

FY20/21 Maintenance and Monitoring

AD98-3, Malibu Road

City of Malibu, California

Yeh Project No.: 220-278

June 22, 2022



Prepared for:

City of Malibu
23825 Stuart Ranch Rd.
Malibu, California 90265
Attn: Mr. Arthur Aladjadjian

Prepared by:

Yeh and Associates, Inc.
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June 22, 2022

Project No. 220-278

City of Malibu
23825 Stuart Ranch Rd.
Malibu, California 90265

Attn: Mr. Arthur Aladjajian, Public Works Superintendent

Subject: Annual Monitoring and Maintenance Report FY20/21, City of Malibu Assessment District 98-3, Malibu Road, Malibu, CA

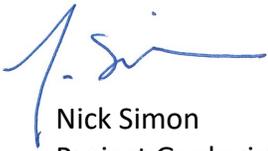
Dear Mr. Aladjajian:

Yeh and Associates, Inc. is pleased to submit this monitoring and maintenance report FY20/21 City of Malibu Assessment District AD-3, Malibu Road in Malibu, California. This report was prepared in accordance with our Agreement for Professional Services, dated June 22, 2020 between the City of Malibu and Yeh and Associates, Inc. This report provides geotechnical an annual summary of monitoring and maintenance for the project over fiscal year July 1, 2020 to June 30, 2021.

The geotechnical services consisted of monitoring and maintenance, data management, public outreach, reporting, and capital improvement planning. A map showing the location of the maintenance and monitoring facilities are provided on Plate 1. Plate 2 provides a summary of maintenance activities performed during the monitoring year.

We appreciate the opportunity to be of service. Please contact Loree Berry at 805-289-9590 x271 or lberry@yeh-eng.com if you have questions or require additional information.

Sincerely,
YEH AND ASSOCIATES, INC.


Nick Simon
Project Geologist


Loree A. Berry, PE
Senior Project Manager

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1. PURPOSE AND SCOPE OF STUDY

Yeh and Associates (Yeh) was retained by the City of Malibu (City) to perform maintenance and monitoring of the existing geotechnical instrumentation and dewatering facilities within the City of Malibu's Malibu Road Landslide Assessment District, 98-3. The project location is shown by the polygon on Figure 1. This report presents monitoring results, a maintenance summary, and facilities status for the monitoring year July 2020 through July 2021 (monitoring year). Yeh monitors groundwater levels, surveys slope inclinometers, and measures the dewatering flow from dewatering wells and horizontal drains. Yeh also oversees and maintains function of the monitoring and dewatering facilities. Plate 1 shows the approximate locations of the assessment district facilities. Table 1 summarizes the equipment inventory and the approximate frequency of monitoring and maintenance over the monitoring year. Plate 2 and Section 4.0 of this report and provides detailed summary of the maintenance activities performed during this monitoring period.



Figure 1: Project Location Map

Table 1. Summary of Annual Monitoring and Maintenance

Type of Monitoring Instrument or Dewatering Device	Number of Locations	Brief Description	Monitoring Frequency	Maintenance Effort ²
Standpipe piezometer	7 ¹	2.75 inch PVC, or other casing, used to measure depth to groundwater using electric sounder or by a transducer/datalogger	monthly; hourly data from pressure transducer	low
Inclinometer survey casings	5 ¹	2.75 inch diameter grooved casings made of PVC, used to survey for shear displacement by an inclinometer probe	quarterly	low
Dewatering wells	14	6-inch or 12-inch diameter steel or PVC casings equipped with 0.5 to 1/3 HP submersible pump and connected to electrical controls, pumped water flows through meter and into conveyance piping to discharge	monthly	high
Horizontal Drains (hydraugers)	19	1-inch to 1.5-inch perforated PVC casings drilled slightly higher than horizontal into the slope along Malibu Road for up to 180feet and used to drain groundwater that intercepts the casing. Flow can be measured along Malibu Road before it flows to discharge	monthly	medium
Big Rock Mesa Rain Gauge #1239	1	Documented Rainfall, Data obtained from Los Angeles County Public Works	monthly	N/A
Notes:				
¹ - SI-5 and SI-6 are used as both inclinometers and standpipe piezometer. ² - maintenance effort (generalized): "high" – services monthly, "medium" – services quarterly, "low" – services annually				

2. MONITORING

The following provides the result of monitoring the water level in standpipe piezometers and the results of inclinometer surveys performed. For the purposes of discussion and context throughout the report, the monitoring results are discussed with respect to two areas within the 1978 landslide boundaries; Malibu Road and Bayshore Drive:

- **Malibu Road:** The southern portion of landslide including Malibu Road and the toe of the 1978 landslide.
- **Bayshore Drive:** The northern portion of the landslide above Malibu Road and including Bayshore Drive and the 1978 headscarp.

2.1 GROUNDWATER LEVELS

Groundwater levels were measured approximately monthly in 7 standpipe piezometers shown on Plate 1. Groundwater level data and hydrographs for individual standpipes are presented in Appendix A for the FY20/21 monitoring year. Water levels are acquired by lowering an electric probe into the standpipe to contact the groundwater surface and manually record the depth to water.



Table 1 summarizes the average groundwater levels over the monitoring year for standpipe water levels along Malibu Road and along Bayshore Drive and the change from the prior monitoring year.

Table 2: Summary of Average Groundwater Elevations

Area Averaged	Total No. of Standpipes Monitored	2020-2021 Average Groundwater Elevation (ft)	Change in Average Groundwater Elevation from Prior Monitoring Period (ft)	2020-2021 Average Peak Groundwater Elevation (ft)	Change in Average Peak Groundwater Elevation from Prior Monitoring Period (ft)
Malibu Road	5	6.6	+0.2	6.8	-0.5
Bayshore Drive	2	27.3	+1.7	27.9	+0.2

2.1.1 MALIBU ROAD AREA

Five standpipes are in use for groundwater level monitoring in the Malibu Road area. The average groundwater level for the Malibu Road area remained relatively unchanged relative to the prior monitoring year, increasing by 0.2 feet. Groundwater levels measured within individual standpipes maintained consistent levels with some variations in response to rainfall and tidal influence.

2.1.2 BAYSHORE DRIVE AREA

Two standpipes are in use for groundwater level monitoring in the Bayshore Drive Area. The average groundwater level for the Bayshore Drive Area increased by 1.7 feet since the prior monitoring year. The increase reflects a water level change in SI-5 which had shown an increasing trend since March 2019 and throughout the prior monitoring year. During the FY20/21 monitoring year, the water level in SI-5 decreased by 1.4 feet with a decreasing trend since July 2020. Water levels in SI-6 remained relatively unchanged.

2.1.3 ADDITIONAL INVESTIGATION

Yeh installed PVC sounding tubes in dewatering wells W-14 and W-11 and is recording water level data at least hourly with a downhole pressure transducer. That data will be used to evaluate pump cycle timing, drawdown, and recharge to assist in evaluating the reasons for the rise in water levels in SI-5 and for improving dewatering efficiency. The findings will be documented in future reports.

2.2 SLOPE INCLINOMETERS

2.2.1 SUMMARY OF SLOPE INCLINOMETER MONITORING EVENTS

At the start of the monitoring year, inclinometer surveys were performed with a new DGSI AT system inclinometer probe, cable and electronics to replace the DGSI classic system probe that had been in use by the previous consultant since at least 2004. The AT system inclinometer was chosen for more repeatable and accurate positioning of the probe on the casing. The introduction of a new probe and cable necessitated a new baseline survey for each of the useable inclinometer casings.



Page B-1 provides a historic summary of the Malibu Road inclinometers. Appendix B provides profile change plots for each of the inclinometers surveyed over the FY20/21 monitoring year. Inclinometers were assessed for distinct shear-type movement. The inclinometers did not display potential measurable shear-type movement over the current monitoring year.

3. WATER BUDGET TRACKING

3.1 RAINFALL DATA

Yeh obtained rainfall data for the 2020-2021 monitoring year from the Big Rock Mesa Rain Gauge #1239 operated by the Los Angeles County Department of Public Works. Plate 3 - Rainfall Graph displays historical monthly and average annual rainfall for the Big Rock Mesa area from October 1968 through June 2021. Prior to 1984, rainfall data was obtained from the Carbon Canyon Rain Gauge #447C and after 1984 from the onsite Big Rock Mesa Rain Gauge #1239. Rainfall for Big Rock Mesa area for the 2020-2021 monitoring year totaled 3.67 inches, which is 11.7 inches below the 53-year area average of 15.3 inches.

Plate 5 – Summary of Groundwater Levels, Dewatering, and Rainfall shows annual rainfall deviation from the 53-year mean and compares rainfall changes to total dewatering output. Dewatering production typically reacts to rainfall totals. During the 2020-2021 monitoring year, total dewatering production decreased in response to well below average rainfall.

3.2 DEWATERING

Yeh tracks dewatering production for actively pumping dewatering wells installed throughout the assessment district and passive horizontal drains (hydraugers) installed in the bluff along Malibu Road. During the 2020-2021 monitoring year total dewatering production from all facilities averaged 966 gpd a decrease of 37% from the previous monitoring years' total average production of 1,545 gpd. These values represented a decrease of 52% less than the historical production average of 2,023 gpd calculated from 1991 to present and 82% less than the maximum average annual production of 5,369 gpd recorded during the 1994-1995 monitoring year.

3.2.1 DEWATERING WELL PRODUCTION

Yeh performed monthly monitoring of production for the 14 active district dewatering wells. Well production is measured approximately monthly for each well by reading flow totalizers that are installed along the discharge line. Production data and well status for individual wells is included in Page C-1 through C-3. A graph showing total well production since 1992 is included on Plate 4.

During the 2020-2021 monitoring year, the average total well production was 770 gpd which is 31.6% lower than last year's average production of 1,126 gpd and 37 % less than the historical production



average of 1,221 gpd calculated from 1991 to present and 74 % less than the maximum average annual production of 2,930 gpd recorded during the 2004-2005 monitoring year.

Well production typically varies in response to rainfall totals. The dewatering well production decrease over this monitoring year is consistent with the historically low rainfall totals and extended drought conditions at the project. Electrical and power connectivity issues were identified and repaired during October through December 2021 and the effect of those repairs on dewatering production will be presented in subsequent reports.

3.3 HYDRAUGER PRODUCTION

Hydrauger production is measured directly from a sampling port installed on each hydrauger. Yeh performed monthly monitoring to measure flow from 19 hydrauvers, of which only three to four locations have recorded consistent flow in recent years. Most of the hydrauvers flow intermittently in response to rainfall. Production data and status for individual hydrauger is included in Appendix C. A graph showing total hydrauger production since 1992 is included on Plate 4.

During the 2020-2021 monitoring year, the average monthly hydrauger production was 196 gpd which is approximately 53% less than last year's average monthly production of 420 gpd and 75 % less than the historical production average of 800 gpd calculated from 1991 to present and 75 % less than the maximum average annual production of 3925 gpd recorded during the 1994-1995 monitoring year. Over the monitoring year hydrauger production was highest in December, the decrease in average annual hydrauger production is consistent with historically low annual rainfall.

4. MAINTENANCE AND CAPITAL IMPROVEMENTS

A summary table of the maintenance and capital improvement activities performed over this monitoring year is provided on Plate 2. Typical maintenance activities to dewatering wells include assessing and replacing or repairing dewatering well pumps, well electronics and well controls; Typical maintenance to hydrauvers included PVC repairs within the conveyance piping for discharge. Capital improvements include replacement and rehabilitation of existing facilities and special projects to improve the monitoring and maintenance capabilities.

It was a priority to construct protective walls around some of the well control boxes to sustain access to the electrical components for maintenance and during an emergency. An accumulation of eroded soil had built up around many of the dewatering electrical boxes that impeded the ability to open the box to perform typical maintenance repairs or troubleshoot the dewatering well electronics. Three protective structures were constructed during this monitoring year and three additional protective structures are planned to be constructed during the next monitoring year. Yeh performed numerous



other maintenance and repairs to dewatering facilities and improvements to the project assets throughout the monitoring year.

5. ADDITIONAL OBSERVATIONS AND MONITORING

- Rainfall totals for the 2020-2021 monitoring year were the driest on record for the area and imported water usage increased approximately 16%.

6. RECOMMENDATIONS FOR MAINTENANCE AND CAPITAL IMPROVEMENTS

- A modern form of repeatable surface survey should be re-introduced and continued for the project as a consistent means to observe and evaluate potential land movement throughout the extent of the assessment district area and more specifically in-between inclinometer casing locations.
- Plan and design for stormwater improvements to reduce stormwater infiltration into the undeveloped ground between Malibu Road and Highway 1.
- Coordinate a solution to repair or replace the obstructed and damaged storm drain on Bayshore Drive.
- Replace Inclinometer SP-3.

7. REFERENCES

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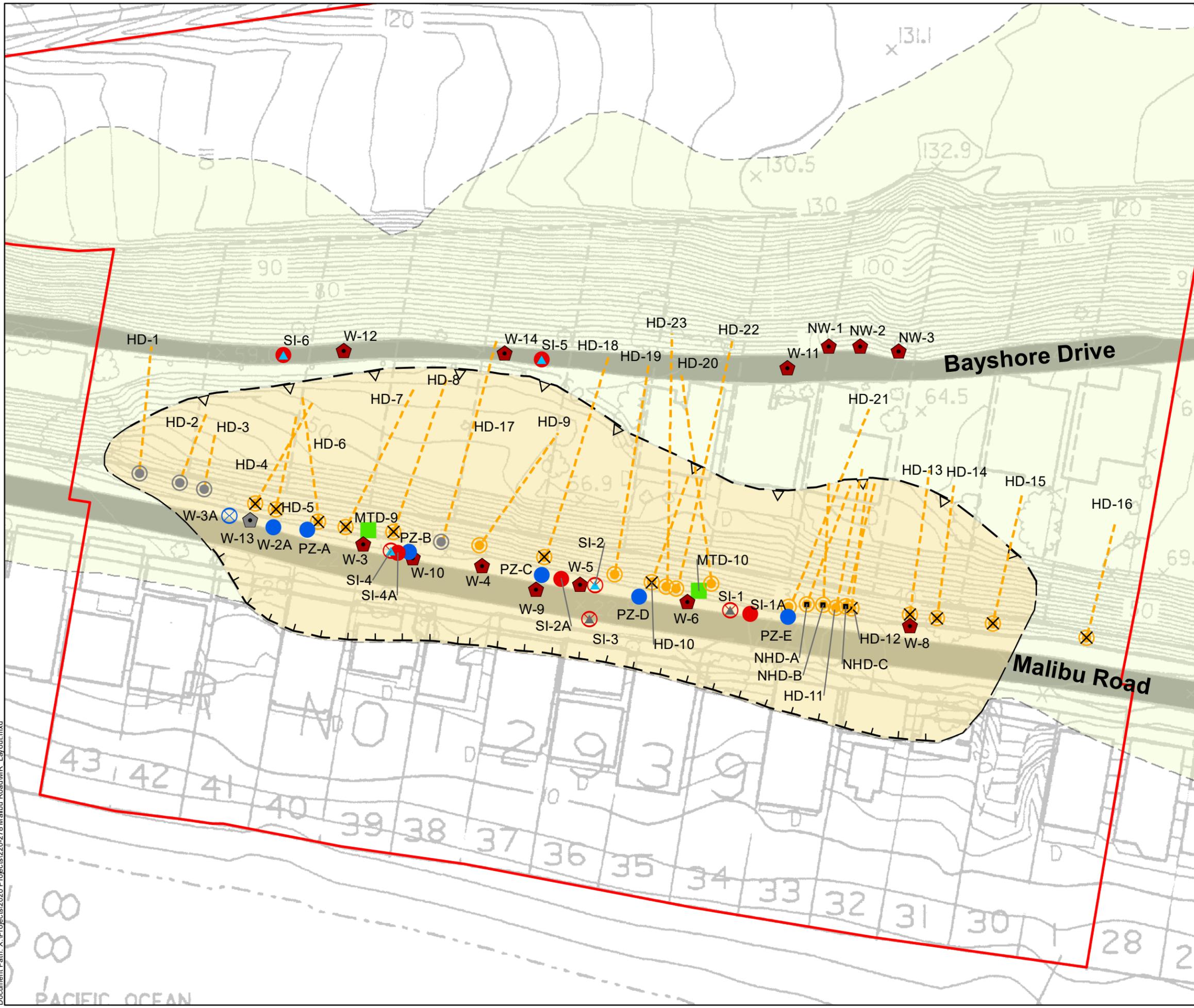
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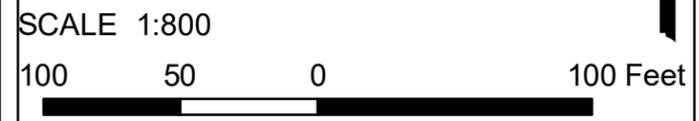
MALIBU ROAD LANDSLIDE ASSESSMENT DISTRICT MALIBU, CALIFORNIA

MONITORING INSTRUMENTATION AND DEWATERING FACILITIES MAP

Yeh and Associates, Inc.
Geotechnical • Geological • Construction Services



- Dewatering Well
- Dewatering Well (out of service)
- Slope Inclinator/Standpipe Piezometer
- Slope Inclinator/Standpipe Piezometer (standpipe only, not usable for inclinometer)
- Standpipe Piezometer
- Standpipe Piezometer (buried)
- Pneumatic Piezometer
- Pneumatic Piezometer (nonfunctioning)
- Nonproducing Hydrauger
- Private Hydrauger
- Producing Hydrauger
- Hydrauger (unable to locate)
- Hydrauger Installed Length
- Storm Drain Outfall
- District Boundary
- Recent Landslide of 1978 (Boundary from Leighton, 1979)
- Ancient Landslide (Boundary from Leighton, 1979)



DATE: 1/26/22	PROJECT NUMBER: 220-278	PLATE: 1
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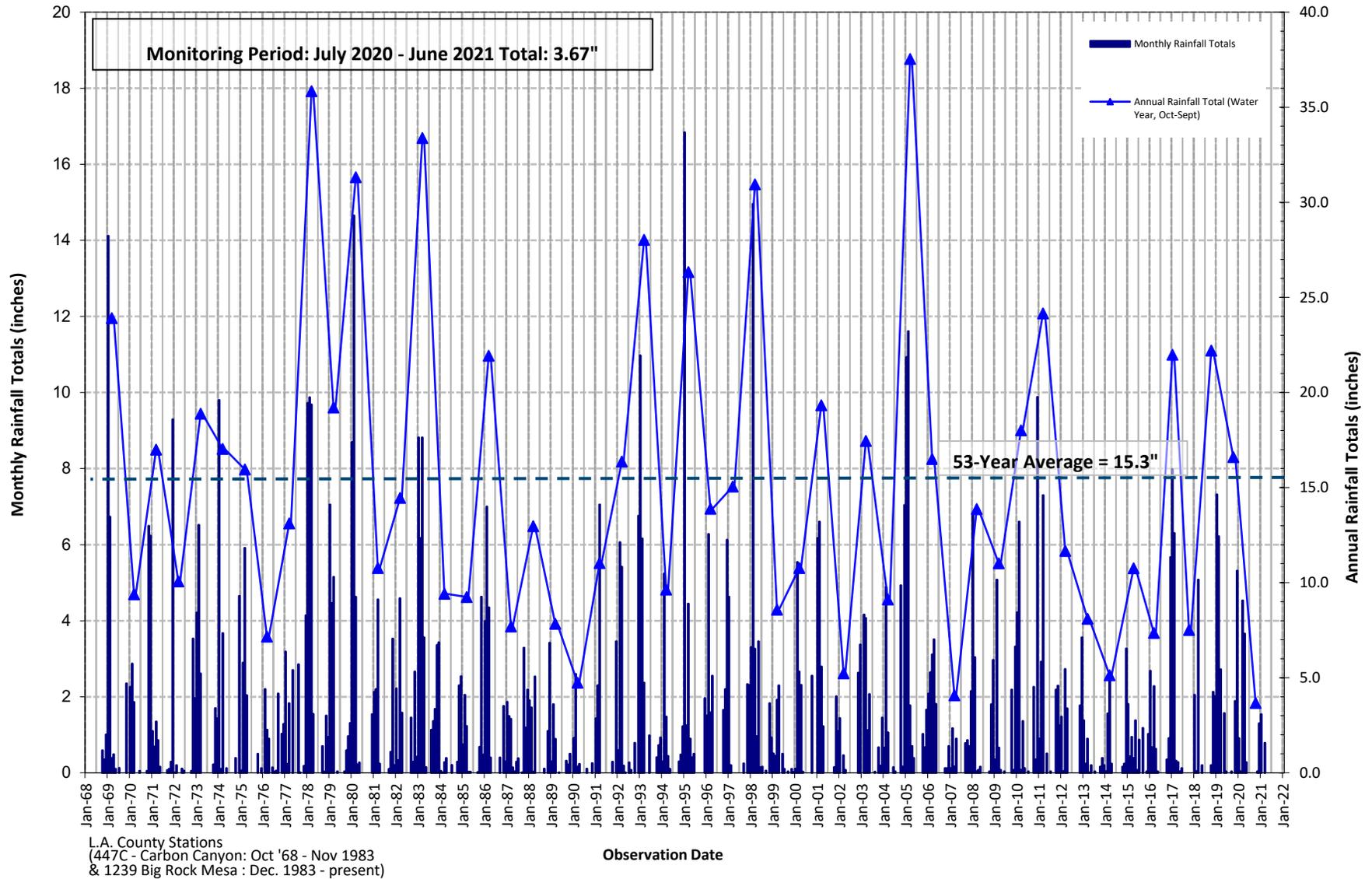
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FY20/21 MAINTENANCE SUMMARY

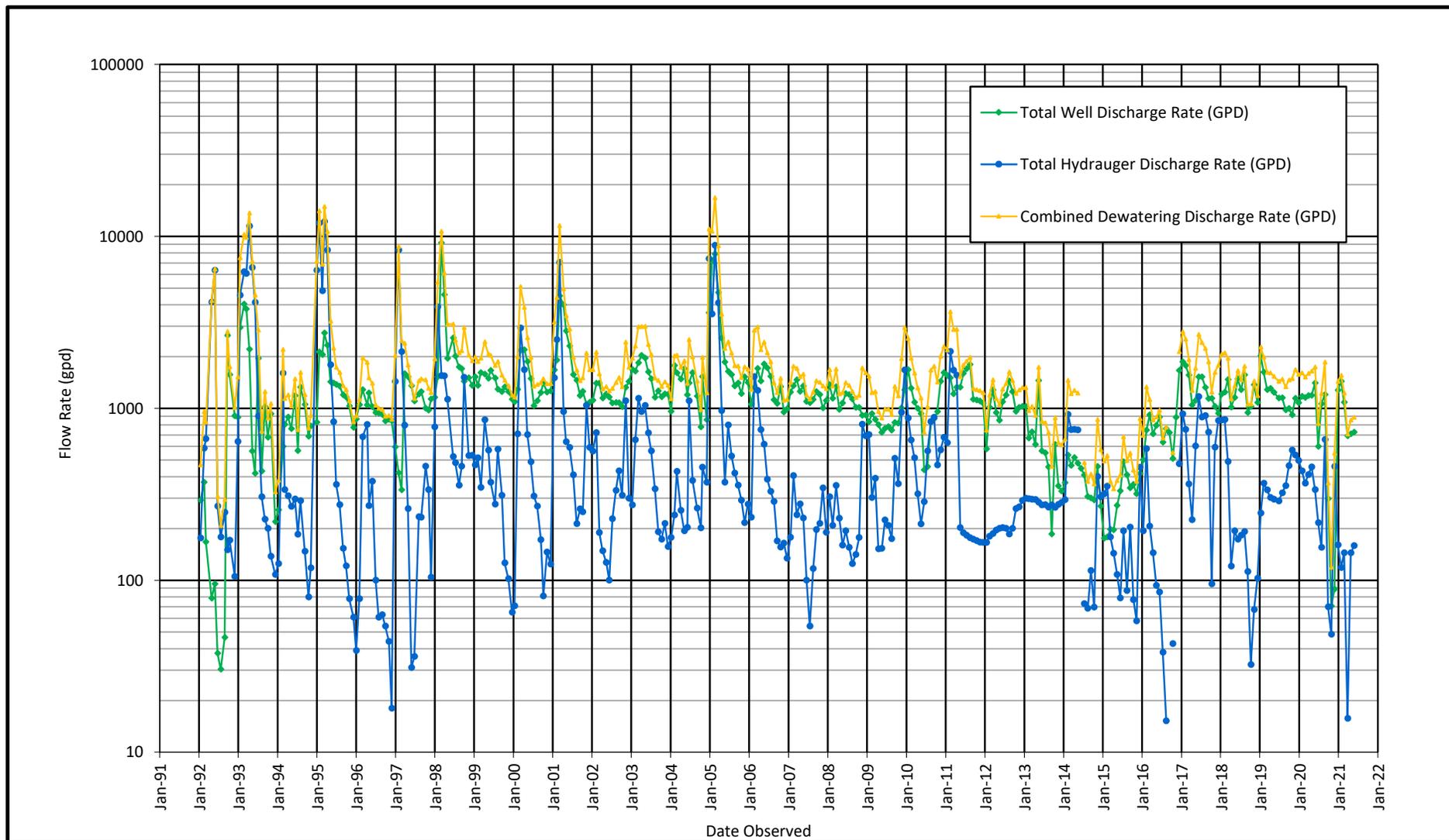
Date Entered	Facility	Description/Observation	Status or Resolution
DEWATERING WELLS			
Jul-20	W-11	stopped producing 1/2020	Assessed by Coast Pump 10/16/20, WL at 28'. Pump removed by Coast 12/1/20. Pump was observed to be decoupled from drop pipe. New pump and controller installed 12/9/20 with 1-inch sounding tube installed and returned to service
Jul-20	W-12, W-14	above ground discharge lines, leaking at W-14 and W-12, both repeatedly disconnected or broken, keep getting run over, black corrugated plastic lines decomposing	Collected quotes 1/31/22 to replace existing black corrugated plastic lines with 2-inch PVC and re-align discharge to tie into CMP storm drain, or extend the PVC downslope face to the eastern common conveyance line to be completed next monitoring year
Jul-20	W-14	possible low discharge relative to nearby water level, no access to measure water level directly in W-14	Assessed by Coast Pump 10/16/20. Pump removed 12/1/20, Pump replaced 12/9/20 and returned to service. Installed 1-inch sounding tube to record water level directly in the well for future troubleshooting
Jul-20	W-14	discharge line leak inside vault	Discharge line repaired by Coast Pump 12/11/20 following pump replacement
Jul-20	Well control Boxes W-3, W-4, W-5	well control boxes partially buried by soil creep, erosion, and vegetation. Unable to access panels for maintenance. Surge on box from soil pressure. Higher potential for corrosion electrical box is in contact with soil and vegetation	excavate soil and clear vegetation around vaults to provide access, construct protective structures around 3 control boxes to preserve access and prevent damage. 3/16/21 - 3/19/20: Vegetation and soil removed and hauled, three-sided protective structures constructed
Jul-20	Well control Boxes W-6 and W-8	well control boxes partially buried by soil creep, erosion, and vegetation. Unable to access panels for maintenance. Surge on box from soil pressure. Higher potential for corrosion electrical box is in contact with soil and vegetation	excavate soil and clear vegetation around vaults to provide access, construct protective structures around 2 additional control boxes to preserve access and prevent damage. Protective structures planned for construction next monitoring year.
Oct-20	All wells along Malibu Road; W-3, 4, 5, 6, 8, 9, 10	decrease/ low / no production from dewatering wells along Malibu Road	10/16/20: Assess all wells with Coast Pump, anomolous voltages incoming to all well control panels. Power source for all Malibu Road area wells is a common electrical panel where the main well circuit breakers and Edison meter are located. Need to clear vegetation and soil to gain access for assessment and repairs. 11/24/20: Burns Pacific hired to remove and haul vegetation and excavat soil from common electrical panel box and main breaker. Elecrical problem is suspected to be with Edison meter and wiring. 11/25/20: Create Edison service ticket. 12/1/20: Re-create Edison service ticket after reaching representative by phone. 12/3/20: Edison visit site and replace electric meter and wiring. 12/3/20: Coast Pump checked and confirmed typical power conditions to well control panels.
Jan-21	W-10	low/ no production	Pump did not record production after Edison power restored to Malibu Road on 12/3/2020. Well control box was excavated and protective structure built. 6/7/2021: Pump re-assessed by Coast Pump, pump running at typical normal amps with no discharge. No discharge noted at storm drain MTD-10. Pump and drop pipe replacement is scheduled for the next monitoring year

FY20/21 MAINTENANCE SUMMARY

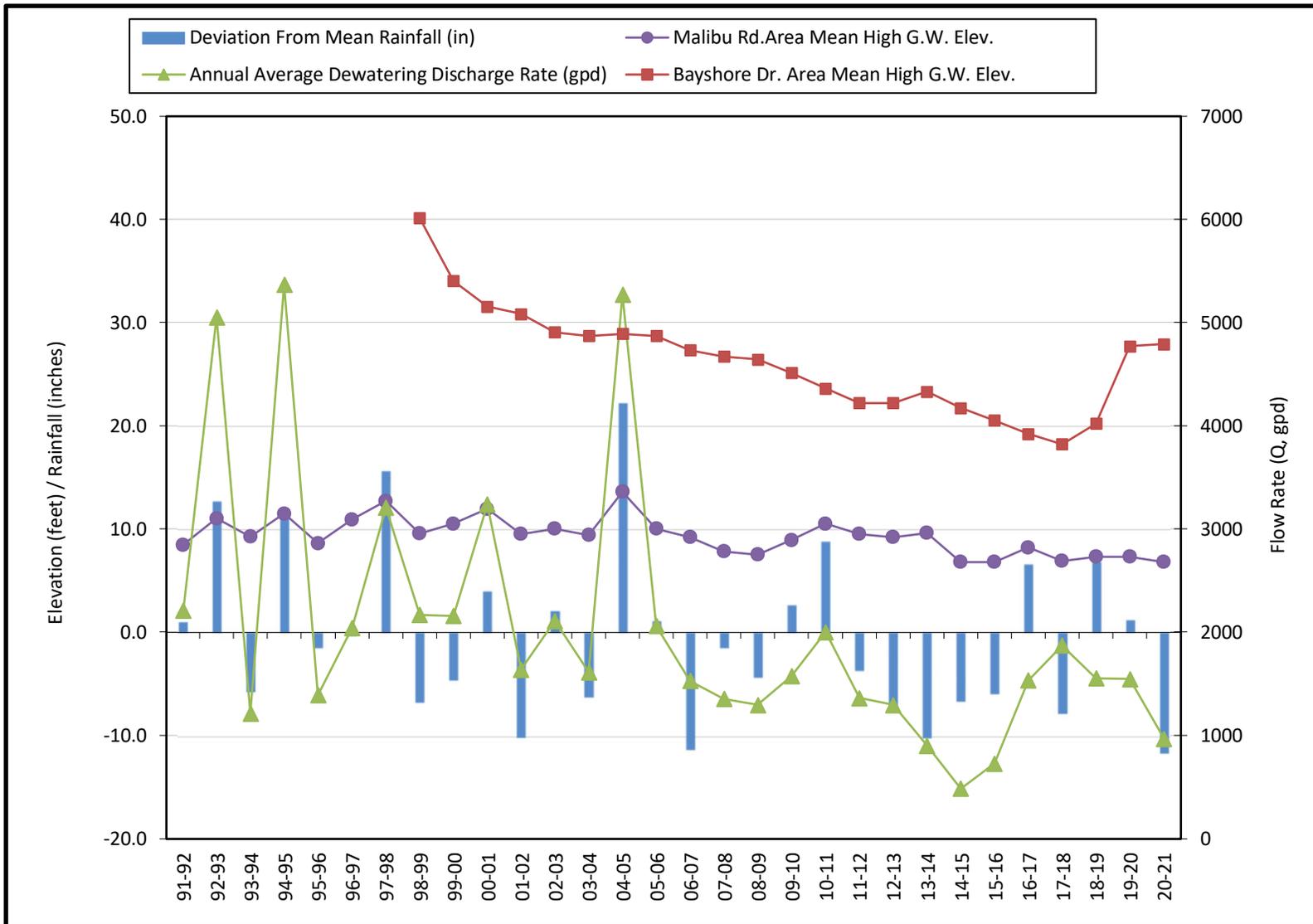
Date Entered	Facility	Description/Observation	Status or Resolution
DEWATERING WELLS			
Jan-21	W-8	low/ no production	12/3/20: Edison repaired electrical connection to well. 8/19/21-8/20/21: Well box uncovered and Yeh and Coast Pump gained access. Casing/pump may be within a zone of sedimented material inside the casing based on previously reported pump elevations. Evaluations and proposed repair will be continued during the next monitoring year.
Jan-21	W-4	not pumping, no power	7/8/21: assesed with Coast Pump, well has power, running at 21 amps, 15 amp circuit breaker not turning off pump, pump saver not turning off pump. 8/12/21: Coast Pump removed pump; 8/19/21: WRS video-logged well. 10/4-10/5/2021: Attempted to vaccume well bottom without notable results. Applied chemical treatment to casing and filter pack. 12/9: Coast Pump install new pump and 1-inch sounding tube. Returned to service.
2/12/2021	W-9	low/ no production, no power	2/12/21: unable to access well controls due to debris and vegetation. 6/7/21: Assessed with Coast Pump after cleared and protected. Power restored but needs new pump saver device. Planned for next monitoring year.
3/1/2021	W-6	low production/ no production noted after March/21 monthly record	3/19-3/20: assessed with Coast Pump, no power to pump, circuit breaker in panel failed, new pump saver needed. Location scheduled for debris/veg clearance and a protective structure. Electrical repair to follow.
3/17/2021	W-9	damaged discharge line	Repair planned to coincide with additional repairs at site next monitoring year
Date Entered	Facility	Description/Observation	Status or Resolution
HYDRAUGERS			
3/17/2021	HD-9	temporarily cut HD-9 to accommodate installation of well box W-4 protective structure	Repair planned to coincide with additional repairs at site next monitoring year
INCLINOMETERS			
No entries	--	--	--



RAINFALL GRAPH
 Landslide Assessment Districts
 Malibu, California



TOTAL DISCHARGE - WELLS AND HYDRAUGERS
Malibu Road Landslide Assessment District
Malibu, California



* Graph shows the mean value of the highest groundwater elevations recorded for each standpipe piezometer during the monitoring year.

GROUNDWATER LEVELS, DEWATERING, AND RAINFALL
 Malibu Road Landslide Assessment District
 Malibu, California

APPENDIX A - GROUNDWATER

MALIBU ROAD LAD - Standpipe Piezometer Information						
Standpipe ID	Previous Reference Elevation (8/91)	Updated Reference Elevation (4/00)	Casing Depth (ft)	Perforation Interval	Installed By	Notes
W-2A	22.6	20.6	9.0	Unknown	LA COUNTY	Dry
W-3A	22.0	20.5	32.5	Unknown	LA COUNTY	Buried
PZ-A	20.0	19.8	17.2	Unknown	LA COUNTY	
PZ-B	20.0	19.1	27.9	Unknown	LA COUNTY	
PZ-C	20.0	19.4	29.7	Unknown	LA COUNTY	
PZ-D	20.0	19.2	24.7	Unknown	LA COUNTY	
PZ-E	20.0	21.4	15.8	Unknown	LA COUNTY	
SI-5 ⁺	59.0	59.3	78.0	-19.0 to -14.0	BYA	
SI-6 ⁺⁺	57.0	58.0	78.0	-21.0 to -16.0	BYA	

Note: + Formerly designated as MR-5

++ Formerly designated as MR-6

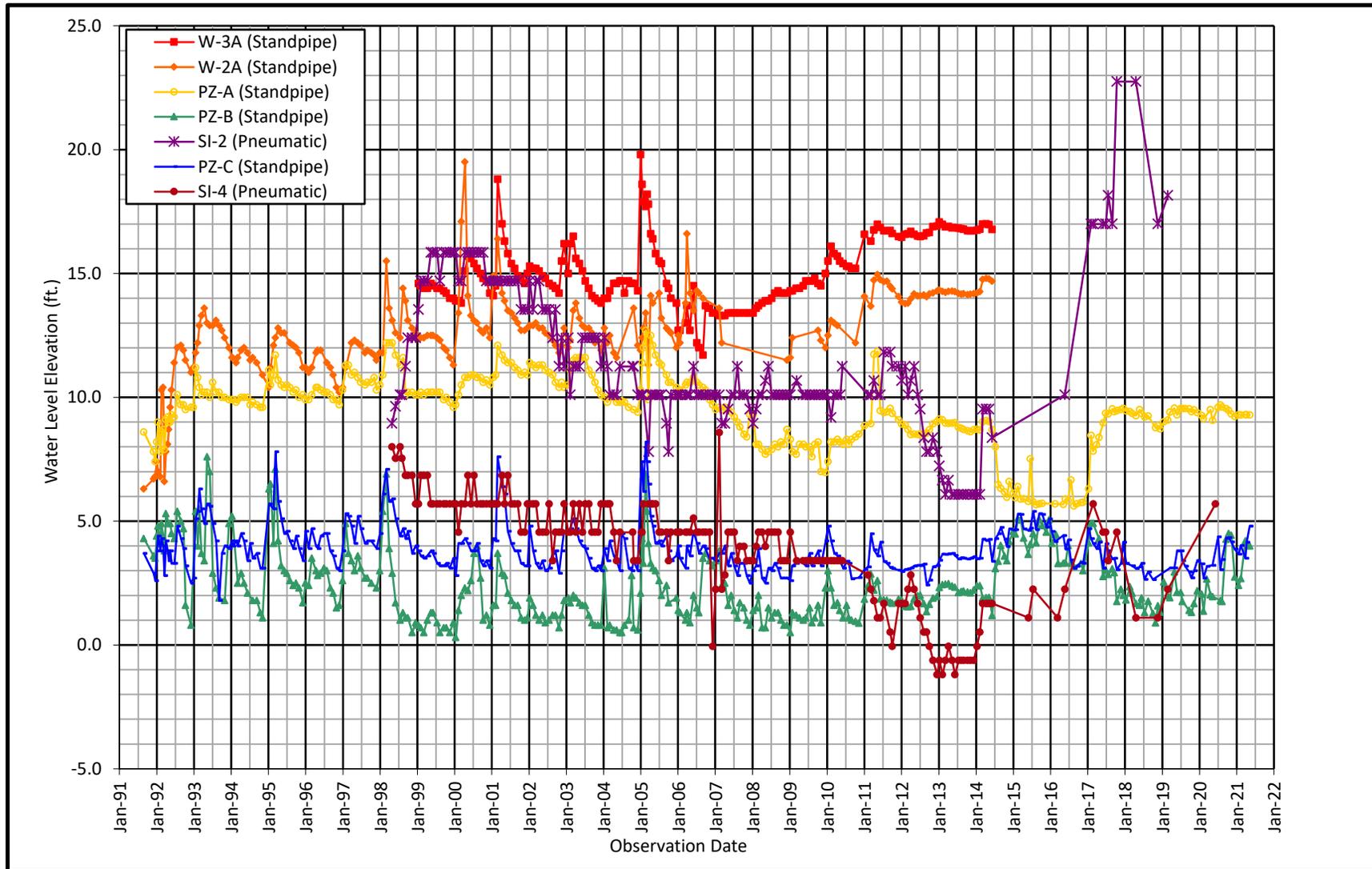
MALIBU ROAD LAD - Pneumatic Piezometer Information						
Well Identification	Previous Reference Elevation (8/91)	Updated Reference Elevation (4/00)	Tip Depth (ft.)	Tip El. (ft)	Installed By	Notes
SI-1*	20.0	20.1	34.6	-14.6	BYA	leaking
SI-2	20.0	19.7	65.1	-45.1	BYA	
SI-3*	20.0	20.3	49.8	-29.8	BYA	clogged
SI-4	22.0	18.9	43.9	-21.9	BYA	
SI-5 Tip 1	59.0	59.3	60	-1	BYA	
SI-5 Tip 2	59.0	59.3	40	19	BYA	
SI-6 Tip 1	57.0	58.0	60	-3	BYA	
SI-6 Tip 2	57.0	58.0	40	17	BYA	
SI-1A	20.0	20.0	50	-30	FUGRO	

Note: SI-1 thru SI-4 were previously designated MR98-1 thru MR98-4

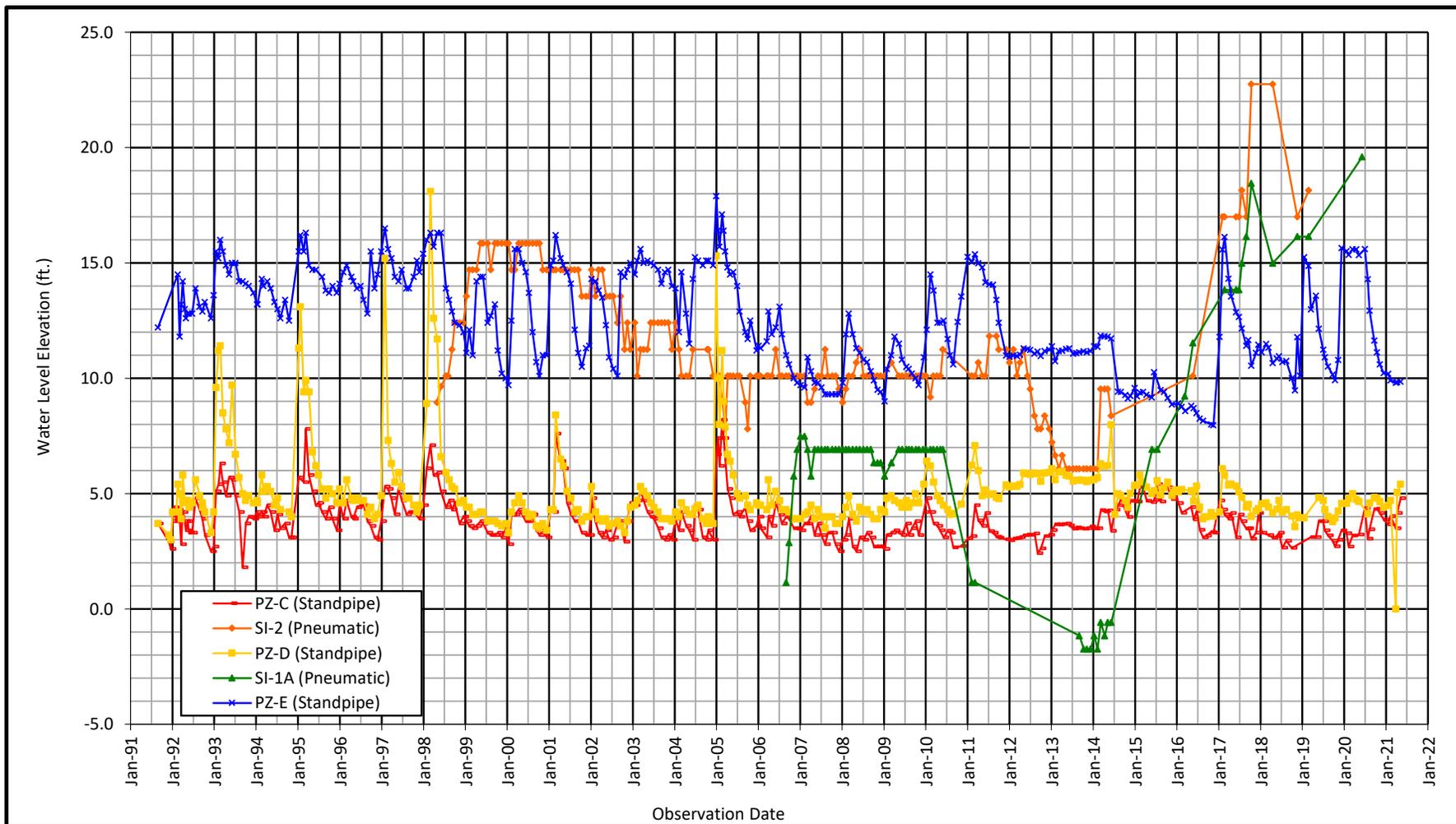
SI-5 and SI-6 were previously designated MR-5 and MR-6

* Piezometer not functioning

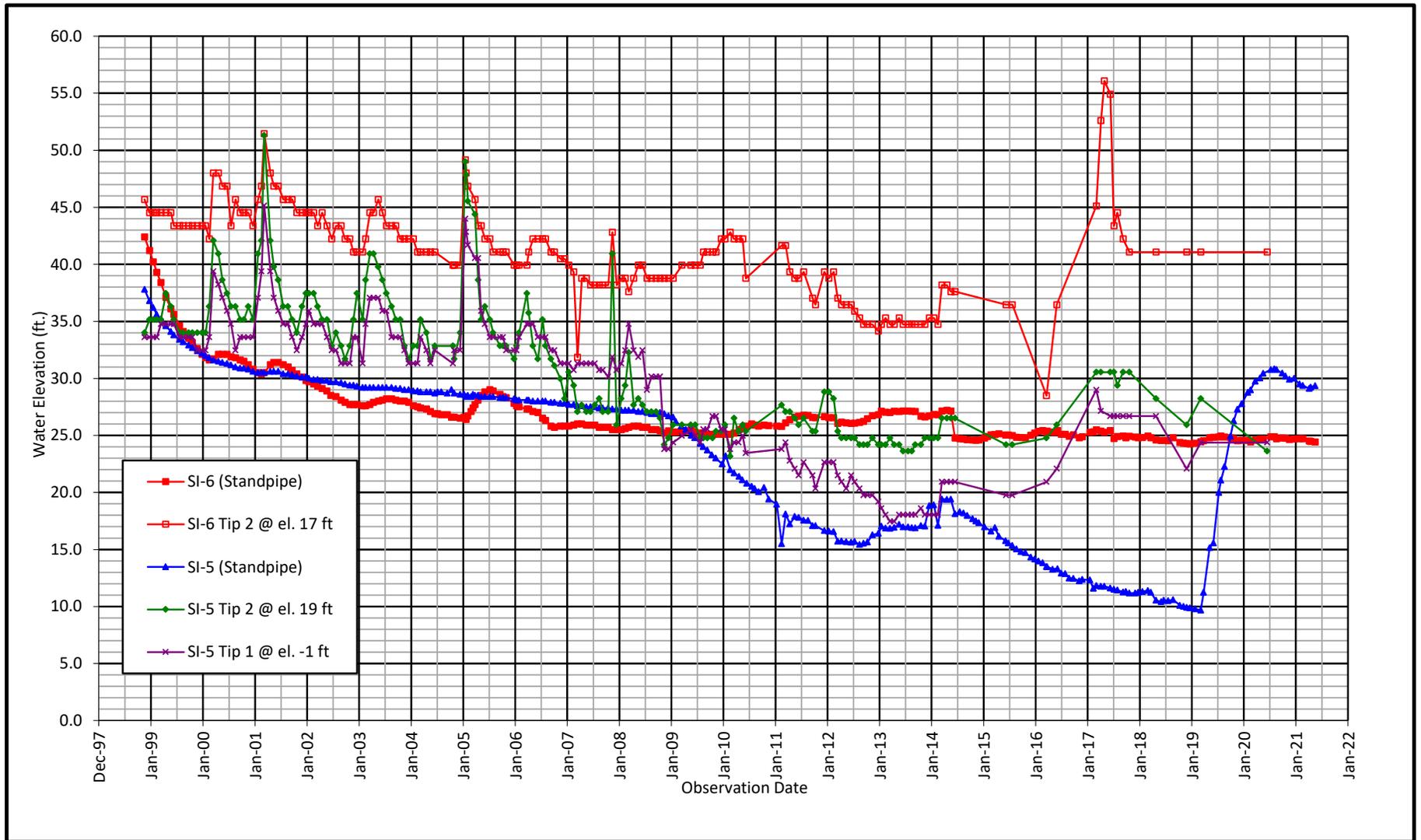
MALIBU ROAD LANDSLIDE ASSESSMENT DISTRICT - SUMMARY OF GROUNDWATER DATA																																						
Standpipe / Piezometer I.D.	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00	00-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08	08-09	09-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-21	Mean '91-21	Stand Dev.	20-21 vs. 97-98	20-21 vs. mean				
MALIBU ROAD - Standpipe Piezometers																																						
W-2A	Mean El.	8.3	12.3	12.1	11.8	11.7	11.2	12.4	12.8	13.5	13.7	12.9	12.6	12.3	12.8	13.4	13.7	--	--	--	14.1	14.2	14.2	14.4	DRY													
	Highest El.	11.4	13.6	13.1	12.8	12.2	12.3	15.5	14.4	19.5	16.4	13.4	13.8	12.8	14.1	16.6	14.3	--	--	--	15.0	14.7	14.3	14.8	DRY													
W-3A	Mean El.								14.5	14.4	15.5	15.0	15.3	14.3	16.4	13.9	13.1	13.6	14.3	15.2	16.1	16.6	16.8	16.8	UTL													
	Highest El.								14.6	15.7	18.8	15.4	16.5	14.7	19.8	15.5	13.7	13.9	14.7	16.1	17.0	16.7	17.1	17.0	UTL													
PZ-A	Mean El.	8.6	10.1	10.0	10.4	10.2	10.5	11.1	10.4	10.2	11.1	11.2	11.0	10.3	10.8	10.7	9.9	8.5	8.1	7.9	9.2	9.0	8.9	8.8	6.3	6.0	6.9	9.4	9.1	9.4	9.4	9.4	1.4	-1.7	0.0			
	Highest El.	9.3	11.2	10.6	11.7	10.5	11.3	12.2	11.6	10.9	12.1	11.4	11.6	11.6	12.7	11.4	10.6	9.3	8.7	8.3	11.9	9.6	9.1	9.1	8.0	7.5	9.0	9.6	9.6	9.6	9.7	10.3	1.4	-2.5	-0.6			
PZ-B	Mean El.	4.4	4.5	2.9	3.7	2.6	2.9	3.4	1.0	1.3	2.3	1.3	1.5	1.0	2.8	1.7	2.7	1.3	1.0	1.6	1.8	1.7	2.1	2.1	4.1	4.2	3.8	2.3	1.8	1.9	3.4	2.4	1.1	0.0	0.9			
	Highest El.	5.3	7.6	5.2	7.1	3.5	4.9	6.9	1.3	2.6	4.0	1.9	2.0	3.1	6.9	2.6	3.8	2.0	1.3	3.0	2.9	2.0	2.5	2.4	5.1	5.1	4.9	3.1	3.0	2.7	4.5	3.8	1.8	-2.4	0.7			
PZ-C	Mean El.	3.6	4.6	3.9	4.7	4.2	4.2	5.1	4.0	3.6	4.5	3.6	4.1	3.4	5.2	3.9	3.7	3.0	3.0	3.7	3.4	3.1	3.3	3.7	4.6	4.8	3.7	3.5	3.1	3.2	4.0	3.9	0.6	-1.1	0.1			
	Highest El.	4.4	6.3	4.9	7.8	4.7	5.3	7.1	4.7	4.3	7.6	4.8	5.1	4.2	8.2	4.6	4.1	3.9	3.4	4.8	4.5	3.4	3.7	4.3	5.3	5.4	4.7	4.2	3.8	3.8	4.8	4.9	1.3	-2.3	-0.1			
PZ-D	Mean El.	4.4	6.9	5.1	7.6	5.0	5.9	7.8	4.7	4.0	4.8	4.2	4.3	4.1	7.0	4.7	4.2	4.0	4.4	5.1	5.2	5.3	5.8	5.9	5.0	5.1	4.8	4.5	4.2	4.4	4.7	5.1	1.0	-3.1	-0.4			
	Highest El.	5.8	11.4	6.7	13.1	5.8	15.2	18.1	5.9	4.9	8.4	5.3	5.3	4.6	15.3	5.6	4.7	4.9	4.9	6.4	7.1	5.9	6.1	8.0	5.8	5.6	6.1	5.1	4.8	5.0	5.4	7.2	3.6	-12.7	-1.8			
PZ-E	Mean El.	13.0	14.3	13.9	14.5	14.2	14.6	15.2	12.8	12.7	13.3	12.5	14.1	13.8	15.6	12.1	10.5	10.4	10.4	11.6	13.5	11.9	11.2	11.4	9.3	9.1	11.4	11.4	11.9	13.0	11.3	12.5	1.7	-3.9	-1.2			
	Highest El.	14.5	16.0	15.0	16.3	14.9	16.5	16.3	14.4	15.6	16.2	14.3	15.6	14.9	17.9	14.0	13.1	12.8	11.8	14.5	15.4	14.1	11.4	11.8	9.6	10.3	16.1	12.7	15.3	15.7	9.7	14.2	2.1	-6.6	-4.5			
Area Average	Mean El.	7.0	8.8	8.0	8.8	8.0	8.2	9.2	8.6	8.5	9.3	8.7	9.0	8.5	10.1	8.6	8.2	6.8	6.9	7.5	9.0	8.8	8.9	9.0	5.9	5.8	6.1	6.2	6.0	6.4	6.6	7.9	1.2	-2.6	-1.4			
	Highest El.	8.5	11.0	9.3	11.5	8.6	10.9	12.7	9.6	10.5	11.9	9.5	10.0	9.4	13.6	10.0	9.2	7.8	7.5	8.9	10.5	9.5	9.2	9.6	6.8	6.8	8.2	6.9	7.3	7.3	6.8	9.3	1.8	-5.9	-2.5			
Change vs. Prior	Mean El.		1.7	-0.8	0.8	-0.8	0.3	0.9	-0.6	-0.1	0.8	-0.6	0.3	-0.5	1.6	-1.5	-0.4	-1.4	0.1	0.6	1.5	-0.2	0.1	0.1	-3.1	-0.1	0.3	0.1	-0.2	0.4	0.2							
	Highest El.		2.6	-1.8	2.2	-2.9	2.3	1.8	-3.1	0.9	1.4	-2.4	0.5	-0.6	4.1	-3.5	-0.9	-1.4	-0.3	1.4	1.7	-1.0	-0.3	0.5	-2.9	0.0	1.4	-1.3	0.4	0.1	-0.5							
Bayshore Drive - Standpipe Piezometers																																						
SI-5	Mean El.								35.5	32.2	30.7	30.1	29.3	29.0	28.6	28.2	27.8	27.3	26.3	22.6	18.8	16.5	16.4	18.0	17.4	14.3	12.2	11.2	11.1	26.5	30.0	23.5	7.5		6.5			
	Highest El.								37.8	33.4	31.2	30.4	29.7	29.2	29.0	28.4	28.0	27.5	27.0	24.3	20.5	17.6	17.2	19.4	18.3	15.6	12.9	11.5	15.6	30.4	30.8	24.6	7.3		6.2			
SI-6	Mean El.								38.8	32.6	31.2	29.9	27.9	27.7	27.2	27.9	26.0	25.7	25.4	25.3	26.1	26.4	26.7	26.8	24.8	25.1	25.2	24.8	24.5	24.7	24.7	27.2	3.3		-2.5			
	Highest El.								42.4	34.6	31.9	31.2	28.4	28.2	28.8	29.0	26.5	25.9	25.7	25.8	26.7	26.8	27.1	27.2	25.1	25.4	25.5	25.0	24.8	25.0	24.9	27.9	4.0		-3.0			
Area Average	Mean El.								37.2	32.4	31.0	30.0	28.6	28.3	27.9	28.0	26.9	26.5	25.8	23.9	22.4	21.5	21.6	22.4	21.1	19.7	18.7	18.0	17.8	25.6	27.3	10.8	4.9		16.5			
	Highest El.								40.1	34.0	31.5	30.8	29.1	28.7	28.9	27.3	26.7	26.4	25.1	23.6	22.2	22.2	23.3	21.7	20.5	19.2	18.2	20.2	27.7	27.9	11.3	5.2		16.5				
Change vs. Prior	Mean El.								-4.7	-1.5	-1.0	-1.3	-0.3	-0.4	0.2	-1.2	-0.4	-0.6	-1.9	-1.5	-0.9	0.1	0.8	-1.3	-1.4	-1.0	-0.7	-0.2	7.8	1.7								
	Highest El.								-6.1	-2.5	-0.7	-1.8	-0.4	0.2	-0.2	-1.5	-0.6	-0.3	-1.3	-1.5	-1.4	0.0	1.1	-1.6	-1.2	-1.3	-1.0	2.0	7.5	0.2								
MALIBU ROAD - Pneumatic Piezometers																																						
SI-1	Mean El.																																					
	Highest El.																																					
SI-1A	Mean El.																5.8	6.9	6.5	6.9	Piezometer Not Functioning						8.6	13.8	15.7	16.1	19.6		11.1	5.2	19.6	8.5		
	Highest El.																7.5	6.9	6.9	6.9	Piezometer Not Functioning						11.5	13.8	18.4	16.1	19.6		12.0	5.2	19.6	7.6		
SI-2	Mean El.								9.3	13.2	15.6	15.1	14.1	11.9	11.5	10.1	9.9	9.9	10.1	10.2	10.1	10.2	11.0	7.4	7.1		10.1	17.0	19.5	17.6		11.9	3.3					
	Highest El.								9.6	15.9	15.9	15.9	14.7	13.6	12.4	11.3	11.3	10.1	11.3	10.7	11.3	10.7	11.8	9.5	9.5		10.1	17.0	22.8	18.2		13.0	3.5					
SI-3	Mean El.																																					
	Highest El.																																					
SI-4	Mean El.								7.8	6.6	5.7	6.0	5.2	4.8	5.0	4.9	4.5	4.0	4.0	3.9	3.4	1.8	1.6	-0.3	0.3		1.7	5.1	3.4	1.7	5.7		3.9	2.1	-2.1	1.8		
	Highest El.								8.0	8.0	6.9	6.9	5.7	5.7	5.7	5.7	5.1	8.6	4.6	4.6	3.4	2.8	2.8	1.1	1.7		2.3	5.7	4.6	2.3	5.7		4.9	2.1	-2.3	0.8		
Bayshore Drive - Pneumatic Piezometers																																						
SI-5 Tip 1	Mean El.								34.2	34.7	36.3	34.2	33.9	32.7	37.6	33.6	31.8	31.7	26.9	25.1	22.9	21.7	18.9	19.0		20.6	27.6	26.7	23.2	24.4		28.5	6.0		-4.1			
	Highest El.								34.8	39.4	45.1	35.9	37.1	35.9	44.0	34.8	33.6	34.8	30.1	26.7	24.4	22.6	20.9	20.9		22.1	29.0	26.7	24.4	24.4		30.8	7.4		-6.5			
SI-5 Tip 2	Mean El.								35.4	36.1	39.1	35.8	36.5	34.0	39.5	33.7	29.8	29.2	26.0	25.2	26.8	26.3	24.3	25.1		24.8	30.5	29.8	27.1	23.6		30.4	5.2		-6.8			
	Highest El.								37.5	42.1	51.3	37.5	40.9	37.5	49.0	37.5	35.1	40.9	27.1	26.5	27.7	28.8	24.8	26.5		25.9	30.5	30.5	28.2	23.6		33.8	8.0		-10.2			
SI-6 Tip 1	Mean El.								42.4	Piezometer Not Functioning												25.7	25.9	23.8	24.6		27.1	34.8	35.6	34.9	36.1		31.1	6.4				5.0
	Highest El.								44.1	Piezometer Not Functioning												26.8	27.4	24.0	26.3		30.3	36.1	38.4	34.9	36.1		32.4	6.5				3.6
SI-6 Tip 2	Mean El.								44.5	44.6	46.0	44.4	43.0	42.0	43.8	41.0	39.5	39.0	39.0	41.4	40.0	37.7	34.9	35.9		34.5	52.2	42.5	41.1	41.1		41.3	4.1			-0.3		
	Highest El.								45.7	48.0	51.5	45.7	45.7	43.4	49.1	42.2	42.2	42.8	39.9	42.8	41.6	39.3	35.9	38.2		36.5	56.1	44.5										



GROUNDWATER HYDROGRAPH
 Malibu Road (West End)
 Malibu Road Landslide Assessment District
 Malibu, California



GROUNDWATER HYDROGRAPH
Malibu Road (East End)
Malibu Road Landslide Assessment District
Malibu, California



GROUNDWATER HYDROGRAPH
Bayshore Drive
Malibu Road Landslide Assessment District
Malibu, California

APPENDIX B - SLOPE INCLINOMETERS

MALIBU ROAD LAD - Slope Inclinator Interpretation Summary									
	SI-1 (MR98-1)	SI-1A	SI-2 (MR98-2)	SI-2A	SI-3 (MR98-3)	SI-4 (MR98-4)	SI-4A	SI-5	SI-6
Installation Details									
Previous Ref.Elev.(8/91)	20.0	20.0	20.0	20.0	20.0	22.0	N/A	59.0	57.0
Updated Ref.Elev.(4/00)	20.1	20.0	19.7	19.7	20.3	18.9	18.9	59.3	58.0
Depth (ft.)	34	50	64	64	49	43	50	78	78
Install Date	Apr-98	Aug-06	Apr-98	Sep-10	Apr-98	Apr-98	Aug-12	Apr-98	Apr-98
A+ Axis orientation (deg)	184	197	201	200	190	204	204	176	186
Casing	RST	SI	RST	RST	RST	RST	SI	SI	SI
Installer	BYA	Fugro	BYA	Fugro	BYA	BYA	Fugro	BYA	BYA
Interpreted Rupture Depth (ft)	30-32	23-30	28-32	28-32	35-38	32-34	32-34	unknown	unknown
Status	D	F	D	F	D	D	F	F	F
Reading Interval	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Semi	Semi
Interpretation Movement (inches)									
2019-2020	NR	--	NR	--	NR	NR	--	--	--
2018-2019	NR	--	NR	--	NR	NR	--	--	--
2017-2018	NR	--	NR	--	NR	NR	--	--	--
2016-2017	NR	0.1	NR	0.15	NR	NR	0.15	--	--
2015-2016	NR	--	NR	--	NR	NR	--	--	--
2014-2015	NR	<0.1	NR	--	NR	NR	--	--	--
2013-2014	NR	0.1	NR	--	NR	NR	--	--	--
2012-2013	NR	<0.1	NR	<0.1	NR	NR	--	0.1	0.1
2011-2012	NR	<0.1	NR	--	NR	--	NR	--	<0.1
2010-2011	NR	<0.1	NR	--	NR	0.6	NR	--	<0.1
2009-2010	NR	<0.1	NR	--	NR	--	NR	--	<0.1
2008-2009	NR	<0.1	<0.1 (4)	NR	NR	--	NR	--	<0.1
2007-2008	NR	<0.1	--	NR	NR	--	NR	--	<0.1
2006-2007	NR	NR	--	NR	NR	--	NR	--	0.1
2004-2005	0.5 (3)	NR	0.4	NR	>1(3)	0.4 to 0.5	NR	~ 0.2 *	--
2003-2004 (1)	--	NR	--	NR	--	--	NR	--	--
2002-2003	~ 0.2 *	NR	~ 0.1 *	NR	--	--	NR	--	--
2001-2002	--	NR	--	NR	--	--	NR	--	--
2000-2001	0.5	NR	0.4	NR	0.3	0.6	NR	--	--
1999-2000	--	NR	--	NR	--	--	NR	--	--
1998-1999	3.1	NR	1.5	NR	4.1	1.3 (2)	NR	--	--

NOTES:
D Destroyed

F Functioning

NI No information

(1) Readings only through March 2004

(2) Readings are through 2000, although majority of movement occurred in 1998

(3) Inclinator sheared off in January, 2005.

(4) Inclinator sheared off winter of 2009.

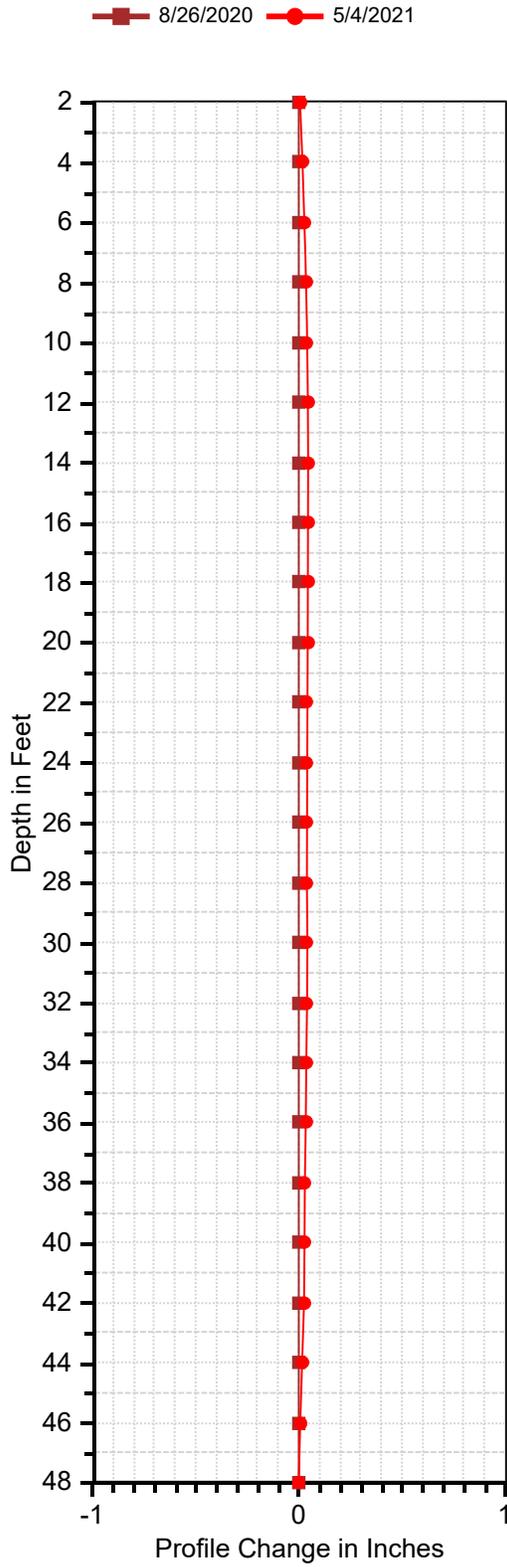
NR No reading

-- No clearly defined interpreted movement.

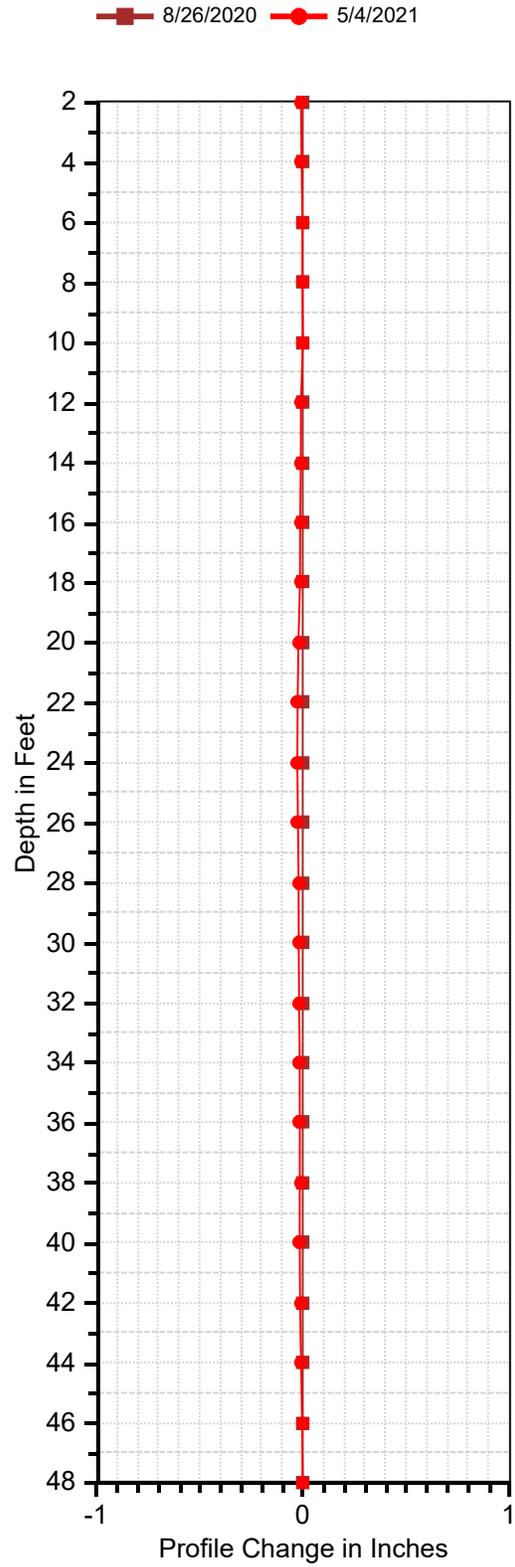
~ 0.1 * Indicated displacement is less than reliable instrument accuracy. Interpreted movement is theoretical.

SLOPE INCLINOMETER INFORMATION
 Malibu Road Landslide Assessment District
 Malibu, California

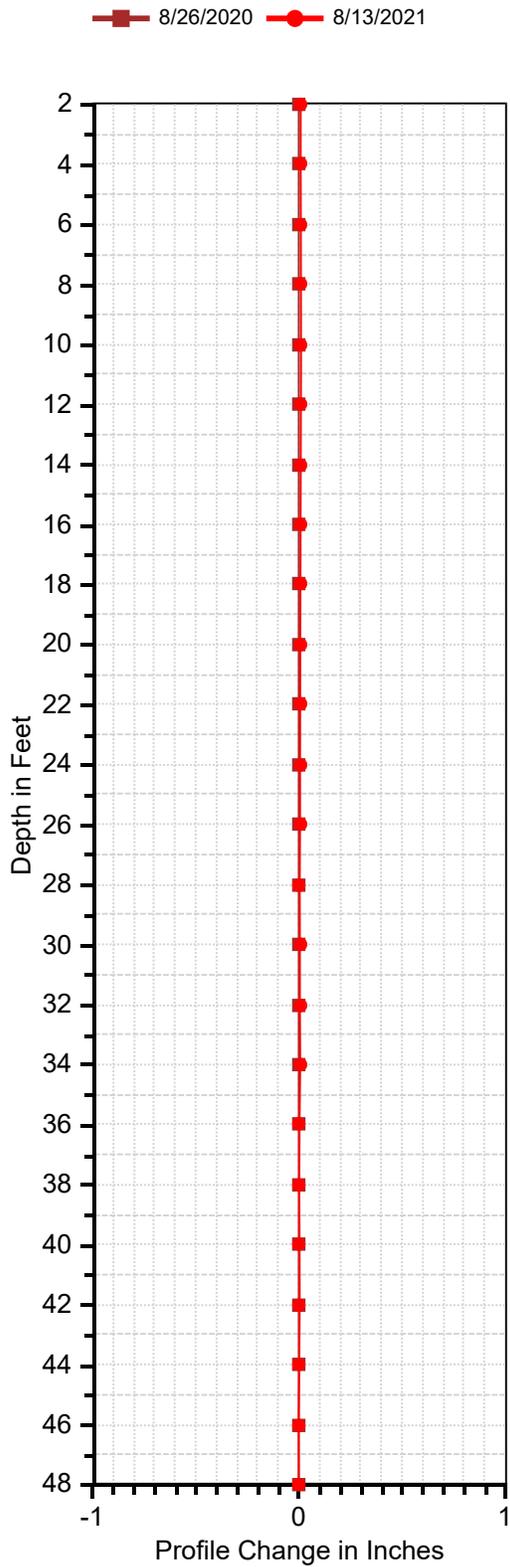
MR SI-1A A



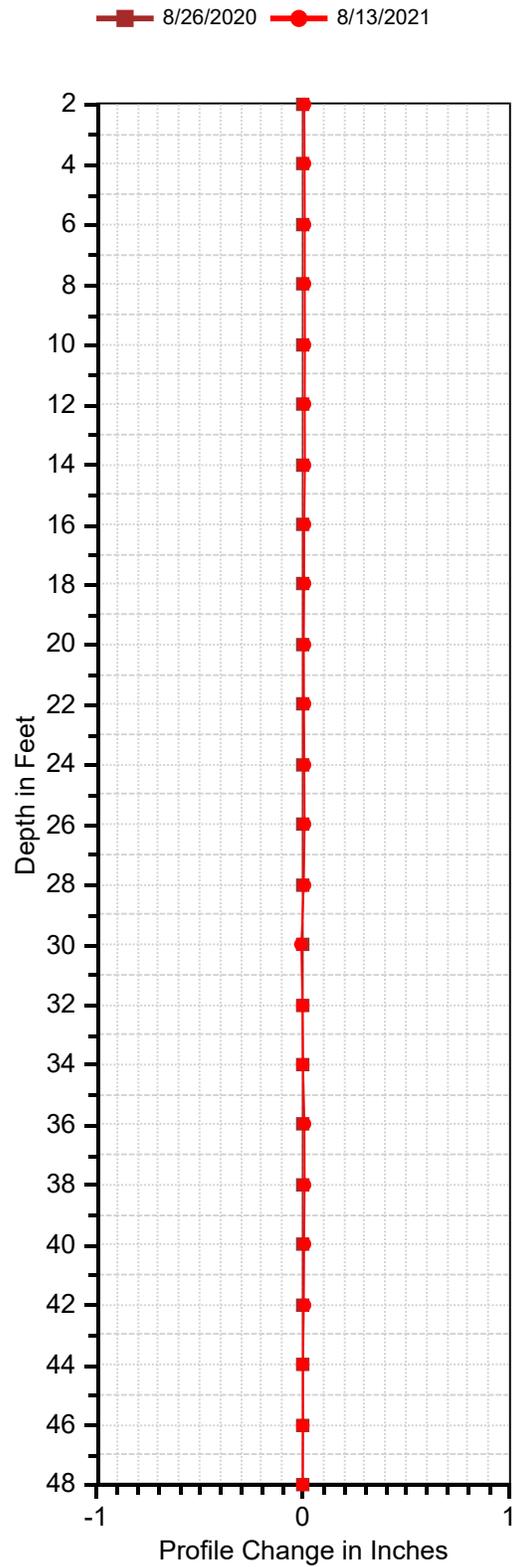
MR SI-1A B



MR SI-2A A

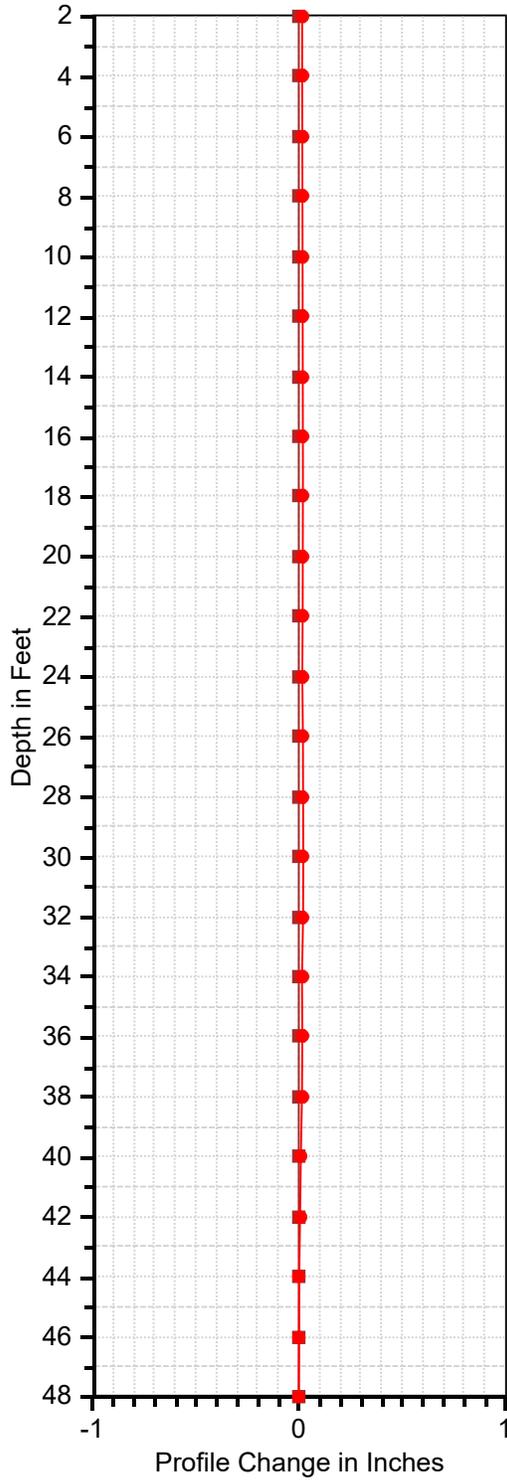


MR SI-2A B



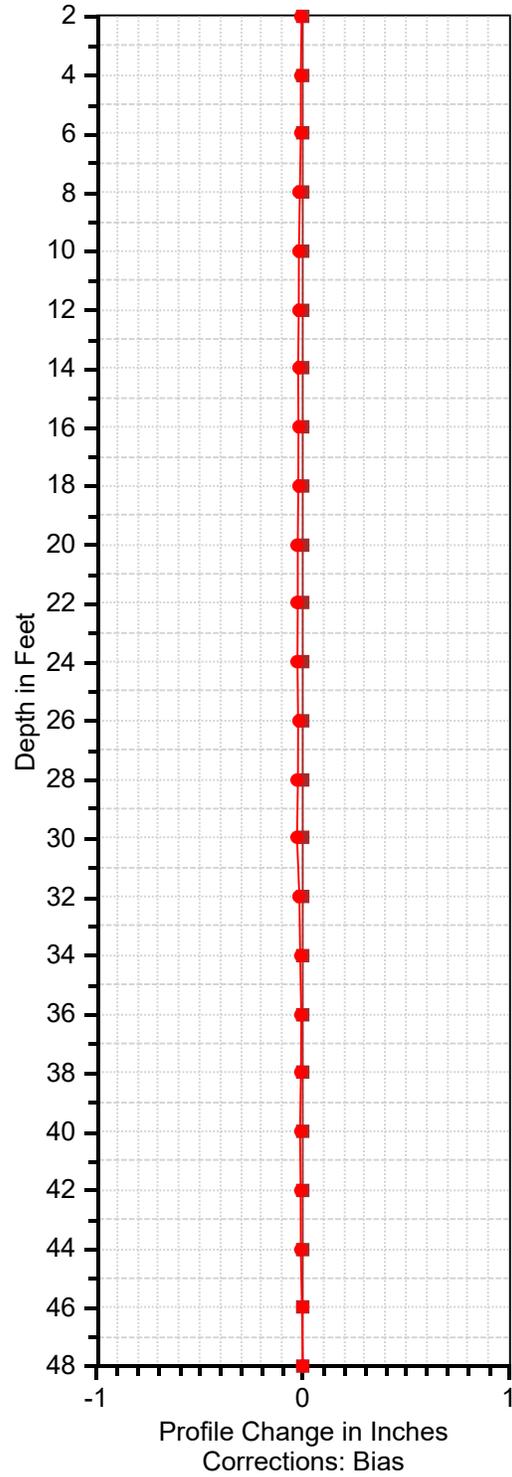
MR SI-4A A

8/26/2020 8/6/2021



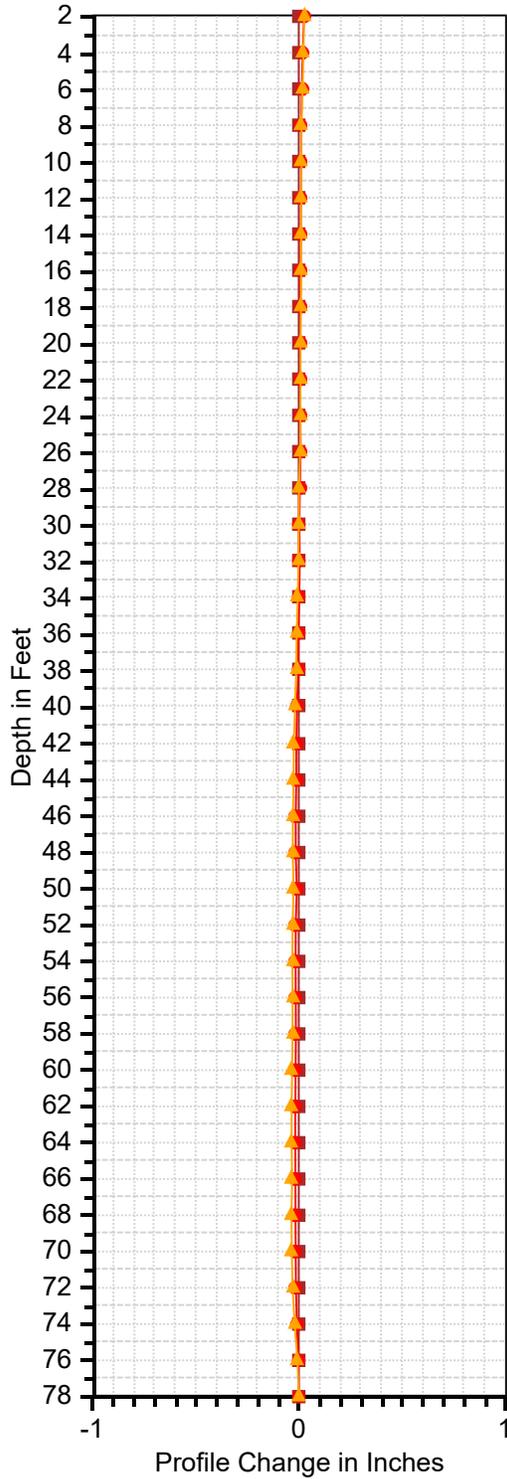
MR SI-4A B

8/26/2020 8/6/2021



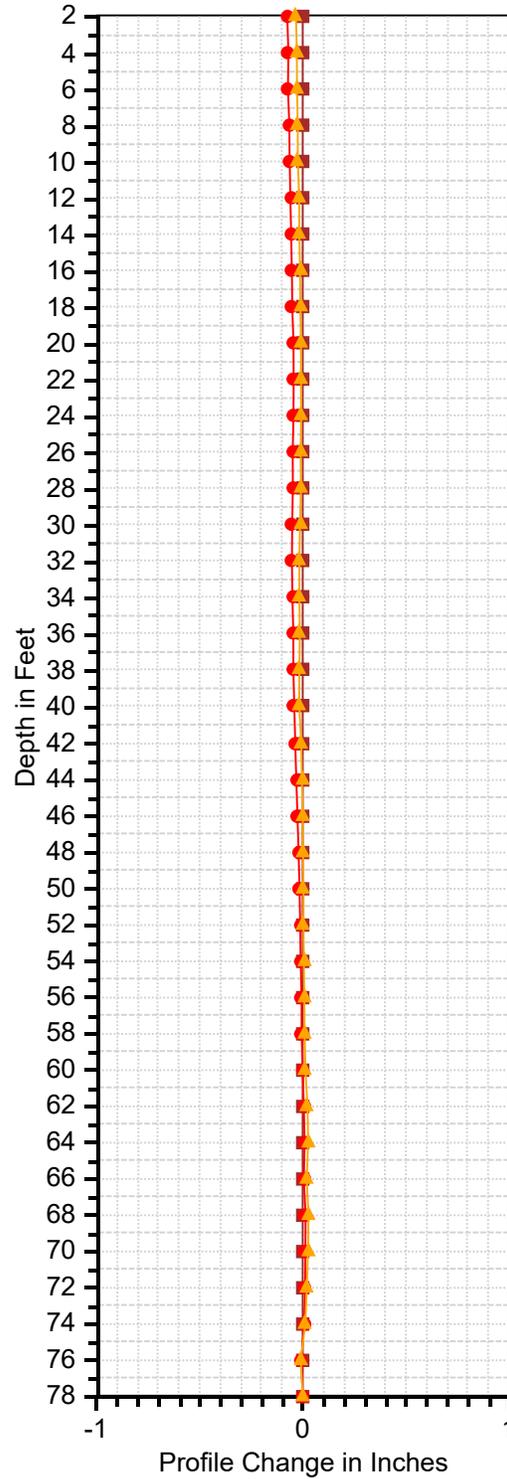
MR SI-5 A

8/7/2020 5/3/2021 8/6/2021



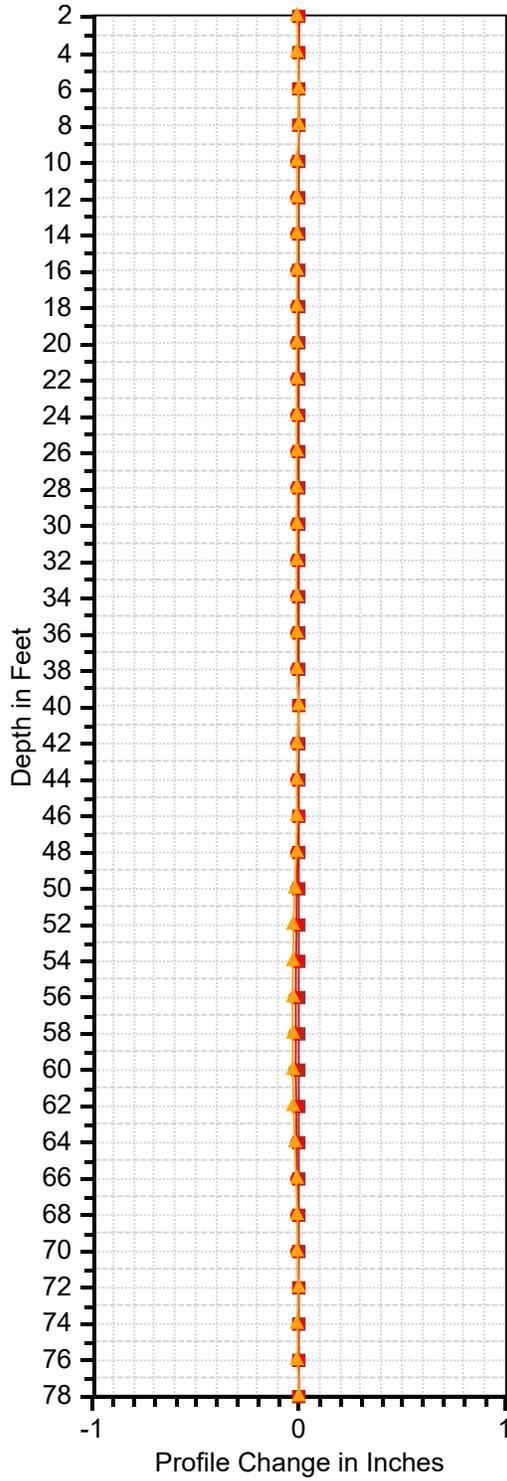
MR SI-5 B

8/7/2020 5/3/2021 8/6/2021



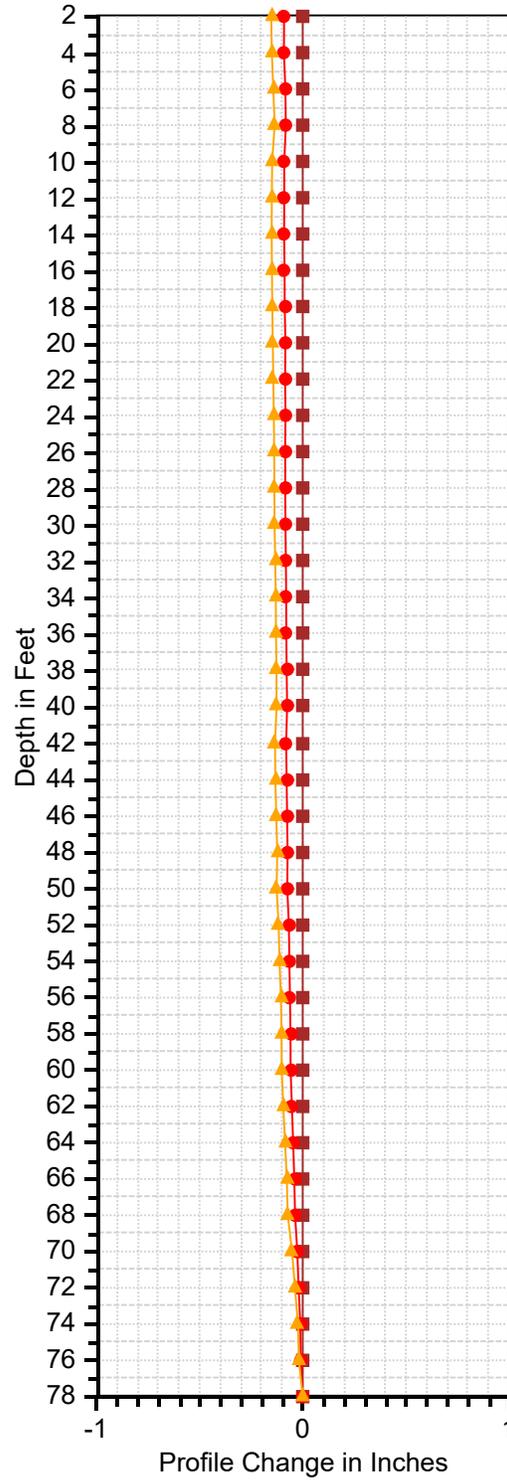
MR SI-6 A

8/7/2020 5/3/2021 8/6/2021



MR SI-6 B

8/7/2020 5/3/2021 8/6/2021



APPENDIX C - DEWATERING

MALIBU ROAD LAD - Dewatering Well Information							
Well ID	Vault Elevation (ft.)	Bottom Elevation (ft.)	Pump Elevation (ft.)	Pump Size (hp)	2020-2021 Mean Pumping Rate (gpd)	% of Total Well Production	Installed By
W-3	19.5	-4.0	Unknown	1/2	292	37%	LA Co.
W-4	20.0	-9.0	-4.0	1/2	1	0%	LA Co.
W-5	19.0	-9.5	Unknown	1/2	385	48%	LA Co.
W-6	20.0	-4.5	0.0	1/2	10	1%	LA Co.
W-8	27.5	11.0	Unknown	1/2	8	1%	LA Co.
W-9	20.0	-40.0	-35.0	1/3	3	0%	LA Co.
W-10	19.0	-26.0	-21.0	1/3	0	0%	LA Co.
W-11	61.0	1.0	13.0	1/3	20	3%	BYA
W-12	58.0	-2.0	8.0	1/3	14	2%	BYA
W-13	20.0	-28.0	N/A	N/A	0	0%	Fugro
W-14	60.0	-20.0	Unknown	1/3	48	6%	Fugro
NW-1	Unknown	Unknown	Unknown	Unknown	3	0%	Homeowner
NW-2	Unknown	Unknown	Unknown	Unknown	9	1%	Homeowner
NW-3	Unknown	Unknown	Unknown	Unknown	3	0%	Homeowner

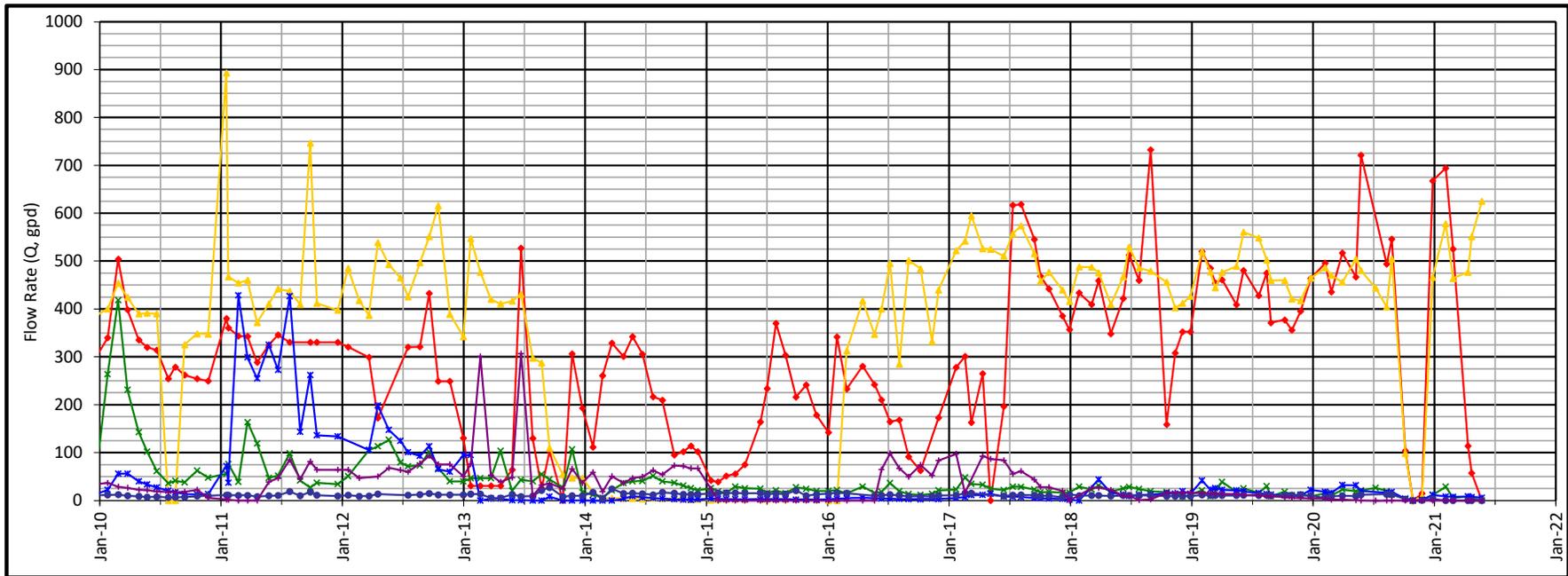
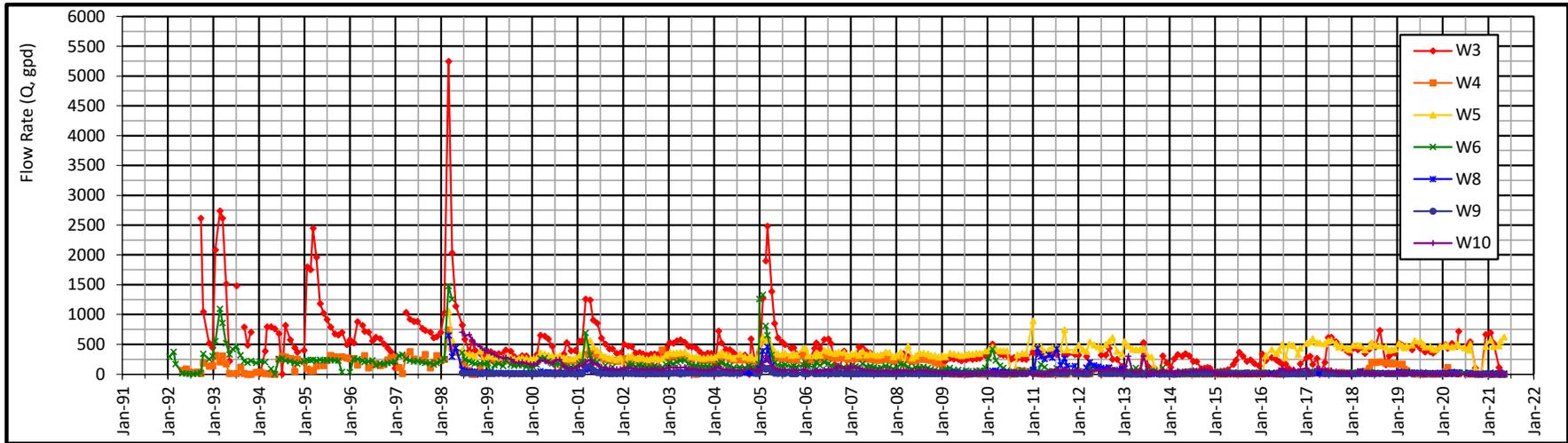
MALIBU ROAD LAD- Hydrauger Information						
Hydrauger ID	Installed Length (ft.)	Bearing	Functional Length* (ft)	2020-2021 Mean Flow Rate (gpd)	% of Total Production	Installed By
HD-1**	Unknown	N05E	74	0	0%	LA County
HD-2**	Unknown	N21E	34	0	0%	LA County
HD-3**	Unknown	N06E	13	0	0%	LA County
HD-4	Unknown	N29E	53	0	0%	LA County
HD-5A	Unknown	N13E	41	113	46%	LA County
HD-6	Unknown	N08W	55	12	5%	LA County
HD-7	Unknown	N26E	87	3	1%	LA County
HD-8	Unknown	N19E	92	4	2%	LA County
HD-8A	Unknown	Unknown	Unknown	24	10%	Unknown
HD-9	Unknown	N34E	76	50	21%	LA County
HD-10	Unknown	N19E	55	0	0%	LA County
HD-11	Unknown	N11E	78	0	0%	LA County
HD-12	Unknown	N08E	70	0	0%	LA County
HD-13	Unknown	N09E	79	0	0%	LA County
HD-14	Unknown	N08E	80	0	0%	LA County
HD-15	Unknown	N14E	82	0	0%	LA County
HD-16	Unknown	N15E	69	0	0%	LA County
HD-17**	150	N15E	150	0	0%	BYA
HD-18	150	N18E	150	1	0%	BYA
HD-19	150	N10E	150	0	0%	BYA
HD-20	150	N09W	150	18	7%	BYA
HD-21	150	N22E	150	19	8%	BYA
HD-22	180	N13E	180	0	0%	Fugro West
HD-23	160	N01E	160	0	0%	Fugro West

Note: * Measured on 4/1/98 (except HD-22 and HD-23 installed 1/22/05)

** buried/unable to locate

DEWATERING WELL / HYDRAUGER INFORMATION

Malibu Road Landslide Assessment District
 Malibu, California

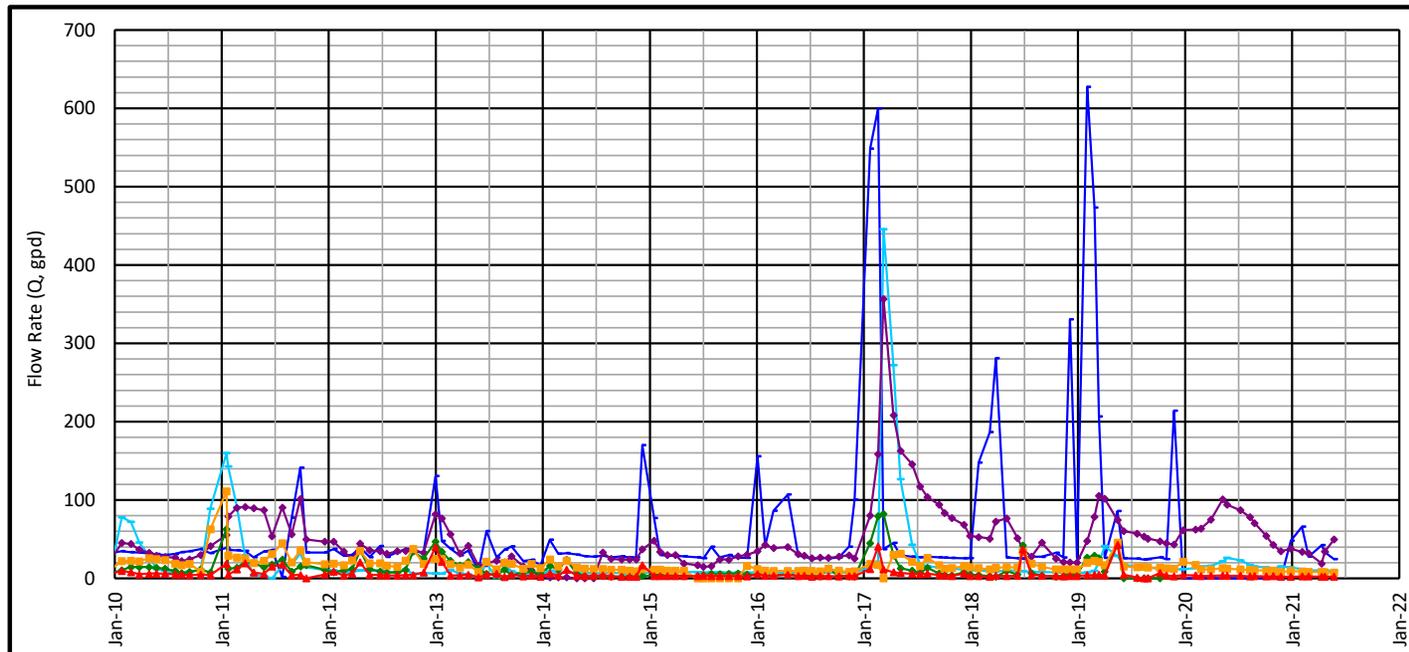
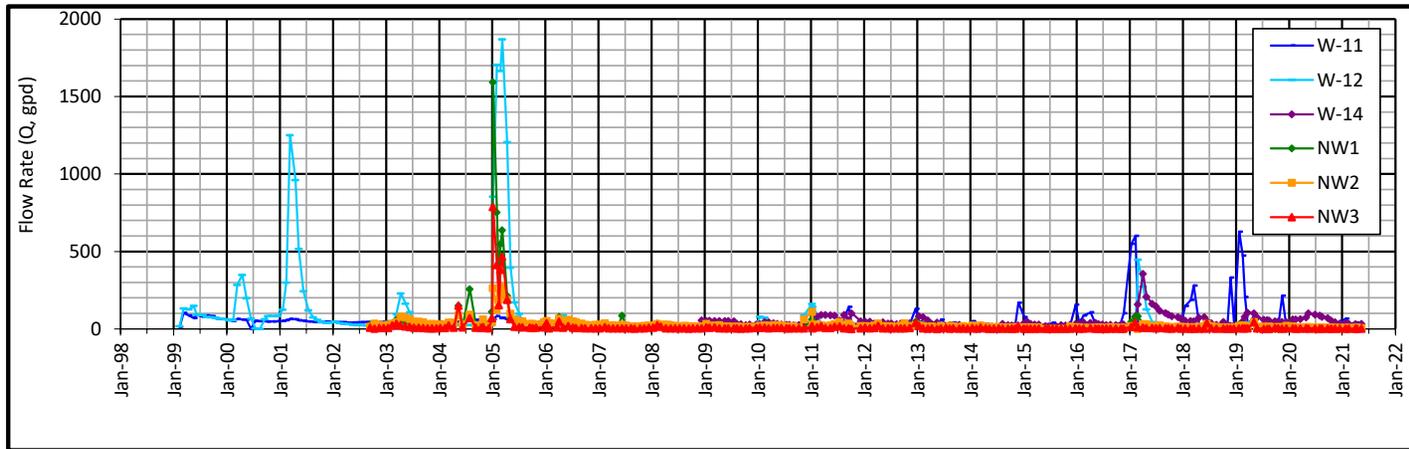


DEWATERING WELL DISCHARGE RATE GRAPH

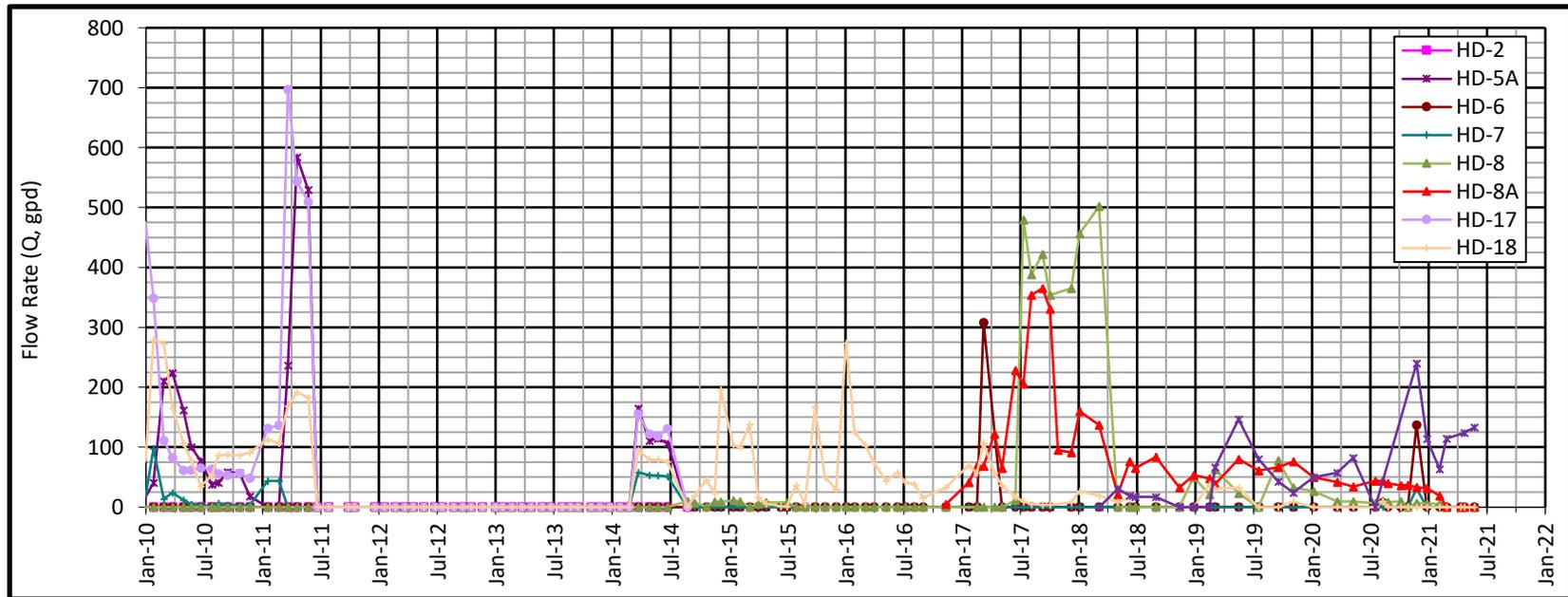
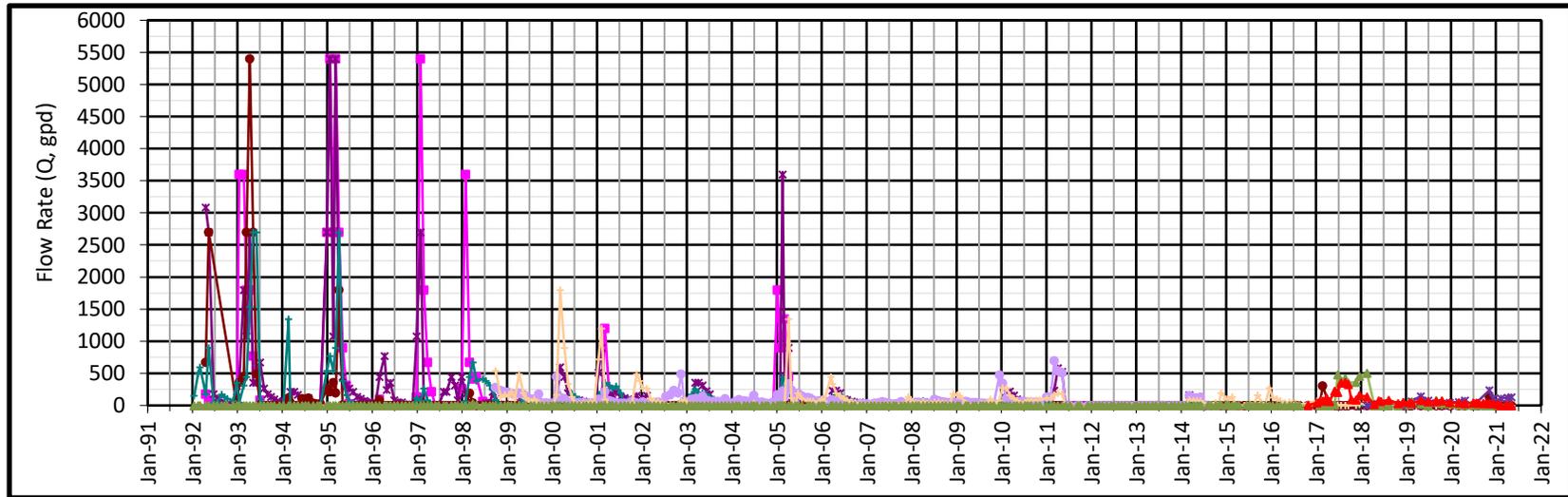
Malibu Road

Malibu Road Landslide Assessment District

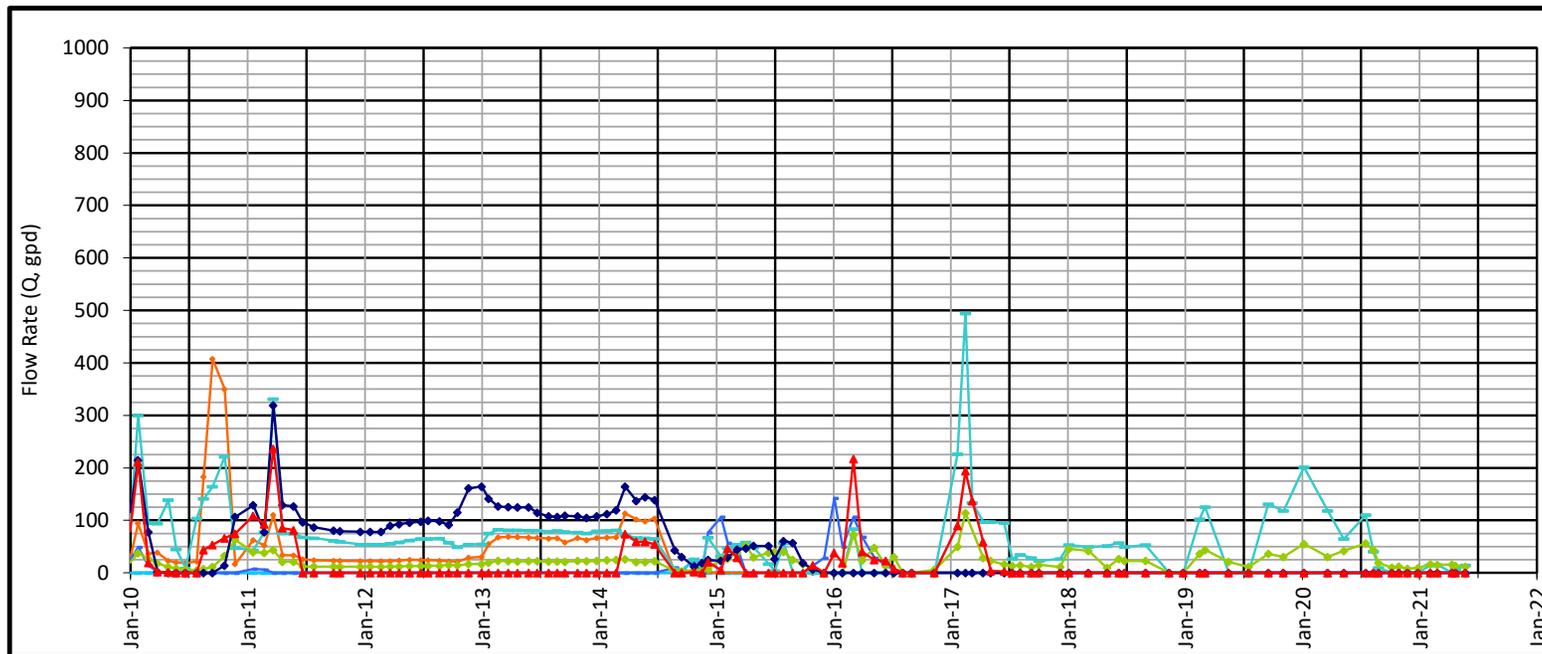
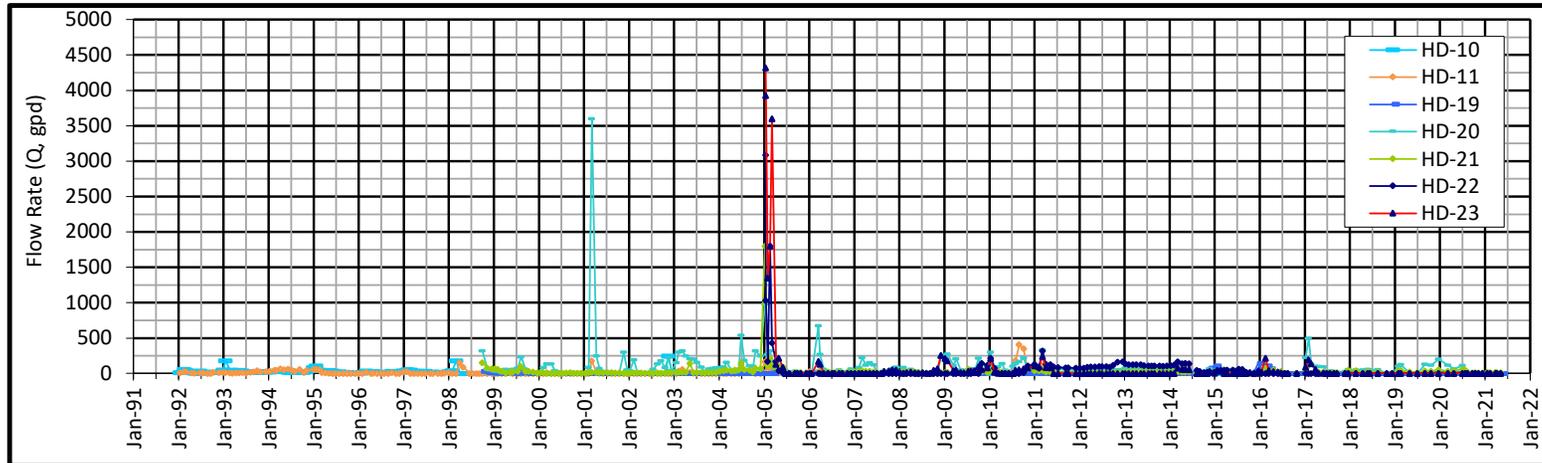
Malibu, California



DEWATERING WELL DISCHARGE RATE GRAPH
Bayshore Drive
Malibu Road Landslide Assessment District
Malibu, California



HYDRAUGER DISCHARGE RATE GRAPH
Malibu Road (West End)
 Malibu Road Landslide Assessment District
 Malibu, California



HYDRAUGER DISCHARGE RATE GRAPH
Malibu Road (East End)
 Malibu Road Landslide Assessment District
 Malibu, California