3.2.4 Paleontology

Regulatory Setting

Paleontology is the study of life in past geologic time based on fossil plants and animals. A number of federal statutes specifically address paleontological resources, their treatment, and funding for mitigation as a part of federally authorized or funded projects. (e.g., Antiquities Act of 1906 [16 USC 431-433], Federal-Aid Highway Act of 1960 [23 USC 305]). Under California law, paleontological resources are protected by the California Environmental Quality Act, the California Code of Regulations, Title 14, Division 3, Chapter 1, Sections 4307 and 4309, and Public Resources Code Section 5097.5.

Federal Regulations

Omnibus Public Lands Act of 2009

The Omnibus Public Lands Act of 2009 (H.R. 146 [2009], Pub. L. No. 111-11) includes provisions for the protection and preservation of paleontological resources. Under this law, the Secretaries of both the Department of the Interior and the Department of Agriculture are directed to inventory, manage, and protect paleontological resources on the public lands they administer. In addition, the Secretaries are directed to coordinate these efforts and to establish education programs to increase public awareness of the significance of paleontological resources. The law also prohibits the collection of paleontological resources from federal land without a permit, except in the case of noncommercial collecting that complies with other regulations for that federal land.

State Regulations

California Environmental Quality Act

CEQA encourages the protection of all aspects of the environment by requiring state and local agencies to prepare multidisciplinary analyses of the environmental impacts of a proposed project and to make decisions based on the findings of those analyses.

CEQA includes in its definition of *historical resources* “any object [or] site … that has yielded or may be likely to yield information important in prehistory” (State CEQA Guidelines 15064.5[3]), which typically is interpreted as including fossil materials and other paleontological resources. More specifically, destruction of a “unique paleontological resource or site or unique geologic feature” constitutes a significant impact under CEQA (State CEQA Guidelines, Appendix G). The treatment of paleontological resources under CEQA is generally similar to the treatment of cultural resources, requiring an evaluation of resources in a project’s area of potential effects; an assessment of potential impacts on significant or unique resources; and the development of mitigation measures for potentially significant impacts, which may include monitoring combined with data recovery or avoidance.

California Public Resources Code

Several sections of the California Public Resources Code (PRC) protect paleontological resources. PRC 5097.5 prohibits “knowing and willful” excavation, removal, destruction, injury,

and defacement of any paleontologic feature on public lands (lands under the jurisdiction of a state, county, city, district, or public authority or under the jurisdiction of a public corporation), except where the agency with jurisdiction has granted express permission. PRC 30244 requires reasonable mitigation for impacts on paleontological resources that occur as a result of development on public lands. The sections of the California Administrative Code relating to the state Division of Beaches and Parks afford protection to geologic features and "paleontological materials" but grant the director of the state park system authority to issue permits for specific activities that may result in damage to such resources, if the activities are in the interest of the state park system and for state park purposes (California Administrative Code 4307–4309).

Local Regulations

The Solano County General Plan does not have policies related to paleontological resources. However, the background report prepared for the Solano County General Plan update (EDAW 2006:7-23–7-26) assigns a paleontological sensitivity to geologic units found in the county. The sensitivity evaluations are based on the Society of Vertebrate Paleontology (SVP) guidelines and record searches of the University of California Museum of Paleontology (UCMP) database (EDAW 2006:7-20 and 7-26). In addition, the EIR written for the general plan update provides mitigation measures to protect paleontological resources (EDAW 2008:4.10-39–4.10-40).

Professional Standards and Guidelines

In response to a recognized need for standard guidance, the SVP published *Standard Guidelines for the Assessment and Mitigation of Adverse Impacts to Nonrenewable Paleontologic Resources*, a set of standard guidelines that are now widely followed (Society of Vertebrate Paleontology Conformable Impact Mitigation Guidelines Committee 1995, updated 2007). These guidelines are generally consistent with Caltrans criteria and represent the accepted standard of care for paleontological resources. The SVP guidelines identify two key phases in the process for protecting paleontological resources from project impacts.

1. Assess the likelihood that the project's area of potential effect contains significant nonrenewable paleontological resources that could be directly or indirectly affected, damaged, or destroyed as a result of the project.
2. Formulate and implement measures to mitigate potential adverse impacts.

An important strength of the SVP's approach to assessing potential impacts on paleontological resources is that the SVP guidelines provide some standardization in evaluating a project area's paleontological sensitivity. Table 3.2.4-1 defines the SVP's sensitivity categories for paleontological resources and summarizes SVP's recommended treatments to avoid adverse impacts in each sensitivity category.

Table 3.2.4-1. Society of Vertebrate Paleontology's Definitions of Sensitivity Categories and Recommended Treatment for Paleontological Resources

Sensitivity Category	Definition	Recommended Mitigation Treatment
High	Areas underlain by geologic units from which vertebrate or significant invertebrate fossils or suites of plant fossils have been recovered	• Preliminary survey and surface salvage before construction begins • Monitoring and salvage during construction • Specimen preparation; identification, cataloging, curation, and storage of materials recovered • Preparation of final report describing finds and discussing their significance • All work should be supervised by a professional paleontologist who maintains the necessary collecting permits and repository agreements
Undetermined	Areas underlain by geologic units for which little information is available	• Preliminary field surveys by a qualified vertebrate paleontologist to assess the project area's sensitivity • Design and implementation of mitigation if needed, based on the results of field survey
Low	Areas underlain by geologic units that are not known to have produced a substantial body of significant paleontologic material	Protection and salvage generally are not required; however, a qualified paleontologist should be contacted if fossils are discovered during construction, in order to salvage finds and assess the need for further mitigation

Source: Society of Vertebrate Paleontology Conformable Impact Mitigation Guidelines Committee 1995 and 2007.

SVP's guidelines also provide a working definition of *significance* as applied to paleontological resources. According to SVP, significant paleontological resources are those that fulfill one or more of the following criteria (Society of Vertebrate Paleontology Conformable Impact Mitigation Guidelines Committee 1995 and 2007).

- Provide important information shedding light on evolutionary trends and/or helping to relate living organisms to extinct organisms.
- Provide important information regarding the development of biological communities.
- Demonstrate unusual circumstances in the history of life.
- Represent a rare taxon or a rare or unique occurrence; are in short supply and in danger of being destroyed or depleted.
- Have a special and particular quality, such as being the oldest of their type or the best available example of their type.
- Provide important information used to correlate strata for which it may be difficult to obtain other types of age dates.

Significant paleontological resources may include vertebrate fossils and their associated taphonomic and environmental indicators; invertebrate fossils; and/or plant fossils.

Affected Environment

The information in this section is taken from the *I-80/I-680/SR 12 Interchange Project, Paleontological Sensitivity Analysis* conducted for the proposed project in 2009.

Site Geology

Site geology is provided in Section 3.2.3, "Geology/Soils/Seismic/Topography," Figure 3.2.3-1 is a generalized geologic map of the project site, based on the work of Graymer et al. (2002).

Paleontological Sensitivity

Most of the project alternatives would be located on Holocene alluvial fan deposits (Qhf or Qhff) or levee deposits (Qhl) (Graymer et al. 2002) (Figure 3.2.4-1). These deposits are young and have low potential to contain paleontological resources (in contrast to older sediments of Pleistocene age), and there are no known records of vertebrate fossils in these deposits in Solano County (University of California Museum of Paleontology 2007). Although the alluvial fan deposits (Qhf) are not considered highly sensitive, they may overlie relatively shallow Pleistocene sediments that could be sensitive. The depth of the Holocene alluvial fan deposits ranges from approximately 0 to 25 feet.

The results of database and literature searches indicate that units are highly sensitive for paleontological resources. Table 3.2.4-2 summarizes paleontological resources and sensitivity of geological units in the project area.

Some of the western and southern portion of the project area is located in Late Pleistocene alluvial fan deposits (Qpf). Although there are no known fossils records from this deposit within Solano County, diverse vertebrate faunas have been collected from similar Pleistocene alluvial units in other parts of northern California. These deposits are sensitive for paleontological resources because they tend to contain vertebrate fossils. In addition, Pleistocene units containing nonmarine fossil are considered highly sensitive.

Outcrops of the Sonoma Volcanics (Tsvt and Tsva) occur in the western portion of the project area, west of Suisun Creek, and in the vicinity of the I-80/SR 12W interchange. Of the 69 records of vertebrate fossils in Solano County (University of California Museum of Paleontology 2007a), 29 are from the Sonoma Volcanics unit. These records include horse, deer, and unidentified mammals. The unit is sensitive for paleontological resources because it is known to contain vertebrate fossils.

The Markley Sandstone occurs on the western edge of the project area. This unit is a marine deposit containing bony fish (Osteichthyes) fossils, as well as gastropods and microfossils. The UCMP (2007a) database has no records of fossils from the Markley Formation in Solano County, but it does have four records of Osteichthyes in this unit in neighboring Contra Costa County. The unit is sensitive for paleontological resources because it contains vertebrate fossils (Society of Vertebrate Paleontology Conformable Impact Mitigation Guidelines Committee 1995).

Table 3.2.4-2. Preliminary Summary of Paleontological Resource Sensitivity for Geologic Units in the I-80/I-680/SR 12 Interchange Project Area[a]

Geologic Unit	Age	Fossil Content and Fossils	Solano County General Plan Background Report Description of Sensitivity[b]	Potential to Contain Significant Fossils
Artificial fill (af)	Historic	Deposits are artificial and will not contain fossils	Holocene alluvium does not contain paleontologically sensitive resources	No potential for fossils
Artificial fill over bay mud (afbm)	Historic	Deposits are artificial and will not contain fossils		No potential for fossils
Alluvial fan deposits (Qhf)	Holocene	No record of fossils in the project area; in general, these younger alluvial units do not contain significant vertebrate fossils		Low; however, it may form only a thin veneer over sensitive Pleistocene sediments (Graymer et al. 2002)
Fine-grained alluvial fan deposits (Qhff)	Holocene	No record of fossils in the project area; in general, these younger alluvial units do not contain significant vertebrate fossils		Low
Natural levee deposits (Qhl)	Holocene	No record of fossils in the project area; most likely no significant fossils in this unit		Low
Landslide deposits (Qls)	Holocene and Pleistocene	No record of fossils in the project area; these deposits are shed from the hills to the northwest; it is possible that landslide units of Pleistocene age could contain significant vertebrate fossils	Not applicable	Unknown and monitoring or detailed geologic mapping of this unit should occur
Allluvial fan deposits (Qpf)	Late Pleistocene	No record of fossils in the project area; however, diverse vertebrate faunas have been collected from other similar Pleistocene alluvial units in northern California; Pleistocene alluvial units tend to contain vertebrate fossils	Pleistocene alluvium is highly sensitive for paleontological resources	High
Sonoma Volcanics (Tsv) and ash-flow tuff (Tsvt)—subdivision of Sonoma volcanics	Pliocene and late Miocene	This unit is well known for its fossils; the UCMP (2007a) database includes 29 records of vertebrate fossils in this unit in Solano County alone; records are of unidentified mammals, one horse (*Equus occidentalis*), and deer (Cervidae)	Sonoma Volcanics are highly sensitive for paleontological resources	High
Markley Sandstone (Tmk)	Eocene	This unit is a marine deposit and contains bony fish (Osteichthyes) fossils, as well as gastropods and microfossils; no records of fossils from the unit in Solano County, but the UCMP (2007a) database contains four records of Osteichthyes (bony fishes) in neighboring Contra Costa County	Fossils commonly found in the Markley Formation are not highly sensitive because of their abundance, but there is potential for significant resources	High
Undivided sandstone, siltstone, and shale of the Great Valley complex (Ku)	Late Cretaceous	The UCMP database contains no records of fossils from the Great Valley complex (or sequence), and there is only one record of a Cretaceous fossil not assigned to a unit; however, strata of Great Valley complex in other areas are known to contain Cretaceous marine fossils, including invertebrates and marine reptiles (University of California Museum of Paleontology 2007b)		High

[a] Information is based on geologic formations identified in the project area from the geologic map of Graymer et al. (2002), UCMP database searches (2007), and a review of the *Solano County General Plan* (EDAW 2006).
[b] EDAW 2006.

Environmental Consequences

Impacts on paleontological resources were analyzed qualitatively, based on professional judgment. This analysis focuses on (1) identifying activities with the potential to disturb, damage, or destroy paleontological resources if any are present on the work site and (2) developing a strategy to ensure that mitigation requiring paleontological sensitivity assessment and appropriate treatment developed on a site-specific basis is in place for those activities identified as likely to result in damage.

Two factors are considered when evaluating a proposed project's potential to disturb or damage significant paleontological resources. First, most vertebrate fossils are rare and are therefore considered important paleontological resources. Second, unlike archaeological sites, which are narrowly defined, paleontological sites are defined by the entire extent (both areal and stratigraphic) of a unit or formation. In other words, once a unit is identified as containing vertebrate fossils or other rare fossils, the entire unit is a paleontological site (Society of Vertebrate Paleontology Conformable Impact Mitigation Guidelines Committee 1995 and 2007).

Because excavation can disturb or destroy paleontological resources, the potential for impacts on paleontological resources is based on the depth and extent of excavation and the paleontological sensitivity of the units. Figures 3.2.4-2, 3.2.4-3a and b, and 3.2.4-4a and b show areas where bridge work will occur and the area where excavation for the Red Top Road expansion will occur. These areas are overlain on the sensitivity of the geologic units for paleontological resources. Note that not all the ground in the bridge areas will be excavated (i.e., excavation for footings will occur in localized areas within the bridge areas), but the entire Red Top Road expansion area will be excavated. The figures evaluate the potential to encounter paleontological resources during excavation. Three designations are given to excavation:

- Excavation in areas with high potential for paleontological resources (i.e., areas of paleontologically sensitive high-potential units such as the Sonoma Volcanics and Late Pleistocene alluvial deposits, and areas with shallow low-potential units—Holocene deposits believed to be less than 15 feet thick—overlying high-potential units such as Late Pleistocene alluvial deposits).
- Excavation in areas with low potential for paleontological resources (i.e., Holocene deposits believed to be greater than 15 feet thick).
- Excavation in areas with unknown potential for paleontological resources (i.e., thickness of Holocene deposits is unknown).

Although Figures 3.2.4-2, 3.2.4-3a and b, and 3.2.4-4a and b provide more detailed information on the potential to encounter paleontological resources, the figures are approximate (i.e., they are not georectified and the exact boundaries and depths of geologic units is not known).

Destruction of Vertebrate or Otherwise Scientifically Significant Paleontological Resources as a Result of Construction Activities

Several units are sensitive for paleontological resources and fossils could be present in the project area. Figure 3.2.4-2, Figure 3.2.4-3a, and Figure 3.2.4-3b show the locations of the following sensitive units.

- Relatively shallow Pleistocene sediments that could be sensitive underlying Holocene alluvial fan deposits (Qhf), which range in depth from approximately 0 to 25 feet, in the central and eastern portion of the project area—the likelihood of encountering sensitive deposits increases with depth and with proximity to surficial exposures of sensitive deposits.
- Late Pleistocene alluvial fan (Qpf) deposits that are highly sensitive in the western portion of the project area—although there are no known fossils records from this deposit within Solano County, diverse vertebrate faunas have been collected from similar Pleistocene alluvial units in other parts of northern California. These deposits are sensitive for paleontological resources because they tend to contain vertebrate fossils.
- Outcrops of Sonoma Volcanics (Tsvt and Tsva) that are highly sensitive in the western portion of the project area, west of Suisun Creek, and in the vicinity of the I-80/SR 12W interchange—of the 69 records of vertebrate fossils in Solano County (University of California Museum of Paleontology 2007), 29 of them are from the Sonoma Volcanics unit, including horse, deer, and unidentified mammals (Table 3.2.4-2).

If fossils are present in the project area, they could be damaged during project construction. Substantial damage to or destruction of significant paleontological resources as defined by the SVP (Society of Vertebrate Paleontology Conformable Impact Mitigation Guidelines Committee 1995and 2007) would represent an impact.

The effect under Alternative C would be the same as under Alternative B but to a greater extent (Figure 3.2.4-2, Figure 3.2.4-4a, and Figure 3.2.4-4b). Table 3.2.4-3 compares the impacts of major excavation areas for Alternatives B and C on paleontological resources based on depth and extent of excavation and the paleontological sensitivity of the unit. Only project components that differ between alternatives are included. It should be noted, however, that both alternatives involve extensive, deep grading associated with the Red Top Road expansion in the paleontologically sensitive Markley Sandstone (Eocene), Sonoma Volcanics (Pliocene and late Miocene), and alluvial fan deposits (Late Pleistocene). It would not be possible to avoid paleontologically sensitive units in the project area because they are widespread. Any improvements involving excavation for bridge or overcrossing footings in the vicinity of the I-80/I-680 or I-80/SR 12W interchanges would, therefore, have the potential to affect significant paleontological resources.

Table 3.2.4-3. Comparison of Paleontological Impacts by Alternative

Project Component	Alternative B		Alternative C		Comment
	Activity	Sensitivity of Work Area	Activity	Sensitivity of Work Area	
New Interchange at SR 12W and I-80	Excavation of bridge footings excavated for improvements	High	Excavation of numerous bridge footings for new interchange and expansion	High	Alternative C involves many more footings and greater excavation area
Realignment of I-680	None	None	Grading	High	Alternative C involves extensive ground-disturbing activities
Improvements of I-80 and I-680	Grading for expanded interchange and excavation of footings for new bridge over Green Valley Creek	High to low	Excavation of footings for new bridge over Green Valley Creek	Low	Alternative B involves more extensive excavation, including excavation in a sensitive unit
New Single-Span Bridges over Green Valley Creek	None	None	Excavation of bridge footings	Low at surface but unknown at depth	
New Bridge at Suisun Creek	Excavation of bridge footings	Low	None	None	Alternative B would involve more excavation but only in low-sensitivity units
Truck Scale On-Ramp to Eastbound I-80	Excavation of bridge footings	Low at surface but unknown at depth	None	None	All impacts are related to Alternative B; impacts will depend on depth of excavation relative to depth of Holocene deposits
New Central Interchange					
Widened Bridge at Myer Lane over Ledgewood Creek					
New Overcrossing at Beck Avenue	None	None	Excavation of bridge footings for new overcrossing	Low at surface but unknown at depth	All impacts are related to Alternative C; impacts will depend on depth of excavation relative to depth of Holocene deposits

Notes: Project components common to both alternatives are not included in this table.
Alternative with greater impact is shaded.

The effect under the fundable first phases of the alternatives would be the same as the full-build alternatives but to a lesser extent, given the smaller project footprint and the smaller amount of excavation. Implementation of avoidance and minimization measures listed below would result in no adverse effect relating to destruction of vertebrate or otherwise scientifically significant paleontological resources under all build alternatives.

There would be no excavation or other ground disturbance under the No-Build Alternative. Therefore, there would be no potential for adverse effect relating to paleontological resources under the No-Build Alternative.

Avoidance, Minimization, and/or Mitigation

Avoidance or minimization would not be possible because paleontologically sensitive units in the project area are widespread. Any improvements involving excavation for bridge or

overcrossing footings in the vicinity of the I-80/I-680 or I-80/SR 12W interchanges would, therefore, have the potential to affect significant paleontological resources.

Mitigation measures that will be used to reduce project effects are described below. As part of the monitoring and mitigation strategy, further geotechnical data will be reviewed as they become available, and this information will be used to develop and refine an appropriate, effective, and feasible monitoring and mitigation strategy.

Conduct Preconstruction Surveys

The Department will conduct preconstruction studies to ensure that paleontological materials exposed at the surface are recovered and properly prepared and curated, or protected from damage using exclusion fencing or other appropriate means, and to further assess potential for impacts.

Educate Construction Personnel in Recognizing Fossil Material

The applicant will ensure that all construction personnel receive training provided by a qualified professional paleontologist experienced in teaching non-specialists, to ensure that they can recognize fossil materials in the event any are discovered during construction.

Retain a Qualified Professional Paleontologist to Monitor Ground-Disturbing Activities

In accordance with the Department's standard mitigation procedures for construction in units with the potential to contain fossils, the applicant will retain a qualified professional paleontologist as defined by the Department's Standard Environmental Reference and the Society of Vertebrate Paleontology Conformable Impact Mitigation Guidelines Committee (1995 and 2007) to monitor activities with the potential to disturb units sensitive for paleontological resources. Data gathered during preconstruction surveys for paleontological resources, and detailed project design, will be used to determine the activities that will require the presence of a monitor. In general, these activities include any ground-disturbing activities involving excavation in areas with high potential to contain fossils or excavation deeper than three feet in areas with low or unknown potential to contain fossils. Recovered fossils will be prepared so that they can be properly documented. Recovered fossils will then be curated at a facility that will properly house and label them, maintain the association between the fossils and field data about their provenance, and make the information available to the scientific community.

Stop Work and Conduct Appropriate Treatment if Substantial Fossil Remains Are Encountered During Construction

In accordance with the Department's standard mitigation procedures for construction in units with the potential to contain fossils, when requested by the paleontological monitor, earth-disturbing activities will be stopped in an area or diverted to allow for the safe recovery of fossil specimens. Additionally, if construction personnel observe fossils in an area where paleontological resources were not anticipated and paleontological monitors are therefore not present, earth-disturbing activities will be stopped until the material can be evaluated by a monitor and appropriate treatment taken. Recovered fossils will be prepared so that they can be

properly documented. Recovered fossils will then be curated at a facility that will properly house and label them, maintain the association between the fossils and field data about their provenance, and make the information available to the scientific community. The applicant will be responsible for ensuring that monitor's recommendations regarding treatment and reporting are implemented.

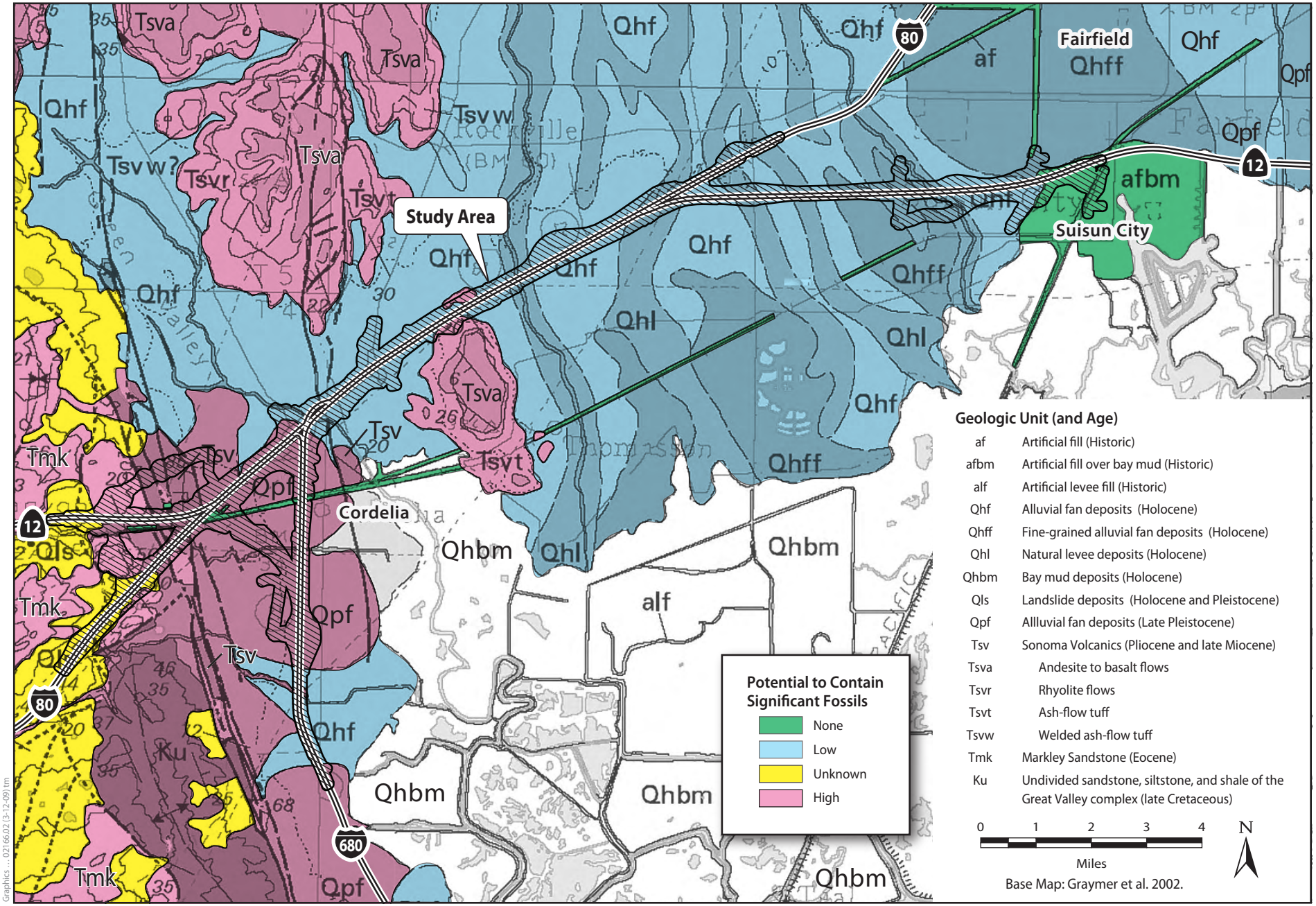

Figure 3.2.4-1
Paleontological Sensitivity Map of the Project Area

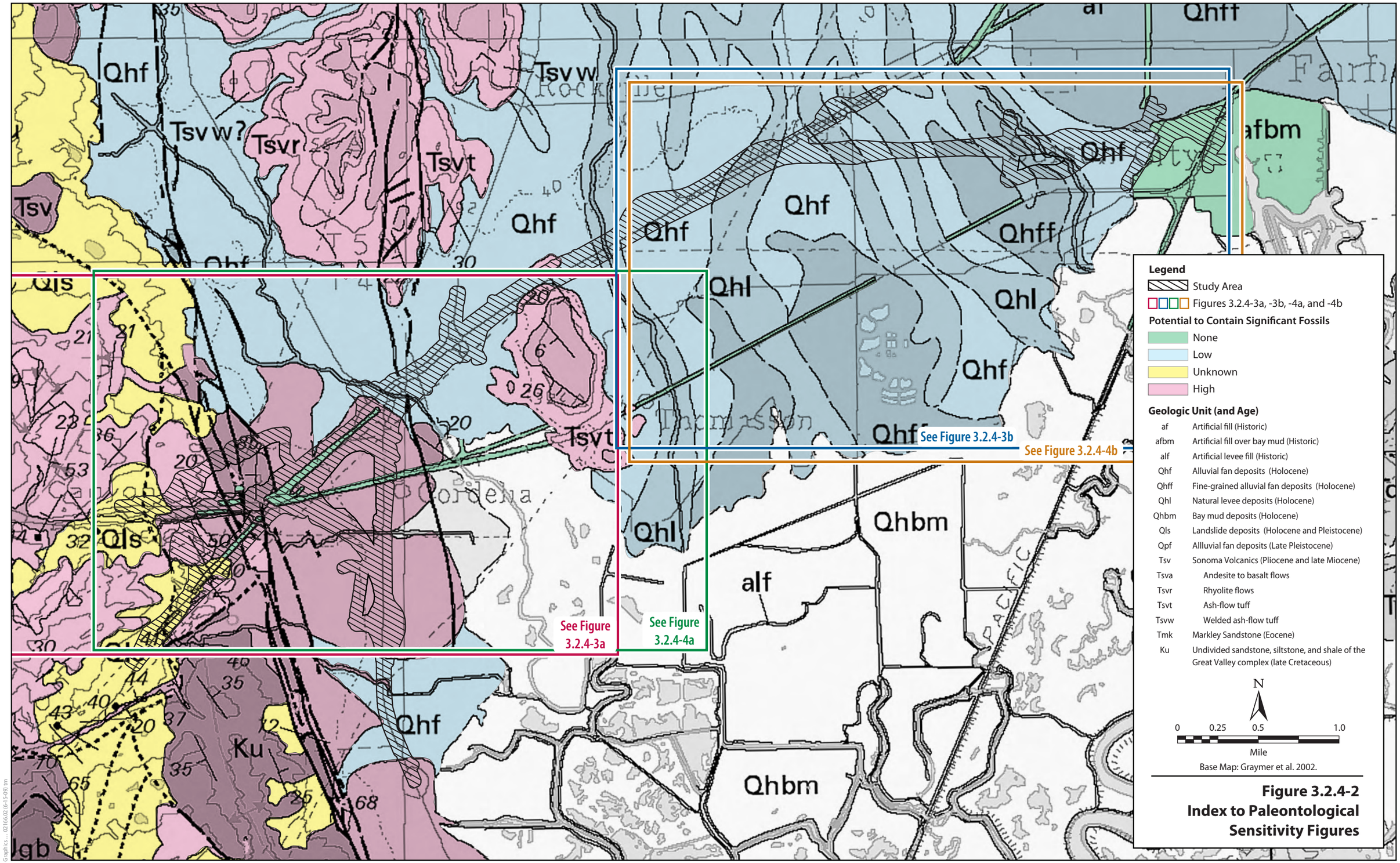

Figure 3.2.4-2
Index to Paleontological Sensitivity Figures

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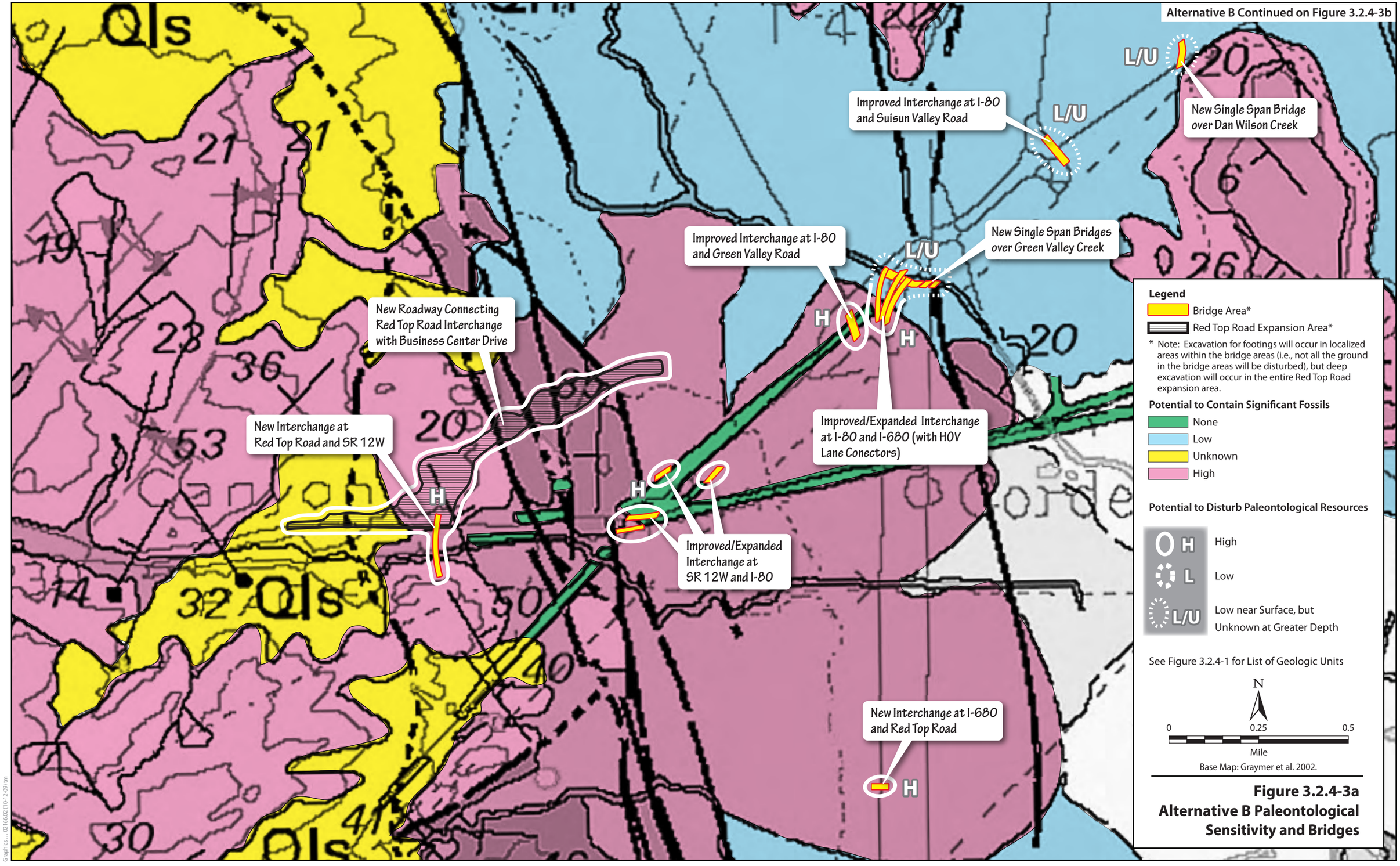

Figure 3.2.4-3a
Alternative B Paleontological Sensitivity and Bridges

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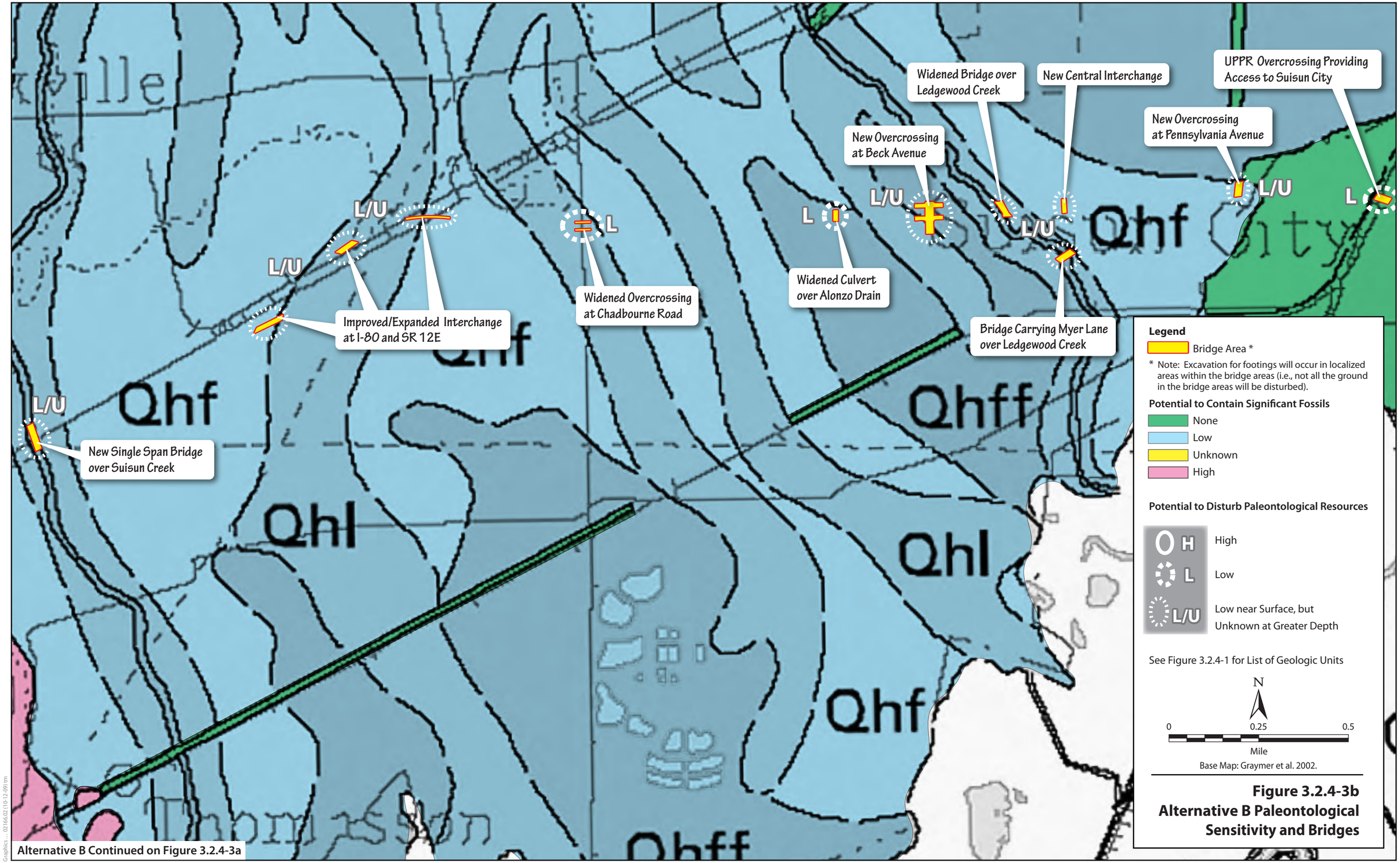

Figure 3.2.4-3b
Alternative B Paleontological Sensitivity and Bridges

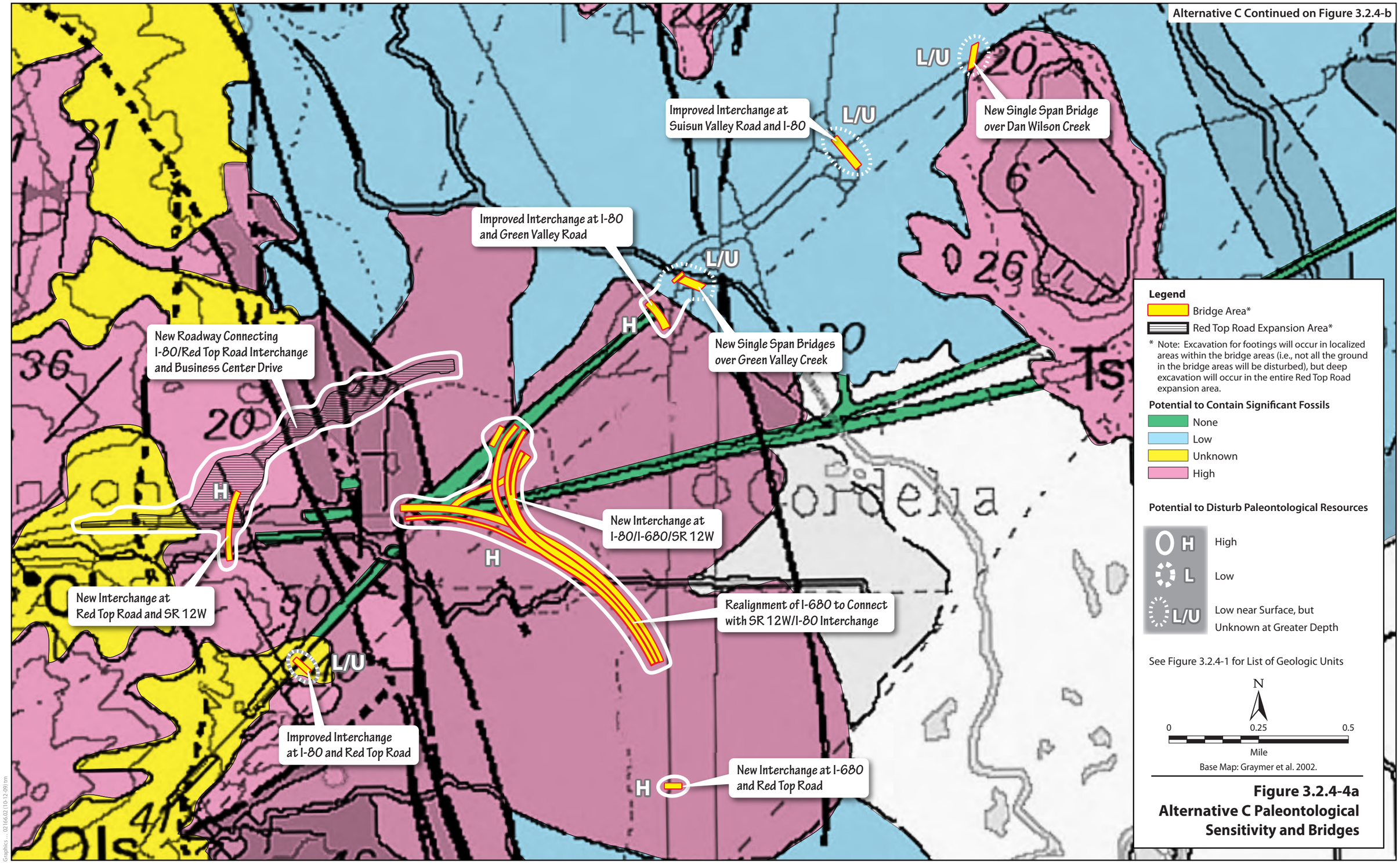

Figure 3.2.4-4a
Alternative C Paleontological Sensitivity and Bridges

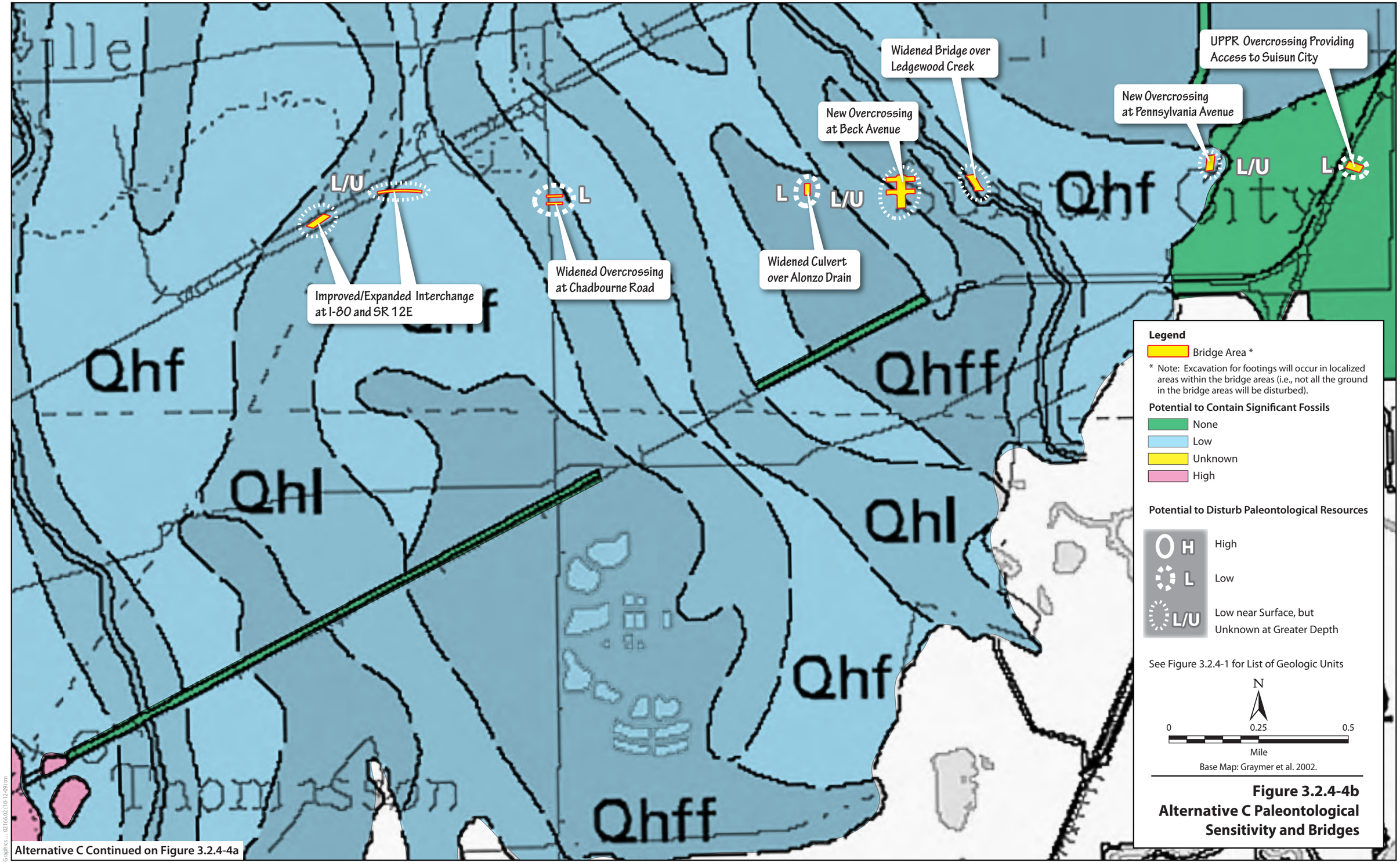

Figure 3.2.4-4b
Alternative C Paleontological Sensitivity and Bridges

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