APPENDIX E
GREENE REPORT

Substrate and Habitat Types Along PG&E's OBS Cable Route

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Introduction

Substrate and potential marine benthic habitat descriptions are provided here for the proposed Pacific Gas and Electric (PG&E) cable corridor designed to connect four long-term, Ocean Bottom Seismographs (OBS) on the seafloor offshore of Diablo Canyon Power Plant (DCPP) with a land based signal receiving station. The habitat types are based on interpretive Potential Habitat and Geologic maps constructed for PG&E from multibeam echosounder bathymetry and backscatter data collected offshore of DCPP. Potential marine benthic habitats are habitat types based on seafloor substrate types and processes and yet to be confirmed as true habitat types using biological and ecosystems information (see Greene et al., 1999, 2005, 2007 for further information). The habitat types referred to in this report are based on the habitat characterization scheme and mapping code of Greene et al. (2007).

The 30 m (100 ft) wide corridor describe here is an 18.383 km long, four segment route that extends from the entrance to the DCPP intake bay to a location north and west of the receiving station (Figure A). Two of the cable segments are sinuous with Segment 1 having four bends and five separate tangents (route direction changes) and Segment 2 having three bends with four separate tangents. Segments 3 and 4 are straight without bends, tangents. The following descriptions are based on the segment and tangents.

Segment 1 – From km mark (KM) 0.585 (~20 m deep) to OBS-4 (53 m deep) at KM 2.751 (cumulative distance = 2.166 km)

This segment is sinuous with four bends that divide the segment into 5 tangents and ranges in depth from ~20 m to 53 m, a depth range of ~33 m. Most of the cable route crosses relatively smooth, flat sediment seafloor for most of its 2.166 km stretch, but short stretches are within hard bedrock exposures (see Figure B).

Tangent 1 – The eastern end of Segment 1, tangent 1 is located in ~20 m water depth on a soft mobile unconsolidated sand sheet that covers the southern tip of a hard bedrock (diabase) exposure that crops out to the north of KM 0.585 and appears to form an ~10 m high rock face at the entrance to DCPP intake bay. At KM 0.6 a trough (depression) of unconsolidated rippled sand and gravel is exposed on the seafloor and is probably ephemeral as mobile sand sheets that migrate through this area periodically cover the substrate at the base of the depression. From KM 0.6 to where the route bends to south at KM 0.933 the seafloor within the cable corridor is composed of a soft mobile unconsolidated sand sheet habitat with locally exposed small hard bedrock outcrops and boulders. At KM 0.9 the center of the cable corridor crosses an approximate 3 m high boulder or bedrock exposure. The end of this tangent is at ~27m giving an overall depth range of 7 m for the 0.384 km stretch (0.018° slope or 1.82% grade).

Tangent 2 – From KM 0.933 at ~27m water depth to the next bend at KM 1.214 the cable corridor along this tangent is located mainly on soft mobile unconsolidated sand sheets with local exposures of bedrock or sediment-covered bedrock. A small scour depression of soft unconsolidated rippled sand and gravel is located just to the west of the bend at KM 0.933 and may be covered in the future by the migrating mobile unconsolidated sand sheets that are prominent in this area. At KM 1.0 the center of the cable corridor splits two bedrock exposures that rise several meters above the seafloor and crosses a boulder at KM 1.05 in about 28 m water depth. Further along this segment, between KM 1.1 and 1.2 the cable corridor is composed of soft mobile unconsolidated sand sheets that locally cover bedrock with small, scattered hard bedrock outcrops producing a fairly varied and rugose seafloor. The end of this tangent is located at ~29 m water depth giving an overall depth range of 2 m for the 0.281 km length of the tangent (0.01° slope or 0.71% grade).

Tangent 3 – The most complex benthic habitat types of Segment 1, and the entire cable route, exist between the bend at KM 1.214 and the bend at KM 1.919. From KM 1.29 to 1.4 in about 32 m water depth on a flat seafloor the centerline of the proposed cable corridor skirts along the southern margin of hard bedrock exposure that is locally covered with sediment. The northern half of the corridor is located mostly in hard differentially

eroded bedrock that is mixed with locally unconsolidated sediment pockets while the southern half is located on mobile unconsolidated sand sheets. From KM 1.4 the center and northern half of the cable corridor, and from KM 1.425 the entire corridor width, to KM 1.5 is located on differentially eroded bedrock exposures that are locally covered with unconsolidated sediment. Two closely spaced (~20 m peak to peak) rock pinnacles, one rising 1 m off the seafloor and the other 2.5 m high, are crossed by the centerline of the proposed cable corridor between KM 1.45 and 1.48 in 37 m water depth.

From KM 1.45 to 1.62 where a lithologic contact exists in 40 m water depth the corridor crosses a hard bedrock surface covered locally with unconsolidated sediment, the centerline crossing only flat sediment covered substrate overlying hard bedrock. The proposed cable corridor crosses a fairly flat sediment covered bedrock seafloor from KM 1.62 to the end of the tangent at KM 1.919 with the centerline crossing over several small hard rock boulders or pinnacles, the most prominent one being at KM 1.86 that rises ~1 m off the 39 m deep seafloor.

Tangent 3 varies in depth from ~32 m to ~45 m, a range of 13 m along a 0.705 km stretch (0.18° slope or 1.8% grade). This tangent is equal to the slope and grade of Tangent 1, the steepest of all the segments.

Tangent 4 – This is a short tangent that extends from KM 1.919 in ~45 m water depth to KM 2.146 in ~47 m water depth, a length of 0.227 km. The entire proposed cable corridor along this tangent crosses flat scoured sediment (rippled sand and gravel) substrate with the exception at KM 2.1 where the centerline crosses the front of a mobile unconsolidated sand sheet and the southern edge of the corridor skirts several hard outcrops of differentially eroded sedimentary bedrock. Water depth ranges from about 45 m to about 47 m, a differential of 2 m for the 0.227 km length of the tangent (0.01° slope, 0.9% grade).

Tangent 5 – This tangent begins at KM 2.146 in a water depth of ~47 m and extends to the site of OBS-4 at the bend at KM 2.751 in ~53 m water depth. With the exception of 3

small hard bedrock outcrops at KM 2.146 (located along the southern margin of the corridor), KM 2.27 (located along the northern margin of the corridor) and KM 2.7 (located in the southern half of the corridor) this tangent crosses soft unconsolidated sediment. Most of the route is in scoured substrate of rippled sand and gravel while from KM 2.4 to 2.5 the centerline skirts the front of a mobile unconsolidated sand sheet that covers most of the northern half of the corridor. Also, from KM 5.2 to 6.2 at a general depth of 50 m the corridor crosses a mobile unconsolidated sand sheet. Water depth along this tangent ranges from ~47 to ~53 m along the 0.605 km length, a depth differential of 6 m for the tangent (0.01° slope, 0.1% grade).

OBS-4

The proposed location of OBS-4 is located on flat current scoured rippled sand and gravel substrate, near and down current of the front of a mobile unconsolidated sand sheet (see Figures B, F-O4). The sand sheet is an ephemeral feature and could migrate across the proposed OBS location. No bedrock outcrops or other hard habitat type is located within a 15 m radius of the location. The closest alternative habitat type is a small bedrock exposure located 0.17 km E of the OBS location with scattered rocks present 0.17 km and further away north of the OBS location (Figure A).

Segment 2 – From OBS-4 (~53 m deep) at KM 2.751 to OBS-3 (~113 m deep) at KM 11 (4.808 km long)

Segment 2 has 4 tangents with 3 bends and a total length of 8.249 km. The most sinuous part of the segment is located along its southern half, which parallels the coast and isobaths, while the northern half is oriented nearly E-W as one straight tangent that is oblique to the coastline and obliquely crosses isobaths (see Figure C).

Tangent 1 – Tangent 1 of Segment 2 begins at the proposed site of OBS-4, at KM 2.751 in ~53 m of water and extends to a bend at KM 3.51 in water depth of ~61 m. The entire tangent corridor is located on soft mobile unconsolidated sand sheets and with the exception of a small bedrock outcrop in the northern part of the corridor at KM 3.3 the

entire tangent is positioned in a soft unconsolidated sand habitat. For the 0.759 km length of the tangent depth varies by 8 m (0.01° slope, 1.05% grade).

Tangent 2 – This tangent crosses a flat seafloor and extends from km mark 3.51 at ~61 m water depth to the bend at km mark 4.183 at a depth of ~64 m. The seafloor habitat is composed primarily of soft unconsolidated mobile sand sheets interspersed with fingers of scoured sand and gravel substrate, the surface upon which the sand is migrating. These scour fingers are located between km marks 3.59 and 3.62 and km marks 3.93 and 4.0 at an average depth of 64 m. A lone small hard bedrock pinnacle is located at the northeastern margin of the corridor along this tangent at km mark 3.77. Depth along this 0.673 km long tangent varies from ~61 m to ~64 m, ~3 m difference (0.004° slope, 0.45% grade).

Tangent 3 – This tangent is primarily located on the soft mobile unconsolidated sand sheets that are migrating over scoured unconsolidated rippled sand and gravel substrate with occasional local exposures of hard flat bedrock. The tangent is located between bends at KM 4.183 in a water depth of ~64 m to KM 6.192 in a water depth of ~55 m. From the bend at KM 4.183 to 4.44 the benthic habitat is composed of soft mobile unconsolidated sand. From KM 4.44 to 4.5 the proposed cable corridor crosses a depression of scoured unconsolidated rippled sand and gravel that separate two mobile sand sheets. Then from KM 4.5 to 4.56 the tangent is located on a soft mobile unconsolidated sand sheet. Between KM 4.56 and 4.58 a low relief hard bedrock outcrop, locally covered with unconsolidated sediment (sand?), is exposed in the northern half of the corridor. Hard differentially eroded sedimentary bedrock is located at the northern boundary of the corridor at KM 4.9 and again at KM 5.2. Fingers of scoured unconsolidated rippled sand and gravel substrate are located between KM 4.87 to 4.88 (restricted to northern margin of corridor), KM 5.13 to 5.15, KM 5.23 to 5.25, KM 5.42 to 5.48, at KM 6 and 6.1 (all scours cut across the entire width of the corridor). All other parts of the tangent are located on the soft mobile unconsolidated sand sheets. The fronts (east facing) of the mobile sand sheets locally obtain 1 m in height.

Tangent 3 ranges in depth from ~64 m to ~55 m, ~9 m difference along its 2.727 km length (0.003° slope, 0.33% grade).

Tangent 4 – This is a 4.808 km long transect extending from the bend of Segment 2 at KM 6.192 in ~55 m water to the proposed OBS-3 location in ~113 m of water. The shallow part of this tangent crosses benthic habitats of soft mobile unconsolidated sands sheets interspersed with scoured depressions of rippled sand and gravel. The scour depressions are located approximately between KM 6.2 and 6.3, KM 6.35 and 6.42, KM 6.45 and 6.47, at KM 6.55, and KM 6.8 to 6.84. As these features are mobile and ephemeral they may not be present in these locations in the future. The mobile sand sheets appear to die out below a depth of ~ 78 m near KM 7.5.

From KM 7.5 to the end of the tangent at OBS-3 location the proposed corridor cuts across the Hosgri fault zone and is located within undifferentiated unconsolidated sediment (possible mud and sand habitat) on a gently sloping seafloor. No fault scarps or bedrock exposures are seen to be present in the proposed corridor along this part of the tangent, although the possibility exists that an occasional isolated boulder or pinnacle may be present.

Tangent 4 ranges in water depth from ~55 m to ~113 m for its 4.808 km length, a depth variation of ~58 m (0.012° slope, 1.206% grade). The seafloor is generally smooth and soft with a very gently inclination.

OBS-3

The location of OBS-3 at km mark 11.0 and at a depth of ~113 m of water is located in a homogeneous undifferentiated soft unconsolidated seafloor habitat of mud or sandy mud (see Figures C, F-O3). No hard rock outcrops, pinnacles or boulders appear to exist anywhere in the vicinity of a 15 m radius of its proposed location. The closest rock outcrop is located 0.8 km NE of the OBS location (Figure A).

Segment 3 – From OBS-3 (~113 m deep) at KM 11.0 to OBS-2 (~97m deep) at KM 15.411 (4.411 km long)

Segment 3 consists of one long tangent oriented N-S from the proposed OBS-3 location at KM 11.0 in ~113 m water depth to proposed OBS-2 location at KM 15.441 in ~97 m water depth (see Figure D). The entire proposed cable corridor route is located on flat smooth soft unconsolidated sediment (mud and sand) habitat. In only one location is there a different habitat type and that is at KM 15.2 in about 97 m of water where a boulder or bedrock pinnacle with a scour moat and down current soft hummocky sediment depression exist, located just outside of the eastern margin of the corridor. This linear hummocky soft sediment comet-shaped mark is oriented parallel to the proposed cable route extending along the eastern margin of the corridor from the boulder at KM 15.2 to km mark 14.9, 300 m in length.

The difference in depth along this 4.411 km long segment ranges from ~113 m at OBS-3 location to ~97 m at OBS-2 location, a total of ~16 m for the 4.411 km long segment (0.004° slope, 0.363% grade). This segment is extremely flat and smooth.

OBS-2

The proposed location of OBS-2 is within the soft unconsolidated sediment (mud and sand) habitat with no hard rock or other habitat type located within a 15 m radius of the location (see Figures D, F-O2). A single small bedrock outcrop is located 0.2 km SE of the OBS site. The OBS location is the turn point at km mark 15.411 in a water depth of ~97.

Segment 4 - From OBS-2 (~97 m deep) at KM 15.411 to OBS-1 (~62 m deep) at KM 18.383 (2.972 km long)

Segment 4 is oriented nearly east-west extending from the bend at KM 15.411 at the proposed location of OBS-2 in ~97 m water depth to the end of the proposed cable route at KM 18.383 at proposed OBS-1 position in ~62 m water depth (see Figure E). This segment is almost exclusively in soft sediment, crossing soft unconsolidated (mud and sand) habitat from KM 15.411 to 17.88 with one exception being a small hard bedrock pinnacle located at the northern corridor boundary at KM 16.7 in 80 m water depth. From KM 17.88 to the end of the segment at KM 18.383 the cable corridor is located in a soft mobile unconsolidated sand sheet.

Segment 4 ranges in water depth from ~97 m at KM 15.411 to ~62 m at its end, at the location of OBS-1 at KM 18.383, an ~35 m difference in the 2.972 km long segment (0.013° slope, 1.178% grade). This segment extends along a gentle smooth unconsolidated sediment slope with no hard impediments even though it crosses the Hosgri Fault Zone where no seafloor offsets or bedrock exposures are seen within the cable corridor.

OBS-1

The proposed location of OBS-1 is on a mobile unconsolidated sand sheet that is ephemeral and may move in the future (see Figures E, F-O1). No other habitat type such as hard bedrock exposures or pinnacles are seen within a 15 m radius of the OBS suggested position.

Temporary OBS-4

Temporary OBS-4 is located on flat seafloor in a soft scour depression of unconsolidated rippled sand and gravel (see Figure F-T4). This type of substrate and habitat exists within the 15 m radius around the suggested OBS position, however soft mobile unconsolidated sand sheets surrounds this the rippled scour depression and may migrate across the location in the future. SE of this OBS location is a series of differentially eroded sedimentary bedrock exposures and 0.22 km east of the location is an extensive outcrop of the sedimentary bedrock.

Temporary OBS-3

Temporary OBS-3 proposed location is in soft unconsolidated (mud and sand) habitat on flat seafloor (see Figure F-T3). No other habitat type exists within a 15 m radius of the suggested position.

Temporary OBS-2

Temporary OBS-2 proposed location is in soft unconsolidated (mud and sand) habitat on a flat seafloor (see Figure F-T2). No other habitat type exists within a 15 m radius of the suggested position.

Temporary OBS-1

Temporary OBS-1 proposed location is in soft unconsolidated (mud and sand) habitat on flat seafloor (see Figure F-T1). No other habitat type exists within 15 m radius of the suggested position.

References

Greene, H.G., Yoklavich, M.M., Starr, R., O'Connell, V.M., Wakefield, W.W., Sullivan, D.L. MacRea, J.E. and Cailliet, G.M., 1999. A classification scheme for deep-water seafloor habitats: *Oceanographica ACTA*, v. 22, n. 6, p. 663-678.

Greene, H.G., Bizzarro, J.J., Tilden, J.E., Lopez, H.L., and Erdey, M.D., 2005. The benefits and pitfalls of geographic information systems in marine benthic habitat mapping: *In* Wright, D.J. and Scholz, A.J., (Eds.), Place Matters. *Oregon State University Press*, Portland, OR, p. 34-46.

Greene, H.G., Bizzarro, J.J., O'Connell, V.M., and Brylinsky, C.K., 2007. Construction of digital potential marine benthic habitat maps using a coded classification scheme and its application: *In* Todd, B.J., and Greene, H.G. (Eds.), Mapping the Seafloor for Habitat Characterization, *Canadian Geological Association* Special Paper 47, p. 141-155.

FIGURES:

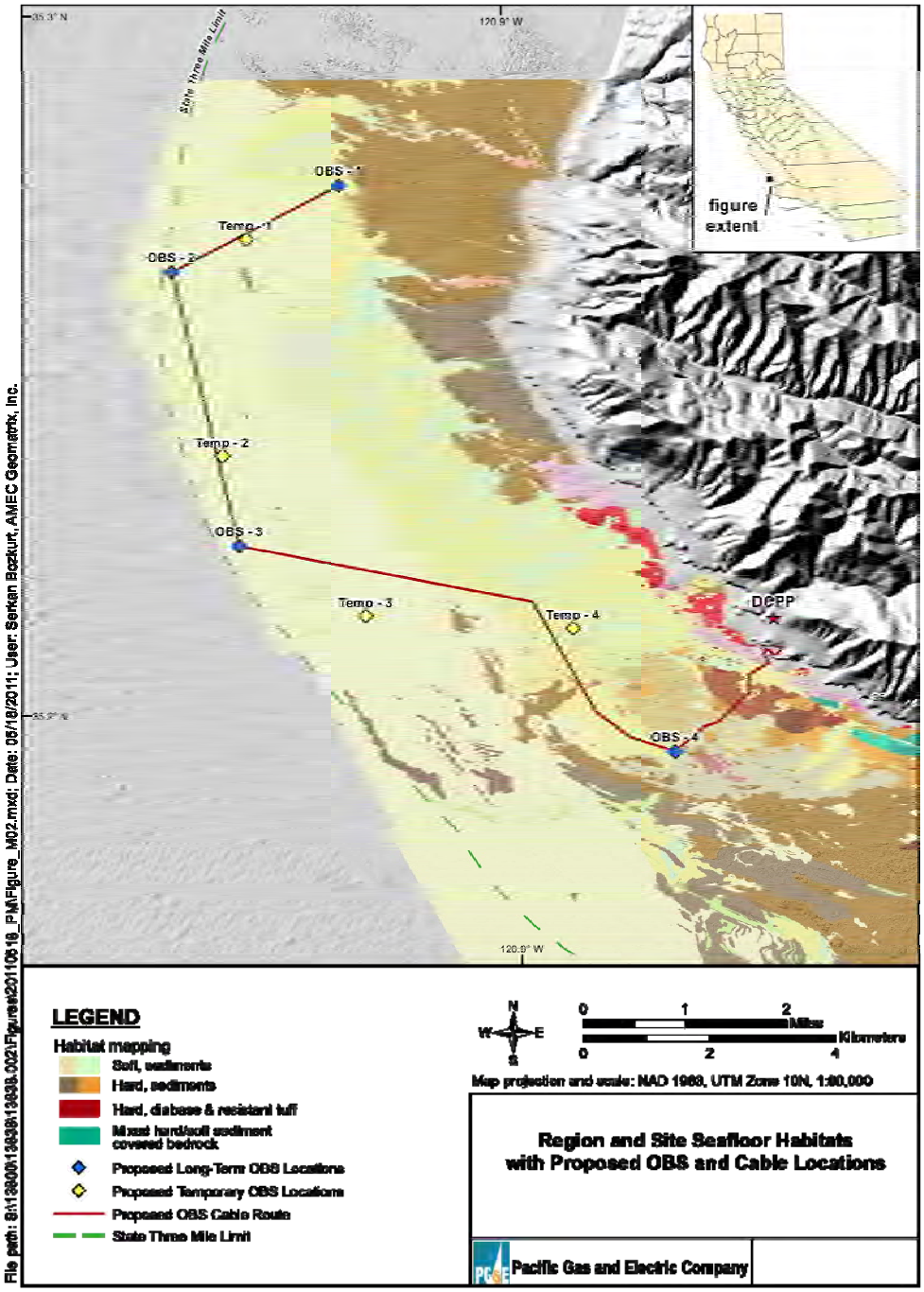

Figure A. Potential marine benthic habitat map offshore DCPP showing PG&E's OBS cable route.

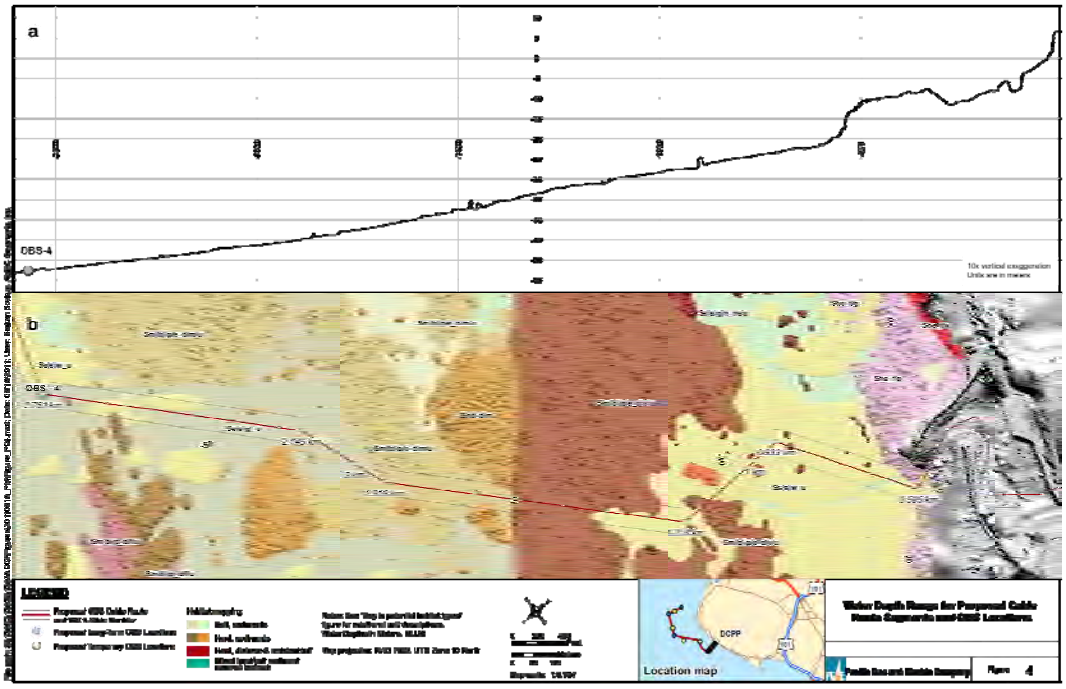

Figure B. Segment 1 of PG&E OBS cable route across various potential habitat and substrate types including bathymetric profile along the route.

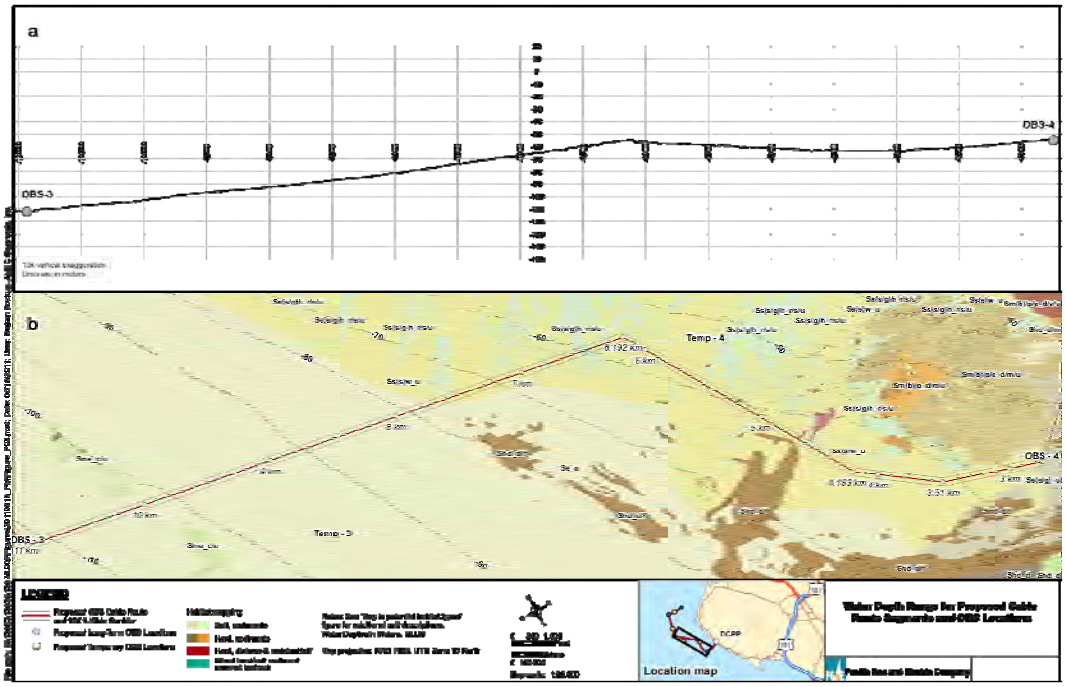

Figure C. Segment 2 of the PG&E OBS cable route across various habitat and substrate types including a bathymetric profile along the route.

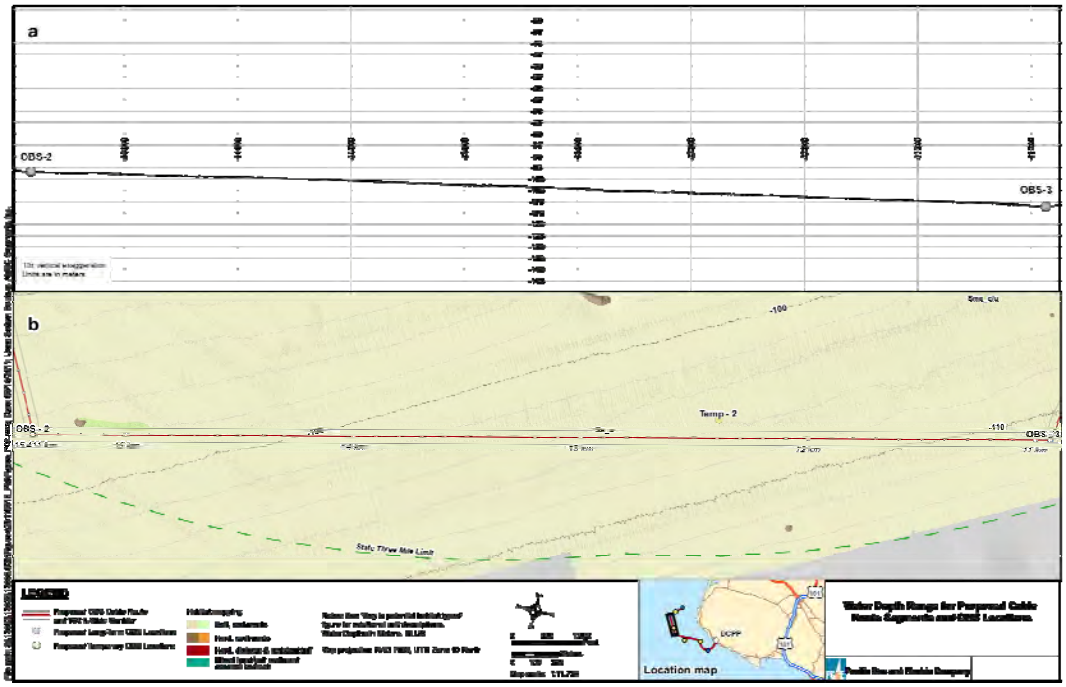

Figure D. Segment 3 of PG&E OBS cable route across a sole habitat and substrate habitat type including bathymetric profile along the route.

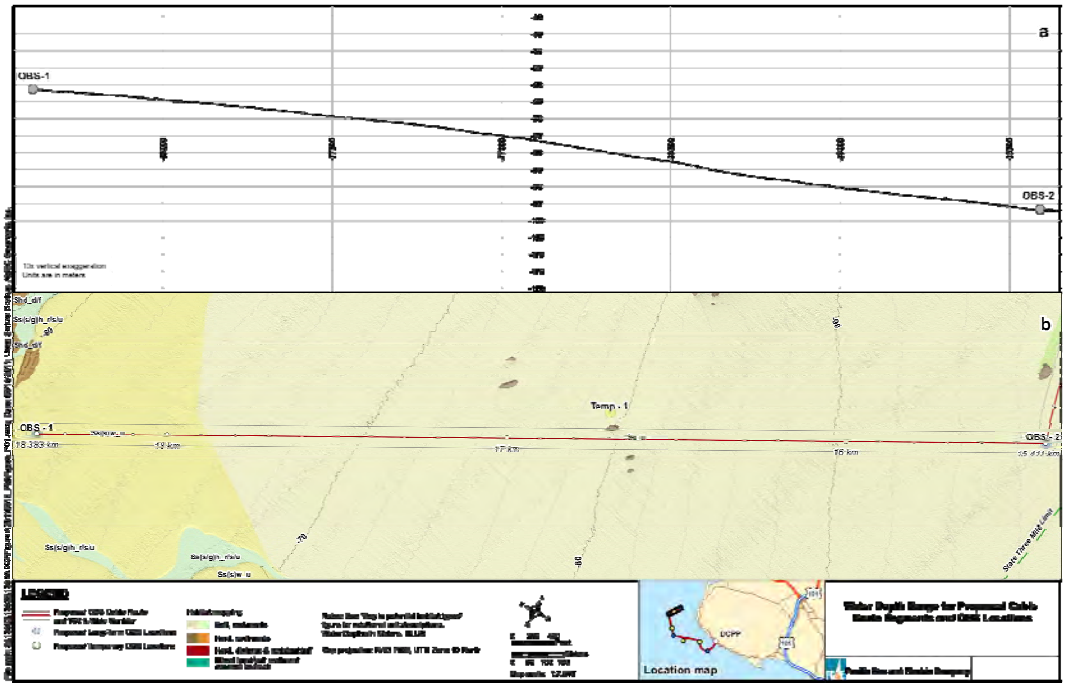

Figure E. Segment 4 of PG&E OBS cable route across two habitat and substrate types including bathymetric profile along the route.

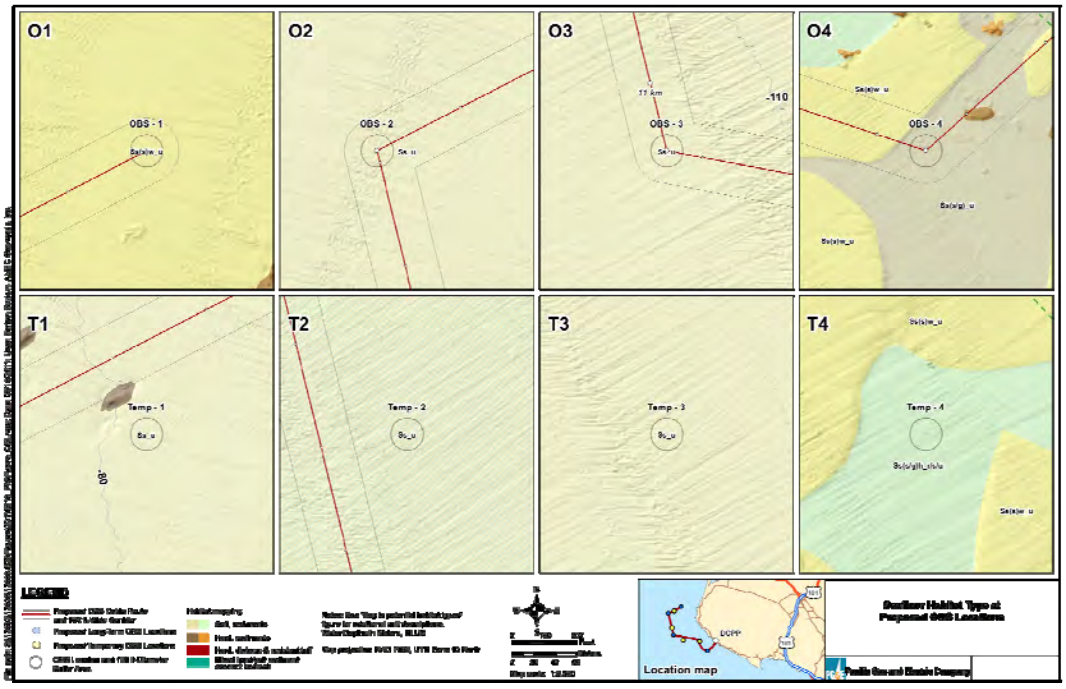

Figure F. Locations of proposed PG&E permanent and temporary OBS locations in relation to habitat and substrate types.