Report of Investigation 2014-1B

UPDATED TSUNAMI INUNDATION MAPS FOR CORDOVA, ALASKA

E.N. Suleimani, D.J. Nicolsky, and J.B. Salisbury

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Map Sheets

UPDATED TSUNAMI INUNDATION MAPS FOR CORDOVA, ALASKA

E.N. Suleimani[1], D.J. Nicolsky[1], and J.B. Salisbury[2]

Abstract

This release updates the previous tsunami hazard assessment for Cordova, Alaska, by Nicolsky and others (2014). We numerically remodel the extent of potential inundation from tsunami waves using a new, more accurate digital elevation model (DEM) that covers areas in the Copper River delta adjacent to the Cordova Municipal Airport. Results presented here are intended to provide guidance to local emergency management agencies for tsunami inundation assessment, evacuation planning, and public education to mitigate impacts of future tsunami events.

INTRODUCTION

In 2020, the National Oceanic and Atmospheric Administration's (NOAA) National Centers for Environmental Information (NCEI) used lidar and IfSAR to develop a seamless 8/15 arc-second resolution bathymetric–topographic digital elevation model (DEM) to support tsunami hazard mitigation efforts in Cordova, Alaska (Carignan and others, 2020). We use this updated, more accurate DEM to calculate potential inundation zones in Cordova as the previous study (Nicolsky and others, 2014) was based on a lower resolution and less accurate elevation dataset—the 2-arc-second National Elevation Dataset (NED) supplemented with pointwise RTK GPS measurements in downtown Cordova.

METHODOLOGY AND TSUNAMI SOURCES

In this update we use the same hypothetical tectonic tsunami sources and tsunami modeling techniques as the previous study (see table 2 and "Numerical Model of Tsunami Propagation and Runup" in Nicolsky and others, 2014). Similarly, we use a series of nested grids, ranging from level 0—the North Pacific grid, to level 4—high-resolution grid focused on Cordova, to model tsunami dynamics and runup (table 1, Nicolsky and others, 2014). In this update, the level 4 high-resolution DEM is now based on the lidar-derived DEM developed by Carignan and others (2020), allowing for more accurate tsunami runup modeling in the community. The increased spatial extent of the updated grid now includes areas in the Copper River delta. The west-east and south-north boundaries of the DEM are now 146°08'W–145°21'W and 60°13'N–60°42'N, respectively.

MODELING RESULTS

New results suggest that potential tsunami wave heights in Orca Inlet are the same as shown in Nicolsky and others (2014), but the extent of modeled inundation within the community of Cordova is more severe. Notable differences occur in flat, low-lying areas adjacent to the coast (fig. 1, map sheets 2–4). Areas adjacent to the airport were not addressed by Nicolsky and others (2014), and potential inundation is now presented in this update. Near the airport, flooding can reach far inland and along the Eyak River (map sheets 5–6). Graphical plots of modeled tsunami wave height dynamics and water velocities are shown in appendix A for selected locations.

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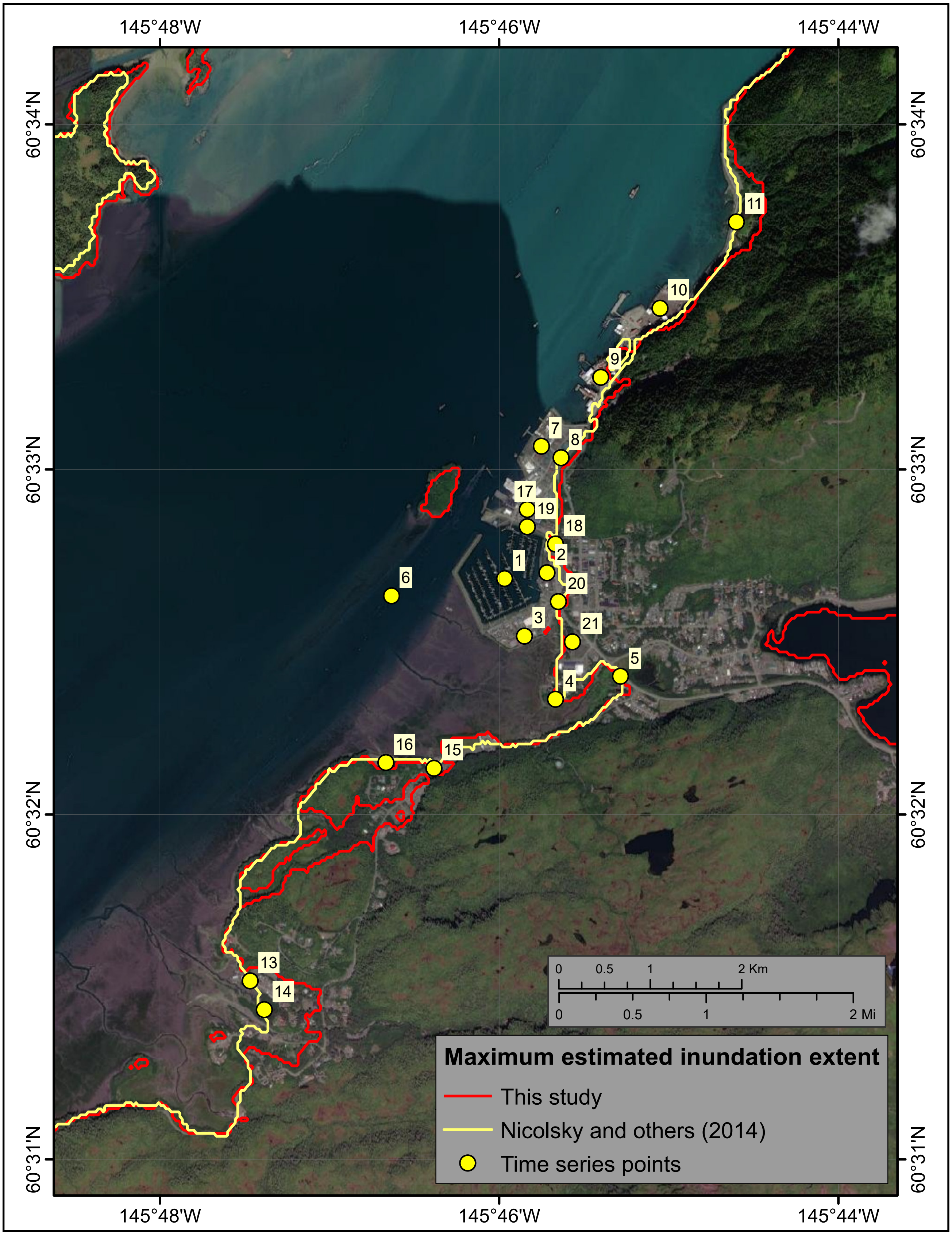


Figure 1. Comparison of the potential inundation according to this study and Nicolsky and others (2014). Locations of time series points are shown by yellow circles.

SUMMARY

We updated our tsunami hazard assessment for Cordova, Alaska, by numerically modeling hypothetical tectonic tsunami waves on a new, high-resolution DEM. We considered several geologically plausible earthquake-generated tsunami scenarios and provide an estimate of maximum credible tsunami inundation associated with each. A M_w 8.8 megathrust earthquake in the eastern Gulf of Alaska region with maximum slip at a depth of 12–28 km (7.5–17.4 mi) to 17–30 km (10.6–18.6 mi), results in the largest inundation area in downtown Cordova along Orca Inlet (scenario 13, Nicolsky and others, 2014). The largest inundation near the airport is due to a M_w 9.0 earthquake in the Gulf of Alaska region with maximum slip at a depth of 4–18 km (2.5–11.2 mi) (scenario 12, Nicolsky and others, 2014).

The maps in this report have been completed using the best information available and are believed to be accurate; however, their preparation required many assumptions. Actual conditions during a tsunami event may vary from those considered, so the report's accuracy cannot be guaranteed. The limits of inundation shown should only be used as a guideline for emergency planning and response action. Actual inundated areas will depend on specifics of earth deformations, on-land construction, and tide level, and may differ from areas shown on the map. The information on this map is intended to assist state and local agencies in planning for emergency evacuation and tsunami response actions in the event of a major tsunamigenic earthquake. These results are not intended for land-use regulation or building-code development.

ACKNOWLEDGMENTS

This report was funded by the Department of Commerce/National Oceanic at Atmospheric Administration through the National Tsunami Hazard Mitigation Program (NTHMP), Award #NA21NWS4670003 to the Alaska Division of Homeland Security & Emergency Management. This does not constitute an endorsement by NOAA. Numerical calculations for this work were supported by High Performance Computing (HPC) resources at the Research Computing Systems unit at the Geophysical Institute, University of Alaska Fairbanks.

REFERENCES

Carignan, K.S., Amante, C.J., Love M.R., and Stiller, M., 2020, Digital Elevation Model of Cordova, Alaska: Procedures, Data Sources, and Analysis: Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado, Boulder, CO.

Nicolsky, D.J., Suleimani, E.N., and Koehler, R.D., 2014, Tsunami inundation maps of Cordova and Tatitlek, Alaska: Alaska Division of Geological & Geophysical Surveys Report of Investigation 2014-1, 49 p., 2 sheets, scale 1:31,000. https://doi.org/10.14509/27241

Table A1. Maximum water levels and water velocities for tectonic scenarios at time series points near Cordova. The maximum water depth above ground is provided for onshore (S) locations, whereas the maximum water level above the pre-earthquake mean high high water (MHHW) is provided for offshore (O) locations. The minimum elevation above the post-earthquake MHHW datum is provided for onshore locations, while the minimum post-earthquake depth is provided for offshore locations. The horizontal datum used is World Geodetic System of 1984.

#	Label	S / O	Longitude (°W)	Latitude (°N)	Minimum elevation/ depth (m)	Maximum Water Depth Above Ground/Sea Level (m) Tectonic scenarios													Maximum Water Velocity (m/sec) Tectonic scenarios												
						1	2	3	4	5	6	7	8	9	10	11	12	13	1	2	3	4	5	6	7	8	9	10	11	12	13
1	Harbor	O	145.766111	60.544722	7.9	2.7	1.2	3.4	2.5	1.9	1.1	1.7	3.4	2.7	3.9	3.1	4.3	5.5	0.6	0.2	0.5	0.3	0.1	0	0.2	0.6	0.3	0.7	0.5	0.7	0.8
2	Waterfront	S	145.761944	60.545000	1.4	0.8	0	1.5	0.6	0	0	0	1.5	0.9	2.0	1.3	2.5	3.7	0.2	0	0.3	0.1	0	0	0	0.2	0.3	0.3	0.6	0.8	0.9
3	Harbor Loop Rd.	S	145.764167	60.541944	2.0	0.3	0	0.9	0	0	0	0	1.0	0.3	1.4	0.8	1.8	3.2	0	0	0.7	0	0	0	0	0.6	0.7	0.9	2.0	2.0	1.9
4	Marine Way	S	145.761111	60.538889	5.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	Copper River Hwy.	S	145.754722	60.540000	6.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	Orca Inlet	O	145.777222	60.543889	7.2	2.7	1.2	3.3	2.4	1.9	1.1	1.8	3.4	2.6	3.8	2.9	4.2	5.6	2.4	1.5	2.0	1.7	1.1	0.7	0.9	2.0	1.2	2.6	1.4	1.8	2.6
7	Docks	S	145.762500	60.551111	2.1	0.2	0	0.7	0	0	0	0	0.7	0	1.2	0.3	1.7	2.8	0	0	1.3	0	0	0	0	1.3	0	2.1	0.8	0.9	3.4
8	Sorrell Rd.	S	145.760556	60.550556	2.3	0	0	0.6	0	0	0	0	0.6	0	1.1	0	1.7	2.7	0	0	0.6	0	0	0	0	0.5	0	0.9	0	1.3	2.1
9	Cannery	S	145.756667	60.554444	2.8	0	0	0.1	0	0	0	0	0	0	0.4	0	1.0	2.1	0	0	0	0	0	0	0	0	0	1.3	0	0.8	2.7
10	Storage facilities	S	145.750833	60.557778	0.5	1.6	0.1	2.4	1.4	0.9	0	0.3	2.4	1.4	3.0	1.7	3.3	4.8	1.0	0	1.2	0.9	0.3	0	0.4	1.2	0.8	1.3	0.9	1.0	1.7
11	New England Canary Rd.	O	145.743333	60.561944	-0.3	2.6	1.2	3.4	2.5	2	1	1.4	3.5	2.4	3.9	3	4.4	5.6	2.3	1.7	2.5	2.1	0.6	0.4	2.1	2.1	2.5	2.6	3.8	3.3	3.9
12	Old Cannery	S	145.717500	60.580000	3.4	0	0	0	0	0	0	0	0	0	0.2	0	0	2.4	0	0	0	0	0	0	0	0	0	0	0	0	2.2
13	Prince William Marina Rd.	S	145.791111	60.525278	-0.4	2.8	1.3	3.3	2.4	1.7	1.1	2.4	3.3	2.8	3.7	3.3	4.6	5.4	1.1	0.4	1.0	0.5	0.3	0.3	3.0	0.7	2.5	1.0	2.6	2.8	0.6
14	Old Sawmill Rd.	S	145.789722	60.523889	0.9	1.6	0.1	2.0	1.1	0.5	0	1.2	2.0	1.6	2.5	2.0	3.4	4.1	1.0	0	1.7	0.5	0.3	0	1.9	0.5	3.6	0.6	3.7	4.4	0.8
15	Orca Inlet Dr., east	S	145.773056	60.535556	4.3	0	0	0	0	0	0	0	0	0	0	0	0	1.0	0	0	0	0	0	0	0	0	0	0	0	0	0.4

Table A1, continued. Maximum water levels and water velocities for tectonic scenarios at time series points near Cordova. The maximum water depth above ground is provided for onshore (S) locations, whereas the maximum water level above the pre-earthquake mean high high water (MHHW) is provided for offshore (O) locations. The minimum elevation above the post-earthquake MHHW datum is provided for onshore locations, while the minimum post-earthquake depth is provided for offshore locations. The horizontal datum used is World Geodetic System of 1984.

#	Label	S/O	Longitude (°W)	Latitude (°N)	Minimum elevation/ depth (m)	Maximum Water Depth Above Ground/Sea Level (m) — Tectonic scenarios													Maximum Water Velocity (m/sec) — Tectonic scenarios												
						1	2	3	4	5	6	7	8	9	10	11	12	13	1	2	3	4	5	6	7	8	9	10	11	12	13
16	Orca Inlet Dr., west	S	145.777778	60.535833	3.0	0	0	0	0	0	0	0	0	0	0.5	0	1.0	2.2	0	0	0	0	0	0	0	0	0	0.6	0	2	0.6
17	Seafood Ln.	S	145.763889	60.548056	1.6	0.6	0	1.3	0.3	0	0	0	1.3	0.5	1.7	1.1	2.2	3.4	0.7	0	1.0	0.3	0	0	0	0.9	0.9	1.4	1.3	1.5	1.9
18	Railroad Ave.	S	145.761111	60.546389	7.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	Breakwater Ave.	S	145.763889	60.547222	0.4	1.7	0.3	2.5	1.5	0.9	0.1	0.8	2.4	1.7	2.9	2.2	3.4	4.6	0.4	0	0.4	0.2	0.2	0	0.3	0.4	0.6	0.5	0.9	2.3	1.2
20	Nicholoff Way and Railroad Ave.	S	145.760833	60.543611	3.7	0	0	0	0	0	0	0	0	0	0	0	0.3	1.3	0	0	0	0	0	0	0	0	0	0	0	0	0.6
21	Sawmill Rd.	S	145.759444	60.541667	7.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	Deep Bay	O	145.769444	60.597500	5.4	2.9	1.3	3.8	2.8	2.0	1.0	1.3	4.0	2.0	4.4	2.0	3.5	6.7	4.1	1.3	2.9	1.3	0.7	0.4	0.7	2.9	1.1	4.0	1.4	1.8	4.0
23	Nelson Bay	O	145.643611	60.655278	31.3	3.5	1.8	4.7	3.4	2.6	1.1	1.5	4.5	2.0	5.3	2.3	3.1	7.9	0.4	0.2	0.4	0.4	0.2	0.1	0.2	0.4	0.2	0.5	0.3	0.3	1.0
24	Shipyard Bay	O	145.800278	60.570833	0.4	2.7	1.0	3.5	2.4	2.1	1.1	1.7	3.5	2.6	3.9	2.9	4.5	5.7	2.3	1.6	2.2	2.1	1.2	0.6	1.2	2.0	1.9	2.2	2.0	2.3	2.1
25	Orca Inlet entrance	O	145.871944	60.522500	2.2	2.5	1.0	3.1	1.8	1.7	1.1	1.6	3.2	2.3	3.7	2.9	3.3	5.5	2.7	1.8	2.7	1.7	1.2	1.0	2.0	2.5	2.2	3.1	2.9	3.0	3.0
26	Orca Bay entrance	O	145.888333	60.598889	187.0	2.5	0.6	3.2	1.8	1.7	0.9	1.0	3.3	1.1	4.0	2.0	2.2	6.1	0.7	0.4	0.7	0.5	0.2	0.1	0.2	0.6	0.3	0.8	0.4	0.6	0.9

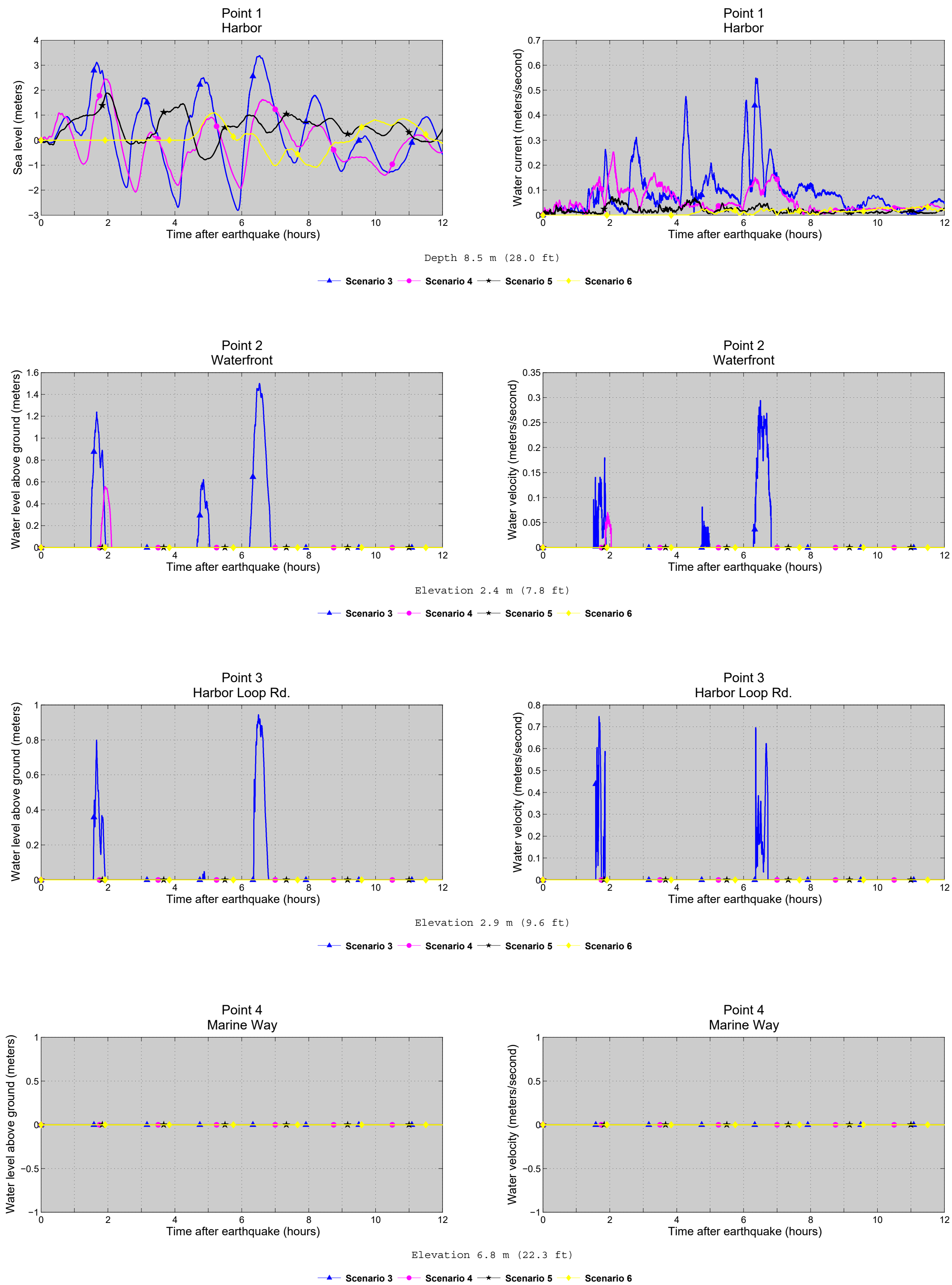
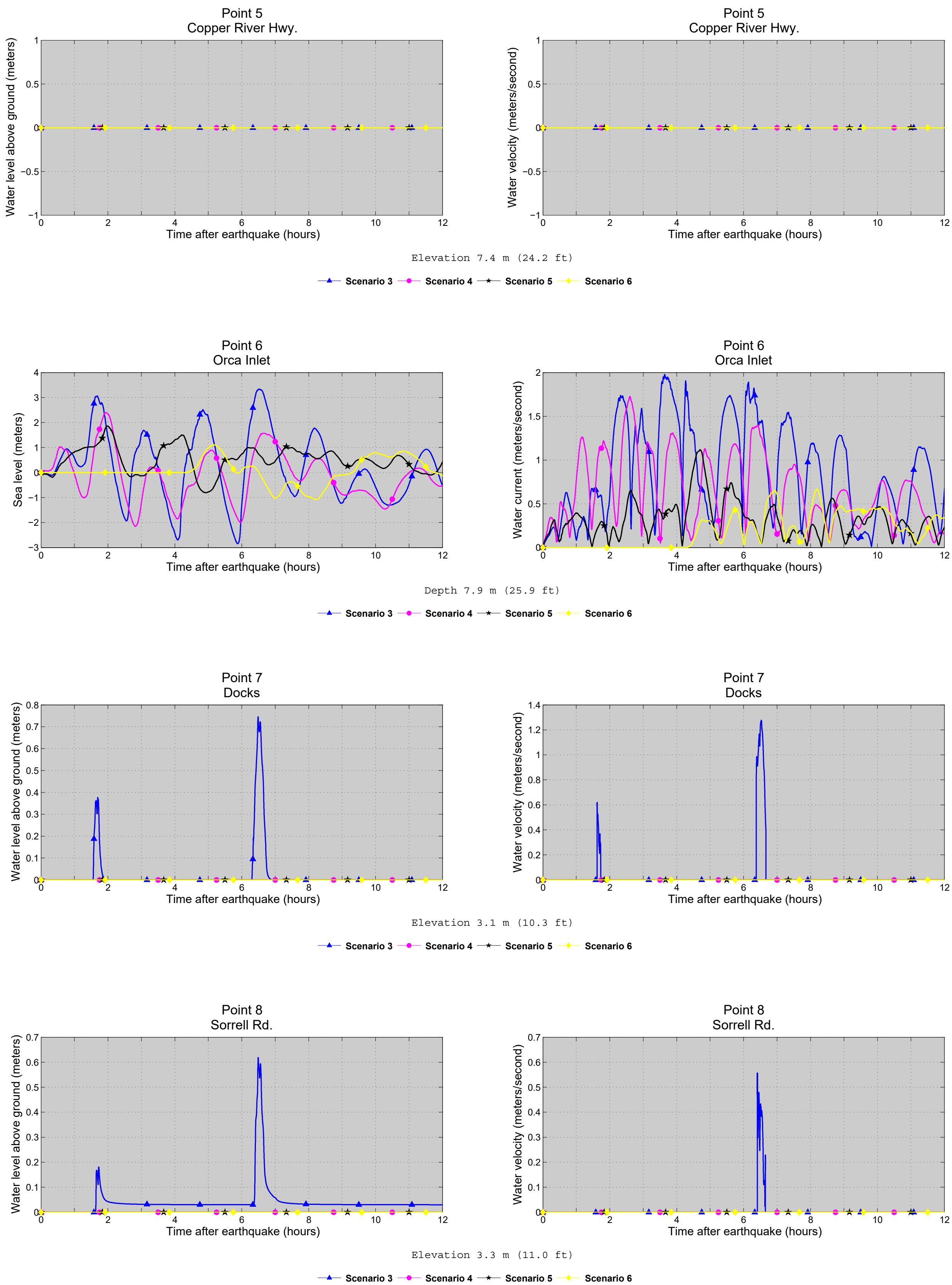


Figure A1. Time series of water level (left column) and velocity (right column) for tectonic scenarios 3–6 at selected locations shown in figure 1 and in Nicolsky and others (2014, figure A1). Elevations of onshore locations and ocean depth at offshore locations are given based on the pre-earthquake MHHW datum.



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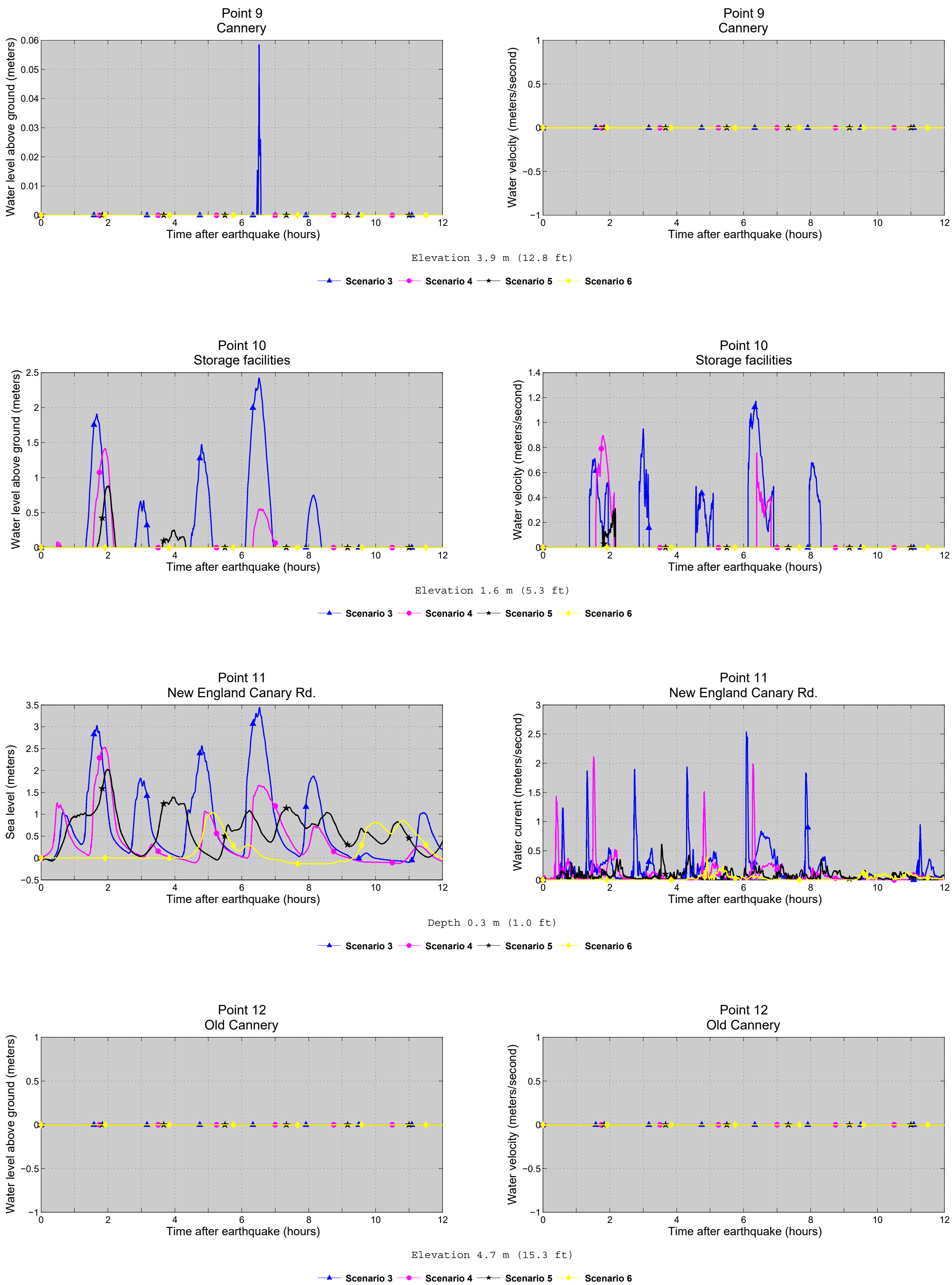

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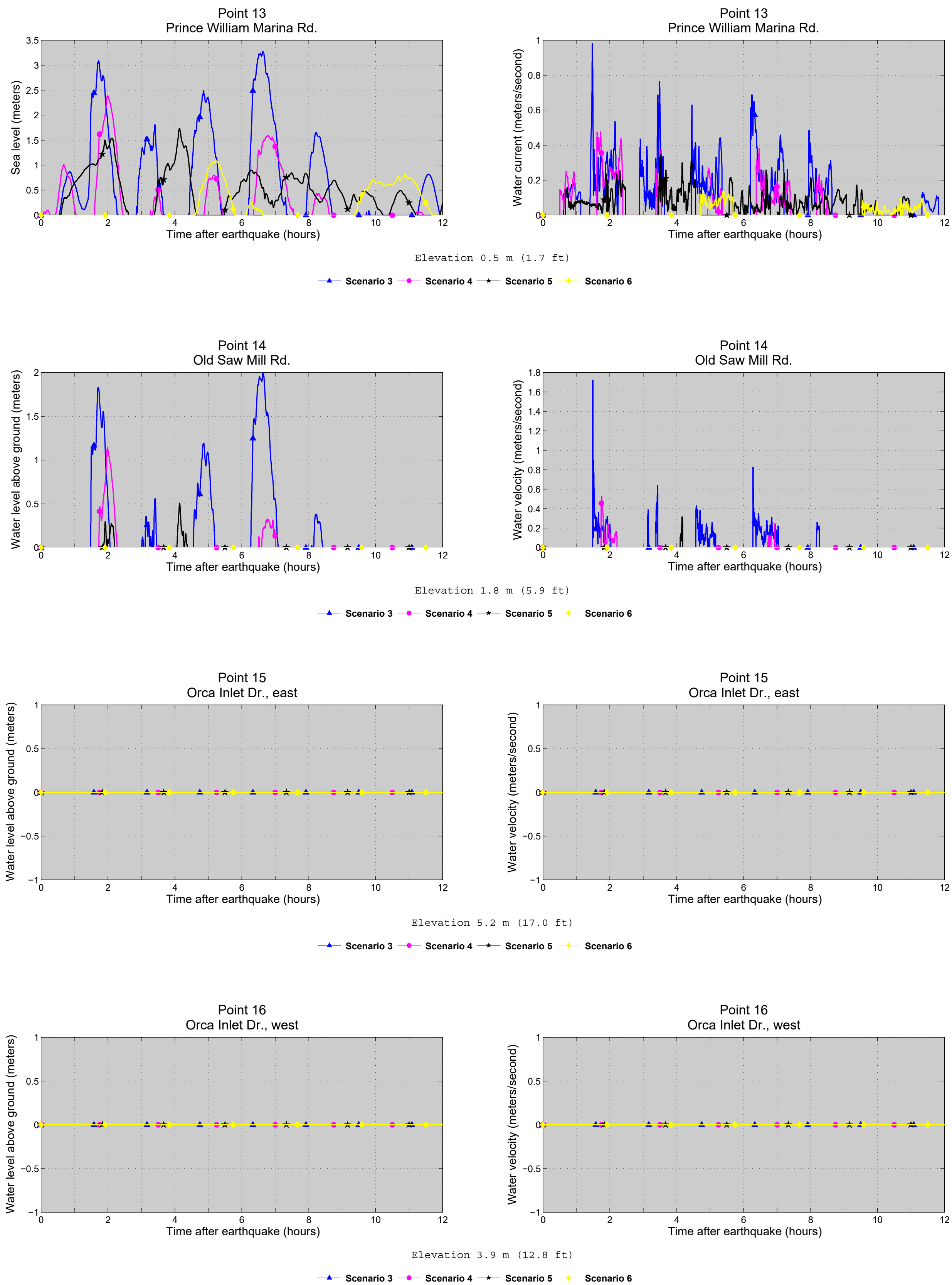

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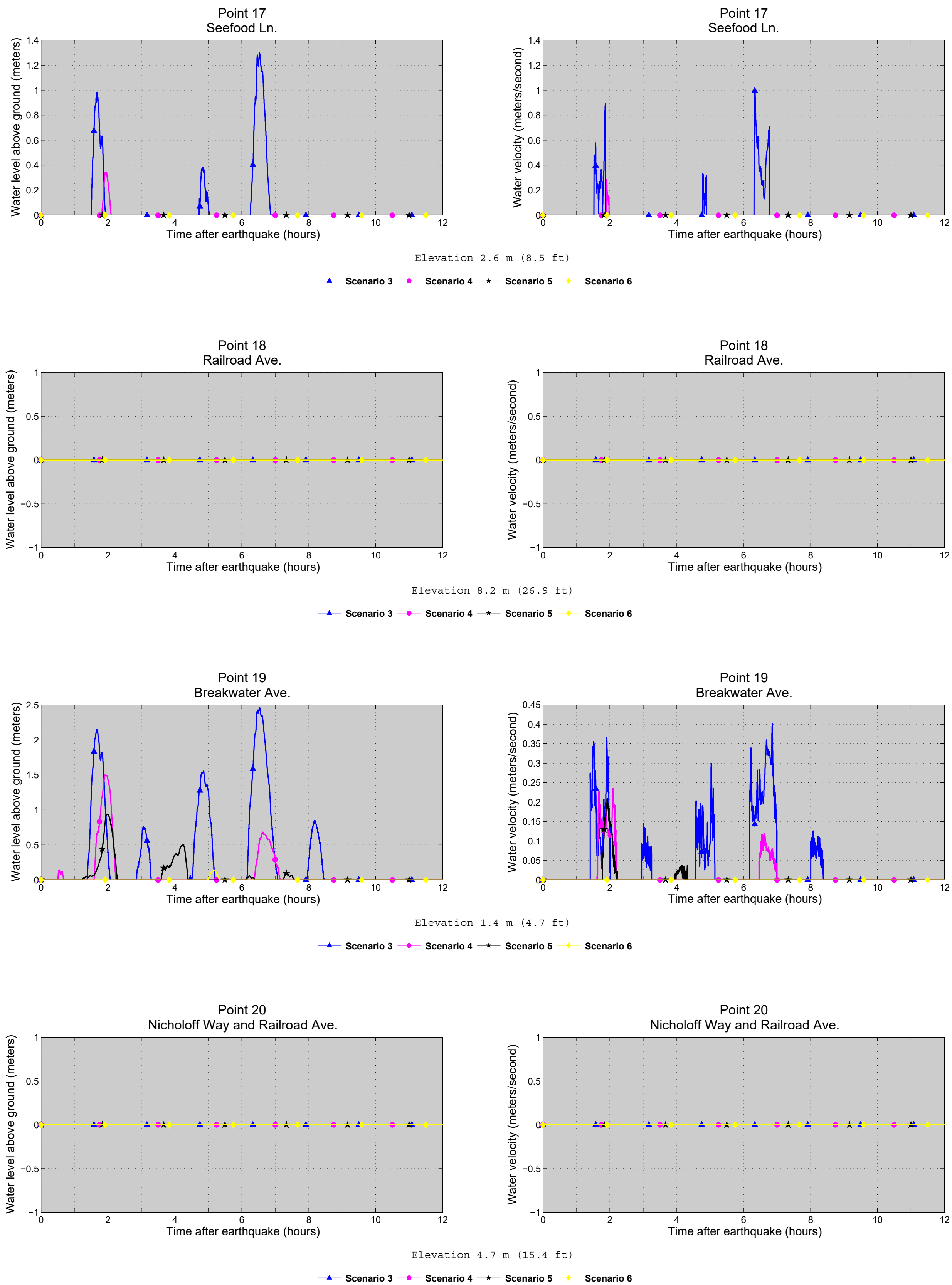

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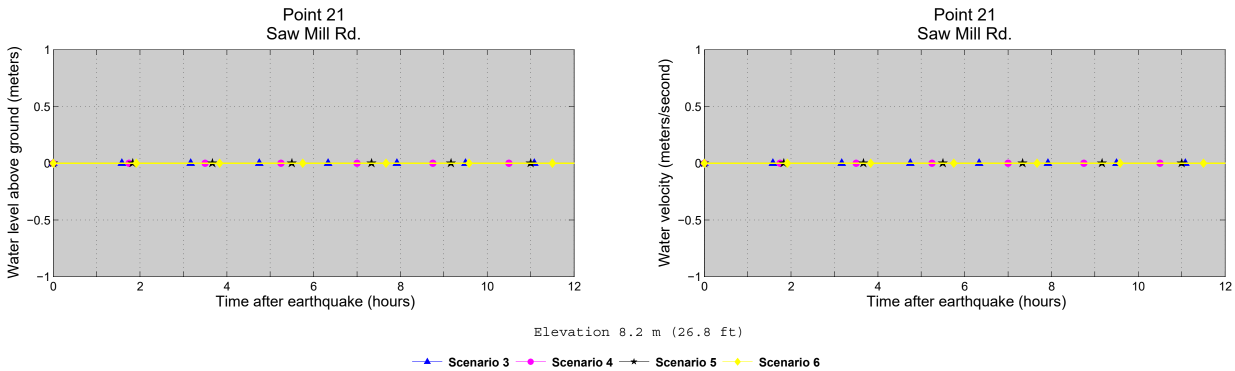

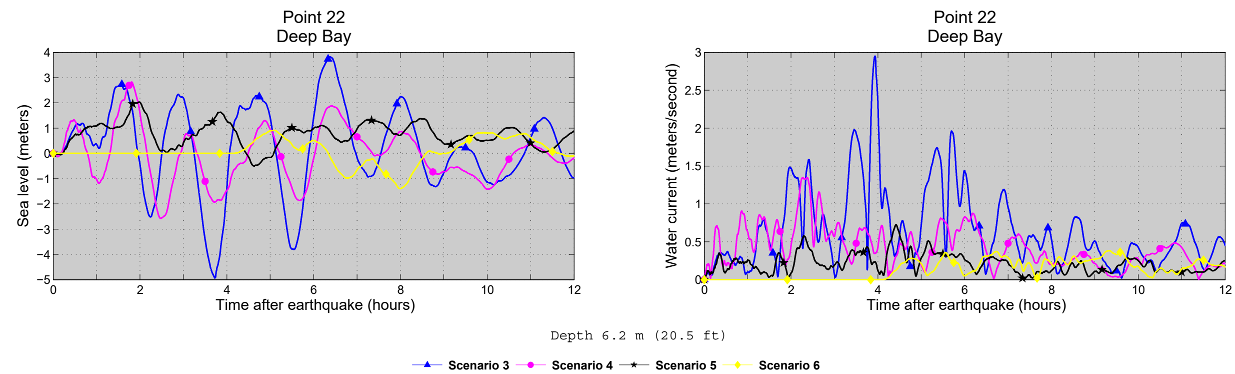

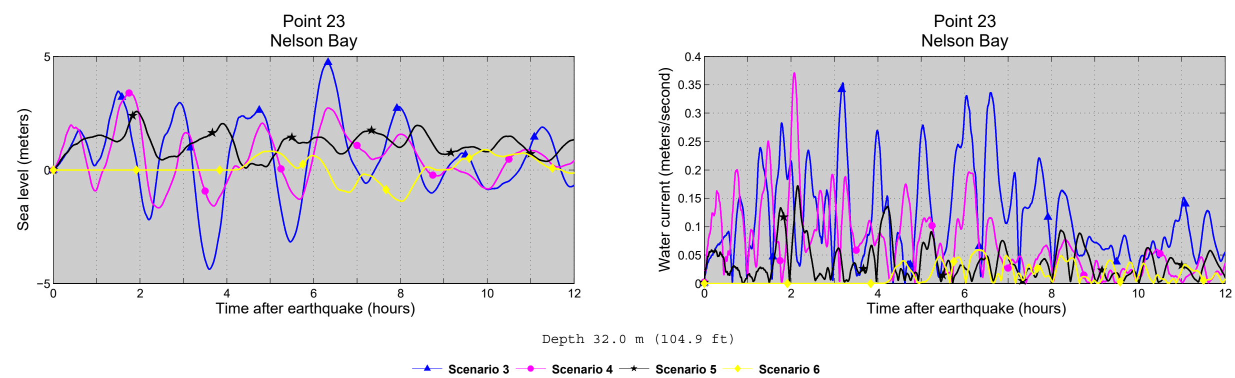

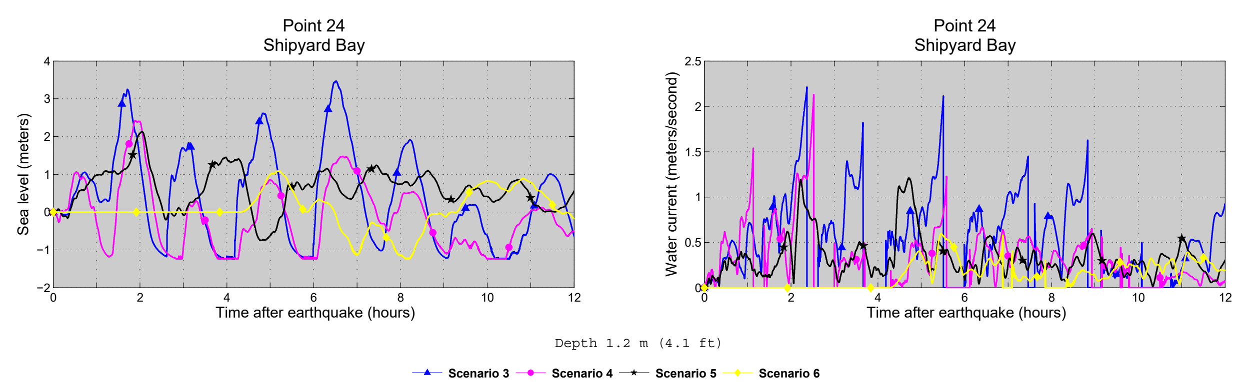

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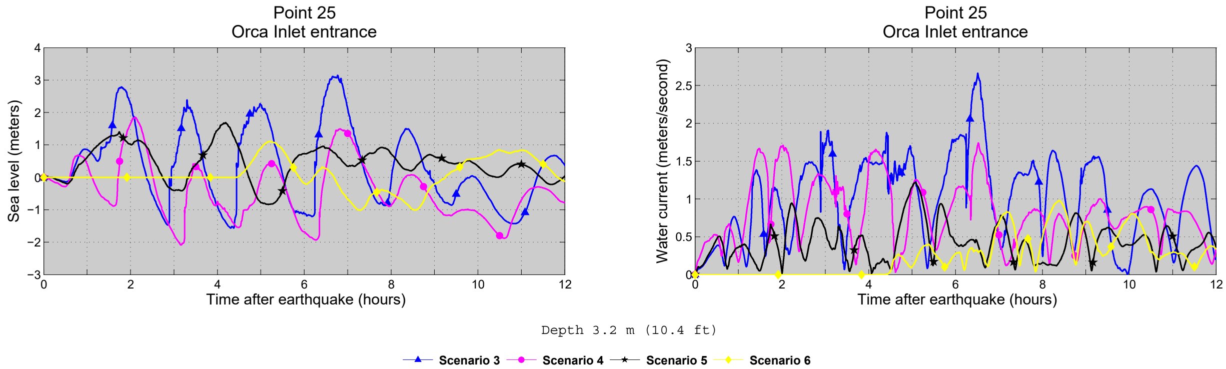


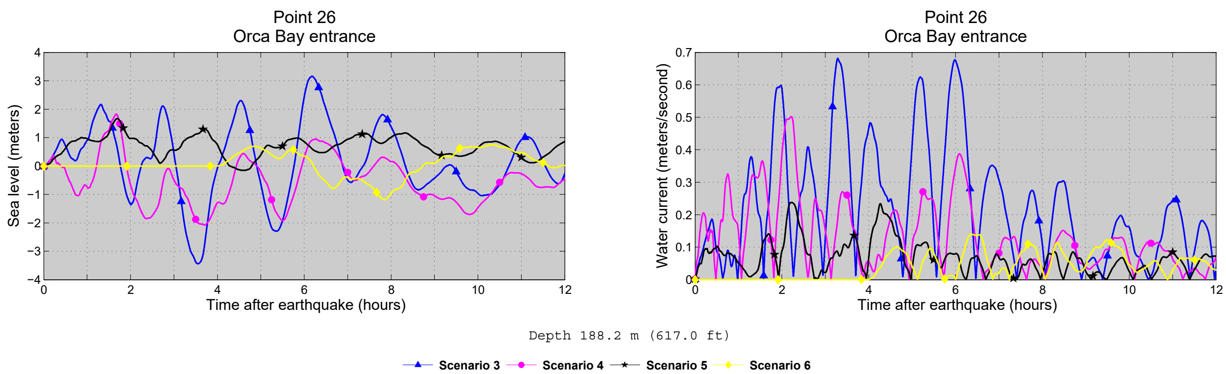


Figure A1, continued. Time series of water level (left column) and velocity (right column) for tectonic scenarios 3–6 at selected locations shown in figure 1 and in Nicolsky and others (2014, figure A1). Elevations of onshore locations and ocean depth at offshore locations are given based on the pre-earthquake MHHW datum.

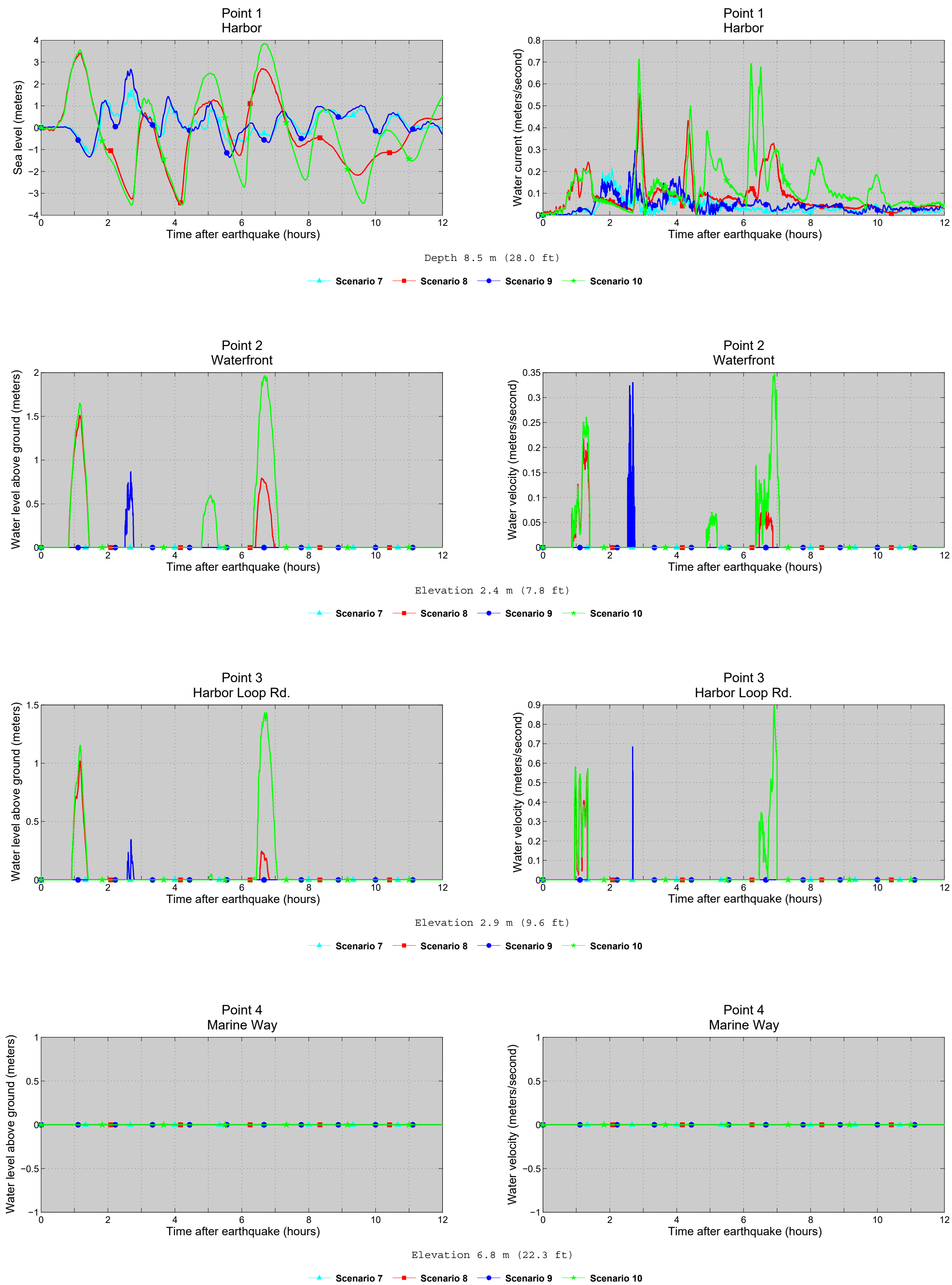
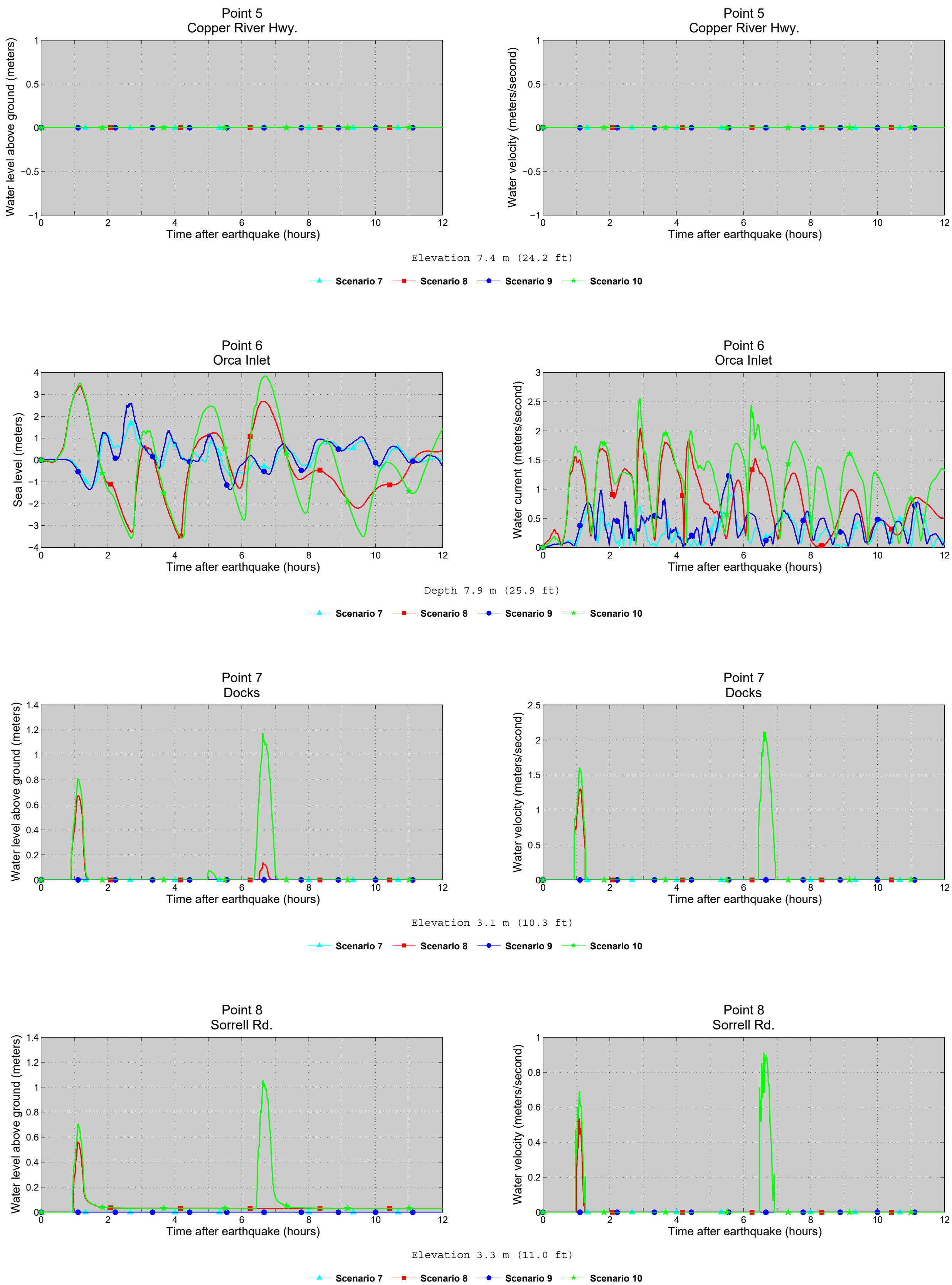


Figure A2. Time series of water level (left column) and velocity (right column) for tectonic scenarios 7–10 at selected locations shown in figure 1 and in (Nicolsky and others, 2014, figure A 1). Elevations of onshore locations and ocean depth at offshore locations are given based on the pre-earthquake MHHW datum.



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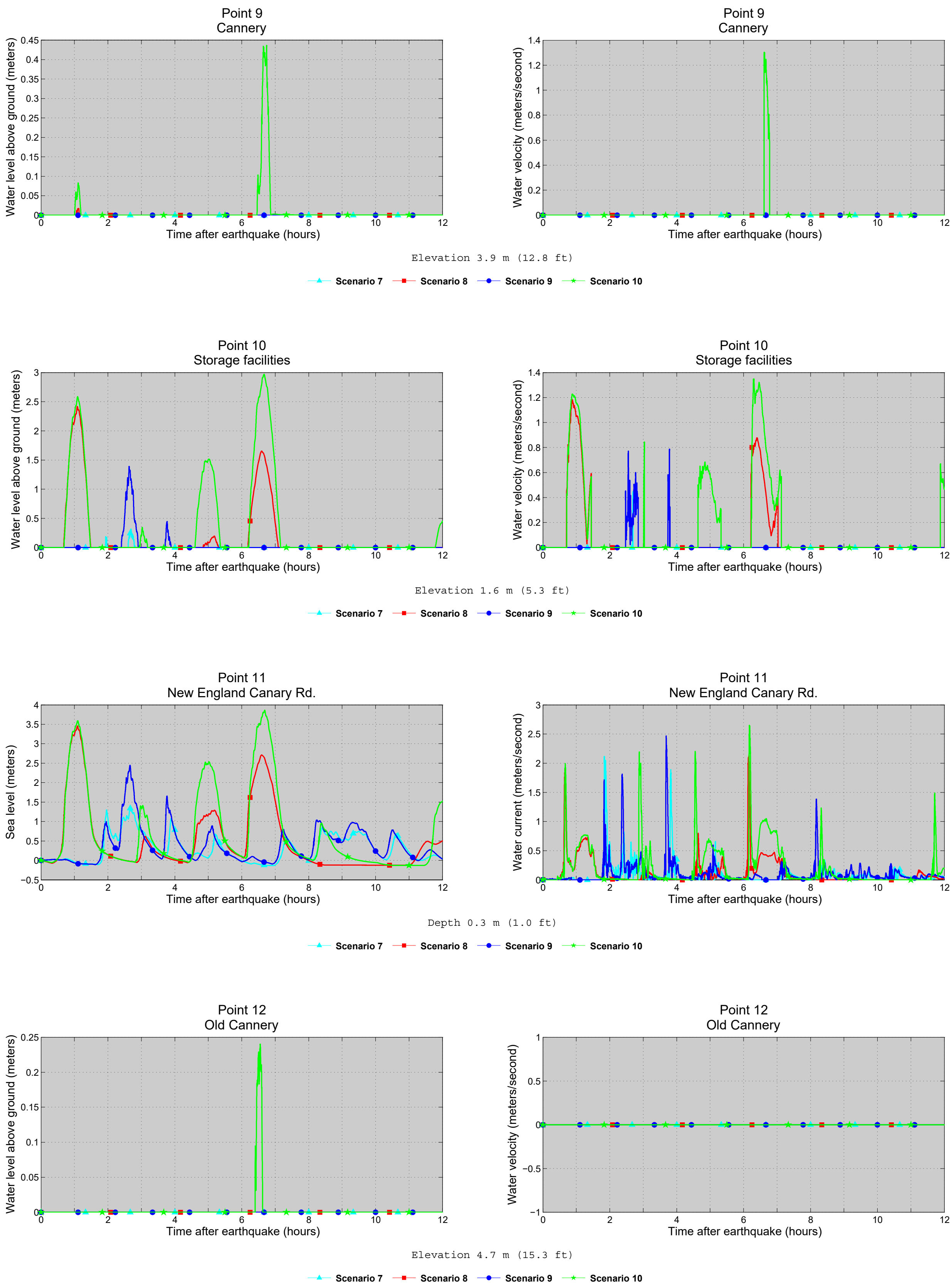

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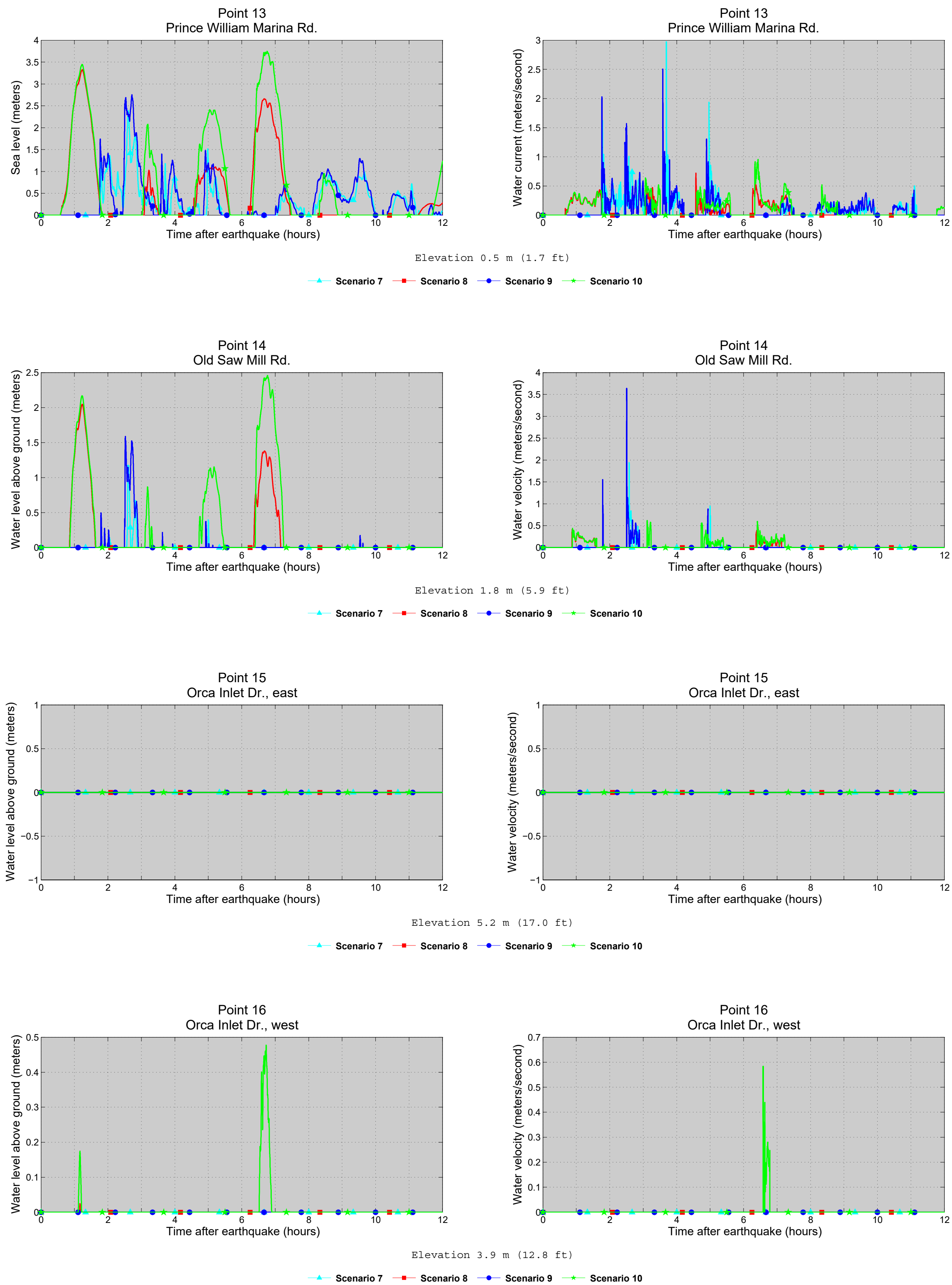

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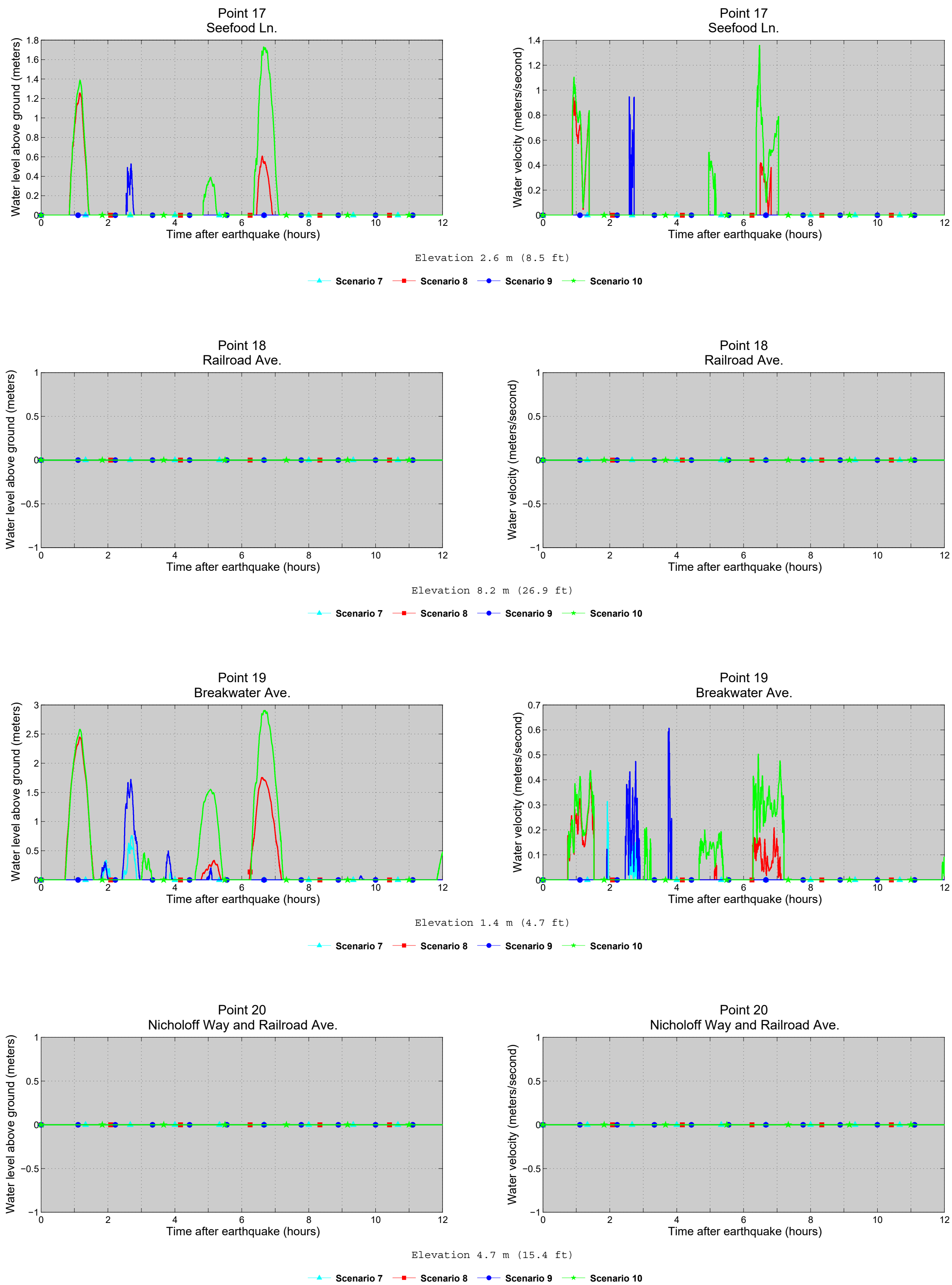


Figure A2, continued. Time series of water level (left column) and velocity (right column) for tectonic scenarios 7–10 at selected locations shown in figure 1 and in (Nicolsky and others, 2014, figure A 1). Elevations of onshore locations and ocean depth at offshore locations are given based on the pre-earthquake MHHW datum.

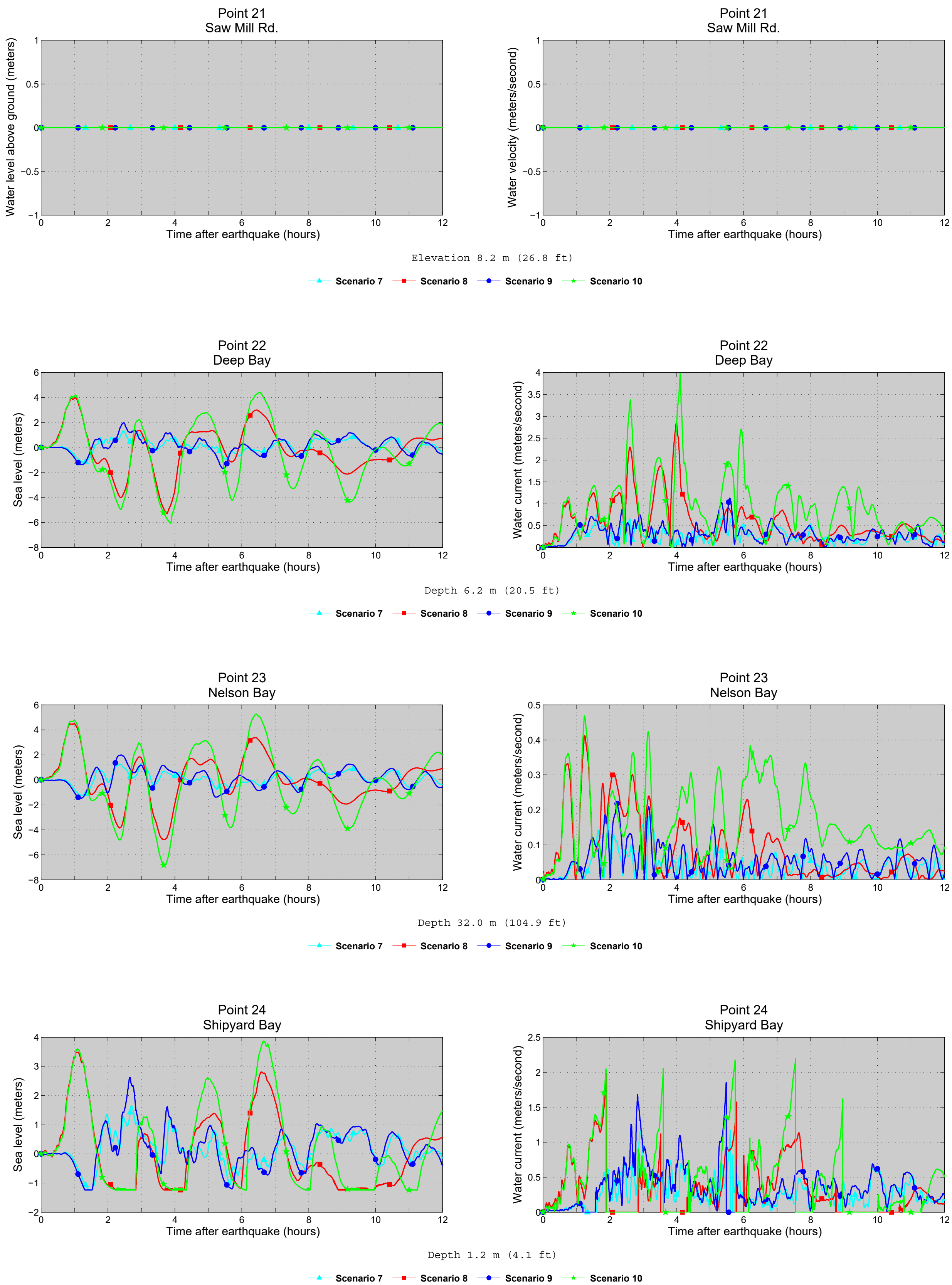


Figure A2, continued. Time series of water level (left column) and velocity (right column) for tectonic scenarios 7–10 at selected locations shown in figure 1 and in (Nicolsky and others, 2014, figure A 1). Elevations of onshore locations and ocean depth at offshore locations are given based on the pre-earthquake MHHW datum.

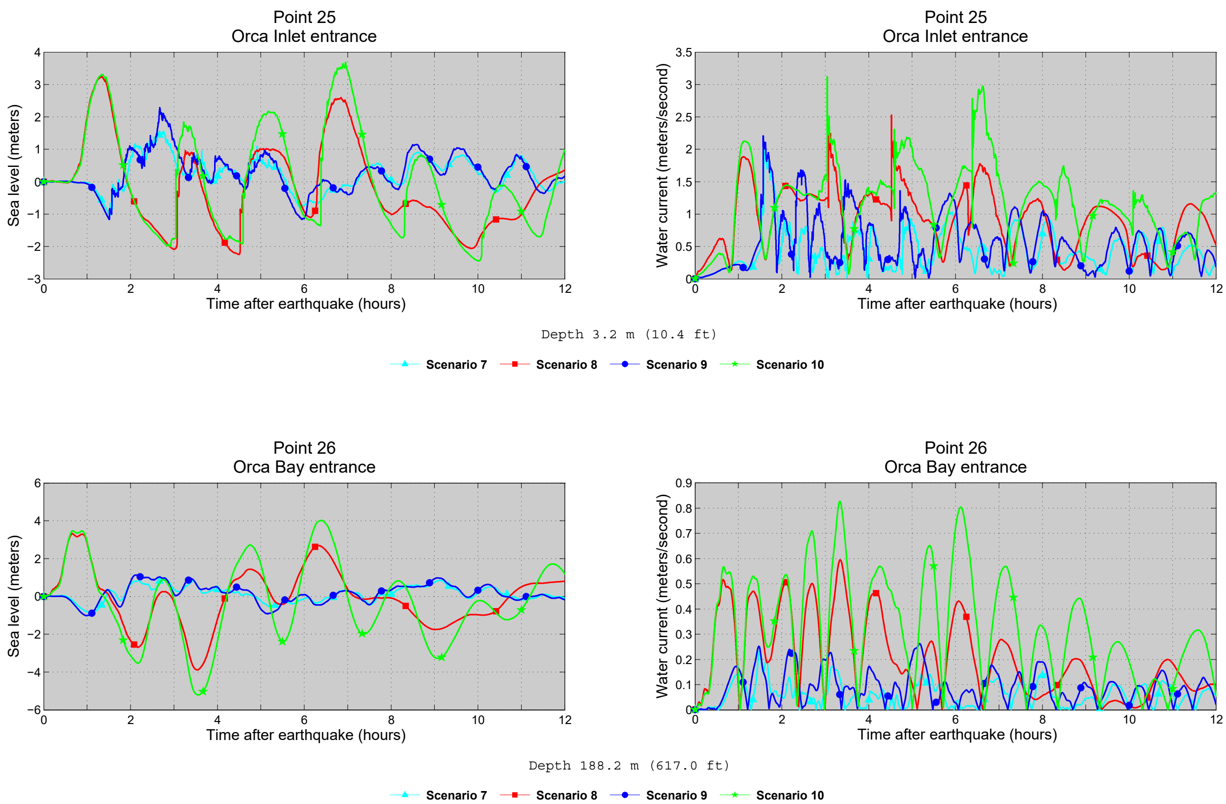


Figure A2, continued. Time series of water level (left column) and velocity (right column) for tectonic scenarios 7–10 at selected locations shown in figure 1 and in (Nicolsky and others, 2014, figure A 1). Elevations of onshore locations and ocean depth at offshore locations are given based on the pre-earthquake MHHW datum.

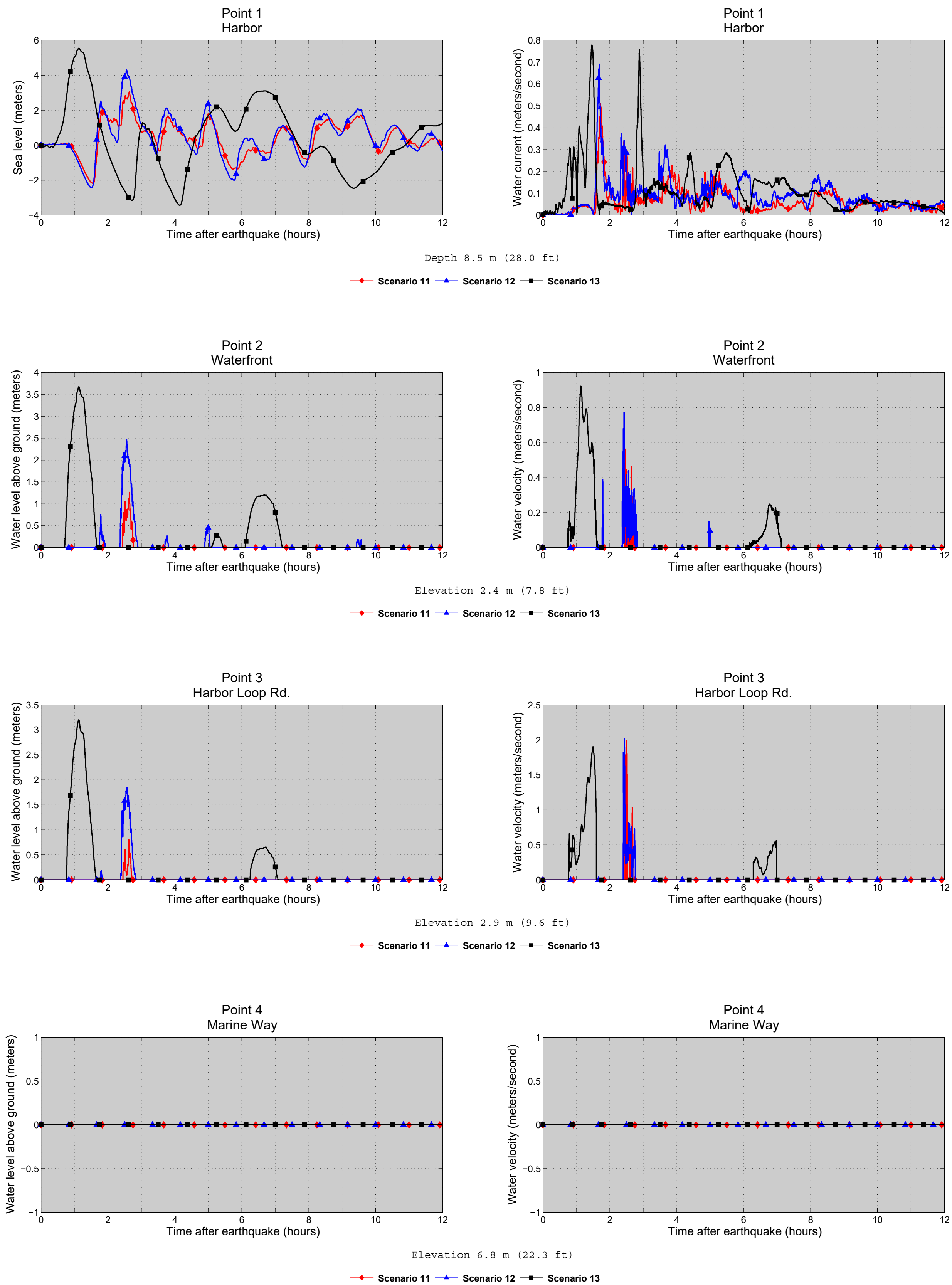
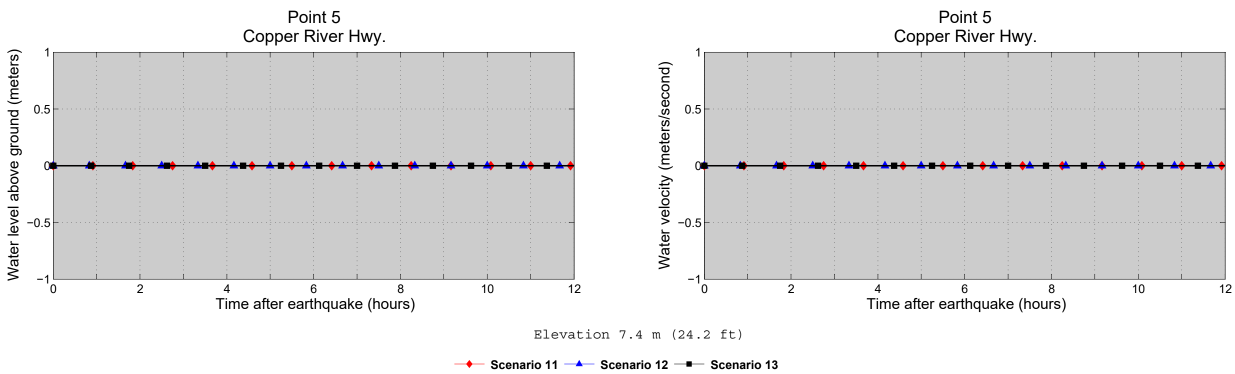
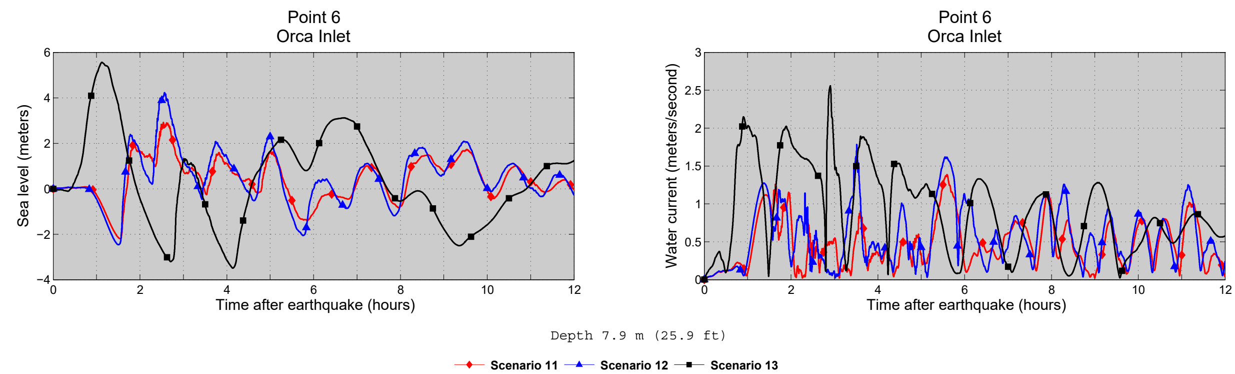
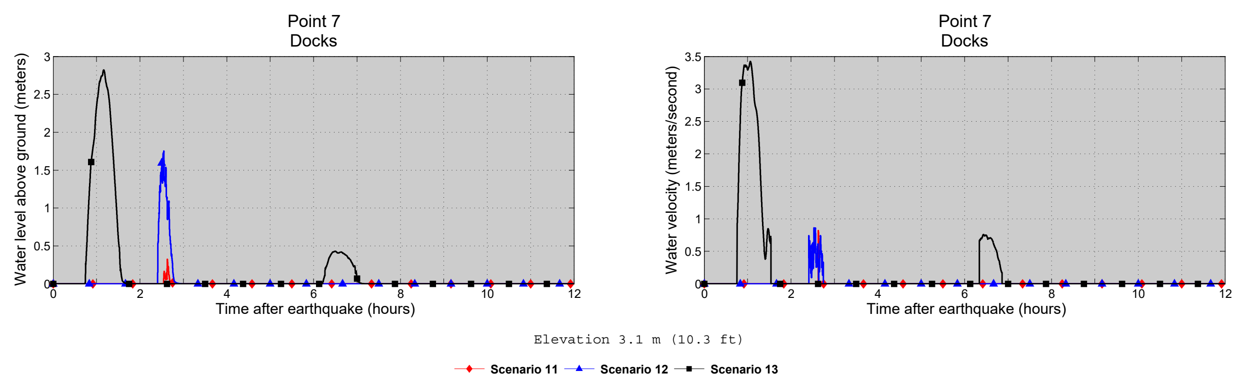


Figure A3. Time series of water level (left column) and velocity (right column) for tectonic scenarios 11–13 at selected locations shown in figure 1 and in Nicolsky and others (2014, figure A1). Elevations of onshore locations and ocean depth at offshore locations are given based on the pre-earthquake MHHW datum.







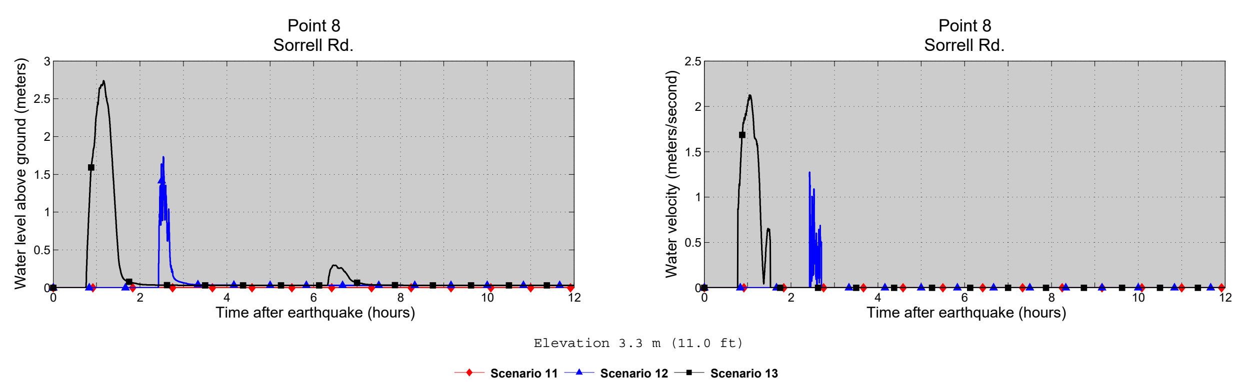


Figure A3, continued. Time series of water level (left column) and velocity (right column) for tectonic scenarios 11–13 at selected locations shown in figure 1 and in Nicolsky and others (2014, figure A1). Elevations of onshore locations and ocean depth at offshore locations are given based on the pre-earthquake MHHW datum.

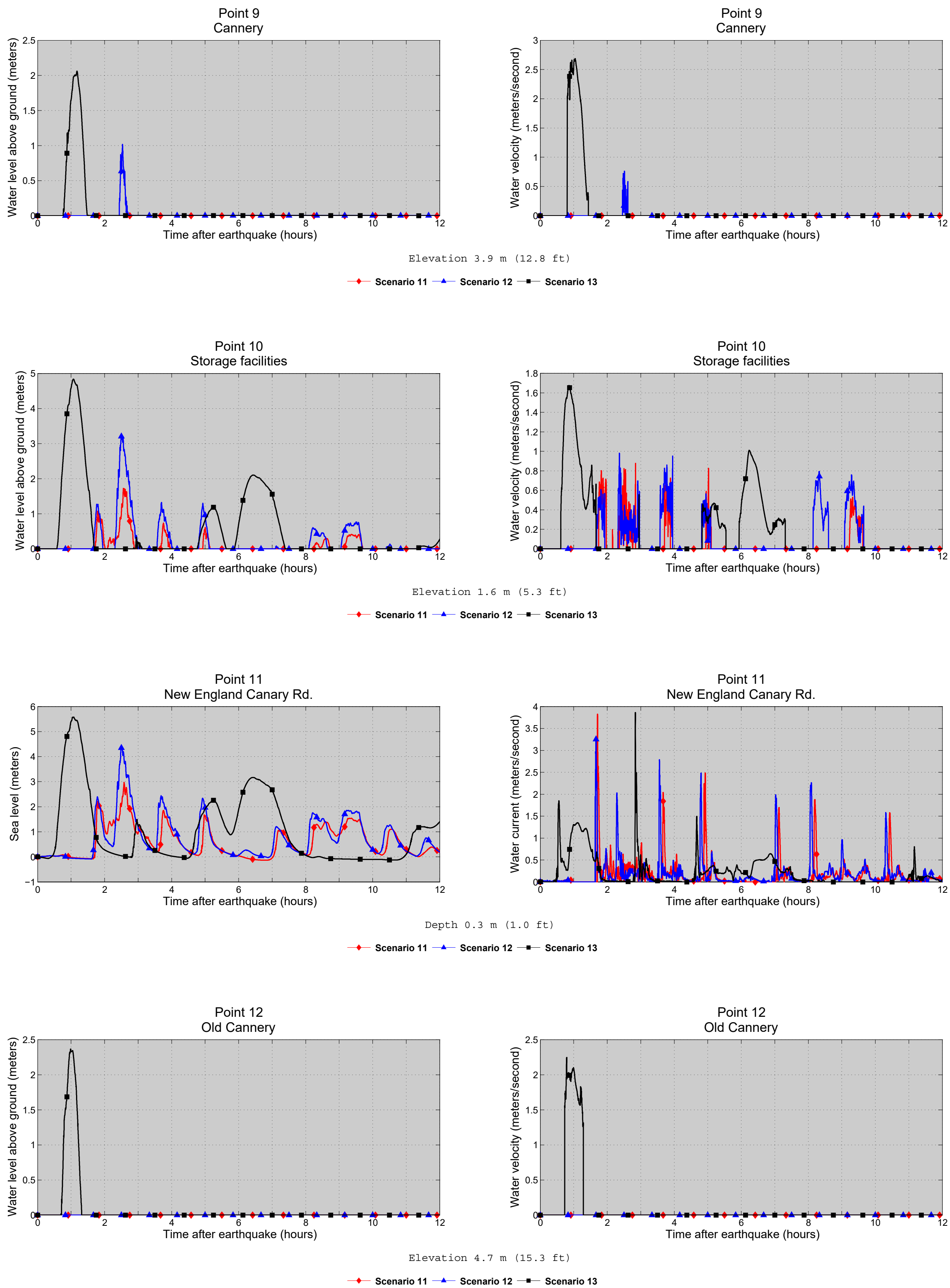


Figure A3, continued. Time series of water level (left column) and velocity (right column) for tectonic scenarios 11–13 at selected locations shown in figure 1 and in Nicolsky and others (2014, figure A1). Elevations of onshore locations and ocean depth at offshore locations are given based on the pre-earthquake MHHW datum.

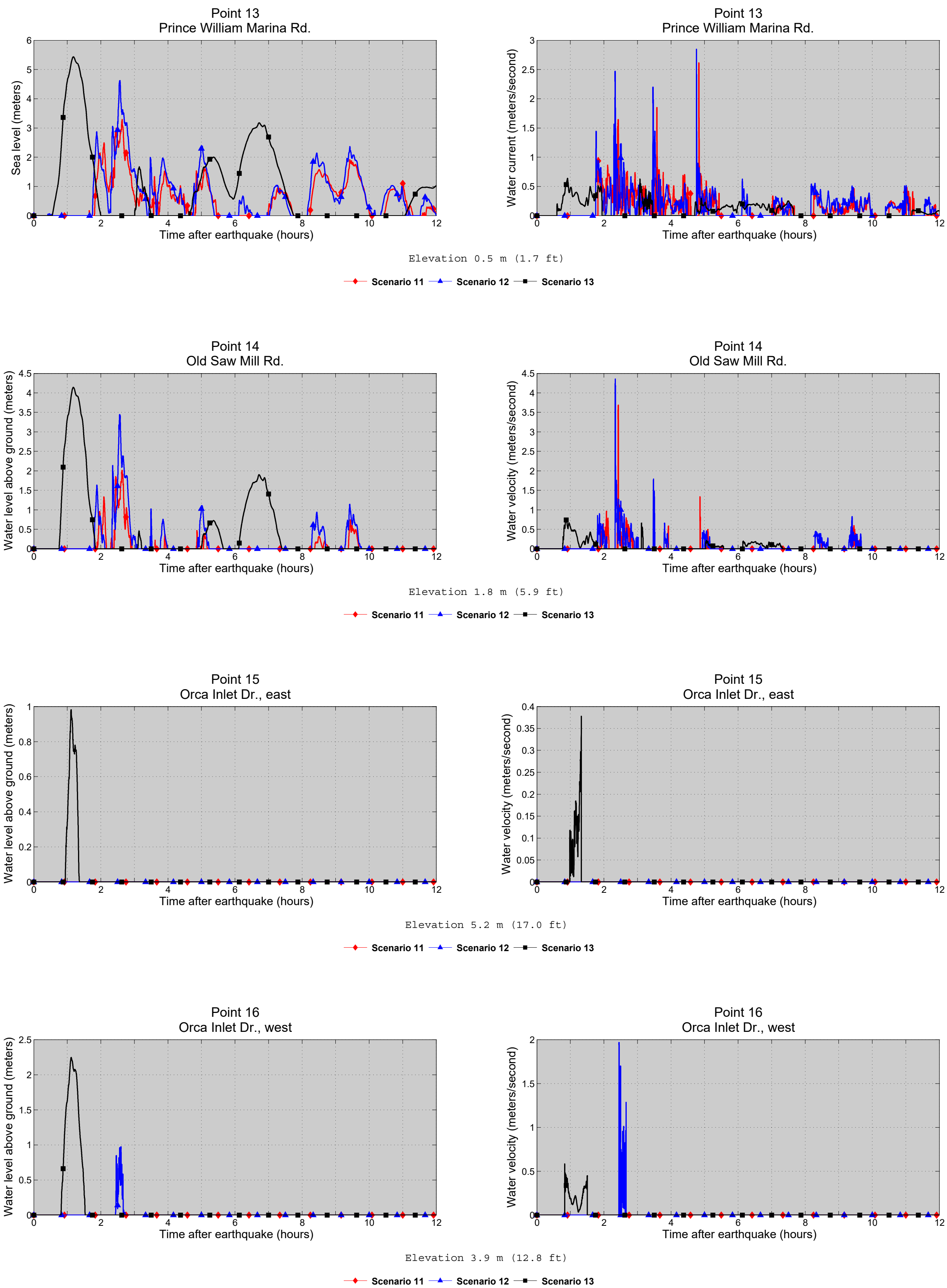
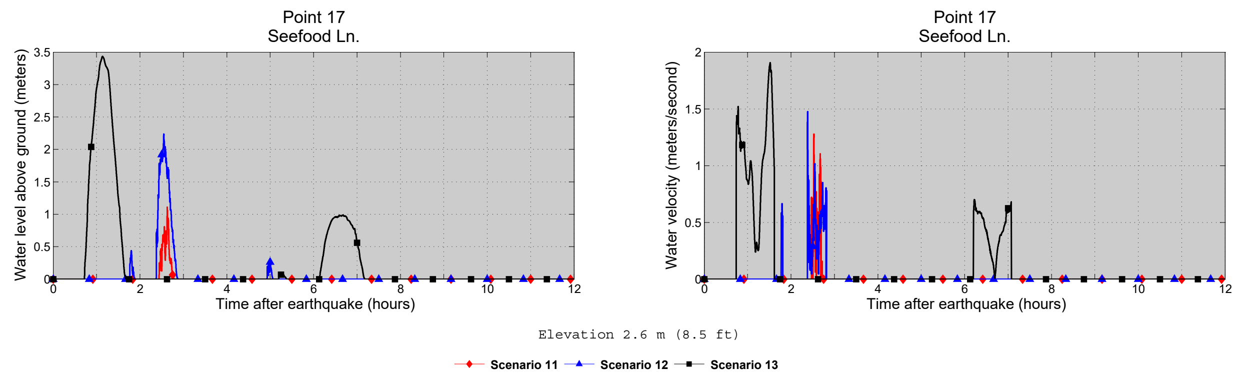
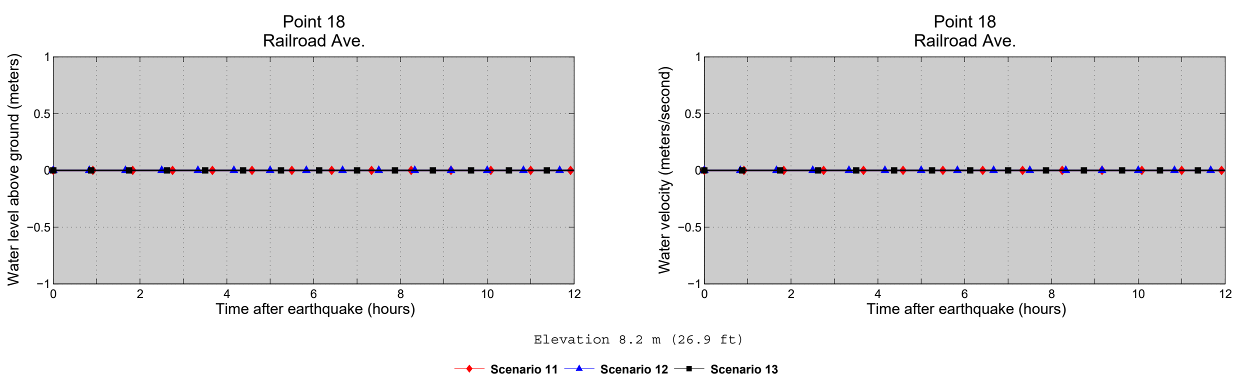
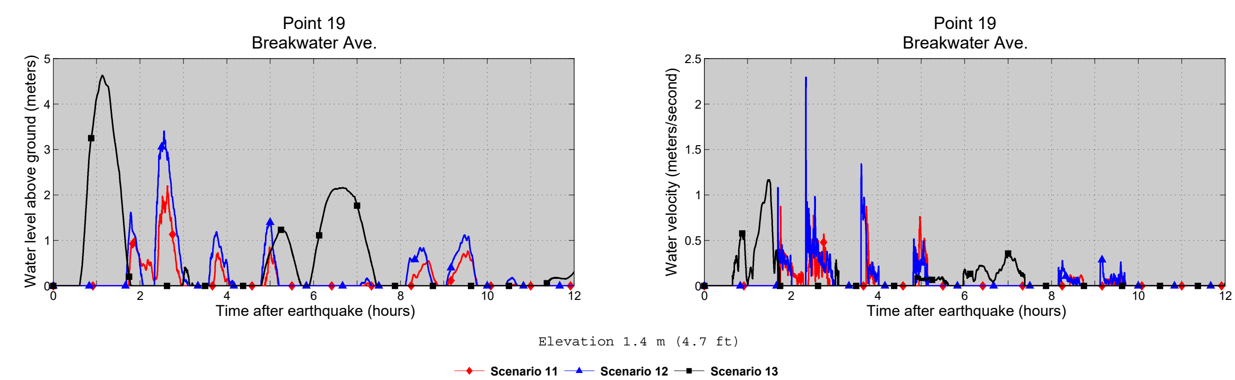


Figure A3, continued. Time series of water level (left column) and velocity (right column) for tectonic scenarios 11–13 at selected locations shown in figure 1 and in Nicolsky and others (2014, figure A1). Elevations of onshore locations and ocean depth at offshore locations are given based on the pre-earthquake MHHW datum.







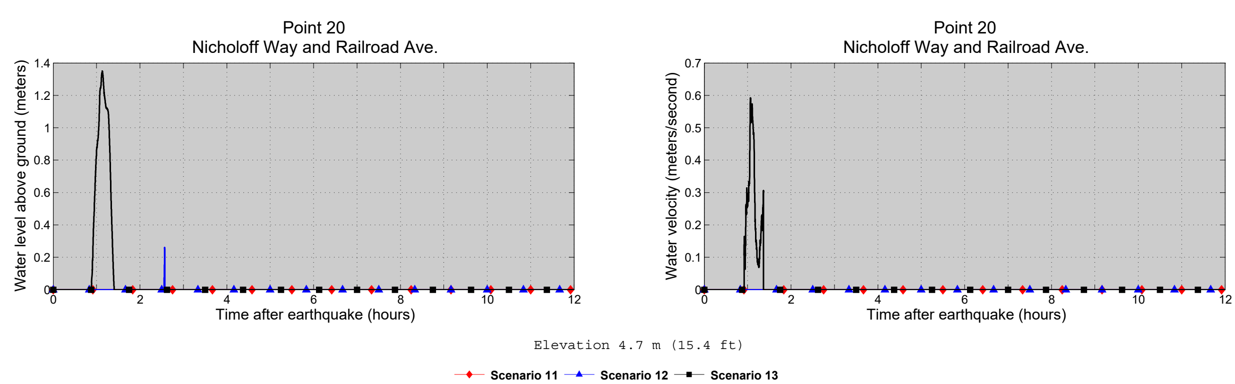


Figure A3, continued. Time series of water level (left column) and velocity (right column) for tectonic scenarios 11–13 at selected locations shown in figure 1 and in Nicolsky and others (2014, figure A1). Elevations of onshore locations and ocean depth at offshore locations are given based on the pre-earthquake MHHW datum.

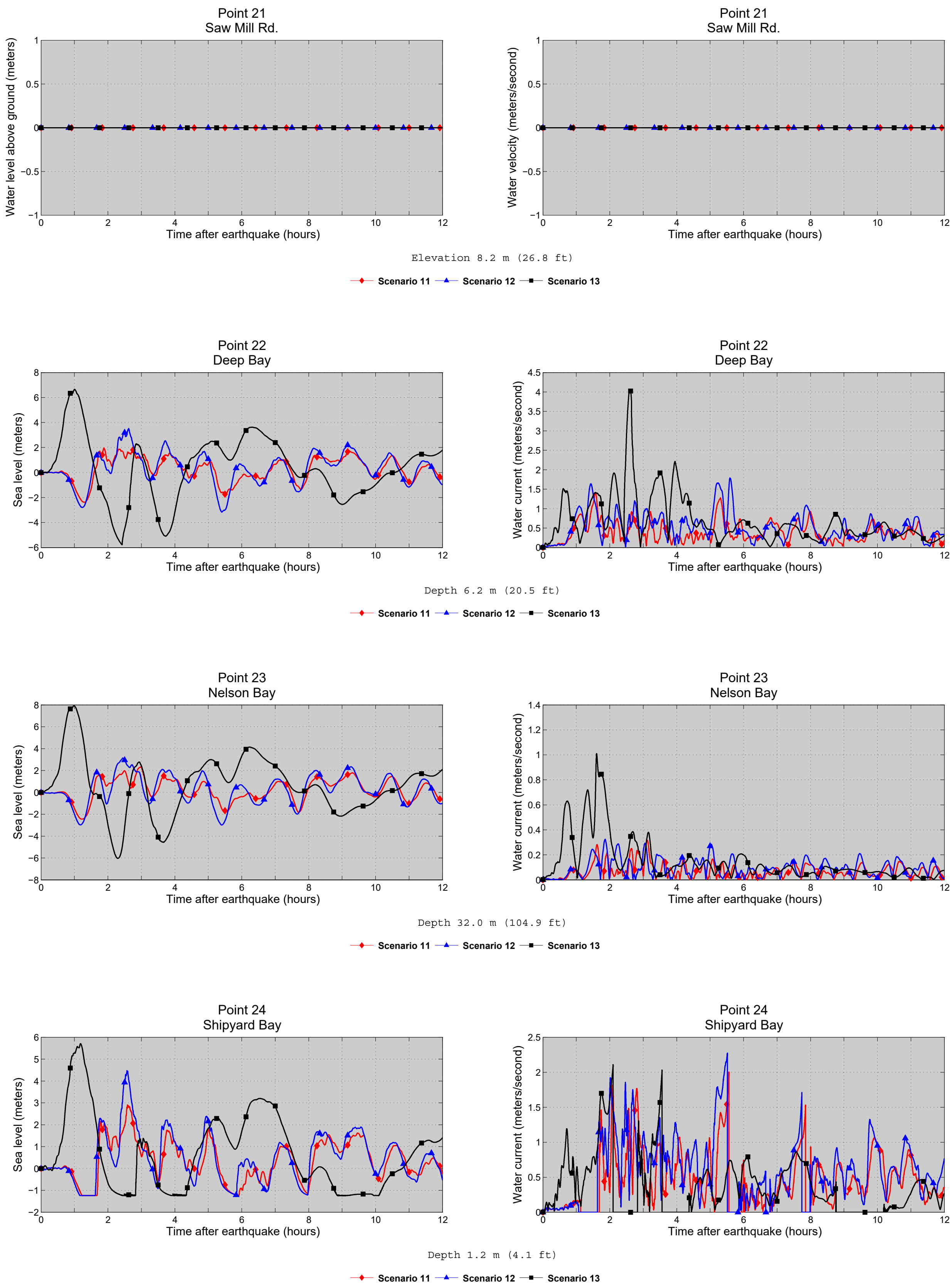


Figure A3, continued. Time series of water level (left column) and velocity (right column) for tectonic scenarios 11–13 at selected locations shown in figure 1 and in Nicolsky and others (2014, figure A1). Elevations of onshore locations and ocean depth at offshore locations are given based on the pre-earthquake MHHW datum.

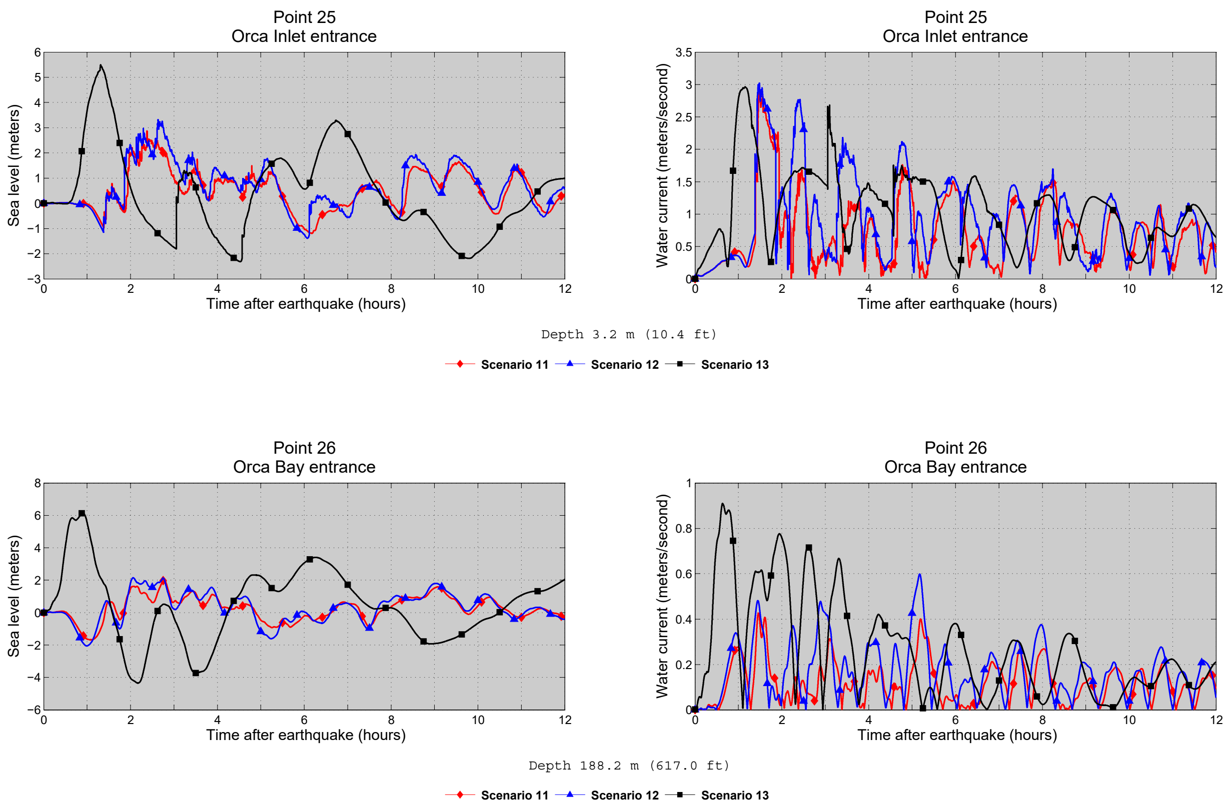


Figure A3, continued. Time series of water level (left column) and velocity (right column) for tectonic scenarios 11–13 at selected locations shown in figure 1 and in Nicolsky and others (2014, figure A1). Elevations of onshore locations and ocean depth at offshore locations are given based on the pre-earthquake MHHW datum.