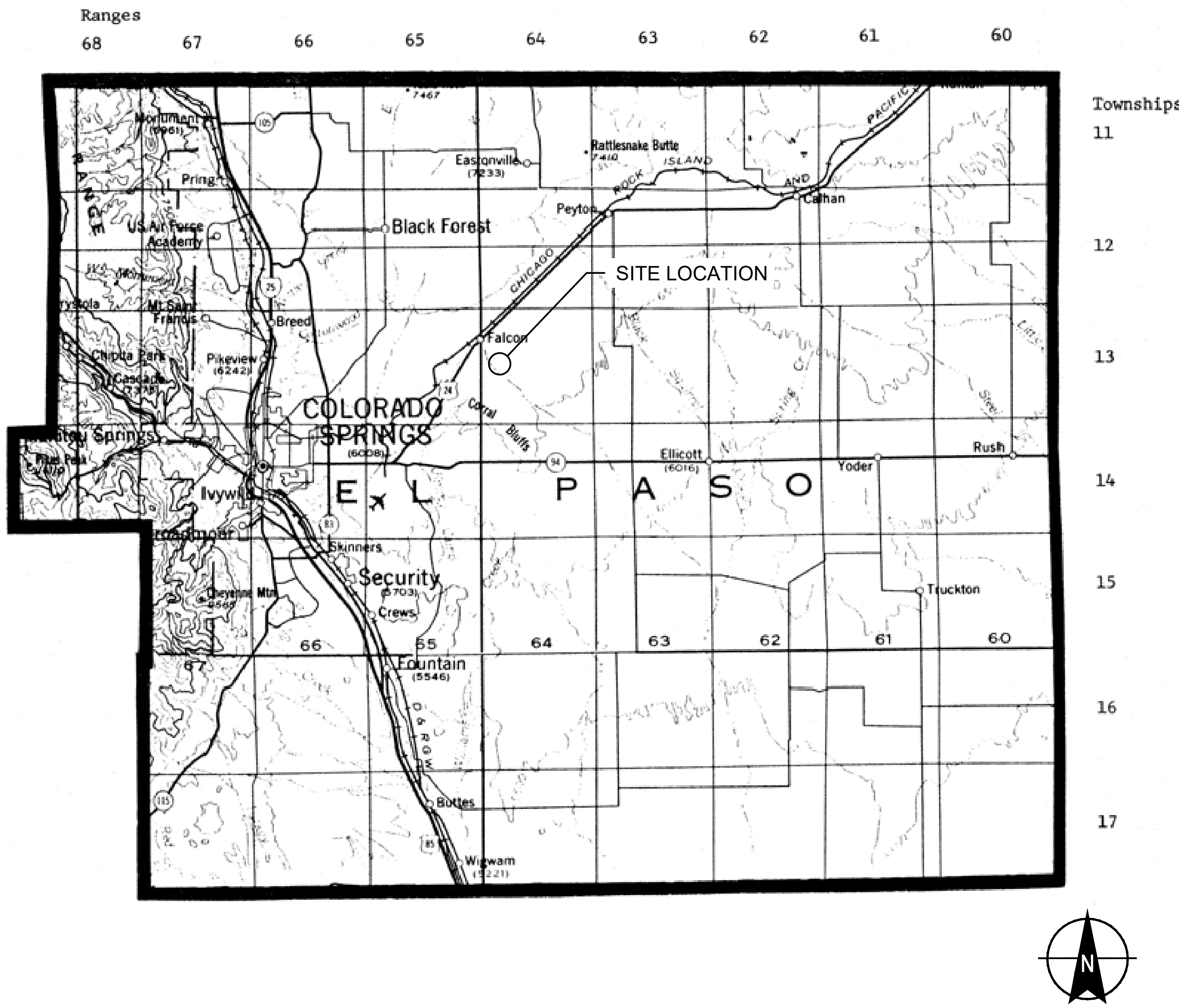
2. Debris Flow Susceptibility Map of El Paso County, Colorado. Open-file Report 18-11. Kevin M. McCoy, Matthew L. Morgan, and Karen A. Berry. Colorado Geological Survey, 2018.

3. Falcon Quadrangle Geologic Map, El Paso County, Colorado. Open-file Report 12-05. Colorado Geological Survey Department of Natural Resources Denver, Colorado. 2012.

4. Pleistocene and recent deposits in the Denver area, Colorado: U.S. Geological Survey Bulletin 996-G. Hunt, C.B., 1954.

5. Preliminary Geological Radon Potential Assessment of Colorado. Open-file Report 93-292-H. United States Geological Survey, 1993.

FIGURE



SITE LOCUS

TOPO SOURCE: EL PASO COUNTY MAP FROM COLORADO DIRECTORY (2021)

SITE AERIAL

MAP SOURCE:IMAGE DATED 6 OCTOBER 2019
TAKEN ELECTRONICALLY FROM GOOGLE EARTH PRO.

0 1000 2000
SCALE IN FEET

HALEY ALDRICH

SOLBERG PIT SITE GEOLOGY REPORT
PEYTON, COLORADO

SITE LOCATION MAP

SCALE: AS SHOWN
JULY 2022

FIGURE 1

Saved by: ZSMITH Printed: 3/16/2022 2:22 PM Sheet: HA-FIG-B-L-H
\\HALEYALDRICH.COM\SHARE\CF\PROJECTS\0204990\CAD\WORKING\135330-FIG-1.DWG

APPENDIX A
Historical Site Aerial Photographs

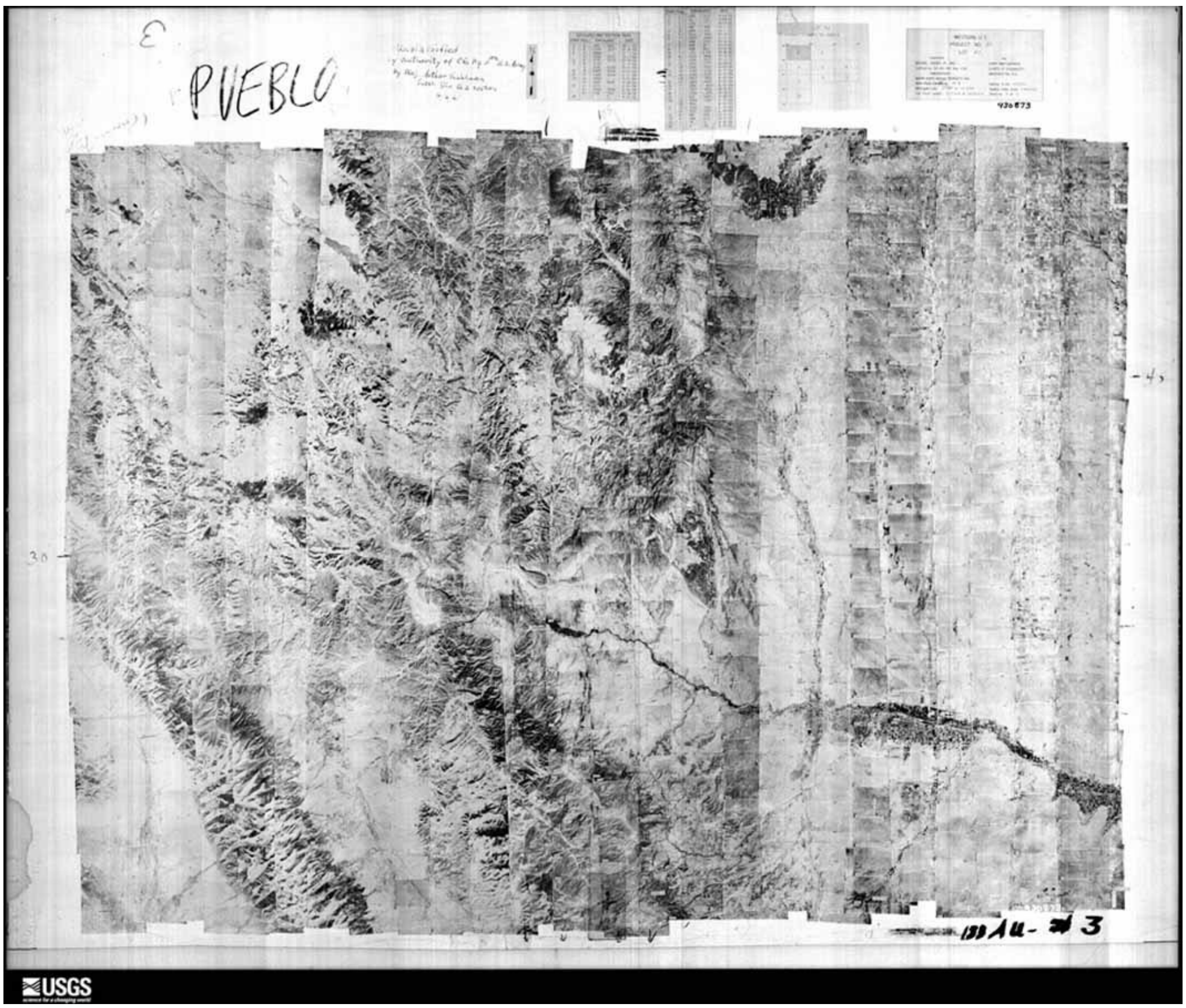


Photo 1: USGS 1953 Aerial Photo

Photo 2: USGS 1972 Aerial Photo

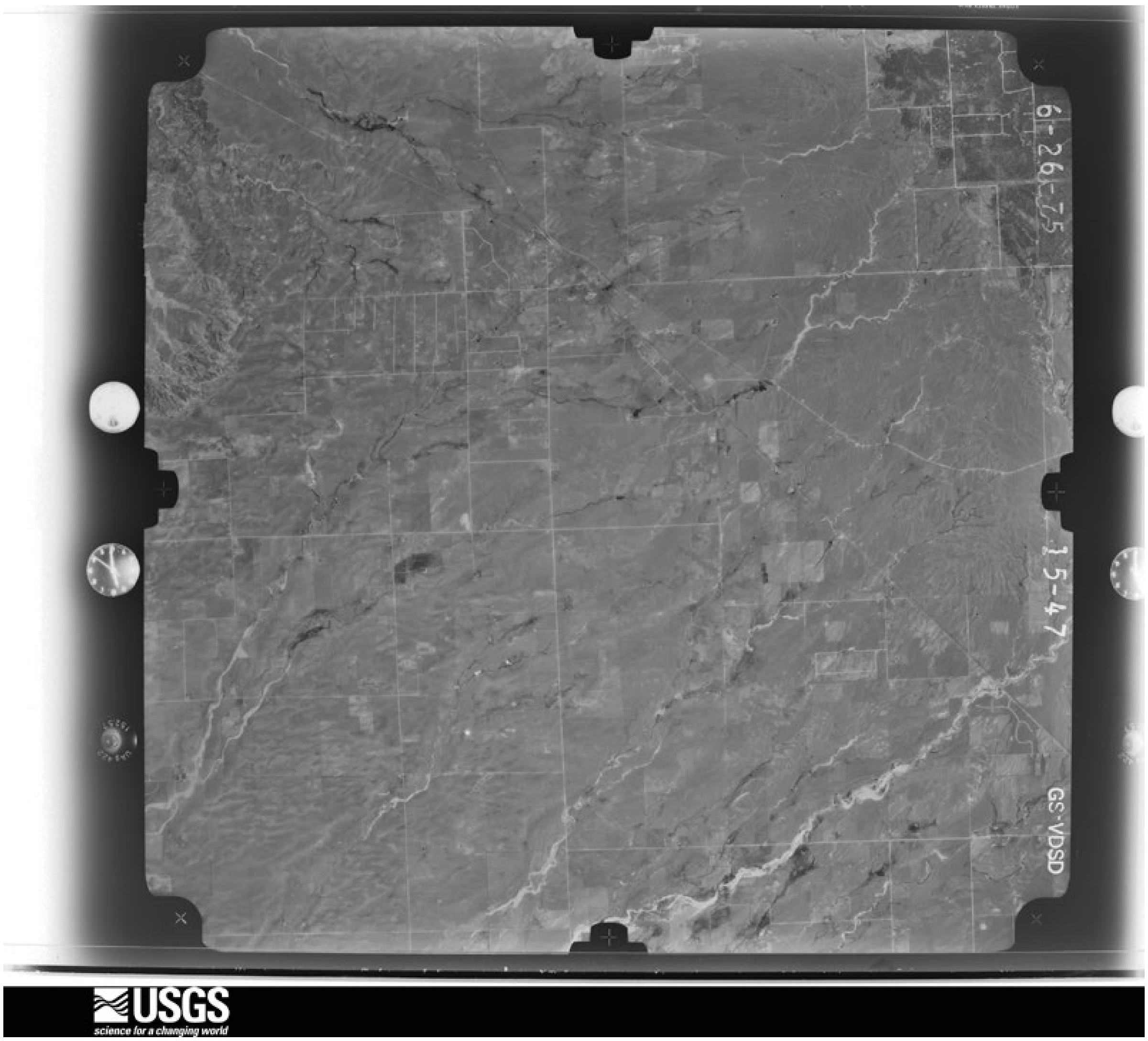


Photo 3: USGS 1975 Aerial Photo

Photo 4: Google Earth 1985 Aerial Photo

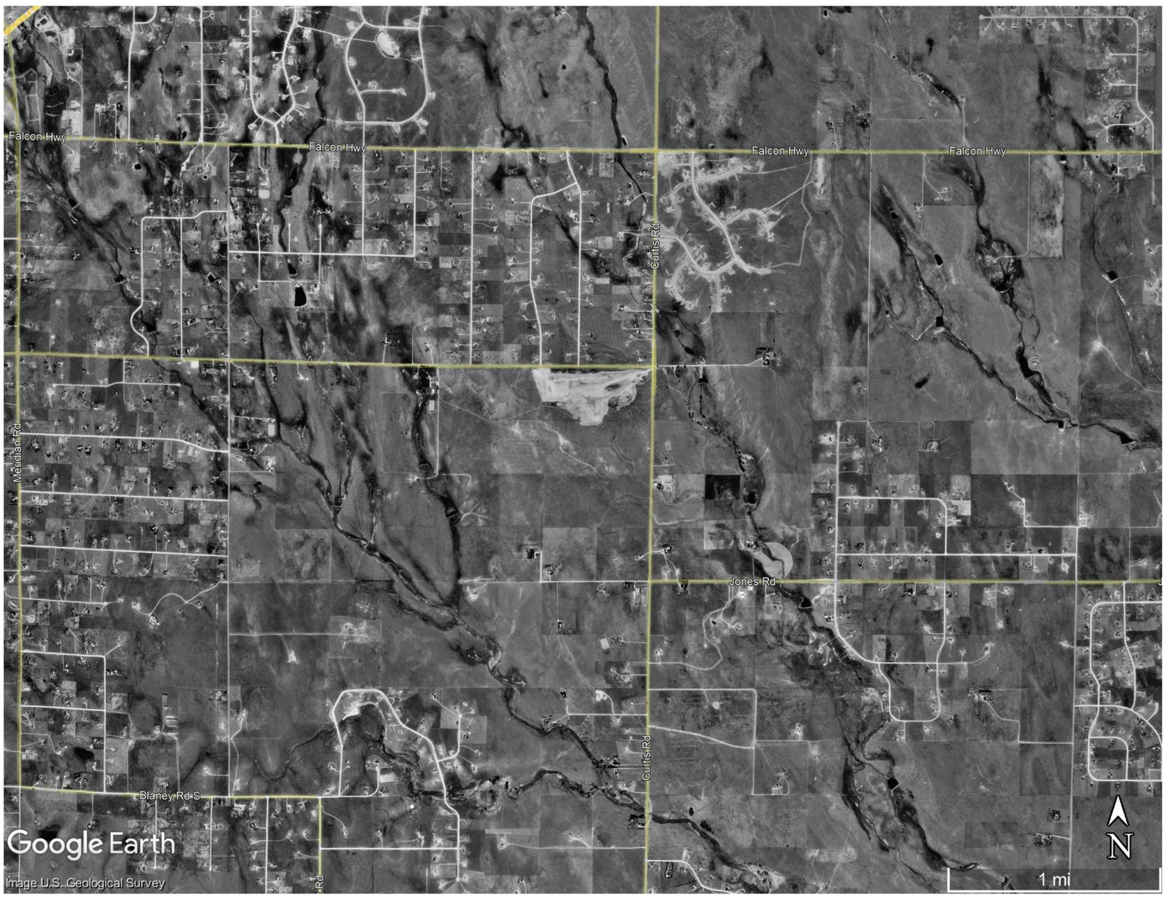


Photo 5: Google Earth 1999 Aerial Photo

Photo 6: Google Earth 2004 Aerial Photo

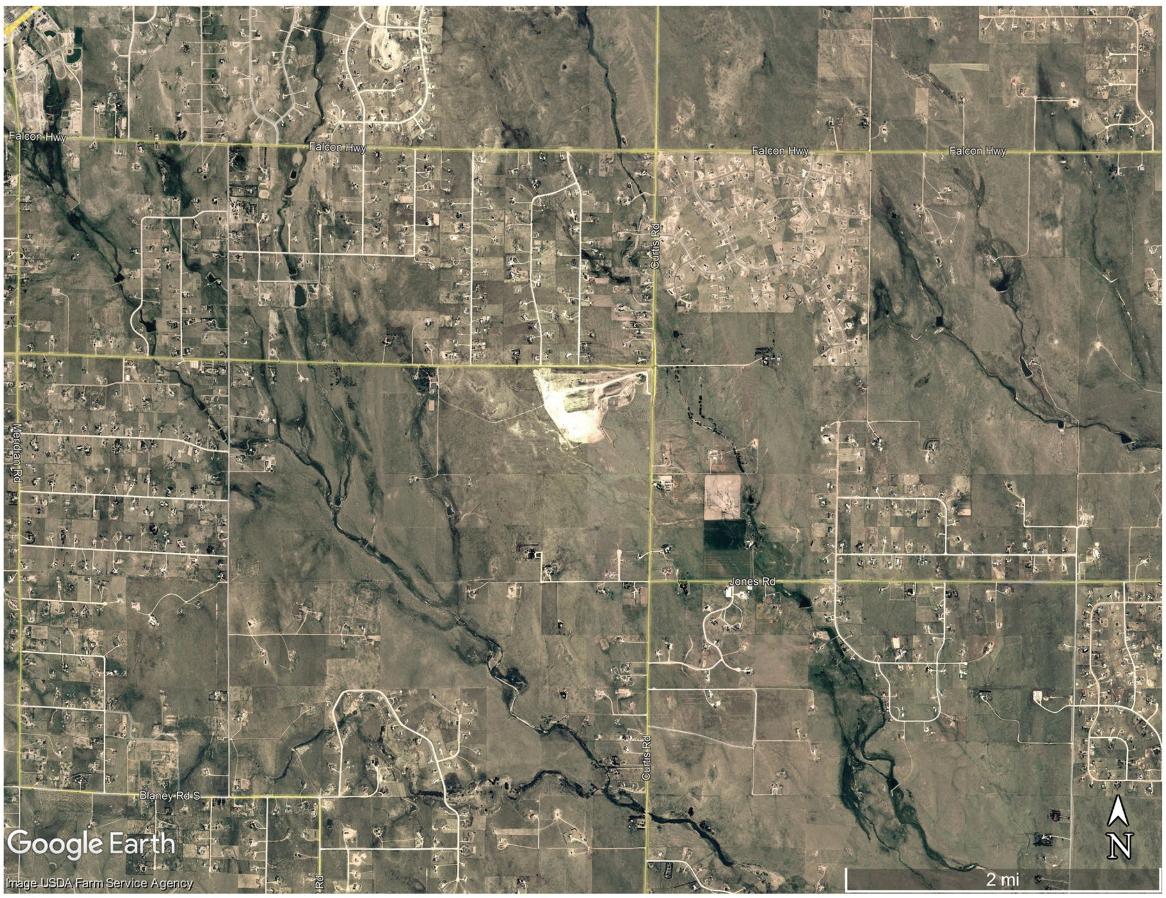


Photo 7: Google Earth 2005 Aerial Photo

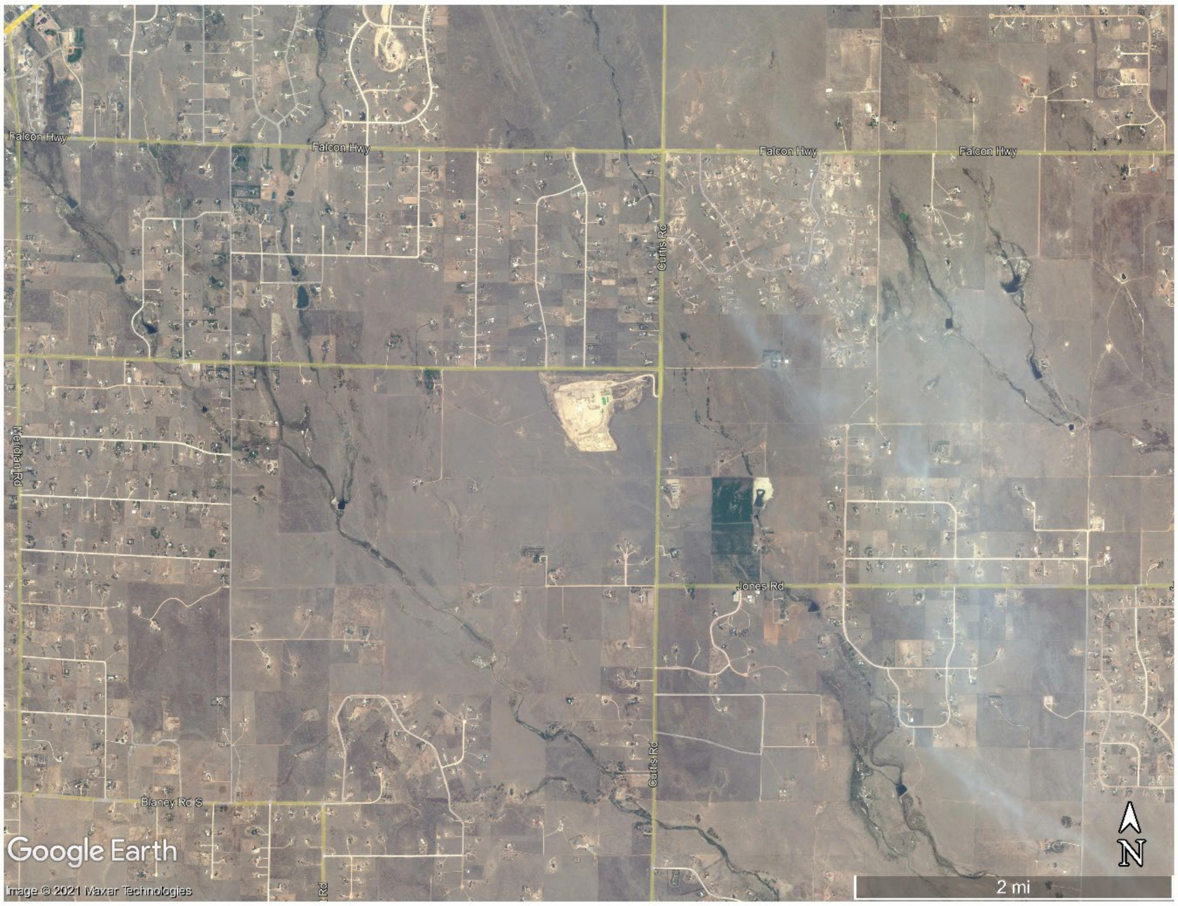


Photo 8: Google Earth 2011 Aerial Photo

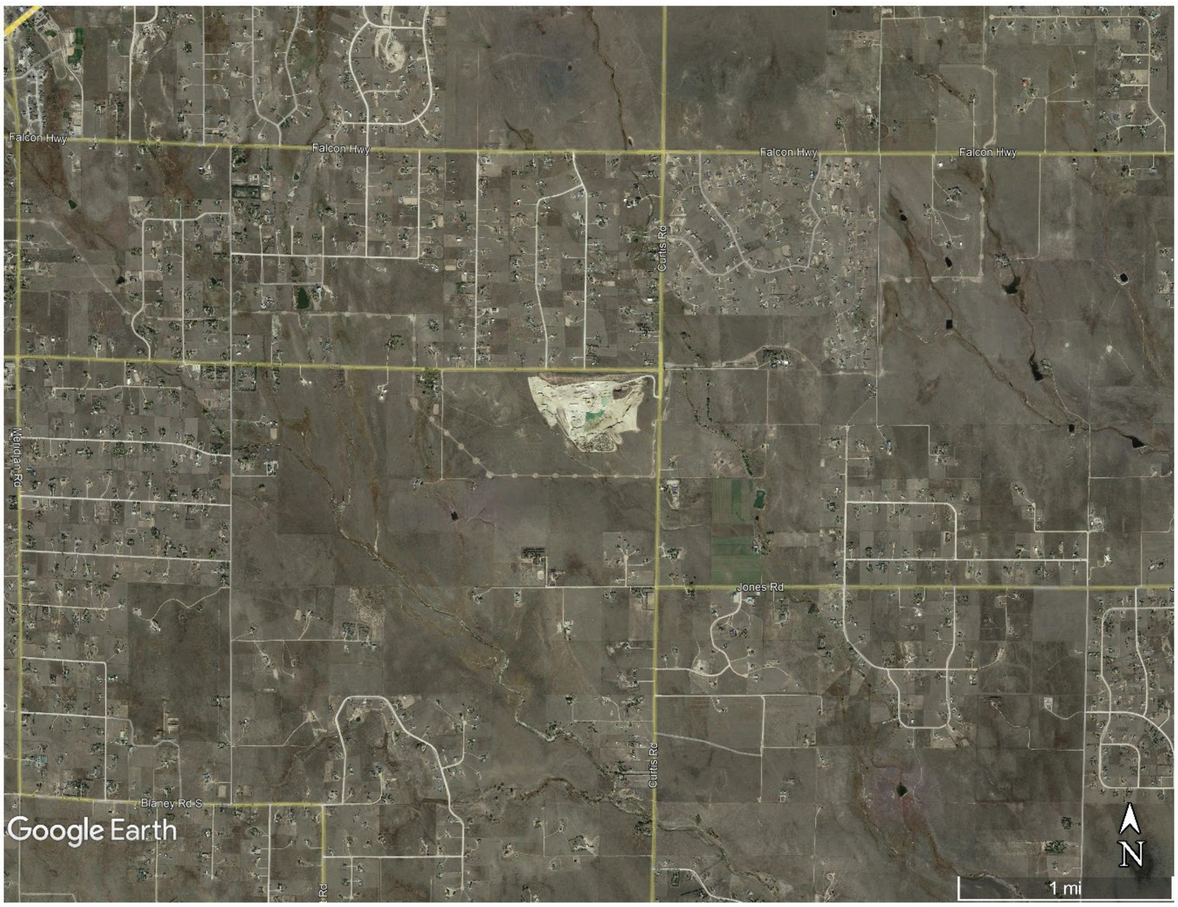


Photo 9: Google Earth 2015 Aerial Photo

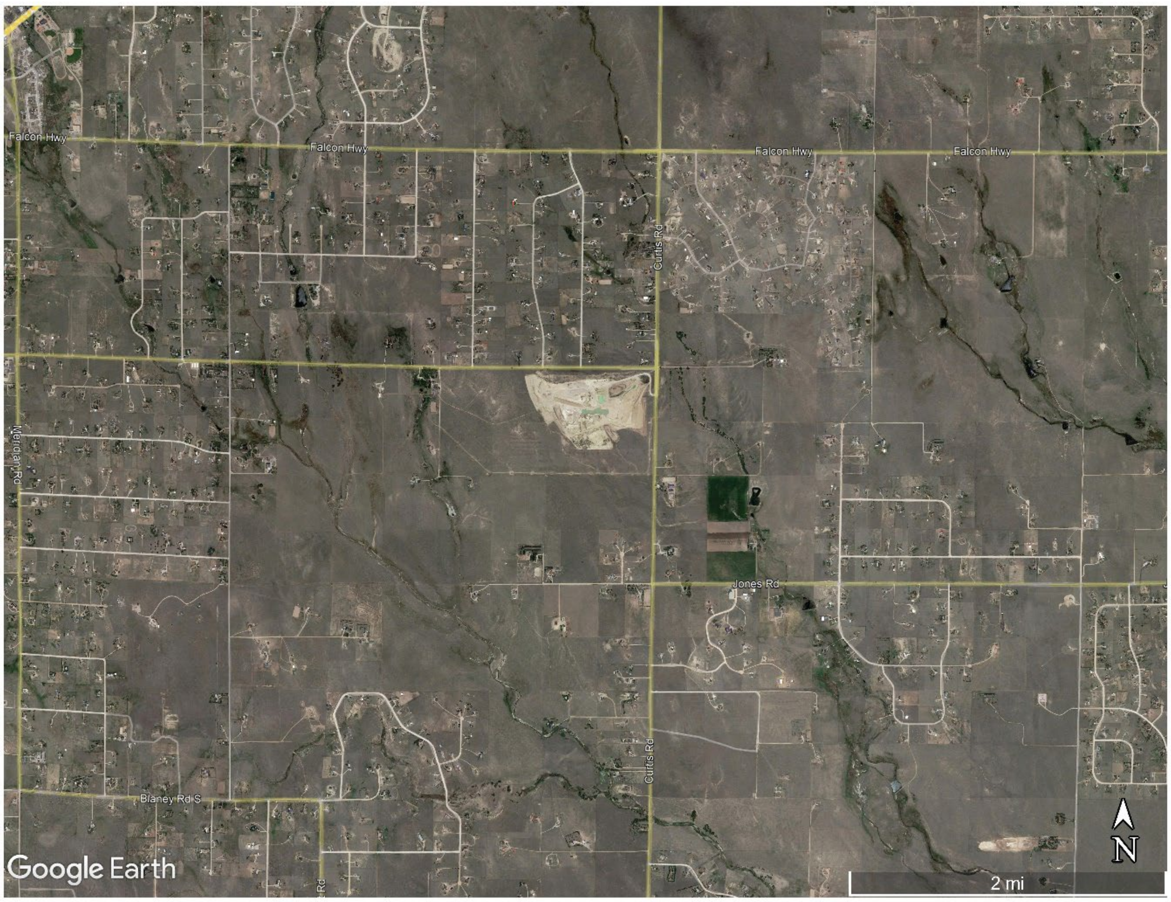


Photo 10: Google Earth 2017 Aerial Photo

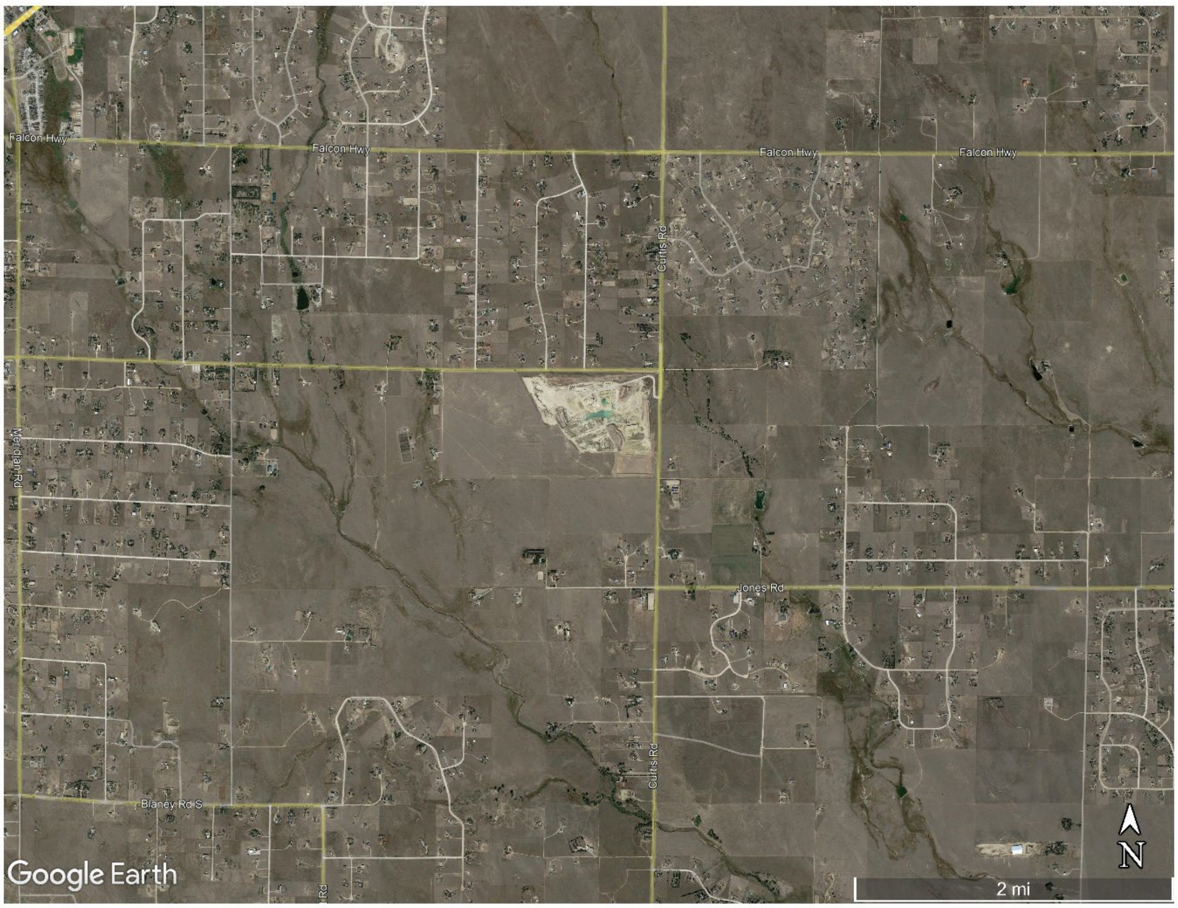


Photo 11: Google Earth 2019 Aerial Photo

Photo 12: ERSI 2020 Aerial Photo

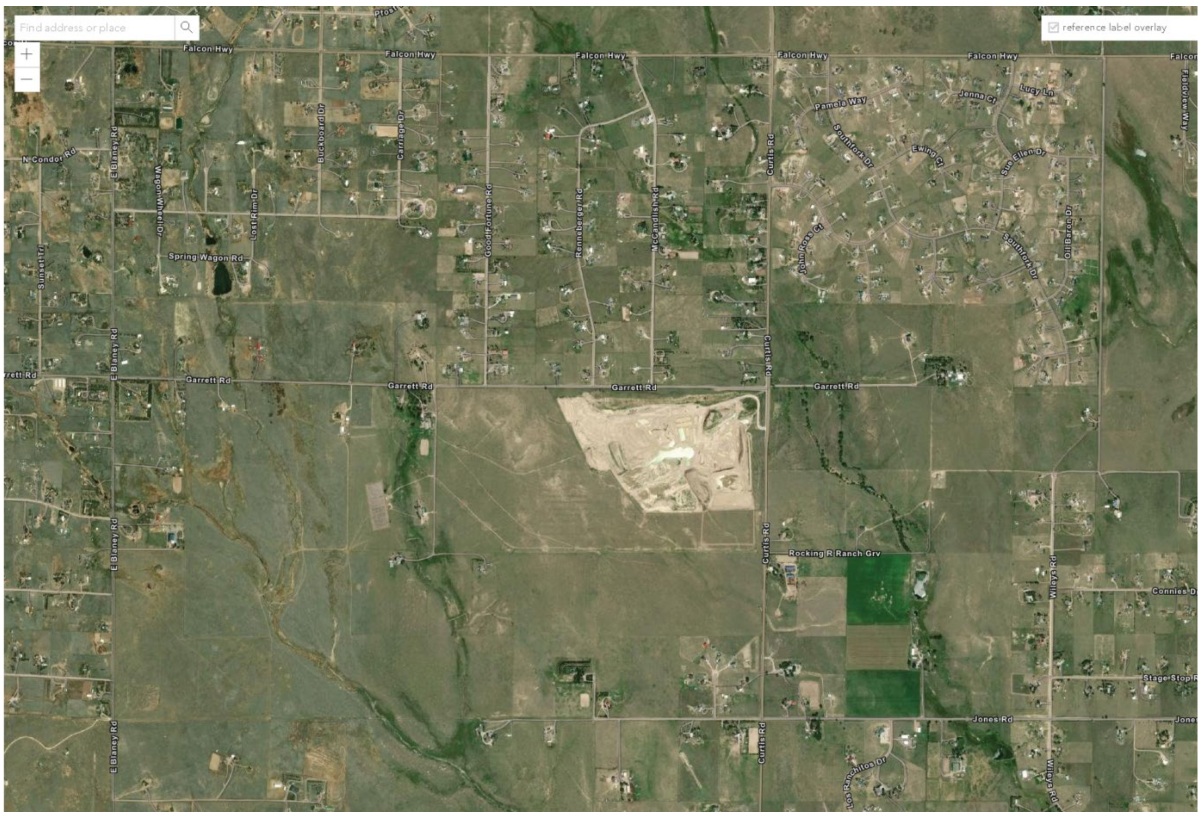


Photo 13: ERSI 2021 Aerial Photo

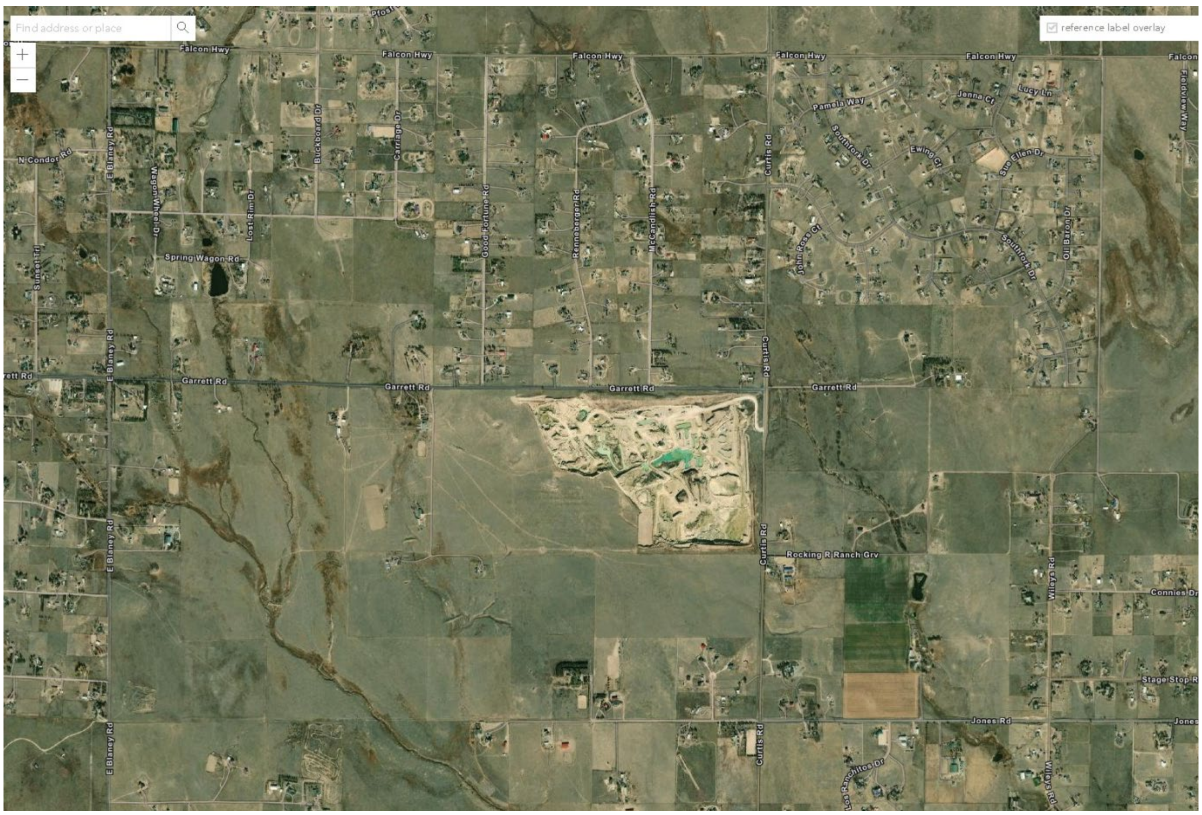
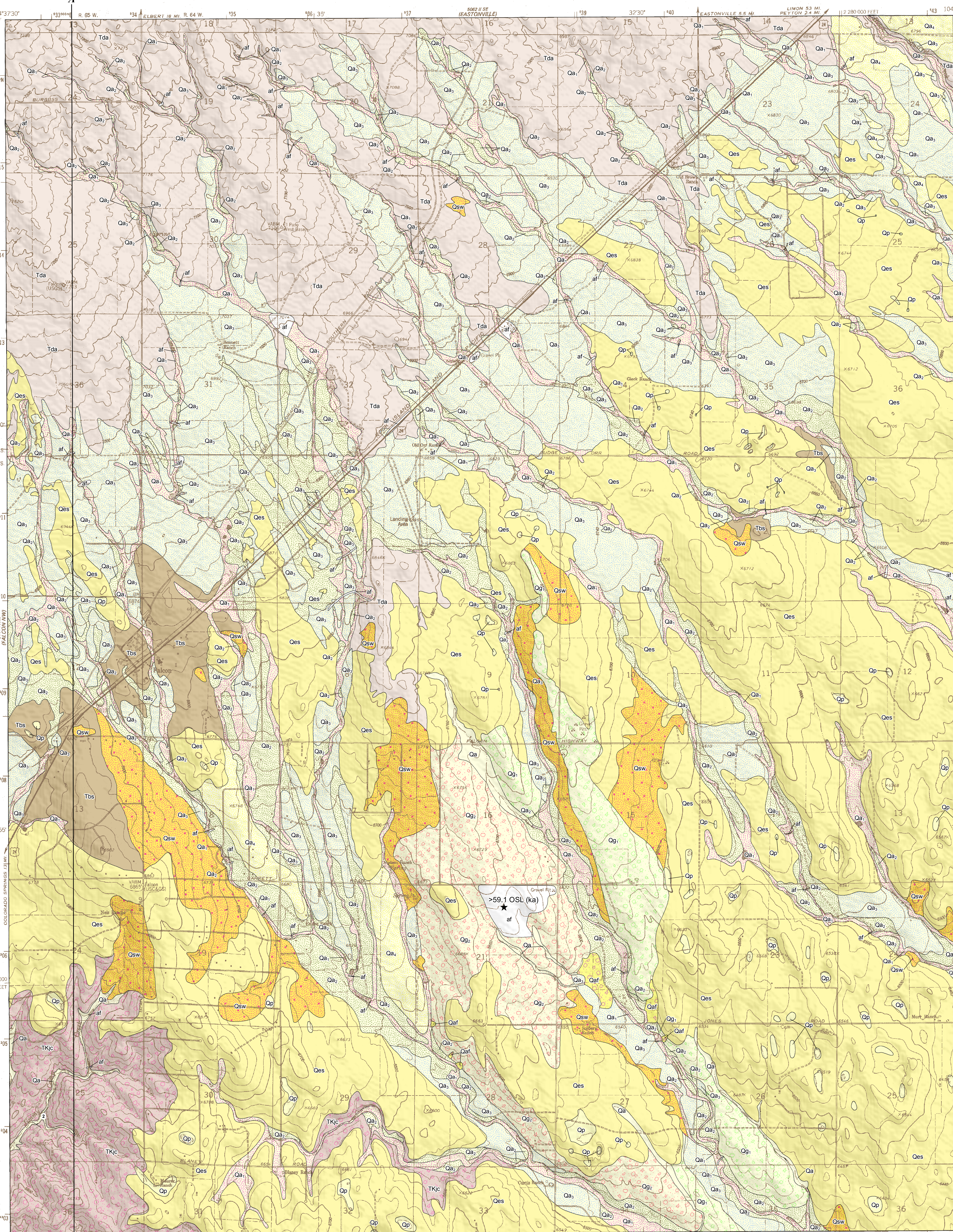


Photo 14: ERSI 2022 Aerial Photo

APPENDIX B
USGS Geologic Maps



Mapped, edited, and published by the Geological Survey in cooperation with U.S. Corps of Engineers

Control by USGS and NOS/NOAA

Topography by photogrammetric methods from aerial photographs taken 1947. Field checked 1948. Revised from aerial photographs taken 1960. Field checked 1961

Polyconic projection. 1927 North American datum
10,000-foot grid based on Colorado coordinate system, central zone
1000-meter Universal Transverse Mercator grid ticks, zone 13, shown in blue

Fine red dashed lines indicate selected fence and field lines where generally visible on aerial photographs. This information is unchecked

Revisions shown in purple compiled from aerial photographs taken 1975. This information not field checked

UTM GRID AND 1975 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000

CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

This mapping project was funded jointly by the Colorado Geological Survey and the U.S. Geological Survey through the National Cooperative Geologic Mapping Program under STATEMAP agreement number G10AC00410

QUADRANGLE LOCATION

1	2	3
4		5
6	7	8

1 Black Forest
2 Eastonville
3 Peyton
4 Falcon NW
5 Haegle Ranch
6 Elsmere
7 Corral Bluffs
8 Ellicott

ADJOINING 7.5' QUADRANGLES

Geology mapped in 2010
GIS and cartography by Karen Morgan

LIST OF MAP UNITS

SURFICIAL DEPOSITS

HUMAN-MADE DEPOSITS

af — **Artificial fill (latest Holocene)** — Riprap, engineered fill, and refuse placed during construction of roads, railroads, buildings, dams, and landfills. Generally consists of unsorted silt, sand, clay, and rock fragments. The average thickness of the unit is less than 20 feet. Artificial fill may be subject to settlement, slumping, and erosion if not adequately compacted.

ALLUVIAL DEPOSITS

Qa_1 — **Alluvium one (late Holocene)** — Tan to pale-brown, poorly to moderately sorted, poorly consolidated, sand, gravel, silt, and minor clay and occasional boulders in the currently active stream channels or in low stream-terrace deposits less than 5 feet above the current stream channel. It may be deposited as non-terrace forming alluvium in valleys and swales. Clasts are subrounded to well rounded and the dominant sediment is sandy gravel with a sandy silt matrix. The unit correlates with the Post-Piney Creek Alluvium described by Hunt (1954) in the Denver area and of Maberry and Lindvall (1972). The unit is subject to frequent flooding and is a source of sand and gravel. Maximum exposed thickness of the unit locally exceeds 5 feet.

Qa_2 — **Alluvium two (early Holocene)** — Dark gray to brown, poorly to well sorted, moderately consolidated, silt, sand, gravel, and minor clay and occasional boulders in stream terrace deposits approximately 6-12 feet above the modern flood plain or as non-terrace forming alluvium in valley headwaters. Clasts are subrounded to well rounded and the dominant sediment is sandy gravel with a silty sand matrix. Clay seams are poorly to moderately stratified. The unit correlates with the Piney Creek Alluvium described by Hunt (1954) in the Denver area and of Maberry and Lindvall (1972). The unit is subject to occasional flooding and is a potential source of sand and gravel. Maximum exposed thickness of the unit locally exceeds 20 feet.

Qa_3 — **Alluvium three (late Pleistocene)** — Tan to reddish brown to grayish brown, poorly sorted, moderately consolidated, poorly to moderately stratifed silt, sand, gravel, and cobbly gravel and occasional boulders in stream terrace deposits approximately 10-20 feet above the modern flood plain or as non-terrace forming alluvium in valley headwaters that underlies the younger alluviums. The unit contains dark gray clay beds that may be expansive. Clasts are subrounded to well rounded and the dominant sediment is sandy gravel with a sandy matrix. The unit correlates with the Broadway Alluvium described by Hunt (1954) in the Denver area and of Maberry and Lindvall (1972). The unit is a potential source of sand and gravel. Maximum exposed thickness of the unit locally exceeds 20 feet.

Qa_4 — **Alluvium four (late middle Pleistocene)** — Dark grayish-brown to yellow-reddish-brown, poorly sorted, moderately consolidated, weakly stratified silt, sand, gravel, and cobbly gravel and occasional boulders in stream terrace deposits approximately 20-30 feet above the modern flood plain. Clasts are subrounded to well rounded and have varied lithology. The unit is correlative with the Louviers Alluvium of the Denver area (Scott and Wobus, 1973). This unit is a source of commercial sand and gravel. Maximum exposed thickness of unit locally may exceed 40 feet.

Qa — **Alluvium, undivided (Holocene to late Pleistocene)** — Gray brown to tan brown, poorly sorted sand and fine gravel in valley heads in the upper parts of drainages and in main trunk streams where differentiation of specific alluvial units was not possible. The unit includes sheetwash and stream-deposited alluvium that are undivided. Maximum exposed thickness of the unit locally exceeds 20 feet.

Qaf — **Alluvial-fan deposits (late Holocene)** — Tan to pale-brown, poorly to moderately sorted, poorly consolidated clay, silt, sand, gravel, and boulders deposited as alluvial fans at the mouths of perennial streams. They have a fan-like shape and consist of subangular to well-rounded clasts of varied lithology that are derived from local surficial deposits; however, sand and gravel derived from the Dawson Basin Group is a major constituent. Sediments are deposited primarily by streams with significant input from sheetwash, debris flows, and hyperconcentrated flows. Deposits locally exceed 10 feet in thickness. Areas mapped as alluvial fans are subject to future flash floods and debris flow events. Deposits may be prone to collapse, hydrocompaction, or slope failure when wetted or loaded. The unit is a potential source of sand and gravel.

Qg_1 — **Pediment gravel one (middle Pleistocene)** — Brownish-red to reddish-tan, poorly sorted, moderately to poorly stratified pebble and cobble gravel derived from the upper Denver Basin Group of Thorson (2011) and older gravel deposits. Clasts are subrounded to rounded and are moderately weathered. Locally, the unit is stained by iron-oxides. Top of the unit is 30-40 feet above adjacent modern streams and the unit locally exceeds 30 feet in thickness. Unit correlates the Slocum Alluvium of the Denver area (Scott and Wobus, 1973). The deposit forms a stable building surface, but excavations may be prone to slumping. The unit is a potential source of sand

Qg_2 — **Pediment gravel two (middle Pleistocene)** — Medium-red to brown, poorly sorted, moderately to poorly stratified pebble, cobble, and boulder gravel derived from the upper Denver Basin Group of Thorson (2011). Clasts are subrounded to rounded and are moderately weathered. Locally, the unit is stained by iron-oxides and may contain large fragments of petrified wood. Top of the unit is 60-80 feet above adjacent modern streams and the unit locally exceeds 40 feet in thickness. Unit correlates with the Verdos Alluvium of the Denver area (Scott and Wobus, 1973). An minimum age of >59,100 OSL years was determined from a fine sand sample taken within an active gravel pit in sec. 21, T. 13 S., R. 64 W. In the Denver area, the upper part of the Verdos Alluvium contains Lava Creek B ash (Scott, 1963), which was dated at 640,000 years before present (Lanphere and others, 2002). This unit forms a stable building surface, but excavations may be prone to slumping. The unit is a source of sand and gravel.

Qsw — **Sheetwash deposits (Holocene to late Pleistocene)** — Light-grayish-brown, pale-brown, to brown, poorly sorted sand, silty and clayey sand, and minor amounts of gravel including some cobbles. Unit consists chiefly of local materials transported on moderate slopes (~10 percent grade) by sheet flow but also includes some sediment delivered by runoff in rills and minor gullies. Maximum exposed thickness is 20 feet.

EOLIAN DEPOSITS

Qes — **Eolian sand (Holocene to late Pleistocene)** — Yellowish-brown to tan, fine- to coarse-grained, frosted sand and silt deposited by wind. Typically this unit is faintly stratified and non-cohesive; dune forms are not present. The unit is likely deposited as a sandsheet by winds capable of moving very fine gravel-sized clasts. Eolian sand is moderately compacted, easily excavated, and drains well. Unit locally may exceed 5 feet in thickness.

PLUVIAL DEPOSITS

Qp — **Playa deposits (Holocene)** — Gray to dark brown, moderately well sorted, moderately consolidated, clay, silt, sand, and scattered granules. Forms flat-surfaced seasonal ponds within eolian sand (Qes). In some areas this unit may be overlain by windblown sand and sheetwash deposits.

BEDROCK

Denver Basin Group

Tda — **Dawson Arkose (Paleocene to Eocene)** — White and tan thick to massive, cross-bedded arkoses, pebbly arkoses, and arkosic pebble conglomerates. Contains beds of white and tan fine- to medium-grained feldspathic cross-bedded friable sandstone that are poorly sorted, have high clay contents, and are commonly thin or medium bedded. The unit also contains sparse interbeds of thin-bedded gray claystone and sandy claystone or dark-brown, organic-rich siltstone to coarse sandstone that contains fossilized plant fragments. Thickness may reach 1000 feet in the Monument area; however, the exposed thickness in the Falcon quadrangle is approximately 700 feet. The unit is prone to swelling when wet. The Dawson Arkose is described in detail by Thorson (2011).

Tbs — **Black Squirrel Formation (Paleocene)** — Gray-green to tan to brownish gray, moderately-well sorted cross-bedded sandy arkoses interbedded with micaceous sandy claystones that contain abundant plant fragments and occasional, fine- to medium-grained massive arkosic beds. Intermittent paleosols are developed locally. The exposed upper part of the Black Squirrel Formation is gradational with the overlying Dawson Arkose making the location of the contact problematic. The basal contact with the underlying Jimmy Camp Formation is not exposed within the mapped area. Thickness may reach 600 feet in the Monument area; however, the exposed thickness in the Falcon quadrangle is approximately 130 feet. The claystones within this unit may be prone to swelling when wet. The Black Squirrel Formation is described in detail by Thorson (2011).

TKjc — **Jimmy Camp Formation (Paleocene)** — Greenish-brown pebbly arkosic sandstone interbedded with dark greenish-gray micaceous claystone with minor amounts of organic material. The pebbles are andesite, dacite, and occasional granite that may reach 6 inches in diameter. Iron concretions and petrified wood are common. The sandstone beds are cross-bedded or massive, poorly sorted, micaceous, and contain coarse sand-sized grains of quartz and feldspar. Thickness may reach 1000 feet in the Elsmere area; however, the exposed thickness in the Falcon quadrangle is approximately 200 feet. The Jimmy Camp Formation is described in detail by Thorson (2011).

TKdb — **Denver Basin Group, undivided (Upper Cretaceous to Paleocene)** — Includes the Pikeview Member and Pulpit Rock Member of Thorson (2011). Shown on cross section only.

Contact—Approximately located

Strike and dip of inclined bedding—Showing direction and angle of dip

★ **Sample location for optically stimulated luminescence (OSL) age dating**

A——A' **Alignment of cross section**

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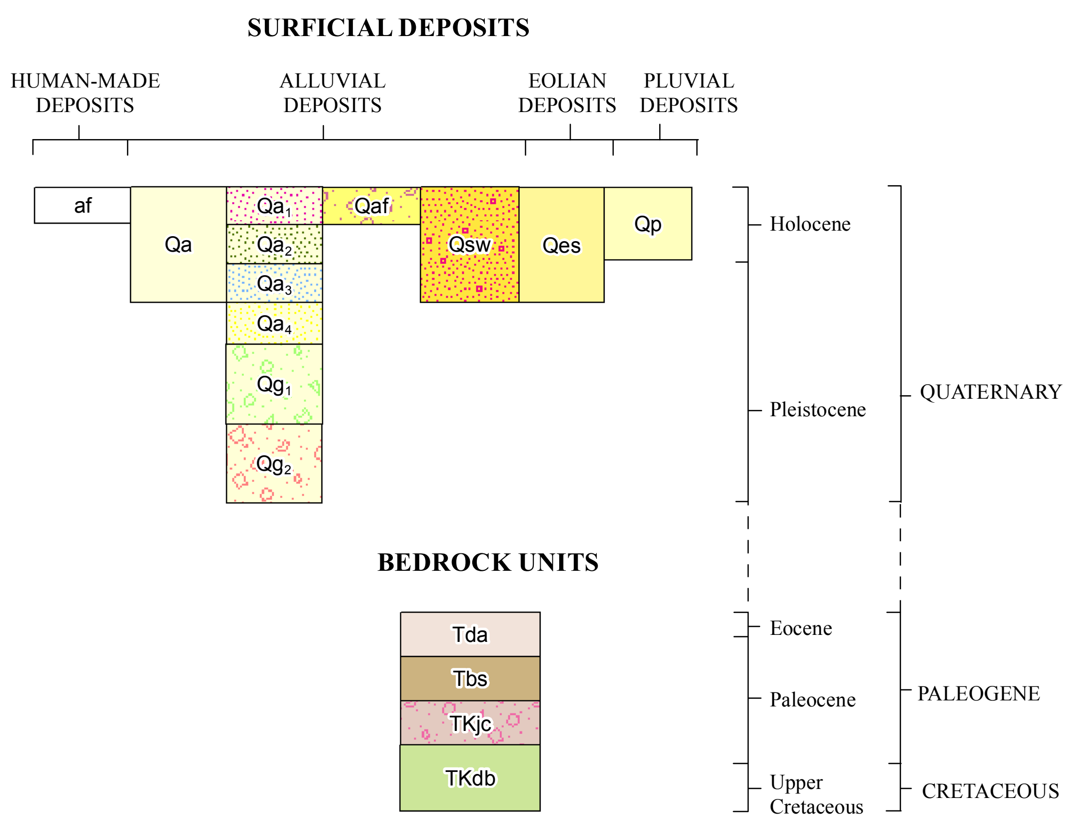
FALCON QUADRANGLE GEOLOGIC MAP, EL PASO COUNTY, COLORADO

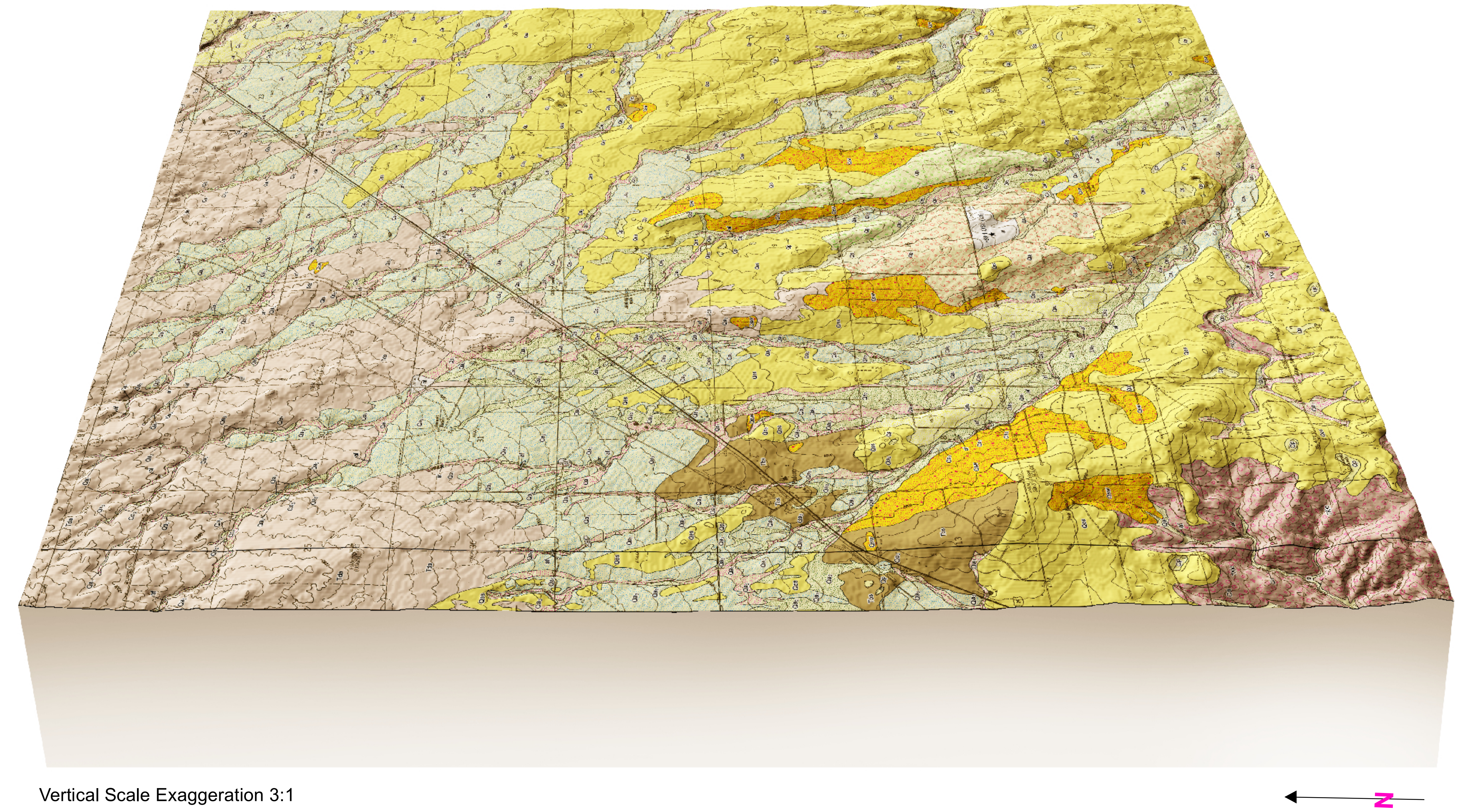
By Matthew L. Morgan and Jonathan L. White
2012

John W. Hickenlooper, Governor
State of Colorado
Mike King, Executive Director
Department of Natural Resources
Vincent Matthews
State Geologist and Director
Colorado Geological Survey

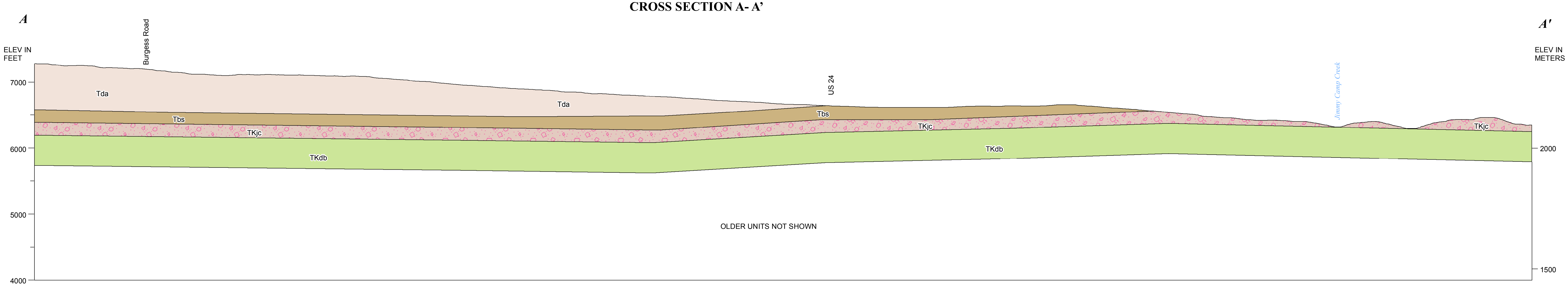
CORRELATION OF MAP UNITS



3-D OBLIQUE VIEW



CROSS SECTION A- A'



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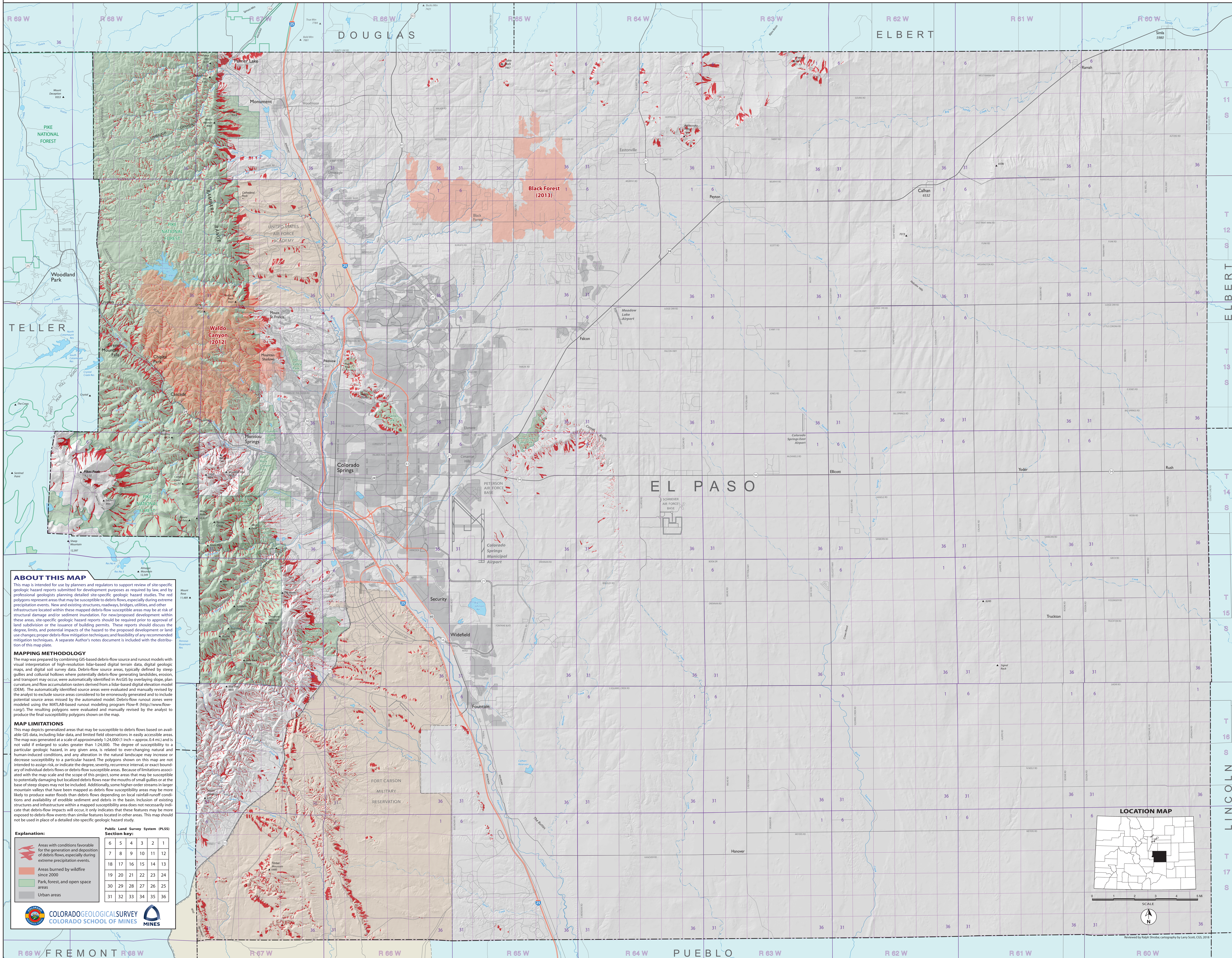
APPENDIX C
Site Hazard Maps

DEBRIS FLOW SUSCEPTIBILITY MAP OF EL PASO COUNTY, COLORADO

Kevin M. McCoy, Matthew L. Morgan, and Karen A. Berry
Colorado Geological Survey, 2018

Open-file Report 18-11



ABOUT THIS MAP

This map is intended for use by planners and regulators to support review of site-specific geologic hazard reports submitted for development purposes as required by law, and by professional geologists planning detailed site-specific geologic hazard studies. The red polygons represent areas that may be susceptible to debris flows, especially during extreme precipitation events. New and existing structures, roadways, bridges, utilities, and other infrastructure located within these mapped debris-flow susceptible areas may be at risk of structural damage and/or sediment inundation. For new/proposed development within these areas, site-specific geologic hazard reports should be required prior to approval of land subdivision or the issuance of building permits. These reports should discuss the degree, limits, and potential impacts of the hazard to the proposed development or land use changes; proper debris-flow mitigation techniques; and feasibility of any recommended mitigation techniques. A separate Author's notes document is included with the distribution of this map plate.

MAPPING METHODOLOGY

The map was prepared by combining GIS-based debris-flow source and runout models with visual interpretation of high-resolution lidar-based digital terrain data, digital geologic maps, and digital soil survey data. Debris-flow source areas, typically defined by steep gullies and colluvial hollows where potentially debris-flow generating landslides, erosion, and transport may occur, were automatically identified in ArcGIS by overlaying slope, plan curvature, and flow accumulation rasters derived from a lidar-based digital elevation model (DEM). The automatically identified source areas were evaluated and manually revised by the analyst to exclude source areas considered to be erroneously generated and to include potential source areas missed by the automated model. Debris-flow runout zones were modeled using the MATLAB-based runout modeling program Flow-R (http://www.flow-r.org/). The resulting polygons were evaluated and manually revised by the analyst to produce the final susceptibility polygons shown on the map.

MAP LIMITATIONS

This map depicts generalized areas that may be susceptible to debris flows based on available GIS data, including lidar data, and limited field observations in easily accessible areas. The map was generated at a scale of approximately 1:24,000 (1 inch = approx. 0.4 mi.) and is not valid if enlarged to scales greater than 1:24,000. The degree of susceptibility to a particular geologic hazard, in any given area, is related to ever-changing natural and human-induced conditions, and any alteration in the natural landscape may increase or decrease susceptibility to a particular hazard. The polygons shown on this map are not intended to assign risk, or indicate the degree, severity, recurrence interval, or exact boundary of individual debris flows or debris-flow susceptible areas. Because of limitations associated with the map scale and the scope of this project, some areas that may be susceptible to potentially damaging but localized debris flows near the mouths of small gullies or at the base of steep slopes may not be included. Additionally, some higher-order streams in larger mountain valleys that have been mapped as debris flow susceptibility areas may be more likely to produce water floods than debris flows depending on local rainfall-runoff conditions and availability of erodible sediment and debris in the basin. Inclusion of existing structures and infrastructure within a mapped susceptibility area does not necessarily indicate that debris-flow impacts will occur, it only indicates that these features may be more exposed to debris-flow events than similar features located in other areas. This map should not be used in place of a detailed site-specific geologic hazard study.

Explanation:

- Areas with conditions favorable for the generation and deposition of debris flows, especially during extreme precipitation events.
- Areas burned by wildfire since 2000
- Park, forest, and open space areas
- Urban areas

Public Land Survey System (PLSS) Section key:

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

COLORADO GEOLOGICAL SURVEY
COLORADO SCHOOL OF MINES
MINES

Reviewed by Ralph Shroba; cartography by Larry Scott, CGS, 2018

COLORADO - EPA Map of Radon Zones

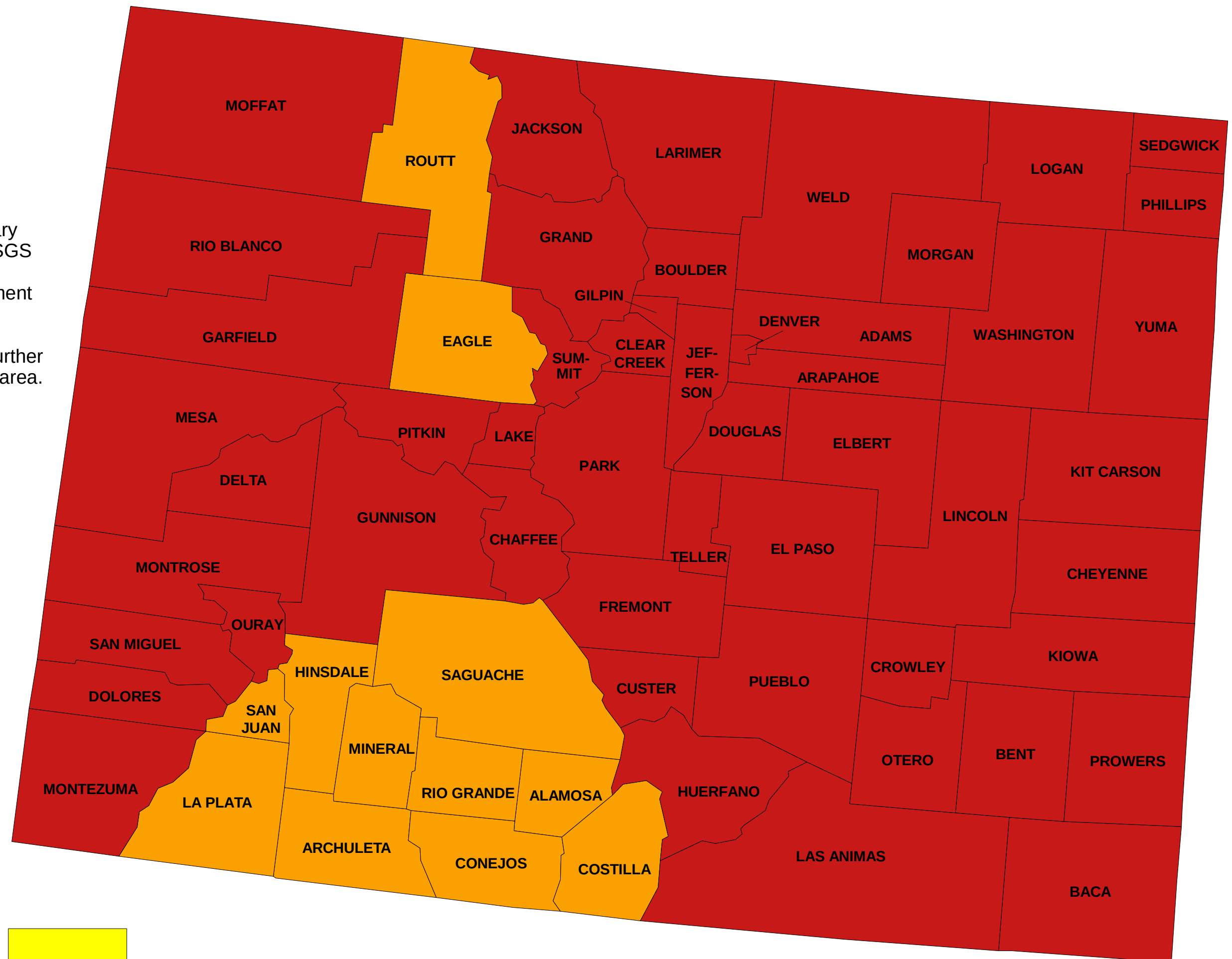
http://www.epa.gov/radon/zonemap.html

The purpose of this map is to assist National, State and local organizations to target their resources and to implement radon-resistant building codes.

This map is not intended to determine if a home in a given zone should be tested for radon. Homes with elevated levels of radon have been found in all three zones.

All homes should be tested, regardless of zone designation.

IMPORTANT: Consult the publication entitled "Preliminary Geologic Radon Potential Assessment of Colorado" (USGS Open-file Report 93-292-H) before using this map. http://energy.cr.usgs.gov/radon/grpinfo.html This document contains information on radon potential variations within counties. EPA also recommends that this map be supplemented with any available local data in order to further understand and predict the radon potential of a specific area.



Zone 1 | Zone 2 | Zone 3