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Table 5.16-1 Summary of LORS – Paleontological Resources

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5.16 PALEONTOLOGICAL RESOURCES

Hydrogen Energy International LLC (HEI or Applicant) is jointly owned by BP Alternative Energy North America Inc. and Rio Tinto Hydrogen Energy LLC. HEI is proposing to build an Integrated Gasification Combined-Cycle power generating facility called Hydrogen Energy California (HECA or the "Project") in Kern County, California. The Project will produce low-carbon baseload electricity by capturing carbon dioxide (CO_2) and transporting it for CO_2 enhanced oil recovery (EOR) and sequestration (storage)[1].

The 473-acre Project Site is located approximately 7 miles west of the outermost edge of the city of Bakersfield and 1.5 miles northwest of the unincorporated community of Tupman in western Kern County, California, as shown in Figure 2-1, Project Vicinity. The Project Site is near a hydrocarbon-producing area known as the Elk Hills Field. The entire Project Site is currently used for agricultural purposes. Existing surface elevations vary from about 282 feet to 291 feet above mean sea level.

The Project will gasify petroleum coke (petcoke) (or blends of petcoke and coal, as needed) to produce hydrogen to fuel a combustion turbine operating in combined-cycle mode. The Gasification Block feeds a 390-gross-megawatt (MW) combined cycle plant. The net electrical generation output from the Project will provide California with approximately 250 MW of low-carbon baseload power to the grid. The Gasification Block will also capture approximately 90 percent of the carbon from the raw syngas at steady-state operation, which will be transported to the Elk Hills Field for CO_2 EOR and Sequestration. In addition, approximately 100 MW of natural-gas–generated peaking power will be available from the Project.

The Project Site and linear facilities comprise the affected study area and are entirely located in Kern County, California. These Project components are described below.

Major onsite Project components will include, as shown on Figure 2-5, Preliminary Plot Plan:

- Solids Handling, Gasification, and Gas Treatment
  - Feedstock delivery, handling, and storage
  - Gasification
  - Sour shift/gas cooling
  - Mercury removal
  - Acid gas removal

- Power Generation
  - Combined-cycle power generation
  - Auxiliary combustion turbine generator
  - Electrical switching facilities

[1] This carbon dioxide will be compressed and transported via pipeline to the custody transfer point at the adjacent Elk Hills Field, where it will be injected. The CO_2 EOR process involves the injection and reinjection of carbon dioxide to reduce the viscosity and enhance other properties of the trapped oil, thus allowing it to flow through the reservoir and improve extraction. During the process, the injected carbon dioxide becomes sequestered in a secure geologic formation. This process is referred to herein as CO_2 EOR and Sequestration.

- Supporting Process Systems
  - Natural gas fuel systems
  - Air separation unit
  - Sulfur recovery unit/tail gas treating unit
  - Zero-liquid–discharge units for process and plant waste water streams
  - Carbon dioxide compression
  - Raw water treatment plant
  - Other plant systems

The Project also includes the following offsite facilities, as shown on Figure 2-7, Project Location Map:

- **Electrical Transmission Line –** An electrical transmission line will interconnect the Project to Pacific Gas & Electric's (PG&E) Midway Substation. Two alternative transmission routes are proposed; each alternative is approximately 8 miles in length.

- **Natural Gas Supply –** A natural gas interconnection will be made with PG&E or So Cal Gas natural gas pipelines, each of which are located southeast of the Project Site. The natural gas pipeline will be approximately 8 miles in length.

- **Water Supply Pipelines –** The Project will use brackish groundwater supplied from the Buena Vista Water Storage District (BVWSD) located to the northwest. The raw water supply pipeline will be approximately 15 miles in length. Potable water for drinking and sanitary use will be supplied by West Kern Water District to the southeast. The potable water supply pipeline will be approximately 7 miles in length.

- **Carbon Dioxide Pipeline –** The carbon dioxide pipeline will transfer the carbon dioxide captured during gasification from the Project Site southwest to the custody transfer point. Two alternative carbon dioxide pipeline routes are proposed; each alternative will be approximately 4 miles in length.

The Project components described above are shown on Figure 2-8, Project Location Details, which depicts the region, the vicinity, the Project Site and its immediate surroundings for Project components.

All temporary construction equipment laydown and parking, including construction parking, offices, and construction laydown areas, will be located on the Project Site.

This section of the Application for Certification (AFC) summarizes the potential environmental impacts on paleontological resources that could result from construction of the Project. This paleontological resources inventory and impact assessment was prepared by Lanny H. Fisk, Ph.D., PG, a California-licensed Professional Geologist (PG) and Principal Paleontologist; and by Stephen J. Blakely, Project Manager and Staff Paleontologist, both with PaleoResource Consultants (PRC). It meets all requirements of the California Energy Commission (CEC) regulations (CEC 2007), and the standard measures for mitigating adverse construction-related environmental impacts on significant paleontological resources established by the Society of Vertebrate Paleontology (SVP 1995, 1996).

Paleontological resources (fossils) are the remains or traces of prehistoric animals and plants. Fossils are important scientific and educational resources because of their use in (1) documenting the presence and evolutionary history of particular groups of now extinct organisms; (2) reconstructing the environments in which these organisms lived; (3) determining the relative ages of the strata in which they occur; and (4) determining the geologic events that resulted in the deposition of the sediments in which they were buried.

5.16.1 Affected Environment

5.16.1.1 Geographic Location

The Project Site is located approximately 1 mile north of the border of the Elk Hills Oil Field Unit (Figure 2-5, Project Location Map) and is within Section 10 of Township 30 South, Range 24 East. The center of the Project Site is at approximately latitude 35°19'41" North and longitude 119°23'08" West.

The Project Site will impact most of Section 10 within Township 30 South, Range 24 East on the East Elk Hills U.S. Geological Survey (USGS) 7.5-minute Quadrangle.

The electrical transmission lines (considering two alternatives) are located in the following areas:

- Section 13 within Township 29 South, Range 23 East;
- Sections 18 through 21 and 28 through 33 within Township 29 South, Range 24 East; and
- Sections 3 through 5, and 10 within Township 30 South, Range 24 East.

The natural gas pipeline will be located in the following areas:

- Sections 10, 14, 15, and 23 through 26 within Township 30 South, Range 24 East;
- Sections 30 through 33 within Township 30 South, Range 25 East; and
- Sections 4 and 5 within Township 31 South, Range 25 East.

The process water supply pipeline will be located in the following areas:

- Sections 27 and 34 within Township 28 South, Range 22 East;
- Sections 1, 2, and 12 within Township 29 South, Range 22 East;
- Sections 7, 17, 18, 20, 21, 27, 28, and 34 through 36 within Township 29 South, Range 23 East;
- Section 1 within Township 30 South, Range 23 East; and
- Sections 5, 6, 8 through 10, and 15 within Township 30 South, Range 24 East.

The potable water supply pipeline will be located in the following areas:

- Sections 10, 14, 15, and 23 through 26 within Township 30 South, Range 24 East;
- Sections 30 through 32 within Township 30 South, Range 25 East; and
- Section 5 within Township 31 South, Range 25 East.

The carbon dioxide pipeline (considering four alternatives) will impact Sections 9, 10, 15, 16, 20, 21, and 28 within Township 30 South, Range 24 East.

The Project area is located near the northern edge of the Elk Hills, which are near the western border of the San Joaquin Valley. The San Joaquin Valley comprises roughly the southern two-thirds of the major north-northwest-oriented synclinorium called either the Valle Grande (Clark 1929), Great Valley (Fenneman 1931, Hackel 1966), Great Interior Valley (Harradine 1950), Great San Joaquin Valley (Piper et al. 1939, Davis et al. 1957), or California Trough (Piper et al. 1939). The Great Valley Physiographic Province is located between the Sierra Nevada Physiographic Province on the east and the Coast Ranges Physiographic Province on the west (Jahns 1954). The Elk Hills are approximately 17 miles (~27 kilometers) long and 7 miles (~11 kilometers) wide, and reach an elevation of 1,551 feet (~473 meters), which is approximately 1,200 feet (~366 meters) above the floor of the San Joaquin Valley (Berryman 1973). Access to the Project Site is provided from Tupman Road, Adohr Road, and Dairy Road.

5.16.1.2 Regional Geologic Setting

The general geology of the San Joaquin Valley has been described in some detail by Mendenhall (1908), Mendenhall et al. (1916), Piper et al. (1939), Hoots et al. (1954), Davis et al. (1957, 1959, 1964), Davis and Hall (1959), Hoffman (1964), Croft and Wahrhaftig (1965), Hackel (1966), Croft and Gordon (1968), Bull (1973), Page (1986), Marchand (1977), Bartow and Marchand (1979), Marchand and Allwardt (1981), Lettis (1988), Bartow (1987, 1991), Beyer and Bartow (1988), Callaway and Rennie (1991), and Lettis and Unruh (1991), among others.

Only a few authors have specifically described the geology in the vicinity of the unincorporated community of Tupman or the Elk Hills Oil Field Unit, including Woodring et al. (1932), Porter (1943), Wells (1952), Adkison (1973), Berryman (1973), Dibblee (1973), and Maher et al. (1975). Surficial geologic mapping of the Project vicinity has been provided at a scale of 1:1,000,000 by Wahrhaftig et al. (1993); at a scale of 1:750,000 by Jennings (1977); at a scale of 1:500,000 by Mendenhall et al. (1916), Jenkins (1938), and Bartow (1987, 1991); at a scale of approximately 1:320,000 by Morton and Troxel (1962); at a scale of 1:250,000 by Smith (1964); at a scale of 1:62,500 by Dibblee (1972); at a scale of 1:31,680 by Woodring et al. (1932); and at a scale of 1:24,000 by Dibblee (2005a, 2005b, 2005c, 2005d, 2005e, 2005f).

The information in these geologic maps and published and unpublished reports form the basis of the following discussion. Individual maps and publications are incorporated into this report and referenced where appropriate. For obtaining the older geological literature, the exhaustive compilation entitled "Geological Literature on the San Joaquin Valley of California" by Maher et al. (1973) was particularly helpful. The aspects of geology pertinent to this report are the types, distribution, and age of sediments immediately underlying the Project area and their probability of producing fossils during construction. The site-specific geology in the vicinity of the Project is discussed separately below.

The San Joaquin Valley is a great structural depression between the westerly tilted Sierra Nevada block on the east and the complexly folded and faulted Coast Ranges on the west. The Valley is filled with thick Mesozoic and Tertiary marine and non-marine sediments covered by a relatively thin veneer of Quaternary alluvial sediments (Bailey 1966). The Elk Hills are located along the western edge of the San Joaquin Valley, where they rise above the surrounding relatively flat valley. The Elk Hills are the topographic expression of the Elk Hills Anticline, which is part of the *en echelon* folding of the Tertiary and Quaternary sedimentary strata along the western side of the San Joaquin Valley (White 1987). The axes of these folds trend generally northwest-southeast, and are associated with strain caused by movement along the San Andreas Fault (White 1987).

5.16.1.3 Resource Inventory Methods

To develop a baseline paleontological resource inventory of the Project Site and surrounding geographical and geological area (i.e., within a 1-mile radius of these features), and to assess the potential paleontological productivity of each stratigraphic unit present, the published as well as available unpublished geological and paleontological literature was reviewed. Stratigraphic and paleontologic inventories were compiled, synthesized, and evaluated (see below). These methods are consistent with CEC (2007) and Society of Vertebrate Paleontology (SVP) (1995) guidelines for assessing the importance of paleontological resources in areas of potential environmental effect.

Geologic maps and reports covering the bedrock and surficial geology of the Project vicinity were reviewed to determine the exposed and subsurface rock units, to assess the potential paleontological productivity of each rock unit, and to delineate their respective areal distribution in the Project area. Museum record searches were conducted at the University of California Museum of Paleontology (UCMP) at Berkeley, the Los Angeles County Natural History Museum (LACM), and the San Bernardino County Museum of Natural History (SBMNH) in order to determine whether any of the stratigraphic units found within the Project vicinity had previously yielded significant paleontological resources. In addition, aerial photographs of the area were examined to aid in determining the areal distribution of distinctive sediment and soil types. No subsurface exploration was conducted for this assessment; however, a PRC field paleontologist was present during augering for geotechnical boreholes at a site approximately 1 mile south of the Project Site, and observed subsurface stratigraphy and fossils (see discussion below).

A field survey, which included visual inspection of exposures of potentially fossiliferous strata in the Project area, was conducted to document the presence of sediments suitable for containing fossil remains and the presence of any previously unrecorded fossil sites. The field survey for this assessment was conducted over several site visits from March 2008 through March 2009. Lanny H. Fisk, Ph.D., PG, is the principal paleontologist with PRC and surveyed during March 4 and 12, 2008; and May 14 and 15 and 20 and 21, 2008. Hugh M. Wagner, Ph.D. is a senior paleontologist with PRC and surveyed during March 4-12, 2008 and during April 29, 2008. Mr. Patrick W. Riseley, PG is a field paleontologist with PRC and surveyed March 2 through 7, 9 through 13, 19 through 21, and 31, 2008; April 1 through 4 and 6 and 7, 2008; and May 20 through 22, 2008. David M. Maloney, field supervisor with PRC, surveyed the site March 5 and 6, 2008; May 20 through 22, 2008; and March 17 through 20, 2009. Stephen J. Blakely, staff paleontologist with PRC, surveyed January 22 and 23, 2009, and March 17 through 20, 2009. Levi R. Pratt, field paleontologist with PRC, surveyed January 22 and 23, 2009. John N. Adrian, field paleontologist with PRC, surveyed March 31, 2008 and April 1 through 4, 2008. Phil R. Peck, field paleontologist with PRC, surveyed May 8 and 9, 12 through 15, 20 through 23, and 28, 2008. Richard J. Serrano, field paleontologist with PRC, surveyed May 8 through 10, 12 through 15, 20 through 24, and 28 and 29, 2008. During the field survey, stratigraphy was observed in arroyos, hill-slopes, badlands, and road cuts. Exposed sediments up to approximately 30 feet (~9 meters) were observed in locations in the vicinity of the Project linears.

5.16.1.4 Paleontological Resource Assessment Criteria

The SVP (1995), in common with other environmental disciplines such as archaeology and biology (specifically in regard to listed species), considers any fossil specimen significant unless demonstrated otherwise, and protected by environmental statutes. This position is held because fossils are uncommon, and only rarely will a fossil locality yield a statistically significant number of specimens representing the same species. In fact, vertebrate fossils are so uncommon that, in most cases, each fossil specimen found will provide additional important information about the characteristics or distribution of the species it represents.

A stratigraphic unit (such as a formation, member, or bed) known to contain significant fossils is considered to be "sensitive" to adverse impacts if there is a high probability that earth-moving or ground-disturbing activities in that rock unit will either disturb or destroy fossil remains. This definition of sensitivity differs fundamentally from that for archaeological resources:

> *It is extremely important to distinguish between archaeological and paleontological (fossil) resource sites when defining the sensitivity of rock units. The boundaries of archaeological sites define the areal extent of the resource. Paleontologic sites, however, indicate that the containing sedimentary rock unit or formation is fossiliferous. The limits of the entire rock formation, both areal and stratigraphic, therefore define the scope of the paleontologic potential in each case* (SVP 1995).

This distinction between archaeological and paleontological sites is important. Most archaeological sites have a surface expression that allows for their geographic location. Fossils, on the other hand, are an integral component of the rock unit below the ground surface; therefore, they are not observable unless exposed by erosion or human activity. Thus, a paleontologist cannot know either the quality or quantity of fossils present before the rock unit is exposed as a result of natural erosion processes or earth-moving activities. The paleontologist can only make conclusions on sensitivity to impact based upon what fossils have been found in the rock unit in the past, along with a judgment on whether or not the depositional environment of the sediments that compose the rock unit was likely to result in the burial and preservation of fossils.

Fossils are seldom uniformly distributed within a rock unit. Most of a rock unit may lack fossils, but at other locations within the same rock unit, concentrations of fossils may exist. Even within a fossiliferous portion of the rock unit, fossils may occur in local concentrations. For example, Shipman (1977, 1981) excavated a fossiliferous site using a three-dimensional grid and removed blocks of matrix of a consistent size. The site chosen was known prior to excavation to be richly fossiliferous, yet only 17 percent of the blocks actually contained fossils. These studies demonstrate the physical basis for the difficulty in predicting the location and quantity of fossils in advance of project-related ground disturbance.

Since it is unfortunately not possible to determine where fossils are located without actually disturbing a rock unit, monitoring of excavations by an experienced paleontologist during construction increases the probability that fossils will be discovered and preserved. Preconstruction mitigation measures, such as surface prospecting and collecting, will not prevent adverse impacts on fossils because many sites will be unknown in advance due to an absence of fossils at the surface.

The non-uniform distribution of fossils within a rock unit is typical. Many paleontological resource assessment and mitigation reports conducted in support of environmental impact documents and mitigation plan summary reports document similar findings (see for instance Lander 1989, 1993, Reynolds 1987, 1990, Spencer 1990, Fisk et al. 1994, and references cited therein). In fact, most fossil sites recorded in reports of impact mitigation (where construction monitoring has been implemented) had no previous surface expression. Because the presence or location of fossils within a rock unit cannot be known without exposure resulting from erosion or excavation, under SVP (1995) standard guidelines, an entire rock unit is assigned the same level of sensitivity based on recorded fossil occurrences.

Using SVP (1995) criteria, the paleontological importance or sensitivity (high, low, or undetermined) of each rock unit exposed in a project site or surrounding area is the measure most amenable to assessing the significance of paleontological resources because the areal distribution of each rock unit can be delineated on a topographic or geologic map. The paleontological sensitivity of a stratigraphic unit reflects: (1) its potential paleontological productivity; and (2) the scientific significance of the fossils it has produced. This method of paleontological resources assessment is the most appropriate because discrete levels of paleontological importance can be delineated on a topographic or geologic map.

The potential paleontological productivity of a stratigraphic unit exposed in a project area is based on the abundance/densities of fossil specimens and/or previously recorded fossil sites in exposures of the unit in and near a project site. The underlying assumption of this assessment method is that exposures of a stratigraphic unit in a project site are most likely to yield fossil remains both in quantity and density similar to those previously recorded from that stratigraphic unit in and near the Project Site.

An individual fossil specimen is considered scientifically important if it is:

- Identifiable
- Complete
- Well preserved
- Age diagnostic
- Useful in paleo-environmental reconstruction
- A type or topotypic specimen
- A member of a rare species
- A species that is part of a diverse assemblage

- A skeletal element different from, or a specimen more complete than, those now available for that species.

All identifiable land mammal fossils are considered scientifically important because of their potential use in providing relative age determinations and paleo-environmental reconstructions for the sediments in which they occur. Moreover, vertebrate remains are comparatively rare in the fossil record. Although fossil plants are usually considered of lesser importance because they are less helpful in age determination, they are actually more sensitive indicators of their environment (Miller et al. 1971), and as sedentary organisms, are more valuable than mobile animals for paleo-environmental reconstructions. For marine sediments, invertebrate and marine algal fossils, including microfossils, are scientifically important for the same reasons that land mammal and/or land plant fossils are valuable in terrestrial deposits. The value or importance of different fossil groups varies depending on the age and depositional environment of the stratigraphic unit that contains the fossils.

The following tasks were completed to establish the paleontological importance and sensitivity of each stratigraphic unit exposed in or near the Project Site:

- The potential paleontological productivity of each rock unit was assessed based on previously recorded and newly documented fossil sites it contains at and/or near the Project Site.

- The scientific importance of fossil remains recorded from a stratigraphic unit exposed at and/or near the Project Site were assessed.

- The paleontological importance of a rock unit was assessed, based on its documented and/or potential fossil content in the area surrounding the Project Site.

Categories of Sensitivity

In its standard guidelines for assessment and mitigation of adverse impacts to paleontological resources, the SVP (1995) established three categories of sensitivity for paleontological resources: high, low, and undetermined.

High Sensitivity. Stratigraphic units in which fossils have been previously found have a high potential to produce additional fossils and are therefore considered to be highly sensitive. In the significance criteria of the SVP (1995), all vertebrate fossils are categorized as having significant scientific value, and all stratigraphic units in which vertebrate fossils have previously been found have high sensitivity. In areas of high sensitivity, full-time monitoring is recommended during any project-related ground disturbance.

Low Sensitivity. Stratigraphic units that are not sedimentary in origin or that have not been known to produce fossils in the past are considered to have low sensitivity. Monitoring is usually not recommended nor needed during excavation in a stratigraphic unit with low sensitivity.

Undetermined Sensitivity. Stratigraphic units that have not had any previous paleontological resource surveys or any fossil finds are considered to have undetermined sensitivity. After reconnaissance surveys, observation of artificial exposures (e.g., road cuts) and natural exposures (e.g., stream banks), and possible subsurface testing (e.g., augering or trenching), an experienced, professional paleontologist can often determine whether the stratigraphic unit should be categorized as having high or low sensitivity.

The Bureau of Land Management (BLM) Paleontological Resources Handbook H-8270-1 (BLM 1998) uses a slightly different classification system for ranking areas according to their potential to contain significant fossils. These rankings are used in land use planning, as well as to identify areas that may warrant special management and/or special designation such as Areas of Critical Environmental Concern. Public lands managed by BLM are classified based on their potential to contain fossils using the following criteria:

Condition 1 – Areas that are known to contain vertebrate fossils or noteworthy occurrences of invertebrate or plant fossils.

Condition 2 – Areas with exposures of geological units or settings that have high potential to contain vertebrate fossils or noteworthy occurrences of invertebrate or plant fossils.

Condition 3 – Areas that are very unlikely to produce vertebrate fossils or noteworthy occurrences of invertebrate or plant fossils based on their surficial geology, igneous or metamorphic rocks, extremely young alluvium, colluvium, or aeolian deposits, or the presence of deep soils (BLM 1998).

A 1971 BLM (Marshall 1976) internal memorandum suggested the following criteria for determining the significance of individual paleontological resources. “A paleontological resource may be significant if:

- It represents a rare species or one that has not been recorded previously in the literature.
- It illustrates previously unknown sexual dimorphism, phenotypic variation, or an ontogenetic series of a given taxon.
- It is from a locality that marks either a geographical or temporal range extension for a given species.
- It is exceptional in that it represents an exhibit-quality specimen.
- It represents material that assists in refining the age assignment of an otherwise poorly dated litho-stratigraphic unit.
- It represents a concentration of vertebrate specimens in a bed or series of beds. The sample may include either associated skeletal material referable to an individual or an aggregate of specimens referable to more than one individual. In either case, the material yields potentially significant taphonomic information that can be utilized in paleontologic analyses.

- It provides important information on the evolutionary trends among organisms, relating inhabitants of the earth to extinct organisms.
- It provides important information regarding development of biological communities or interaction between botanical and zoological biota.
- It demonstrates unusual or spectacular circumstances in the history of life.
- It is in short supply and in danger of being depleted or destroyed by the elements, vandalism, or commercial exploitation, and is not found in other geographic localities.
- All vertebrate fossils are of scientific value."

The previously described BLM criteria have been widely used by both lead agencies and professional mitigation paleontologists as objective measures of significance. In this paleontological resource impact assessment, the criteria of both the SVP (1995) and the BLM (1998) are applied. BLM lands will not be directly impacted by the Project or by any of its associated linears. However, BLM lands do occur within the paleontological survey area (i.e., 1 mile from the Project Site and linear facilities), so the criteria will be considered.

5.16.1.5 Resource Inventory Results

Stratigraphic Inventory

Regional geologic mapping in the vicinity of the Project Site has been provided by Jennings (1977; 1:750,000), Mendenhall et al. (1916; 1:500,000), Jenkins (1938; 1:500,000), Bartow (1987, 1991; 1:500,000), Morton and Troxel (1962; ~1:320,000), and Smith (1964; 1:250,000). Larger-scale mapping of the Project Site has been provided by Dibblee (1972; 1:62,500), Woodring et al. (1932; 1:31,680), and Dibblee (2005a-2005f; 1:24,000).

Project Geology

Based upon the available geologic literature, recent geologic maps, and field observations, two stratigraphic units will be potentially impacted during Project construction activities. In the discussion below, the stratigraphic nomenclature of the area will follow that of Dibblee (2005a through 2005f), the most detailed and also most recent geologic maps available. Dibblee (2005a through f) identified two stratigraphic units within the Project vicinity: Quaternary alluvium and Tulare Formation. Each of these stratigraphic units is described below.

In his geologic mapping, Dibblee (2005a through f) mapped the area in the vicinity of the Project Site and the (rights-of-way) ROWs of the linears as either Quaternary alluvium or Tulare Formation. The Project Site is mapped as Quaternary alluvium, although the map indicates that this alluvium unconformably overlies sediments of the Tulare Formation (Dibblee 2005f). Thus, although Quaternary alluvium is mapped as being present at the surface over the Project Site, the older Tulare Formation may still be encountered in the shallow subsurface. This was confirmed in the geotechnical investigation performed for this Project (Appendix M), which indicated that sediments of the Tulare Formation are present at approximately 10 feet (~ 3 meters) below ground surface. Linear facilities associated with Project construction will also potentially impact sediments of the Tulare Formation. Many of the linear facilities will at some point pass through areas mapped as Tulare Formation or areas mapped as Quaternary alluvium overlying Tulare Formation (Dibblee 2005a through f).

Excavations at the Project Site and along the ROWs of the process water pipeline and electrical transmission lines will disturb sediments of Quaternary alluvium, and potentially Tulare Formation. Excavations along the ROWs of the potable water, natural gas, and CO_2 pipelines will disturb sediments of both the Quaternary alluvium and the Plio-Pleistocene Tulare Formation.

Tulare Formation. Late Pliocene- to Pleistocene-age Tulare Formation was named by Anderson (1905), who did not designate a type section. Woodring et al. (1940) later designated the Kettleman Hills North Dome as the type section for the formation. Dibblee (1973) described the Tulare Formation as "locally deformed dissected valley deposits composed of gravel, sand, and silt." Lithologically, the Tulare Formation consists of argillaceous sand and silt deposits with lenses of coarse sand and gravel. White (1987) described sediments of the Tulare Formation found in the Elk Hills as "low-angle, cross-bedded, fine to medium pebbly sands interbedded with structureless to faintly laminated, gypsiferous, olive-green, brown, and gray muds and clays. Conglomerate units do occur, but are rare overall. Pebbles and clasts of siliceous shale are common and are most likely derived from the Monterey Formation exposed in the Temblor Range to the west." Tulare Formation sediments in the Elk Hills have a thickness of up to approximately 610 meters (~2,000 feet), while Tulare sediments found elsewhere may be as much as 1,525 meters (~5,000 feet) thick (Maher et al. 1975, White 1987). Most of the formation is composed of reworked sedimentary materials whose origin is from erosion of the Coast Ranges. The Tulare Formation overlies the San Joaquin Formation, likely conformably, in the Elk Hills area, although in other places throughout the San Joaquin Valley it unconformably overlies sediments of various formations and ages (Dibblee 1973, Lettis 1982). The age of the Tulare Formation has been determined based upon structural and stratigraphic relationships, paleontological correlations, radiometric dating methods, and paleomagnetic data. White (1987) used measured magnetic polarities within the Tulare Formation from locations in the southern San Joaquin Valley to determine this age to be between 0.90 million years and 2.48 million years.

Quaternary Alluvium. Quaternary alluvium is composed primarily of fluvial sands and gravels reworked from older formations and transported from the topographically high adjacent areas. Within and in the immediate vicinity of the Project Site, the alluvium is primarily composed of either reworked Tulare Formation material and recent soils, or sediments of the Kern River distal fan. There is also some lacustrine material in the local alluvium, including sediments of Buena Vista Lake and other periodic lakes. Two drill sites located northeast of Buttonwillow, produced fossil wood that was analyzed using radiometric dating methods (Manning 1968). These samples, recovered at 20 and 35 feet below ground surface, produced a late-Pleistocene age.

Paleontological Resource Inventory

An inventory of known paleontological resources previously discovered in the vicinity of the Project is presented below and the paleontological importance of these resources is assessed.

The literature review and UCMP, LACM, and SBMNH archival records search conducted for this inventory documented no previously recorded fossil sites within the actual Project Site. Previously reported fossil sites do occur within 1 mile of the Project Site and linear facilities, and numerous previously unreported fossil sites were identified during the field survey for this Project. In addition, sediments of Quaternary alluvium and Plio-Pleistocene Tulare Formation have yielded fossilized remains of extinct species of continental vertebrates and other types of organisms at previously recorded fossil sites in the region (Jefferson 1991a, 1991b, UCMP records; others described below).

Tulare Formation. The Tulare Formation has yielded fossil remains at numerous sites in the San Joaquin Valley. These remains include algal stromatolites (vertically layered mat-like algal growths); diatoms; petrified wood; shells of snails and clams; and the bones and teeth of bony fishes, amphibians, turtles, lizards, snakes, birds, and a diversity of extinct land mammals, including moles, ground sloths, rabbits, squirrels, gophers, pocket mice, kangaroo rats, pack rats, deer mice, cotton rats, grasshopper mice, dogs, saber-tooth cats, horses, peccaries, camels, tapirs, and deer (Anderson and Pack 1915; Arnold and Johnson 1910, Davis et al. 1957, 1959, Foss and Blaisdell 1968, Gester 1917, Hoots et al. 1954, Lander 1993, Maher et al. 1975, Merriam 1903, 1905, 1914, 1915a, 1915b, 1917; Porter 1943, Repenning 1980, Reynolds 1987, 1990, Stirton and VanderHoof 1933, Taylor 1966, Wood and Davis 1959, Woodring et al. 1932, UCMP records). Anderson and Pack (1915) also mentioned recycled fossils from older stratigraphic units and silicified wood in the Tulare Formation.

There are a number of previously recorded fossil sites in the Tulare Formation within approximately 15 miles of the Project Site. These include several sites in the Elk Hills, in addition to several others in neighboring areas such as McKittrick (Woodring et al. 1932, Jefferson 1991a, 1991b, UCMP records). Several fossil localities described by Woodring et al. (1932) are present in the Elk Hills, and include specimens of camel, horse, rabbit, wood rat, cotton rat, and silicified wood. Additionally, Woodring et al. (1932) described freshwater invertebrates from “ditch samples” in the Elk Hills. Based upon these fossil localities, Woodring et al. (1932) stated that “the Elk Hills offer a promising field for collecting vertebrate fossils, which would fill a gap in the succession of vertebrate faunas on the Pacific coast.” Maher et al. (1975) indicated that “scattered fish remains,” mollusk fragments, reworked foraminifers, ostracodes, pelecypods, and small gastropods had been identified from wells in the Elk Hills. Jefferson (1991a, 1991b) in his previously described database of California Late Pleistocene (Rancholabrean North American Land Mammal Age [NALMA]) vertebrate fossils, indicated two localities in the Tulare Formation.

During the field survey for prospective fossil localities, many previously unrecorded sites were identified as occurring within 1 mile of the Project Site and linear facilities. Fossils at these localities included vertebrate fossil bones and bone fragments, invertebrate shells, and fossilized wood. Numerous paleosols were also identified within the Tulare Formation, which contained ichnofossils.

In summary, sediments referable to the Tulare Formation have yielded an abundance of invertebrate, vertebrate, and plant fossils, including microfossils. Several previously recorded and previously unrecorded fossil localities are found in the area of the Project Site, including several sites within the Elk Hills (Jefferson 1991b, UCMP records). Because this unit has in the past produced significant vertebrate fossils, the Tulare Formation is categorized as highly sensitive (SVP 1995).

Quaternary Alluvium. No fossil localities have previously been reported from Quaternary alluvium at the Project Site. However, significant vertebrate fossils have been reported from Holocene and Pleistocene sediments in several areas of Kern County (Jefferson 1991a, 1991b, UCMP records). Jefferson (1991a, 1991b) compiled a database of California Late Pleistocene (Rancholabrean NALMA) to earliest Holocene vertebrate fossils from published records, technical reports, unpublished manuscripts, information from colleagues, and inspection of museum paleontological collections at more than 40 public and private institutions. He listed more than 70 individual sites in Kern County that yielded vertebrate fossils of these ages. Many of these sites are not assigned to a specific formation, group, or member, and may be referable to sediment of unnamed (Quaternary) alluvium. Among these localities is a Rancholabrean vertebrate fossil locality discovered during construction of the Bakersfield Canal (UCMP V-65247). Fossils discovered during that construction project have been identified as an extinct species of horse. Additionally, Pleistocene fossil wood was recovered from well borings 10 to 15 miles northwest of Buttonwillow (Manning 1968).

During the field survey performed for this Project, previously unrecorded fossil localities were identified within the paleontological study area (i.e., 1 mile from the Project Site and linear facilities). Specimens identified during the field survey included freshwater invertebrate shells and ichnofossils. Fossils occurring in Quaternary alluvium are valuable to the scientific community because they provide information about climatic conditions in the not-too-distant past. The occurrence of large and small mammals is well documented from these and older subsurface deposits; and with further observation of earth-moving activities and prospecting for fossils, more specimens could be unearthed. Since fossil vertebrates have been previously reported from Quaternary alluvium within Kern County, the Quaternary alluvium is also judged to have high sensitivity based on SVP guidelines (1995).

Summary

In summary, although no fossils were previously reported to directly underlie the Project Site, numerous fossil localities nearby within the Quaternary alluvium and the Tulare Formation have been reported in both the published scientific literature and museum records. In addition, numerous previously unrecorded fossil localities were identified during the field surveys of the Project Site and linear facility ROWs. Many of these previously reported and unreported localities occur within 1 mile of Project-related features. The presence of fossils in sediments of Quaternary alluvium within 1 mile of the Project and elsewhere in Kern County, and of fossils in sediments of Plio-Pleistocene Tulare Formation within 1 mile of the Project, elsewhere, and in the Elk Hills suggests that there is a high potential for additional similar fossil remains to be uncovered by excavations during Project construction. Under SVP (1995) criteria, these stratigraphic units have a high potential for producing additional sensitive paleontological resources.

5.16.2 Environmental Consequences

Potential impacts on paleontological resources resulting from construction of the Project can be divided into construction-related impacts and operation-related impacts. The potential environmental effects from construction and operation of the Project on paleontological resources are presented in the following subsections.

5.16.2.1 Potential Impacts from Project Construction

Construction-related impacts to paleontological resources primarily involve terrain modifications (excavations and drainage diversion measures). Paleontological resources, including an undetermined number of fossil remains and unrecorded fossil sites; associated specimen data and corresponding geologic and geographic site data; and the fossil-bearing strata, could be adversely affected by (i.e., will be sensitive to) ground disturbance and earth moving associated with construction of the Project. Direct impacts could result from: vegetation clearing; grading of roads, drainage diversions, pile driving, and other ground disturbance at the Project Site; trenching for pipelines; augering for foundations for electrical transmission towers or poles; and any other Project-related earth-moving activity. Such disturbance may result in significant impacts because it may result in the loss or destruction of the fossil specimen or the loss of the corresponding geographic data.

Identifiable fossil remains recovered from the Quaternary alluvium or the Plio-Pleistocene Tulare Formation during Project construction could be scientifically important and significant. These fossil remains discovered during construction could represent new taxa or new fossil records for the San Joaquin Valley, for the state of California, for the Quaternary/Tertiary eras, or for a stratigraphic unit. They could also represent geographic or temporal range extensions. Moreover, discovered fossil remains could make it possible to more accurately determine the age, paleo-climate, and depositional environment of the sediments from which they are salvaged. Finally, fossil remains salvaged during Project construction could provide a more comprehensive documentation of the diversity of animal and plant life that once existed in Kern County, and could result in a more accurate reconstruction of the geologic and paleo-biologic history of the San Joaquin Valley and the Elk Hills area.

Clearing, grading, and excavations that encounter previously undisturbed sediment at the Project could result in significant adverse impacts to paleontological resources. At the Project Site, this may occur within 5 feet (~ 1.5 meters) of the ground surface. At other locations along the linear ROWs, undisturbed sediment occurs at ground surface. These construction impacts could disturb previously undisturbed fossiliferous sediments that without mitigation, could make those sediments and their paleontologic resources unavailable for future scientific investigation. However, with the properly designed and implemented mitigation program, these impacts will be reduced to less than significant.

5.16.2.2 Potential Impacts from Project Operation

No impacts on paleontological resources are expected to occur from the continuing operation of the Project or any of its related facilities.

5.16.3 Cumulative Impacts Analyses

If paleontological finds were to be encountered during Project construction, the potential for cumulative impacts will exist. The Elk Hills are highly disturbed by a number of previous impacts. Were mitigation measures not implemented for this Project, Project construction could potentially add to the cumulative impact on paleontological resources. However, mitigation measures will be implemented to salvage such resources and reduce cumulative impacts to a level that is less than significant. Section 5.16.4, Mitigation Measures, describe the steps to be taken to effectively preserve the value to science of any significant fossils uncovered during Project-related construction.

5.16.4 Mitigation Measures

This section describes mitigation measures that will be implemented to reduce potential adverse impacts to significant paleontological resources resulting from Project construction. Mitigation measures are necessary because of potential adverse impacts of Project construction on significant paleontological resources within the Quaternary alluvium, and the Plio-Pleistocene Tulare Formation. The paleontological resource impact mitigation program will reduce direct, indirect, and cumulative adverse environmental impacts on paleontological resources that could result from Project construction to a less-than-significant level. The mitigation measures summarized below are consistent with SVP standard guidelines for mitigating adverse construction-related impacts on paleontological resources (SVP, 1995, 1996), and fulfill the requirements of the BLM (1998).

Implementation of these mitigation measures will reduce the potentially significant adverse environmental impact of Project-related ground disturbance and earth-moving on paleontological resources to a less-than-significant level by allowing for the salvage of fossil remains and associated specimen data, and corresponding geologic and geographic site data, that otherwise might be lost to earth-moving and to unauthorized fossil collecting.

With a well-designed and -implemented paleontological resource monitoring and mitigation plan, Project construction could actually result in beneficial impacts on paleontological resources through the discovery of fossil remains that would not have been exposed without Project construction, and therefore would not have been available for study. The salvage of fossil remains as part of Project construction could help answer important questions regarding the geographic distribution, stratigraphic position, and age of fossiliferous sediments in the Project area.

5.16.4.1 PALEO-1: Paleontological Monitoring

Prior to construction, a qualified paleontologist will be retained to both design and implement a monitoring and mitigation program. During construction, ground-disturbing activities will be monitored where these activities will potentially disturb previously undisturbed sediment. Monitoring will not be conducted in areas where the ground has been previously disturbed, or in areas where exposed sediment will be buried, but not otherwise disturbed. Construction monitoring will be conducted to ensure that unanticipated discoveries are addressed in a timely manner.

5.16.4.2 PALEO-2: Paleontological Monitoring and Mitigation Program

The paleontological resource monitoring and mitigation program will include preconstruction coordination; construction monitoring; emergency discovery procedures; sampling and data recovery, if needed; preparation, identification, analysis, and museum curation of any fossil specimens and data recovered; and reporting. This monitoring and mitigation plan will be consistent with SVP (1995) standard guidelines for the mitigation of construction-related adverse impacts on paleontological resources, as well as the requirements of the designated museum repository for any fossils collected (SVP 1996).

5.16.4.3 PALEO-3: Construction Personnel Education

To enhance awareness of potential impacts to paleontological resources prior to start of Project construction, construction personnel involved with earth-moving activities should be informed: (1) that fossils may be discovered during excavating; (2) that these fossils are protected by laws; (3) on the appearance of common fossils; and (4) on proper notification procedures. This worker training should be prepared and presented by a qualified paleontologist.

5.16.4.4 PALEO-4: Paleontological Monitoring

Prior to the start of construction, the paleontologist should conduct a field survey of exposures of sensitive stratigraphic units that will be disturbed, and any fossils discovered should be salvaged. Earth-moving construction activities should be monitored wherever these activities will disturb previously undisturbed sediment. Monitoring will not need to be conducted in areas where sediments have been previously disturbed or in areas where exposed sediments will be buried, but not otherwise disturbed.

5.16.5 Laws, Ordinances, Regulations, and Standards

Paleontological resources are classified as non-renewable scientific resources and are protected by several federal and state statutes (California State Historic Preservation Office 1983, Marshall 1976, West 1991, Fisk and Spencer 1994, Gastaldo 1999), most notably by the 1906 Federal Antiquities Act and other subsequent federal legislation and policies, and by the state of California's environmental regulations (California Environmental Quality Act [CEQA], §15064.5). Professional standards for assessment and mitigation of adverse impacts on paleontological resources have been established by the SVP (1995, 1996). Design, construction, and operation of the Project, including ancillary facilities, will be conducted in accordance with laws, ordinances, regulations, and standards (LORS) applicable to paleontological resources. Federal and state LORS applicable to paleontological resources are summarized in Table 5.16-1, Summary of LORS – Paleontological Resources, and discussed briefly below, together with county and city requirements and SVP professional standards.

5.16.5.1 Federal

There are no applicable federal LORS because the Project affects no federal lands.

5.16.5.2 State

The CEQA lead agency having jurisdiction over a project is responsible for ensuring that paleontological resources are protected in compliance with CEQA and other applicable statutes. California Public Resources Code § 21081.6, entitled Mitigation Monitoring Compliance and Reporting, requires that the lead agency demonstrate project compliance with mitigation measures developed during the environmental impact review process.

Table 5.16-1
Summary of LORS – Paleontological Resources

LORS	Requirements	Conformance Section	Administering Agency	Agency Contact
State Jurisdiction				
CEQA	Protects paleontological resources on state lands.	5.16.5	CEC	Eileen Allen 916-654-4082
Public Resources Code §5097.5/§5097.9	Protects paleontological resources on state lands.	5.16.5	CEC	Eileen Allen 916-654-4082
Local Jurisdiction				
Kern County General Plan	Protects paleontological resources on county lands.	5.16.5	Kern County Planning Department	Cheryl Casdorph 661-862-8600

Source: HECA Project
Notes:
CEQA = California Environmental Quality Act
LORS = laws, ordinances, regulations, and standards

Other state requirements for paleontological resources management are in Public Resources Code Chapter 1.7, § 5097.5 (Statute 1965, c. 1136, p. 2792), entitled Archaeological, Paleontological, and Historical Sites. This statute defines any unauthorized disturbance or removal of a fossil site or fossil remains on public land as a misdemeanor, and specifies that state agencies may undertake surveys, excavations, or other operations as necessary on state lands to preserve or record paleontological resources. This statute will apply to the Project if the Project will be built on city-owned or state-managed lands.

5.16.5.3 Local

California Planning and Zoning Law requires each county and city jurisdiction to adopt a comprehensive, long-term general plan for its development. The general plan is a policy document designed to give long-range guidance to those making decisions affecting the future character of the planning area. It represents the official statement of the community's physical development, as well as its environmental goals. The general plan also acts to clarify and articulate the relationship and intentions of local government to the rights and expectations of the general public, property owners, and prospective investors. Through its general plan, the local jurisdiction informs these groups of its goals, policies, and development standards, thereby communicating what must be done to meet the objectives of the general plan. State planning law requires each jurisdiction to identify environmental resources and to prepare and implement policies that relate to the use and management of these resources.

The Kern County General Plan addresses paleontological resources in the Land Use, Open Space, and Conservation Element under "General Provisions 1.10.3: Archaeological, Paleontological, Cultural, and Historical Preservation." Under this heading, Policy 25 states, "the County will promote the preservation of cultural and historic resources which provide ties with the past and constitute a heritage value to residents and visitors." Implementation Measure L for this Policy states that "the County shall address archaeological and historical resources for discretionary projects in accordance with CEQA." Implementation Measure M for this Policy states that "in areas of known paleontological resources, the County should address the preservation of these resources where feasible."

5.16.6 Involved Agencies and Agency Contacts

Other than CEC, no state or local agencies have specific jurisdiction over paleontological resources; therefore, no state or local agencies were contacted.

5.16.7 Permits Required and Permit Schedule

No state or local agency requires a paleontological collecting permit to allow for the salvage of fossil remains discovered as a result of construction-related earth moving on non-federal public or private land in a project site.

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Adequacy Issue:	Adequate ____	Inadequate ____	DATA ADEQUACY WORKSHEET	Revision No.	0	Date ____
Technical Area:	**Paleontological Resources**		Project:	Technical Staff:		
Project Manager:			Docket:	Technical Senior:		

SITING REGULATIONS	INFORMATION	AFC PAGE NUMBER AND SECTION NUMBER	ADEQUATE YES OR NO	INFORMATION REQUIRED TO MAKE AFC CONFORM WITH REGULATIONS
Appendix B (g) (1)	...provide a discussion of the existing site conditions, the expected direct, indirect and cumulative impacts due to the construction, operation and maintenance of the project, the measures proposed to mitigate adverse environmental impacts of the project, the effectiveness of the proposed measures, and any monitoring plans proposed to verify the effectiveness of the mitigation.	Section 5.16.1, p. 5.16-3 Section 5.16.2, p. 5.16-14 Section 5.16.3, p. 5.16-15 Section 5.16.4, p. 5.16-15		
Appendix B (g) (16) (A)	Identification of the physiographic province and a brief summary of the geologic setting, formations, and stratigraphy of the project area. The size of the paleontological study area may vary depending on the depositional history of the region.	Section 5.16.1.1, p. 5.16-3 Section 5.16.1.2, p. 5.16-4 Section 5.16.1.3, p. 5.16-5 Section 5.16.1.4, p. 5.16-6 Section 5.16.1.5, p. 5.16-10		

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SITING REGULATIONS	INFORMATION	AFC PAGE NUMBER AND SECTION NUMBER	ADEQUATE YES OR NO	INFORMATION REQUIRED TO MAKE AFC CONFORM WITH REGULATIONS
Appendix B (g) (16) (B)	A discussion of the sensitivity of the project area described in subsection (g)(16)(A) and the presence and significance of any known paleontologic localities or other paleontologic resources within or adjacent to the project. Include a discussion of sensitivity for each geologic unit identified on the most recent geologic map at a scale of 1:24,000. Provide rationale as to why the sensitivity was assigned.	Section 5.16.1.4, p. 5.16-6 Section 5.16.1.5, p. 5.16-10		.
Appendix B (g) (16) (C)	A summary of all local museums, literature searches and field surveys used to provide information about paleontologic resources in the project area described in subsection (g)(16)(A). Identify the dates of the surveys, methods used in completing the surveys, and the names and qualifications of the individuals conducting the surveys.	Section 5.16.1.3, p. 5.16-5		

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Project Manager:	________		Docket: ________	Technical Senior:	________	

Siting Regulations	**Information**	**AFC Page Number And Section Number**	**Adequate Yes Or No**	**Information Required To Make AFC Conform With Regulations**
Appendix B (g) (16) (D)	Information on the specific location of known paleontologic resources, survey reports, locality records, and maps at a scale of 1:24,000, showing occurrences of fossil finds, if known, within a one-mile radius of the project and related facilities shall be included in a separate appendix to the Application and submitted to the Commission under a request for confidentiality, pursuant to Title 20, California Code of Regulations, s 2501 *et seq*.	Appendix Q, Paleontological Technical Report		
Appendix B (g) (16) (E)	A discussion of any educational programs proposed to enhance awareness of potential impacts to paleontological resources by employees, measures proposed for mitigation of impacts to known paleontologic resources, and a set of contingency measures for mitigation of potential impacts to currently unknown paleontologic resources.	Section 5.16.4, p. 5.16-15		

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Project Manager:			Docket:	Technical Senior:		

Siting Regulations	**Information**	**AFC Page Number And Section Number**	**Adequate Yes Or No**	**Information Required To Make AFC Conform With Regulations**
Appendix B (i) (1) (A)	Tables which identify laws, regulations, ordinances, standards, adopted local, regional, state, and federal land use plans, leases, and permits applicable to the proposed project, and a discussion of the applicability of, and conformance with each. The table or matrix shall explicitly reference pages in the application wherein conformance, with each law or standard during both construction and operation of the facility is discussed.	Section 5.16.5, p. 5.16-16 Table 5.16-1, p. 5.16-17		
Appendix B (i) (1) (B)	Tables which identify each agency with jurisdiction to issue applicable permits, leases, and approvals or to enforce identified laws, regulations, standards, and adopted local, regional, state and federal land use plans, and agencies which would have permit approval or enforcement authority, but for the exclusive authority of the commission to certify sites and related facilities.	Section 5.16.5, p. 5.16-16 Table 5.16-1, p. 5.16-17		
Appendix B (i) (2)	The name, title, phone number, address (required), and email address (if known), of an official who was contacted within each agency, and also provide the name of the official who will serve as a contact person for Commission staff.	Section 5.16.5, p. 5.16-16 Table 5.16-1, p. 5.16-17 Section 5.16.6, p. 5.16-18		

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SITING REGULATIONS	INFORMATION	AFC PAGE NUMBER AND SECTION NUMBER	ADEQUATE YES OR NO	INFORMATION REQUIRED TO MAKE AFC CONFORM WITH REGULATIONS
Appendix B (i) (3)	A schedule indicating when permits outside the authority of the commission will be obtained and the steps the applicant has taken or plans to take to obtain such permits.	Section 5.16.7, p. 5.16-18		