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January 30, 2025
3218-1, L-33567

Zach Heineman
Team Projects
zach@teamprojects.com

RE: Geotechnical Evaluation - Bluff Setback Assessment
20 Ocean Avenue and Adjacent Parcel
Bolinas, California

Dear Mr. Heineman:

At your request, we have performed a geotechnical evaluation to assess the bluff setback for your properties at 20 Ocean Avenue and the parcel across the street in Bolinas, California. The location of these properties is shown on the Area Map, Figure 1. It is likely the bluff setback will have an impact on the location of your proposed new home. The purpose of our geotechnical evaluation was to assess the general geotechnical conditions at the site, evaluate potential bluff setback requirements, and provide a map of the proposed bluff setback.

SCOPE OF WORK

The scope of our geotechnical evaluation has included the following:

1. A review of relevant published topographic, geologic, and aerial imagery materials;
2. A study of the relevant regulations governing the bluff setback;
3. A reconnaissance of the site to observe the general surficial conditions present; and
4. A review of current bluff setback requirements for the area.

DOCUMENTS REVIEWED

We reviewed a large number of documents with respect to the geologic setting, the bluff retreat rate in the area, and various regulatory materials. These documents are listed at the end of this report.

SITE GEOLOGIC SETTING

A commonly used geologic map of the Point Reyes Peninsula was prepared in 1976 by Alan Galloway for the California Division of Mines and Geology (now the California Geological Survey). The portion of this map that includes Bolinas is presented as Figure 2; the location of the project site is shown on this figure.

As indicated on Figure 2, most of Bolinas is underlain by bedrock belonging to the Monterey Formation. In the site area, this bedrock typically consists of thin-bedded to massive shale beds with occasional sandstone interbeds. The subject site is located on a small Terrace Deposit (Qt) which consists of "unsorted and unconsolidated rock fragments" likely to have been placed on a wave-cut terrace.

The lots located along Ocean Avenue are present on what appears to be a massive block of shale and sandstone, elevated above the area along Terrace Avenue to the northwest (see Figure 1). As seen on the aerial photographs presented on Figure 3, this terrace block results in an outward "bulge' in the shoreline and continues about 450 feet offshore as a reef structure. The waves in Bolinas Bay break a considerable distance offshore due to this reef. It is our judgment that although this block experiences coastal and bluff retreat, it has a greater resistance to bluff retreat than the immediately adjacent areas to the northeast and southwest.

MARIN COUNTY ZONING SETBACK REQUIREMENTS

Ocean bluff setbacks are specified in Title 20 of the Marin County Coastal Zoning Code (last updated on February 9, 2024). Within Chapter 20.64.060 – Environmental Hazards of this Code, Section B - Shoreline Protection contains Subsection 1 - Bluff Top Setbacks. This subsection states:

New structures shall be set back from coastal bluff areas a sufficient distance to ensure with reasonable certainty that they are not threatened from cliff retreat within their economic life expectancies. Adequate setback distances will be determined from information contained in required geologic reports and the setback formula established below. These setbacks will be of sufficient distance to eliminate the need for shoreline protective works. The following formula will be used to determine setbacks from the bluff for new structures:

Setback (meters) = structure of life (years, normally at least 40 years) X retreat rate (meters/year). In areas where vigorous sliding is taking place, an additional 15 meters should be added as a safety factor.

The retreat rate shall be determined by a geotechnical investigation conducted by a professional engineer or registered geologist which explicitly examines the site's geotechnical capability to adequately support the proposed development. The report shall include the historic and projected rate(s) of bluff retreat attributable to wave and/or surface runoff erosion. The geotechnical report shall be required in either of the following:

a. The building or proposed development site is within one hundred fifty feet of a blufftop.

b. The building site is located within stability zones 3 or 4 as indicated on the slope stability maps for the Bolinas and Tomales areas, which maps accompany Wagner's 1977 report, "Geology for Planning, Western Marin County." This report and accompanying maps are incorporated by reference as part of this chapter.

BLUFF RETREAT RESEARCH AND ANALYSES

The maps that accompany Wagner (1977) indicate that the site is located within Stability Zones 3 and 4. Thus, this location meets one of the triggers detailed in the Marin County Coastal Zone Code discussed above of bluff top setback requirements.

The assumption used in the Marin County Coastal Zone Code is that a realistic retreat rate from an adjacent bluff top can be calculated. However, historic experience by all people involved in the observations and measurements over many decades of the Marin County coastal bluffs is that the retreat process is highly episodic, such that no movement may occur over an extended period followed by a large movement in a very short period of time. In addition, large variations may take place with a section of bluff, and a highly active section in one period may slow and be less active than an immediately adjacent area for the next period of time. Taking all of this variability into consideration, the Marin County Coastal Zone Code approach still has merit, but the likelihood of imprecision should be understood, and some caution taken in the estimation of an average retreat rate.

Berquist (1978) includes discussions regarding cliff recession in the Bolinas Bay and Pacific Ocean areas. Figure 14 from that report is presented as our Figure 4 at the end of our report. This figure summarizes cliff recession data from 1854 to 1929 for five locations around Bolinas Mesa. Along Bolinas Bay, an average of 30 meters of cliff recession is reported to have occurred during the 75-year reporting period, an average of 0.8 meters per year (1.3 feet per year). The movement amounts shown on this figure indicate the Bolinas Bay section has the lowest amount of recession of the areas studied, and would not qualify as an area "where vigorous sliding is taking place" per the Marin County Coastal Zone Code. Also, the rate of recission of 1.3 feet per year is an average for the entire cliff area abutting Bolinas Bay, a distance of about 6,500 feet. As noted earlier, the terrace block where the site is located extends out further into the Bay than the adjacent Bay cliffs to the northeast and southwest. Therefore, the retreat rate is probably lower at the site than in the adjacent areas, and would have a lower recession rate.

Swirad et al. (2022) complied a database of cliff retreat rates along the California coast for the periods of 1998 to 2010 and 2010 to 2016. This data can be accessed using the online California Coastal Cliff Erosion Viewer they developed. The data obtained from this Viewer for the northeast half of the Bolinas Bay cliff area is presented on Figure 5. If average (mean) values for both the cliff top and cliff face are considered, the values range from about 0 to 0.13 meters per year (0 to 0.4 feet per year) for the relatively short monitoring periods (6 and 12 years). However, the large range of data also reveals that extreme rates of about 0.4 to 0.5 meters per year (1.3 to 1.7 feet per year) have been documented; these more extreme values may not have occurred on the Ocean Avenue terrace block.

You have also provided us with LiDAR data along three transects on 20 Ocean Avenue taken between 1998 and 2018 (a 20-year period); this data is presented on Figure 6. Transects 2 and 3 indicate about 16 to 12 feet of recession, respectively, or about 0.8 to 0.6 feet per year. Transect 1 appears to have an irregular dataset but may indicate about 50 feet of recession or about 2.5 feet per year.

SITE VISIT AND BLUFF TOP MAPPING

On December 12, 2024, the undersigned visited the site and made observations of the exposed conditions using maps of property lines and some topographic information from a 2024 site development map you supplied. The map you provided included an indication of the "Current Edge of Bluff" in 2024; this map

was used as a base for Figure 7 discussed in the nest section. During our site visit, a special emphasis was given to mapping the top of bluff locations in the field and comparing the identified locations to the line indicated on your site map. It was our opinion that the edge of bluff line on your 2024 map was a reasonable representation of the location of the top of bluff at the time of our visit.

SUMMARY CONCLUSION

Based on our interpretation of the entirety of available data, it is our judgment that an average retreat rate of 1 foot per year is a reasonable approximation for your properties. No "vigorous sliding" additional safety factor is warranted. It is likely the County will consider that your house would have a 40-year life, so a total setback of 40 feet (40 years x 1 foot per year) seems reasonable.

Based on our field mapping and the calculated setback, we developed the location of the bluff setback, and it is also shown on Figure 7, Bluff Setback Map.

LIMITATIONS

My work has been performed in accordance with generally accepted geotechnical engineering principles and practices. No other warranty, expressed or implied, is made. Should additional important data regarding the bluff edge or retreat rate become available, please submit them to me for consideration as the opinions and conclusions presented in this letter may be modified.

Contact me if you have any questions.

Very truly yours,

DRAFT

Alan Kropp, G.E.
Principal Engineer

AK/jc

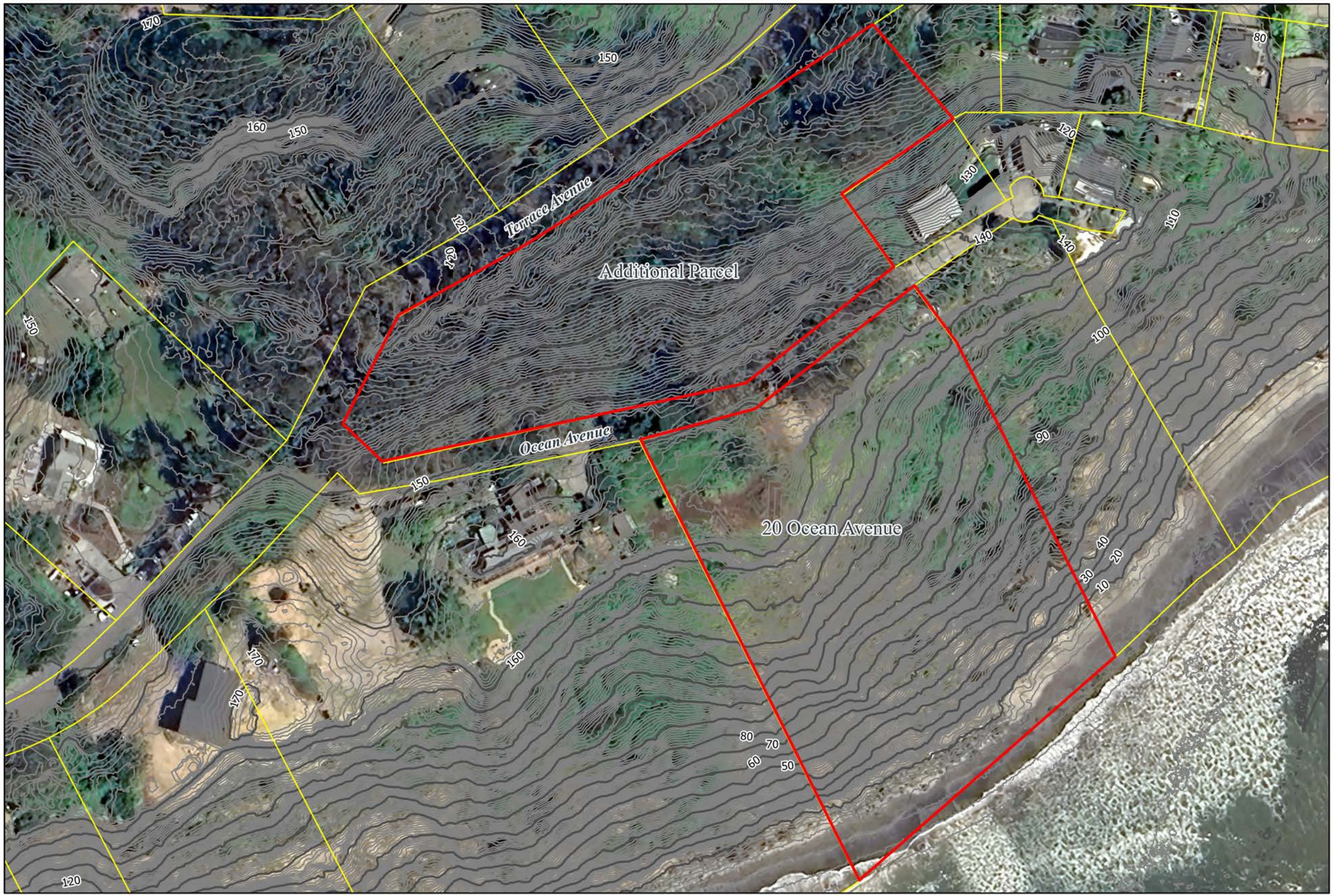
Copies: Addressee (PDF) – zach@teamprojects.com

Attachments:

Figure 1	Area Map
Figure 2	Geology Map
Figure 3	Aerial Images of Terrace Block at Site
Figure 4	Historic Movement Rates at Bolinas Bluffs
Figure 5	Recent Movement Rates at Project Area
Figure 6	LIDAR Readings at Site
Figure 7	Bluff Setback Map

DOCUMENTS REVIEWED

- Berquist, J.R. (1978), "Depositional History and Fault-Related Studies, Bolinas Lagoon, California," Open-File Report 78-802, California Division of Mines and Geology.
- Clark, J.C. and Brabb, E.E. (1997), "Geology of the Point Reyes National Seashore and Vicinity," Open-File Report 97-456, U. S. Geologic Survey.
- Galloway, Alan J. (1976), "Geology of the Point Reyes Peninsula, Marin County, California," Bulletin 202, California Division of Mines & Geology.
- Hapke, C.J., Reid, D., Green, K.R., and Borrelli, M. (2007), "National Assessment of Shoreline Change: Part 4: A GIS Compilation of Vector cliff edges and associated change data for the cliffed shorelines of the California Coast," Open-File Report 2007-1112, U.S. Geological Survey, Coastal and Marine Geology Program, U.S. Geological Survey, Pacific Science Center, Santa Cruz.
- Hapke, C.J. and Reid, D. (2007), cencal1929_1935.shp - Vectorized Cliff Edge of Central California Derived from 1929-1935 Source Data: Open-File Report 2007-1112, U.S. Geological Survey, Coastal and Marine Geology Program, U.S. Geological Survey, Pacific Science Center, Santa Cruz, California.
- Hapke, C.J., Reid, D., and Green K.R. (2007) cencal1998_2002.shp - Vectorized Cliff Edge of Central California Derived from 1998/2002 Lidar Source Data: Open-File Report 2007-1112, U.S. Geological Survey, Coastal and Marine Geology Program, U.S. Geological Survey, Pacific Science Center, Santa Cruz, California.
- Hapke, C.J. and Reid, D. (2007), "National Assessment of Shoreline Change Part 4: Historical Coastal Cliff Retreat along the California Coast," Open File Report 2007-1133, U.S. Geological Survey, Coastal and Marine Geology Program, U.S. Geological Survey, Pacific Science Center, Santa Cruz, California.
- Marin County Community Development Agency, Planning Division (2003), "Marin County Local Coastal Program Update, Coastal Cliff and Bluff Erosion Technical Background Report."
- Marin County Coastal Zoning Code (last updated February 9, 2024).
- Swirad, Z.M. and Young, A.P. (2022), "Spatial and Temporal Trends in California Coastal Cliff Retreat," Geomorphology, Volume 412.
- Swirad, Z.M. and Young, A.P. (2022), California Coastal Cliff Erosion Viewer (Online presentation of Swirad and Young datasets), Coastal Processes Group, Scripps Institution of Oceanography at UC San Diego, (https://siocpg.ucsd.edu/data-products/ca-cliff-viewer/).
- Wagner, D.L. (1977), "Geology for Planning in Western Marin County, California," Open-File Report 77-15 SF, California Division of Mines and Geology.



N

LEGEND

- Property line
- 20 Ocean Avenue and additional parcel
- 120 Topographic contour lines

Source: Marin County parcel boundaries, 2020; Contours derived from USGS LiDAR, 2018; Google Earth imagery, 5/6/2024.

Original figure produced in color.

0 40 80 160 Feet

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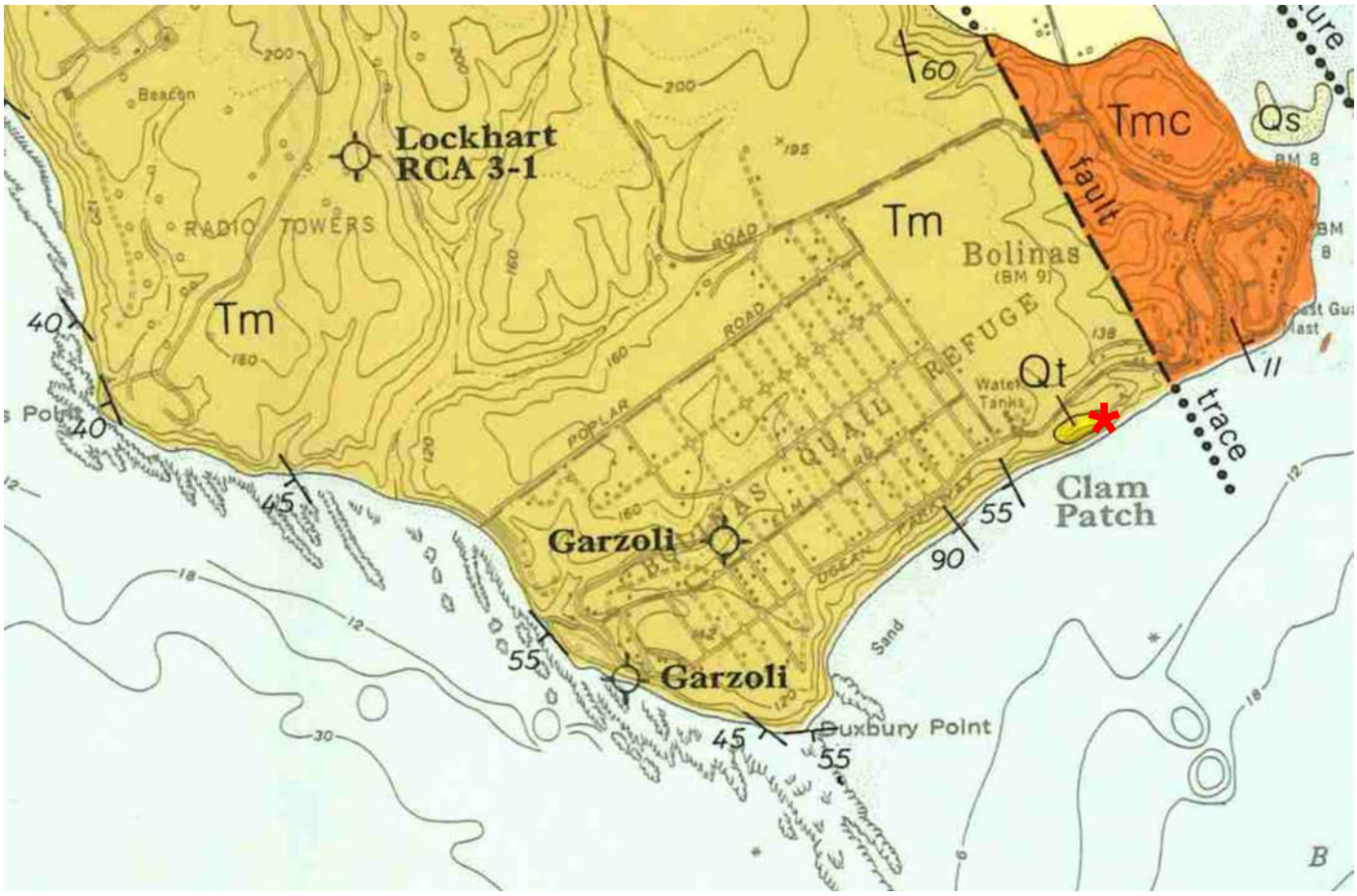
AREA MAP

20 OCEAN AVENUE
Bolinas, California

PROJECT NO.	DATE	FIGURE
3218-1	**January 2025**	**1**



LEGEND

✱ Site

Qt

Terrace deposits

(Unsorted and unconsolidated rock fragment debris deposited on stream and wave cut surfaces.)

Tmc

Merced Formation

(Blue-gray siltstone and soft, easily erodible, brown to tan sandstone, pebbly in places.)

Tm

Monterey Shale

(Mainly thin-bedded to massive, gray to brown organic shales, and thin bedded, commonly highly contorted cherts. Contains sandstone beds in a few places.)

Source: Galloway, Alan, 1976, "Geology of the Point Reyes Peninsula, Marin County, California," California Division of Mines and Geology, Bulletin 202.

Original figure produced in color.

1000 0 2000 4000

APPROXIMATE SCALE FEET

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GEOLOGY MAP

20 OCEAN AVENUE
Bolinas, California

PROJECT NO. **3218-1**

DATE **January 2025**

FIGURE **2**

Source: Google Earth.

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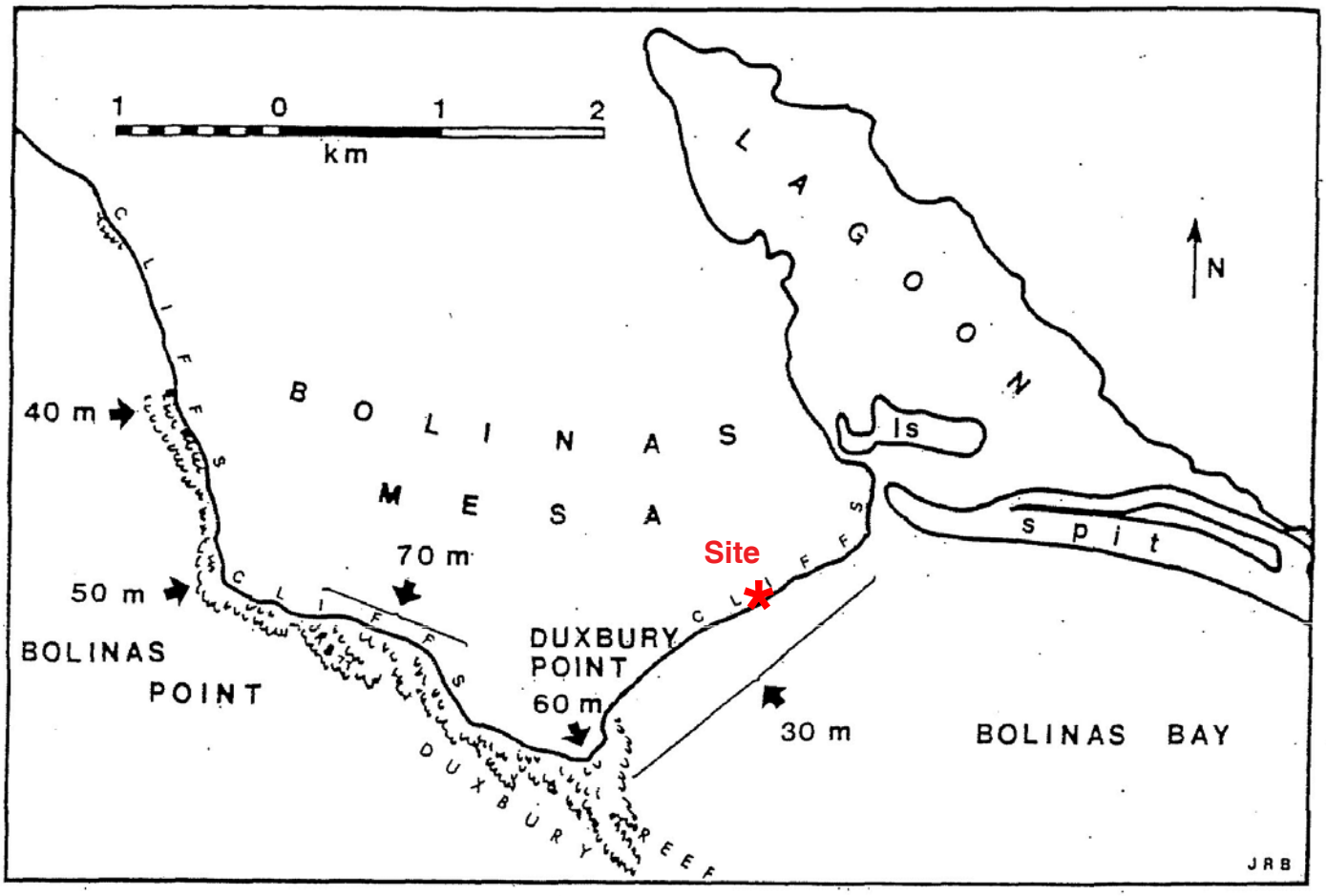
AERIAL IMAGES OF TERRACE BLOCK AT SITE

20 OCEAN AVENUE
Bolinas, California

PROJECT NO.	DATE	FIGURE
3218-1	**January 2025**	**3**

CLIFF RECESSION: 1854 - 1929



Source: Figure 14 from Bergquist (1978)

HISTORIC MOVEMENT RATES AT BOLINAS BLUFFS

20 OCEAN AVENUE
Bolinas, California

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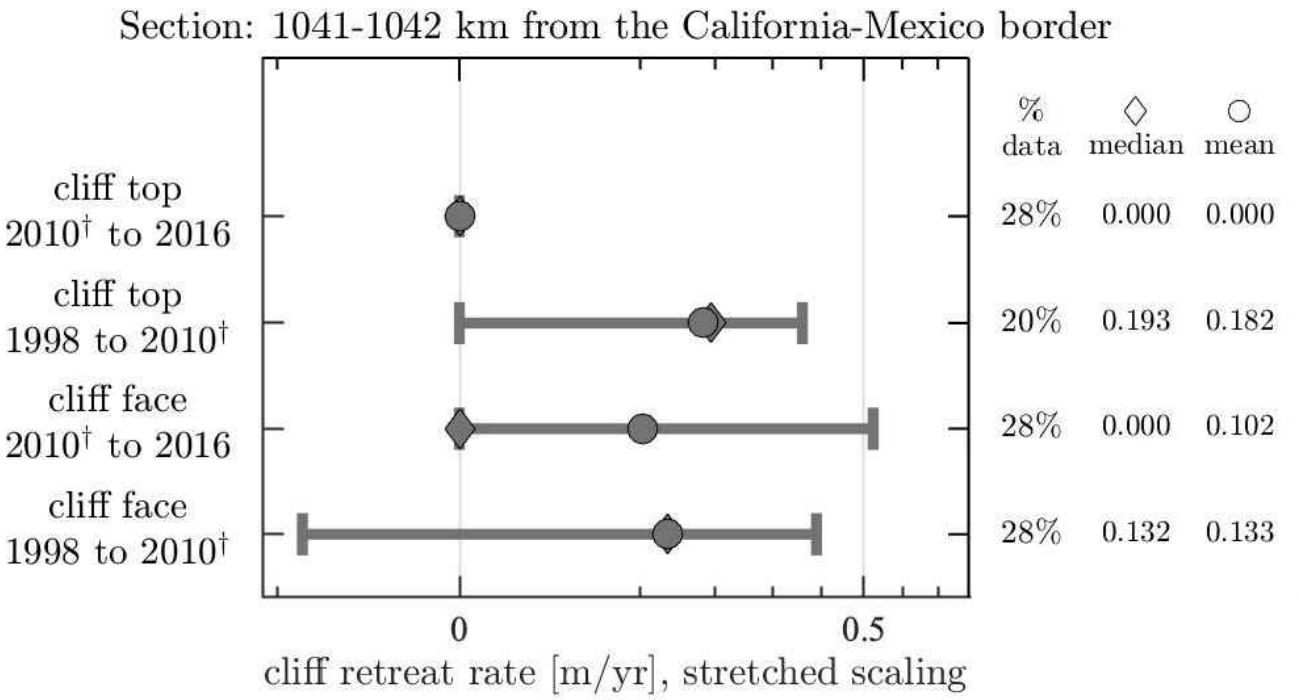
PROJECT NO.	DATE	FIGURE
3218-1	**January 2025**	**4**



Caption: Dark gray bars indicate data range within the section. % data is the percentage of the coastal section analyzed. †The 2010 survey was conducted between 2009-2011. X-axes are square root scaled with ticks spaced at 0.1 m/yr between -1 and 1 and spaced at 0.25 m/yr otherwise. Data sources: Young (2018), Swirad & Young (2021, 2022a, 2022b).

OCEAN PROTECTION COUNCIL

Source: California Coastal Cliff Erosion Viewer (Downloaded 1/2824)

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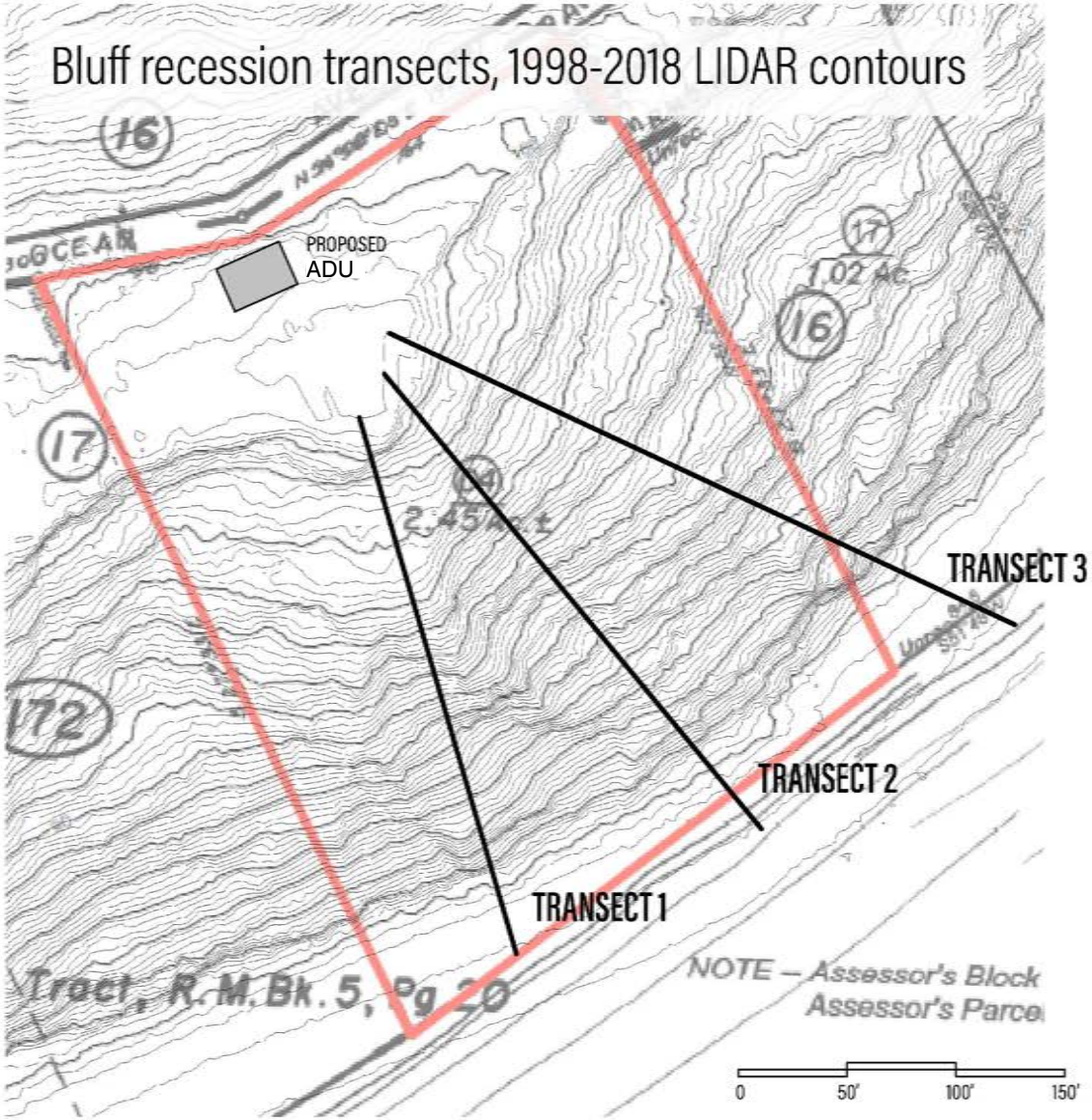
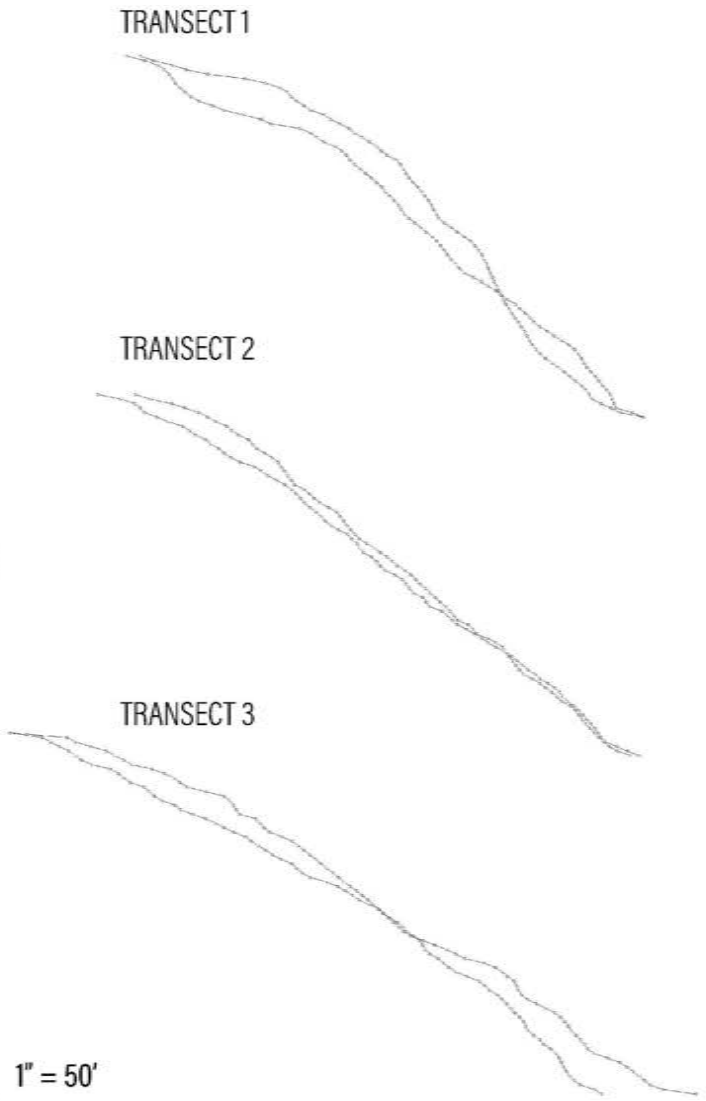
RECENT MOVEMENT RATES AT PROJECT AREA

20 OCEAN AVENUE
Bolinas, California

PROJECT NO.	DATE	FIGURE
3218-1	**January 2025**	**5**





Data provided by Zach Heinemen

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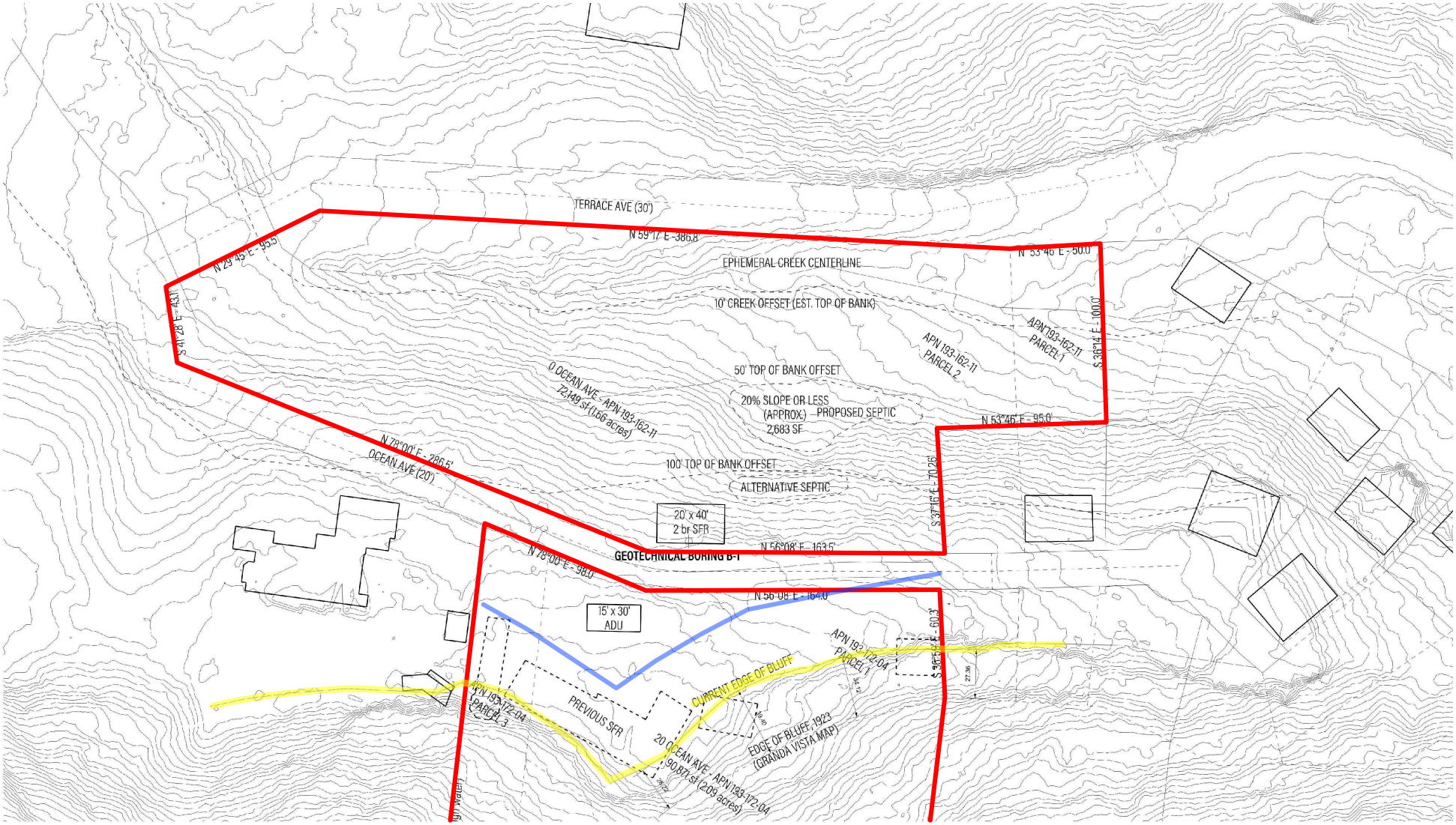
LIDAR READINGS AT SITE

20 OCEAN AVENUE
Bolinas, California

PROJECT NO.	DATE	FIGURE
3218-1	**January 2025**	**6**



Site plan provided by Zach Heinemen dated Oct 18, 2024.

40 0 80 160
APPROXIMATE SCALE FEET

Original figure produced in color.

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LEGEND

- Outlines of Heineman parcels
- Current edge of bluff
- Setback

BLUFF SETBACK MAP

20 OCEAN AVENUE
Bolinas, California

PROJECT NO.	DATE	FIGURE
3218-1	**January 2025**	**7**