Paleontological Survey Report

Crossroads Pump Station

Prepared for

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1.0 INTRODUCTION

In accordance with BLM guidelines and policies, a reconnaissance paleontological field survey was required by Rock Springs Field Office (RSFO) for an ~2.8 miles water pipeline, pumpstation and staging area running north-south and adjacent to the west side of Rock Springs Wy. (Project). The Project in sections 29 and 32, T. 19 N., R. 105 W., and Sections 5 and 6, T. 18 N., R. 105 W. (Maps 1 and 2 in Appendix A) on both BLM-managed federal lands and private property. The Survey was conducted by the Primary Investigator (PI) with Stratigraphic rex LLC*.* The Survey was contracted with Sunrise Engineering for the City of Rock Springs and the Green River-Rock Springs Joint Powers Water Board. See Table 1.

2.0 DEFINITION AND SIGNIFICANCE OF PALEONTOLOGICAL RESOURCES

Paleontological Resources are described by the Paleontological Resources Preservation Act (PRPA) of 2009. Section 6301 defines a paleontological resource as any fossilized remains, traces, or imprints of organisms, preserved in or on the Earth's crust, which are of paleontological interest and provide information about the history of life on Earth.

The study of life in past geologic time, paleontology, is based on fossil plants and animals and includes studies in, phylogeny, paleoecology, morphology, chronology, etc. (Bates and Jackson, 1976). This multidiscipline approach requires studies in geology and other science and mathematical fields. Fossils are evidence of past life and come in many forms of preservation including permineralization, replacement, pyritization, recrystallization, molds and casts, impressions, and mummifications (Martin, 2013).

According to the Society of Vertebrate Paleontology, the leading group of vertebrate paleontologists (SVP, 2013):

> *Fossil vertebrates are usually unique or rare, nonrenewable resources that constitute part of our natural heritage. They provide data by which the history of vertebrate life on Earth may be reconstructed and are one of the primary means of studying evolutionary patterns and processes as well as environmental change.*
>
> *Many kinds of fossils, including those of most vertebrates, are rare for several reasons. Far less than 1% of the organisms that have ever lived become fossils. Many organisms are not readily preserved as fossils because they do not have hard parts. Only rather unusual sedimentary environments preserve soft parts long enough to become fossilized. The remains of small organisms are more readily destroyed by mechanical and biological processes than the remains of large organisms.*
>
> *Also, organisms can only be preserved where sediments accumulate at a fairly high rate. Most organic remains are not buried fast enough to contribute to the fossil record. In addition,*

vertebrate fossils are generally less common than invertebrate fossils because there have been fewer living vertebrates than invertebrates over geologic time. Although we are fortunate to have some exceptions to these generalizations, spectacular deposits of diverse and complete organisms are rare over the history of the earth. All of this means that the chances of any vertebrate becoming a fossil are very small. Thus, vertebrate fossils are extremely valuable as bearers of information about the past. Furthermore, fossils of extinct groups are not renewable. More fossils will be discovered and collected, but always from a finite supply.

The rocks in which the fossils are found provide information about the environment of preservation and its climate, position in a historical sequence, and paleogeographic location. Fossil assemblages provide information about ecological interactions and communities.

A fossil collected without this information has lost much of its value, and we know little more than that this animal lived and died. In contrast, when contextual data are collected and studied, we begin to understand how the animal lived. As paleontologists and geologists learn more ways to interpret ancient environments and ecological communities from fossil assemblages in their original context, this information becomes more and more valuable and important.

The understanding of evolutionary processes and relationships comes primarily from comparing the skeletons from different animals to each other. In order to do this; researchers must be able to compare new specimens with those previously unearthed. Only when specimens are properly collected and curated in public institutions can researchers access these specimens in order to make these comparisons. And when these comparisons and interpretations are made, education and the general public greatly benefit by having access to this new interpretive knowledge.

3.0 METHODS

3.1 BLM Standards

The surveys were conducted at the request of the BLM RSFO, in accordance with BLM policies and guidelines established by the Federal Land Management and Policy Act of 1976, the Paleontological Resources Preservation of the Omnibus Public Lands Act of 2009 (OPLA-PRP), Paleontological Resources Preservation Act (PRPA) of 2009 Section 6304, and the BLM's Instructional Memorandum (IM) 2009-011. The IM 2009-011 provides the general procedures and guidelines for the management of paleontological resources. These acts recognize the importance of fossils as part of our heritage and protect these resources for the benefit of all. In addition, the OPLA-PRP and PRPA defines the term paleontological resources, outlines the minimum requirements for paleontological resource-use permits, outlines criminal and civil penalties for illegal sale, transport, theft, and vandalism of fossils from federal lands as well as defines uniform requirements for curation of federal fossils in approved repositories. In addition, the work supports the recommendations set forth by the document, *Best Practices in Mitigation Paleontology* by Murphey, et al. (2019).

According to the BLM's IM 2009-011 document:

> A significant paleontological resource is defined as: *Any paleontological resource that is considered to be of scientific interest, including most vertebrate fossil remains and traces, and certain rare or unusual invertebrate and plant fossils. A significant paleontological resource is considered to be scientifically important because it is a rare or previously unknown species, it is of high quality and well preserved, it preserves a previously unknown anatomical or other characteristic, provides new information about the history of life on earth, or has identified educational or recreational value. Paleontological resources that may be considered to not have paleontological significance include those that lack provenience or context, lack physical integrity because of decay or natural erosion, or that are overly redundant or are otherwise not useful for research. Vertebrate fossils remains and traces include bone, scales, scutes, skin impressions, burrows, tracks, tail drag marks, vertebrate coprolites (feces), gastroliths (stomach stones), or other physical evidence of past vertebrate life activities.*

Paleontological Resources Preservation Act (PRPA) 6304 states:

> *Section 6304 states that a paleontological resource may not be collected from Federal land without a permit (except for the casual collecting exemption), and directs the bureaus to implement a paleontology permit system.*
>
> - *An applicant must be qualified to carry out the permitted activity.*
> - *Activity must be undertaken for the purpose of furthering paleontological knowledge or for public education.*
> - *Paleontological resources collected from Federal land must remain the property of the United States.*

3.2 Records and Literature Search Methods

Literature searches are conducted using GeoRef database, established by the American Geosciences Institute in 1966. This database provides access to the geoscience literature of the world. "GeoRef is the most comprehensive database in the geosciences and continues to grow by more than 100,000 references a year. The database contains over 3.4 million references to geoscience journal articles, books, maps, conference papers, reports, and theses." This search is used to determine if any previously recorded fossil localities exist in the study area as well as the fossil richness of the formations and rock units involved. In addition to a literature search, paleontological records easily accessible, such as GIS-based locality data, aerial photos, soils maps, and other known paleontological locality information may be consulted.

3.3 Resource Assessment Methods

The assessment of the potential fossil resources is determined first by identifying the bedrock and surficial geological units. These units are then compared to the Potential Fossil Yield Classification System (PFYC) ranking by the Paleontology Resource Lead (BLM, 2016, and Breithaupt, 2020). These rankings are based on the taxonomic diversity and abundance of previously recorded, scientifically significant fossil occurrences from each geologic unit, and the potential for future discoveries.

3.4 Field Survey Methods

Field Surveys are pedestrian surveys to be performed in areas where significant fossils can be expected to occur within the boundary and immediate vicinity of the anticipated disturbance, or where the probability of encountering significant fossils is unknown. The survey will be performed prior to any surface disturbing activities. The purpose of the survey is to identify, avoid, or recover paleontological resources to prevent damage or destruction from project activities. During the field survey, the paleontologist surveys, locates, and documents all paleontological resources within one hundred feet of the proposed project location or corridor unless the buffer intersects private land. Significant fossils that may be damaged or destroyed during project activities will be collected, along with all relevant contextual and locational data.

In accordance with the above requirements, the surveyor will provide a reconnaissance survey to determine the exposure of potentially fossiliferous rock, areas in which fossiliferous rock would be impacted by construction activities, and location of any fossil material. Areas with exposures of paleontologically sensitive geological units receives a 100% pedestrian survey where it was safe to navigate. Areas covered by thick soil, vegetation, alluvium and/or colluvium may be visually inspected from a distance. Field locations will be collected using a Garmin GPSMAP 64. Mapping software include AllTopo, ArcGIS Online, and Google Earth Maps.

When a fossil site is located, GPS data will be collected along with photographs and field notes. Float material may be collected if significant or recognizable and placed in a sample bag. Fragile material will be wrapped in tissue or placed in a small container for protection. These containers will be labeled with the locality field numbers, date, formation, etc. Large and/or in-situ material will be collected and wrapped with padding. A locality form (BLM - Form 827-3 (Temporary) May 1994) will be generated for all fossil sites regardless of whether they are collected or left in the field. The BLM Consulting permit held by the PI does not allow for collections that disturb an area larger than 1 square meter of in-situ fossil material. Therefore, any large in-situ fossil remains will be identified and reported but not collected during the survey. All fossil material, copies of notes, and locality forms will be turned over to the Tate Geological Museum for curation.

3.5 Distribution of Data

Copies of this report will be submitted to Continental Resources Incorporated, to the RSFO, and the Repository (Tate Geological Museum) along with relevant field notes, maps and other data. A copy will also be retained by Stratigraphic rex LLC. In order to protect fossil localities, detailed locality data (in an attached Appendix) will be limited to authorized parties.

Table 1 - Project Summary

Project Names	Crossroads Pump Station	
Project Description	~2.8 miles water pipeline, pumpstation and staging area	
Managing Land Agency	BLM, Rock Springs Field Office	
Location (PLS)	Sections 29 and 32, T. 19 N., R. 105 W., and Sections 5 and 6, T. 18 N., R. 105 W.	
Topographic Map(s)	USGS 1:24,000 Kanda, WY 1961	
Geologic Map	Love and Christianson, 1985	
Geologic Formation(s)	Wasatch Formation	
Principal Investigator	Melissa Connely	BLM permit # PA02-WY-090
Surveyor(s)	Melissa Connely	
Area Surveyed	~2.8 miles of linear pathway with buffer zone.	
Topography	Gentle slope with minor gullies	
Bedrock Exposure Status	Poorly exposed bedrock with a few resistant sandstone beds and alluvium sediments.	
Nearest Previously Documented Fossil Locality	Significant Wasatch fossils localities exist near Fossil Butte National Monument. Ex: Eoictops noveceki, Sec. 5, T. 21 N., R. 117 W. (Gunnell et al., 2016)	
Fossil Localities Discovered During Survey	Small samples of Elimia Agate (Aka, "Turritella Agate") and a single bivalve	

4.0 RESULTS

4.1 Geological Setting

Based on published geological maps, the Project area includes sediments associated with the Wasatch Formation (Eocene) and alluvium/colluvium deposits (Love and Christianson, 1985, and Watson, 1980). The formation is described as:

- Soft nonresistant shale and light grey to buff colored siltstone and sandstone. Thin coal beds and carbonate rich paper-shales were also present. The upper contact of the Wasatch Formation is unconformable with the Green River Formation and the lower contact is unconformable to the Paleocene Fort Union Formation.
- Quaternary sediments of unconsolidated silt, sands and gravels were present in the streams and gullies and in heavy soil horizons.

The Wasatch has a PFYC listing of a 5 suggesting it is of high potential. This is described as:

> *Class 5 – Very High. Highly fossiliferous geologic units that consistently and predictably produce significant paleontological resources. Units assigned to Class 5 have some or all of the following characteristics:*
>
> - *Significant paleontological resources have been documented and occur consistently.*
> - *Paleontological resources are highly susceptible to adverse impacts from surface disturbing activities.*
> - *Unit is frequently the focus of illegal collecting activities.*
> - *Management concerns for paleontological resources in Class 5 areas are high to very high.*
> - *A field survey by a qualified paleontologist is almost always needed. Paleontological mitigation may be necessary before or during surface disturbing activities.*
>
> *The probability for impacting significant paleontological resources is high. The area should be assessed prior to land tenure adjustments. Pre-work surveys are usually needed and on-site monitoring may be necessary during land use activities. Avoidance or resource preservation through controlled access, designation of areas of avoidance, or special management designations should be considered.*

4.2 Literature Search Results

The Wasatch Formation in the Project area has a PFYC of 5 and is known for its Eocene fauna and flora. There is a significant amount of published works on this formation. The majority of previously collected material from the Wasatch Formation came from the western half of the state including the Green River and Big Horn basins (Gunnell, et al., 2016). Although not as frequent, historic quarries are known from the Powder River Basin.

The Wasatch Formation is the defining formation for the Wasatchian, ranging from 55.8 to 50.3 Ma, within the North American land mammal ages, (NALMA) classification. The Wasatchian followed the Clarkforkian stage (56.8-55.8 Ma) is defined by the simultaneous first appearance of adapid and omomyid euprimates, hyaenodontid creodonts, perissodactyls and artiodactyls. The deposits of the formation were laid down during a period of globally high temperatures during the Paleocene-Eocene Thermal Maximum (PETM). Deposits include a combination of mudstone, siltstone, sandstone, conglomerate, cyanobacterial limestone, bioclastic limestone, evaporite, oil shale, and paleosol units (Zeller and Stephens, 1969).

Fieldwork conducted by Gunnell, et al., (2002) in the Wasatch Formation around the Fossil Butte area has generated a diverse assemblage of early Eocene vertebrates distributed through three discrete stratigraphic intervals within the uppermost 180 m of the main body of the Wasatch Formation. These assemblages originated from variable paleosols, fluvial overbank mudstone and channel sandstones. This study revealed at least 46 species of mammals.

In the Green River Basin, the Wasatch Formation contains many mammal, reptile, and bird fossils and is one of 10 of the richest assemblages of any other Eocene rocks in the world (Roehler, 1991 and Bartels et al., 2011). The most common fossils found in the northern Green River Basin are turtle carapace and plastron fragments, but rare mammal fossils are important in the area (Bartels et al., 2011). Trace fossils are also present and have contributed to the understanding of the Wasatch ecosystem, (Zonneveld, et al. 2006). Studies were also done north of the Project area near the Pennacles (Neumann et al., 2018) and near South Pass, WY (McHugh, 2012).

Outside of the Green River Basin, studies were done as far as in the Powder River Basin to determine body size changes in mammals during the height of the Paleocene-Eocene Thermal Maximum by Wagner et al, 2012. Fricke, 2003, reported the use of *Coryphodon* teeth found in the Powder River Basin for oxygen isotope studies. These studies are important in determining evolutionary and ecological changes caused by global warming events. Similar studies in the flora were also made by Wing, et al, (2003), Pocknall, (1987), and Tschudy, (1976). In addition, studies on non-marine mollusks by Hartman (1993) and Jackson, (1975), were made. The Wasatch in the Powder River Basin is also home to the holotype and paratype of a Glyptosaurine lizard, *Melanosaurus maximus* (Conrad and Norell, 2008).

4.3 Records Search Results

Historical references to this area were done by consulting the University of Wyoming (UW) and the Tate Geological Museum (TM), both of which are federal repositories for Wyoming. At the time of this report, a response from the University of Wyoming has not been received. Minedat.org listed several fossil localities east of Rock Springs. Wilf, (2000a and 2000b), did a Palaeobotanical analysis in the area and documented at least 11 species of plants from the Ramsey Ranch near Wamsutter, WY. There were no reports of historical fossil localities in the Project areas.

4.4 Survey Results

The Project area was surveyed on June 30th and 31st, 2023, by the PI with Stratigraphic rex LLC. This was a pedestrian survey where outcrops were inspected for fossil remains. The Project area was partially covered by vegetation of short grasses and greasewood (Figure 1 and 2). In addition, part of the area was covered with alluvium with evidence of debris flow like deposits (Figure 3). Within the Project area, few outcrops existed (Figures 4 and 5). These outcrops showed that the subsurface includes soft mudstone beds, carb rich shales, and thin lenses of sandstone. No vertebrate fossil remains were found during the survey. The only fossil material recognized were float blocks of 'turritella agate' (Figure 6) and a bivalve. Most were small pieces and likely washed in from the overlying Green River Formation.

4.5 Significance of findings

The survey of the Project area did not produce vertebrate remains of any kind. Only a few mollusks and a hint of plant material (carb rich shale) were present. Plant fossils include pollen can be useful in understanding the climatic conditions and changes during the Paleocene/Eocene Periods. In addition, flora studies help recreate paleoecology of an area and helps researchers better understand the life and habitat of extinct species. Vertebrate remains are useful in understanding environmental impacts and evolutionary responses to climatic changes in addition to ecological studies of past ecosystems. Therefore, fossil remains in the area should be considered significant.

Figure 1 - View of Project area looking north. Notice greasewood and other vegetation.

Figure 2 – Image of the Project's central area. Image looking south.

Figure 3 – Outcrop of alluvial deposit.

Figure 4 – Sandstone lens in Project area.

Figure 5 – Paleosol outcrop in Project area.

Figure 6 – Mollusk fossils ('Turritella agate') and bivalve found in project area. Presumably washed down from the overlying Green River Formation.

5.0 RECOMMENDATIONS

The Wasatch Formation produces significant fossil resources. Most well-known specimens come from the western part of the state in the Green River and adjacent basins. Therefore, any fossil remains has the potential to be equally significant and may provide new insights into the early Eocene ecosystem. Based on this survey, it is recommended that the project continue. This is based on these key points.

1. No vertebrate fossil remains were discovered during the survey and in nearby outcrops. Only mollusks, thought to be float material from overlying sediments, were discovered during the survey.

2. The surface is covered with vegetation and a soil horizon so surface impact should have little effect on subsurface material.
3. Some minor disturbances have been made in the past.

However, when the surface is heavily covered with vegetation, it is difficult to assess subsurface lithology. In addition, quaternary fossils may be present in hidden channel fills that could not be detected. Therefore, it is further recommended that a trench inspection be done during construction, and the project operator should be mindful of the fossil potential. Below are the BLM paleontological resources protection stipulations for H – 3809-1 – Surface Management:

> *5.3.8.3 Resources Discovered After Operations Begin*
> *If, after the commencement of surface-disturbing activities, the BLM or the operator discover resources that were not noted in the earlier surveys, the operator must immediately cease surface disturbing activities near the find and notify the BLM District/Field Manager of any potential cultural and/or paleontological resources on Federal lands that might be altered or destroyed by continued operations. The operator must leave such discovery intact until receiving written notice to proceed from the District/Field Office. The District/Field Manager will evaluate the discoveries brought to his or her attention, take action to protect or remove the resource, and allow operations to proceed within 10 working days after notification to the District/Field Office of such discovery, unless alternative arrangements are negotiated with the operator. If the resources discovered are objects subject to the Native American Graves Protection and Repatriation Act of 1990 (NAGPRA), then operations can be suspended for 30 days.*

Table 2 – Project Recommendations

Project Recommendation Summary	• Paleontological clearance recommended for the proposed Project area. • Trench inspection should take place prior to backfilling. • Operators should be made aware of the fossil potential and follow BLM guidelines if a discovery is made.

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Appendix A – Maps of the Project Area Showing Land Ownership (Map 1 created by Sunrise Engineering) and Geology (Map 2).

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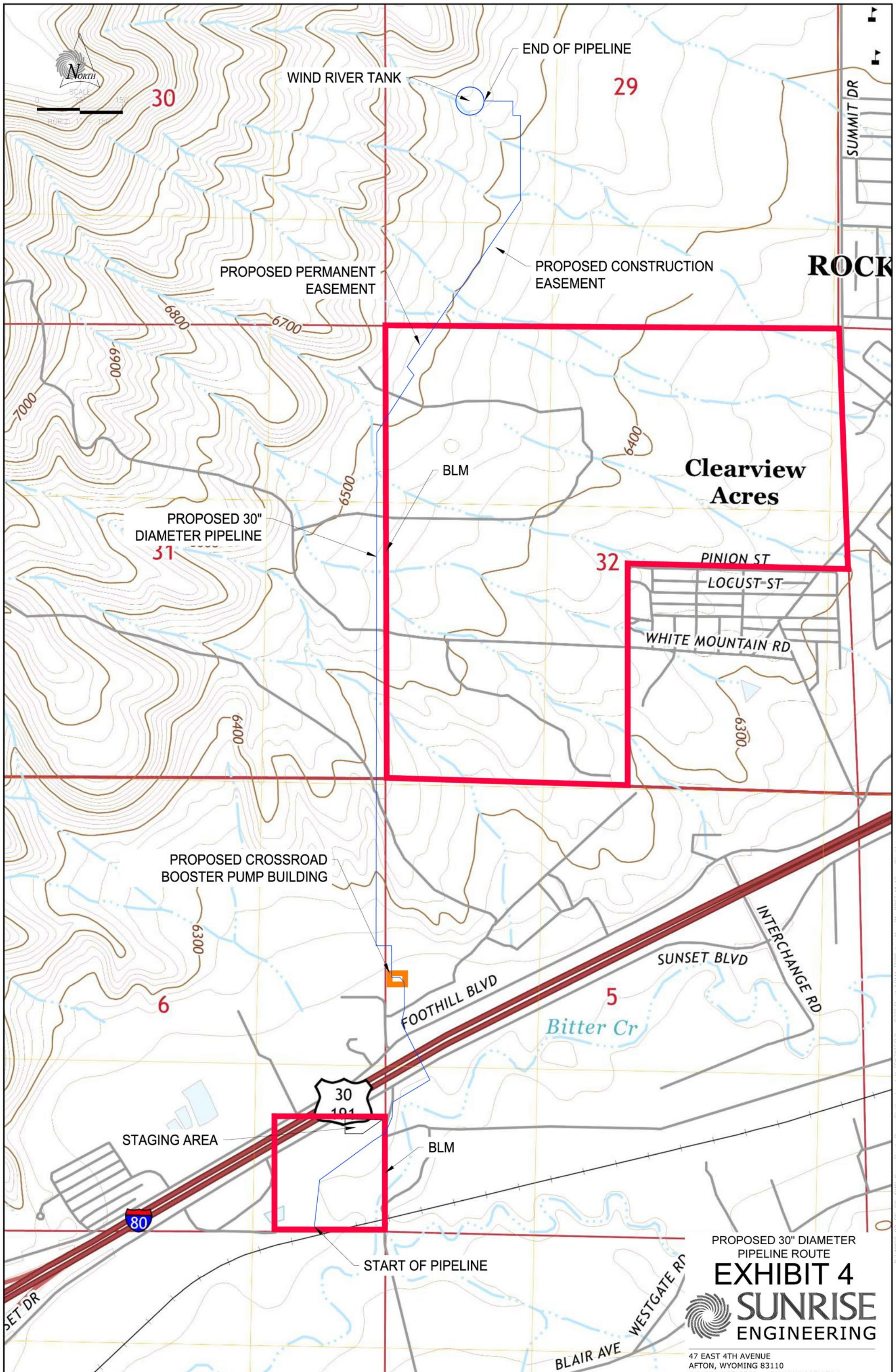
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WIND RIVER TANK
30
29
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6900
7000
6400
Clearview Acres
BLM
6500
PROPOSED 30" DIAMETER PIPELINE
31
32
PINION ST
LOCUST ST
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6400
6300
PROPOSED CROSSROAD BOOSTER PUMP BUILDING
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INTERCHANGE RD
SUNSET BLVD
FOOTHILL BLVD
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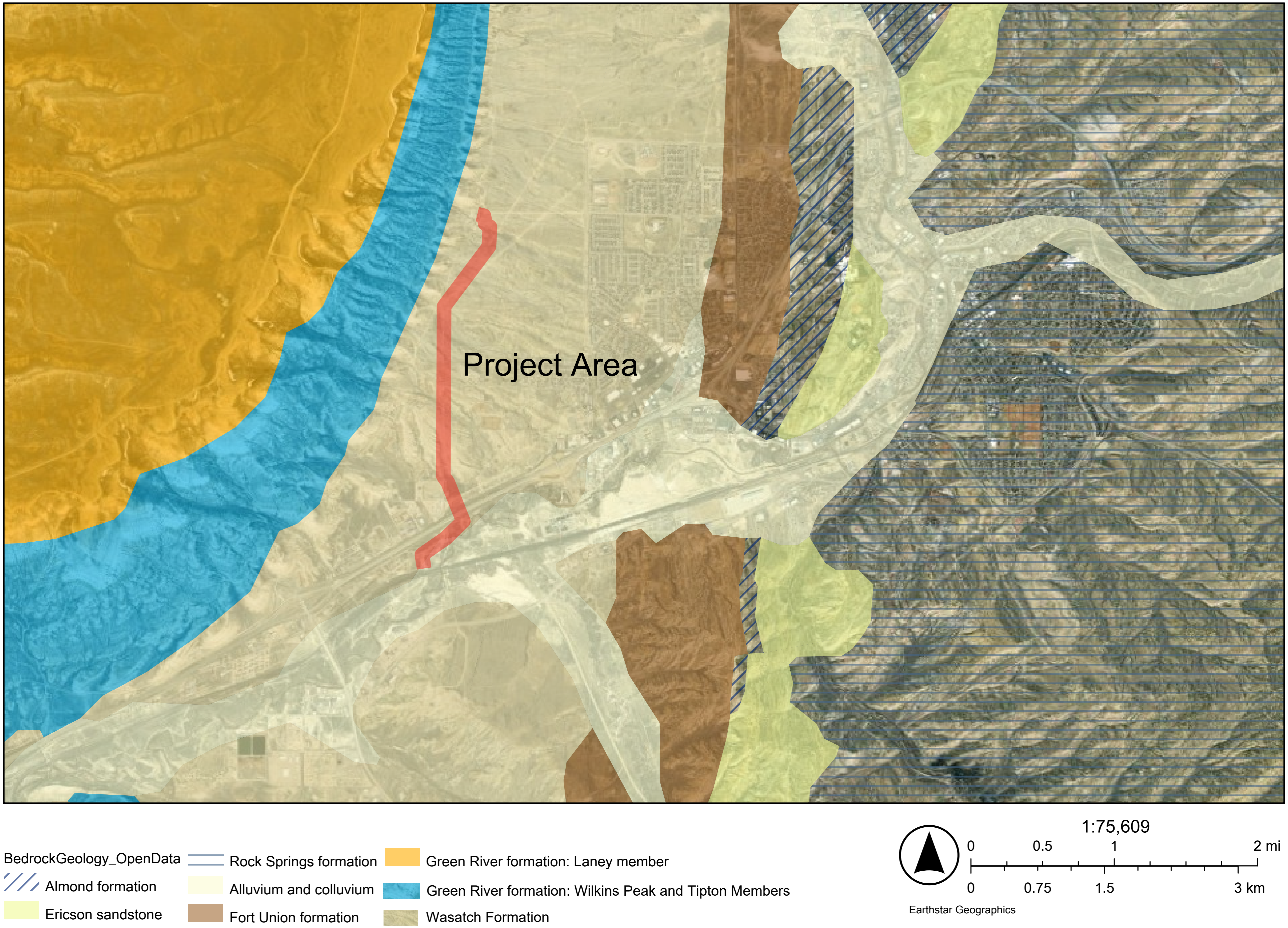
STAGING AREA
BLM
80
START OF PIPELINE
BLAIR AVE
WESTGATE RD
PROPOSED 30" DIAMETER PIPELINE ROUTE
EXHIBIT 4
SUNRISE ENGINEERING
47 EAST 4TH AVENUE
AFTON, WYOMING 83110
TEL 307.885.8500 · FAX 307.885.8501
www.sunrise-eng.com

Crossroads Pump Station - Geology



Appendix B – Fossil Locality Form. (only provided to BLM copy)

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Form 8270-3 (Temporary)
(May 1994)

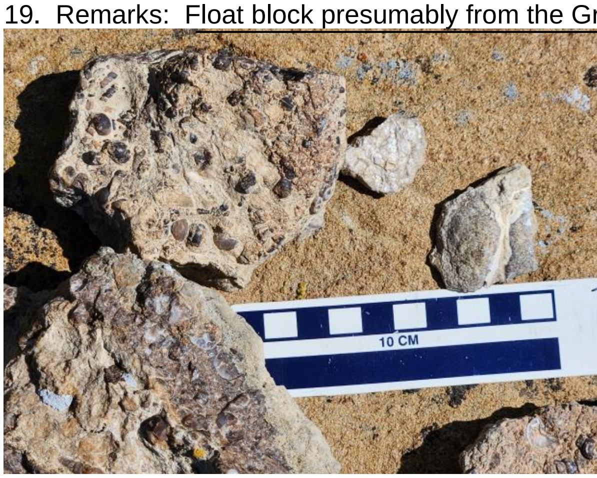
United States
Department of the Interior
Bureau of Land Management

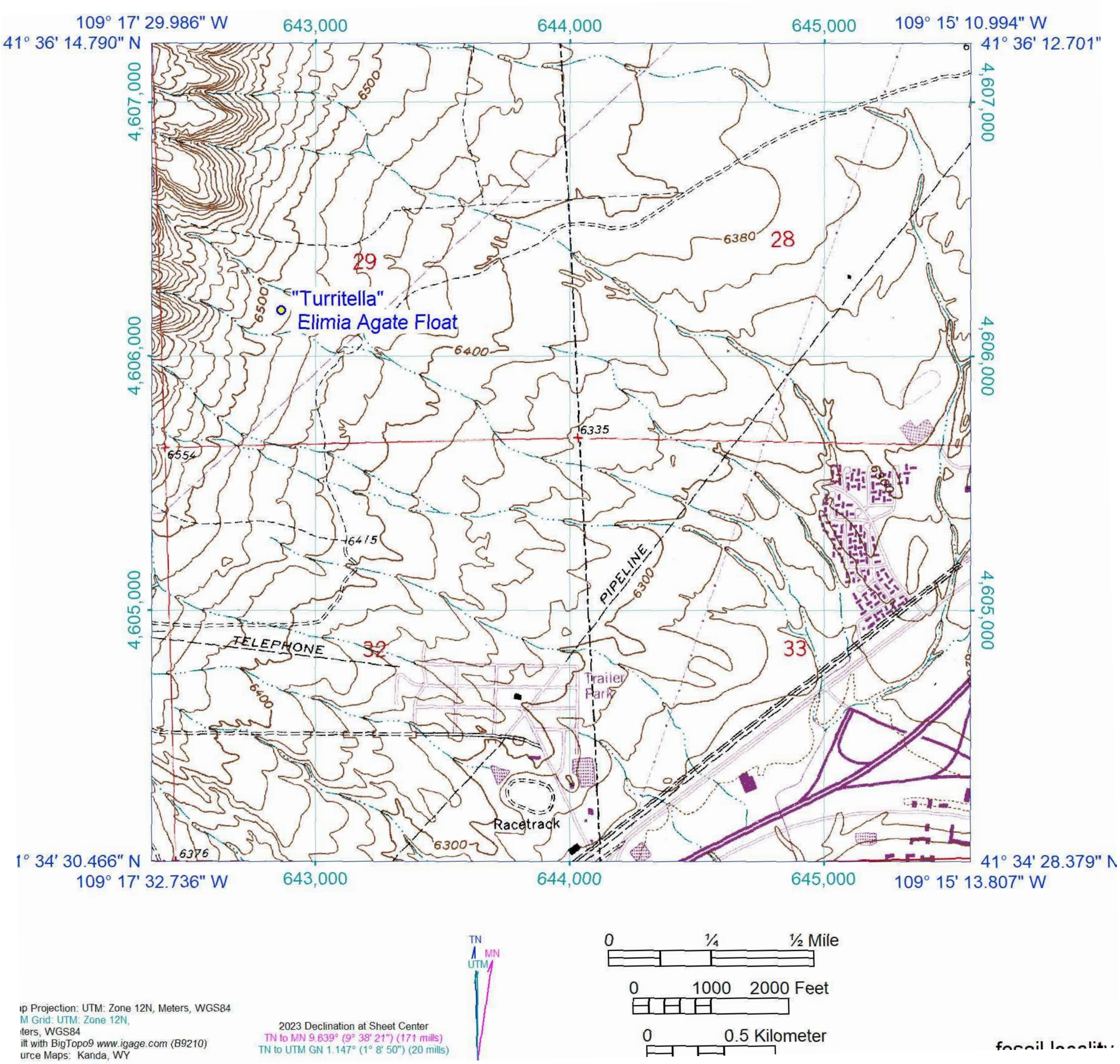
Paleontological Locality Form

1. Permit #/Permittee: PA02-WY-090 Melissa Connely
2. Repository/Accn.#: Tate Geological Museum
3. Locality #: 063123-01 ☐ Plant ☐ Vertebrate ☒ Invertebrate ☐ Other
4. Formation (and subdivision, if known): Green River Formation?
5. Age: Eocene 6. County: Sweetwater
7. BLM Field Office: Rock Springs Field Office
9. Map name: Kanda 10. Map source: USGS
11. Map size: 1:24,000 12. Map edition: 1961
13. Latitude (deg., min., sec., direction): 41 35' 39.9"
14. Longitude (deg., min., sec., direction): 109 17' 9.2"

and UTM Grid: Zone 12 642868.9 m E 4606181.25 m N WGS84

15. Survey (Twp, Rge, Sec, subdiv): Sections 29 T. 19 N., R. 105 W.
16. Taxa Collected/observed: Elimia Agate (Turritella) and unknown bivalve
17. Collector: Not collected 18. Date: 063123
19. Remarks: Float block presumably from the Green River formation




109° 17' 29.986" W
643,000
644,000
645,000
109° 15' 10.994" W
41° 36' 14.790" N
41° 36' 12.701"
4,607,000
4,606,000
4,605,000
"Turritella"
Elimia Agate Float
29
28
32
33
6500
6380
6400
6335
6554
6415
PIPELINE
6300
TELEPHONE
Trailer Park
Racetrack
6376
41° 34' 30.466" N
109° 17' 32.736" W
41° 34' 28.379" N
109° 15' 13.807" W
TN
MN
UTM
0
¼
½ Mile
1000
2000 Feet
0.5 Kilometer
p Projection: UTM: Zone 12N, Meters, WGS84
M Grid: UTM: Zone 12N,
ters, WGS84
ilt with BigTopo9 www.igage.com (B9210)
urce Maps: Kanda, WY
2023 Declination at Sheet Center
TN to MN 9.639° (9° 38' 21") (171 mills)
TN to UTM GN 1.147° (1° 8' 50") (20 mills)