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Reading the Landscape: Stream Discharge, Erosional Scarps, and Mass Wasting on the SDSU Campus

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Via Alvarado Stream Survey

Research Question: What is the total discharge moving through Alvarado Creek at the survey cross section, and how does velocity and depth vary laterally across the channel?

Stream discharge surveys are a foundational tool in fluvial geomorphology, providing quantitative data on the volume of water moving through a channel cross section at a given moment. This information directly informs assessments of erosion potential, sediment transport capacity, and flood risk, all of which are amplified in urbanized watersheds where impervious surfaces accelerate runoff delivery to channels. The February 20, 2026, survey of Alvarado Creek (Image 1) applied the mid-section method, a standard USGS field protocol, to characterize discharge distribution across the channel and identify where flow energy is concentrated.

Image 1: J. Bissell and J. Cross conducting stream survey

- Alvarado Creek drains a heavily urbanized catchment on the eastern edge of San Diego, where rooftops, roads, and parking lots replace the infiltration capacity that natural soils would otherwise provide. This land cover transformation compresses the hydrograph, stormwater reaches the channel faster and in greater volume than in a comparable undeveloped watershed, increasing the erosive work the stream performs on its banks and bed. Evidence of this erosive energy was visible both upstream and downstream of the survey cross section (Images 3 and 4), including a scour pool immediately downstream (Image 2). Discharge measurement at a stable cross section provides a snapshot of that energy and serves as a baseline for tracking change over time. The mid-section method divides the channel into discrete panels and calculates discharge for each as the product of velocity, width, and depth, and sums the panels to yield total cross-sectional discharge.

Image 2: Scour pool seen downstream of survey area.

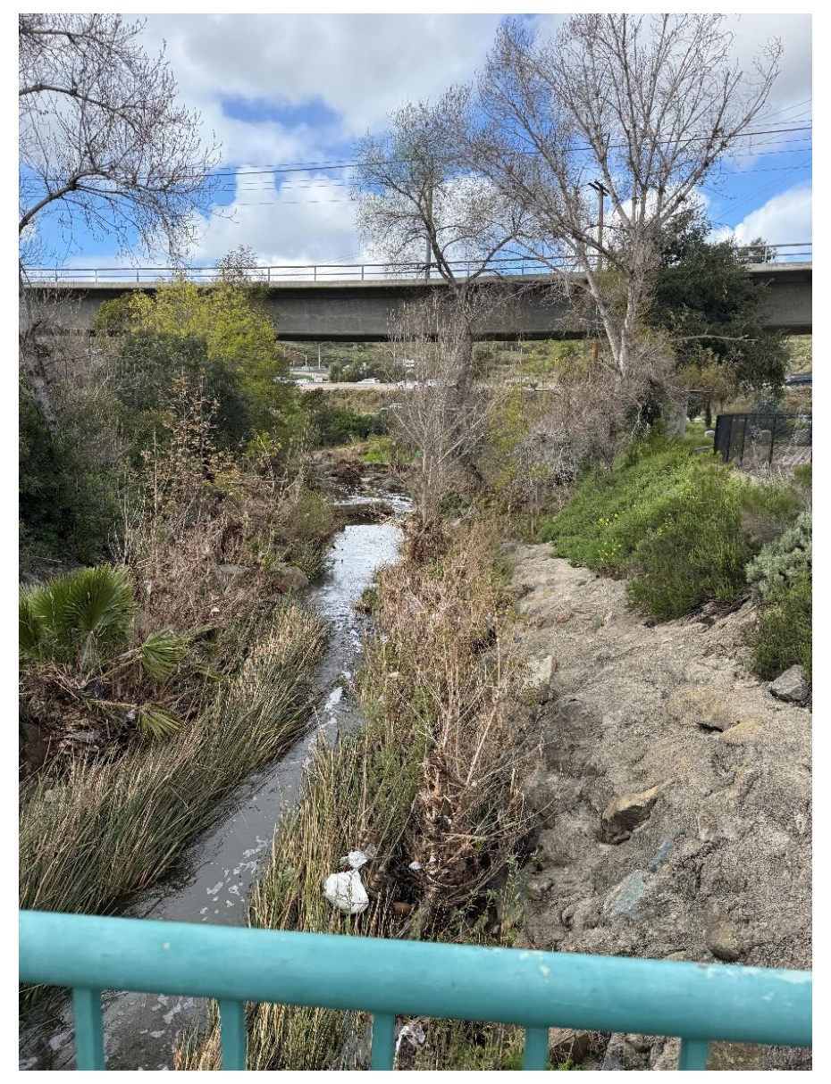

Image 3: Downstream view of stream as seen from footbridge

Image 4: Upstream view of stream as seen from footbridge

METHODS

- We divided the channel into 10 stations using a tape measure stretched across the cross section. At each station, we recorded water depth with a wading rod and measured point velocity at 60% depth using the Hach FH950, the standard single-point approximation of mean column velocity. Panel discharge was calculated as Q = V × W × D and summed across all panels to yield total cross-sectional discharge. Data was processed in Python and visualized as a depth profile and a per-panel discharge bar chart

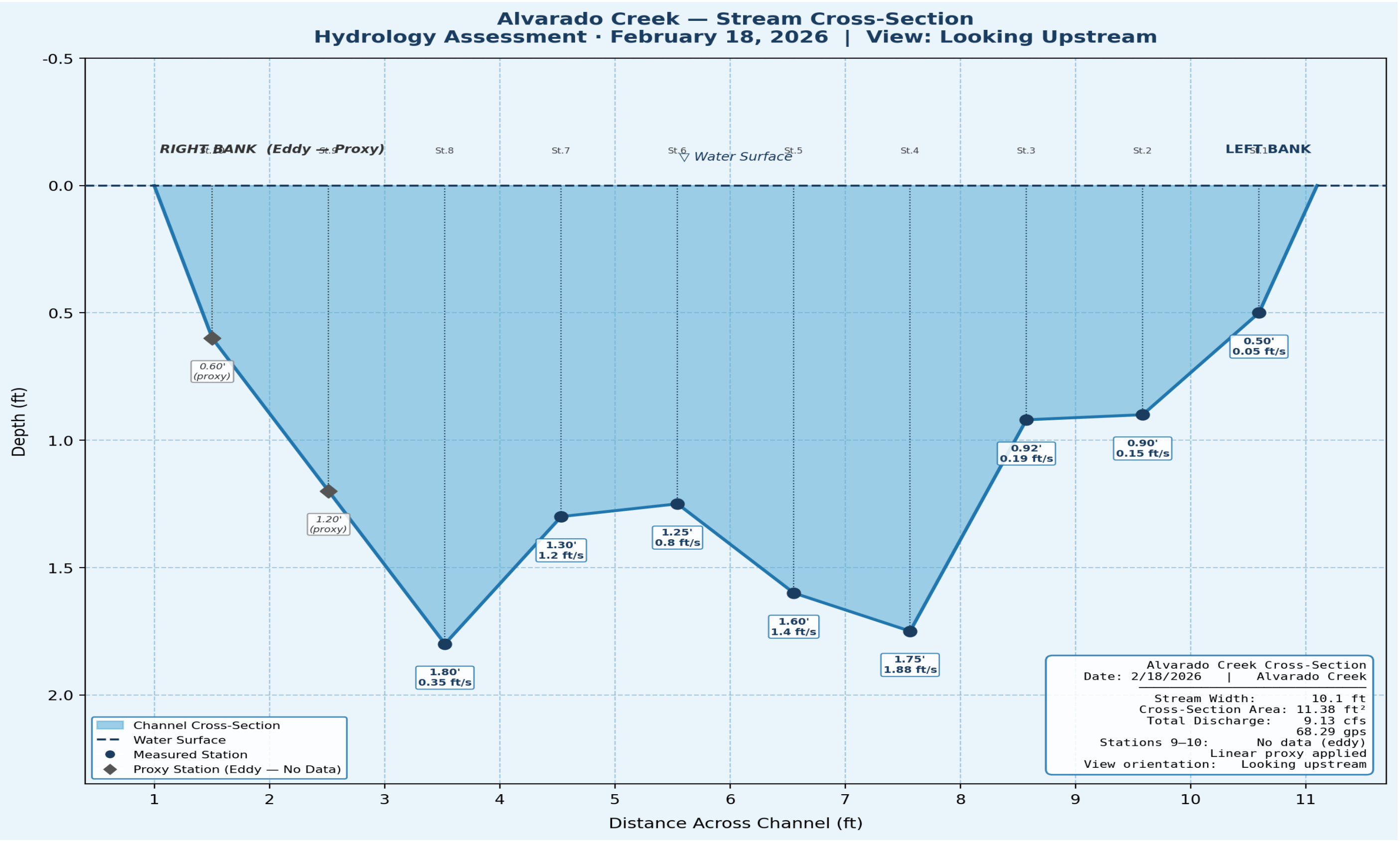

Figure 1: This figure shows the cross-section of the Alvarado creek and its total discharge rate.

SDSU Aquaplex Canyon survey

The April 3, 2026, survey used drone-based structure-from-motion (SfM) photogrammetry to document an active erosional scarp on the hillslope above the SDSU Aquaplex (Image 5). Overlapping aerial imagery was processed in Agisoft Metashape to generate a point cloud, digital elevation model (DEM), and orthophoto of the feature (Figure 2). SfM photogrammetry has become a widely adopted low-cost alternative to traditional ground-based survey for characterizing small-scale geomorphic features at high resolution. Key findings from the survey include:

- The scarp exhibited clear signs of active erosion: exposed soil horizons, tension cracking at the headwall, and a debris lobe accumulating at the toe.
- DEM analysis revealed a scarp face approximately 2–3 meters in height, with slope gradients across the degraded area measurably steeper than the surrounding stable hillslope (Figure 2).
- Erosion is likely accelerated by discharge from a broken drainage pipe originating in the parking lot immediately east of the canyon, which delivers concentrated surface flow directly onto the scarp face; sparse vegetative cover at the headwall further reduces surface cohesion and root reinforcement, leaving the slope largely unprotected against continued incision.

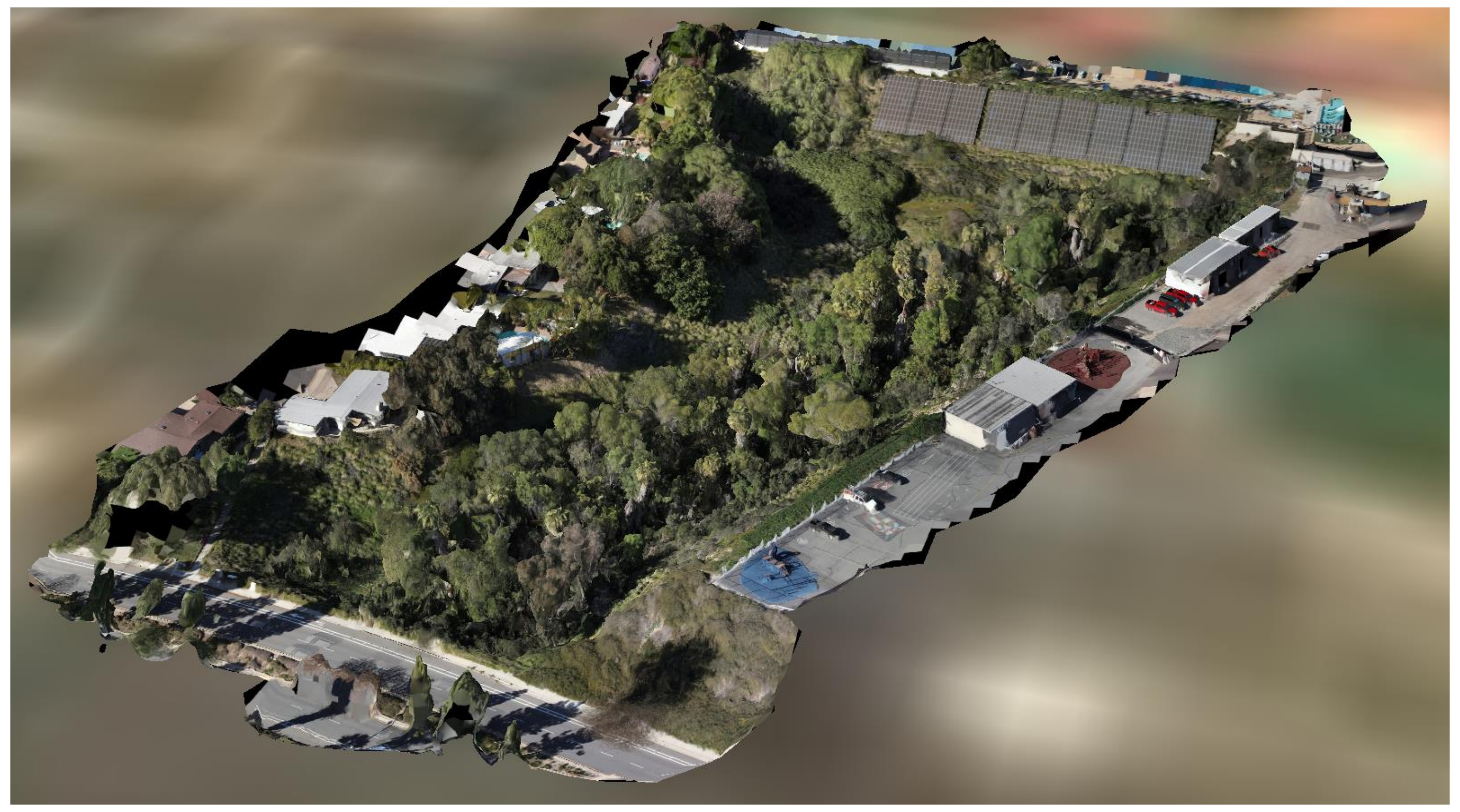

Image 5: SfM Photogrammetry of the canyon behind the Aquaplex. This was used to create the DEM model used to calculate valley erosional volume.

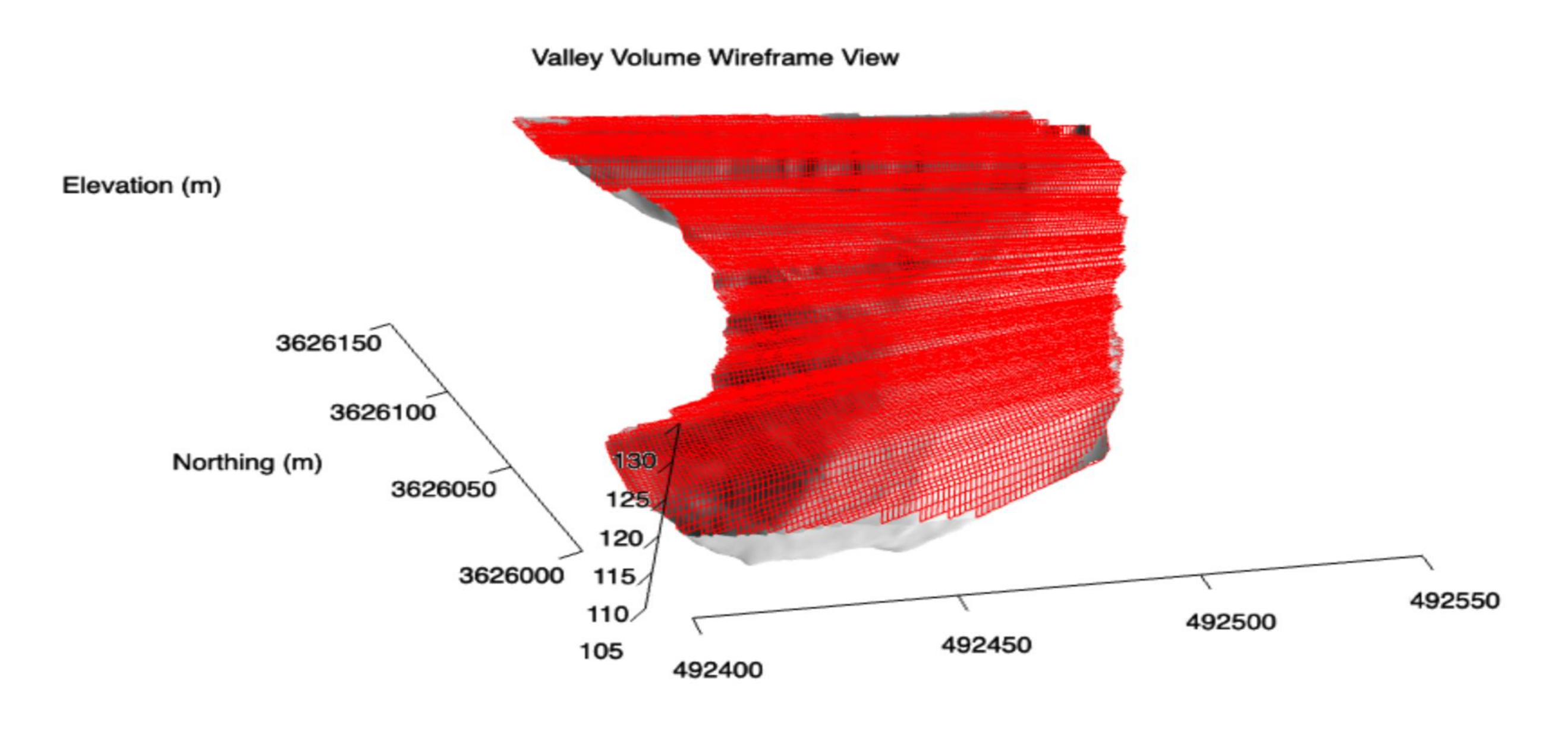

Figure 2: The above figure shows the 3D model created in RStudio to determine erosional volume of canyon.

Takeaways

- Across all three field exercises, a consistent theme emerged: vegetation is doing significant geomorphic work. At Alvarado Creek, riparian cover along the banks moderates erosion during high-flow events. At the Aquaplex scarp, the absence of vegetative cover at the headwall is the most probable accelerant of ongoing retreat. On the northwest campus hillslopes, the difference between loaded and unloaded catch fence sections mapped almost exactly onto the difference between bare and vegetated slope faces. Engineering interventions, catch fences, retaining walls, drainage systems, manage the symptoms of instability effectively in the short term, but the underlying driver in each case is the disruption of natural surface processes by development and human use. Sustainable slope management requires addressing that disruption directly, not just intercepting its products. The Alvarado Creek discharge data grounds the other two observations in a quantitative framework: the same impervious surfaces driving slope saturation on the northwest hillslopes are compressing the hydrograph upstream, concentrating erosive energy at the channel bed and banks where it is most measurable.

SDSU Northwest Campus Hillslope Degradation

Image 6: Construction fence on east side of campus housing, holding back rocks from mass wasting slide event.

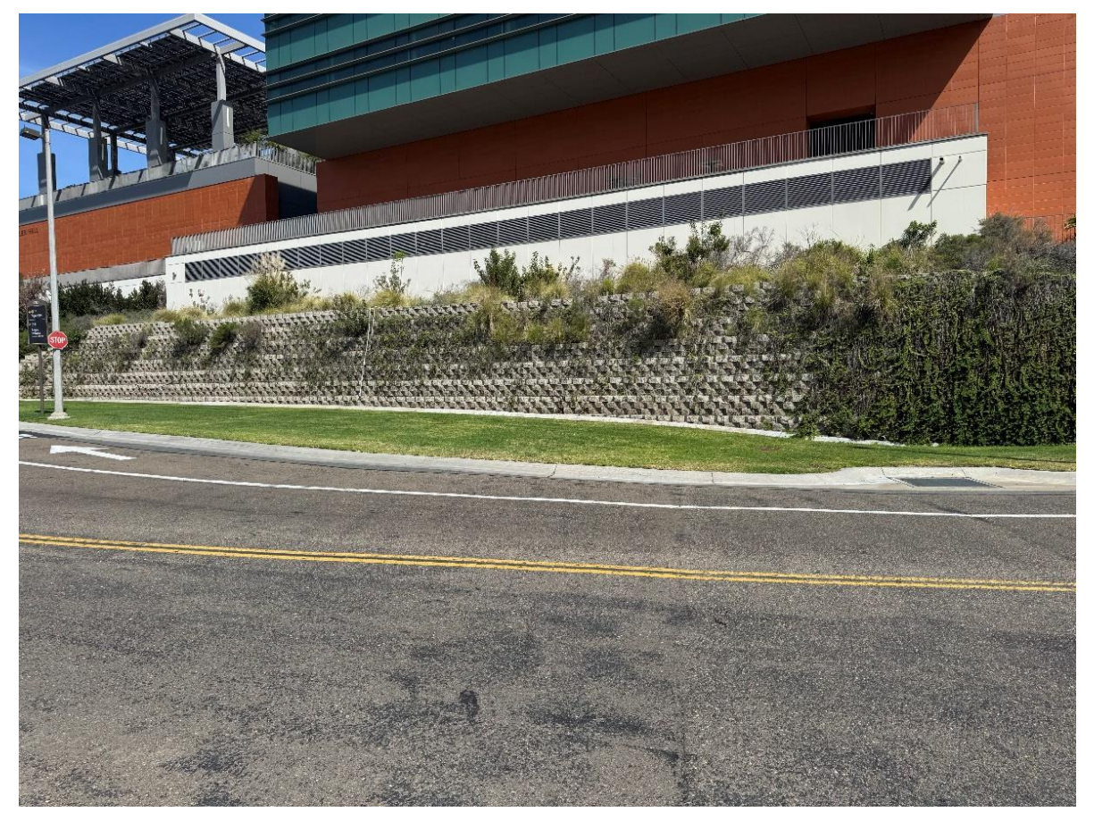

Image 7: Retaining wall below west side of Storm Hall.

Image 8: Professor J. Bissell pointing out that loss of vegetation will accelerate erosional events.

Research Question: What mass wasting processes are actively operating on the SDSU northwest campus slopes, and how effective are the engineered mitigation strategies in place to manage them?

- Field exercise conducted March 16, 2026, along the northern campus edge adjacent to the Mission Valley freeway corridor, descending from Storm Hall toward the parking lot overlook, providing direct access to a range of active slope conditions.
- The campus sits on steep slopes underlain by weathered metasedimentary and granitic materials that are highly susceptible to disaggregation and failure, particularly under saturated or seasonally wet conditions.
- Urban development has both increased slope instability through grading, vegetation removal, and impervious surface runoff, and necessitated active mitigation through engineered construction fences (Image 6), retaining walls (Image 7), and subsurface drainage systems designed to intercept and redirect slope flow.
- Observations documented rockfall, soil creep, shallow translational sliding, rill and gully incision, and colluvial debris accumulation distributed across multiple slope positions and aspect orientations throughout the study area.
- Eight to nine discrete mass wasting scars were identified on the parking lot hillslope alone (Images 8 and 9), indicating repeated and ongoing failure events at this location; slopes in this area approached 65° in places, well exceeding the typical angle of repose for unconsolidated granular material.

By The Numbers

9 Scarps Mass wasting scars, parking lot hillslope Documented on a single slope face, indicating repeated failure events at this site. Processes include rockfall, soil creep, shallow translational sliding, rill and gully incision, and colluvial debris accumulation.	**~65° Slope** Angle of repose exceeded Steepest slopes north of Parking Structure 14 approach 65°, well above the stable threshold for unconsolidated granitic and metasedimentary material. Grading and vegetation removal compound natural susceptibility.
3 Interventions Engineered mitigation strategies Catch fences (loaded vs. unloaded sections tracked), retaining walls (west face of Storm Hall), and active drainage systems — each managing symptoms of instability driven by urbanization and human use.	**2 Root Causes** Primary instability drivers Impervious surface runoff accelerating slope saturation, and loss of vegetative cover reducing root reinforcement and surface cohesion. Engineering controls address outputs; vegetation loss is the underlying mechanism.

Image 9: ~65˚ angle of repose on hillside north of parking structure 14.

Citations

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