Restoration of the Salton Sea

Volume 2: Embankment Designs and Optimization Study

Appendix 2A: Evaluation of Construction Material Sources

Prepared for:
U.S. Department of the Interior
Bureau of Reclamation
Lower Colorado Region
Boulder City, Nevada

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1.0 Introduction

This report presents the outcome of the Task 3-Materials Evaluation for the Salton Sea restoration project and forms Appendix 2A in Kleinfelder's complete report for the Salton Sea restoration project. The scope of Task 3 has included review of available regional geologic mapping, collection of information on active and inactive mining operations near the site, and review of environmental constraints that could affect existing and new borrow sources. This evaluation has focused on the previously developed Eagle Mountain Mine Site in Riverside County and the undeveloped Coolidge Mountain Site adjacent to the northwest margin of the Salton Sea. The data have been compiled into a KMZ file that can be opened using Google Earth. A copy of the KMZ file is attached with this report. A series of figures showing how the file can be used to identify potential borrow sites are presented and described in Section A.8.

The California Department of Water Resources has already prepared extensive studies for the Eagle Mountain Mine Site. No site-specific work has been completed for the Coolidge Mountain Site. Information on the Coolidge Mountain Site has been developed for this study using the geologic mapping and anecdotal materials characterization available verbally from materials suppliers operating aggregate quarries adjacent to Coolidge Mountain.

Task 3 was completed early in our evaluation of the Salton Sea restoration project. This discussion reflects our knowledge of the project needs as of June 2006. Additional information has been developed since the completion of the Task 3 deliverable. The following information should therefore be used in conjunction with the refined materials needs as described in Chapters 7.0-Project Constructability and 8.0-Construction Cost Estimates of the main report.

2.0 Mapping and Databases

Baseline data were collected and compiled from the following GIS databases.

- California Division of Mines and Geology- 2 Degree Geologic Maps
- US Geological Survey Mineral Resource Database
- Riverside County Multiple Species Habitat Conservation Plan

Other information on the Eagle Mountain Mine and Coolidge Mountain sites was collected through interviews with aggregate suppliers in the region.

3.0 Materials Required for Project

The Salton Sea restoration project would require large quantities of earth materials for construction. The type and volume of materials would obviously depend upon the project alternative and the embankment configuration that, at the time of this evaluation, have yet to be selected. However, it can reasonably be expected that any project would have need for the following range of materials:

- General Embankment Materials (Sands and Gravels)
- High Quality Graded Aggregates (Filters)
- Fine Rockfill
- Coarse Rockfill (Riprap)

Characteristics for General Embankment Materials and Fine Rockfill would be dependent upon the final design criteria. Characteristics such as gradation and strength would be the primary tools to determine suitability. Characteristics for the High Quality Graded Aggregates and Coarse Rockfill would also have gradation and strength criteria as a consideration. In addition, these materials would also have to meet additional properties including:

Minimum Specific Gravity:	Greater than 2.6
Sodium Sulfate Soundness:	Less than 10% Loss (5 Cycles)
Abrasion Resistance:	Less than 40 % Loss (500 Cycles)

Given the highly saline environment, breakdown of the Coarse Rockfill material may occur due to wedging effect of salt crystal growth if porous rock is used. Absorption criteria should be established as well. A maximum absorption criterion of 1.5 to 2.0% appears reasonable.

4.0 Eagle Mountain Mine Site

CH2M Hill has completed extensive exploration of the Eagle Mountain Mine site as a potential borrow source. They have focused the bulk of their work on the waste rock dumps on the north side of the Mine. Laboratory testing of this material showed the waste rock has a very high specific gravity, very high abrasion resistance, and very low loss using the sodium sulfate soundness test protocol. Vast materials are present in the waste rock dumps. The materials represented by the CH2M Hill study would be suitable for any application including general embankment material, high quality graded aggregates, fine rockfill, and coarse rockfill. Constraints to using the Eagle Mountain site beyond materials characteristics include:

- Materials handling is complicated, requiring multiple movement cycles. The waste rock dumps are located approximately 11 miles from the head of the existing rail spur. Materials would have to be trucked or conveyed to the rail spur and then loaded onto bulk carrier cars.
- The site is currently being acquired by the Los Angeles County Sanitation Districts as a super regional landfill. Export operations would need to be coordinated with their development and operation activities. This assumes that the new owners would be willing to donate or sell the waste rock for the Salton Sea project.
- The site is under consideration by the U.S. Congress to be declared a Historic Mining District. This designation could restrict or prevent access to the existing mine site for commercial purposes.
- The existing Kaiser rail spur is in very poor condition. The line would need to be reconstructed before it can be used for the project. This may not be a dramatic constraint if the LACSD repairs the line as a part of their landfill development. In fact, the LACSD will use rail cars to import refuse to the mine site. It may be possible to use the empty train sets to backhaul borrow to the Salton Sea site.
- Rail haul out of the Eagle Mountain Mine site must use the Union Pacific Railroad (UPRR) main line track. This track is already congested with UPRR's current freight customers. Gaining trackage rights may be an issue unless it is possible to use the LACSD empty train sets for importing materials to the site.

5.0 Coolidge Mountain Site

Very little information is available for the Coolidge Mountain site. A specific site has not been identified though the greater Coolidge Mountain site covers an area measuring approximately 5 miles long (east to west) and 3 miles wide (north to south). The Torres Martinez Indian Tribe controls much of the Coolidge Mountain site. The bulk of Coolidge Mountain is mapped as granitic basement complex of the southern California batholith. The granitics should be suitable for developing much of the borrow materials for the project including general embankment material, high quality graded aggregates, fine rockfill and coarse rockfill. One concern is the degree of weathering of the granitic bedrock. If extensive weathering is present, there may not be sufficient hard material for the aggregates and coarse rockfill. However, extensive weathering can be viewed as positive as this could be a source for the poorly graded materials being considered in the "sand dam with stone columns" alternative for the mid-Sea dam.

The geology on the east end of Coolidge Mountain is more complicated. These materials include a variety of igneous and metamorphic rock types. The variability in materials is not favorable for creating high quality aggregates or the coarse rockfill. Again, these rock types could be used for general embankment material and potentially as fine rockfill.

There are two existing aggregate pits present adjacent to the east end of Coolidge Mountain. The Aggregate Products Inc. (API) pit is used for sand and gravel products. These materials are screened from rocky alluvial soils that have eroded from the Coolidge Mountain area to the north. We have not been able to collect any materials data for the API products, but have been told verbally that they produce high quality aggregates for road base, asphalt concrete, and Portland cement concrete. We also understand that Granite Construction has operated an aggregate borrow pit immediately adjacent and north of the API plant. This material was most recently used for an asphalt concrete overlay for US Highway 86 that extends along the west shore of the Salton Sea.

From this information, the existing borrow operations should be suitable for general embankment material, high quality graded aggregates, and perhaps fine rockfill. These sites would not be suitable for coarse rockfill. The following potential issues or constraints may be in play for the Coolidge Mountain site:

- No specific borrow sites have been identified on the Coolidge Mountain site. Therefore, no specific material characteristics are known. Suitability for various material uses could only be judged on prior experience in similar geologic conditions.

- Much of Coolidge Mountain is under the control of the Torres Martinez Indian Tribe. It is not known whether or under what conditions the owners would be willing to allow borrow operations on the site.
- Coolidge Mountain is within the jurisdiction of the Coachella Valley Multiple Species Habitat Conservation Plan that severely limits borrow activities. In addition, the State of California has enacted a ban on new sand and gravel operations within the 3.4 million acres managed under the California Desert Conservation Area (CDCA). The CDCA is intended to protect critical habitat for the desert tortoise and other threatened and endangered species. California is restricting new mines to less than 20 acres in area. It is not known whether Coolidge Mountain is subject to the CDCA constraint.

6.0 Other Potential Quarry Sites

Several other nearby areas that could be potential borrow sites have been identified. These include the following:

Location	Deposit Type
San Felipe Wash (west of Salton Sea)	Alluvial Sands/Gravels
Chuckawalla Mountains (northeast of Salton Sea)	Granitic Bedrock
Orocopia Mountains (northeast of Salton Sea)	Granitic Bedrock
Chocolate Mountains (east of Salton Sea)	Granitic Bedrock
Fish Creek Mountains (southwest of Salton Sea)	Granitic Bedrock
Algodones Dunes (southeast of Salton Sea)	Aeolian Dune Sands

Unfortunately, the Chuckawalla, Orocopia, and Fish Creek Mountains have been withdrawn as developable sites under the MSHCP jurisdiction. The San Felipe Wash has some degree of habitat protection but the actual extent of these protections is unknown. The Chocolate Mountains are used by the US Navy as an aerial bombing range and public access is closed. The Algodones Dunes have been partially closed to the public to protect critical desert habitat. There are existing off-road vehicle areas on the north end of the Algodones Dunes that is nearest to the southeast margin of the Salton Sea. It is not known whether any existing borrow sites have been developed within the dune complex. The aeolian sand deposits are obviously poorly graded and could be suitable for the “sand dam with stone columns” concept for the mid-Sea dam and other alternatives. Availability and accessibility for these materials are unknown.

Materials suppliers in the area indicate that the available aggregate sources are becoming very scarce. Natural sands found in the Coachella and Imperial Valleys are being exported to the growing suburbs in San Diego, Orange, and Los Angeles Counties. Local contractors expect the supply of natural sands to be exhausted in the very near future. Aggregate suppliers are telling their customers to anticipate a dramatic shift to manufactured sand products such as crusher dust, etc.

7.0 Protocols for Evaluating Potential Borrow Sites

The following approach should be used for evaluating future borrow site locations for the Salton Sea restoration project.

- Compile a GIS database of all known environmental constraints such as the Riverside County MSHCP, California Desert Conservation Area, etc.
- Compile a comprehensive list of all active and inactive borrow sources in the area
- Compile a GIS database showing public and private land ownership
- Expand the geologic base map to areas further east of the site
- Develop a comprehensive constraints map from the data above to identify possible "constraint free" sites

Once a potential site is identified, site-specific investigation will be necessary. URS plans to perform some subsurface exploration within the Coolidge Mountain area. The exact scope is unknown at this time since a firm site location has not been established. It is recommended that the exploration of the borrow sites include the following broad range of activities.

- Intensive and detailed surface geologic mapping of the various soil and rock types. Understanding joint patterns and spacing is critical to assessing suitability of hard rock deposits as coarse rock fill and riprap. This would be useful in laying out a cost effective program of targeted boring and dozer test pit locations.
- Geophysical surveys (seismic refraction) to assess degree/ depth of weathering of the bedrock units. This would be useful in assessing rippability of the rock units and whether "fresh" rock suitable for coarse rockfill is potentially present.
- Subsurface exploration using both dozer test pits and deep borings. The dozer pits would be the preferred method for assessing the characteristics of the working borrow face, such as hardness, rippability, percentage of large oversize material and gradation. Deeper borings would be needed to gauge how the materials may or may not vary with depth.
- Trial crushing operations should be performed. This would consist of transporting several truck loads of the potential borrow materials to a screening and crushing plant. The API plant near Coolidge Mountain

would be convenient. The raw materials could then be processed and the resulting material evaluated using laboratory methods for gradation, specific gravity, abrasion resistance, soundness, and other useful properties. Careful characterization of the borrow material would allow future bidders to better estimate production rates, equipment wear, and handling methods during construction.

- Availability of water for screening and dust control should also be considered. Many of the sites are located with a PM10 non-attainment zone for air quality. Control of fugitive dust may be a constraint that must be considered. It is recommended that potential water sources be identified early in the evaluation process. Water sources could include existing municipal supplies, private domestic wells, irrigation wells, surface irrigation canals and new onsite wells.

8.0 Description of KMZ Data Base Model

The geologic mapping of the greater Salton Sea area has been compiled onto a Google Earth KMZ file. The attached file is labeled Salton Sea.kmz. Each of the major rock units has been further rated as to its likely suitability as a source for various embankment materials. The embankment materials have been broken down into four broad categories as listed below:

- General embankment materials (sands and gravels)
- High quality graded aggregates (filters)
- Fine rockfill
- Coarse rockfill (riprap)

The KMZ is an interactive file, which can be merged with other land use or ownership maps. This allows for quick identification of potential constraints or limitations to development as material sources. The KMZ file can be manipulated in all three axes. Plan views can be varied by altitude. Three-dimensional views can be developed from virtually any altitude and direction. A layer that shows all of the active and inactive mine sites in the general area has also been added. This information was imported from the USGS Mineral Resource Database System. Each of the identified mines on the KMZ file also has embedded attributes such as the most common mineral exploited from the current or past operations.

Figures A.8.1 through A.8.9 illustrate some of the attributes of this file.

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Figures

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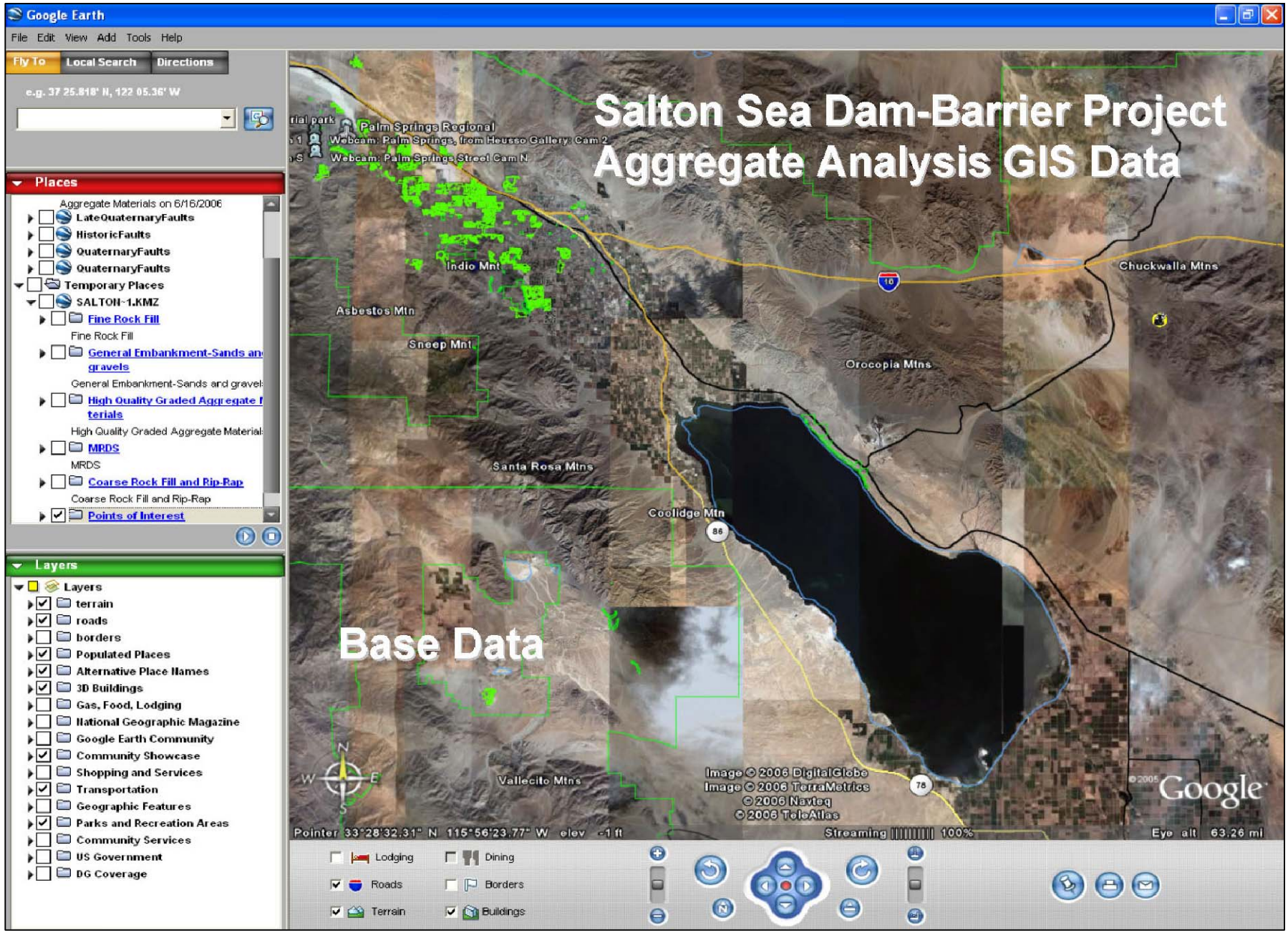
Project No. 71100

May 2007



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Base Data

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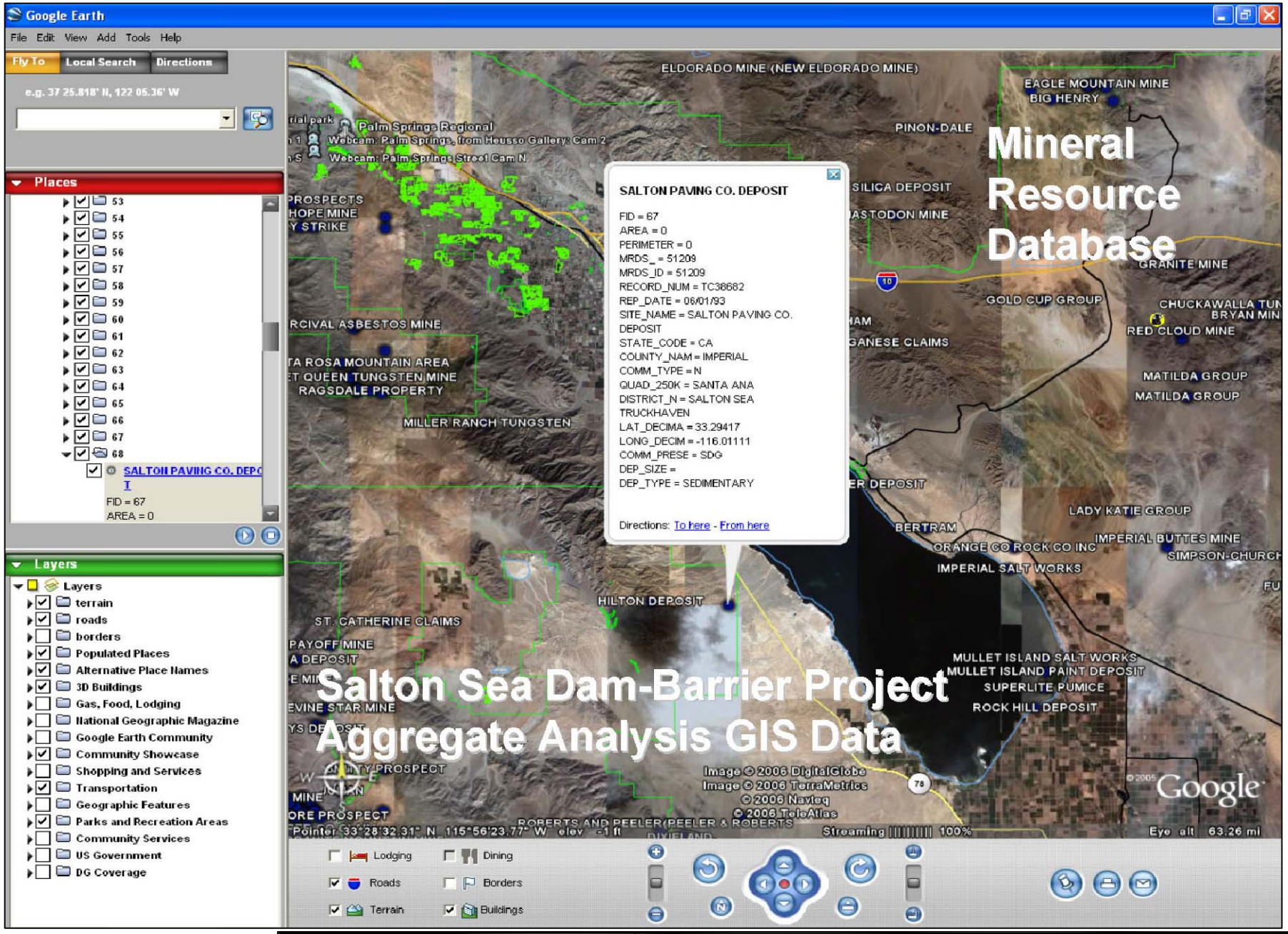

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Mineral Resource Database

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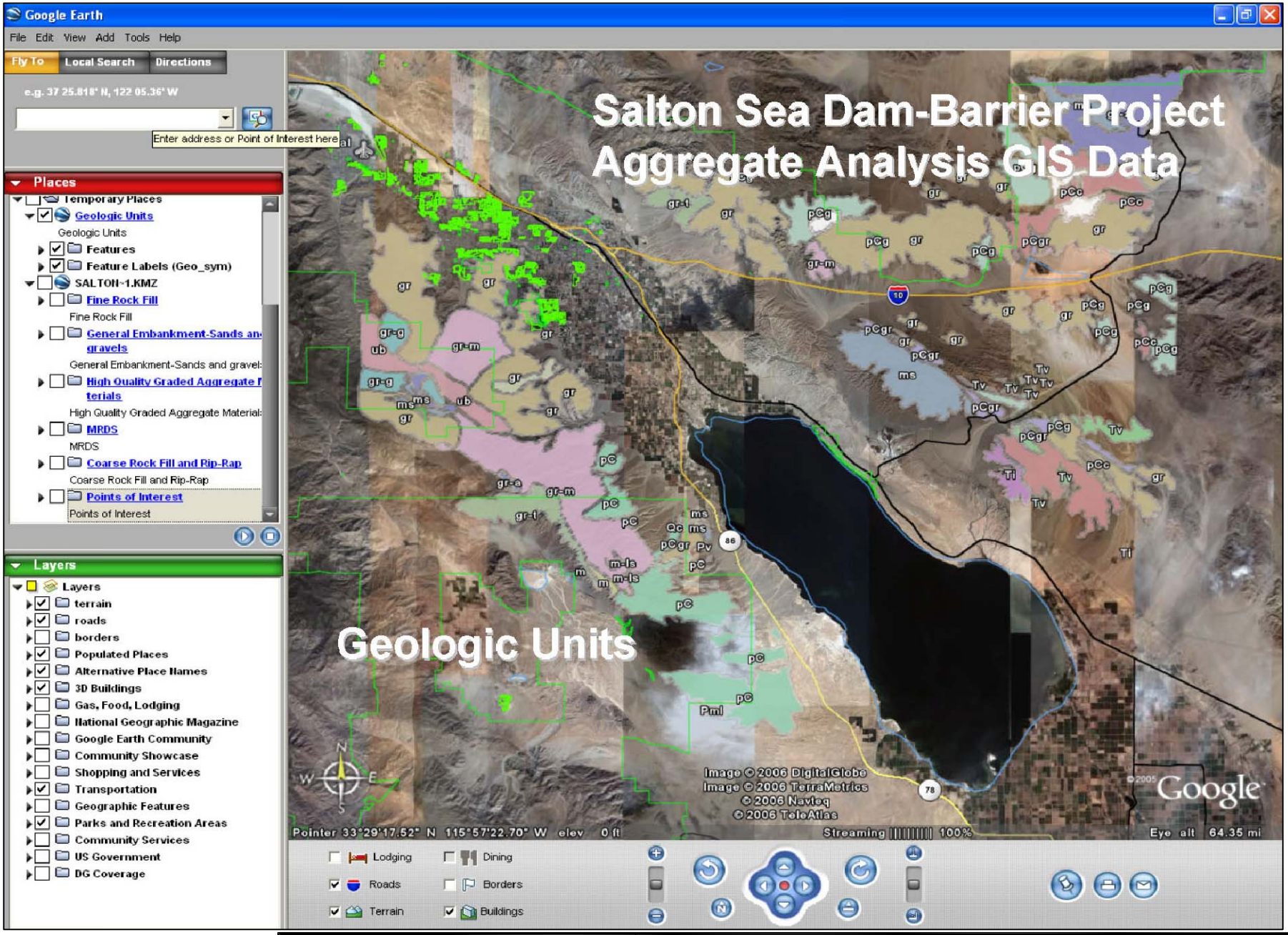

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Geologic Units

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Salton Sea Dam-Barrier Project
Aggregate Analysis GIS Data

	A	B	C	D	E	F	G
1				Low	Low	Low	Low
2				Med	Med	Med	Med
3				High	High	High	High
4	AGE	GEOSYM	GEONAME	MASS_EMB	HIQ_AGGR	FI_ROCK FILL	CO_ROCK FILL
5	Pleistocene	QPv	Rhyolite, Andesite, Basalt, and Pyroclastic Rocks	Med	Low	Low	Low
6	Pliocene	Pv	Rhyolite, Andesite, Basalt, and Pyroclastic Rocks	Med	Low	Low	Low
7	Pliocene	Pml	Middle and / or Lower Pliocene Marine	High	Low	Med	Low
8	Miocene	Mv	Rhyolite, Andesite, Basalt, and Pyroclastic Rocks	Med	Low	Low	Low
9	Unidfferentiated Tertiary	QTv	Rhyolite, Andesite, Basalt, and Pyroclastic Rocks	Med	Low	Low	Low
10	Undifferentiated Tertiary	Ti	Intrusive Rocks	Med	Low	Low	Low
11	Undifferentiated Tertiary	Tv	Volcanic Rocks	Med	Low	Low	Low
12	Unidfferentiated Early Cretaceous	gr	Undivided Granitic Rocks (Southern CA Batholith)	High	High	High	High
13	Early Cretaceous	gr-g	Granodiorite (Southern CA Batholith)	High	High	High	High
14	Early Cretaceous	gr-m	Monzonite (Southern CA Batholith)	High	High	High	High
15	Early Cretaceous	gr-t	Tonalite and Diorite (Southern CA Batholith)	High	High	High	High
16	Early Cretaceous	gr-a	Andesite (Southern CA Batholith)	High	High	High	High
17	Jurassic	ub	Ultrabasic Intrusive Rocks	Med	Med	Med	Med
18	Pre-Cretaceous	m	Undivided Metamorphic Rocks	High	Med	Med	Med
19	Pre-Cretaceous	m-ls	Marine Limestone and Dolomite	High	High	Med	Med
20	Pre-Cretaceous	mv	Metavolcanic Rocks	High	Med	Med	Med
21	Pre-Cretaceous	ms	Metasedimentary Rocks	High	Med	Med	Med
22	Pre-Cretaceous	gr-m	Granitic and Metamoprhic Rocks	High	High	High	High
23	Paleozoic	Pls	Marine Limestone and Dolomite	High	High	Med	Med
24	Paleozoic	Pv	Metavolcanic Rocks	High	Med	Med	Med
25	Precambrian	pCc	Igenous and Metamoprhic Rocks	High	Med	Med	Med
26	Precambrian	pC	Undivided Gneissic Rocks and Schist	High	High	High	High
27	Precambrian	pCgr	Undivided Granitic Rocks	High	High	High	High
28	Precambrian	pCg	Gneissic Rocks	High	High	High	High
29	Pliocene	Pml	Middle and / or Lower Pliocene Marine	High	Low	Med	Low
30							

Aggregate Quality Rankings - Attributes

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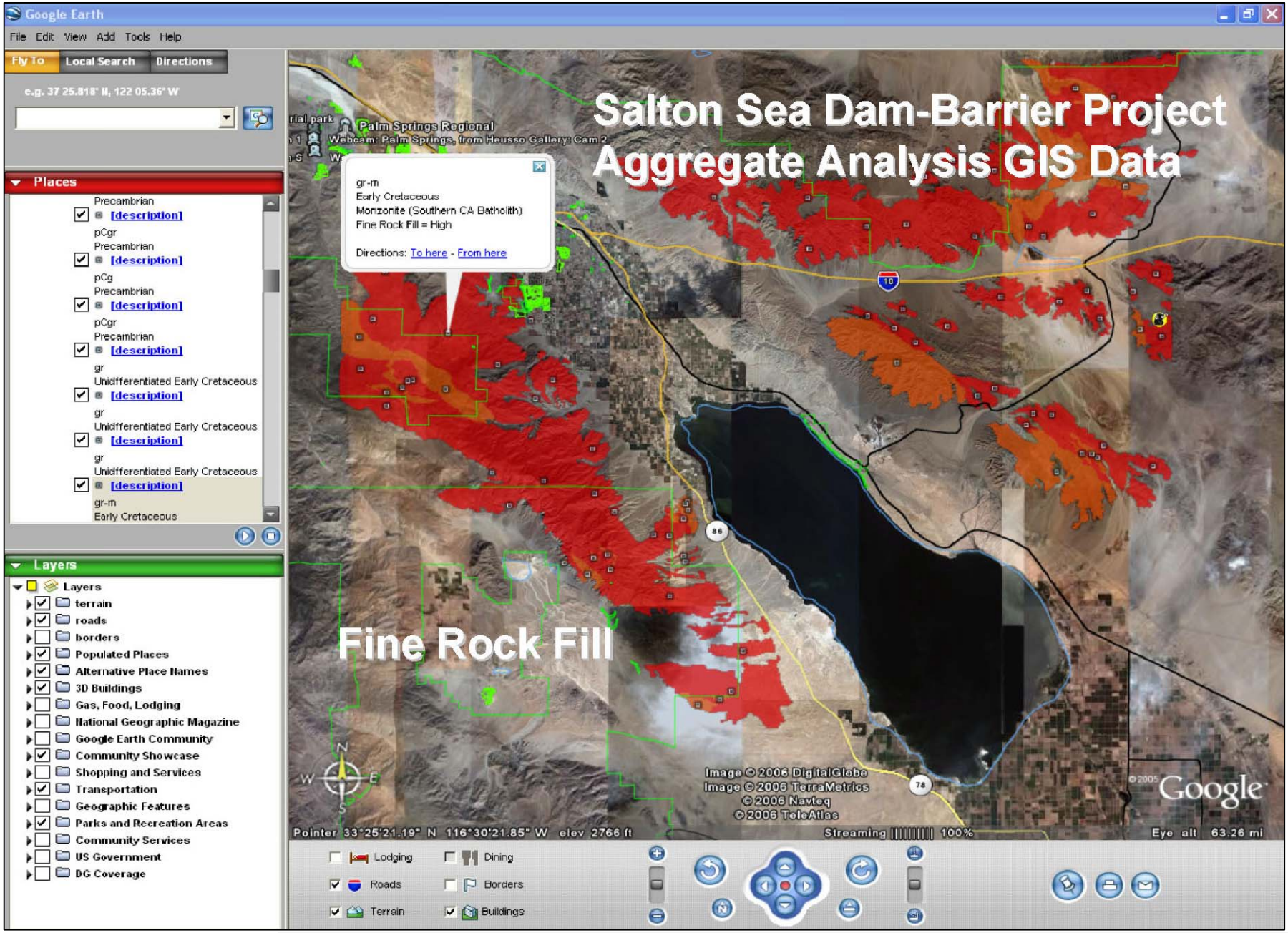
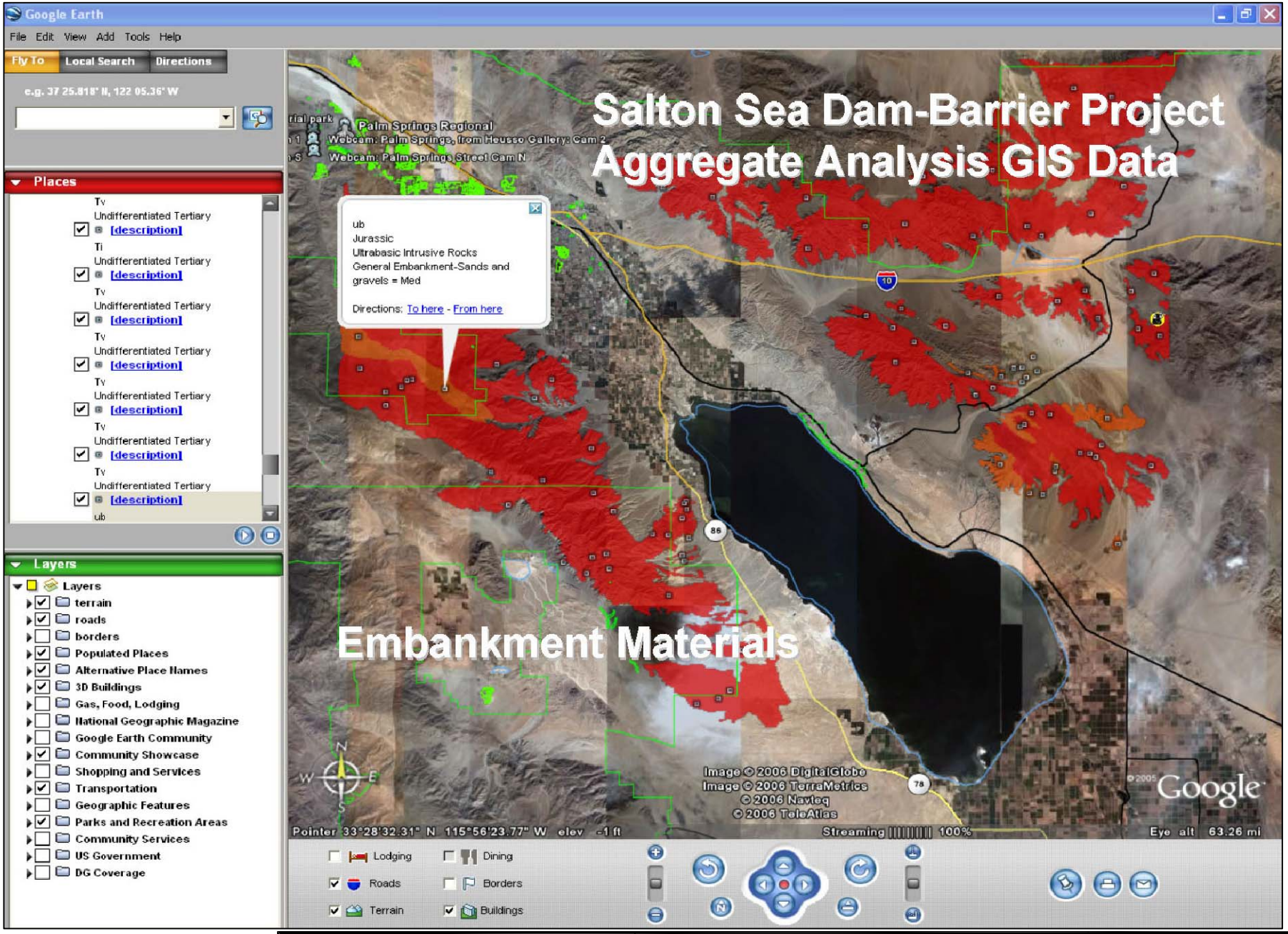
Aggregate Quality Rankings - Attributes

FIGURE A.8.4



United States Department of the Interior Bureau of Reclamation	**SALTON SEA RESTORATION PROJECT** Embankment Alternatives Optimization Study Appendix 2A		**Fine Rock Fill**
KLEINFELDER	Project: 71100	By: KAF/CL	Date: August 2006	**FIGURE A.8.5**



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Embankment Materials

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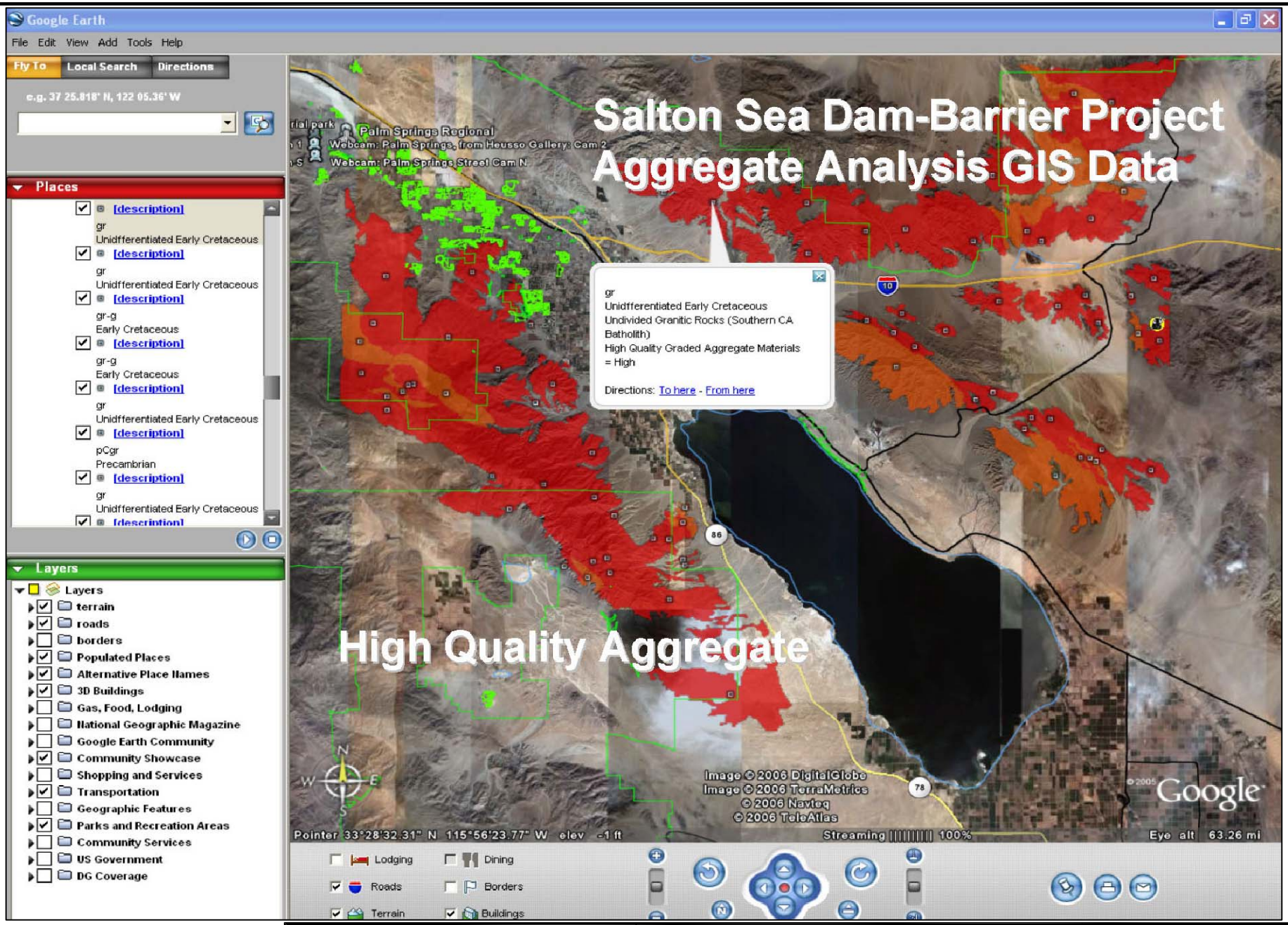

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High Quality Aggregate

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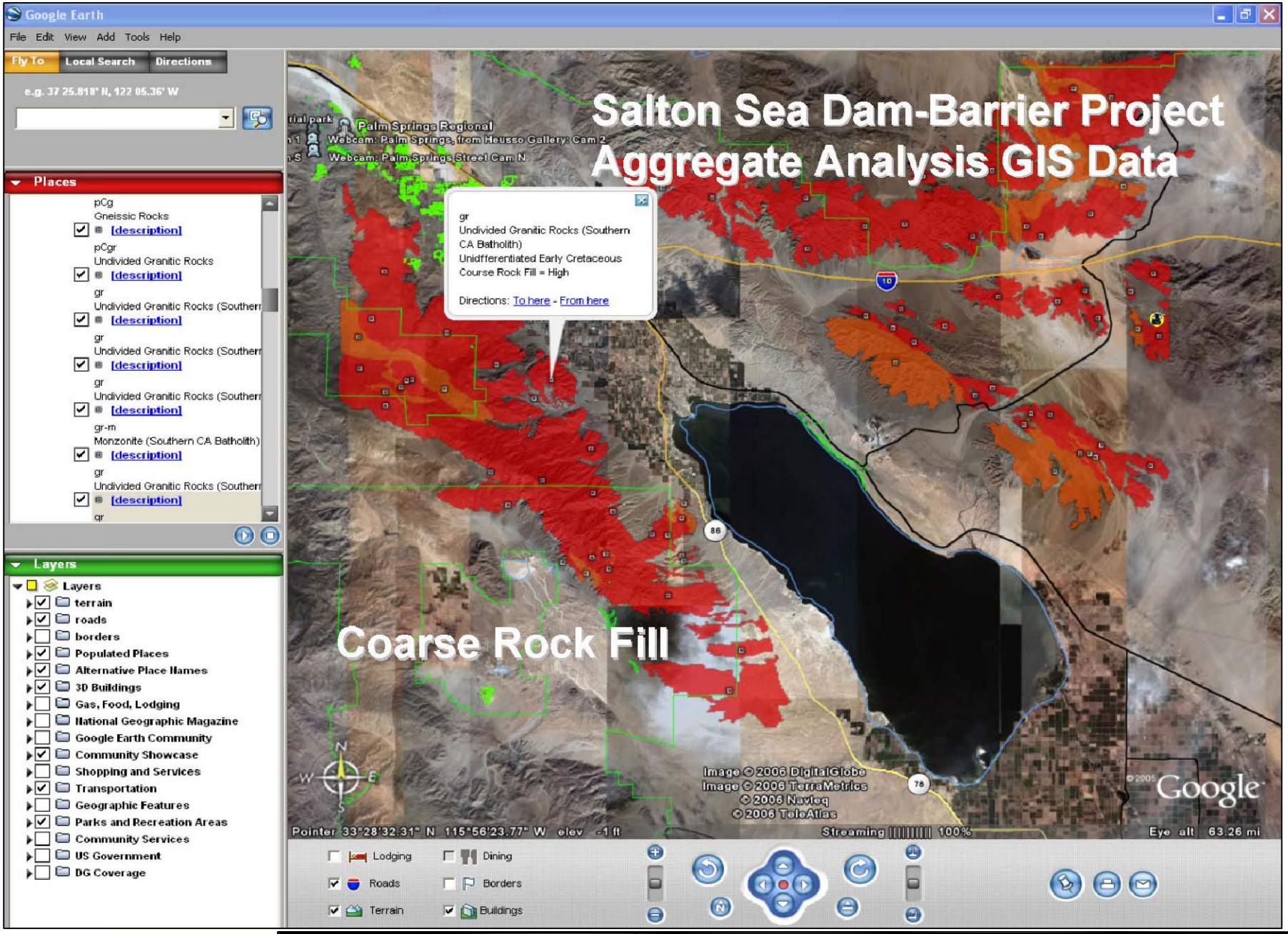

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Coarse RockfIII

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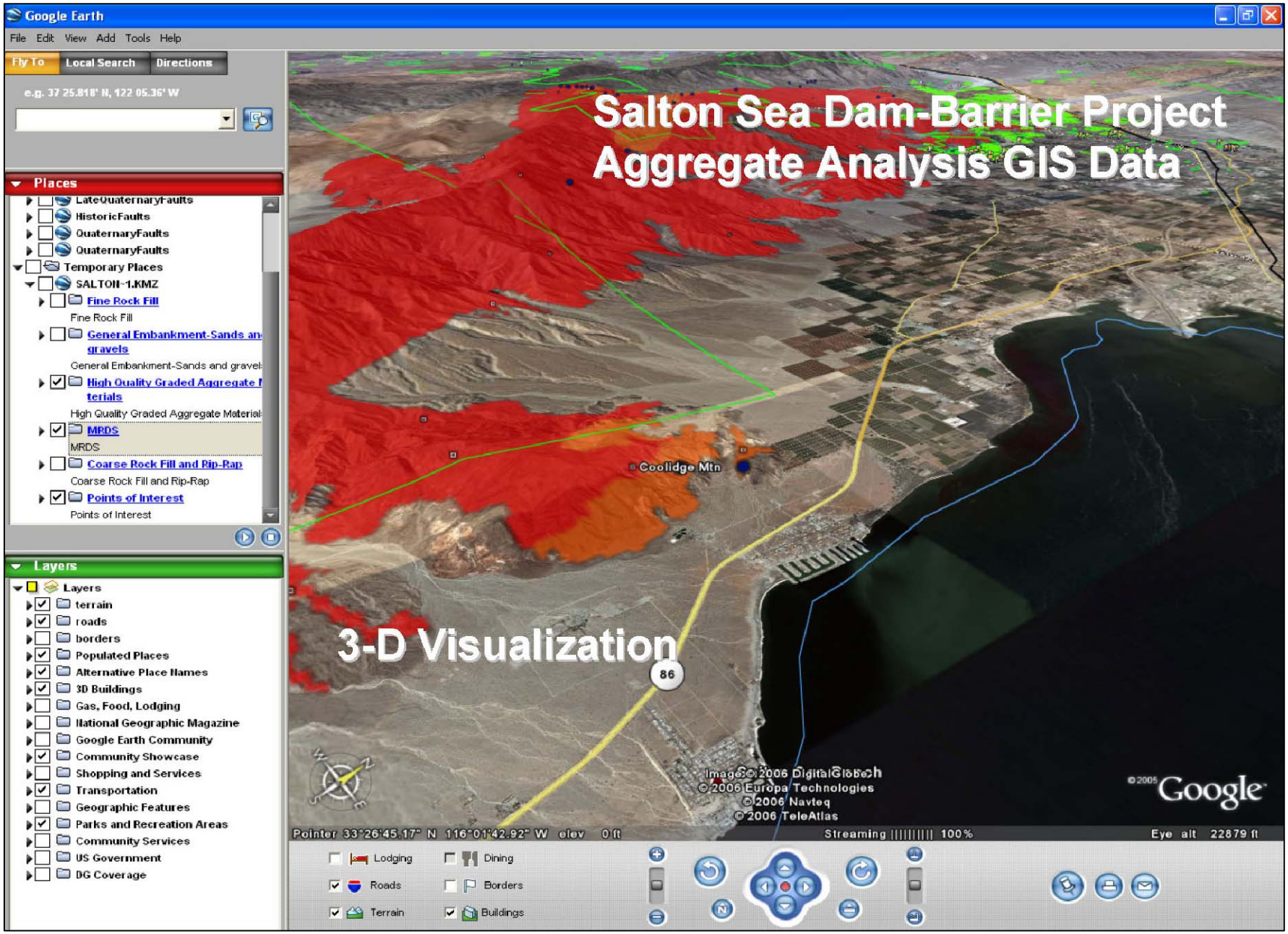

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KLEINFELDER	Project: 71100	By: KAF/CL	Date: August 2006	FIGURE A.8.9