Paleontological Analysis for the Town of Windsor Eastside Road Storage Project

PREPARED FOR: Town of Windsor

PREPARED BY: W. Geoffrey Spaulding, Ph.D./CH2M HILL
Raj B. G.-Naidu/CH2M HILL

COPIES: Andrea Gardner/CH2M HILL

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1.0 Introduction

Paleontological resources are fossils-the remains or traces of prehistoric life preserved in the geological (rock stratigraphic) record. They range from the well-known and well-publicized (e.g., dinosaur and mammoth bones) to the more obscure but nevertheless scientifically important (e.g., mollusks, paleobotanical remains, trace fossils, microfossils). This resource is considered important because of the potential of fossil remains to contribute substantively to science and education, including our understanding of climate change and its effect on ecosystems and species. Therefore, fossils are protected by both state and federal laws.

The purpose of this technical memorandum (TM) is to assess the paleontological resources that may be affected by the Eastside Road Storage Project (the Project), to determine what effects may occur from construction and operation of the Project, and to recommend measures that would be appropriate to mitigate the impacts of the Project on paleontological resources. The Project consists of the construction of a reservoir pond; its retaining dam; associated inlet, outlet and emergency overflow pipelines; a pump station; extension of the current reclaimed water pipeline to bring water to the reservoir; power line; and access road. The purpose of the Project is to provide additional reclaimed-water storage capacity to meet current and future operational requirements of the Town of Windsor's (Town's) water system. The reservoir pool will provide seasonal storage when irrigation customer demands are low. The Project site will occupy a parcel owned by the Town of Windsor, situated in a hilly, wooded area immediately east of the Russian River floodplain. The reservoir site was evaluated and included in the Town's *Water Reclamation Master Plan For Treatment, Storage And Disposal Environmental Impact Report* (EIR) (ESA, 2001). The final EIR was approved in 2001.

1.1 Methods

The assessment of paleontological resources that follows, and the subsequent analysis of Project-related impacts and mitigation recommendations, are consistent with Society for Vertebrate Paleontology (SVP) resource assessment and mitigation guidelines (SVP, 1995; SVP, 1996). Geological maps and the geological literature were reviewed to provide the physiographic and geological context for the study area, and are cited as appropriate in the discussion below. Two standard online databases were used in addition to internet queries to determine the relative paleontological potential of the rock units identified in the Project vicinity. One database is that of the University of California Museum of Paleontology at Berkeley (UCMP) and the other is the Paleobiology Database, managed by a consortium of academic institutions and supported in part by the National Science Foundation.

The following tasks were completed to establish the paleontological sensitivity and distribution of rock unit exposed within the study area:

- The study area was defined and its physiographic context described,
- A stratigraphic inventory of the area was completed, and the mapped geologic units within the study area were identified,
- A paleontological records review of the area was completed to identify previously recorded fossil resources, and the context of their discovery, and
- The mapped geologic units were assigned levels of paleontological sensitivity based on the fossil remains previously documented within that unit, and on other relevant geological and paleontological data.

The paleontological sensitivity of the Project vicinity can be assessed by identifying the stratigraphic units that have paleontological potential within the area, chiefly through concurrent paleontological records and literature searches, followed by a field reconnaissance by a qualified paleontologist. The distribution of stratigraphic units in the Project vicinity is identified through geologic mapping, and therefore the parts of the Project crossing units of varying paleontological sensitivity (high, moderate, low, or no sensitivity) can be delineated. Impact assessments and mitigation recommendations can then be formulated based on these data coupled with descriptions of what ground-disturbing activities will take place where.

1.2 Setting

The Project is located in the foothills that form the western rim of the Cotati Valley, also called the Santa Rosa Valley in the literature, which lies within the northern Coast Ranges of California. As the name implies, the Coast Ranges are a series of discontinuous mountain ranges that generally parallel the Pacific coast of California. Between these low ranges are intervening valleys oriented in more or less the same direction as the bounding mountains (Fenneman, 1931). The Cotati Valley is a large, elongated northwest-trending valley bounded on the east side by a fault-controlled abrupt rise in topography, and on the west side by low hills which form a broken piedmont to the mountainous highlands that rise to the west. The bounding faults are generally northwest-trending and are associated with the San Andreas Fault system (SAFS). The Russian River enters the valley from the north and skirts its western margin before exiting through a gap west of the Project. At its closest point the river is about 0.7 mile northwest of the Project. The low hills that form the west flank of the valley are the local foothills of the Marin Range, and are composed of Late Tertiary (~ 23 to 1.6 million years ago [mya]) sedimentary rocks. The east side of the valley is bordered by the Sonoma Range, which are composed of Late Tertiary volcanic and sedimentary rocks. The Tertiary rocks in the area unconformably overlie meta-sedimentary and meta-volcanic rocks of the Jurassic-Cretaceous (~206 to 65 mya) Franciscan Complex, which forms the basement of the northern California Coast Ranges east of the SAFS (Fenneman, 1931; Geomatrix, 2007).

1.3 Stratigraphic Inventory of the Project Vicinity

Guidelines for paleontological resources assessments promulgated by the SVP (1995; 1996) call for the inventory of all geological units within one mile of the ground-disturbing activities associated with any project. These geological units in turn are evaluated for paleontological sensitivity. This evaluation is dependent to the extent of available published studies of the relevant rock units. Principal resources for this stratigraphic inventory, as it relates to the Project location, are the geological investigation by Blake et al. (2002), and the paleontological study of Powell et al. (2004). Geological units within this portion of the Santa Rosa-Cotati Valley include older, Mesozoic basement rocks of the Franciscan Formation, the younger Mio-Pliocene marine sediments of the Wilson Grove Formation, and contemporaneous continental rocks of the Petaluma Formation, overlain by older and then younger Quaternary sediments. The older Quaternary sedimentary units in the axial portion valley are the Glen Ellen and Huichica Formations (Wentworth, 1993), but these named Quaternary units have not been differentiated in the Project vicinity itself. Quaternary sediments in the Project vicinity range from unnamed older “terrace” deposits occupying topographic highs, to younger Pleistocene and Holocene sediments comprising true terraces on the margins of tributary drainages.

1.3.1 Mesozoic Rocks – The Franciscan Complex and the Great Valley Complex

Several sections of the Franciscan complex outcrop in the vicinity of the Project. These include the greywacke and mélange section, the mélange section, and the greenstone block. The greywacke and mélange section consists of massive to bedded, green to gray, lithic wacke and dark gray to black shale, siltstone, and slate which grades into a mélange consisting of a greywacke and sheared argillite matrix enclosing metamorphic, sedimentary, and volcanic blocks and lenses. The mélange section is composed of greywacke, sheared argillite and minor green tuff matrix enfolding blocks and lenses of greenstone, chert, metachert, sperentinite, blueschist, limestone and quartz-mica schist. The greywacke matrix has been shown to yield Late Jurassic fossils. The mélange section has been shown to match the greywacke and mélange section in composition and age and is most likely a portion of that section. The greenstone block is enclosed within the mélange section and is composed of massive and pillowed greenstone and basalt. Large foraminifers, several polychaete taxa, and undetermined invertebrate trackways have been recovered from Franciscan sediments in western Sonoma County. The section of the Great Valley complex exposed in the Project vicinity is composed of siltstone, sandstone, and shale. (Blake et al., 2002). Great Valley Sequence sediments in Sonoma County near Sebastopol, Occidental, Healdsburg and Jenner have yielded invertebrate and plant fossils.

1.3.2 Tertiary Rocks – Wilson Grove and Petaluma Formations

Tertiary marine deposits now known as the Wilson Grove Formation in Sonoma County have been referred to as the Merced Formation or the Sonoma County Merced Formation; however, as Higgins (1960) observed, there is no Merced Formation present in Sonoma County. Roth and G.-Naidu (1974) characterized the sediments as Sonoma County Merced

Formation and suggested a late Miocene age for the locality designated CAS 54164, the type locality of *Nattullia jamesi* (CAS = California Academy of Sciences). Zullo and G.-Naidu (1982) referred to the western Sonoma County late Miocene sediments as the Wilson Ranch beds (of Osmont, 1905). Wagner and Bortugno (1982) mapped these sediments as the Wilson Grove Formation (Wilson Grove is a later place name for Wilson Ranch) and Fox (1983) formally named the unit.

1.3.2.1 Wilson Grove Formation (Late Miocene to late Pliocene)

The marine Wilson Grove Formation is the primary unit underlying the Project vicinity. This formation generally consists of massive and thick-bedded to hummocky cross-stratified, buff weathering, yellowish-brown to dark brown, fine to medium grained sandstone and siltstone with localized beds of gravel and gastropod and mollusk shell hash (Blake et al., 2002; Powell et al., 2004). The formation takes its name from the hamlet of Wilson Grove, only 0.75 mile to the north-northeast of the Project. The stratigraphic relationship of the type area of the Wilson Grove (Fox, 1983) to the rest of the Wilson Grove Formation has not yet been resolved. G.-Naidu (1999) suggested three components of Wilson Grove deposition, defined by underlying structure, for the Wilson Grove Formation west of the type area, but did not attempt comparisons with the type section. The Wilson Grove Formation in the immediate area of the Project is moderately to severely weathered, fractured, friable to weak, fossiliferous sandstone and siltstone with local of conglomerate strata, and well cemented shell beds. Fossils encountered in the immediate area during geotechnical investigations consist of clay filled shell casts within siltstone and sandstone, local well cemented shell beds, and shell dispersed through a sandstone matrix (Geomatrix, 2007).

1.3.2.2 Petaluma Formation (Late Miocene to Pliocene)

Blake et al. (2002) identified a possible outcrop area of the Petaluma Formation near the Project vicinity, immediately southeast of Mark West Road and the right-of-way of the current recycled water pipeline. Powell et al. (2004) record the Petaluma Formation about 1.3 miles south of the Project vicinity, where it is unconformably overlain by the Roblar tuff of Sarna-Wojcicki (1992). The Petaluma Formation is generally composed of gray weathering, brown to green continental rocks including conglomerate, sandstone, siltstone, gritstone and mudstone. It is considered to be contemporaneous with, and the non-marine equivalent of, the Wilson Grove Formation. Locally, the Petaluma Formation is known to contain mammalian and ostrocod fossils of Miocene age (Blake et al., 2002). Other vertebrates include rhinoceros (CAS collections) and horses (UCMP). Younger parts of the Petaluma Formation include rabbits (*?Paleolagus*, sp.: locality RBGN 1968-3 reposited at UCMP); mastodon (ranch-owner personal collection, observed by G.-Naidu, 1978); *?catastomid* fish remains (localities RBGN 1988-2, 1988-3 = CAS 67734, 67741) and bison. Fox (1983) discounted the idea that there might be fossils as young as the Rancholabrean Land Mammal Age (= Late Pleistocene) from the Petaluma Formation, but the type section as described by Dickerson (1922) probably includes overlying or incised Pleistocene sediments. In the Santa Rosa area, sediments probably referable to the Petaluma have yielded mastodon and camelid remains. However, neither the UCMP nor the Paleobiology Database show fossil localities in this formation in Sonoma County and detailed mapping (Geomatrix, 2007) indicates that it does not occur in the Project vicinity.

1.3.3 Quaternary Deposits – Alluvial, Fluvial, and Marine Terrace

The assignment of older Quaternary deposits to the Glen Ellen and(or) Huchica Formations by Wentworth (1993) has not been followed in subsequent more detailed studies (e.g., Blake et al., 2002), and we follow the latter in using informal descriptors as names for the Quaternary sediments in the Project vicinity. That notwithstanding, field relationships show clearly distinct differences among Quaternary units, and these appear generally correlated with age.

1.3.3.1 Older Alluvial Fan Deposits (Pleistocene)

Generally horizontal units of buff to grey pebble to cobble conglomerate, fine to coarse grained sandstone, pebbly sandstone, pebbly siltstone and siltstone, mudstone and claystone. Clasts include various volcanics, greywacke and metagreywacke, chert, charcoal, and petrified wood. This unit is at least 65 meters thick and is overlain in some locations by younger Quaternary alluvium (Blake et al., 2002). It is found to the northeast and east of the Project vicinity closer to the axial portion of the Santa Rose-Cotati Valley, and does not occur in the Project vicinity (Geomatrix, 2007).

1.3.3.2 Alluvial and Marine Terrace Deposits (Pleistocene)

This unit is composed of alluvium consisting of clast supported boulders, cobbles and gravels in a sandy matrix with local course sand lenses. The terraces in this area are up to 275 feet above current sea level and lie unconformably on the Wilson Grove Formation. In the Project vicinity where they have been mapped (Geomatrix, 2007) they consist of fluvial gravels armoring topographic highs that are more or less of equivalent elevation, but that do not describe a terrace *per se*. These deposits are relicts of former, higher base-level(s) and likely include deposits of the ancestral Russian River as well as alluvium from the surrounding uplands. Uplift in response to regional tectonic forces (Blake et al., 2002), and perhaps changes in sea level father west, and concomitant down-cutting of the Russian River led to lowering of local base level and the topographic isolation of these deposits.

1.3.3.3 Alluvial Fan and Fluvial Deposits (Late Pleistocene and Holocene)

These alluvial and fluvial deposits are generally tan to brown, medium dense to dense, sandy gravel to gravely sand that grades upward to sandy or silty clay. In the vicinity of the Project this unit consists of stream channel deposits which include poorly sorted sand to silty sand, silts, cobbles and pebbles of various lithologies (Blake et al., 2002). At least two distinct ages are reflected; higher terraces several feet to as much as ten feet above current stream level likely represent Late Pleistocene deposits, while lower elevation terraces of more limited extent and current floodplains are composed of Holocene alluvium and colluvium. This also includes landslide deposits, which are common in the study area as a result of the poorly consolidated nature of the underlying Wilson Grove Formation.

2.0 Regulatory Requirements

Paleontological resources are non-renewable resources protected under federal as well as California State laws. These laws do not extend to privately held lands, but they do apply to lands managed by federal as well as state agencies, and to other lands where paleontological resources may be affected by a federal or state undertaking as provided for by the National

Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA), respectively.

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, and (3) determining the relative ages of the strata in which they occur and the geologic events that resulted in the deposition of the sediments that formed these strata. Paleontological resources include the casts or impressions of ancient animals and plants, their trace remains (e.g., burrows, trackways), microfossils (such as fossil pollen, ostracodes, diatoms, etc.), and unmineralized remains such as the bones of Ice Age mammals or the trunks of trees that lived long ago.

As non-renewable scientific resources the preservation and protection of paleontological resources are addressed by several federal and state statutes (California Office of Historic Preservation, 1983; see also Marshall, 1976; Fisk and Spencer, 1994), most notably by the 1906 Federal Antiquities Act and other subsequent federal legislation and policies, and by the State of California's environmental regulations (CEQA, Section 15064.5). Professional standards for assessment and mitigation of adverse impacts on paleontological resources have been established by the Society of Vertebrate Paleontology (SVP, 1995; 1996). Laws, ordinances, regulations, and standards (LORS) applicable to paleontological resources are summarized in Table 1 and discussed briefly below, along with SVP professional standards.

TABLE 1
Laws, Ordinances, Regulations, and Standards (LORS) Applicable to Paleontological Resources

LORS	Function	Project Applicability
Antiquities Act of 1906	Protects paleontological resources on federal lands and if a federal entitlement is required.	No
CEQA, Appendix G	Requires evaluation and consideration of impacts to paleontological resources on State lands, and if a State or County entitlement is required.	Yes
Public Resources Code, Sections 5097.5/5097.9	Would apply only if some project land were owned or acquired by the State of California.	No

2.1 Federal LORS

Federal protection for significant paleontological resources would apply if any construction or other related Project impacts occurred on federally managed lands, or if federal funds or entitlements are necessary for project implementation. Federal legislative protection for paleontological resources stems from the Antiquities Act of 1906 (PL 59-209; 16 United States Code 431 et seq.; 34 Stat. 225), which calls for protection of historic landmarks, historic and prehistoric structures, and other objects of historic or scientific interest on federal lands. In addition, the National Environmental Policy Act of 1969 (United States Code, section 4321et seq.; 40 Code of Federal Regulations, section 1502.25), as amended, requires analysis of potential environmental impacts to important historic, cultural, and natural aspects of our national heritage.

2.2 State LORS

CEQA (Public Resources Code Sections 21000 et seq.) requires that public agencies and private interests identify the environmental consequences of their proposed projects on any object or site of significance to the scientific annals of California (Division I, California Public Resources Code: 5020.1 [b]). Guidelines for the implementation of CEQA (Public Resources Code Sections 15000 et seq.) define procedures, types of activities, persons, and public agencies required to comply with CEQA. Appendix G in Section 15023 provides an Environmental Checklist of questions that a lead agency should normally address if relevant to a project's environmental impacts. One of the questions to be answered in the Environmental Checklist (Section 15023, Appendix G, Section V, part c) is the following: "Would the project directly or indirectly destroy a unique paleontological resource or site?"

Although CEQA does not define what is "a unique paleontological resource or site," Section 21083.2 defines "unique archaeological resources" as "any archaeological artifact, object, or site about which it can be clearly demonstrated that, without merely adding to the current body of knowledge, there is a high probability that it meets any of the following criteria:

1. Contains information needed to answer important scientific research questions and that there is a demonstrable public interest in that information.
2. It has a special and particular quality such as being the oldest of its type or the best available example of its type.
3. Is directly associated with a scientifically recognized important prehistoric or historic event.

With only slight modification, this definition is equally applicable to recognizing "a unique paleontological resource or site." Additional guidance is provided in CEQA Section 15064.5 (a)(3)(D), which indicates "generally, a resource shall be considered historically significant if it has yielded, or may be likely to yield, information important in prehistory or history."

Section XVII, part a, of the CEQA Environmental Checklist asks a second question equally applicable to paleontological resources: "Does the project have the potential to…eliminate important examples of the major periods of California history or pre-history?" To be in compliance with CEQA, environmental impact assessments, statements, and reports must answer both these questions in the Environmental Checklist. If the answer to either question is *yes* or *possibly*, a mitigation and monitoring plan must be designed and implemented to protect significant paleontological resources.

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

Other state requirements for paleontological resource management are in California Public Resources Code Chapter 1.7, Section 5097.5 (Stats. 1965, c. 1136, p. 2792), entitled Archaeological, Paleontological, and Historical Sites. This statute defines as a misdemeanor any unauthorized disturbance or removal of a fossil site or remains on public land 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 would apply to any construction or other related project impacts that would occur on state-owned or -managed lands.

2.3 County and City LORS

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 can inform these groups of its goals, policies, and development standards, thereby communicating what must be done to meet the objectives of the general plan.

The current general plan for the County of Sonoma (1989) contains no specific requirements, regulations, ordinances, conditions, standards, goals, or objectives designed to mitigate the negative impacts of development on paleontological resources. However, the proposed new general plan for the County of Sonoma that is currently under review by the County board contains the following provision:

> **Policy OSRC-19j:** Develop an archaeological and paleontological resource protection program that provides:
>
> (1) Guidelines for land uses and development on parcels identified as containing such resources,
>
> (2) Standard project review procedures for protection of such resources when discovered during excavation and site disturbance, and
>
> (3) Educational materials for the building industry and the general public on the identification and protection of such resources.

2.4 Professional Standards

The Society of Vertebrate Paleontology, an international scientific organization of professional vertebrate paleontologists, has established standard guidelines (SVP, 1995; 1996) that outline acceptable professional practices in the conduct of paleontological resource assessments and surveys, monitoring and mitigation, data and fossil recovery, sampling procedures, and specimen preparation, identification, analysis, and curation. Most practicing professional paleontologists in the nation adhere closely to the SVP's assessment, mitigation, and monitoring recommendations as specifically spelled out in these standard guidelines. Many federal and state regulatory agencies have either formally or informally adopted the SVP standard guidelines.

3.0 Paleontological Sensitivity of the Project Vicinity

3.1 Standards of Significance and Sensitivity Criteria

The Standards of Significance for paleontological resources were based on Appendix G of the CEQA Guidelines.

Significant impacts could occur if implementation of the Project would:

- Cause a substantial adverse change in the significance of a historical resource as defined in Public Resources Code Section 15064.5 of the CEQA Guidelines;
- Cause a substantial adverse change in the significance of a paleontological resource as defined in Public Resources Code Section 15064.5 of the CEQA Guidelines; or
- Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature.

In its standard guidelines for assessment and mitigation of adverse impacts to paleontological resources, the SVP (1995) notes that an individual fossil specimen is considered scientifically important and significant if it is: 1) identifiable, 2) complete, 3) well preserved, 4) age diagnostic, 5) useful in paleoenvironmental reconstruction, 6) a type or topotypic specimen, 7) a member of a rare species, 8) a species that is part of a diverse assemblage, and/or 9) a skeletal element different from, or a specimen more complete than, those now available for that species. For example, identifiable land mammal fossils are considered scientifically important because of their potential use in determining the age and providing input to paleoenvironmental reconstructions for the sediments in which they occur. Moreover, vertebrate remains are comparatively rare in the fossil record. Fossil plants are also important in this regard and, as sedentary organisms, are actually more sensitive indicators of their paleoenvironment, and thus are more important than mobile mammals for paleoenvironmental reconstructions. For marine sediments, invertebrate fossils, including marine 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, their abundance in the record, and their degree of preservation.

To establish the paleontological sensitivity of each stratigraphic unit likely to be present in or near the Project site the recorded paleontological productivity of those formations was assessed, based on the abundance of fossil remains in that unit elsewhere in Sonoma County, including previously recorded localities near the Project site. According to SVP (1995) standard guidelines, sensitivity comprises both (a) the potential for yielding abundant or significant vertebrate fossils or for yielding a few significant fossils, large or small, vertebrate, invertebrate, or botanical; and (b) the importance of recovered evidence for new and significant taxonomic, phylogenetic, ecologic, or stratigraphic data.

Using the criteria of the SVP (1995) and the sensitivity ratings provided in Table 2, the significance of potentially adverse impacts of earth moving on the paleontological resources was assessed. This assessment reflects the paleontological importance (sensitivity) of the stratigraphic unit, which in turn reflects the potential for fossil remains and fossil sites being encountered during earth moving. Any unmitigated impact on a fossil site or a fossil-bearing rock unit during construction/demolition activities would be considered significant, regardless of the previously determined paleontologic importance of the rock unit in which the site or fossiliferous layer occurs.

The rock stratigraphic record potentially present in the Project vicinity includes the following units, with their relative level of paleontological sensitivity assigned based on their known fossil record. The sensitivity ratings follow the criteria established for this region where fossil-bearing sediments are very common (Table 2).

TABLE 2
Definitions of Paleontological Sensitivity Ratings Employed in this Assessment

Sensitivity	Definition
High	Assigned to geological formations known to contain paleontological resources that include rare, well-preserved, and/or fossil materials important to on-going scientific studies. They have the potential to produce, or have produced, vertebrate remains that are the particular research focus of many paleontologists, and can represent important educational resources as well.
Moderate	Stratigraphic units that have yielded fossils that are but moderately well-preserved, are common elsewhere, and/or that are stratigraphically long-ranging would be assigned a moderate rating. This evaluation can also be applied to strata that have an unproven but strong potential to yield fossil remains based on its stratigraphy and/or geomorphologic setting.
Low	These include units that are relatively recent, or that represent a high-energy subaerial depositional environment where fossils are unlikely to be preserved. A low abundance of invertebrate fossil remains, or reworked marine shell from other units, can occur but the paleontological sensitivity would remain low due to their lack of potential to serve as significant scientific or educational purposes.
Marginal and Zero	Stratigraphic units with marginal potential include pyroclastic flows and soils that might preserve traces or casts of plants or animals. Most igneous rocks, however, have zero paleontological potential. Other stratigraphic units deposited subaerially in a high energy environment (such as alluvium) may also be assigned a marginal or zero sensitivity rating.

3.2 Results of Paleontological Records and Literature Review

A paleontological resources records review was conducted using two on-line databases: that of the University of California Museum of Paleontology at Berkeley, and the Paleobiology Database, an on-line tool maintained by an international consortium of scientists and funded in part by the National Science Foundation. Neither database can provide information on the location of paleontological sites at a level of resolution more exact than that of county, although literature searches can often reveal the position of these sites.

The UCMP records search returned results indicating that there are a minimum of 49 fossil localities within Sonoma County, yielding more than 300 specimens from six epochs including 1 specimen from the Late Cretaceous, 10 from the Miocene, 227 from the Pliocene, 12 from the Pleistocene and 16 from the Holocene. Only one of the specimens recorded by the UCMP database[1] is identified as coming from the principal fossiliferous unit at the Project site, the Wilson Grove Formation. This is the skull of a primitive balaenopterid whale from the Steinbeck Ranch locality ca. 13 miles to the southeast in the eastern Marin Range. Balaenopterid whales are filter-feeding, whale-bone whales such as the rorqual of the Pacific Ocean.

A search of the Paleobiology Database yielded two specimens collected from Sonoma County, California. These two samples are both Pliocene in age and were collected from the sediments described as the Merced Formation. As Powell et al. (2004) point out, many collections attributed to the Merced Formation in this area are now more properly attributed to the Wilson Grove Formation. Most of the Neogene fossil records from eastern Sonoma County are from the Petaluma Formation which is the terrestrial correlative of the Wilson Grove Formation. The Petaluma Formation outcrops generally farther east and represents the continental strata and paralic (shoreline and nearshore) sediments that were laid down at the same time as the off-shore sediments of the marine Wilson Grove Formation.

Powell et al. (2004) have mapped the recorded fossil localities within the Wilson Grove Formation. These are based on marine invertebrate collections housed chiefly at the California Academy of Sciences in San Francisco, the Los Angeles County Museum of Natural History, and the UCMP. The Project vicinity is just 0.75 mile south-southwest from the eponymous hamlet of Wilson Grove, and the fossil sites from this area constitute the type locality of the Wilson Grove Formation. The Project vicinity lies in similar geology less that 0.5 mile to the south. Twenty-one paleontological sites are mapped by Powell et al. (2004) within one mile of the Project vicinity, and two of these are immediately adjacent to the Project site. One is a collection site along the Eastside Road on the western periphery of the Project, and the other is immediately west of Mark West Station about 0.3 mile east-southeast of the Project vicinity. All of the fossils from the Wilson Grove Locality listed by Powell at al. (2004) are marine mollusks.

3.3 Paleontological Sensitivity of the Project Vicinity

The paleontological sensitivity of sediments that may be disturbed by the Project is a subjective assessment that incorporates (1) a probability assessment that fossils will be encountered during subsurface excavations, with (2) the chances that the encountered fossils will be scientifically significant according to the criteria discussed above. This paleontological sensitivity assessment is restricted to sediments and geological units that that are within the Project vicinity, which has been subject to detailed geological mapping and paleontological study (Blake et al., 2002; Powell et al., 2004; Geomatrix, 2004). The units

[1] More than 40 collections from the UCMP are listed by Powell et al. (2004) as from the Wilson Grove Formation, but these were not originally cataloged as from this formation, so they are not appropriately cross-referenced with respect to stratigraphic context in the database. This is not an uncommon phenomenon.

that occur in the Project vicinity are the Late Miocene to Late Pliocene Wilson Grove Formation, Quaternary terrace deposits capping the Wilson Grove Formation, and younger Quaternary sediments inset into the terrain formed by the erosion of the soft sediments comprising the Wilson Grove Formation. A field review carried out by the Project paleontologist provided additional perspective.

3.3.1 Wilson Grove Formation

As noted above, close to two dozen fossil sites comprise the Wilson Grove type locality of the Wilson Grove Formation (Powell et al., 2004). The Wilson Grove Locality is the highest in the formation's stratigraphic sequence and it therefore is the youngest. Several molluscan species restricted to the Late Pliocene in the fossil fauna of this area dates these strata to approximately 2.2 to 1.7 mya. The composite faunal list from the Wilson Grove Locality (Table 3) shows that the strata in the vicinity of the Project site contain a diverse molluscan fauna:

TABLE 3
Composite List of the Fossil Taxa Recovered from the Wilson Grove Formation in the Vicinity of the Project Site

Mollusca	
Bivalvia	**Gastropoda**
Anadara trilineata (Conrad)	*Astyris gausapata* (Gould)
Cardiidae, indeterminate	*Calicantharus*? sp.
Clinocardium sp., cf. *C. meekianum* (Gabb) *s.l.*	*Crepidula* sp., cf. *C. onyx* Sowerby
Cryptomya californica (Conrad)	*Crepidula princeps* Conrad
Glycymeris sp., cf. *G. grewingki* Dall	*Cryptonatica affinis* (Gmelin)
Macoma sp., cf. *M. addicotti* Nikas	*Fusitriton* sp., cf. *F. oregonensis* (Redfield)
Macoma nasuta (Conrad)	*Littorina petricola* Dall
Mactridae, indeterminate	*Megascurcula* sp., cf. *M. carpenteriana* (Gabb)
Mactromeris albaria (Conrad)	*Megascurcula remondi* (Gabb)
Mactromeris sp., cf. *M. polynyma* (Stimpson)	*Nassarius californianus* (Conrad)
Modiolus sp.	*Nassarius grammatus* (Dall)
Ostreidae, indeterminate	*Nucella* sp., cf. *N. emarginata* (Deshayes)
Pandora sp.	*Nassarius* sp.
Protothaca staleyi (Gabb)	*Natica janthostoma* Deshayes
Protothaca sp.	Naticidae, indeterminate
Siliqua lucida Conrad	*Neverita reclusiana* (Deshayes)
Solen sp., cf. *S. sicarius* Gould	*Neptunea tabulata* (Baird)?
Tresus sp., cf. *T. nuttallii* (Conrad)	*Nucella transcoana* Arnold
Tresus pajaroanus (Conrad)?	*Olivella biplicata* (Sowerby)
Veneridae, indeterminate	*Ophiodermella* sp., cf. *O. graciosana* Arnold
	Turridae, indeterminate

Source:
Powell et al., 2004

Twenty bivalve taxa and 21 gastropods comprise the faunal list for the Wilson Grove Locality; no arthropods (excluding indeterminate barnacle fragments) are reported. Powell et al. mentioned that vertebrates were recorded from CAS 54164 but were outside of their project scope.

Additional taxa from the type Wilson Grove beds not listed by Powell et al. (2004) include *?Scutellaster* sp. (CAS collections) and an odobenid (walrus) humerus (Los Angeles County Museum of Natural History collections). Bulk sampling of sediment from the Wilson Grove shell beds has yielded vertebrate and decapod remains, both of which can be useful chronological indicators. Locality CAS 54164, adjacent to the Project site, is a case in point. Concerted collecting there between 1969 and 1990 produced an aggregate faunal list of over 140 species including more than 65 invertebrate taxa, including 14 decapod and stomatopod crustaceans, a few polychaetes, and two echinoderms including *Scutellaster* n. sp. (J.W. Durham *fide* Roth and G.-Naidu, 1974). There are an additional minimum of 77 taxa of vertebrates including at least 52 fish taxa, 10 or 11 marine mammals, and at least 14 bird taxa. The bulk of this collection, reposited at CAS, UCMP and under study, was obtained through bulk sampling of over 6 metric tons of sediment. When considering both published and unpublished material, the aggregate biota of the Wilson Grove Formation exceeds 350 taxa including over 100 vertebrate taxa (G.-Naidu, 1999). Roth and G.-Naidu (1974) mention numerous fish, bird and mammal remains at locality CAS 54164, southwest of Wilson Grove. Zullo and G.-Naidu (1982) described and illustrated a bone lag overlying CAS 54135 in eastern Sonoma County, at the local base of the formation. Several cetacean (whales, dolphins and allies) taxa have been recovered from the Wilson Grove Formation, two of which were from locality CAS 51664 (UCMP V71108). One of these refers to the toothed odontocete *Parapontoporia* (Barnes, 1985).

Powell et al. (2004) placed CAS 54164 in the Pliocene and the type Wilson Grove Formation even later. Vertebrates from locality CAS 54164 (UCMP V71108) include small alcid birds and other taxa with great resemblance to similar taxa in the “Opal Cliffs beds” of the Purisima Formation at coastal Santa Cruz. Likewise, we note that several extinct decapod crustaceans from CAS 54164 are conspecific with material from the Opal Cliffs. The “Opal Cliffs beds” are estimated at 5.2-5.3 mya, constrained by rock magnetic polarity evidence (Madrid et al., 1986) and diatom (siliceous microfossil) zonation (Dumont et al., 1986). The Opal Cliffs beds are an estimated 40 or more meters below the section near Capitola (G.-Naidu, 1977) which Powell et al. (2004) report as containing an association of *Nuttallia jamesi* Roth and G.-Naidu and *Macoma addicotti* Nikas. This association was used to support a late Pliocene age for the Wilson Grove Formation at locality CAS 54164, south of Wilson Grove. Elsewhere, the vertebrates from CAS 54164 are estimated to be approximately 5.5 mya, or late Miocene.

Not far to the south of Wilson Grove, at locality CAS 51464 in road cuts immediate north and west of the Project vicinity, Powell et al. (2004) note that there are outcrops containing a tuff, faulted against fossiliferous strata, identified by them as the Roblar tuff. The Roblar tuff was dated at 5.4 mya by zircon fission-tract analysis and 6.2 mya based on recalculated potassium-argon analysis (Fox et al., 1985). A lack of suitable outcrops in this heavily vegetated area currently prevents understanding how this older volcanic ash can be in proximity to sediments that are apparently 4 million years younger based on paleontology (ibid., pp. 45-47). However, G.-Naidu (1999) detailed multiple tuffs present in the Wilson Grove Formation in its central western part, where at least four are relatively prominent (G.-Naidu*). The lower-most tuff is apparently undated, one of two stratigraphically central tuffs is apparently the Roblar tuff and the original Sonoma tuff of Osmont (1905) lies above the Roblar (G.-Naidu*). These tuffs are not necessarily all visible at the same time, dependent on local conditions including slumping and construction grading. Therefore the assumption made by Powell et al. (2004) regarding the identification of the Roblar tuff in the Project vicinity may be incorrect.

The Late Pliocene (2.2 to 1.7 mya) Wilson Grove Locality fauna includes four bivalve species that last appear in the fossil record in the Late Pliocene, with another four that may extend into the Early Pleistocene (Powell et al., 2004). So a total of eight taxa appear to indicate a Late Pliocene age for near the top of the Wilson Grove Formation, while the tuff would appear to contradict that if it is indeed of Late Miocene age and not separated by an unidentified discontinuity. Although Powell et al. (2004) are clear in that they believe that at least twelve bivalve taxa support a Late Pliocene age for the Wilson Grove Locality, they also admit that all these taxa are rare and their stratigraphic ranges are not well documented. They also come from separate collections comprising a composite fauna, rather than from a clearly measured stratigraphic section.

While it is more difficult to understand the paleoecology of the extinct species, the gastropod taxa from this fossil record (Table 3) that still survive occur along the present northern California coast, therefore suggesting that the temperature regime at that time was not substantially different from that of the present (Powell et al., 2004). There is apparently no indication in the fauna of the cooling that would have happened soon afterward during the transition from the Pliocene to a colder Pleistocene Epoch. Expansion of the polar ice caps and the beginning of episodic continental glaciations during this time led to important changes in the environment of the North Pacific.

Analysis: Any single marine invertebrate (a shell or shell fragment) encountered in this or any other portion of the Wilson Grove Formation would possess minimal scientific significance. However, assemblages of marine invertebrates from the Wilson Grove Formation have played an important role in understanding the geological and environmental history of this portion of California which has transitioned from coastal to interior in a geologically short span of time. New fossil assemblages from this formation could potentially address the scientific issues described above, and could have potentially substantive scientific significance should they be collected from a carefully measured stratigraphic section. Well controlled collections from the Wilson Grove Formation would yield additional fossil assemblages that could clarify:

- The age of the upper portion of the Wilson Grove Formation.
- The stratigraphic implications and relationships that may account for strata that may be somewhat younger approximately half mile to the north, and a volcanic tuff in the area that may be 4 million years older.
- The effects of environmental change and the chronology of oceanic cooling at the Plio-Pleistocene boundary.
- Material to better clarify the taxonomy of the Wilson Grove mollusks; 54 percent of those listed by Powell et al. (2004) have not been identified to species (Table 3). This in turn would yield better paleoenvironmental data.

Additional investigations in the Wilson Grove Formation could also yield the remains of either marine or terrestrial vertebrates, which to now have been scarce or entirely lacking in the fossil record of this formation. Hence, the Wilson Grove Formation which underlies the entire Project vicinity to depths exceeding 20 feet below ground surface (bgs) (Geomatrix, 2004) is considered to possess high paleontological sensitivity.

3.3.2 Older Quaternary Terrace Deposits

These sediments are the "alluvial and marine terrace deposits" of some authors (see Section 1.3.3.2, above). They are likely to be fluvial gravels of the ancestral Russian River, when it lay at a considerably higher base level than today. Their topographic position suggests an age of at least Middle Pleistocene (>125,000 B.P. [years before present]). There exist no outcrops in the Project vicinity where these Quaternary terrace deposits are likely to be more than 5 to 6 feet thick (Geomatrix, 2004), consistent with their topographic position as capping deposits on the crests of the highest ridges in the Project vicinity (ibid.). Similar gravel units forming "inverted topography" are common throughout the Central Valley (e.g., the Red Bluff Formation [Lettis and Unruh, 1991]). Inverted topography occurs as a result of erosion of soft sediment when river gravels, which once occupied the topographically low portion of a river bed, now armor the topographic highs of ridges and terraces.

Analysis: Fossils from these sediments would provide important information on the age of the ancestral Russian River when it stood at a considerably higher altitude than today, and on the paleontology of the Early to Middle Pleistocene of this area. However, Quaternary terrace deposits are typically relatively thin units such as those that occur in the Project vicinity, and are not known to be fossiliferous because their near-surface position means that they are strongly affected by soil formation processes. These chemical processes alter the sediment and usually destroy bone, shell and other organic remains over the millennia. This is consistent with the results of the records search and literature review, which revealed no fossil records for this geological unit. Therefore, older Quaternary terrace deposits in the Project vicinity have low paleontological sensitivity.

3.3.3 Younger Quaternary Terrace and Landslide Deposits

Some of the older terrace and landslide deposits in the study area may have buried Pleistocene fossils at depth, although none have been recorded in the Project vicinity. Younger colluvial mantle and alluvium dating to the Holocene are unlikely to yield scientifically significant fossils, but older sediments may be present in the small valleys in the Project vicinity where the streams appear underfit, and terraces can be found as much as five to ten feet above current base level. Late Pleistocene channel fills have in the past yielded occasional important records of Rancholabrean vertebrates. In the Wilson Grove Formation southwest of the Project, inset Pleistocene sediment occupies significant portions of exposed strata. These are difficult to recognize because they are composed primarily of sediment derived from the underlying Wilson Grove Formation. Among the Rancholabrean vertebrate remains recovered by local ranchers from younger sediment in the project vicinity over the years are the bones and teeth of mammoth (*Mammuthus*), horse (*Equus*), *Bison*, and an antilocaprid (an antelope-type ungulate). Younger sediments in the Project vicinity all have potential for fossil remains.

Analysis: A landslide deposit would contain no paleontological sensitivity except beneath its foot, where strata encased by the landslide would have high paleontological sensitivity. These encapsulated pods of sediment have yielded important Late Quaternary age fossils (e.g., Axelrod, 1988), although locating them can be problematic. The case cited (ibid.) is one of a number where erosion along long expanses of beach-cliff can be expected to expose the occasional landslide-encapsulated pod of sediment. If encountered, these sediments would have high paleontological sensitivity. The older (Late Pleistocene) and higher Late Quaternary terraces inset into current stream beds possess high paleontological sensitivity, while lower and younger Holocene terraces possess low paleontological sensitivity.

4.0 Environmental Consequences

The environmental impacts on paleontological resources from both construction and operation of the Project are assessed in the following subsections. As noted in Section 3.3 above, the geology of the Project vicinity is well-understood. Using that and an understanding of the paleontological sensitivity of those geological units, grading and excavation plans were reviewed to assess the impact to paleontological resources resulting from implementation of the Project.

4.1 Paleontological Resource Impact Assessment

In this section an assessment is presented of the significance of potential adverse impacts of Project-related activities on the paleontological resources of each stratigraphic unit present at the Project site. This assessment includes the entirety of the Project, including the right-of-way for the new pipeline proposed to extend from the pre-existing wastewater pipeline to the reservoir, the access road, the dam and its foundation excavations, excavations intended to contour the reservoir pool, the pump station immediately to the west, and pipelines extending from the reservoir.

4.1.1 Direct Impacts

The disturbance through excavation or grading of sediments that possess moderate to high paleontological sensitivity would be a significant adverse impact to non-renewable paleontological resources. However, simple placement of fill or structures constructed over paleontologically sensitive sediments would not adversely affect paleontological resources if no mechanical disturbance to those sediments is involved.

- **Younger Quaternary Terrace and Landslide Deposits -** Construction-related excavations in Holocene alluvium, or in colluvium and landslide deposits, will result in no adverse impacts to paleontological resources because these sediments possess low paleontological sensitivity. Reworked and disturbed fossil material, especially mollusks from the underlying Wilson Grove Formation, can be expected in colluvial and landslide deposits, but lack of stratigraphic context compromises their scientific value.

  Mechanical disturbance of older Pleistocene terraces and pods of sediment that may lie beneath the lobes of older landslides would adversely affect non-renewable paleontological resources. These sediments possess high paleontological sensitivity because, in other areas, geologically similar deposits have yielded scientifically important Late Pleistocene vertebrate and paleobotanical remains.

- **Older Quaternary Terrace Deposits** - Excavation, grading, or other mechanical disturbance to these sediments would not adversely impact paleontological resources. Although their topographic position high above the current level of the Russian River speaks to an intriguing geological history, the fluvial gravels that mantle the ridge crests in the Project vicinity are unlikely to yield paleontological resources, and therefore have a low paleontological sensitivity.
- **Sediment of The Wilson Grove Formation-** Present at shallow depth below colluvium and relatively thin Quaternary deposits, construction-related disturbance of this unit by trenching, grading, or other means would constitute a significant adverse impact to paleontological resources because of the potential for the loss of scientifically important fossil remains, faunal assemblages, unrecorded fossil sites, and corresponding specimen data, as well as associated geochronological and paleoenvironmental data.

Impacts to paleontological resources as a consequence of the implementation of the Project would be those resulting from construction. Construction-related impacts to paleontological resources from the Project would result primarily from terrain modification (grading for the reservoir pool, excavations for the dam foundation) and facility installation (temporary excavations for pipelines, pump house foundations, etc.).

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, would be adversely affected by (i.e., would be sensitive to) direct environmental impacts resulting from ground disturbance and earth moving associated with construction of the Project, including its ancillary facilities. Direct impacts would result from trenching, grading, augering, and any other activity that would impact previously undisturbed fossiliferous sediments, compromising the scientific value of the paleontological resources affected. Although earth moving associated with construction of the Project would be a comparatively short-term activity, the loss of fossil remains, unrecorded fossil sites, associated specimen data and corresponding geologic and geographic site data, and the fossil-bearing strata would be a significant and adverse environmental impact.

No impacts to paleontological resources would occur from the operation and maintenance of the Project or any of its ancillary facilities, because operation and maintenance of these facilities would not involve disturbance of paleontologically sensitive sediments.

4.1.2 Indirect Impacts

Indirect impacts to paleontological resources are not anticipated from the construction or operation of the Project. Indirect impacts could include, hypothetically, unauthorized fossil collection resulting in the loss of significant specimens, or *in situ* degradation of fossils by additional groundwater passing through strata as a result of a newly emplaced reservoir. Due to the widespread occurrence of the Wilson Grove Formation, and the ubiquity of the common mollusks that comprise the majority of its fauna, unauthorized casual collection is unlikely to result in the loss of scientifically significant specimens. Restricted access to the Project vicinity after construction will also reduce the probability of this activity occurring. Engineering measures will be taken to minimize infiltration, including lining of the reservoir, that will physically impede additional saturation. Also, the fact that the strata underlying the Project vicinity are saturated with percolating meteoric water for extensive periods during the winter rainy season indicates that the precondition for degradation through saturation (persistently dry sediment) does not exist.

4.1.3 Cumulative Impacts

Widespread recent development in Sonoma County has resulted in proportionately extensive impacts to paleontological resources, and this is anticipated to continue. The extensive nature of these cumulative impacts is in part due to the widespread presence of a number of fossiliferous sedimentary units in the Santa Rosa-Cotati Valley (see Sections 1.3.2 and 3.3.1).

Because paleontological resources will be encountered during Project-related ground disturbance, the Project has the potential to contribute to cumulative impacts to paleontological resources resulting from development in this region. However, the relative contribution of the Project to cumulative negative impacts would be negligible with implementation of the mitigation measures proposed in Section 5.0. Full implementation of these measures would effectively recover the value to science of significant fossils and fossil assemblages encountered during Project construction. Thus, the proposed Project would not cause or contribute substantively to cumulative impacts to paleontological resources.

5.0 Mitigation Measures

5.1 Environmental Checklist

Guidelines for the Implementation of CEQA (Public Resources Code Sections 15000 et seq.) include the following among the questions to be answered in the Environmental Checklist (Section 15023, Appendix G): “Would the project directly or indirectly destroy a unique paleontological resource or site?” and “Does the project have the potential to…eliminate important examples of the major periods of California…pre-history?” These questions are answered in the affirmative based on the data and considerations provided above. Because construction of the Project will have potential adverse impacts on significant paleontological resources, mitigation measures are appropriate to reduce these impacts to a less-than-significant level.

The effectiveness of these mitigation measures lie in the fact that the chief value possessed by fossil resources is their scientific and educational potential; mitigation of Project impacts is directed at recovering these values. Not unrelated to these core values but particularly relevant to a growing urgency regarding climate change in the Twenty-First Century, they also represent periods of California prehistory that have particular relevance to understanding the causes and effects of environmental change.

5.2 Proposed Mitigation Measures

Impacts to non-renewable paleontological resources would result from construction of the Project. No operational impacts are anticipated, and no indirect effects were identified. Mitigation measures that would be implemented to reduce potential adverse impacts to significant paleontological resources resulting from Project construction would also reduce the Project’s contribution to cumulative impacts. These proposed paleontological resource impact mitigation measures would reduce, to an insignificant level, the direct and cumulative adverse environmental impacts on paleontological resources that might result from Project construction. The mitigation measures proposed below are in compliance with SVP standard guidelines for mitigating adverse construction-related impacts on paleontological resources (SVP, 1995, 1996):

PALEO-1. Project Paleontologist. Prior to construction, a qualified paleontologist will be retained as Project paleontologist to design and implement a monitoring and mitigation program during Project-related earth-moving activities. Qualifications will include at least an advanced degree in paleobiology or paleontology and experience in paleontological resources mitigation.

PALEO-2. Paleontological Resources Monitoring. Prior to construction, the paleontologist will review excavation plans to determine where sensitive stratigraphic units will be disturbed by Project-related earth movement, and during what phases of construction this will occur. Earth moving construction activities will be monitored where they will disturb previously undisturbed sediment of the Tertiary Wilson Grove Formation, or paleontologically sensitive Quaternary sediment.

Monitoring will be coordinated with other aspects of the mitigation program (see Paleo-3, below), and will be guided by a Monitoring Plan that has been reviewed and commented upon by construction management. Monitoring will not be conducted in areas where the ground will not be disturbed, and when only sediment or fill of low or no paleontological sensitivity will be disturbed. Those operations that are expected to have no impacts to paleontological resources, such as clearing and grubbing, grading, and construction, will be identified as requiring no monitoring.

PALEO-3. Paleontological Resources Program. The Paleontological Resources Mitigation Program (PRMP) will be developed for review and approval by the Town of Windsor prior to implementation. The PRMP will include, at a minimum:

- Preconstruction coordination and planning requirements
- The construction monitoring plan including coordination requirements for monitoring
- Fossil discovery procedures for construction personnel
- Plans for salvage, sampling and data recovery
- Minimum requirements for museum storage including specimen preparation, data requirements, and curation costs
- Reporting requirements, to include monthly monitoring reports as well as a final report

Because the Project will be affecting a known fossil resource (the Tertiary Wilson Grove Formation), paleontological sampling will be conducted during excavations. The sampling will be coordinated in such a fashion as to avoid interference with construction-related activities. Per standard paleontological techniques (SVP, 1995; 1996) it will involve bulk sampling of at least 200 lbs and as much as 6,000 lbs of sediment for screen washing and sorting of fossil materials. A construction contractor's front-end loader is usually used to transport a single large scoop of material to a temporary stockpile area, where the sediment is screen-washed for fossils by a paleontological technician or monitor.

Design of the sampling program will maximize the probability that the specimens collected will come from different strata affected by the Project, and that sample sizes be sufficient to provide a data source to address important geological and paleontological questions that remain outstanding (see Section 3.3). Along with bulk sampling for mitigation purposes, "discovery" procedures for construction equipment encounters with paleontological specimens, and procedures for the collection of other scientifically important materials such as volcanic ash or paleobotanical materials, will be described in the PRMP.

PALEO-4. Construction Personnel Education. Prior to working on the site for the first time, all personnel involved in earth-moving activities will be provided with Paleontological Resources Awareness Training as a module in their worker environmental awareness training. They will be informed that fossils are likely to be encountered, provided with information on their appearance, the role of the paleontological monitors and the PRMP, and on proper notification procedures. This worker training will be prepared and initially presented by the Project paleontologist. Subsequent training may be conducted using recorded and hard copy training materials, or be given by qualified paleontological monitors.

Implementation of these mitigation measures would reduce the potential impact from Project-related ground disturbance on paleontological resources to an insignificant level by allowing for the recovery of fossil remains and associated specimen data, and corresponding geologic and paleoenvironmental data, that otherwise might be lost to earth moving and to other mechanical disturbance. These scientific and associated educational values constitute the chief significance of the resource, and their recovery therefore mitigates the impacts to that resource.

6.0 Residual Impacts

With a well designed and implemented PRMP, Project construction could result in beneficial impacts to paleontological resources through the recovery of fossil remains that would otherwise not have been exposed, and therefore would not have been available for study. This consideration is particularly applicable to this area with its complex geological history and potentially rich, but largely inaccessible, paleontological record.

6.1 Significant Unavoidable Adverse Impacts

No significant unavoidable adverse impacts on paleontological resources are anticipated as a result of the construction and/or operation of the Project.

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